



CITY OF ROHNERT PARK

BID DOCUMENT
SPECIFICATIONS

LIBRARY BUILDING SYSTEMS
REPLACEMENT PROJECT
CIP 2411

December 22, 2025

STRATA ^{AP}

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SECTION 00002

PROJECT DIRECTORY

Project: LIBRARY BUILDING SYSTEMS REPLACEMENT PROJECT

Location: 6250 Lynne Conde Way, Rohnert Park, California 94928

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The specification sections in this project manual may either be in the form of written specifications or product literature. Whether the section contains product literature or written specifications, it is assumed that the work of that section shall be performed in accordance with industry standards and applicable codes. Regardless of how the specification sections are provided they are part of the Contract Documents and as such are complementary, and what is required by one shall be as binding as if required by all.

DIVISION 01

GENERAL REQUIREMENTS

SECTION 01 11 00
WORK SUMMARY

PART 1 - GENERAL

1.01 DESCRIPTION

- A. The Bid Documents for this project include the following:
1. Site Drawings and Photographs, and
 2. Project Manual.

1.02 SCOPE OF WORK

- A. The Contractor and his Subcontractors shall furnish all labor, materials, equipment, transportation, supervision, permits, and incidents required to safely and legally perform the work for the City of Rohnert Park, Library Building Systems Replacement Project including, but not limited to:

1. Demolition of roof mounted and interior HVAC unit.
2. Installation of new HVAC unit on the roof and throughout the building.
3. Demolition of exhaust fans on roof.
4. Installation of new exhaust fans and exterior duct work on roof and weatherproof. Ducting shall be painted Owners color of choice.
5. Demolition of lighting, lighting controls, and all associated equipment and accessories.
6. Installation of a new interior and exterior lighting, lighting controls, and associated equipment and accessories.
7. Demolition of VAV coil kits throughout the building.
8. Installation of VAV coil kits throughout the building.
9. Demolition of Fire detection and alarm system.
10. Installation of Fire detection and alarm system.

- B. It is the intent of the Bid Documents to include everything necessary and required for proper completion of the work. All work is to be performed as required to carry out the intent whether each individual item is specifically stated.

- C. All work shall be performed in accordance with Bid Documents, industry standards, state and local requirements, federal requirements, and fire official requirements.

1.03 CONTRACTOR RESPONSIBILITIES

- A. Contractor shall carefully compare and study the project, specifications, drawings, and all other applicable Bid Documents. No "extras" shall be allowed for any errors, discrepancies, or omissions that contractor failed to report to the Owner prior to award of the contract.

- B. Contractors shall tour the project sufficiently, prior to the bid, to adequately bid the project, taking into consideration project delays and slower production due to compliance with all applicable code required inspections.

- C. Failure to examine the project building and the site and to become familiar with the existing conditions shall not constitute cause for a complaint or claim for extra payment. Accept project site as it exists.

- D. Contractor shall notify the Owner of any condition not in conformance with the project requirements.

END OF SECTION

SECTION 01 31 13
COORDINATION

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: Provision of coordination of the Work of the Contract.
- B. Related Sections: The completion of the work described in this Section may require work in or coordination with other Sections of these specifications. The Contractor and the subcontractor shall be responsible for identifying and including all related work in other Sections of these specifications and/or drawings necessary for a complete installation of the work described in this Section. These related Sections include but are not limited to the following:
- C. Drawings and general provisions of the Contract, including Contract Documents, Special Provisions and Standard Specifications apply to this Section.

1.02 GENERAL COORDINATION

- A. Contractor shall be responsible for all project coordination.
- B. Coordinate schedules, submittals, and work of the various trades to ensure efficient and orderly sequence of installation of construction, with provisions for accommodating items to be installed later. Coordinate the work among the Specifications and Drawings. Work shown on any drawing or specification is required by the Contract irrespective of the trade subdivision. Contractor shall require each trade subcontractor to review all other subdivisions of the documents for related work and shall coordinate the subcontracts accordingly.
- C. Require all parties involved in the performance of the Work to cooperate in the overall coordination of the work under the direction of the Contractor. Each party, when requested to do so, shall furnish information concerning its portion of the work, and shall respond promptly and reasonably to the decisions and requests of persons designated with coordination, supervisory, administrative, or similar authority.
- D. The Drawings use graphic symbols to show certain physical relationships of the various elements and systems and their interfacing with other elements and systems. Establishing and coordinating the actual physical relationships is the responsibility of the Contractor. Layout and arrange all elements to contribute to safety and efficiency while maintaining the intent of the design. Before work proceeds in areas of potential conflict for installing different components of the work, Contractor shall prepare supplementary drawings for review by the Owner and resolve the conflict.
- E. Coordinate completion and cleanup Work of various trades in preparation for the Completion.

1.03 SUBCONTRACT COORDINATION

- A. Coordinate the Work and do not delegate responsibility for coordination to any Subcontractor.
- B. Anticipate the interrelationship of all Subcontractors and their relationship with the Work.
- C. Resolve differences or disputes between Subcontractors concerning coordination, interference, or extent of work between sections of the specifications. Contractor's decisions, if consistent with the Contract Document requirements, shall be final.
 - 1. If the Architect is required to resolve disputes between the Contractor and his Subcontractors, all associated costs will be billed directly to the Contractor as Additional Services by the Architect.
- D. Coordinate the work of Subcontractors so that their portions of the work are performed in a manner that minimizes interference with the progress of the Work.

1.04 ADMINISTRATION

- A. General: The Contractor shall prepare a written memorandum on required coordination activities. Include such items as required notices, reports and attendance at meetings. Distribute this memorandum to each trade performing work at the project site and the City Project Manager. Prepare similar memorandum for separate contractors where interfacing of their work is required.
- B. Coordination Meetings: Conduct general project coordination meetings with Subcontractors at least weekly at regularly scheduled times convenient for all parties involved. The coordination meetings shall be held far enough in advance of a particular Subcontractors work so as to avoid conflict with the work of other trades. Request representation at each meeting by every party currently involved in coordination or planning for the work of the entire project. Keep the Owner informed about coordination meetings. Conduct meetings in a manner which will resolve coordination problems. Record results and minutes of each meeting and distribute copies to everyone in attendance and to the Owner. Owner may attend weekly jobsite meetings with subcontractors.
- C. Superintendent: Provide a full-time Superintendent experienced in administration and supervision of building construction. This Superintendent shall be authorized to act as general coordinator of interfaces between units of work. This Superintendent shall be on site, during the construction period as needed to coordinate and supervise the work. Construction coordination shall be his/her principal duty.
 - 1. For the purpose of this provision, "Interface" is defined to include scheduling and sequencing of work, sharing of access to workspaces, installations, protection of each other's work, cutting and patching, tolerances, cleaning, selections for compatibility, preparation of coordination drawings, inspections, tests, and temporary facilities and services.

1.05 COORDINATION WITH WORK PERFORMED BY OWNER UNDER SEPARATE CONTRACTS

- A. Contractor is responsible for coordinate with the work of other contractors, including scheduling and work necessary for other contractors to perform their work including but not limited to block outs, bracing, blocking, reinforcement, and electrical and mechanical connects.
- B. Use Coordination Drawings of structural, mechanical, and electrical Work, together with shop drawings and layout drawings of affected Work to check, coordinate and integrate the Work to prevent interferences.
- C. Contractor shall coordinate shop drawings to include any and all penetrations of framing members and finish material resulting from the coordination of and with the work of the Owner's mechanical and electrical subcontractors.
- D. Do not install any finishes that may impact the work of Owner's Contractor's without prior review and approval of Architect.

1.06 COORDINATION WITH PUBLIC UTILITY AND SAFETY PROVIDERS

- A. These providers include but are not limited to: The local Fire Department, electrical, gas, internet and telephone providers, and the City of Rohnert Park.
- B. Contractor is responsible for coordination with all utility service that may be affected by the project.
- C. Public utility hookup fees shall be paid by the Owner.

1.07 COORDINATION WITH CITY STAFF AND PUBLIC

- A. Contractor to coordinate activities so as to not disrupt the functioning of the building and the use by city staff and the public. Contractor is to ensure the safety of the city staff and the public for the duration of the project.
 - 1. This includes the removal of HVAC components replacements such as the VAV's and coil kits. Contractor to deliver an HVAC Removal and Replacement sequencing plan detailing the timeline of removal occurring in a timely manner with minimal shut off days.
 - 2. Removal and replacement of lighting and lighting controls will similarly require a phased or zoned plan indicating stages or zones during construction. Contractor to coordinate the timeline of these phases to allow employees or workers to coordinate and schedule work disruptions at the site. Contractor is responsible for clear advance notice detailing these phases.

END OF SECTION

SECTION 01 31 21
PROJECT MEETINGS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Work Included: To enable orderly review during progress of the Work, and to provide for systematic discussion of problems, the Architect will conduct project meetings throughout the construction period.
- B. Related Work Described Elsewhere: The Contractor's relations with his subcontractors and materials suppliers, and discussions relative thereto, are the Contractor's responsibility and are not part of project meetings contents.

1.02 QUALITY ASSURANCE

- A. Persons designated by the Contractor to attend and participate in the project meetings shall have all required authority to commit the Contractor to solutions agreed upon in the project meetings.

1.03 SUBMITTALS

- A. Agenda Items: To the maximum extent practicable, advise the Architect at least 24 hours in advance of project meetings regarding all items to be added to the agenda.
- B. Minutes: The Contractor will compile minutes of each project meeting and will furnish copies to the Owner and Architect. The Contractor may make and distribute such other copies as he wishes.

PART 2 - PRODUCTS
NOT USED

PART 3 - EXECUTION

3.01 MEETING SCHEDULE

- A. Except as noted below for Preconstruction Meeting, project meetings will be held weekly. Coordinate as necessary to establish mutually acceptable schedule for meetings.

3.02 MEETING LOCATION

- A. To the maximum extent practicable, meetings will be held at the job site.

3.03 PRE-CONSTRUCTION MEETING

- A. Preconstruction Meeting will be scheduled within ten days after the Owner has issued Notice to Proceed. Provide attendance by authorized representatives of the Contractor and all major subcontractors. The Architect will advise other interested parties and request their attendance.
- B. Minimum Agenda: Distribute data on and discuss:
 - 1. Organizational arrangement of Contractor's forces and personnel and those of subcontractors, materials suppliers and Architect.
 - 2. Channels and procedures for communications.
 - 3. Construction Schedule, including sequence of critical work.
 - 4. Contract Documents, including distribution of required copies of original Documents and revisions.
 - 5. Processing of Shop Drawings and other data submitted to the Architect for review.
 - 6. Processing of field decisions and Change Orders.
 - 7. Rules and regulations governing performance of the work.

8. Procedures for safety and first aid, security, quality control, housekeeping, and other related matters.
9. Proposed Staging Area to be indicated on site plan showing minimal impact to parking.

3.04 PROJECT MEETINGS

A. Attendance: To the maximum extent practicable, assign the same person to represent the Contractor at project meetings throughout progress of the work. Subcontractors, materials suppliers, and others may be invited to attend those project meetings in which their aspects of the Work are involved.

B. Minimum Agenda:

Review, revise as necessary and approve minutes of previous meeting.

Contractor shall provide:

Current Weekly Report
Three-Week Look Ahead Schedule

Review progress of the Work since last meeting, including status of submittals for approval.

Identify problems which impede planned progress.

Develop corrective measures and procedures to regain planned schedule.

Complete other current business.

END OF SECTION

SECTION 01 32 16
PROJECT SCHEDULE

PART 1- GENERAL

1.01 DESCRIPTION

- A. Work Included: To assure adequate planning and execution of the work so that the work is completed within the number of calendar days allowed in the Contract, and to assist the Owner and Architect in appraising the reasonableness of the proposed schedule and in evaluating progress of the work, prepare and maintain the schedules as described in this Section.
- B. Definition: "Day" used throughout the Contract, unless otherwise stated, means "calendar day".

1.02 QUALITY ASSURANCE

- A. Reference Standards: Perform all data preparation, analysis, charting, and updating in accordance with all recommendations contained in the current edition of "CPM In Construction" manual of Associated General Contractors, or in accordance with other standards approved by the Owner and Architect.
- B. Reliance upon approved schedule:
 - 1. The Project schedule as approved by the Owner and Architect will be an integral part of the Contract, and will establish interim contract completion dates for the various activities.

1.03 SUBMITTALS

- A. General: Comply with the provisions of all specification sections.
- B. All measurements shall be in U.S. customary units.
- C. Preliminary Analysis: Within ten days after receipt of Notice to Proceed, submit one reproducible copy and four prints of a preliminary Project Schedule, plus four prints of proposed forms for Materials Status Reports, prepared in accordance with Part Three of this Section.
- D. Periodic Reports:
 - 1. On the first working day of each month following submittals described above, submit four prints of the Project Schedule updated as described in Part Three of this Section.
 - 2. Accompanying each periodic submittal of Project Schedule submit four prints of the Materials Status Reports updated as described in Part Three of this Section.

PART 2 - PRODUCTS

2.01 PROJECT ANALYSIS

- A. Diagram:
 - 1. Graphically show the order and interdependence of all activities necessary to complete the Work, and the sequence in which each activity is to be accomplished, as planned by the Contractor and his project field superintendent in coordination with all Subcontractors whose work is shown on the diagram. Activities shown on the diagram shall include, but are not necessarily limited to:
 - a. Project mobilization;
 - b. Submittals and approvals of Shop Drawings and Samples;
 - c. Procurement of equipment and critical materials;
 - d. Fabrication of special material and equipment, and their installation and testing;

- e. Final clean up;
 - f. Final inspection and testing;
 - g. All activities by the Owner and Architect that affect progress, required dates for completion, or both, for all and for each part of the Work.
2. The detail of information shall be such that duration times of activities shall normally range from one to 15 days. The selection and number of activities shall be subject to the Owner's and Architect's approvals.
 3. Show on the diagram, as a minimum for each activity, preceding and following event numbers, description of each activity, cost, and activity duration in calendar days. Submit diagram on a sheet 30" high by the width required.

B. Mathematical Analysis:

1. Furnish a mathematical analysis of the diagram by manual or computer aided means, including a tabulation of each activity. Show the following information as a minimum for each activity:
 - a. Preceding and following event number;
 - b. Activity description;
 - c. Estimated duration of activities;
 - d. Earliest start date (by calendar date);
 - e. Latest start date (by calendar date);
 - f. Earliest finish date (by calendar date);
 - g. Latest finish date (by calendar date);
 - h. Slack or float (in calendar days);
 - i. Monetary value of the activity;
 - j. Percentage of activity completed;
 - k. Contractor's earnings based on portion of activity completed.
2. The means used in making the mathematical analysis shall be capable of compiling the total value of completed and partially completed activities, and be capable of accepting modifications approved for time and logic adjustment.

C. Periodic Reports:

1. If computer-aided means are used, list the activities in computer printout sorts as follows:
 - a. By the preceding event number from lowest to highest, and then in order of the following event number;
 - b. By the amount of float, then in order of preceding event numbers, and then in order of succeeding event numbers;
 - c. In order of preceding event numbers, and then in order of succeeding event numbers (show the dollar amount and dollars spent to date for each activity);
 - d. Other sorts requested by the Architect, for which the Contractor will be reimbursed in accordance with the General Conditions provisions for "Changes".
2. If computer-aids are not used, provide equivalent information to the approval of the Owner and Architect.

2.02 MATERIALS STATUS REPORTS

- A. Format: The Contractor's standard materials status report form will be acceptable if, in the Owner's and Architect's judgments, it provides sufficient pertinent data to determine that materials procurement flow is adequate for all needs of the Work.
- B. Content: Show at limit the following information:
 1. Item description, listed in accordance with Specifications Section number in which the item is called for;
 2. Purchase Order number and date of issue;
 3. Vendor name;

4. Date shipped, and shipping means utilized;
 5. Estimated date of arrival at job site;
 6. Actual date of arrival at job site, and receiving report number.
- C. Data Processing: Process the data by manual or computer-aided methods, but to a degree of promptness and accuracy assuring complete display of all pertinent current information at date of each periodic report.

PART 3 - EXECUTION

3.01 PRELIMINARY ANALYSIS

- A. Contents:
1. Show all activities of the Contractor under this Work for the period between receipt of Notice to Proceed and submittal of Project Schedule required under Article 1.03 above.
 2. Show the Contractor's general approach to remainder of the Work.
 3. Show cost of all activities scheduled for performance before submittal and approval of the Project Schedule.
- B. Submittal: Submittal shall be in accordance with Article 1.03 above.

3.02 PROJECT SCHEDULE

- A. As soon as practicable after receipt of Notice to Proceed, complete the Project analysis described in Articles 2.01 above, in preliminary form. Meet with the Owner and Architect, review contents of proposed Project Schedule, and make all revisions agreed upon. Submit in accordance with Article 1.03 above.

3.03 MATERIALS STATUS REPORT

- A. As soon as practicable after receipt of Notice to Proceed, meet with the Owner and Architect, review contents of proposed Materials Status Reports, and make all revisions to format agreed upon.

3.04 PERIODIC REPORTS

- A. Project Schedule:
1. Contents:
 - a. Report actual progress by updating the mathematical analysis.
 - b. Note on the summary report, or clearly show on a revised issue of affected portions of the detailed diagram, all revisions causing changes in the detailed program.
 - c. Revise the summary report as necessary for clarity.
 - d. Show activities or portions of activities completed during the reporting period, and their actual value.
 - e. State the percentage of Work actually completed as scheduled as of the report date, and the progress along the critical path in terms of days ahead of or behind the allowable dates.
 - f. If the Work is behind schedule, also report progress along other paths with negative slack.
 - g. Include a narrative report which shows, but is not necessarily limited to:
 - h. A description of the problem areas, current and anticipated;
 - i. Delaying factors, and their impact;
 - j. An explanation of corrective actions taken or proposed.
 2. Show the date of latest revision. Submit in accordance with the provisions of Article 1.03 above.

B. Materials Status Report:

1. On the letter of transmittal accompanying periodic reports, on an accompanying summary sheet, or by other means acceptable to the Owner and Architect, clearly indicate those items the deliveries of which are critically overdue or otherwise hazardous to maintenance of the approved schedule.
2. Submit in accordance with the provisions of Article 1.03 above.

3.05 REVISIONS

- A. Make only those revisions to approved Project Schedule and approved Materials Status Reports as are approved in advance by the Owner and Architect.

END OF SECTION

SECTION 01 32 33
APPLICABLE STANDARDS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Included:

1. Throughout the Contract Documents, reference is made to codes and standards which establish qualities and types of workmanship and materials, and which establish methods for testing and reporting on the pertinent characteristics.
2. Where materials or workmanship are required by these Contract Documents to meet or exceed the specifically named code or standard, it is the Contractor's responsibility to provide materials and workmanship which meet or exceed the specifically named code or standard.
3. It is also the Contractor's responsibility, when so required by the Contract Documents or by written request from the Owner and Architect, to deliver to the Owner and Architect all required proof that the materials or workmanship, or both, meet or exceed the requirements of the specifically named code or standard. Such proof shall be in the form requested in writing by the Owner and Architect and generally will be required to be copies of a certified report of tests conducted by a testing agency approved for that purpose by the Owner and Architect.

B. All measurements shall be in imperial units.

C. Related Work Described Elsewhere: Specific naming of codes or standards occurs on the Drawings and in other Sections of these Specifications.

1.02 QUALITY ASSURANCE

Familiarity with Pertinent Codes and Standards: In procuring all items used in this Work, it is the Contractor's responsibility to verify the detailed requirements of the specifically named codes and standards and to verify that the items procured for use in this Work meet or exceed the specified requirements.

Rejection of Non-Complying Items: The Owner and Architect reserves the right to reject items incorporated into the Work which fail to meet the specified minimum requirements. The Owner and Architect further reserves the right, and without prejudice to other recourse the Owner and Architect may take, to accept non-complying items subject to an adjustment in the Contract Amount as approved by the Owner and Architect.

Applicable Standards listed in these Specifications include, but are not necessarily limited to, standards promulgated by the following agencies and organizations:

ASSHTO = American Association of State Highway and Transportation Officials, 341 National Press Building, Washington, D.C. 20004.

ACI = American Concrete Institute, Box 19150, Redford Station, Detroit, Michigan 48129.

AISC = American Institute of Steel Construction, Inc., 1221 Avenue of the Americas, New York, New York 10020.

ANSI = American National Standards Institute (successor to USASI and ASA), 1430 Broadway, New York, New York 10018.

ASTM = American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.

AWS = American Welding Society, Inc., 2501 N.W. 7th Street, Miami, Florida 33125.

AWWA = American Water Works Association, Inc., 6666 West Quincy Avenue, Denver, Colorado 80235.

CRSI = Concrete Reinforcing Steel Institute, 228 North LaSalle Street, Chicago, Illinois 60610.

CS = Commercial Standard of NBS, U.S. Department of Commerce, Government Printing Office, Washington, D.C. 20402.

FGMA = Flat Glass Marketing Association, 3310 Harrison, Topeka, Kansas 66611.

NAAMM = National Association of Architectural Metal Manufacturers, 1033 South Boulevard, Oak Park, Illinois 60302.

NEC = National Electrical Code (see NFPA).

NEMA = National Electrical Manufacturers Association, 155 East 44th Street, New York, New York 10017.

NFPA = National Fire Protection Association, 470 Atlantic Avenue, Boston, Massachusetts 12210.

SDI = Steel Deck Institute, 135 Addison Avenue, Elmhurst, Illinois 60125.

SSPC = Steel Structures Painting Council, 4400 5th Avenue, Pittsburgh, Pennsylvania 15213.

TCA = Tile Council of America, Inc., P.O. Box 326, Princeton, New Jersey 08540.

UL = Underwriters' Laboratories, Inc., 207 East Ohio Street, Chicago, Illinois 60611.

CBSC = 2013 California Building Standard Code.

ICC = International Code Council - 5203 Leesburg Pike, Suite 600; Falls Church, VA 22041-3401.

Fed. Specs. and Fed Standards: Specifications Sales (3FRI), Bldg. 197, Washington Navy Yard, General Services Administration, Washington, D.C. 20407.

END OF SECTION

SECTION 01 33 24
SUBMITTALS AND SUBSTITUTIONS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Work included:
 - 1. Make submittals required by the Contract Documents, and revise and resubmit as necessary to establish compliance with the specified requirements.

- B. Related work:
 - 1. Documents affecting work of this Section include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Sections in Division 1 of these Specifications.
 - 2. Individual requirements for submittals also may be described in pertinent Sections of these Specifications.
 - 3. See General Conditions for submittal of schedules, cost breakdown, subcontractors' list, etc.

- C. Work not included:
 - 1. Unrequired submittals will not be reviewed by the Architect.
 - 2. The Contractor may require his subcontractors to provide drawings, setting diagrams, and similar information to help coordinate the Work, but such data shall remain between the Contractor and his subcontractors and will not be reviewed by the Architect.

1.2 QUALITY ASSURANCE

- A. Coordination of submittals:
 - 1. Prior to each submittal, carefully review and coordinate all aspects of each item being submitted.
 - 2. Verify that each item and the submittal for it conform in all respects with the specified requirements.
 - 3. Shop drawings shall be submitted by the Contractor. Shop drawings shall be stamped and signed by the Contractor showing that they have been reviewed and approved by him/her before being sent to the Architect.
 - a. Details shall be identified by reference number to sheet and detail, schedule or room numbers on the Contract Drawings.
 - b. Submittals that have not been reviewed by the Contractor and do not bear a stamp of review by the Contractor will be returned and will not be reviewed by the Architect.
 - 4. All Shop Drawings and material submittals shall be numbered in sequence of submittal. Resubmittals shall receive a new number.
 - 5. Fabrication of work shall not be started or any parts shipped or transported to the job site prior to the review of shop drawings by the Architect, and compliance with the Contract Documents has been verified.
 - 6. The Contractor shall assume full responsibility for coordinating and verifying schedules, quantities and dimensions shown on Shop Drawings. The Architect assumes no responsibility for checking schedules, quantities or dimensions.

- B. Substitutions:
 - 1. The Contract is based on the standards of quality established in the Contract Documents. Substitutions will be considered only when substantiated by the Contractor's submittal of required data within 5 calendar days after the Notice to Proceed. Only one substitution request will be considered for each specified item. Unless noted otherwise in a specific Section of the Specifications after 5 calendar days after the Notice to Proceed it will be assumed all items are to be as specified in these documents and substitutions may not be accepted by the Architect. It shall be the Contractor's responsibility to notify the Architect in writing, of any deviations in the submittals from the requirements of the Contract Documents.

 - 3. The following products do not require further approval except for interface within the Work:

- a. Products specified by reference to standard specifications such as ASTM and similar standards.
 - b. Products specified by manufacturer's name and catalog model number.
 - c. The Contractor, however, shall submit to the Architect a letter stating that the products submitted will be as stated in a. and b. above.
 - 4. Do not substitute materials, equipment, or methods unless such substitution has been specifically approved in writing for this Work by the Architect.
- C. Time for review of substitutions:
- 1. In the interest of time, substitutions are not encouraged unless absolutely unavoidable. When submitting an item for substitution for a specified item, use the Submittal Request form on page 01 33 24-5, submit all pertinent data required to enable the Architect to make an accurate and timely evaluation. Incomplete submittals or insufficient data will be cause for the submittal to be rejected.
 - 2. Requests for extension of the time directly or indirectly related to approval of substituted items will not be granted.
 - 3. Additional review time by the Architect caused by a substitution shall in no way be charged as a delay to the Project.
 - 4. It shall be the sole responsibility of the Contractor to avoid delays through the process of substitution.
- D. "Or equal":
- 1. Where the phrase "or equal," or "as approved equal," occurs in the Contract Documents, do not assume that the materials, equipment, or methods will be considered as equal unless the item has been specifically so reviewed by the Architect and deemed in conformance with design intent and quality established for this Work.
 - 2. The decision of the Architect shall be final.
 - 3. If submittals on "or equal" items are not made within the prescribed time or are incomplete, then the item or material originally specified shall be supplied.

1.3 SUBMITTALS

- A. Make submittals of Shop Drawings, Samples, substitution requests, and other items in accordance with the provisions of this Section.
- B. Submittals shall include all technical and performance data on the product or material required for the Architect to make a fair evaluation, including physical samples if deemed necessary by the Architect.
- C. Incomplete submittals will be returned to the Contractor and will not be reviewed by the Architect. The Contractor shall be solely responsible for any delays caused by making incomplete submittals
- D. For purposes of uniformity, only one make and/or brand of material will be accepted for each type of material used. All electrical material shall be listed by Underwriters Laboratories, Inc., and shall meet their requirements and bear their label.

PART 2 - PRODUCTS

2.1 SHOP DRAWINGS

- A. Scale and measurements: Make Shop Drawings accurately to a scale sufficiently large to show all pertinent aspects of the item and its method of connection to the Work.
- B. Types of prints required:
 - 1. Submit Shop Drawings in the form of an electronic PDF file or hard copy.
- C. Review comments of the Architect will be shown on the transparency when it is returned to the Contractor. The Contractor may make and distribute such copies as are required for his purposes.

- D. Review of Shop Drawings and submittals is only for general conformance with the design concept, colors, texture of material and general compliance with the Contract Documents. Any action indicated or shown is subject to the requirements of the Contract Drawings and Specifications. Review of Shop Drawings is not intended to modify or change in any way the Contract Documents (any deviations shall be separately stated in writing). The Contractor shall be solely responsible for fabrication processes and methods, field dimensions and quantities.

2.2 MANUFACTURERS' LITERATURE

- A. Where contents of submitted literature from manufacturers includes data not pertinent to the submittal, clearly show which portions of the contents is being submitted for review.
- B. Submit the number of paper copies which are required to be returned, plus three copies which will be retained by the Architect or submit one electronic copy in PDF format to the Owner and Architect.

2.3 SAMPLES

- A. Provide Sample or Samples identical to the precise article proposed to be provided. Identify as described under "Identification of submittals" below.
- B. Number of Samples required:
 - 1. Unless otherwise specified, submit Samples in the quantity, which is required to be returned, plus one which will be retained by the Architect.

2.4 COLORS AND PATTERNS

- A. Unless the precise color and pattern is specifically called out in the Contract Documents, and whenever a choice of color or pattern is available in the specified products, submit accurate color and pattern charts to the Architect for selection.
- B. Within 10 days from the Notice to Proceed, General Contractor shall submit to the Architect a list of manufacturers of all products or materials requiring color selections, which will be used on the job. Samples of the manufacturer's complete color range shall also be submitted at this time. Color selections will not be made by the Architect until color samples for all items to be selected have been submitted. The Architect will not make partial color selections.
- C. Failure of the Contractor to submit all color charts for all products or materials requiring color selections within 10 days, thus requiring additional time for the Architect to make selections, shall not be grounds for a delay claim.
- D. Allow 10 working days after the receipt of all color lists of all products or materials requiring color selections for the Architect to make color selections.
- E. All concrete colors including the natural concrete color shall have 3'x3' samples poured in place on site. Review and approval by Architect is required for all concrete colors and finish prior to final placement.

PART 3 - EXECUTION

3.1 IDENTIFICATION OF SUBMITTALS

- A. Each submittal shall be numbered or named consecutively by the Contractor and all documentation shall refer to that number.
 - 1. When material is resubmitted for any reason, transmit under a new letter of transmittal and with a new transmittal number.
 - 2. On resubmittals, cite the original submittal number for reference.

- B. Accompany each submittal with a letter of transmittal or e-mail showing all information required for identification and checking.
- C. On at least the first page of each submittal, and elsewhere as required for positive identification, show the submittal number in which the item was included.
- D. Maintain an accurate submittal log for the duration of the Work, showing current status of all submittals at all times. Make the submittal log available to the Architect for his review upon request.

3.2 GROUPING OF SUBMITTALS

- A. Unless otherwise specified, make submittals in groups containing all associated items to assure that information is available for checking each item when it is received.
 - 1. Partial submittals may be rejected as not complying with the provisions of the Contract.
 - 2. The Contractor may be held liable for delays so occasioned.

3.3 TIMING OF SUBMITTALS

- A. Make submittals far enough in advance of scheduled dates for installation to provide time required for reviews, for securing necessary approvals, for possible revisions and resubmittals, and for placing orders and securing delivery. The Contractor will be solely responsible for any delays caused by not making submittals in time for proper review.
- B. In scheduling, allow Sufficient time for review by the Architect following his receipt of the submittal as set forth in the General Conditions.

3.4 ARCHITECT'S REVIEW

- A. Review by the Architect does not relieve the General Contractor from responsibility for errors which may exist in the submitted data nor does review by the Architect relieve the Contractor from responsibility or in any way change the original Contract.
- B. Revisions:
 - 1. Make revisions required by the Architect.
 - 2. If the Contractor considers any required revision to be a change, he shall so notify the Architect as provided for in the Contract Documents.
 - 3. Make only those revisions directed by the Architect.
- C. Reimbursement of Architect's costs:
 - 1. In the event substitutions are proposed to the Architect after the Contract has been awarded, the Architect will record all time used by him and by his consultants in evaluation of each such proposed substitution.
 - 2. Whether or not the Architect approves a proposed substitution, the Contractor promptly upon receipt of the Architect's billing shall reimburse the Architect at his standard billing rates and that of his consultants for all time spent by them in evaluating the proposed substitution.
 - 3. If the Contractor does not reimburse the Architect for all time spent by them in evaluating the proposed substitution, with the authorization of the Owner, the amounts due the Architect will be deducted from the pay request.

END OF SECTION

SUBSTITUTION REQUEST FORM

TO: STRATAap

PROJECT:

We hereby submit for your consideration the following product instead of the specified item for the above project:

<u>Section</u>	<u>Paragraph</u>	<u>Specified Item</u>
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Proposed Substitution:

Attached complete technical data, including laboratory tests, if applicable.

Include complete information on changes to Drawings and/or Specifications, which proposed substitution will require for its proper installation.

Fill in blanks below:

What affect does the substitution have on other trades?

Yes No

Does the substitution affect dimensions shown on the Drawings?
Differences between proposed substitution and specified item?

Manufacturer's guarantees of the proposed and specified items are:
 Same Different (explain on attachment)

The undersigned states that the function, appearance, and quality of the proposed substitution are equivalent or superior to the specified item.

Will the undersigned pay for changes to the building design, including engineering and detailing costs caused by the requested substitution? Yes No

Submitted by:
Contractor
Street Address
City, CA Zip

By: _____

Firm: _____

Phone:

Fax:

Date: _____

For use by Architect/Engineer:

Accepted Accepted as noted Not Accepted Received too late

SECTION 01 60 00
PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.
- B. Related Requirements:
 - 1. Section 01 33 24 "Substitution Procedures" for requests for substitutions.

1.2 DEFINITIONS

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

1.3 ACTION SUBMITTALS

- A. Comparable Product Requests: Submit request for consideration of each comparable product. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 - 1. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within one week of receipt of a comparable product request. Architect will notify Contractor of approval or rejection of proposed comparable product request within [15] days of receipt of request, or [seven] days of receipt of additional information or documentation, whichever is later.
 - a. Form of Approval: As specified in Section 01 33 24 "Submittal Procedures."
 - b. Use product specified if Architect does not issue a decision on use of a comparable product request within time allocated.

1.4 QUALITY ASSURANCE

- A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.
- B. Delivery and Handling:
 - 1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
 - 2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
 - 3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
 - 4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.
- C. Storage:
 - 1. Store products to allow for inspection and measurement of quantity or counting of units.
 - 2. Store materials in a manner that will not endanger Project structure.
 - 3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
 - 4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
 - 5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
 - 6. Protect stored products from damage and liquids from freezing.

1.6 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
 - 1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
 - 2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner.
- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.
 - 1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
 - 2. Specified Form: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.
 - 3. Refer to other Sections for specific content requirements and particular requirements for submitting special warranties.
- C. Submittal Time: Comply with requirements in Section 01 77 00 "Closeout Procedures."

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.
 - 1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
 - 2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.

3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
4. Where products are accompanied by the term "as selected," Architect will make selection.
5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.

B. Product Selection Procedures:

1. Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
2. Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
3. Products:
 - a. Restricted List: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience **may be considered by the Owner**
 - b. Nonrestricted List: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed, or an unnamed product, that complies with requirements. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product.
4. Manufacturers:
 - a. Restricted List: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience may be considered by the Owner.
 - b. Nonrestricted List: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed, or a product by an unnamed manufacturer, that complies with requirements. Comply with requirements in "Comparable Products" Article for consideration of an unnamed manufacturer's product.
5. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.

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

1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Section 012500 "Substitution Procedures" for proposal of product.

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

2.2 COMPARABLE PRODUCTS

A. Conditions for Consideration: Architect will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Architect may return requests without action, except to record noncompliance with these requirements:

1. Evidence that the proposed product does not require revisions to the Contract Documents that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.

2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
3. Evidence that proposed product provides specified warranty.
4. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
5. Samples, if requested.

END OF SECTION

SECTION 01 71 13
MOBILIZATION AND DEMOBILIZATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Mobilization and demobilization requirements.

1.02 DEFINITIONS

- A. Mobilization includes bringing in all necessary equipment to the site to do the work. It also includes all labor materials and equipment to set up temporary offices, structures, facilities, signs and utilities.
- B. Demobilization includes removing all construction equipment and debris, so site is left clean.

1.03 TEMPORARY FACILITIES

- A. Field Office: CONTRACTOR'S OPTION (Not required). If provided, the Contractor's field office must be confined to the designated staging area as determined by City of Rohnert Park's project manager.
- B. Phone: Contractor shall maintain a mobile phone on site at all times with a number available to the Project Manager and Architect.
- C. Utilities: Owner will provide power, water. Contractor shall provide all other temporary utilities required.
- D. Sanitary facilities: Contractor to provide and maintain.
- E. Construction and Support: Set up and maintain in a neat and orderly manner temporary enclosures, identification signs, and waste material disposal.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Temporary Materials: CONTRACTOR'S OPTION.

PART 3 - EXECUTION

3.01 INSTALLATIONS

- A. Relocate and modify temporary facilities as required.
- B. Install temporary utility service or connect to existing service.
- C. Locate field office, storage sheds, sanitary facilities and other temporary construction and support facilities for easy access and within the staging area shown on the plans. Use of gasoline-burning, open flame or salamander type heating units is prohibited.
- D. Conform to local standards and codes for erection of adequate fences and barricades. Maintain all signing, barricades, fencing, drainage, and other items as required to protect public and private property from damage caused by demolition operations.
- E. Coordinate location of storage areas to avoid interference with drainage, traffic, or private property.
- F. Provide and maintain all temporary signage required by the Work.
- G. Provide and install safety barriers as required by the work to protect employees and the public.

3.02 REMOVALS

- A. Completely remove temporary materials and equipment:
 - 1. At completion of work.
- B. Clean and repair damage caused by installation of temporary facilities.
- C. Restore areas to original or to specified conditions at completion of the Work.

END OF SECTION

SECTION 01 73 29
CUTTING AND PATCHING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Work Included: This Section establishes general requirements pertaining to cutting (including excavating), fitting, and patching of the Work required to:
1. Make the several parts fit properly.
 2. Removal of weather damaged material in preparation for replacement.
 3. Uncover Work to provide for installation, inspection or both of ill-timed Work.
 4. Remove and replace Work not conforming to requirements of the Contract Documents.
 5. Remove and replace defective work.
 6. Remove and replace work described in the contract documents.
- B. Related Work Described Elsewhere:
1. In addition to other requirements specified, upon the Owner's request, uncover Work to provide for inspection by the Owner of covered Work, and remove samples of installed materials for testing.
 2. Do not cut or alter work performed under separate contract without the Owner's written permission.

1.02 QUALITY ASSURANCE

- A. Perform all cutting and patching in strict accordance with pertinent requirements of these Specifications and, in the event no such requirements are determined, in conformance with the Owner's written direction.

1.03 SUBMITTALS

- A. Request for the Owner 's Consent:
1. Prior to cutting which affects structural safety, submit written request to the Owner for permission to proceed with cutting.
 2. Should conditions of the Work, or Schedule, indicate a required change of materials or methods for cutting and patching, so notify the Owner and secure his written permission prior to processing.
- B. Notice to the Owner:
1. Prior to cutting and patching performed pursuant to the Owner's instructions, submit cost estimate to the Owner. Secure the Owner's approval of cost estimates and type of cost reimbursement before proceeding with cutting and patching.
 2. Submit written notice to the Owner designating time the Work will be uncovered, to provide for the Owner's observation.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. For replacement of Work removed, use materials which comply with the pertinent Sections of these Specifications.

PART 3 - EXECUTION

3.01 CONDITIONS

- A. Inspection:
1. Inspect existing conditions, including elements subject to movement or damage during cutting, excavating, backfilling, and patching.
 2. After uncovering the Work, inspect conditions affecting installation of new Work.
- B. Discrepancies:

1. If uncovered conditions are not as anticipated, immediately notify the Owner and secure needed directions.
2. Do not proceed in areas of discrepancy until all such discrepancies have been fully resolved.

3.02 PREPARATION PRIOR TO CUTTING

- A. Provide all required protection including, but not necessarily limited to, shoring, bracing, and support to maintain structural integrity of the Work.

3.03 PERFORMANCE

- A. Perform cutting and demolition by methods which will prevent damage to other portions of the Work and will provide proper surfaces to receive installation of repair and new work. Perform fitting and adjustment of products to provide finished installation complying with the specified tolerances and finishes.
- B. The Contractor shall do all cutting, fitting or patching of its work that may be required to make its several parts come together properly and fit it to receive or be received by work of other contractors shown upon, or reasonably implied by, the Drawings and Specifications for the completed structure, and Contractor shall make good after them.
- C. Contractor shall match existing and adjoining materials and details wherever possible. Re-use of existing materials may be allowed only where specifically designated in the Contract Documents or approved by the Architect or Owner.
- D. The Contractor shall not endanger any work by cutting, digging or otherwise and shall not cut or alter the work of any other contractor, without the prior written consent of the Owner.
- E. Contractor shall uncover out-of-sequence, defective and non-conforming work, provide openings for penetrations of existing surfaces and provide samples for testing. Contractor shall seal penetrations through floors, walls and ceilings.

END OF SECTION

SECTION 01 74 13
CLEANING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Work Included: Throughout the construction period, maintain the buildings and site in a standard of cleanliness as described in this Section.
- B. In addition to standards described in this Section, comply with all requirements for cleaning up as described in various other Sections of these Specifications.
- C. Related Sections: The completion of the work described in this Section may require work in or coordination with other Sections of these specifications. The Contractor and the sub-contractor shall be responsible for identifying and including all related work in other Sections of these specifications and/or drawings necessary for a complete installation of the work described in this Section. These related Sections include but are not limited to the following:
 - 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 QUALITY ASSURANCE

- A. Inspection: Conduct daily inspection, and more often, if necessary, to verify that requirements of cleanliness are being met.
- B. Codes and Standards: In addition to the standards described in this Section, comply with all pertinent requirements of governmental agencies having jurisdiction.

PART 2 - PRODUCTS

2.01 CLEANING MATERIALS AND EQUIPMENT

- A. Provide all required personnel, equipment, and materials needed to maintain the specified standard of cleanliness.

2.02 COMPATIBILITY

- A. Use only the cleaning materials and equipment which are compatible with the surface being cleaned, as recommended by the manufacturer of the material or as approved by the architect.

PART 3 - EXECUTION

3.01 PROGRESS CLEANING

- A. General:
 - 1. Retain all stored items in an orderly arrangement allowing maximum access, not impeding drainage or traffic, and providing the required protection of materials.
 - 2. Do not allow the accumulation of scrap, debris, waste material, and other items not required for construction of this Work.
 - 3. At least twice each month, and more often, if necessary, completely remove all scrap, debris, and waste material from the job site.
 - 4. Provide adequate storage for all items awaiting removal from the job site, observing all requirements for fire protection and protection of the ecology.
- B. Site:
 - 1. Daily, and more often, if necessary, inspect the site and pick up all scrap, debris, and waste material. Remove all such items to the place designated for their storage.

2. Weekly, and more often, if necessary, inspect all arrangements of materials stored on the site; restock, tidy, or otherwise service all arrangements to meet the requirements of subparagraphs 3.1.1.
3. Maintain the site in a neat and orderly condition at all times.

C. Structures:

1. Weekly, and more often, if necessary, inspect the structures and pick up all scrap, debris, and waste material. Remove all such items to the place designated for their storage.
2. Weekly, and more often, if necessary, sweep all interior spaces clean. "Clean," for the purpose of this sub-paragraph, shall be interpreted as meaning free from dust and other material capable of being removed by use of reasonable effort and hand-held broom.
3. As required preparatory to installation of succeeding materials, clean the structures or pertinent portions thereof to the degree of cleanliness recommended by the manufacturer of the succeeding material, using all equipment and materials required to achieve the required cleanliness.

3.02 FINAL CLEANING

- A. Definition: Except as otherwise specifically provided, "clean," for the purpose of this Article, shall be interpreted as meaning the level of cleanliness generally provided by skilled cleaning using commercial quality building maintenance equipment and materials.
- B. General: Prior to completion of the Work, remove from the job site all tools, surplus materials, equipment, scrap, debris, and waste. Conduct final progress cleaning as described in Article 3.01 above.
- C. Site: Unless otherwise specifically directed by the architect, broom clean all paved areas on the site and all public paved areas directly adjacent to the site. Completely remove all resultant debris.
- D. Structures:
 1. Exterior: Visually inspect all exterior surfaces and remove all traces of soil, waste material, smudges, and other foreign matter. Remove all traces of splashed materials from adjacent surfaces. If necessary to achieve a uniform degree of exterior cleanliness, hose down the exterior of the structure. In the event of stubborn stains not removable with water, the architect may require light sandblasting or other cleaning at no additional cost to the Owners.
 2. Interior: Visually inspect all interior surfaces and remove all traces of soil, waste material, smudges, and other foreign matter. Remove all traces of splashed materials from adjacent surfaces. Remove all paint dropping, spots, stains, and dirt from finished surfaces. Use only the specified cleaning materials and equipment.
- E. Timing: Schedule final cleaning as approved by the architect to enable the Owners to accept a completely clean project.

END OF SECTION

SECTION 01 77 00
PROJECT CLOSEOUT

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section describes contract closeout procedures including:
1. Project record documents
 2. Product Data
 3. Operation and Maintenance data
 4. Removal of temporary construction facilities
 5. Final completion
 6. Final cleaning
 7. Material, equipment and finish data
 8. Project guarantee
 9. Warranties
 10. Restorative and Remedial Work
 11. Turn-in
 12. Fire Inspection Coordination
 13. Building Inspection Coordination
- B. Related Sections: The completion of the work described in this Section may require work in or coordination with other Sections of these specifications. The Contractor and the sub-contractor shall be responsible for identifying and including all related work in other Sections of these specifications and/or drawings necessary for a complete installation of the work described in this Section. These related Sections include but are not limited to the following:
1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 PROJECT RECORD DOCUMENTS

- A. Maintenance of Documents and Samples:
1. Store Project documents and samples in field office apart from documents used for construction.
 2. Maintain Project documents in a clean, dry, legible condition and in good order.
 3. Do not use Project record documents for construction.
- B. Recording:
1. Record information carefully and neatly, with felt tip pens, in color code designated, and in the manner approved in advance by the Architect.
 - a. Information recording will be continuous throughout construction. Information shall be recorded at the time of event(s) and shall be available at all times for review by the Architect and Owner.
 2. Label each document "Project Record" in large, neat, printed letters.

C. Record Drawings:

1. Record the following kinds of information on black line or blue line prints or in electronic PDF format:
 - a. Changes made by Change Orders and other modifications described in the General Conditions.
 - b. Locations of work buried under or outside the building, such as plumbing and electrical lines and conduits.
 - c. Locations of work concealed inside the building whose general location is changed from that shown on the Contract Documents.
 - d. Locations of items, not necessarily concealed, which have been changed, with the Architect's prior acceptance, from the locations indicated on the Contract Documents.
 - e. Locations of significant items such as main power disconnect, main water and gas shutoffs, motor disconnects, filters, controls, isolating valves and the like shall be highlighted on the record drawings.
 - f. Provide line diagrams of all installed electrical power, lighting, switching, low voltage, security electronics, subpanels, meter mains, termination points, transformers and systems.
 - g. In addition to the previously specified requirements for record drawings: Keep up to date during the entire progress of the work, and make available to the Architect. Furnish additional drawings necessary for clarification. Record deviations from the sizes, locations, and other features of installations shown in the Contract Documents. Establish locations of underground work by dimensions to column lines or walls, locating turns, and by referenced centerline or invert elevations and rates of fall. Give sufficient information to locate work concealed in the Building. Drawing to Scale:
 - Locate main runs of piping, conduit, ductwork, and similar items by dimensions.
 - Locate other items either by dimensions or in relation to spaces within the building.
2. Furnish reproducible record drawings, made from final Shop Drawings, updated to show actual conditions, for specified work.

D. "As-Built" Drawings:

1. At time of acceptance of the work and prior to final payment, using the record drawings for reference, prepare "As-Built" drawings on permanent, transparent, reproducible prints or in electronic PDF format that will be furnished by the Architect and paid for by the Owner.
2. Employ a professional draftsman to prepare the "As-Built" drawings from the record drawings; record information in ink in electronic PDF format.

E. Specifications and Addenda:

1. Mark each Specification Section to record:
 - a. Manufacturer, trade name, catalog number, and supplier of each product and item of equipment incorporated in the work.
 - b. Changes made by Change Order and other modifications described in the General Conditions.

F. Large Scale Layout Drawings:

1. The preparations of large-scale detailed layout drawings are required for the coordination of the work. These layout drawings are not Shop Drawings as defined by the General Conditions, but, together with Shop Drawings or layout drawings of affected Sections, are used to check, coordinate, and integrate the work of the various Sections.
2. Provide layout drawings as part of the Project record documents.

G. Record Construction Schedule: Using the latest Progress Schedule required by Section

01 32 16 as a reference, submit a Record Construction Schedule showing the actual dates and duration of construction activities.

- H. Sign and date the completed Project record documents; deliver to the Architect who will deliver to the Owner after Final Acceptance of the Work.

1.03 PRODUCT DATA

- A. Furnish three copies of manufacturers' product data, specifications, installation instructions, and maintenance instructions for products incorporated in the work; information specified herein shall be for products in addition to equipment items requiring operating and maintenance data specified elsewhere in this Section. All product data pertaining to an item shall be assembled together.
- B. Sign and date the completed product data, and submit to the Architect, who will deliver them to the Owner.

1.04 OPERATING AND MAINTENANCE DATA

- A. General: Where maintenance manuals, record data, and operating instructions are specified, assemble in three ring, plastic binders sized for 8-1/2" x 11" sheets or in electronic PDF format; include the following:
 - 1. Identification on, or readable through, the front cover containing the Project name and address and the general subject matter in the manual.
 - 2. Typewritten index near the front of the manual indicating locations of emergency data for equipment included in the manual.
 - 3. Instructions regarding operation and maintenance of the equipment included in the manual.
 - 4. Replaceable parts, part numbers, cost, and name and address of nearest parts distributor.
 - 5. Copy of each warranty and service contract issued for the equipment included in the manual.
 - 6. Include additional data required for the Owner's operation and maintenance.
- B. Catalog Data: Where contents of manuals include manufacturers' catalog pages, indicate the items included in the Project and delete data which is not applicable.
- C. Shop Drawings: Furnish one set of reviewed or revised Shop Drawings showing changes made during construction and/or installation.
- D. Number of Copies Required:
 - 1. Submit manuals in the quantity required to be returned, plus the following which will be retained by the Architect:
 - a. Two copies of other manuals; In lieu of paper copies, manuals may be submitted in electronic PDF format.

1.05 INSTRUCTION OF THE OWNER'S PERSONNEL

- A. Furnish qualified personnel for on the job instruction of the Owner's operating and maintenance personnel.

1.06 REMOVAL OF TEMPORARY CONSTRUCTION FACILITIES

- A. Remove temporary materials, equipment, services, and construction prior to Substantial Completion Inspection.
- B. Clean and repair damage caused by installation or use of temporary facilities.
- C. Restore permanent facilities used during construction to specified condition.

1.07 SUBSTANTIAL COMPLETION

- A. When Contractor considers Work or designated portion of the Work as substantially complete, Contractor shall submit written notice to Owner, with list of items to be completed or corrected.
- B. Within reasonable time, Architect and Owner will inspect to determine status of completion.
- C. Should Architect and Owner determine that Work is not substantially complete, Owner will promptly notify Contractor in writing, listing all defects and omissions.
- D. Contractor shall remedy deficiencies and send a second written notice of substantial completion. Owner and Architect will reinspect the Work. If deficiencies previously noted are not corrected on reinspection, then Contractor shall pay the cost of the reinspection.
- E. When Owner and Architect concurs that Work is substantially complete, Owner will issue a Certificate of Substantial Completion, accompanied by Contractor's list of items to be complete or corrected as verified by Owner and Architect.
- F. Manufactured units, equipment and systems that require startup must have been started up and run for periods prescribed by Owner before a Certificate of Substantial Completion will be issued. The term "Substantial Completion" is defined in the General Conditions of the Contract.
 - 1. Certification that all mechanical, electrical, plumbing, and hardware equipment has been tested and is operational. The Contractor will provide copies of all test results and reports including a binder by division fully indexed, outlining all equipment and performance tests. See Section 01 33 24 - Submittals and Substitutions.

1.08 COMMISSIONING:

- A. Building Commissioning:
 - 1. Not Applicable

1.09 FINAL COMPLETION

- A. Final Completion is defined in the General Conditions. Final Completion occurs when Work meets requirements for Owner's Final Acceptance. When Contractor considers Work is finally complete, submit written certification that:
 - 1. Contractor has inspected Work for compliance with Contract Documents, and all requirements for Final Acceptance have been met.
 - 2. Except for Contractor maintenance after Final Acceptance, Work has been completed in accordance with Contract Documents and deficiencies listed with Certificate of Substantial Completion have been corrected. Operation of equipment and systems have been reviewed with Owner Maintenance and Operational personnel, have been tested in the presence of Owner's representative, and are operative.
 - 3. Work is complete and ready for final inspection.
- B. In addition to submittals required by conditions of Contract, Contractor shall provide submittals required by governing authorities and submit final statement of accounting giving total adjusted Contract Sum, previous payments, and sum remaining due.
- C. When Architect and Owner finds Work is acceptable and final submittal is complete, Owner will issue final change order reflecting approved adjustments to Contract Sum not previously made by Change Order. Should Architect or Owner determine that Work is incomplete or defective:
 - 1. Owner promptly will so notify Contractor, in writing, listing the incomplete or defective items.
 - 2. Contractor shall promptly remedy the deficiencies and notify the Owner when it is ready for re inspection.

3. When Architect and Owner determine that the Work is acceptable under the Contract Documents, Owner will request Contractor to make closeout submittals.
- D. Final adjustments of accounts:
1. Contractor shall submit a final statement of accounting to Owner, showing all adjustments to the Contract Sum and complete and execute a notarized Final Lien Release.
 2. If so required, Owner shall prepare a final Change Order for submittal to Contractor, showing adjustment to the Contract Sum that were not previously made into a Contract Modification.

1.10 FINAL CLEANING

- A. Execute final cleaning prior to final inspection.
- B. Clean interior and exterior surfaces exposed to view; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces, vacuum carpeted and soft surfaces.
1. Clean equipment and fixtures to a sanitary condition, clean or replace filters of mechanical equipment operated during construction, clean ducts, blowers and coils of units operated without filters during construction.
 2. Employ skilled workers for final cleaning.
- C. Clean Site; mechanically sweep paved areas.
- D. Remove waste and surplus materials, rubbish, and construction facilities from Site.

1.11 MATERIAL, EQUIPMENT AND FINISH DATA

- A. Contractor shall submit two sets of data for primary materials, equipment and finishes as required under each specification section prior to final inspection, bound in 8-1/2" by 11" three-ring binders with durable plastic covers to Owner for Owner's records. In lieu of paper copies, Contractor may submit an electronic version of material data in PDF format.

1.12 MISCELLANEOUS PROJECT RECORD 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 records and place in good order, properly identified and bound or filed, ready for use and reference. Submit to Owner for Owner's records.

1.13 PROJECT GUARANTEE

- A. Contractor shall guarantee Work done under Contract against failures, leaks or breaks or other unsatisfactory conditions due to defective equipment, materials or workmanship, and perform repair work or replacement required, at Contractor's sole expense, for period of one year from date of Final Acceptance.
- B. Neither recordation of final acceptance nor final certificate for payment nor provision of the Contract nor partial or entire use or occupancy of premises by Owner shall constitute acceptance of Work not done in accordance with Contract Documents nor relieve Contractor of liability in respect to express warranties or responsibility for faulty materials or workmanship.
- C. Owner may make repairs to defective Work as set forth in the General Conditions, if, within 5 working days after mailing of written notice of defective work to Contractor or authorized agent, Contractor shall neglect to make or undertake repair with due diligence; provided, however, that in case of leak or emergency where, in opinion of Owner, delay would cause hazard to health or serious loss or damage, repairs may be made without notice being sent to Contractor, and Contractor shall pay cost thereof.
- D. If, after installation, operation or use of materials or equipment to be furnished under Contract proves to be unsatisfactory to Owner, Owner shall have right to operate and use materials or equipment until it can, without damage to Owner, be taken out of service for

correction or replacement. Period of use of defective materials or equipment pending correction or replacement shall in no way decrease guarantee period required for acceptable corrected or replaced items of materials or equipment.

- E. Nothing in this Section shall be construed to limit, relieve or release Contractor's, subcontractors' and equipment suppliers' liability to Owner for damages sustained as result of latent defects in equipment caused by negligence of suppliers' agents, employees or subcontractors. Stated in another manner, warranty contained in the Contract Documents shall not amount to, nor shall it be deemed to be, waiver by Owner of any rights or remedies (or time limits in which to enforce such rights or remedies) it may have for defective workmanship or defective materials under laws of this State pertaining to acts of negligence.

1.14 WARRANTIES

- A. Execute Contractor's submittals and assemble warranty documents, and operations and maintenance manuals, executed or supplied by subcontractors, suppliers, and manufacturers.
 - 1. Provide table of contents and assemble in 8-1/2" by 11" three-ring binder with durable plastic cover, appropriately separated and organized.
 - 2. Assemble in Specification Section order.
- B. The Contractor shall not be held responsible for defects due to misuse, negligence, willful damage, improper maintenance or accident caused by Others, or for defective parts whose replacement is necessitated by failure of Owner's maintenance forces to properly clean and service them, provided the Contractor has furnished complete maintenance instructions and appropriate instruction to the Owner.
- C. Submit material prior to final application for payment.
 - 1. For equipment put into use with Owner's permission during construction, submit within ten (10) working days after first operation.
 - 2. For items of Work delayed materially beyond Date of Substantial Completion, provide updated submittal within ten (10) working days after acceptance, listing date of acceptance as start of warranty period.
- D. Warranties are intended to protect Owner against failure of work and against deficient, defective and faulty materials and workmanship, regardless of sources.
- E. Limitations: Warranties are not intended to cover failures that result from the following:
 - 1. Unusual or abnormal phenomena of the elements
 - 2. Vandalism after substantial completion
 - 3. Insurrection or acts of aggression including war
- F. Related Damages and Losses: Remove and replace Work which is damaged as result of defective Work, or which must be removed and replaced to provide access for correction of warranted Work.
- G. Warranty Reinstatement: After correction of warranted Work, reinstate warranty for corrected Work to date of original warranty expiration or to a date not less than 365 days after corrected Work was done, whichever is later.
- H. Replacement Cost: Replace or restore failing warranted items without regard to anticipated useful service lives.
- I. Warranty Forms: Submit drafts to Owner for approval prior to execution. Forms shall not detract from or confuse requirements or interpretations of Contract Documents.
 - 1. Warranty shall be countersigned by manufacturers.
 - 2. Where specified, warranty shall be countersigned by subcontractors and installers.

- J. Rejection of Warranties: Owner reserves right to reject unsolicited and coincidental product warranties that detract from or confuse requirements or interpretations of Contract Documents.
- K. Term of Warranties: For materials, equipment, systems and workmanship warranty period shall be one (1) year minimum from date of final completion of entire Work except where:
 - 1. Detailed specifications for certain materials, equipment or systems require longer warranty periods.
 - 2. Materials, equipment or systems are put into beneficial use of Owner prior to Final Completion as agreed to in writing by Owner.
- L. Warranty of Title: No material, supplies, or equipment for Work under Contract shall be purchased subject to any chattel mortgage, security agreement, or under a conditional sale or other agreement by which an interest therein or any part thereof is retained by seller or supplier. Contractor warrants good title to all material, supplies, and equipment installed or incorporated in Work and agrees upon completion of all work to deliver premises, together with improvements and appurtenances constructed or placed thereon by Contractor, to Owner free from any claim, liens, security interest, or charges, and further agrees that neither Contractor nor any person, firm, or corporation furnishing any materials or labor for any Work covered by Contract shall have right to lien upon premises or improvement or appurtenances thereon. Nothing contained in this Paragraph, however, shall defeat or impair right of persons furnishing materials or labor under bond given by Contractor for their protection or any rights under law permitting persons to look to funds due Contractor in hands of Owner.

1.15 SERVICE AND MAINTENANCE CONTRACTS

- A. Compile, review, and submit specified service and maintenance contracts as specified for warranties and bonds.

1.16 PREPARATION FOR FINAL INSPECTION

- A. Perform final cleaning as specified in Section 01 74 13.
- B. Assemble warranties, service and maintenance contracts, operating and maintenance instructions, and other items as specified, and submit to the Architect.
- C. Remove temporary tapes, wrapping, coatings, paper labels, and other similar items. Dust, mop, wash, or wipe exposed and semi-exposed surfaces.
- D. At the Contractor's request, the Architect will attend a pre-final detailed Project review, to allow the Contractor to gather the majority of punch list items while the subcontractors are still on the Project. Provide a typewritten list of all items remaining to be completed or corrected; list by room number and item number. Segregate plumbing, HVAC, and electrical on separate lists.

If the Owner requires that the Architect perform, assemble or assist in creating the pre-final project list in order to move the Project to completion, the Architect shall be compensated for all associated costs which will be deducted from the progress payment due the Contractor. Any associated costs resulting from the additional work will be processed as a Deductive Change Order in accordance with the General Conditions.

If the Architect or Owner determines that the list is inadequate, non-descriptive or incomplete based on the review, the Architect shall generate the list. The Architect shall be compensated for all associated costs which will be deducted from the progress payment due the Contractor.

Any associated costs resulting from the additional work will be processed as a Deductive Change Order in accordance with the General Conditions.

- E. At the Contractor's request, the Architect will make a final Project review when the items in the pre-final punch list have been completed and after final cleanup, operation tests and the like have been performed.
- F. When the Architect determines that the Project is substantially complete and that final punch list items are completed, a final Project Inspection Report shall be executed.

- G. Upon execution of the Final Project Inspection Report, record and pay for Notice of Completion and furnish copies to the Owner and the Architect.
- 1.17 RESTORATION OF DAMAGED WORK
- A. Restore or replace damaged materials and finishes caused by movement of equipment or other operations of the Contractor or as specified or directed by the Architect, at no additional cost to the Owner.
 - B. Restoration shall be equal to the original work, and finishes shall match the appearance of existing adjacent work.
- 1.18 REMEDIAL WORK
- A. Replace work due to faulty workmanship or materials at no additional Cost to the Owner.
 - B. Coordinate work with the Owner and perform at such time and manner to cause minimal interruption and inconvenience to the Owner's operations.
- 1.19 EXTRA MATERIALS
- A. Where specified, provide extra materials in the quantities and manner specified.
 - B. Store these materials as directed by the Owner.
 - C. Delivery and certification of extra materials shall be prerequisite to Substantial Completion.
- 1.20 TURN-IN
- A. Contract Documents will not be closed out and final payment will not be made until all personnel Identification Media, vehicle permits and keys issued to Contractor during prosecution of Work are turned in to Owner.
- 1.21 RELEASE OF CLAIMS
- A. Contract Documents will not be closed out and final payment will not be made until a Release of Any and All Claims, is completed and executed by Contractor and Owner.
- 1.22 FIRE INSPECTION COORDINATION
- A. Contractor shall coordinate fire inspection and secure sufficient notice to Owner to permit convenient scheduling.
- 1.23 BUILDING INSPECTION COORDINATION
- A. Contractor shall coordinate with Owner's and Building inspectors a final inspection for the purpose of obtaining final approval an occupancy certificate.

END OF SECTION

DIVISION 02

EXISTING CONDITIONS

SECTION 02 41 19
SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Demolition and removal of selected portions of building or structure.
2. Demolition and removal of selected site elements.
3. Salvage of existing items to be reused or recycled.

1.2 DEFINITIONS

- A. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.
- B. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Owner.
- C. Remove and Reinstall: Detach items from existing construction, prepare for reuse, store in a secure location, and reinstall where indicated.
- D. Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.3 PREINSTALLATION MEETINGS

- A. Predemolition Conference: Conduct conference at project site with demolition subcontractor.

1.4 QUALITY ASSURANCE

- A. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.

1.5 FIELD CONDITIONS

- A. Owner will utilize portions of building during selective demolition. Conduct selective demolition so Owner's operations will not be disrupted.
- B. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

1.6 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that utilities to be disconnected have been disconnected and capped before starting selective demolition operations.
- B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
- C. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly report to design team lead.
- D. Survey of Existing Conditions: Compare existing conditions in field with those indicated on drawings. Report any discrepancies to design team lead.

3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Existing Services/Systems to Remain: Maintain services/systems to remain and protect them against damage.
- B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.
 - 1. Arrange to shut off indicated utilities with Owner's representative.
 - 2. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
 - 3. Disconnect, demolish, and remove components indicated to be removed.
 - a. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - b. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - c. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

3.3 PREPARATION

- A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
 - 1. Comply with requirements for access and protection specified in Section 01 50 00 "Temporary Facilities and Controls."
- B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

- C. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

3.4 SELECTIVE DEMOLITION, GENERAL

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
 - 1. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
 - 2. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 - 3. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
 - 4. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
 - 5. Dispose of demolished items and materials promptly.
- B. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition.

3.5 DISPOSAL OF DEMOLISHED MATERIALS

- A. General: Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in an approved landfill.
 - 1. Do not allow demolished materials to accumulate on-site.
 - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
 - 3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
 - 4. See PART 2 – SPECIAL PROVISIONS – Approved Debris Haulers.
- B. Burning: Do not burn demolished materials.
- C. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

3.6 CLEANING

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

END OF SECTION

DIVISION 06

WOODS, PLASTICS AND COMPOSITES

SECTION 06 10 00
ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Framing with dimension lumber.
2. Framing with engineered wood products.
3. Shear wall & roof panels.
4. Rooftop equipment bases and support curbs.
5. Wood blocking, cants, and nailers.
6. Wood furring.
7. Wood sleepers.
8. Plywood backing panels.

B. Related Requirements:

1. Section 02 41 19 Selective Demolition.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements
2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements.

1.3 INFORMATIONAL SUBMITTALS

A. Material Certificates: For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.

B. Evaluation Reports: For the following, from ICC-ES:

1. Wood-preservative-treated wood.
2. Fire-retardant-treated wood.
3. Engineered wood products.
4. Shear panels.
5. Power-driven fasteners.
6. Powder-actuated fasteners.
7. Expansion anchors.
8. Metal framing anchors.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

- A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
 2. Provide dressed lumber, S4S, unless otherwise indicated.
- B. Maximum Moisture Content of Lumber: **19 percent at time of installation, 16 percent at loading and 15 percent at close-in**, unless otherwise indicated.
- C. Engineered Wood Products: Provide engineered wood products acceptable to authorities having jurisdiction and for which current model code research or evaluation reports exist that show compliance with building code in effect for Project.
1. Allowable Design Stresses: Provide engineered wood products with allowable design stresses, as published by manufacturer, that meet or exceed those indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

2.2 WOOD-PRESERVATIVE-TREATED LUMBER

- A. Preservative Treatment by Pressure Process: AWWA U1; Use Category UC2 for interior construction not in contact with the ground, Use Category UC3b for exterior construction not in contact with the ground, and Use Category UC4a for items in contact with the ground.
1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or that does not comply with requirements for untreated material.
- C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
- D. Application: Treat items indicated on Drawings, and the following:
1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
 2. Wood sills, sleepers, blocking, **furring**, and similar concealed members.
 3. Wood floor plates that are installed over roof deck.

2.3 DIMENSION LUMBER FRAMING

- A. Framing - minimum grades UON:
1. Posts and beams 4x and larger: DF No. 1.
 2. Joists, rafters, plates and 2x6 studs: DF No. 2
 3. 2x4 studs, construction grade beams and posts to be free of heart center (FOHC). "Framing Other Than Non-Load-Bearing Interior Partitions" Paragraph below is an example of a performance requirement that can be used instead of "Framing Other Than Non-Load-Bearing Interior Partitions" Paragraph above.
- B. Exposed Framing: Provide material hand-selected for uniformity of appearance and freedom from characteristics, on exposed surfaces and edges, that would impair finish appearance, including decay, honeycomb, knot-holes, shake, splits, torn grain, and wane.
1. Application: Exposed exterior.
 2. Species and Grade: As indicated above for load-bearing construction of same type.

2.4 MISCELLANEOUS LUMBER

- A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
 - 1. Blocking.
 - 2. Nailers.
 - 3. Rooftop equipment bases and support curbs.
 - 4. Cants.
 - 5. Furring.
 - 6. Grounds.
- B. For items of dimension lumber size, provide Construction or No. 2 grade lumber of any species.

2.5 PLYWOOD SHEATHING

- A. Structural Plywood shall conform to PSI-07, stamped and graded by APA with exterior glue 5/8" min.

2.6 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
 - 1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.
- B. Power-Driven Fasteners: NES NER-272.
- C. Bolts: Steel bolts complying with ASTM A 307, Grade A hex nuts and, where indicated, flat washers.

2.7 METAL FRAMING ANCHORS

- A. Allowable Design Loads: Provide products with allowable design loads, as published by manufacturer, that meet or exceed those of products of manufacturers listed. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.
- B. Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653/A 653M, G60 coating designation.
 - 1. Use for interior locations unless otherwise indicated.
- C. Hot-Dip, Heavy-Galvanized Steel Sheet: ASTM A 653/A 653M; structural steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G185 (Z550) coating designation; and not less than 0.036 inch (0.9 mm) thick.
 - 1. Use for wood-preservative-treated lumber and where indicated.

2.8 MISCELLANEOUS MATERIALS

- A. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber or rubberized-asphalt compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch (0.6 mm).

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry to other construction; scribe and cope as needed for accurate fit. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.
- B. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- C. Framing with Engineered Wood Products: Install engineered wood products to comply with manufacturer's written instructions.
- D. Install fire-retardant treated plywood backing panels with classification marking of testing agency exposed to view.
- E. Shear Wall Panels: Install shear wall panels to comply with manufacturer's written instructions.
- F. Metal Framing Anchors: Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.
- G. Do not splice structural members between supports unless otherwise indicated.
- H. Comply with AWPAC M4 for applying field treatment to cut surfaces of preservative-treated lumber.
- I. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.
- J. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 - 1. NES NER-272 for power-driven fasteners.
 - 2. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
 - 3. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.

3.2 PROTECTION

- A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.
- B. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes sufficiently wet that moisture content exceeds that specified, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION

DIVISION 07

THERMAL AND MOSITURE PROTECTION

SECTION 07 62 00
SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. Fabricated sheet metal items, including flashings, counter flashings, gutters, downspouts, and other items indicated in Schedule and as follows:
 - 1. Edge strip and flashing.
 - 2. Counter Flashings for roof accessories, roof mounted equipment, vent stacks and similar items.

- B. Sealants for joints within sheet metal fabrications.

1.2 RELATED SECTIONS

- A. Drawings and general provisions of the Contract, including General Supplementary Conditions and Division 1 Specification Sections apply to this section.
- B. Coordinate with related work specified elsewhere:
 - 1. Division 6 Section "Rough Carpentry" for wood blocking and nails.

1.3 REFERENCE

- A. ASTM A792/A792M - Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
- B. ASTM D1970/D1970M - Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Wall Underlayment for Ice Dam Protection.
- C. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.
- D. ASTM E1646 - Standard Test Method for Water Penetration of Exterior Metal Wall Panel Systems by Uniform Static Air Pressure Difference.
- E. ASTM E1680 - Standard Test Method for Rate of Air Leakage Through Exterior Metal Wall Panel Systems.
- F. California Code of Regulations, Title 24, Part 2, California Building Code (CBC), International Building Code
- G. California Code of Regulations, Title 24, Part 11 California Green Building Standards Code, "CAL-Green".
- H. Sheet Metal and Air Conditioning Contractors National Association: "Architectural Sheet Metal Manual".
- I. ASTM E108 – Standard Test Methods Fire Tests of Wall Coverings.
- J. ASTM E1592 Standard Test Method for Structural Performance of Sheet Metal Wall and Siding Systems by Uniform Static Air Pressure Difference.
- K. American Society of Civil Engineers (ASCE):
 - 1. ASCE 7-16 Minimum Design Loads for Buildings and Other Structures.

1.4 SUBMITTALS

- A. PRODUCT DATA: Submit brochures containing material samples, SDS, schedules, charts, literature, and illustrations to indicate the performance, fabrication procedures, product variations, and accessories.
 - 1. Within four (4) weeks of award of contract, submit:

- a. Minimum of two (2) samples of each material and descriptive literature.
 - b. All other data and information to satisfy requirements of manufacturer on warranty needs.
 - c. A written statement from the materials manufacturer's corporate officer approving the installer and stating the intent to guarantee the completed project as specified.
 - d. Samples of proposed warranty complete with any addenda necessary to meet the warranty requirements as specified.
 - e. Certified copy of ISO 9001 compliance.
- B. SHOP DRAWINGS: Indicate size and materials. Show locations and installation procedures. Include details of joints, attachments, fastening patterns, and clearances. Submit 1 electronic original and retain approved copies at the Site.
- C. MAINTENANCE PROCEDURES: Upon substantial completion of the project, deliver to Owner three (3) copies of manufacturer's printed instructions regarding care and maintenance of wall.
- D. Litigation and settlements: provide a notarized statement from a corporate officer stating wall system manufacturer has not settled litigation or paid fines to a public agency in excess of \$20 million dollars.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: System manufacturer shall have a minimum of 10 years experience in manufacturing products in the United States and be ISO 9001 certified.
- A. Installer Qualifications: Installer shall be specializing in wall application with minimum 5 years experience and who is certified by the system manufacturer as qualified to install manufacturer's wall materials.
- C. Regulatory Requirements:
 - 1. System shall be installed in accordance with ASCE-7 wind uplift requirements for geographical location and a 120 MPH 3-second gust wind speed zone with an importance factor of 1.15 based on IBC requirements. Wind-resistance loads listed below have a safety factor of 2.0 incorporated into the calculation.
 - 2. Follow local, state, and federal regulations of safety standards and codes. Refer to applicable building code or International Building Code for wall system installation requirements and limitations.
- D. Installer's Field Supervision: Require Installer to maintain a full-time Supervisor/Forman on job site during all phases of work and at any time work is in progress, proper supervision of workmen shall be maintained. A copy of the specification shall be in the possession of the Supervisor/Foremen at all times.
- E. It shall be the Contractor's responsibility to respond immediately to correction of wall leakage during construction.
- F. Disqualification of Bidders: A bidder can be disqualified by the Architect or Owner for any of the following reasons, but not limited to:
 - 1. The failure to attend the Pre-Bid conference at the time and place so described under Bidding Dates.
 - 2. Incorrect use of the "Proposal" as provided by the Architect/Owner. Any changes in said format shall be accepted by the Architect/Owner only when requested and approved in writing prior to the bid opening. Changes in the Proposal after the opening of the bids will not be accepted.
 - 3. Lack of proficiency as shown by past work or incomplete work under other contracts which, in the judgement of the Architect/Owner might hinder or prevent the prompt completion of additional work if so awarded or any involvement in any legal actions which relate to past or present performance. This includes, but is not limited to lawsuits, court appointed actions, and/or ongoing litigation.
- G. Pre-installation Conference: Approximately 2 weeks before scheduled of commencement of system and associated work, meet at Project site with Installer, installer of each component of associated work, installers of deck or substrate construction to receive work, installers of units and other work must precede or follow work (including mechanical work if any), Architect/Owner, system manufacturer's representative, and other representatives directly concerned with performance of the

Work, including (where applicable) Owner's insurers, test agencies, and governing authorities. Objectives to include:

1. Review foreseeable methods and procedures related to wall work. Tour representative areas of substrates (decks), inspect and discuss condition of substrate, penetrations, and other preparatory work performed by other trades.
2. Review structural loading limitations of deck and inspect deck for loss of flatness and for required attachment.
3. Review systems requirements (drawings, specifications, and other contract documents).
4. Review required submittals, both completed and yet to be completed.
5. Review and finalize construction schedule related to work and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
6. Review required inspection, testing, certifying, and material usage accounting procedures.
7. Review weather and forecasted weather conditions and procedures for coping with unfavorable conditions, including possibility of temporary wall (if not a mandatory requirement).
8. Record (contractor) discussion of conference, including decisions and agreements (or disagreements) reached, and furnish copy of record to each party attending. If substantial disagreements exist at conclusion of conference, determine how disagreements will be resolved and set date for reconvening conference.
9. Review notification procedures for weather or non-working days.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver products to site with seals and labels intact, in manufacturer's original containers, dry and undamaged.
- B. Store and handle sheets in a dry, well-ventilated, weather-tight place to ensure no possibility of significant moisture exposure. Store rolls of felt and other sheet materials on pallets or other raised surface. Stand all roll materials on end. Cover roll goods with a canvas tarpaulin or other breathable material (not polyethylene).
- C. Do not leave unused rolled goods exposed overnight or when work is not in progress unless protected from weather and other moisture sources.
- D. Handle and store materials or equipment in a manner to avoid significant or permanent deflection of deck.

1.7 MANUFACTURER'S INSPECTIONS

- A. When the project is in progress, the System Manufacturer will provide the following:
 1. Keep the Architect informed as to the progress and quality the work as observed.
 2. Provide job site inspections minimum three days per week by a full time employee of the manufacturer.
 3. Report to the Architect in writing, any failure or refusal of the Contractor to correct unacceptable practices called to the Contractor's attention.
 4. Confirm, after completion of the project and based on manufacturer's observations and tests, that manufacturer has observed no applications procedures in conflict with the specifications other than those that may have been previously reported and corrected.

1.8 PROJECT CONDITIONS

- A. Weather Condition Limitations: Do not apply membrane during inclement weather or when a 30% chance of precipitation is expected.
- B. Do not apply insulation or membrane to damp deck surface.
- C. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weather walled during same day.
- D. Proceed with wall work only when existing and forecasted weather conditions will permit unit of work to be installed in accordance with manufacturer's recommendations and warranty requirements.

1.9 SEQUENCING AND SCHEDULING

- A. Sequence installation of modified bituminous sheet wall with related units of work specified in other sections to ensure that wall assemblies, including wall accessories, flashing, trim, and joint sealers, are protected against damage from effects of weather, corrosion, and adjacent construction activity.
- B. All work must be fully completed on each day. Phased construction will not be accepted.

PART 2 PRODUCTS

2.1 GENERAL

- A. When a particular trade name or performance standard is specified it shall be indicative of a standard required.
- B. Provide products as specified. Prime bidding contractors proposing substitutes shall submit all required submittal information under 07 60 00, PART 1, 1.4 to The Owner's representative at least 10 days prior to bid due date. All substitutions have to be approved prior to bidding. No substitutions will be accepted after bidding or contract award. All bidders will have an opportunity to bid on any substitute system that is approved. Substitution requests will not be accepted from anyone other than prime bidding contractors who have attended the prebid walkthrough.
- C. Any item or materials submitted as an alternate to the manufacturer specified must comply in all respects as to the quality and performance, including job site investigation of the brand name specified. The Owner shall be the sole judge as to whether or not an item submitted as an equal is truly equal. Should the contractor choose to submit on the equal basis, he shall assume all risk involved, monetary or otherwise, should the Owner find it unacceptable. The Contractor is warned to obtained prior approval at least ten days prior to bid date of any material not specified. The following must be included for materials submitted for substitutions: (five copies)
 - 1. Complete data substantiating compliance of proposed substitution with Contract Documents.
 - 2. For products:
 - a. Product identification, including manufacturer's literature and manufacturer's name and address.
 - b. Material Safety Data Sheets providing all pertinent data as to flammability, combustibility, toxicity, etc.
 - c. List of at least five (5) local jobs within 50 miles, where the proposed alternate material was used under similar conditions. These jobs must be available for inspection by the Owner. Names, phone numbers, and a copy of manufacturer's warranty on each job are required for verification.
 - d. Notarized statement from the System Manufacturer, signed by a corporate officer of the Corporation with the Corporate Seal affixed thereto stating in writing that:
 - All Bidding Documents have been inspected.
 - The project site has been inspected.
 - The wall system manufacturer will provide field inspections on a daily basis, on during, and until all construction work is completed and accepted by the Owner. Inspections shall be performed by a full time employee of the manufacturer. These inspections shall be provided to the Owner at no charge.
 - Furnish the 30 year warranty as stipulated in the Contract Documents.
 - 3. For construction methods:
 - a. Detailed description of proposed method.
 - b. Drawings illustrating methods.
 - 4. Itemized comparison of proposed substitution with product or method specified.
 - 5. Data related to changes in construction schedule.
 - 6. Relation to separate contracts.
- D. In making request for substitution, Bidder / Contractor represents:
 - 1. He has personally investigated proposed product or method, and determined that it is equal or superior in all respects to that specified.
 - 2. He will provide the same guarantee for substitution as for product or method specified.
 - 3. He will coordinate installation of accepted substitution in work, making such changes as may be required for work to be completed in all respects.
 - 4. He waives all claims for additional cost related to substitution which consequently become apparent.
 - 5. Cost data is complete and includes all related cost under his contract or other contracts which may be affected by the substitution.

6. He will reimburse the Owner for all redesign cost substitute may require.
- E. Substitutions will not be considered if:
1. Product or method to be considered does not have a minimum of ten (10) years of successful performance of system applications in the United States.
 2. Any discrepancies in the test data, or if the tests or submittals are incomplete.
 3. They are indicated or implied on Shop Drawings or Project Data Submittals without formal request submitted in accordance with Paragraph 2.01.
 4. Acceptance will require substantial revision of Contract Documents.

2.2 MATERIALS

- A. Materials: Minimum gauge of steel or thickness of Aluminum to be specified in accordance with Architectural Sheet Metal Manual, Sheet Metal and Air Conditioning Contractor's National Association, Inc. recommendations.
- B. Finishes
1. Exposed surfaces for coated panels:
 - a. Steel Finishes: fluorocarbon finish. Epoxy primer baked both sides, .2-.25 mils thickness as approved by finish coat manufacturer. Weathering finish as referred by National Coil Coaters Association (NCCA).

PROPERTY	TEST METHOD	FLUOROCARBON*
Pencil Hardness	ASTM D3363 NCCA II-2	HB-H
Bend	ASTM D-4145 NCCA II-19	O-T
Cross-Hatch Adhesion	ASTM D3359	no loss of adhesion
Gloss (60° angle)	ASTM D523	25+/-5%
Reverse	ASTM D2794	no cracking or loss of Impact adhesion
Nominal Thickness	ASTM D1005 Primer Topcoat	0.2 mils 0.8 mils
	TOTAL	1.0 mils

- b. Color shall be as Selected from the Standard Color Options

2. Exposed and unexposed surfaces for mill finish flashing, fascia, and coping cap, shall be as shipped from the mil

1.3 RELATED MATERIALS AND ACCESSORIES

- A. Metal Primer: Zinc chromate type.
- B. Plastic Cement: ASTM D 4586
- C. Sealant:
1. Reglet and general use: TiteBond by IMETCO.
 2. Flashless edge metal system: GreenLock Sealant XL structural sealant by Garland.
- D. Fasteners:
1. Corrosion resistant screw fastener as recommended by metal manufacturer. Finish exposed fasteners same as flashing metal.
 2. Fastening shall conform to Factory Mutual requirements or as stated on section details, whichever is more stringent.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Do not begin installation of preformed metal system until substrates have been properly prepared.
 - 1. Determine if work of other trades which penetrates the system.
 - 2. Verify pipes, sleeves, or vents through system are solidly set, reglets are in place, and nailing strips located.
 - 3. Verify system termination, base flashings and gutter flanges are in place, sealed, and secure.
 - 4. Notify Architect in writing if substrates are not suitable for application of panel system.
 - 5. Do not proceed with installation until substrates are acceptable.
- B. Structural surfaces: Smooth, even, sound, surface dry 19 percent maximum, clean and free of depressions, waves, or projections before material is applied.
 - 1. Examine the alignment and placement of the building structure and substrate. Correct any objectionable warp, waves or buckles in the substrate before proceeding with installation of the preformed metal system. The installed system will follow the contour of the structure and may appear irregular if not corrected.
 - b. Apply no materials during wet weather or on wet surface.

3.2 INTERFACE WITH OTHER WORK

- A. Coordinate with system accessories, miscellaneous sheet metal accessories, piping vents and other items specified in related sections penetrating metal system work. Avoid conflict or omission in waterproofing systems and provide watertight installation.

3.3 PREPARATION

- A. Verify field dimensions prior to ordering materials.
 - 1. Establish straight side and crosswise benchmarks.
 - 2. Check rectangular walls for squareness and straightness. Gable ends may not be straight; set a true line for the gable clips and flashing with stringline.
- B. Broom clean wood sheathing prior to installation of cures and patch.
- C. Coordinate system work with provisions for system drainage, flashing, trim, penetrations, and other adjoining work to assure that the completed system will be free of leaks.
- D. Remove protective film from surface of system immediately prior to installation. Strip film carefully, to avoid damage to prefinished surfaces.
- E. Separate dissimilar metals by applying a bituminous coating, self-adhering rubberized asphalt sheet, or other permanent method approved by system manufacturer.
- F. Where metal will be in contact with wood or other absorbent material subject to wetting, seal joints with sealing compound and apply one coat of heavy-bodied bituminous paint.

3.4 MANUFACTURED SHEET METAL SYSTEMS

- A. Provide factory-fabricated accessories including, but not limited to, fascia extenders, miters, scuppers, joint covers, etc. refer to Source limitation provision in Part 1.

3.5 SHOP-FABRICATED SHEET METAL

- A. Metal work shall be shop fabricated to configurations and forms in accordance with recognized sheet metal practices.
- B. Hem exposed edges.
- C. Angle bottom edges of exposed vertical surfaces to form drip.
- D. Lap corners with adjoining pieces fastened and set in sealant.
- E. Form joints for gravel stop fascia system, coping cap with a 3/8" opening between sections. Back the opening with an internal drainage plate formed to the profile of fascia piece.
- F. Install sheet metal to comply with referenced ANSI/SPRI, SMACNA and NRCA standards.
- G. Fabricate minimum 20' lengths.

3.6 CONSTRUCTION WASTE MANAGEMENT

- A. Remove and properly dispose of waste products generated. Comply with requirements of authorities having jurisdiction.

3.7 FINAL INSPECTION

- A. At completion of installation and associated work, meet with Contractor, Architect, installer, installer of associated work, Owner, roofing system manufacturer's representative, and other representatives directly concerned with performance of roofing system.
- B. Inspect work and flashing of roof penetrations, walls, curbs, and other equipment. List all items requiring correction or completion and furnish copy of list to each party in attendance.
- C. Repair or replace deteriorated or defective work found at time above inspection as required to produce an installation which is free of damage and deterioration at time of Substantial Completion and according to warranty requirements.
- D. Notify the Owner upon completion of corrections.
- E. Following the final inspection, provide written notice of acceptance of the installation from the roofing system manufacturer.
- F. Immediately correct roof leakage during construction. If the Contractor does not respond within twenty-four (24) hours, the Owner will exercise rights to correct the Work under the terms of the Conditions of the Contract.

3.8 DEMONSTRATION AND TRAINING

- A. At a time and date agreed to by the Owner, instruct the Owner's facility manager, or other representative designated by the Owner, on the following procedures:
 - 1. Troubleshooting procedures
 - 2. Notification procedures for reporting leaks or other apparent roofing problems
 - 3. Maintenance
 - 4. The Owner's obligations for maintaining the warranty in effect and force.

3.10 FIELD QUALITY CONTROL

- A. Testing:
 - 1. Re-test until system is shown to be weathertight.
- B. Manufacturer Field Services: Provide daily site inspection for a minimum of one (1) hour during active system operations by an experienced, full time employee of the system manufacturer. Submit written reports weekly.

3.11 CLEANING

- A. Clean exposed sheet metal work at completion of installation. Remove grease and oil films, excess joint sealer, handling marks, and debris from installation, leaving the work clean and unmarked, free from dents, creases, waves, scratch marks, or other damage to the finish.
- B. Touch up minor abrasions and exposed fasteners with matching paint provided by panel manufacturer. Remove and replace panels that cannot be satisfactorily touched up.
 - 1. No exposed sealant or visible raw metal.
- C. Sweep and remove chips, shavings, and dust from system on a daily basis during installation period. Leave installed work clean, free from grease, finger marks and stains.
- D. Upon completion of installation, remove scraps and debris from project site.

3.12 PROTECTION

- A. Provide temporary walkways or planks as necessary to avoid damage to completed work. Protect system until completion of project.
- B. Touch-up, repair, or replace damaged material or accessories before date of Substantial Completion.

3.13 OWNER SUPPLIED MATERIALS

- A. Contractor must include in their base bid any additional materials to complete the roof patch area. Contractor must provide all labor to install owner-supplied materials as part of their bid. All materials not specifically included in the owner supplied materials section will be the responsibility of the contractor to provide and install in compliance with section 07 54 16. Freight charges of Owner supplied materials will be the responsibility of the Owner. Contractor must take delivery of materials, properly cover and store at jobsite or their shop. Contractor must be able to provide certification in writing from roof system manufacturer that the contractor is approved to install the specified roof system and provide all warranty requirements of section 07 54 16. The Owner will supply the materials and quantities as listed in section 01640.

END OF SECTION

SECTION 07 72 00
ROOF ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Roof curbs.
 - 2. Equipment supports.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of roof accessory.
- B. Shop Drawings: For roof accessories.
- C. Samples: For each exposed product and for each color and texture specified.

1.3 INFORMATIONAL SUBMITTALS

- A. Sample warranties.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.5 WARRANTY

- A. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finishes or replace roof accessories that show evidence of deterioration of factory-applied finishes within 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 ROOF CURBS

- A. Roof Curbs: Internally reinforced roof-curb units capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings, bearing continuously on roof structure, and capable of meeting performance requirements; with welded or mechanically fastened and sealed corner joints, stepped integral metal cant raised the thickness of roof insulation, and integrally formed deck-mounting flange at perimeter bottom.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Adaptable Air Products.
 - b. AES Industries, Inc.
 - c. Greenheck Fan Corporation.
 - d. Roof Curb Systems.
 - e. Vent Products Co., Inc.
- B. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.
- C. Material: Zinc-coated (galvanized) steel sheet, 0.052 inch thick.
- 1. Finish: Baked enamel or powder coat.
 - 2. Color: As selected by Architect from manufacturer's full range.
- D. Construction:
- 1. Curb Profile: Manufacturer's standard compatible with roofing system.
 - 2. On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.
 - 3. Fabricate curbs to minimum height of 12 inches above roofing surface unless otherwise indicated.
 - 4. Top Surface: Level top of curb, with roof slope accommodated by sloping deck-mounting flange.
 - 5. Sloping Roofs: Where roof slope exceeds 1:48, fabricate curb with perimeter curb height tapered to accommodate roof slope so that top surface of perimeter curb is level. Equip unit with water diverter or cricket on side that obstructs water flow.
 - 6. Insulation: Factory insulated with 1-1/2-inch-thick glass-fiber board insulation.
 - 7. Liner: Same material as curb, of manufacturer's standard thickness and finish.
 - 8. Nailer: Factory-installed wood nailer along top flange of curb, continuous around curb perimeter.
 - 9. Wind Restraint Straps and Base Flange Attachment: Provide wind restraint straps, welded strap connectors, and base flange attachment to roof structure at perimeter of curb, of size and spacing required to meet wind uplift requirements.
 - 10. Platform Cap: Where portion of roof curb is not covered by equipment, provide weathertight platform cap formed from 3/4-inch thick plywood covered with metal sheet of same type, thickness, and finish as required for curb.
 - 11. Metal Counterflashing: Manufacturer's standard, removable, fabricated of same metal and finish as curb.
 - 12. Security Grille: Provide where indicated.
 - 13. Damper Tray: Provide damper tray or shelf with opening 3 inches.

2.2 EQUIPMENT SUPPORTS

- A. Equipment Supports: Internally reinforced perimeter metal equipment supports capable of supporting superimposed live and dead loads between structural supports, including equipment loads and other construction indicated on Drawings, spanning between structural supports; capable of meeting performance requirements; with welded corner joints, integral metal cant, and integrally formed structure-mounting flange at bottom.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Adaptable Air Products.
 - b. AES Industries, Inc.
 - c. Greenheck Fan Corporation.
 - d. Lloyd Industries, Inc.
 - e. Vent Products Co., Inc.

- B. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.
- C. Material: Zinc-coated (galvanized) steel sheet, 0.052 inch thick.
 - 1. Finish: Baked enamel or powder coat.
 - 2. Color: As selected by Architect from manufacturer's full range.
- D. Construction:
 - 1. Curb Profile: Manufacturer's standard compatible with roofing system.
 - 2. Insulation: Factory insulated with 1-1/2-inch-thick glass-fiber board insulation.
 - 3. Liner: Same material as equipment support, of manufacturer's standard thickness and finish.
 - 4. Nailer: Factory-installed continuous wood nailers 3-1/2 inches wide under top flange on side of curb, continuous around support perimeter.
 - 5. Wind Restraint Straps and Base Flange Attachment: Provide wind restraint straps, welded strap connectors, and base flange attachment to roof structure at perimeter of curb of size and spacing required to meet wind uplift requirements.
 - 6. Platform Cap: Where portion of equipment support is not covered by equipment, provide weathertight platform cap formed from 3/4-inch thick plywood covered with metal sheet of same type, thickness, and finish as required for curb.
 - 7. Metal Counterflashing: Manufacturer's standard, removable, fabricated of same metal and finish as equipment support.
 - 8. On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.
 - 9. Fabricate equipment supports to minimum height of 12 inches above roofing surface unless otherwise indicated.
 - 10. Sloping Roofs: Where roof slope exceeds 1:48, fabricate each support with height to accommodate roof slope so that tops of supports are level with each other. Equip supports with water diverters or crickets on sides that obstruct water flow.
 - 11. Security Grille: Provide where indicated on Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Verify dimensions of roof openings for roof accessories. Install roof accessories according to manufacturer's written instructions.
 - 1. Install roof accessories level; plumb; true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.
 - 2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
 - 3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
 - 4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.
- B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
 - 1. Coat concealed side of uncoated aluminum roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.

2. Underlayment: Where installing roof accessories directly on cementitious or wood substrates, install a course of underlayment and cover with manufacturer's recommended slip sheet.

3.2 REPAIR AND CLEANING

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing according to ASTM A 780/A 780M.
- B. Touch up factory-primed surfaces with compatible primer ready for field painting according to Section 09 91 00 "Painting."
- C. Clean exposed surfaces according to manufacturer's written instructions.
- D. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION

SECTION 07 92 00
SEALANTS AND CAULKING

PART 1 - GENERAL

1.01 SUMMARY

- A. Work included: Throughout the Work, seal and caulk joints where shown on the Drawings and elsewhere as required to provide a positive barrier against passage of moisture, fire/smoke, and passage of air.
- B. Related work: Documents affecting work of this Section include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Sections in Division 1 of these Specifications.

1.02 RELATED SECTIONS

- A. The completion of the work described in this Section may require work in or coordination with other Sections of these specifications. The Contractor and the sub-contractor shall be responsible for identifying and including all related work in other Sections of these specifications and/or drawings necessary for a complete installation of the work described in this Section. These related Sections include but are not limited to the following:
 - 1. Section 07 62 00 – Sheet Metal Flashing and Trim
 - 2. Section 09 91 00 – Painting not specified herein.

1.03 QUALITY ASSURANCE

- A. Use adequate numbers of skilled workmen thoroughly trained and experienced in the necessary crafts and completely familiar with the specified requirements and methods needed for proper performance of the work of this Section.

1.04 SUBMITTALS

- A. Product data: Within 15 calendar days after the Contractor has received the Owner's Notice to Proceed, submit:
 - 1. Materials list of items proposed to be provided under this Section;
 - 2. Manufacturer's specifications and other data needed to prove compliance with the specified requirements;
- B. Samples: Accompanying the submittal described above, submit Samples of each sealant, each backing material, each primer, and each bond breaker proposed to be used.

1.05 PRODUCT HANDLING

- A. Comply with pertinent provisions of Section 01 60 00.
- B. Do not retain at the job site material which has exceeded the shelf life recommended by its manufacturer.

PART 2 - PRODUCTS

2.01 SEALANTS

- A. Provide sealant as manufactured by Tremco, Sika, Pecora or approved equal. Products approved by the Architect. Sealant products shall be, but not necessarily limited to, the following types:
 - 1. Non-skinning Butyl: Garland Tuff-Stuff MS, or approved equal.
 - 2. Horizontal surfaces: Garland Tuff-Stuff MS, Green-Lock Sealant, or approved equal.
- B. Colors:
 - 1. Colors for each sealant installation will be selected by the Architect from standard colors normally available from the specified manufacturers.
 - 2. Should such standard color not be available from the approved manufacturer except at additional charge, provide such colors at no additional cost to the Owner.
- C. In concealed installations, and in partially exposed installations, use standard gray or black sealant.

2.02 PRIMERS

- A. Use only those primers which are nonstaining, have been tested for durability on the surfaces to be sealed, and are specifically recommended for this installation by the manufacturer of the sealant used.

2.03 BACKUP MATERIALS

- A. Use only those backup materials which are specifically recommended for this installation by the manufacturer of the sealant used, which are nonabsorbent, and which are nonstaining.
- B. Acceptable types include:
 - 1. Closed-cell resilient urethane or polyvinylchloride foam;
 - 2. Closed-cell polyethylene foam;
 - 3. Closed-cell sponge of vinyl or rubber;
 - 4. Polychloroprene tubes or beads;
 - 5. Polyisobutylene extrusions;
 - 6. Oil-less dry jute.

2.04 BOND-PREVENTATIVE MATERIALS

- A. Use only one of the following as best suited for the application, and as recommended by the manufacturer of the sealant used:
 - 1. Polyethylene tape, pressure-sensitive adhesive, with the adhesive required only to hold tape to the construction materials as indicated;
 - 2. Aluminum foil complying with MIL-A-148E;
 - 3. Wax paper complying with Fed Spec UU-P-270.

2.05 MASKING TAPE

- A. For masking around joints, provide masking tape complying with Fed Spec UU-T-106c.

2.06 OTHER MATERIALS

- A. Provide other materials, not specifically described but required for a complete and proper installation, as selected by the Contractor subject to the review of the Architect.

PART 3 - EXECUTION

3.01 SURFACE CONDITIONS

- A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

3.02 PREPARATION

- A. Steel surfaces:
 - 1. Steel surfaces in contact with sealant:
 - a. Sandblast as required to achieve acceptable surface for bond.
 - b. If sandblasting is not practical, or would damage adjacent finish, scrape the metal or wire brush to remove mill scale.
 - c. Use solvent to remove oil and grease, wiping the surfaces with clean rags.
 - 2. Remove protective coatings on steel by sandblasting or by using a solvent, which leaves no residue.
- B. Aluminum surfaces:
 - 1. Aluminum surfaces in contact with sealant:
 - a. Remove temporary protective coatings, dirt, oil, and grease.
 - b. When masking tape is used for protective cover, remove the tape just prior to applying the sealant.
 - 2. Use only such solvents to remove protective coatings as are recommended for that purpose by the manufacturer of the aluminum work, and which are nonstaining.

3.03 INSTALLATION OF BACKUP MATERIAL

- A. Use only the backup material recommended by the manufacturer of the sealant used for the particular installation, compressing the backup material 25% to 50% to achieve a positive and secure fit.
- B. When using backup of tube or rod stock, avoid lengthwise stretching of the material. Do not twist or braid hose or rod backup stock.

3.04 PRIMING

- A. Use only the primer recommended by the manufacturer of the sealant, for the particular installation, applying in strict accordance with the manufacturer's recommendations.

3.05 BOND-BREAKER INSTALLATION

- A. Provide a bond-breaker where recommended by the manufacturer of the sealant, adhering strictly to the installation recommendations.

3.06 INSTALLATION OF SEALANTS

- A. Prior to start of installation in each joint, verify the joint type according to details on the Drawings, and verify that the required proportion of width of joint to depth of joint has been secured.
- B. Equipment:
 - 1. Apply sealant under pressure with power-actuated or hand gun, or by other appropriate means.
 - 2. Use guns with nozzle of proper size, and providing sufficient pressure to completely fill the joints as designed.
- C. Thoroughly and completely mask joints where the appearance of sealant on adjacent surfaces would be objectionable.
- D. Install the sealant in strict accordance with the manufacturer's recommendations, thoroughly filling joints to the recommended depth.
- E. Tool joints to the profile shown on the Drawings, or as otherwise required if such profiles are not shown on the Drawings.
- F. Cleaning up:
 - 1. Except at aluminum surfaces (see 3.2-C above), remove masking tape immediately after joints have been tooled.
 - 2. Clean adjacent surfaces free from sealant as the installation progresses, using solvent or cleaning agent recommended by the manufacturer of the sealant used.

END OF SECTION

DIVISION 09

FINISHES

SECTION 09 91 00
PAINTING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This Section describes the requirements for painting and finishing of exterior exposed items and surfaces.
1. Surface preparation, priming and coats of paint specified are in addition to shop-priming and surface treatments specified in other Sections.
 2. Work includes painting all exposed wood, pipes, ducts, hangers, exposed steel and iron, and primed metal surfaces of Mechanical and Electrical equipment, and general sheet metal work, except as otherwise indicated or specified.
 3. Work includes painting hardware specified as primed (USP or 600).
 4. Work includes sanding shop-primed surfaces and applying specified primer and finish coats.
 5. "Paint" means coating systems materials, including primers, emulsions, enamels, stains, sealers and fillers, and other applied materials whether used as prime, intermediate or finish coats.
- B. Surfaces Not to Be Painted:
1. Pre-finished items, including but not limited to fire sprinkler heads, casework, and finished mechanical and electrical equipment, including light fixtures, switchgear and distribution cabinets.
 2. Concealed surfaces such as walls or ceilings in concealed areas and inaccessible areas, furred areas, pipe spaces, and duct shafts.
 3. Finished metal surfaces such as anodized aluminum, stainless steel, zinc chromium plate, copper, bronze and similar finished materials, and exterior aluminum entrances and storefronts and curtain walls.
 4. Prefinished metal materials, flashing, gutters and downspouts.
 5. Moving parts of operating units, mechanical and electrical parts, such as valve and damper operators, linkages, sensing devices, motor and fan shafts.
- C. Related Sections: The completion of the work described in this Section may require work in or coordination with other Sections of these specifications. The Contractor and the sub-contractor shall be responsible for identifying and including all related work in other Sections of these specifications and/or drawings necessary for a complete installation of the work described in this Section. These related Sections include but are not limited to the following:
1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
 2. Shop priming ferrous metal items including structural steel, metal fabrications, hollow metal work and similar items. The work of this Section includes sanding and applying specified primer on all shop-primed surfaces exposed to view in the completed work.
 3. Shop priming of fabricated components such as architectural woodwork, wood casework and shop-fabricated or factory-built mechanical and electrical equipment or accessories.
 4. Finishing of exposed interior and exterior structural steel items.
- D. Do not paint over code-required labels, equipment identification, performance rating, name, or nomenclature plates.

1.02 SUBMITTALS

- A. Certification: Furnish certification by the paint manufacturer that products supplied comply with Green Seal recommendations controlling the use of volatile organic compounds (VOCs). Those VOC recommendations for interior paint are 150 g/l for non-flat and 50 g/l for flat.
- B. Samples: Furnish samples of each color and material to be applied, with texture to simulate actual conditions, on representative samples of the actual substrate.
 - 1. Provide stepped samples, defining each separate coat, including block fillers and primers. Use representative colors when preparing samples for review. Resubmit until required sheen, color, and texture are achieved.
 - 2. Furnish samples on the following substrates for review of color and texture only:
 - a. Painted Wood: Two 12"-square samples of each color and material on hardboard.
 - b. Stained or Natural Wood: Two 4" x 8" samples of natural and stained wood finish on actual wood samples.
- C. Product Data: Specified paint systems are those of Benjamin Moore. If other paint manufacturers are proposed and accepted by the Architect, furnish product comparison charts showing that proposed paint systems are equal to the specified materials in number of coats, type of paint, and sheen.

1.03 QUALITY ASSURANCE

- A. Applicators Qualifications: Engage an experienced applicator who has completed painting system applications similar in material and extent.
- B. Single Source Responsibility: Provide primers and other undercoat paint produced by same manufacturer as finish coats. Use thinners approved by paint manufacturer, and use within recommended limits.
- C. Coordination of Work: Review other Sections in which prime paints are to be provided to ensure compatibility of coatings system for various substrates. Upon request, furnish information or characteristics of finish materials to be used.
- D. Field-Applied Samples: provide a field application of each color in an area to be determined by the Architect for final color approval by the Architect.
- E. Requirements of Regulatory Agencies: Comply with applicable rules and regulations of governing agencies for air quality control.
 - 1. Comply with current applicable regulations of the Environmental Protection Agency (EPA).
 - 2. Regulatory changes may affect the formulation, availability, or use of specified coatings. Confirm availability of coatings to be used prior to start of painting.
- F. Field Samples: On exterior surfaces provide full-coat finish samples on at least 100-sq. ft. of surface, as directed by the Architect, until required sheen, color and texture is obtained; simulate finished lighting conditions for review of in-place work. Approved samples will be used as a standard for the Project.
 - 1. Approved samples may be incorporated into work.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to job site in original, new and unopened packages and containers bearing manufacturer's name, batch number, color, and directions.
- B. Store materials in tightly covered containers. Maintain containers in a clean condition, free of foreign materials and residue.
- C. Keep storage area neat and orderly. Remove oily rags and waste daily. Ensure that workers and work areas are adequately protected from fire hazards and health hazards resulting from handling, mixing and application of paints.

1.05 JOB CONDITIONS

- A. Apply water-base paints when temperature of surfaces to be painted and surrounding air temperatures are between 50°F and 90°F, unless otherwise permitted by paint manufacturer's printed instructions.
- B. Apply solvent-thinned paints only when temperature of surfaces to be painted and surrounding air temperatures are between 45°F and 90°F, unless otherwise permitted by paint manufacturer's printed instructions.
- C. Do not apply paint in rain, fog or mist, or when relative humidity exceeds 85%, or to damp or wet surfaces, unless otherwise permitted by paint manufacturer's printed instructions.
- D. Provide adequate ventilation during interior painting using as close to 100% outside air as possible.

PART 2 - PRODUCTS

2.01 APPROVED MANUFACTURERS

- A. Benjamin Moore products are specified as a standard of quality against which the equivalency of other products will be determined by the Architect.
 - 1. Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to Frazee, Dunn Edwards, Kelly Moore, Sherwin Williams or approved equal.

2.02 MATERIALS

- A. Material Compatibility: Provide block fillers, primers, finish coat materials, and related materials that are compatible with one another and the substrates indicated under conditions of service and application.
- B. Material Quality: Provide best quality grade of coatings as regularly manufactured by acceptable paint materials manufacturers. Materials not displaying manufacturer's identification as a standard, best-grade product will not be acceptable.

2.03 COLORS

- A. Colors will generally match existing colors as specified by the Architect.
- B. Colors of paints, including shades of stain, shall match color samples approved by Architect.
- C. Paint colors not scheduled will be selected by Architect.

2.04 PATCHING MATERIALS

- A. Wood Patching Compound: Two-part, epoxy-resin patching system; knife-grade formulation as recommended by manufacturer for type of wood repair indicated, tooling time required for the detail of work, and site conditions. Compound shall be designed for filling voids in damaged wood materials that have deteriorated due to weathering and decay. Compound shall be capable of filling deep holes and spreading to feather edge.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Abatron, Inc.; LiquidWood with WoodEpoxy.
 - b. Advanced Repair Technology, Inc.; Primatrate with Flex-Tec HV.
 - c. ConServ Epoxy LLC; Flexible Epoxy Consolidant 100 with Flexible Epoxy Patch 200.
 - d. Polymeric Systems, Inc.; QuickWood.
 - e. West System Inc.; West System.
 - f. Wood Care Systems; ROTFIX with SCULPWOOD.
 - g. Approved equal.

- B. Metal Patching Compound: Two-part, polyester-resin metal patching compound; knife-grade formulation as recommended by manufacturer for type of metal repair indicated, tooling time required for the detail of work, and site conditions. Compound shall be produced for filling metal that has deteriorated due to corrosion. Filler shall be capable of filling deep holes and spreading to feather edge.
- C. Cementitious Patching Compounds: Cementitious patching compounds and repair materials specifically manufactured for surface preparation and sanding of cementitious substrates prior to repainting; formulation as recommended by manufacturer for type of cementitious substrate indicated, exposure to weather and traffic, detail of work, and site conditions.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions under which painting is to be applied. Surfaces receiving paint shall be thoroughly dry before paint is applied.
 - 1. Provide barrier coats over incompatible primers or remove and reprime as required. Notify Architect prior to applying barrier coats.
 - 2. Clean surfaces before applying paint or surface treatments. Remove oil and grease prior to mechanical cleaning.
 - 3. Start of painting will be construed as the applicator's acceptance of surfaces and conditions within a particular area.

3.02 PROTECTION

- A. Protection: Protect work of other Sections against damage by painting and finishing work. Correct damage by cleaning, repairing or replacing, and repainting, as acceptable to Architect.
 - 1. Provide "Wet Paint" signs as required to protect newly-painted finishes. Remove temporary protective wrappings provided by others for protection of their work, after completion of painting operations.
 - 2. Remove or protect hardware, hardware accessories, machined surfaces, plates, lighting fixtures, and similar items in place and not to be finish-painted, or provide surface-applied protection prior to surface preparation and painting. Following completion of painting, reinstall removed items.
 - 3. At completion of work of other Sections, touch-up and restore damaged or defaced painted surfaces.

3.03 SURFACE PREPARATION

- A. Concrete and Interior Masonry: Prepare surfaces to be painted by removing surface contaminates.
 - 1. Remove efflorescence with stiff bristle brush, wire brushing, wiping, sandblasting or acid washing and rinsing. Allow to dry.
 - 2. Remove chalk, dust, dirt, asphalt, tar or excessive mortar by scraping or wire brushing.
 - 3. Remove rust, grease or oil by solvent cleaning or sandblasting.
 - 4. Treat concrete surfaces which are highly glazed or where traces of form release agents are present with a preparation of one-part concentrated muriatic acid, 4-parts water and one-part detergent or as recommended by parting compound manufacturer. Remove acid with water. Allow to dry.
 - 5. Remove stains on concrete resulting from weathering or corroded metals, with a solution of 2-oz. sodium methasilicate in one-gallon water. Wet stained areas with water before application of solution. Allow to dry.
- B. Wood: This Section describes the requirements for painting and finishing exterior wood siding, wood trim, cement board surface and exposed metal surface.
 - 1. "Surface Preparation" means pressure washing, scrape loose and peel paint, sanding, setting nails and screws, caulking, spot priming, specified primers and surface treatments specified in other Sections.

2. Remove sheen from previously painted glossy surfaces, if sandpaper is used, dust off surface. Sand new surfaces exposed to view smooth, and dust off surface.
 3. Scrape and clean small, dry, seasoned knots, and apply a thin coat of white shellac or other recommended knot sealer before applying primer. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood filler. Sand smooth when dry.
 4. Prime, stain, or seal unpainted wood to be painted immediately upon delivery. Prime edges, ends, faces, undersides, and backsides of wood.
 5. When transparent finish is required, backprime with spar varnish.
 6. Seal tops, bottoms, and cutouts of unprimed wood doors with a heavy coat of varnish or sealer immediately upon delivery.
 7. Work includes painting exposed pipes and ducts, hangers, exposed steel and iron, and primed metal surfaces of Mechanical and Electrical equipment, and general sheet metal work, except as otherwise indicated or specified.
 8. Work includes pressure washing entire area to be painted. If water collection from pressure washing is required by the Authority Having Jurisdiction it is the responsibility of the general contractor and or painting contractor to include this cost in the base bid.
 9. Work includes scraping all loose and peeling paint in failed areas.
 10. Work includes feather sanding scraped edges.
 11. Work includes setting all existing and new nail heads and/or screws flush.
 12. Work includes caulking nail heads and/or screw below the surface, holes, cracks, all trim butt joints, all siding seams and/or butt joints.
 13. Work includes spot priming repairs, caulking, rusted items, metal and new areas.
 14. ALL SUFACE PREPARATION NEEDS APPROVAL BY ARCHITECT BEFORE ANY FINISH COATS OF PAINT.
 15. Work includes back rolling all finish paint coats and primer coats.
 16. Work includes sanding metal, shop-primed surfaces and applying specified primer and finish coats.
 17. Work includes a uniformly painted finished surface, free of debris and/or material.
 18. "Paint" means coating systems materials, including primers, emulsions, enamels, stains, sealers and fillers, and other applied materials whether used as prime, intermediate or finish coats.
- C. Ferrous Metal: Clean ungalvanized ferrous metal surfaces that have not been shop-coated; remove oil, grease, dirt, loose mill scale, loose paint and other foreign substances. Use solvent or mechanical cleaning methods that comply with recommendations of the Steel Structures Painting Council (SSPC).
1. Treat bare and sandblasted or pickled clean metal with a metal treatment wash coat before priming.
 2. Sand shop-applied prime coats to a smooth surface, ready to receive specified primer and finish coats.
- D. Galvanized Metals:
1. New - Clean with nonpetroleum-based solvents so that the surface is free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods.

2. Previously Painted - Clean surfaces of dirt, oil, loose paint and other foreign substances with scrapers, mineral spirits, and sandpaper, as required. Sand all previously painted surfaces and new surfaces exposed to view smooth and dust off.
- E. Existing and new Cement Fiber Exterior Wallboard & Trim: Clean surfaces of dirt, oil, loose paint and other foreign substances with scrapers, mineral spirits, and sandpaper, as required. Sand all previously painted surfaces and new surfaces exposed to view smooth and dust off.
1. Scrape and clean small, dry, seasoned knots, and apply a thin coat of white shellac or other recommended knot sealer before applying primer. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood filler. Sand smooth when dry.
 2. Prime, stain, or seal wood to be painted immediately upon delivery. Prime edges, ends, faces, undersides, and backsides of wood, including cabinets, counters, cases, and paneling.
 3. All steps identified in item 3.03, B above shall be adhered to for existing or new Exterior Cement Fiber Wallboard and trim as necessary.

3.04 SUBSTRATE REPAIR

- A. This Section describes the requirements for painting and finishing exterior wood siding, wood trim, Cement board siding surface and exposed metal surface.
1. "Surface Preparation" means pressure washing, scrape loose and peel paint, sanding, setting nails and screws, caulking, spot priming, specified primers and surface treatments specified in other Sections. If water collection from cleaning is a requirement of the authority having jurisdiction the contractor is required to include in base bid.
 2. Work includes painting exposed pipes and ducts, hangers, exposed steel and iron, and primed metal surfaces of Mechanical and Electrical equipment, and general sheet metal work, except as otherwise indicated or specified.
 3. Work includes pressure washing entire area to be painted.
 4. Work includes scraping all loose and peeling paint in failed areas.
 5. Work includes feather sanding scraped edges.
 6. Work includes setting all existing nail heads and/or screws flush.
 7. Work includes caulking nail heads and/or screw heads below the surface, holes, cracks, all trim butt joints, all joints in general and siding seams and/or butt joints.
 8. Work includes spot priming repairs, caulking, rusted items, metal and new areas.
 9. ALL SUFACE PREPARATION NEEDS APPROVAL BY ARCHITECT BEFORE ANY FINISH COATS OF PAINT.
 10. Work includes back rolling all finish paint coats and primer coats.
 11. Work includes sanding metal, shop-primed surfaces and applying specified primer and finish coats.
 12. Work includes a uniformly painted finished surface, free of debris and/or material.
 13. "Paint" means coating systems materials, including primers, emulsions, enamels, stains, sealers and fillers, and other applied materials whether used as prime, intermediate or finish coats.
- B. Cementitious Material Substrate:
1. General: Repair defects including dents and chips more than 1/2 inch (13 mm) in size and all holes and cracks by filling with cementitious patching compound and sanding smooth. Remove protruding fasteners.

2. New and Bare Plaster: Neutralize surface of plaster with mild acid solution as recommended by paint manufacturer. In lieu of acid neutralization, follow manufacturer's written instruction for primer or transition coat over alkaline plaster surfaces.
 3. Concrete, Cement Plaster, and Other Cementitious Products: Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents. If surfaces are too alkaline to paint, correct this condition before painting.
- C. Metal Substrate:
1. General: Repair defects including dents and gouges more than 1/2 inch (13 mm) across and all holes and cracks by filling with metal patching compound and sanding smooth. Remove burrs and protruding fasteners.
 2. Prepare repair locations by wire-brushing and solvent cleaning. Use mechanical rust removal method to clean off rust.
 3. Prime iron and steel surfaces immediately after repair to prevent flash rusting. Stripe paint corners, crevices, bolts, welds, and sharp edges. Apply two coats to surfaces that will be inaccessible after completion of the Work.

3.05 MATERIALS PREPARATION

- A. Mix and prepare painting materials in accordance with manufacturer's directions.
- B. Maintain containers used in mixing and application of paint in a clean condition, free of foreign materials and residue.
- C. Stir materials before application to produce a mixture of uniform density, and stir as required during application. Do not stir surface film into material. Remove film and strain material before using.
- D. Use thinners approved by paint manufacturer and only within recommended limits.
- E. Tinting: Tint each undercoat a lighter shade to facilitate identification of each coat where multiple coats of the same material are applied. Tint undercoats to match the color of the finish coat, but provide sufficient differences in shade of undercoats to distinguish each separate coat.

3.06 APPLICATION

- A. General: Apply paint in accordance with manufacturer's directions. Use applicators and techniques best suited for substrate and type of material being applied.
 1. Provide finish coats that are compatible with prime coats
 2. On previously painted surfaces, spot prime any bare surfaces before applying final coat.
 3. The number of coats required is the same regardless of the application method. Do not apply following coats until the previous coat has cured as recommended by the manufacturer. Sand between applications where required to produce a smooth even surface.
 4. Apply additional coats when undercoats, stains or other conditions show through final coat, until paint film is of uniform finish, color and appearance. Edges, corners, crevices, welds, and exposed fasteners shall receive a dry film thickness equivalent to that of flat surfaces.
 5. Paint surfaces behind movable equipment and furniture.
 6. Paint surfaces behind permanently-fixed equipment or furniture with prime coat before final installation of equipment.
 7. Paint back sides of primed access panels, and removable or hinged covers to match exposed surfaces.
 8. Omit primer on metal surfaces that have been shop-primed and touch-up painted, unless otherwise indicated.

- B. Scheduling Painting: Apply first-coat material to surfaces that have been cleaned, pretreated or otherwise prepared for painting as soon as practicable after preparation.
 - 1. Allow sufficient time between successive coatings to permit proper drying.
- C. Application Procedures: Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's instructions.
 - 1. Brushes: Use brushes best suited for the material applied.
 - 2. Rollers: Use rollers of carpet, velvet back or high-pile sheep's wool as recommended by the manufacturer for the material and texture required.
 - 3. Spray Equipment: Use airless spray equipment with orifice size as recommended by the manufacturer for the material and texture required.
- D. Minimum Coating Thickness: Apply materials at not less than manufacturer's recommended spreading rate.
- E. Mechanical and Electrical Work: Painting mechanical and electrical work is limited to items exposed to the exterior. Finish to match adjoining surfaces.
 - 1. Mechanical items to be painted include, but are not limited to, piping, hangers, and supports; supports; motors and mechanical equipment; and accessory items.
 - 2. Electrical items to be painted include, but are not limited to conduit and fittings, panels, and switchgear.
- F. Prime Coats: Before applying finish coats, apply a prime coat. Recoat primed and sealed surfaces where there is evidence of suction spots or unsealed areas to assure a finish coat with no burn-through or other defects.
- G. Pigmented (Opaque) Finishes: Completely cover to provide an opaque, smooth surface of uniform finish, color, appearance and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness and other surface imperfections will not be acceptable.
- H. Transparent (Clear) Finishes: Use multiple coats to produce glass-smooth surface film of even luster. Provide a finish free of laps, cloudiness, color irregularity, runs, brush marks, orange peel, nail holes, or other surface imperfections.
- I. Completed Work: Match approved samples for color, texture and coverage. Remove, refinish or repaint work not in compliance with specified requirements.

3.07 FIELD QUALITY ASSURANCE

- A. The Owner reserves the right to invoke the following test procedure at any time and as often as the Owner deems necessary during painting.
 - 1. The Owner will engage the services of an independent testing agency to sample the paint material being used. Samples of material delivered to the Project will be taken, identified, sealed, and certified in the presence of the Contractor.
 - 2. The testing laboratory will perform appropriate tests for material analysis, abrasion resistance, reflectivity, flexibility, washability, absorption, accelerated weathering, dry opacity, accelerated yellowness, recoating, skinning, color retention, alkali and mildew resistance, and application to specified mil thicknesses.
 - 3. If test results show material being used does not comply with specified requirements, the Contractor may be directed to stop painting, remove noncomplying paint, pay for testing, repaint surfaces coated with rejected material, and remove rejected material from previously painted surfaces if, upon repainting with specified paint, the two coatings are incompatible.

3.08 CLEANING

- A. Clean-Up: During progress of work, remove discarded paint materials, rubbish, cans and rags at end of each work day.
- B. Upon completion of painting work, clean window glass and other paint-spattered surfaces. Remove spattered paint by washing and scraping; do not scratch or damage finished surfaces.

3.09 EXTERIOR PAINT SCHEDULE (Match existing colors)

A. Ferrous Metal, Acrylic Semigloss:

First Coat: 661 Metal Prime
Second and Third Coats: 124 Mirro Glide SG

C. 1. Wood Trim:

First Coat: Moorwhite Exterior Wood Primer (100)
Second and Third Coats: ben Low Lustre 542

2. Previously Painted Hard Board and Wood Trim:

Spot Prime First Coat: Moorwhite Exterior Wood Primer (100)
Second Coat: ben Low Lustre 542

END OF SECTION

DIVISION 22

PLUMBING

SECTION 22 00 00
GENERAL REQUIREMENTS - PLUMBING

PART 1 – GENERAL

1.01 DESCRIPTION – This Section 22 00 00 includes General Requirements for the work comprising the following sections:

- A. Section 22 05 29 Hangers and Supports
- B. Section 22 05 53 Identification for Plumbing Piping and Equipment
- C. Section 22 11 19 Plumbing Specialties
- D. Section 22 11 13 Natural Gas Piping
- E. Section 22 13 13 Condensate Drainage

1.02 WORK INCLUDED

- A. Provide all materials, equipment, labor, fabrication, specialties, and items necessary and incidental to the installations.
- B. Work included shall also include transportation, storage, utilities and required licenses and permits.

1.03 RELATED WORK AND REQUIREMENTS

- A. The work of this Section shall require work in coordination with other Divisions outside of this Section as follows:
 - 1. Section 01 00 00 General Requirements
 - 2. Section 01 33 23 Shop Drawings, Product Data and Samples
 - 3. Section 26 00 00 General Requirements, Electrical

1.04 QUALITY ASSURANCE

- A. Comply with Division 1 requirements regarding Quality Control and Assurance.
- B. Products Criteria:
 - 1. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 3 years. However, digital electronics devices, software and systems such as controls, instruments, computer workstation, shall be the current generation of technology and basic design that has a proven satisfactory service record of at least three years.

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GENERAL REQUIREMENTS - PLUMBING

2. Equipment Service: There shall be permanent service organizations, authorized and trained by manufacturers of the equipment supplied, located within 100 miles of the project. These organizations shall come to the site and provide acceptable service to restore operations within four hours of receipt of notification by phone, e-mail or fax in event of an emergency, such as the shut-down of equipment; or within 24 hours in a non-emergency. Names, mail and e-mail addresses and phone numbers of service organizations providing service under these conditions for (as applicable to the project): pumps, critical instrumentation, computer workstation and programming shall be submitted for project record and inserted into the operations and maintenance manual.
 3. All items furnished shall be free from defects that would adversely affect the performance, maintainability and appearance of individual components and overall assembly.
 4. The products and execution of work specified in Division 22 shall conform to the referenced codes and standards as required by the specifications. Local codes and amendments enforced by the local code official shall be enforced, if required by local authorities such as the natural gas supplier. If the local codes are more stringent, then the local code shall apply. Any conflicts shall be brought to the attention of the Engineer of Record.
 5. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.
 6. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.
 7. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped, or otherwise permanently marked on each item of equipment.
 8. Asbestos products or equipment or materials containing asbestos shall not be used.
- C. Manufacturer's Recommendations: Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished to the Engineer of Record prior to installation. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material.
- D. Execution (Installation, Construction) Quality:
1. All items shall be applied and installed in accordance with manufacturer's written instructions. Conflicts between the manufacturer's instructions and the contract drawings and specifications shall be referred to the Engineer of Record

SECTION 22 00 00

GENERAL REQUIREMENTS - PLUMBING

for resolution. Written hard copies or computer files of manufacturer's installation instructions shall be provided to the Engineer of Record at least two weeks prior to commencing installation of any item.

2. Complete layout drawings shall be required by Paragraph, SUBMITTALS. Construction work shall not start on any system until the layout drawings have been approved.

E. Plumbing Systems: CPC, California Plumbing Code, 2022.

1.05 SUBMITTALS

- A. Comply with Division 1 requirements regarding submittals and the requirements herein.
- B. Contractor shall make all necessary field measurements and investigations to assure that the equipment and assemblies will meet contract requirements.
- C. If equipment is submitted which differs in arrangement from that shown, provide drawings that show the rearrangement of all associated systems. Approval will be given only if all features of the equipment and associated systems, including accessibility, are equivalent to that required by the contract.
- D. Prior to submitting layout drawings for approval, contractor shall certify in writing that manufacturers of all major items of equipment have each reviewed drawings and specifications and have jointly coordinated and properly integrated their equipment and controls to provide a complete and efficient installation.
- E. Upon request by Engineer of Record, lists of previous installations for selected items of equipment shall be provided. Contact persons who will serve as references, with telephone numbers and e-mail addresses shall be submitted with the references.
- F. Manufacturer's Literature and Data: Manufacturer's literature shall be submitted under the pertinent section rather than under this section.
 1. Electric motor data and variable speed drive data shall be submitted with the driven equipment.
 2. Equipment and materials identification.
 3. Fire stopping materials.
 4. Hangers, inserts, supports and bracing. Provide load calculations for variable spring and constant support hangers.
 5. Wall, floor, and ceiling plates.
- G. Maintenance Data and Operating Instructions:
 1. Maintenance and operating manuals in accordance with Division 01 for systems and equipment and as stated herein.

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GENERAL REQUIREMENTS - PLUMBING

2. Listing of recommended replacement parts for keeping in stock supply, including sources of supply, for equipment shall be provided.
 3. The listing shall include belts for equipment: Belt manufacturer, model number, size and style, and distinguished whether of multiple belt sets.
- H. Clearly and neatly strike out of irrelevant information. Clearly and neatly tag and mark equipment, options and specialties and special features. Key tags to match tags on Drawings.
1. If substituting on Specified equipment provide comprehensive written comparison of characteristics between specified and substituted equipment. Doing a data "dump" of Operation and Maintenance manuals, and similar "total catalog dumps" shall not be an acceptable method of submission.
- I. Provide information in an easily readable and legible format presentation.
- J. Provide an index with corresponding labeled and tabbed dividers for sections, in a three-ring hard cover binder or hard cover binding folder. Loose leaf sections, provided separately, shall not be acceptable. Front index shall include, at a minimum:
1. Full, formal, name and address, including zip code, for job.
 2. Company name, address, phone, and fax numbers of General Contractor, including phone land line number of job trailer and cellular phone number and name of job site Superintendent. Also provide contact name of office Project Manager.
 3. Name, address, phone, and fax number of Plumbing Contractor, including phone land line of job trailer, if applicable, and cellular phone number and name of job site Superintendent. Also provide contact name of office Project Manager.
- K. Submit all items at the same time.
- L. Unless specified otherwise in Division 1 requirements submit 5 copies of data. Engineer will return 4 copies while retaining one for internal office use as a Project Record Document.
- M. Paper copies shall be the only acceptable submittal medium.
- N. Submittals shall be prepared and submitted in a timely fashion to allow adequate time for ordering of long lead time equipment and materials.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Protection of Equipment:

SECTION 22 00 00

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1. Equipment and material placed on the job site shall remain in the custody of the Contractor until phased acceptance, whether the Owner has reimbursed the Contractor for the equipment and material, or not. The Contractor is solely responsible for the protection of such equipment and material against any damage.
2. Damaged equipment shall be replaced with an identical unit as determined and directed by the Engineer of Record. Such replacement shall be at no additional cost to the Owner.
3. Interiors of new equipment and piping systems shall be protected against entry of foreign matter. Both inside and outside shall be cleaned before painting or placing equipment in operation.
4. Existing equipment and piping being worked on by the Contractor shall be under the custody and responsibility of the Contractor and shall be protected as required for new work.

B. Cleanliness of Piping and Equipment Systems:

1. Care shall be exercised in the storage and handling of equipment and piping material to be incorporated in the work. Debris arising from cutting, threading, and welding of piping shall be removed.
2. Piping systems shall be flushed, blown, or pigged as necessary to deliver clean systems.
3. The interior of all tanks shall be cleaned prior to delivery and beneficial use by the Owner. All piping shall be tested in accordance with the specifications and the California Plumbing Code (CPC), latest edition. All filters, strainers, fixture faucets shall be flushed of debris prior to final acceptance.
4. Contractor shall be fully responsible for all costs, damage, and delay arising from failure to provide clean systems.

1.07 APPLICABLE PUBLICATIONS

- A. The publications listed below shall form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society of Mechanical Engineers (ASME):
 1. Boiler and Pressure Vessel Code (BPVC):
 2. SEC IX-2021 Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications.
- C. American Society for Testing and Materials (ASTM):
 1. A36/A36M-2019 Standard Specification for Carbon Structural Steel

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2. A575-96-2020 Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades R (2002)
 3. E84-2021 Standard Test Method for Surface Burning Characteristics of Building Materials
 4. E119-2021 Standard Test Methods for Fire Tests of Building Construction and Materials
- D. Manufacturers Standardization Society (MSS) of the Valve and Fittings Industry, Inc:
1. SP-58 Pipe Hangers and Supports-Materials, Design and Manufacture
 2. SP 69 Pipe Hangers and Supports-Selection and Application
- E. National Electrical Manufacturers Association (NEMA):
1. MG1-2003 Motors and Generators

1.08 CODES, REGULATIONS, STANDARDS, AND GUIDELINES

- A. Work shall be in accordance with requirements of the latest jurisdiction adopted editions of the following:
1. CBC - California Building Code, 2022 Edition
 2. CMC - California Mechanical Code, 2022 Edition
 3. CPC - California Plumbing Code, 2022 Edition
 4. CGBCS California Green Building Construction Standards, 2022 Edition
 5. CEC - California Electrical Code, 2022 Edition
 6. CFC - California Fire Code, 2022 Edition
 7. CEC - California Energy Commission, Title 24, Part VI, 2022 Edition
- B. The work shall comply with the latest editions of the following guidelines and standards:
1. AABC Associated Air Balance Council
 2. AGA American Gas Association
 3. AMCA Air Movement and Control Association
 4. ANSI American National Standards Institute
 5. ARI American Refrigeration Institute
 6. ASHRAE American Society of Heating Refrigerating and Air Conditioning Engineers

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- 7. ASME American Society of Mechanical Engineers
- 8. ASTM American Society for Testing and Materials
- 9. NEC National Electric Code
- 10. NFPA National Fire Protection Association
- 11. SMACNA Sheetmetal and Air-Conditioning Contractors National Association
- 12. UL Underwriters Laboratories

C. When the work calls for more stringent requirements than the above listings the Specifications and Drawings shall take precedence.

1.09 SITE VISIT AND FAMILIARIZATION

- A. Visit the site and become familiar with the Drawings and Specifications. Examine the site and understand the conditions under which the Contract shall be performed.
- B. Refer to Division 1 for Pre-Bid Conference requirements.

1.10 REVIEW OF CONSTRUCTION

- A. Work may be reviewed, without prior notice, at any time by representatives of Owner.
- B. Advise Owner and Owner Representative when work is ready for review at the following times:
 - 1. Prior to concealment of Work in walls and above ceilings and any other enclosable spaces. Conceal Work only after obtaining Owner and Architect consent.
- C. Maintain an on the job set of Specifications and Drawings for use by Owner and representatives.

1.11 BID DOCUMENT DESCRIPTION

- A. Specifications describe quality of materials and equipment.
- B. Drawings describe the work in diagrammatic form. Drawings do not show exact detail and arrangements. Final requirements of the Work shall be determined by the Contractor after coordination with other trades.
- C. Do not scale drawings. Contractor is required to visit the site prior to bid and verify all physical sizing of equipment, systems, and components independently prior to bid.

1.12 DEFINITIONS

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A. Definitions following may not match those in other sections. Definitions listed here govern this part of the Work and take precedence over those listed elsewhere.

1. Concealed: Embedded in masonry or other construction, installed in furred spaces, within partitions or hung ceilings, in trenches, crawl spaces, or in enclosures.
2. Connect: Complete hook-up of items with required services.
3. Down: A vertical pipe or piece of work that does penetrate a floor.
4. Drop: A vertical pipe or piece of work that does not penetrate a floor.
5. Exposed: Not installed underground or "concealed" as defined within this list.
6. Provide: To furnish, supply, install and connect up complete and ready safe and regular operation of particular work referred to unless specifically noted.
7. Supply: To purchase, procure, acquire and deliver complete with related accessories.
8. Work: Labor, materials, equipment, apparatus, controls, accessories and other items required for complete and proper operation.
9. Install: To erect, mount and connect complete with related accessories.
10. Riser: A vertical pipe or piece of work having a vertical length greater than one story height.
11. Indicated, Shown or Noted: As indicated, shown, or noted on Drawings and Specifications.
12. Other Division(s): Specification Sections that do not include the HVAC Divisions.
13. Motor Controllers: Manual or magnetic starters (with or without switches), individual pushbuttons or hand-off-automatic (HOA) switches controlling the operation of the motors.

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PART 2 – PRODUCTS

2.01 MATERIALS

- A. Materials, equipment, and supplies shall be new and latest types and models of manufacturers and shall bear identification markings, nameplates, and labels.
- B. Equipment specified by manufacturer's number shall include all accessories, controls, etc., listed in catalog as standard with equipment. Provide optional or additional accessories as specified or scheduled incidental to the Work such as, but not limited to, caulking, gaskets, sealants, fasteners, etc.
- C. Where no specific make of material or equipment is mentioned, any first-class product of good reputable manufacturer may be used, provided it conforms to requirements of system and meets acceptance of Owner.
- D. Equipment, material and supplies damaged during transportation, installation and operation is considered as totally damaged and shall be replaced with new. Variance from this is permitted only with approval of Owner.
- E. Provide an authorized representative to constantly supervise work of this Division, check all materials prior to installation for conformance with Drawings, Specifications, reviewed Submittals and reviewed Coordination Drawings as referenced in Part 1.
- F. Electrical Work performed in the service of the plumbing and piping installation shall conform to Division 26 Electrical requirements. Provide weatherproof devices and installations for Work exposed to the elements.

2.02 FACTORY-ASSEMBLED PRODUCTS

- A. Standardization of components shall be maximized to reduce spare part requirements.
- B. Manufacturers of equipment assemblies that include components made by others shall assume complete responsibility for final assembled unit.
 - 1. All components of an assembled unit need not be products of same manufacturer.
 - 2. Constituent parts that are alike shall be products of a single manufacturer.
 - 3. Components shall be compatible with each other and with the total assembly for intended service.
 - 4. Contractor shall guarantee performance of assemblies of components and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly.

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- C. Components of equipment shall bear manufacturer's name and trademark, model number, serial number and performance data on a name plate securely affixed in a conspicuous place, or cast integral with, stamped or otherwise permanently marked upon the components of the equipment.
- D. Major items of equipment, which serve the same function, shall be the same make and model

2.03 COMPATIBILITY OF RELATED EQUIPMENT

- A. Equipment and materials installed shall be compatible in all respects with other items being furnished and with existing items so that the result will be a complete and fully operational system that conforms to contract requirements.

2.04 EQUIPMENT AND MATERIALS IDENTIFICATION

- A. Interior (Indoor) Equipment: Engraved nameplates, with letters not less than 3/16-inch high of brass with black-filled letters, or rigid black plastic with white letters.
- B. Exterior (Outdoor) Equipment: Brass nameplates, with engraved black filled letters, not less than 3/16-inch high riveted or bolted to the equipment.
- C. Control Items: All temperature, pressure, and controllers shall be labeled, and the component's function identified. Identify and label each item as they appear on the control diagrams.
- D. Valve Tags and Lists:
 - 1. Plumbing: All valves shall be provided with valve tags and listed on a valve list (Fixture stops not included).
 - 2. Valve tags: Engraved black filled numbers and letters not less than 1/2-inch high for number designation, and not less than 1/4-inch for service designation on 19 gage, 1-1/2 inches round brass disc, attached with brass "S" hook or brass chain.
 - 3. Valve lists: Valve lists shall be created using a word processing program and printed on plastic coated cards. The plastic-coated valve list card(s), sized 8-1/2 inches by 11 inches shall show valve tag number, valve function and area of control for each service or system. The valve list shall be in a punched 3-ring binder notebook. A copy of the valve list shall be mounted in picture frames for mounting to a wall.
 - 4. A detailed plan for each floor of the building indicating the location and valve number for each valve shall be provided. Each valve location shall be identified with a color-coded sticker or thumb tack in ceiling.

2.05 PIPE AND EQUIPMENT SUPPORTS AND RESTRAINTS

- A. Model numbers listed are by Cooper Industries.

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- B. For Attachment to Concrete Construction:
1. Concrete insert: Type 18, MSS SP-58.
 2. Self-drilling expansion shields and machine bolt expansion anchors: Permitted in concrete not less than 4 inches thick when approved by the Structural Engineer of Record for each job condition.
 3. Power-driven fasteners: Permitted in existing concrete or masonry not less than 4 inches thick when approved by the Structural Engineer of Record for each job condition.
- C. For Attachment to Steel Construction: MSS SP-58.
1. Welded attachment: Type 22.
 2. Beam clamps: Types 20, 21, 28 or 29. Type 23 C-clamp may be used for individual copper tubing up to 7/8-inch outside diameter.
- D. For Attachment to Wood Construction: Wood screws or lag bolts.
- E. Hanger Rods: Hot-rolled steel, ASTM A36 or A575 for allowable load listed in MSS SP-58. For piping, provide adjustment means for controlling level or slope. Types 13 or 15 turn-buckles shall provide 1-1/2 inches minimum of adjustment and incorporate locknuts. All-thread rods are acceptable.
- F. Multiple (Trapeze) Hangers: Galvanized, cold formed, lipped steel channel horizontal member, not less than 1-5/8 inches by 1-5/8 inches, No. 12 gage, designed to accept special spring held, hardened steel nuts. Trapeze hangers are not permitted for steam supply and condensate piping.
1. Allowable hanger load: Manufacturers rating less 200 pounds.
 2. Guide individual pipes on the horizontal member of every other trapeze hanger with 1/4-inch U-bolt fabricated from steel rod. Provide Type 40 insulation shield, secured by two 1/2-inch galvanized steel bands, or insulated calcium silicate shield for insulated piping at each hanger.
- G. Pipe Hangers and Supports: (MSS SP-58), use hangers sized to encircle insulation on insulated piping. To protect insulation, provide Type 39 saddles for roller type supports or insulated calcium silicate shields. Provide Type 40 insulation shield or insulated calcium silicate shield at all other types of supports and hangers including those for insulated piping.
1. General Types (MSS SP-58):
 - a. Standard clevis hanger: Type 1; provide locknut.
 - b. Riser clamps: Type 8.

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- c. Wall brackets: Types 31, 32 or 33.
- d. Roller supports: Type 41, 43, 44 and 46.
- e. Saddle support: Type 36, 37 or 38.
- f. Turnbuckle: Types 13 or 15.
- g. U-bolt clamp: Type 24.
- h. Copper Tube:
 - 1. Hangers, clamps and other support material in contact with tubing shall be painted with copper colored epoxy paint, plastic coated or taped with isolation tape to prevent electrolysis.
 - 2. For vertical runs use epoxy painted or plastic-coated riser clamps.
 - 3. For supporting tube to strut: Provide epoxy painted pipe straps for copper tube or plastic inserted vibration isolation clamps.
 - 4. Insulated Lines: Provide pre-insulated calcium silicate shields sized for copper tube.
- i. Spring hangers are required on all plumbing system pumps one horsepower and greater.
- 2. Plumbing Piping (Other Than General Types):
 - a. Horizontal piping: Type 1, 5, 7, 9, and 10.
 - b. Chrome plated piping: Chrome plated supports.
 - c. Hangers and supports in pipe chase: Prefabricated system ABS self-extinguishing material, not subject to electrolytic action, to hold piping, prevent vibration and compensate for all static and operational conditions.
 - d. Blocking, stays and bracing: Angle iron or preformed metal channel shapes, 18 gage minimum.
- H. Pre-insulated Calcium Silicate Shields:
 - 1. Provide 360-degree water resistant high density 140 psi compressive strength calcium silicate shields encased in galvanized metal.
 - 2. Pre-insulated calcium silicate shields to be installed at the point of support during erection.
 - 3. Shield thickness shall match the pipe insulation.

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4. The type of shield is selected by the temperature of the pipe, the load it must carry, and the type of support it will be used with.
 - a. Shields for supporting cold water shall have insulation that extends a minimum of one inch past the sheet metal.
 - b. The insulated calcium silicate shield shall support the maximum allowable water filled span as indicated in MSS-SP 69. To support the load, the shields shall have one or more of the following features: structural inserts 600 psi compressive strength, an extra bottom metal shield, or formed structural steel (ASTM A36) wear plates welded to the bottom sheet metal jacket.
5. Shields may be used on steel clevis hanger type supports, roller supports or flat surfaces.

2.06 PIPE PENETRATIONS

- A. Pipe penetration sleeves shall be installed for all piping other than rectangular blocked out floor openings for risers in mechanical bays.
- B. Pipe penetration sleeve materials shall comply with all fire stopping requirements for each penetration.
- C. To prevent accidental liquid spills from passing to a lower level, provide the following:
 1. For sleeves: Extend sleeve 1 inch above finished floor and provide sealant for watertight joint.
 2. For blocked out floor openings: Provide 1-1/2 inch angle set in silicone adhesive around opening.
 3. For drilled penetrations: Provide 1-1/2 inch angle ring or square set in silicone adhesive around penetration.
- D. Penetrations are not allowed through beams or ribs but may be installed in concrete beam flanges. Any deviation from these requirements must receive prior approval of Structural Engineer of Record.
- E. Sheet metal, plastic, or moisture resistant fiber sleeves shall be provided for pipe passing through floors, interior walls, and partitions, unless brass or steel pipe sleeves are specifically called for below.
- F. Cast iron or zinc coated pipe sleeves shall be provided for pipe passing through exterior walls below grade. The space between the sleeve and pipe shall be made watertight with a modular or link rubber seal. The link seal shall be applied at both ends of the sleeve.

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- G. Galvanized steel or an alternate black iron pipe with asphalt coating sleeves shall be for pipe passing through concrete beam flanges, except where brass pipe sleeves are called for. A galvanized steel Sleeve shall be provided for pipe passing through floor of mechanical rooms, laundry work rooms, and animal rooms above basement. Except in mechanical rooms, sleeves shall connect to a floor plate.
- H. Brass Pipe Sleeves shall be provided for pipe passing through quarry tile, terrazzo or ceramic tile floors. The sleeve shall connect to a floor plate.
- I. Sleeve clearance through floors, walls, partitions, and beam flanges shall be 1 inch greater in diameter than external diameter of pipe. Sleeve for pipe with insulation shall be large enough to accommodate the insulation plus 1 inch in diameter. Interior openings shall be caulked tight with fire stopping material and sealant to prevent the spread of fire, smoke, and gases.

2.07 WALL, FLOOR AND CEILING PLATES

- A. Material and Type: Chrome plated brass or chrome plated steel, one piece or split type with concealed hinge, with set screw for fastening to pipe, or sleeve. Use plates that fit tight around pipes, cover openings around pipes and cover the entire pipe sleeve projection.
- B. Thickness: Not less than 3/32-inch for floor plates. For wall and ceiling plates, not less than 0.025-inch for up to 3-inch pipe, 0.035-inch for larger pipe.
- C. Locations: Use where pipe penetrates floors, walls, and ceilings in exposed locations, in finished areas only. Wall plates shall be used where insulation ends on exposed water supply pipe drop from overhead. A watertight joint shall be provided in spaces where brass or steel pipe sleeves are specified.

2.08 ASBESTOS

- A. Materials containing asbestos are not permitted.

PART 3 – EXECUTION

3.01 ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING

- A. Location of piping, sleeves, inserts, hangers, and equipment, access provisions shall be coordinated with the work of all trades. Piping, sleeves, inserts, hangers, and equipment shall be located clear of windows, doors, openings, light outlets, and other services and utilities. Equipment layout drawings shall be prepared to coordinate proper location and personnel access of all facilities. The drawings shall be submitted for review.
- B. Manufacturer's published recommendations shall be followed for installation methods not otherwise specified.

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- C. Operating Personnel Access and Observation Provisions: All equipment and systems shall be arranged to provide clear view and easy access, without use of portable ladders, for maintenance and operation of all devices including, but not limited to: all equipment items, valves, filters, strainers, transmitters, sensors, and control devices. All gages and indicators shall be clearly visible by personnel standing on the floor or on permanent platforms. Maintenance and operating space and access provisions that are shown on the drawings shall not be changed nor reduced.
- D. Structural systems necessary for pipe and equipment support shall be coordinated to permit proper installation.
- E. Location of pipe sleeves, trenches and chases shall be accurately coordinated with equipment and piping locations.
- F. Cutting Holes:
 - 1. Holes through concrete and masonry shall be cut by rotary core drill. Pneumatic hammer, impact electric, and hand or manual hammer type drill will not be allowed, except as permitted by Structural Engineer of Record where working area space is limited.
 - 2. Holes shall be located to avoid interference with structural members such as beams or grade beams. Holes shall be laid out in advance and drilling done only after approval by Structural Engineer of Record. If the Contractor considers it necessary to drill through structural members, this matter shall be referred to Structural Engineer of Record for approval.
 - 3. Waterproof membrane shall not be penetrated. Pipe floor penetration block outs shall be provided outside the extents of the waterproof membrane.
- G. Minor Piping: Generally, small diameter pipe runs from drips and drains, water cooling, and other service are not shown but must be provided.
- H. Protection and Cleaning:
 - 1. Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the manufacturer's recommendations and as approved by the Engineer of Record. Damaged or defective items in the opinion of the Engineer of Record, shall be replaced.
 - 2. Protect all finished parts of equipment, such as shafts and bearings where accessible, from rust prior to operation by means of protective grease coating and wrapping. Close pipe openings with caps or plugs during installation. Pipe openings, equipment, and plumbing fixtures shall be tightly covered against dirt or mechanical injury. At completion of all work thoroughly clean fixtures, exposed materials and equipment.

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- I. Interconnection of Controls and Instruments: Electrical interconnection is generally not shown but shall be provided. This includes interconnections of sensors, transmitters, transducers, control devices, control and instrumentation panels, instruments and computer workstations. Comply with NFPA-70.
- J. Work in bathrooms, restrooms, housekeeping closets: All pipe penetrations behind escutcheons shall be sealed with plumber's putty.
- K. Switchgear Drip Protection: Every effort shall be made to eliminate the installation of pipe above electrical and telephone switchgear. If this is not possible, encase pipe in a second pipe with a minimum of joints.
- L. Inaccessible Equipment:
 - 1. Where the Owner determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled or remedial action performed as directed at no additional cost to the Owner.
 - 2. The term "conveniently accessible" is defined as capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as electrical conduit, motors, fans, pumps, belt guards, transformers, high voltage lines, piping, and ductwork.

3.02 TEMPORARY PIPING AND EQUIPMENT

- A. Continuity of operation of existing facilities may require temporary installation or relocation of equipment and piping. Temporary equipment or pipe installation or relocation shall be provided to maintain continuity of operation of existing facilities.
- B. The Contractor shall provide all required facilities in accordance with the requirements of phased construction and maintenance of service. All piping and equipment shall be properly supported, sloped to drain, operate without excessive stress, and shall be insulated where injury can occur to personnel by contact with operating facilities.
- C. Temporary facilities and piping shall be completely removed and any openings in structures sealed. Necessary blind flanges and caps shall be provided to seal open piping remaining in service.

3.03 PIPE AND EQUIPMENT SUPPORTS

- A. Where hanger spacing does not correspond with joist or rib spacing, use structural steel channels secured directly to joist and rib structure that will correspond to the required hanger spacing, and then suspend the equipment and piping from the channels. Holes shall be drilled or burned in structural steel ONLY with the prior written approval of the Structural Engineer of Record.

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- B. The use of chain pipe supports, wire or strap hangers; wood for blocking, stays and bracing, or hangers suspended from piping above shall not be permitted. Rusty products shall be replaced.
- C. Hanger rods shall be used that are straight and vertical. Turnbuckles for vertical adjustments may be omitted where limited space prevents use. A minimum of 15 mm (1/2-inch) clearance between pipe or piping covering and adjacent work shall be provided.
- D. For horizontal and vertical plumbing pipe supports, refer to the California Plumbing Code (CPC), latest edition, and these specifications.
- E. Overhead Supports:
 - 1. The basic structural system of the building is designed to sustain the loads imposed by equipment and piping to be supported overhead.
 - 2. Provide steel structural members, in addition to those shown, of adequate capability to support the imposed loads, located in accordance with the final approved layout of equipment and piping.
 - 3. Tubing and capillary systems shall be supported in channel troughs.
- F. Floor Supports:
 - 1. Provide concrete bases, concrete anchor blocks and pedestals, and structural steel systems for support of equipment and piping. Concrete bases and structural systems shall be anchored and doweled to resist forces under operating and seismic conditions (if applicable) without excessive displacement or structural failure.
 - 2. Bases and supports shall not be located and installed until equipment mounted thereon has been approved. Bases shall be sized to match equipment mounted thereon plus 2 inch excess on all edges. Structural drawings shall be reviewed for additional requirements. Bases shall be neatly finished and smoothed, shall have chamfered edges at the top, and shall be suitable for painting.
 - 3. All equipment shall be shimmed, leveled, firmly anchored, and grouted with epoxy grout. Anchor bolts shall be placed in sleeves, anchored to the bases. Fill the annular space between sleeves and bolts with a grout material to permit alignment and realignment.

3.04 LUBRICATION

- A. All equipment and devices requiring lubrication shall be lubricated prior to initial operation. All devices and equipment shall be field checked for proper lubrication.
- B. All devices and equipment shall be equipped with required lubrication fittings. A minimum of one quart of oil and one pound of grease of manufacturer's recommended

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grade and type for each different application shall be provided. All materials shall be delivered to the Owner in unopened containers that are properly identified as to application.

- C. A separate grease gun with attachments for applicable fittings shall be provided for each type of grease applied.
- D. All lubrication points shall be accessible without disassembling equipment, except to remove access plates.
- E. All lubrication points shall be extended to one side of the equipment.

3.05 CLEANING AND PAINTING

- A. Prior to final inspection and acceptance of the plant and facilities for beneficial use by the Owner, the plant facilities, equipment, and systems shall be thoroughly cleaned and painted.
- B. In addition, the following special conditions apply:
 - 1. Cleaning shall be thorough. Solvents, cleaning materials and methods recommended by the manufacturers shall be used for the specific tasks. All rust shall be removed prior to painting and from surfaces to remain unpainted. Scratches, scuffs, and abrasions shall be repaired prior to applying prime and finish coats.
 - 2. The following Material and Equipment shall NOT be painted:
 - a. Motors, controllers, control switches, and safety switches.
 - b. Control and interlock devices.
 - c. Regulators.
 - d. Pressure reducing valves.
 - e. Control valves and thermostatic elements.
 - f. Lubrication devices and grease fittings.
 - g. Copper, brass, aluminum, stainless steel and bronze surfaces.
 - h. Valve stems and rotating shafts.
 - i. Pressure gauges and thermometers.
 - j. Glass.
 - k. Name plates.

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3. Control and instrument panels shall be cleaned and damaged surfaces repaired. Touch-up painting shall be made with matching paint obtained from manufacturer or computer matched.
4. Pumps, motors, steel and cast-iron bases, and coupling guards shall be cleaned, and shall be touched-up with the same color as utilized by the pump manufacturer.
5. Temporary Facilities: Apply paint to surfaces that do not have existing finish coats.
6. The result shall be a smooth, even-colored, even-textured factory finish on all items. The entire piece of equipment shall be repainted, if necessary, to achieve this.

3.06 IDENTIFICATION SIGNS

- A. Laminated plastic signs, with engraved lettering not less than 3/16-inch high, shall be provided that designates equipment function, for all equipment, switches, motor controllers, relays, meters, control devices, including automatic control valves. Nomenclature and identification symbols shall correspond to that used in maintenance manual, and in diagrams specified elsewhere. Attach by chain, adhesive, or screws.
- B. Factory Built Equipment: Metal plate, securely attached, with name and address of manufacturer, serial number, model number, size, performance shall be placed on factory-built equipment.

3.07 STARTUP AND TEMPORARY OPERATION

- A. Startup of equipment shall be performed as described in the equipment specifications. Vibration within specified tolerance shall be verified prior to extended operation.

3.08 OPERATING AND PERFORMANCE TESTS

- A. Should evidence of malfunction in any tested system, or piece of equipment or component part thereof, occur during or because of tests, make proper corrections, repairs or replacements, and repeat tests at no additional cost to the Owner.
- B. When completion of certain work or system occurs at a time when final control settings and adjustments cannot be properly made to make performance tests, then make performance tests such systems respectively during first actual seasonal use of respective systems following completion of work.

3.09 OPERATION AND MAINTENANCE MANUALS

- A. Provide four bound copies. The operations and maintenance manuals shall be delivered to the Owner not less than 30 days prior to completion of a phase or final inspection.
- B. All new and temporary equipment and all elements of each assembly shall be included.

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- C. Data sheet on each device listing model, size, capacity, pressure, speed, horsepower, impeller size, and other information shall be included.
- D. Manufacturer's installation, maintenance, repair, and operation instructions for each device shall be included. Assembly drawings and parts lists shall also be included. A summary of operating precautions and reasons for precautions shall be included in the Operations and Maintenance Manual.
- E. Lubrication instructions, type and quantity of lubricant shall be included.
- F. Schematic diagrams and wiring diagrams of all control systems corrected to include all field modifications shall be included.
- G. Set points of all interlock devices shall be listed.
- H. Trouble-shooting guide for the control system troubleshooting guide shall be inserted into the Operations and Maintenance Manual.
- I. The combustion control system sequence of operation corrected with submittal review comments shall be inserted into the Operations and Maintenance Manual.
- J. Emergency procedures.

3.10 PROTECTION OF WORK

- A. Cap all fixture, pipe and equipment openings daily to protect from dust, moisture and incidental debris.
- B. Porous materials that become wetted shall be replaced with new. Drying is not sufficient as it introduces the possibility of microbial growth. This applies to insulation and any material that acts as a sponge.
- C. All air distribution shall be capped during construction to prevent accumulation of dirt, dust, and debris.

3.11 SAFETY

- A. The contractor shall be solely responsible for conditions of the job site, including safety of all persons and property during performance of the work. This shall also apply to non-normal working hours.

3.12 RECORD DRAWINGS

- A. Contractor is required to provide record Drawings in accordance with Division 01 – General Requirements and this section.

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- B. Keep and accurate record of job progress including as-built locations and of the Work. Keep record up-to-date on legible full-size copies as job progresses. Make available to Owner and Owner representatives during project.
- C. In addition to any other requirements, include on as-built Drawings the following:
 - 1. Changes in location of piping or equipment.
 - 2. Ceiling access panel locations.
 - 3. Position of buried or concealed mains accurately dimensioned, both horizontally and vertically.

3.13 COMPLETION

- A. When Work is completed, or when Owner or Owner representative directs, remove surplus equipment, material, waste, and rubbish, and leave building in satisfactory condition.
- B. Adjust faucets and flush valves to give proper supply of water and leave in first class condition.

3.14 WARRANTIES AND GUARANTEES

- A. Contractor is required to provide warranties in accordance with Division 1 – General Requirements.
 - 1. Collect all warranties and guarantees for materials and equipment and neatly fill out all required information for the Owner. Provide one copy of each certificate for turn over to Architect. Arrange certificates in a tabbed and indexed binder for Architect ease of use.
- B. At the completion of the work contractor shall guarantee to repair or replace materials and workmanship found defective for a period of one year from date of filing of Notice of Completion. This work shall be performed at no cost to the Owner.
 - 1. Work of other trades damaged because of faulty workmanship or materials shall be repaired at no cost to the Owner.

END OF SECTION

SECTION 22 05 29
HANGERS AND SUPPORTS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. The work covered under this section consists of providing all necessary labor, supervision, materials, equipment and services to completely execute the hangers and supports as described in this specification.
- B. All work of this section shall comply with Section 22 00 00 GENERAL REQUIREMENTS – PLUMBING.

1.02 REFERENCES

- A. ASTM International:
 - 1. ASTM B633-2019 - Specification for Electrodeposited Coatings of Zinc on Iron and Steel
 - 2. ASTM A123 - Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip
 - 3. ASTM A653 – Specification for Steel Sheet, Zinc-Coated by the Hot-Dip Process
 - 4. ASTM A1011 - Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability (Formerly ASTM A570)

1.03 SUBMITTALS

- A. Submit product data on all hanger and support devices, including shields and attachment methods. Product data to include, but not limited to materials, finishes, approvals, load ratings, and dimensional information.

1.04 QUALITY ASSURANCE

- A. Steel pipe hangers and supports shall have the manufacturer's name, part number, and applicable size stamped in the part itself for identification.
- B. Hangers and supports shall be designed and manufactured in conformance with MSS SP 58.
- C. Supports for sprinkler piping shall be in conformance with NFPA 13.

1.05 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years of documented experience.

SECTION 22 05 29
HANGERS AND SUPPORTS

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- B. Protect from weather and construction traffic, dirt, water, chemical, and damage, by storing in original packaging.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Model numbers are Cooper B-Line. Engineer approved equivalent is acceptable.

2.02 HANGERS AND SUPPORTS

A. Single Pipe Hangers

- 1. Uninsulated pipes 2 inch and smaller:
 - a. Adjustable steel swivel ring (band type) hanger, B-Line B3170.
 - b. Adjustable steel swivel J-hanger, B-Line B3690.
 - c. Malleable iron ring hanger, B-Line B3198R or hinged ring hanger, B3198H.
 - d. Malleable iron split-ring hanger with eye socket, B-Line B3173 with B3222.
 - e. Adjustable steel clevis hanger, B-Line B3104 or B3100.

B. Pipe Clamps

- 1. When flexibility in the hanger assembly is required due to horizontal movement, use pipe clamps with weld-less eye nuts, B-Line B3140 or B3142 with B3200. For insulated lines use double bolted pipe clamps, B-Line B3144 or B3146 with B3200.
- 2. For supporting vertical runs use epoxy painted or plastic coated riser clamps, B-Line B3373CT or B3373CTC.
- 3. For supporting copper tube to strut use epoxy painted pipe straps sized for copper tubing, B-Line B2000 series, or plastic inserted vibration isolation clamps, B-Line BVT series.

C. Supplementary Structural Supports

SECTION 22 05 29
HANGERS AND SUPPORTS

1. Design and fabricate supports using structural quality steel bolted framing materials as manufactured by Cooper B-Line. Channels shall be roll formed, 12 gauge ASTM A1011 SS Grade 33 steel, 1-5/8 inch by 1-5/8 inch or greater as required by loading conditions. Submit designs for pipe tunnels, pipe galleries, etc., to engineer for approval. Use clamps and fittings designed for use with the

2.03 VIBRATION ISOLATION AND SUPPORTS

- A. For refrigeration, air conditioning, hydraulic, pneumatic, and other vibrating system applications, use a clamp that has a vibration dampening insert and a nylon inserted locknut. For copper and steel tubing use B-Line BVT series Vibraclamps, for pipe sizes use BVP series.
- B. For larger tubing or piping subjected to vibration, use neoprene or spring hangers as required.
- C. For base mounted equipment use vibration pads, molded neoprene mounts, or spring mounts as required.
- D. Vibration isolation products as manufactured by B-Line, Vibratrol systems.

2.04 ACCESSORIES

- A. Hanger Rods shall be threaded on both ends, or be continuously threaded rods of circular cross section. Use adjusting locknuts at upper attachments and hangers. No wire, chain, or perforated straps are allowed.
- B. Shields shall be 180 degree galvanized sheet metal, 12 inch minimum length, 18 gauge minimum thickness, designed to match outside diameter of the insulated pipe, B-Line B3151.
- C. Pipe protection saddles shall be formed from carbon steel, 1/8 inch minimum thickness, sized for insulation thickness. Saddles for pipe sizes greater than 12 inch shall have a center support rib.

2.05 FINISHES

- A. Indoor Finishes
 1. Hangers and clamps for support of bare copper piping shall be coated with copper colored epoxy paint, B-Line Dura-Copper®. Additional PVC coating of the epoxy painted hanger shall be used where necessary.
 2. Hangers for other than bare copper pipe shall be zinc plated in accordance with ASTM B633 OR shall have an electro-deposited green epoxy finish, B-Line Dura-Green®.

SECTION 22 05 29
HANGERS AND SUPPORTS

3. Strut channels shall be pre-galvanized in accordance with ASTM A653 SS Grade 33 G90 OR have an electro-deposited green epoxy finish, B-Line Dura-Green®.
- B. Outdoor and Corrosive Area Finishes
1. Hangers and strut located outdoors shall be hot dip galvanized after fabrication in accordance with ASTM A123. All hanger hardware shall be hot dip galvanized or stainless steel. Zinc plated hardware is not acceptable for outdoor or corrosive use.
 2. Hangers and strut located in corrosive areas shall be type 304 [316] stainless steel with stainless steel hardware.

PART 3 – EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation products in accordance with the manufacturer’s written instruction, commercial and industrial standards, and recognized industry practices to ensure that the installation serves the intended purpose. Surfaces to be attached to shall be thoroughly cleaned prior to making attachments.

3.02 PIPE HANGERS AND SUPPORTS

- A. Pipe shall be adequately supported by pipe hanger and supports specified in PART 2 PRODUCTS. Hangers for insulated pipes shall be sized to accommodate insulation thickness.
- B. Horizontal steel piping shall be supported in accordance with MSS SP-69 Tables 3 and 4, excerpts of which follow below:

NOMINAL PIPE SIZE (in)	ROD DIAMETER (in)	MAXIMUM SPACING (ft)
1/2 TO 1-1/4	3/8	7
1-1/2	3/8	9
2	3/8	10

- C. Horizontal copper tubing shall be supported in accordance with MSS SP-69 Tables 3 and 4, excerpts of which follow below:

NOMINAL PIPE SIZE (in)	ROD DIAMETER (in)	MAXIMUM SPACING (ft)
1/2 TO 3/4	3/8	5
1	3/8	6

SECTION 22 05 29
HANGERS AND SUPPORTS

- D. Provide means of preventing dissimilar metal contact such as plastic coated hangers, copper colored epoxy paint, or non-adhesive isolation tape- B-Line Iso-pipe. Galvanized felt isolators sized for copper tubing may also be used, B-Line B3195CT.
- E. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.
- F. Install hangers to provide a minimum of 1/2 inch space between finished covering and adjacent work.
- G. Place a hanger within 12 inches of each horizontal elbow.
- H. Support vertical piping independently of connected horizontal piping. Support vertical pipes at every floor. Wherever possible, locate riser clamps directly below pipe couplings or shear lugs.
- I. Where several pipes can be installed in parallel and at the same elevation, provide trapeze hangers as specified in Part 2. Trapeze hangers shall be spaced according to the smallest pipe size, or install intermediate supports according to schedule in this section.
- J. Do not support piping from other pipes, ductwork or other equipment that is not building structure.

END OF SECTION

SECTION 22 05 53
PIPING IDENTIFICATION

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide complete piping system identification work from equipment for all types of piping systems identified as a part of these specifications. Types of piping identification shall consist of:
 - 1. Painted Identification Materials
 - 2. Plasticized Tags
 - 3. Engraved Plastic Laminate Signs
 - 4. Plastic Tape
- B. Lettering, Size, Colors, and viewing angles of identification devices shall comply with ANSI A13.1.
- C. All work of this section shall comply with Section 22 00 00 GENERAL REQUIREMENTS – PLUMBING.

PART 2 – PRODUCTS

2.01 PIPING PAINT IDENTIFICATION

- A. All exposed piping and piping in accessible chases and areas above ceilings with panels, including stainless steel, galvanized steel, copper, PVC, and Fiberglass RTR piping, shall be completely and totally painted for identification purposes. Piping shall be identified with lettering or tags designating the service of each piping system, shall have flow directional arrows, and shall be completely painted and color coded as scheduled below. All piping scheduled to be color coded shall be completely painted or coated with the indicated colors.
- B. Each pipe identification shall consist of color coding in accordance with PART 3, a painted label, and a directional flow arrow. The painted label and directional arrow shall be placed between color bands.

SECTION 22 05 53
PIPING IDENTIFICATION

- C. Color Bands and Arrows: Pipe color bands shall be painted on the pipe. Paper or plastic banding of pipe shall not be acceptable. Arrows shall be of the same color as the lettering and shall point away from the lettered labels in the direction of the flow. Color band size shall be as follows:

PIPE SIZE	COLOR BAND SIZE
Less than 1" diameter	1" wide
1" to 12" diameter	1 pipe diameter wide
Greater than 12" diameter	12" wide

- D. For cases where there are insulated lines wrapped with aluminum sheathing, stainless steel sheathing, or gray fabric, the background color shall be applied to a 24-inch length of pipe section and color band centered within the 24 inch field of background color.

- E. Paint Colors: Paint colors shall conform to the following Federal designations:

1.	Light Blue	15200
2.	Dark Blue	15102
3.	Red	11105
4.	Yellow	13655
5.	Orange	12246
6.	White	17875
7.	Light Brown	10219
8.	Dark Brown	10080
9.	Light Green	34540
10.	Green	14187
11.	Black	17038
12.	Silver	17178
13.	Grey	16314
14.	Purple	27144

SECTION 22 05 53
PIPING IDENTIFICATION

- F. Lettering: Contents identification labels shall be stenciled directly on pipes. Black identification letters shall be used where the background pipe color is light, and white identification letters where the background color is dark. The size of the letters for identification labels shall be as follows:

Pipe Diameter	Letter Size
5/8" to 1"	5/16" high
1" to 3"	3/4" high
over 3"	2" high

2.02 EXISTING IDENTIFICATION SYSTEMS

- A. In installations where existing piping identification systems have been established, the CONTRACTOR shall continue to use the existing system. Where existing identification systems are incomplete, utilize the existing system as far as practical and supplement with the specified system. The objective is to fully identify all new piping, valves and appurtenances to the level specified herein.

2.03 SMALL PIPE IDENTIFICATION

- A. Identifying devices for valves and the sections of pipe that are too short to be identified with color bands, lettered labels, and arrows shall be identified with metal tags as specified herein.
- B. Metal tags shall be of stainless steel with embossed lettering. All tags shall be designed to be firmly attached to the valves or short pipes or to the structure immediately adjacent to such valves or short pipes.

2.04 IDENTIFICATION LOCATIONS

- A. Straight lines of pipe shall be identified at intervals of 30 feet maximum, and at least once in each room unless otherwise directed by the Engineer.
- B. Piping shall also be identified at a point approximately within 2 feet of all turns, ells, valves, and on the upstream side of all distribution fittings or branches and on both sides of each floor, wall or barrier through which the line passes.
- C. For pipe runs of 50 feet or less the distance between bands shall be 30 inches. For pipe runs of 50 feet or more, spacing between bands shall be 72 inches.
- D. Sections of pipe that are too short to be identified with color bands, lettered labels, and directional arrows shall be tagged and identified similar to valves.

SECTION 22 05 53
PIPING IDENTIFICATION

2.05 PIPING IDENTIFICATION TAPE/SIGNS

A. Plastic Tape

1. General: Manufacturer's standard color-coded pressure sensitive self adhesive vinyl tape, not less than 3 mils thick.
 - a. Width: Provide 1-1/2" inch wide tape markers on pipes with outside diameters (including insulation, if any) of less than 6 inches, 2-1/2 inch wide tape for larger pipes.
 - b. Color: By ANSI A13.1 designation except where other color selection is indicated.

B. Engraved-Plastic Laminate Signs:

1. General: Provide engraving stock melamine plastic laminate complying with FS L-P-387 in the size and thickness indicated, engraved with engraver's standard letter style of the size, and working indicated, black with white core (letter core) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
 - a. Thickness: 1/6 inch for units up to 20 sq. in. or 8 inch in length; 1/8 inch for larger units.
 - b. Fasteners: Self-tapping stainless screws, except contact type permanent adhesive where screws cannot or should not penetrate the substrate.

PART 3 – EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- A. Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceiling and removable concealment.

END OF SECTION

SECTION 22 11 19
PLUMBING SPECIALTIES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide complete plumbing specialties, materials, equipment, and miscellaneous devices to make the plumbing systems completely functional.
- B. Items shall include, but not be limited to:
 - 1. Access Doors
 - 2. Dielectric Unions
 - 3. Escutcheons
 - 4. Flexible Connections
 - 5. Pipe Sleeves
- C. All work of this section shall comply with Section 22 00 00 GENERAL REQUIREMENTS - PLUMBING

SECTION 22 11 19
PLUMBING SPECIALTIES

PART 2 – PRODUCTS

2.01 ACCESS PANELS

- A. Access panels shall be provided wherever required or indicated for proper access to installed equipment, devices, valves, and miscellaneous items of the work. Coordinate with the installing trade contractor providing walls, ceilings, and floors in which the access panels are required to be installed. Coordinate the locations, type, style, and size carefully to match the intended service, alignment with the ceiling and wall elements and per the Architectural plans.
 - 1. In areas with non-accessible ceilings and walls and where access panels are not provided under other Divisions, provide access panels for concealed valves, equipment, dampers, and control devices. Size the access panel for proper access, adjusting and maintenance, but not smaller than 14"x14" or as indicated.

2.02 DIELECTRICS

- A. Dielectric unions shall be used to prevent accelerated corrosion and deterioration in the piping systems due to galvanic and stray current. Install between pipes made of ferrous and non-ferrous metals. Unit shall consist of a union nut, two tailpieces, and a gasket that separates the tailpieces to prevent an electric current from occurring. Maximum Pressure: 250psi. Watts Series 3001A

2.03 ESCUTCHEONS

- A. Where exposed pipes pass through floors, walls, or ceilings, they shall be filled with neat, spun or stamped metal escutcheons, firmly secured to the pipes. Escutcheons shall be of sufficient outside diameter to amply cover up the sleeved openings for the pipes and shall be installed to provide a neat finish. Escutcheons shall be attached by means of expansion bolts, clamps or set screws.
 - 1. At exposed locations provide chrome plated finishes.

2.04 FLASHINGS

- A. Flashing for penetrations of the roof for Plumbing pipes shall be IPS Corp. Water-Tite adjustable multi-size roof vent flashings with minimum 24 gauge galvanized sheet metal base and elastomer color, color finish to match roofing type.

2.05 FLEXIBLE CONNECTIONS

- A. At building joints and seismic separations use Metraflex Metraloop with suitable supports each end.

SECTION 22 11 19
PLUMBING SPECIALTIES

- B. At gas-fired equipment connections, flexible connections shall be ProCoat stainless steel gas connector with all necessary fittings for complete installation as recommended by the manufacturer.
 - 1. Gas connector shall be UV and salt resistant, one piece construction without the use of soldered or brazed joints.

2.06 PIPE SLEEVES

- A. Furnish and install sleeves, large enough to accommodate pipe and its coverings, and passing entirely through floor, ceiling, wall, partition, or other building construction. Sleeves shall be set in new concrete construction before pouring. Sleeves not provided before pouring shall be provided together with necessary cutting and the proper grouting in of the sleeves in the cut opening. Sleeve through outside wall or through slab-on-grade shall be Link-Seal.
- B. All vertical pipes in open chases or shafts shall be provided with galvanized sleeves wired on to pipe or to covering. Provision shall be made for expansion of pipes.
- C. Penetrations at fire rated construction: Through penetrations shall be fire stopped with Hilti brand fire-stop systems/materials/sleeves selected to suit construction type.
- D. Unless otherwise noted, sleeves through walls, floors, and partitions shall be 22-gauge galvanized steel and shall extend ¼ inch above finished tile or other finished floor.
- E. All vertical interior exposed sleeves shall be packed with mineral wool. Fiberglass shall not be acceptable.
 - 1. At lightproof or soundproof walls, floors and partitions pack space between galvanized wall pipe sleeves and piping with non-hardening caulking and non-shrinking acoustical caulking.

SECTION 22 11 19
PLUMBING SPECIALTIES

PART 3 – EXECUTION

3.01 GENERAL INSTALLATION

- A. Install all equipment and materials according to the manufacturers written instructions, and in good workmanship.
- B. The Contractor shall be responsible for protecting against damage from building materials, acids, tools, and equipment included in these specifications.

3.02 ACCESS DOORS

- A. Provide access doors to all plumbing specialties behind walls and ceiling spaces.

END OF SECTION

SECTION 22 11 23
NATURAL GAS PIPING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide complete natural gas plumbing systems from point of connection at existing stub to all fuel consuming equipment.
- B. System shall be complete with piping, pressure reducing valves, plug valves and related specialties required for an operational system.
- C. All work of this section shall comply with Section 22 00 00 GENERAL REQUIREMENTS - PLUMBING

PART 2 – PRODUCTS

2.01 FUEL GAS PIPING

- A. Pipe: Black steel, ASTM A53, Schedule 40.
- B. Nipples: Steel, ASTM A733, Schedule 40.
- C. Fittings:
 - 1. Sizes 2 inch under ANSI B 16.3 threaded malleable iron.
 - 2. Over 2 inches and up to 4 inch) ANSI B16.11 socket welded.
 - 3. Over 4 inch ANSI 16.9 butt welded.
- D. Joints: Provide welded or threaded joints.

2.02 EXTERIOR PIPING

- A. 2 inches and smaller, Schedule 40 galvanized, threaded connections.
- B. 2-1/2" and larger, Schedule 40 black Iron (ungalvanized steel), welded connections. Welds shall be painted with Rust-Oleum pain and finished with silver top coat.

2.03 VALVES

- A. Ball Valve: Bronze body, rated for 150 psi at 365°F, 250 psi at 250°F, reinforced TFE seat, stem seal and thrust washer; end entry, threaded ends, UL-listed for natural or LP gas shut off service when used on those services.
- B. Gas Vent Cocks: Type 701: Bronze body, tee handle, rated for 30 psi at 100°F, ground plug, rated for tight shut-off on fuel gas service.

2.04 WATERPROOFING

SECTION 22 11 23
NATURAL GAS PIPING

- A. Provide at points where pipes pass through membrane waterproofed floors or walls in contact with earth.
- B. Floors: Provide cast iron stack sleeve with flashing device and an under-deck clamp. After stack is passed through sleeve, provide a waterproofed caulked joint at top hub.
- C. Walls: See detail shown on drawings.

2.05 DIELECTRIC FITTINGS

- A. Provide dielectric couplings or unions between ferrous and non-ferrous pipe.

2.06 GAS EQUIPMENT CONNECTORS

- A. Flexible connectors with Teflon core, interlocked galvanized steel protective casing, AGA certified design.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Gas Service: Contact the local gas utility company service planning representative and coordinate with and arrange with the utility company for gas service to the project including finalization of service application as required. Furnish and install all materials and labor necessary for complete installation as noted on drawings. Submit shop drawings and obtain approval from the utility company prior to fabrication.
- B. General: Comply with the codes listed in 22 00 00 and the following:
 - 1. Install branch piping for fuel gas and connect to all fixtures, valves, cocks, outlets, casework, cabinets and equipment, including those furnished by the Owner or specified in other sections.
 - 2. Pipe shall be round and straight. Cutting shall be done with proper tools. Pipe, shall be reamed to full size after cutting.
 - 3. All pipe runs shall be laid out to avoid interference with other work.
 - 4. Install valves with stem in horizontal position whenever possible. All valves shall be easily accessible.
 - 5. Install union and shut-off valve on pressure piping at connections to equipment.
 - 6. Pipe Hangers, Supports and Accessories:
 - a. All piping shall be supported per the International Fuel Gas Code, Chapter No. 4.

SECTION 22 11 23
NATURAL GAS PIPING

- b. Shop Painting and Plating: Hangers, supports, rods, inserts and accessories used for Pipe supports shall be shop coated with red lead or zinc Chromate primer paint. Electroplated copper hanger rods, hangers and accessories may be used with copper tubing.

- c. Floor, Wall and Ceiling Plates, Supports, Hangers:
 - 1. Solid or split un-plated cast iron, chrome plated in finished areas.
 - 2. All plates shall be provided with set screws.
 - 3. Pipe Hangers: Height adjustable clevis type.
 - 4. Adjustable Floor Rests and Base Flanges: Steel.
 - 5. Hanger Rods: Mild, low carbon steel, fully threaded or Threaded at each end with two removable nuts at each end for positioning rod and hanger and locking each in place.
 - 6. Riser Clamps: Malleable iron or steel.
 - 7. Self-drilling type expansion shields shall be "Phillips" type, with case hardened steel expander plugs.
 - 8. Miscellaneous Materials: As specified, required, directed or as noted on the drawings for proper installation of hangers, supports and accessories.

SECTION 22 11 23
NATURAL GAS PIPING

7. Install cast chrome plated escutcheon with set screw at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.
 8. Penetrations:
 - a. Fire Stopping: Where pipes pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, Hilti or equal. Completely fill and seal clearances between piping and openings with the fire stopping materials.
 - b. Waterproofing: At floor penetrations, completely seal clearances around the pipe and make watertight with sealant.
- C. Piping shall conform to the following:
1. Fuel Gas:
 - a. Entire fuel gas piping installation shall be in accordance with requirements of NFPA 54.
 - b. Provide fuel gas piping with plugged drip pockets at low points.
 - c. Install automatic shutoff valve (earthquake valve) on discharge side of meter. Valve shall positively shut off supply of gas in case of pressure failure, remain shut off until manually reopened, and be provided with outside adjustment for reset.

3.02 CLEANING OF SYSTEM AFTER INSTALLATION

- A. Clean all piping systems to remove all dirt, coatings and debris. Remove all valves, controls etc., and reinstall after piping system has been cleaned.

3.03 PIPE THREADING

- A. Threaded joints shall be made up without caulking or the use of filler except approved joint compound that is chemically restive to natural gas. Joint compound shall be used sparingly, and applied to male threads only.

3.04 PURGING

- A. Any sections of indoor gas piping intended to be removed, relocated and/or demolished shall be purged in accordance with all applicable codes and this section.
- B. Indoor piping disconnected indoors shall be purged and vented directly to the outdoors in accordance with NFPA-54. Piping shall be purged outdoors a minimum of 10' from any sources of ignition and not less than 10' away from building openings and a

SECTION 22 11 23
NATURAL GAS PIPING

minimum of 25' away from mechanical air intake openings. Purging shall be continuously monitored.

- C. Upon placing indoor gas piping into operation, piping containing air from testing and greater than 2-1/2" inches in a length in excess of 50' shall be purged and filled with inert gas. The inert gas shall then be displaced with fuel gas in accordance with NFPA 54. Gas piping 3" and 4" and in excess of 30' in length shall follow the requirements of this section and be purged in accordance with NFPA 54, Section 12:8.3.1.2.

3.05 TESTING

- A. All tests shall be made in the presence of the local authorities having jurisdiction. At least 72 hours (three days) notice shall be given in advance of all tests. Contractor shall make preliminary tests prior to giving notice of final test.

1. Contractor shall furnish all pumps, gauges, instruments and any other equipment, including test medium necessary for conducting prescribed tests.

B. Gas System

1. Prior to testing the new gas system (downstream of point of connection to existing system) the piping shall be cleaned by blowing the system clear of moisture, dust, and foreign particulates with oil free air or nitrogen.
2. For low pressure (less than 14" water column) test new gas system downstream from point of connection to existing systems. (do not test existing system). Testing of the new system may be done in whole or in parts. Testing shall be done prior to connecting to equipment. Test shall be for 1 hour at a pressure of three times that of the operating pressure (minimum 10 psi), with no pressure drop, using air, CO2 or nitrogen. If piping system fails the test the leaky portion(s) shall be redone and the system retested until it passes.
3. For pressure higher than 14" water column, test new gas system downstream from point of connection to existing systems. (do not test existing system). Testing of the new system may be done in whole or in parts. Testing shall be done prior to connecting to equipment. Test shall be for 1 hour at a pressure of a minimum of 60 psi, with no pressure drop, using air, CO2 or nitrogen. If piping system fails the test the leaky portion(s) shall be redone and the system retested until it passes.

END OF SECTION

SECTION 22 13 13
CONDENSATE DRAINAGE SYSTEM

SECTION 22 13 13
CONDENSATE DRAINAGE SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide complete condensate drainage system from point of connection at HVAC equipment to termination points, whether shown on the drawings or not. Connections to include, but not limited to:
 - 1. Primary condensate routed to an approved receptor per 2022 CPC from each piece of HVAC equipment.
 - 2. Secondary condensate routed to a readily observable location per 2022 CPC from each piece of HVAC equipment.
 - 3. Condensate drain lines routed to an approved receptors from all condensing flues and gas-fired heating equipment.
- B. System shall be complete with piping, pressure reducing valves, plug valves and related specialties required for an operational system.
- C. All work of this section shall comply with Section 22 00 00 GENERAL REQUIREMENTS – PLUMBING

PART 2 – PRODUCTS

2.01 PIPE

- A. All:
 - 1. DWV copper or type L copper with 95/5 solder joints and DWV or wrought fittings.
 - 2. All condensate piping located in freezing conditions shall be heat traced with Raychem XL-Trace and shall be installed in accordance with manufacturer's instructions.

PART 3 – EXECUTION

3.01 GENERAL INSTALLATION

- A. Piping shall be run parallel to buildings lines and supported at intervals specified. All changes in direction shall be made with standard fittings. Clean out plugs shall be installed at all cumulative changes of direction of 135 degrees or more as a minimum and as shown on the Drawings.

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CONDENSATE DRAINAGE SYSTEM

- B. Piping shall be run free of traps (except trap at equipment connection) and shall be pitched at ¼" vertical drop for every foot of horizontal run.
- C. Provide complete condensate drainage system as shown on the drawings – piping shall extend from drainage connection at HVAC rooftop unit to termination at existing roof drain.
- D. Remove cutting and threading burrs before assembling piping.

3.02 PIPE JOINTS

- A. Cut square and remove all burrs. Ream both ends to full size of pipe inside diameter. Clean ends of tubing to depth of fittings. Use sand cloth, sandpaper or steel wool for cleaning. Apply a coat of Nibco Copperized Flux to tubing and fittings. Solder paste or liquid flux shall not be permitted.

3.03 TESTING

- A. All tests shall be made in the presence of the Engineer and the local authorities having jurisdiction. At least 72 hours (three days) notice shall be given in advance of all tests. Contractor shall make preliminary tests prior to giving notice of final test.
 - 1. Contractor shall furnish all pumps, gauges, instruments, and any other equipment, including test medium necessary for conducting prescribed tests.
- B. Condensate Drainage System
 - 1. Test condensate drainage systems prior to final connection to equipment. Test shall be for 4 hours with the piping filled full of water. If piping system fails, the test the leaky portion(s) shall be redone, and the system retested until it passes.

END OF SECTION

DIVISION 23

HEATING, VENTILATING, AND AIR-CONDITIONING (HVAC)

23 00 00

GENERAL REQUIREMENTS, HVAC

PART 1 – GENERAL

1.01 DESCRIPTION

- A. The requirements of this section apply to all sections of Division 23.
- B. Section 23 00 00 includes General Requirements for Division 23 work including, but not limited to, the following sections:
 - 1. Section 23 00 01 Coordination
 - 2. Section 23 01 30 51 HVAC Piping Hangers & Supports
 - 3. Section 23 05 48 Vibration and Seismic Control for HVAC
 - 4. Section 23 05 53 Identification for HVAC Piping and Equipment
 - 5. Section 23 05 93 Testing, Adjusting, and Balancing
 - 6. Section 23 07 00 Thermal Insulation for Mechanical Systems
 - 7. Section 23 21 13 Hydronic Piping and Specialties
 - 8. Section 23 31 13 Metal Ducts
 - 9. Section 23 80 00 Decentralized HVAC Equipment
 - 10. Section 23 90 23 Direct Digital Controls
- C. Work within these sections may refer to other disciplines which may or may not be within the scope of the project. It is the requirement of the bidding and successful contractor to be aware of the scope of work and to review the Contract Documents in their entirety and not solely rely on the scope mentioned within these sections.

GENERAL REQUIREMENTS, HVAC

1.02 WORK INCLUDED

- A. Provide all materials, equipment, labor, fabrication, specialties, and items necessary and incidental to the installations of a complete system or piece of equipment.
- B. Work included shall also include transportation, storage, utilities and required licenses and permits.

1.03 RELATED WORK AND REQUIREMENTS

- A. The Contractor shall coordinate all HVAC work with any and all electrical, plumbing, fire protection, and structural trades to resolve conflicts prior to installation.
- B. In addition to the above, the work of this Section shall require work in coordination with other Divisions outside of this Section as follows:
 - 1. Division 00 General Requirements
 - 2. Division 00 Shop Drawings

1.04 QUALITY ASSURANCE

- A. Comply with Division 01 requirements regarding Quality Control.
- B. Mechanical, electrical, and associated systems shall be safe, reliable, efficient, durable, easily and safely operable and maintainable, easily and safely accessible, and in compliance with applicable codes as specified. The systems shall be comprised of high quality institutional-class and industrial-class products of manufacturers that are experienced specialists in the required product lines. All construction firms and personnel shall be experienced and qualified specialists in their respective industrial and institutional HVAC system, as applicable.
- C. Products Criteria:
 - 1. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 3 years. The design, model and size of each item shall have been in satisfactory and efficient operation on at least three installations for approximately three years. However, digital electronics devices, software and systems such as controls, instruments, computer workstation, shall be the current generation of technology and basic design that has a proven satisfactory service record of at least three years. See other specification sections for any exceptions.
 - 2. All items furnished shall be free from defects that would adversely affect the performance, maintainability and appearance of individual components and overall assembly.

GENERAL REQUIREMENTS, HVAC

3. Conform to codes and standards as required by the specifications. Conform to local codes, if required by local authorities such as the natural gas supplier, if the local codes are more stringent than those specified, the more stringent requirement shall be used.
4. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.
5. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.
6. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped or otherwise permanently marked on each item of equipment.

1.05 SUBMITTALS

- A. Comply with Division 01 requirements regarding submittals. The requirements of this section are additive to the requirement within Division 01.
- B. Contractor shall make all necessary field measurements and investigations to assure that the equipment and assemblies will meet contract requirements.
- C. If equipment is submitted which differs in arrangement from that shown, provide drawings that show the rearrangement of all associated systems. Approval will be given only if all features of the equipment and associated systems, including accessibility, are equivalent to that required by the contract.
- D. Upon request by Engineer, provide lists of previous installations for selected items of equipment. Include contact persons who will serve as references, with telephone numbers and e-mail addresses.
- E. Submittals and shop drawings for interdependent items, containing applicable descriptive information, shall be furnished together and complete in a group. Coordinate and properly integrate materials and equipment in each group to provide a completely compatible and efficient installation. Final review and approvals will be made only by groups. Submittals and shop drawings shall also incorporate the following items:
 1. Clear and neat strike out of irrelevant information.
 2. Clearly and neatly tag and mark equipment, options and specialties and special features.
 3. Key tags to match tags on Drawings.

GENERAL REQUIREMENTS, HVAC

- a. If substituting on Specified equipment provide comprehensive written comparison of characteristics between specified and substituted equipment.
- b. If equipment is not submitted, it is assumed to be as-specified.
4. Provide information in an easily readable and legible format presentation.
5. Provide bookmarked dividers for sections with a title sheet and table of contents. Title sheet shall include, at a minimum:
 - a. Full, formal, name and address, including zip code (for project).
 - b. Company name, address, phone number, and email address of General Contractor, including land line number of job trailer and cellular phone number and name of job site Superintendent.
6. Submit all items at same time, including all controls information, in one binder/folder.
7. Electronic copies shall be the only acceptable submittal medium allowed.
8. Submittals shall be prepared and submitted in a timely fashion to allow adequate time for ordering of long lead time equipment and materials.

1.06 SHOP DRAWINGS

- A. Submit complete, consolidated, and coordinated layout drawings for all new systems, controls, and for existing systems that are in the same areas.
- B. The drawings shall include plan views, elevations, and sections of all systems (including architectural and structural) and shall be on a scale of not less than 1/8-inch equal to one foot. Clearly identify and dimension, horizontally and vertically, and the proposed locations of the principal items of equipment.
- C. The drawings shall clearly show locations and adequate clearance for all equipment, piping, valves, control panels and other items. Show the access means for all items requiring access for operations and maintenance. Provide detailed layout drawings of all piping and duct systems.
- D. Do not install equipment foundations, mounting, equipment, or piping until layout drawings have been approved.
- E. All equipment shall be installed with clearances and dedicated means of access for service as required by the California and Electrical Codes (2025 Editions). Do not install equipment requiring inaccessible service actions.
- F. In addition, for HVAC systems shown on The Drawings, include the following within the Shop Drawings:

GENERAL REQUIREMENTS, HVAC

1. Mechanical equipment rooms with dimensional control demonstrating access.
 2. Interstitial spaces where equipment, ductwork, and/or piping runs are located.
 3. Pipe sleeves through footings and all field-penetrations of structural members.
 4. Duct, piping, or equipment penetrations of floors, walls, ceilings, or roofs.
- G. Failure of Contractor to provide adequate coordination and Shop Drawings shall not be grounds for adjustment of Project cost or extension of time.

1.07 DELIVERY, STORAGE AND HANDLING

A. Protection of Equipment:

1. Equipment and material placed on the job site shall remain in the custody of the Contractor until phased acceptance, whether the Owner has reimbursed the Contractor for the equipment and material, or not. The Contractor is solely responsible for the protection of such equipment and material against any damage, theft, or vandalism.
2. Place damaged equipment in first class, new operating condition; or replace same as determined and directed by the Engineer.
3. Protect interiors of new equipment and piping systems against entry of foreign matter. Clean both inside and outside before painting or placing equipment in operation.
4. Existing equipment and piping being worked on by the Contractor shall be under the custody and responsibility of the Contractor and shall be protected as required for new work.

B. Cleanliness of Equipment and Products:

1. Exercise care in storage and handling of equipment and piping material to be incorporated in the work. Remove debris arising from cutting, threading and welding of piping or ductwork.
2. Contractor shall be fully responsible for all costs, damage, and delay arising from failure to provide clean systems.

GENERAL REQUIREMENTS, HVAC

1.08 CODES, REGULATIONS, STANDARDS, AND GUIDELINES

A. Work shall be in accordance with requirements of the latest jurisdiction adopted editions of the following:

1. CBC - California Building Code, 2025 Edition
2. CMC - California Mechanical Code, 2025 Edition
3. CPC - California Plumbing Code, 2025 Edition
4. CGBCS California Green Building Construction Standards, 2025 Edition
5. CEC - California Electrical Code, 2025 Edition
6. CFC - California Fire Code, 2025 Edition
7. CEC - California Energy Commission, Title 24, Part VI, 2025 Edition

B. The work shall comply with the latest editions of the following guidelines and standards:

1. AABC Associated Air Balance Council
2. ACG AABC Commissioning Group
3. AGA American Gas Association
4. AMCA Air Movement and Control Association
5. ANSI American National Standards Institute
6. AHRI Air-Conditioning, Heating, and Refrigeration Institute
7. ASHRAE American Society of Heating Refrigerating and Air Conditioning Engineers
8. ASME American Society of Mechanical Engineers
9. ASTM American Society for Testing and Materials
10. CDEH California Department of Environmental Health
11. DSA Department of the State Architect (California)
12. ICC International Code Council
13. MCAA Mechanical Contractors Association of America
14. NADCA National Air Duct Cleaners Association
15. NEC National Electric Code
16. NFPA National Fire Protection Association

GENERAL REQUIREMENTS, HVAC

17. SMACNA Sheetmetal and Air-Conditioning Contractors National Association

18. UL Underwriters Laboratories

C. When the work calls for more stringent requirements than the above listings the Specifications and Drawings shall take precedence.

1.09 SITE VISIT AND FAMILIARIZATION

A. Visit the site and become familiar with the Drawings and Specifications. Examine the site and understand the conditions under which the Contract shall be performed.

B. Refer to Division 01 for any pre-bid conference requirements.

1.10 REVIEW OF CONSTRUCTION

A. Work may be reviewed, without prior notice, at any time by representatives of the Owner or the Owner.

B. In addition to periodic Owner reviews, advise Owner when work is ready for review at the following times:

1. Prior to concealment of work in walls, ceilings, or floors.

2. Prior to the concealment of work and above ceilings and any other enclosable spaces. Conceal work only after obtaining Owner or Owner representative consent.

3. Maintain an on the job set of Specifications and Drawings for use by Owner and representatives.

1.11 BID DOCUMENT DESCRIPTION

A. Specifications describe quality of materials and equipment.

B. Drawings describe the work in diagrammatic form. Drawings do not show exact detail and arrangements. Final requirements of the Work shall be determined by the Contractor after coordination with all other trades.

C. All equipment, systems and items indicated on the drawings and specifications are to be assumed as new unless specifically noted otherwise.

D. Do not scale drawings. Contractor is required to visit the site prior to bid and verify all physical sizing of equipment, systems, and components independently prior to bid.

GENERAL REQUIREMENTS, HVAC

1.12 DEFINITIONS

- A. Definitions following may not match those in other sections. Definitions listed here govern this part of the Work and take precedence over those listed elsewhere.
1. Concealed Embedded within the construction or installed in furred spaces, within partitions or hung ceilings, in trenches, crawl spaces, or within enclosures.
 2. Connect Complete hook-up of items with required services including all final items necessary for a completely functional installation.
 3. Down A vertical pipe, duct or piece of work that penetrates a floor or surface.
 4. Drop A vertical pipe, duct or piece of work that does not penetrate a floor or surface.
 5. Exposed Not installed underground or concealed as defined within this list, visible without removal of enclosure.
 6. Furnish To procure or purchase within the confines of the contract.
 7. HVAC Heating, Ventilation, and Air Conditioning.
 8. Indicated As detailed and specified within the Drawings and Specifications.
 9. Install To erect, mount and connect complete with related accessories.
 10. Noted As indicated on the Drawings and Specifications.
 11. Provide To furnish, supply, install, and connect up complete, ready, safe and in regular operation of particular work referred to.
 12. Riser A vertical pipe, duct or piece of work having a vertical length greater than one story height.
 13. Shown As indicated on the Drawings and Specifications.
 14. Supply To purchase, procure, acquire and deliver complete with related accessories.
 15. Work Labor, materials, equipment, apparatus, controls, accessories and other items required for complete and proper operation.

GENERAL REQUIREMENTS, HVAC

PART 2 – PRODUCTS

2.01 NOT USED

PART 3 – EXECUTION

3.01 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, and handle products in strict accordance with manufacturer's instructions. Provide all required dust, moisture, and weather protection.
- B. Protect materials and equipment from loss, theft, or damage. Replace lost or damaged items with new, identical products at no additional cost to the Owner.
- C. Install all mechanical equipment requiring power with clear working spaces in compliance with the California Electrical Code, Table 110.26(A)(1).
- D. Conceal all facility service piping and conduits behind finished surfaces. Exposed piping or raceways are prohibited unless explicitly indicated on the Drawings. Coordinate with other Divisions for demolition and new finishes. Determine, in advance, the extent of demolition and finish removal necessary for concealed installation.

3.02 PROTECTION OF WORK

- A. A. Cap all duct, pipe, and equipment openings at the end of each workday to prevent intrusion of dust, moisture, or debris. Uncapped equipment shall be fully cleaned prior to resuming work.
- B. Replace porous materials that become wet with new material. Drying of wetted porous materials is not acceptable due to risk of microbial growth. This applies to duct liner, insulation, flexible duct, and any material with moisture absorption potential.
- C. Cap all air distribution system connections during construction to prevent dirt, dust, and debris accumulation.

3.03 CLEANING AND PRESENTATION

- A. Prepare surfaces for painting by leaving surfaces free of oil, dust, rust, scale, adhesions, and debris.
- B. Remove shipping labels and tags from all equipment and material.
- C. Clean exterior surfaces of piping, insulation, ducting and equipment.
- D. Paint visible interior surfaces of supply grille cans, adjacent ducts, insulation pins, dampers, and accessories with two coats of flat black paint.

GENERAL REQUIREMENTS, HVAC

- E. Touch up scratched or marred factory-coated surfaces with matching paint type and color, using manufacturer-recommended cleaning methods. Do not use cleaning agents or methods that could damage finishes or adjoining construction.
- F. Paint cut ends of strut and all uncoated or non-galvanized steel exposed to the elements with two coats of rust-inhibiting paint, color-matched to adjacent materials.

3.04 SAFETY

- A. The Contractor shall be solely responsible for jobsite conditions and for the safety of all persons and property throughout performance of the Work. This responsibility extends to all hours of work.

3.05 CUTTING OF STRUCTURE

- A. Do not cut beams, girders, columns, or any other structural members, or run any pipes, ducts, or work through slabs, unless specifically shown on the Drawings, or unless written approval is obtained from the Owner.
- B. Cutting of walls, floors, or other parts of the building or repairing any work due to neglect of properly directing the locations of necessary openings and framing beforehand shall be done at no additional cost to the Owner.

3.06 RECORD DRAWINGS

- A. Provide record drawings in accordance with Division 01 and this Section.
- B. Maintain accurate, up-to-date as-built drawings reflecting job progress and final installation conditions. Drawings shall be kept on legible, full-size copies equivalent to Contract Documents. Make records available for Owner review at all times during construction.
- C. As-built drawings shall, at minimum, document:
 - 1. All changes in location of piping, ductwork, or equipment.
 - 2. All ceiling access panel locations.
 - 3. Accurate horizontal and vertical dimensions of buried or concealed mains.

3.07 COMPLETION

- A. When work is completed, or when Owner or Owner representative directs, remove surplus equipment, material, waste, and rubbish, and leave building in a good workmanlike condition.
- B. Adjust and program all thermostats, controls, and building management system (BMS) components per Owner direction and as required by Division 23 specifications.

GENERAL REQUIREMENTS, HVAC

- C. Upon completion and prior to turnover, provide a vendor-sponsored training session for Owner and designated personnel. **The training shall be a minimum of eight (8) hours in total** and may be split into multiple sessions as needed. Training must cover the full functionality, operation, and routine maintenance of the installed control system, including but not limited to:
1. Operator control functions and graphical interface navigation.
 2. Programming and adjusting setpoints and schedules.
 3. Alarm response, trending, and reporting features.
 4. Review of system backup, restoration, and common troubleshooting.
 5. Review of critical documentation and system manuals.
 6. Hands-on demonstration on all major control and BMS functions.
- D. Contractor shall also provide general training for the Owner's end users, including orientation to installed systems, review of operational and maintenance documentation, recommended safety, and efficient use practices. Training shall be tailored to the user skill level, include a Q&A period, and provide the Owner with searchable electronic and printed training materials. Training attendance shall be documented and training records included in project closeout documentation.

3.08 WARRANTIES AND GUARANTEES

- A. Contractor is required to provide warranties in accordance with Division 01 – General Requirements.
1. Collect all warranties and guarantees for materials and equipment and neatly fill out all required information for the Owner. Provide one copy of each certificate for turn over to Owner. Arrange certificates in a tabbed and indexed binder for Owner ease of use.
- B. At the completion of the work contractor shall guarantee to repair or replace materials and workmanship found defective for a period of one year from date of filing of Notice of Completion. This work shall be performed at no cost to the Owner.
1. Work of other trades damaged because of faulty workmanship or materials shall be repaired at no cost to the Owner.

END OF SECTION

COORDINATION

PART 1 – GENERAL

1.01 SUMMARY

- A. Section Includes: Provision for the coordination of the Work of the Contract.
- B. Contractor shall coordinate their work with all trades. Coordinate all work with General Contractor and receive hierarchy of importance in determining sequence of installation.

1.02 WORK INCLUDED

- A. Provide all materials, equipment, labor, fabrication, specialties, measurements, IOMs and items necessary and incidental to the coordinated installation of complete systems or equipment as indicated on the Contract Documents.

1.03 RELATED WORK AND REQUIREMENTS

- A. The Contractor shall coordinate all HVAC work with any and all electrical, plumbing, fire protection, and structural trades to resolve conflicts prior to installation.
- B. In addition to the above, the work of this Section shall require work in coordination with other Divisions outside of this Section as follows:
 - 1. Division 00 General Requirements
 - 2. Division 00 Shop Drawings

1.04 GENERAL COORDINATION

- A. Contractor shall be responsible for all project coordination.
- B. Coordinate schedules, submittals, and work of the various trades to ensure efficient and orderly sequence of installation of construction, with provisions for accommodating items to be installed later. Coordinate the work among the Specifications and Drawings.
- C. Work shown on any drawing or specification is required by the Contract regardless of the trade sub-division. Contractor shall require each trade subcontractor to review all other subdivisions of the documents for related work and shall coordinate the subcontracts accordingly.

COORDINATION

- D. Require all parties involved in the performance of the Work to cooperate in the overall coordination of the work under the direction of the Contractor. Each party, when requested to do so, shall furnish information concerning its portion of the work and shall respond promptly and reasonably to the decisions and requests of persons designated with coordination, supervisory, administrative, or similar authority.
- E. The Drawings use graphic symbols to show certain physical relationships of the various elements and systems and their interfacing with other elements and systems. Establishing and coordinating the actual physical relationships is the responsibility of the Contractor.
 - 1. Layout and arrange all elements to contribute to safety and efficiency while maintaining the intent of the design. Before work proceeds in areas of potential conflict for installing different components of the work, Contractor shall prepare supplementary drawings for review by the Architect and resolve the conflict.
- F. Coordinate continuous checking of architectural and structural clearances for accessibility of equipment and mechanical and electrical systems. No allowances of any kind will be made for the Contractor's failure to coordinate sequence of installing materials/equipment into position. Contractor shall verify that equipment will fit within the prescribed equipment room spaces.
- G. Prior to installation of each major unit of work which requires coordination and interfacing with other work, meet at project site with installer and representatives of manufacturers and fabricators who are involved in or affected by unit of work. Review progress of other work and preparations for the work under consideration.
- H. Coordinate the tolerances of all materials to ensure a proper fit in achieving the requirements of the Contract Documents.
- I. Coordinate matching finish, texture, color, etc. for the new work on existing components in the project.
- J. Coordinate work of like materials by submitting pilot samples to the Architect for review of acceptable ranges of finish textures and color variation.
- K. Coordinate completion and cleanup of Work of various trades in preparation for the Substantial Completion and for occupancy of the building.

1.05 SUBCONTRACT COORDINATION

- A. The General Contractor shall coordinate the Work and do not delegate responsibility for coordination to any Subcontractor.

COORDINATION

- B. Anticipate the interrelationship of all Subcontractors and their relationship with the Work.
- C. Resolve differences or disputes between Subcontractors concerning coordination, interference, or extent of work between sections of the specifications. Contractor's decisions, if consistent with the Contract Document requirements, shall be final.
- D. Coordinate the work of Subcontractors so that their portions of the work are performed in a manner that minimizes interference with the progress of the Work.

1.06 ADMINISTRATION

- A. General: Prepare a written memorandum on required coordination activities. Include such items as required notices, reports, and attendance at meetings. Distribute this memorandum to each trade performing work at the project site. Prepare similar memorandum for separate contractors where interfacing of their work is required.
- B. Coordination Meetings: Conduct general project coordination meetings with Subcontractors at least weekly at regularly scheduled times convenient for all parties involved. These meetings are in addition to specific meetings held for other purposes, such as regular project meetings and special preinstallation meetings. Request representation at each meeting by every party currently involved in coordination or planning for the work of the entire project. Keep the Owner Representatives informed about coordination meetings. Conduct meetings in a manner which will resolve coordination problems. Record results and minutes of each meeting and distribute copies to everyone in attendance and to the Owner Representatives. Owner Representatives may attend weekly jobsite meetings with subcontractors.
- C. Superintendent: Provide a full-time Superintendent experienced in administration and supervision of building construction. This Superintendent shall be authorized to act as general coordinator of interfaces between units of work. This Superintendent shall be on site, continuously during the construction period. Construction coordination shall be his/her principal duty.
 - 1. For the purpose of this provision, "interface" is defined to include scheduling and sequencing of work, sharing of access to workspaces, installations, protection of each other's work, cutting and patching, tolerances, cleaning, selections for compatibility, preparation of coordination drawings, inspections, tests and temporary facilities and services.

COORDINATION

2. Mechanical/Electrical Coordinator: Provide a single individual, a mechanical/electrical coordinator, experienced in administrative and supervisory coordination of mechanical and electrical work. This experience in coordination shall include coordination of the type of mechanical/electrical work required for this project. The mechanical/electrical coordinator is required to act as the specialized coordinator of interfaces both within mechanical/electrical work and between that work and other trades. The Mechanical/Electrical Coordinator shall be on site, full time during the construction period. Project Superintendent may serve as mechanical/electrical coordinator.

1.07 COORDINATION DRAWINGS AND SUBMISSION

- A. Prepare Shop Drawings where required before beginning fabrication or delivery of materials and equipment to the jobsite. Refer to 23 00 00 for SHOP DRAWING requirements.
 1. Coordination Drawings shall clearly indicate coordination of mechanical, plumbing, fire protection, electrical, lighting, signal, and equipment installations with structural, architectural and finish elements.
 2. Scale: 1/4" = 1'-0". Scale may be revised to 1/8"=1'-0" with consent of all involved subcontractors.
- B. Keep copies of Coordination Drawings at the jobsite.
- C. Contractor shall provide the Owner with a record copy of initial Shop Drawings and with revisions to Shop Drawings, within three (3) working days of completion of each drawing or revised drawing and 30 days before work begins. The Owner will verify that Coordination Drawings have been made, but no approval of these drawings will be made. Include in submission of drawings the names of coordination staff.
- D. Shop Drawings shall include, but are not limited to structural, fire protection, plumbing, heating, ventilation and air conditioning, electrical power and lighting, security, life safety, data, telephone system, existing or reinstalled equipment and new equipment.
- E. Shop Drawings, shall indicate layout of Work for all trades, for purposes of showing overlays and potential conflicts of crossover work and adjoining work.
- F. Conditionally revise Shop Drawings as subsequent work is added to areas containing existing work.

COORDINATION

- G. Provide dimensions and elevations where conflicts may exist and coordinate conflicts on Coordination Drawings to prevent conflicts in the field.
- H. Contractor shall require Subcontractors to develop Subcontractor Coordination Plans of the same scale as Contractor's Coordination Drawings to assist in making transcripts for transfer to Shop Drawings.
- I. Shop Drawings shall include dates and signatures of Contractor and Subcontractors involved in coordination; signed Coordination Drawings shall be subject to examination by the Owner at any time. Failure to maintain up-to-date drawings will be considered non-conformance with Contract Documents and progress payment will be withheld.
- J. Failure of Contractor to provide adequate coordination and Coordination Drawings shall not be grounds for adjustment of Project cost or extension of time.

1.08 STRUCTURAL, MECHANICAL, PLUMBING AND ELECTRICAL COORDINATION

- A. Use Shop Drawings of structural, mechanical, plumbing, and electrical work, together with shop drawings and layout drawings of affected work to verify, coordinate and integrate the work to prevent interferences.
- B. Coordinate space requirements and installation of mechanical and electrical work which are indicated by graphic symbols on Contract Documents.
- C. Routing shown for pipes, ducts and conduits on Drawings are shown by graphic symbols only; make runs parallel with lines of building.
- D. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance and for repairs.
- E. Conceal pipes, ducts and wiring in finished areas, unless otherwise indicated, coordinate locations of fixtures and outlets with finish elements.
- F. Where there is a potential conflict in the layout or interferences between the work, including structural and architectural, layout the work with tape or other means to depict the layout on site to reduce or resolve the conflict and to allow the Owner to review the work prior to execution. The tape or other means to depict layout shall not cause any damage, change in color or appearance of any work to remain, or leave a residue.

1.09 INTERSTITIAL SPACE COORDINATION

23 00 01

COORDINATION

- A. Contractor shall provide Shop Drawings for the Interstitial Spaces to resolve installation conflicts prior to final approval of any shop drawings. Refer to 23 00 00 for SHOP DRAWING requirements.
- B. All conflicts shall be brought to the attention of the Architect and/or Project Manager.
- C. Elements to include in the Shop Drawings:
 - 1. Mechanical ducts and pipes, including floor penetrations.
 - 2. Plumbing pipes.
 - 3. Fire branch lines and sprinkler heads.
 - 4. Electrical bus ducts.
 - 5. Electrical Conduit, 2" and larger.
 - 6. Telephone communication and data lines.
 - 7. Interstitial space access.
 - 8. Structural elements including, but not limited to, beams, columns, slabs, hangers and seismic bracing.
 - 9. Fireproofing of structural members.
 - 10. Suspended ceilings.
 - 11. Insulation.
 - 12. Security system elements.
 - 13. Others as necessary.
- D. Schedule of Submission
 - 1. Refer to Shop Drawings and Submission specified in this Section and in 23 00 00.
 - 2. Review of the coordinated drawings shall be required prior to approval of any of the sub-system shop drawings for the elements listed above.

23 00 01

COORDINATION

3. An as-built version of this drawing should be required at the end of installation.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 23 05 29
HVAC HANGERS AND SUPPORTS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. The work covered under this section consists of providing all necessary labor, supervision, materials, equipment and services to completely execute the hangers and supports as described in this specification.
- B. All work of this section shall comply with Section 23 00 00 GENERAL REQUIREMENTS - HEATING, VENTILATING, AND AIR-CONDITIONING (HVAC).

1.02 REFERENCES

- A. Sheet Metal and Air Conditioning Contractors National Association, Inc.:
 - 1. SMACNA – Duct Construction Standards, Chapter 5, Hangers and Supports.
- B. ASTM International:
 - 1. ASTM B633 - Specification for Electrodeposited Coatings of Zinc on Iron and Steel
 - 2. ASTM A123 - Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip
 - 3. ASTM A653 – Specification for Steel Sheet, Zinc-Coated by the Hot-Dip Process
 - 4. ASTM A1011 - Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability (Formerly ASTM A570)

1.03 SUBMITTALS

- A. Submit product data on all hanger and support devices, including shields and attachment methods. Product data to include, but not limited to materials, finishes, approvals, load ratings, and dimensional information.

1.04 QUALITY ASSURANCE

- A. Steel pipe hangers and supports shall have the manufacturer's name, part number, and applicable size stamped in the part itself for identification.
- B. Hangers and supports shall be designed and manufactured in conformance with MSS SP 58.
- C. Supports for sprinkler piping shall be in conformance with NFPA 13.

SECTION 23 05 29
HVAC HANGERS AND SUPPORTS

1.05 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- B. Protect from weather and construction traffic, dirt, water, chemical, and damage, by storing in original packaging.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Model numbers are Cooper B-Line. Engineer approved equivalent is acceptable.

2.02 PIPE HANGERS AND SUPPORTS

- A. Hangers
 - 1. Uninsulated pipes 2 inch and smaller:
 - a. Adjustable steel swivel ring (band type) hanger, B-Line B3170.
 - b. Adjustable steel swivel J-hanger, B-Line B3690.
 - c. Malleable iron ring hanger, B-Line B3198R or hinged ring hanger, B3198H.
 - d. Malleable iron split-ring hanger with eye socket, B-Line B3173 with B3222.
 - e. Adjustable steel clevis hanger, B-Line B3104 or B3100.
 - 2. Uninsulated pipes 2-1/2 inch and larger:
 - a. Adjustable steel clevis hanger, B-Line B3100.
 - b. Pipe roll with sockets, B-Line B3114.
 - c. Adjustable steel yoke pipe roll, B-Line B3110.
 - 3. Insulated pipe- Hot or steam piping:

SECTION 23 05 29

HVAC HANGERS AND SUPPORTS

- a. 2 inch and smaller pipes: use adjustable steel clevis with galvanized sheet metal shield. B-Line B3100 with B3151 series.
 - b. 2-1/2 inch and larger pipes:
 1. Adjustable steel yoke pipe roll with pipe covering protection saddle. B-Line B3110 with B3160-B3165 series.
 2. Pipe roll with sockets with pipe covering protection saddle, B-Line B3114 with B3160-B3165 series.
- B. Pipe Clamps
1. When flexibility in the hanger assembly is required due to horizontal movement, use pipe clamps with weldless eye nuts, B-Line B3140 or B3142 with B3200. For insulated lines use double bolted pipe clamps, B-Line B3144 or B3146 with B3200.
- C. Multiple or Trapeze Hanger
1. Trapeze hangers shall be constructed from 12 gauge roll formed ASTM A1011 SS Grade 33 structural steel channel, 1-5/8 inch by 1-5/8 inch minimum, B-Line B22 strut or stronger as required.
 2. Mount pipes to trapeze with 2 piece pipe straps sized for outside diameter of pipe, B-Line B2000 Series.
 3. For pipes subjected to axial movement:
 - a. Strut mounted roller support, B-Line B3126. Use pipe protection shield or saddles on insulated lines.
 - b. Strut mounted pipe guide, B-Line B2417.
- D. Wall Supports
1. Pipes 4 inch and smaller:
 - a. Carbon steel hook, B-Line B3191.
 - b. Carbon steel J-hanger, B-Line B3690.
 2. Pipes larger than 4 inch:
 - a. Welded strut bracket and pipe straps, B-Line B3064 and B2000 series.

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- b. Welded steel brackets, B-Line B3066 or B3067, with roller chair or adjustable steel yoke pipe roll. B-Line B3120 or B3110. Use pipe protection shield or saddles on insulated lines.

E. Vertical Supports

1. Steel riser clamp sized to fit outside diameter of pipe, B-Line B3373.

F. Copper Tubing Supports

1. Hangers shall be sized to fit copper tubing outside diameters.
 - a. Adjustable steel swivel ring (band type) hanger, B-Line B3170CT.
 - b. Malleable iron ring hanger, B-Line B3198RCT or hinged ring hanger B3198HCT.
 - c. Malleable iron split-ring hanger with eye socket, B-Line B3173CT with B3222.
 - d. Adjustable steel clevis hanger, B-Line B3104CT.
 - e.
2. For supporting vertical runs use epoxy painted or plastic coated riser clamps, B-Line B3373CT or B3373CTC.
3. For supporting copper tube to strut use epoxy painted pipe straps sized for copper tubing, B-Line B2000 series, or plastic inserted vibration isolation clamps, B-Line BVT series.

G. Supplementary Structural Supports

1. Design and fabricate supports using structural quality steel bolted framing materials as manufactured by Cooper B-Line. Channels shall be roll formed, 12 gauge ASTM A1011 SS Grade 33 steel, 1-5/8 inch by 1-5/8 inch or greater as required by loading conditions. Submit designs for pipe tunnels, pipe galleries, etc., to engineer for approval. Use clamps and fittings designed for use with the

2.03 UPPER ATTACHMENTS

A. Beam Clamps

1. Beam clamps shall be used where piping is to be suspended from building steel. Clamp type shall be selected on the basis of load to be supported, and load configuration.

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2. C-Clamps shall have locknuts and cup point set screws, B-Line B351L, or B3036L. Top flange c-clamps shall be used when attaching a hanger rod to the top flange of structural shapes, B-Line B3034 or B3033. Refer to manufacturer's recommendation for setscrew torque. Retaining straps shall be used to maintain the clamps position on the beam where required.
 3. Center loaded beam clamps shall be used where specified. Steel clamps shall be B-Line B3050, or B3055. Malleable iron or forged steel beam clamps with cross bolt shall be B-Line B3054 or B3291-B3297 Series as required to fit beams.
- B. Concrete Inserts
1. Cast in place spot concrete inserts shall be used where applicable; either steel or malleable iron body, B-Line B2500 or B3014. Spot inserts shall allow for lateral adjustment and have means for attachment to forms. Select inserts to suit threaded hanger rod sizes, B-Line N2500 or B3014N series.
 2. Continuous concrete inserts shall be used where applicable. Channels shall be 12 gauge, ASTM A1011 SS Grade 33 structural quality carbon steel, complete with styrofoam inserts and end caps with nail holes for attachment to forms. The continuous concrete insert shall have a load rating of 2,000 lbs/ft. in concrete, B-Line B22I, 32I, or 52I. Select channel nuts suitable for strut and rod sizes.

2.04 VIBRATION ISOLATION AND SUPPORTS

- A. For refrigeration, air conditioning, hydraulic, pneumatic, and other vibrating system applications, use a clamp that has a vibration dampening insert and a nylon inserted locknut. For copper and steel tubing use B-Line BVT series Vibraclamps, for pipe sizes use BVP series.
- B. For larger tubing or piping subjected to vibration, use neoprene or spring hangers as required.
- C. For base mounted equipment use vibration pads, molded neoprene mounts, or spring mounts as required.
- D. Vibration isolation products as manufactured by B-Line, Vibratrol systems.

2.05 ACCESSORIES

- A. Hanger Rods shall be threaded on both ends, or be continuously threaded rods of circular cross section. Use adjusting locknuts at upper attachments and hangers. No wire, chain, or perforated straps are allowed.

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- B. Shields shall be 180 degree galvanized sheet metal, 12 inch minimum length, 18 gauge minimum thickness, designed to match outside diameter of the insulated pipe, B-Line B3151.
- C. Pipe protection saddles shall be formed from carbon steel, 1/8 inch minimum thickness, sized for insulation thickness. Saddles for pipe sizes greater than 12 inch shall have a center support rib.

2.06 FINISHES

A. Indoor Finishes

- 1. Hangers and clamps for support of bare copper piping shall be coated with copper colored epoxy paint, B-Line Dura-Copper®. Additional PVC coating of the epoxy painted hanger shall be used where necessary.
- 2. Hangers for other than bare copper pipe shall be zinc plated in accordance with ASTM B633 OR shall have an electro-deposited green epoxy finish, B-Line Dura-Green®.
- 3. Strut channels shall be pre-galvanized in accordance with ASTM A653 SS Grade 33 G90 OR have an electro-deposited green epoxy finish, B-Line Dura-Green®.

B. Outdoor and Corrosive Area Finishes

- 1. Hangers and strut located outdoors shall be hot dip galvanized after fabrication in accordance with ASTM A123. All hanger hardware shall be hot dip galvanized or stainless steel. Zinc plated hardware is not acceptable for outdoor or corrosive use.
- 2. Hangers and strut located in corrosive areas shall be type 304 [316] stainless steel with stainless steel hardware.

PART 3 – EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation products in accordance with the manufacturer's written instruction, commercial and industrial standards, and recognized industry practices to ensure that the installation serves the intended purpose. Surfaces to be attached to shall be thoroughly cleaned prior to making attachments.

3.02 PIPE HANGERS AND SUPPORTS

- A. Pipe shall be adequately supported by pipe hanger and supports specified in PART 2 PRODUCTS. Hangers for insulated pipes shall be sized to accommodate insulation thickness.

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- B. Horizontal steel piping shall be supported in accordance with MSS SP-69 Tables 3 and 4, excerpts of which follow below:

NOMINAL PIPE SIZE (in)	ROD DIAMETER (in)	MAXIMUM SPACING (ft)
1/2 TO 1-1/4	3/8	7
1-1/2	3/8	9
2	3/8	10
2-1/2	1/2	11
3	1/2	12
3-1/2	5/8	13
4	5/8	14
5	3/4	16
6	3/4	17
8	3/4	19
10	7/8	22
12	7/8	23
14	1	25
16	1	27

- C. Horizontal copper tubing shall be supported in accordance with MSS SP-69 Tables 3 and 4, excerpts of which follow below:

NOMINAL PIPE SIZE (in)	ROD DIAMETER (in)	MAXIMUM SPACING (ft)
1/2 TO 3/4	3/8	5
1	3/8	6
1-1/4	3/8	7
1-1/2	3/8	8
2	3/8	8
2-1/2	1/2	9
3	1/2	10

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- D. Provide means of preventing dissimilar metal contact such as plastic coated hangers, copper colored epoxy paint, or non-adhesive isolation tape- B-Line Iso-pipe. Galvanized felt isolators sized for copper tubing may also be used, B-Line B3195CT.
- E. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.
- F. Install hangers to provide a minimum of 1/2 inch space between finished covering and adjacent work.
- G. Place a hanger within 12 inches of each horizontal elbow.
- H. Support vertical piping independently of connected horizontal piping. Support vertical pipes at every floor. Wherever possible, locate riser clamps directly below pipe couplings or shear lugs.
- I. Where several pipes can be installed in parallel and at the same elevation, provide trapeze hangers as specified in Part 2. Trapeze hangers shall be spaced according to the smallest pipe size, or install intermediate supports according to schedule in this section.
- J. Do not support piping from other pipes, ductwork or other equipment that is not building structure.

3.03 CONCRETE INSERTS

- A. Provide inserts for placement in formwork before concrete is poured.
- B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- C. Where concrete slabs form finished ceilings, provide inserts to be flush with slab surface.
- D. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inch.

END OF SECTION

SECTION 23 05 48

VIBRATION AND SEISMIC CONTROL FOR HVAC

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide complete vibration and seismic control for the Work as required by this Section for HVAC equipment and accessories indicated in the Contract Documents.
- B. All work of this section shall comply with Section 22 00 00 GENERAL REQUIREMENTS - HEATING, VENTILATING, AND AIR-CONDITIONING (HVAC).

1.02 QUALITY ASSURANCE

- A. Only firms whose products of vibration isolation products, of types and sizes required and have been in exceptional use in similar service for not less than five years shall be considered.
- B. Unless otherwise indicated, obtain isolation units from a single manufacturer.
- C. Where vibration isolation support units are indicated for minimum static deflection, provide manufacturer's certification that units have been tested and comply with the indicated requirements.

1.03 SUBMITTALS

- A. Submit in accordance with specification Division 01 and Section 23 00 00.
- B. In addition, manufacturer's literature and data shall include:
 - 1. Vibration isolators:
 - a. Floor mountings
 - b. Hangers
 - c. Snubbers
 - d. Thrust restraints
 - 2. Bases.
 - 3. Seismic restraint provisions and bolting.
 - 4. Acoustical enclosures.
 - 5. Duct liner

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VIBRATION AND SEISMIC CONTROL FOR HVAC

- C. Isolator manufacturer shall furnish with submittal load calculations for selection of isolators, including supplemental bases, based on lowest operating speed of equipment supported.
- D. Seismic Requirements: Submittals are required for all equipment anchors, supports and seismic restraints. Submittals shall include; weights, dimensions, standard connections, and manufacturer's certification that all specified equipment will withstand seismic lateral force requirements as shown on drawings and required by their scheduled weights and centers of gravity.

PART 2 – PRODUCTS

2.01 FLEXIBLE DUCT CONNECTORS

- A. Isolate all equipment from ductwork with flexible ductwork connections and, for outside installations, UV resistant flexible connections, reinforced with steel wire mesh where required for strength to withstand duct pressure indicated. Form connectors with full-faced flanges and accordion bellows to perform as flexible isolation units, and manufacturer's standard length for each size unless otherwise indicated.
- B. Equip each unit with galvanized steel retaining rings for airtight connections to ductwork. Flexible duct connectors exposed to the outside shall be watertight and exteriors finished with an impregnated fiberglass cloth bonded to flexible connectors. All flexible connectors shall meet or exceed the requirements of NFPA bulletin 90A, U.L. listing 181, Class 1.

2.02 DUCT LINER

- A. Supply and return ductwork shall have acoustic lining where shown on the drawings and as specified herein. Acoustic lining shall be a minimum of 1-1/2 inches thickness and incorporate an integral mat-face of type in accordance with NFPA 90A, of minimum 1-1/2 lb. per cubic foot density. Adhere mat-faced duct liner with a fire retardant adhesive. Mechanical fasteners that do not pierce the sheet metal shall be on min. 16 inch centers on top sections (when duct width exceeds 12 inches) and on sides when height exceeds 24 inches. All leading edges at beginning of runs and all exposed edges shall be installed with sheet metal nosings to prevent delamination and prevent peel off.
 - 1. Insulate all supply and return ductwork min. 20 ft. from HVAC units, or to lengths shown on drawings.
 - 2. Where ductwork is acoustically lined, thermal insulation is not required if the thermal performance is at least equal to that specified for thermal insulation.
 - 3. Sizes shown on drawings for lined ducts are inside-clear dimensions.
- B. Duct dimensions listed on the Drawings are net interior clear dimensions. Incorporate allowances for linings and insulation to provide the net clear dimensional data provided.

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VIBRATION AND SEISMIC CONTROL FOR HVAC

- C. Provide duct lining including facings and adhesives with incombustible materials meeting all code requirements and fire and smoke hazard ratings as tested by procedure ASTM E-84M, NFPA 225, and U.L. 723, not exceeding flame spread 25 and developed smoke of 50.

2.03 VIBRATION ISOLATORS

- A. Vertically restrained spring isolators: Units shall be equipped with an adjustable assembly which will limit vertical movement, both up and down, without degrading performance of unit for normal equipment loading and operation.
- B. Type of isolator, base, and minimum static deflection shall be as required for each specific equipment application as recommended by isolator or equipment manufacturer but subject to minimum requirements indicated herein and in the schedule on the drawings.
- C. Floor Mountings:
 - 1. Double Deflection Neoprene (Type N): Shall include neoprene covered steel support plated (top and bottom), friction pads, and necessary bolt holes.
 - 2. Spring Isolators (Type S): Shall be free-standing, laterally stable and include acoustical friction pads and leveling bolts. Isolators shall have a minimum ratio of spring diameter-to-operating spring height of 1.0 and an additional travel to solid equal to 50 percent of rated deflection.
 - 3. Captive Spring Mount for Seismic Restraint (Type SS):
 - a. Design mounts to resiliently resist seismic forces in all directions. Snubbing shall take place in all modes with adjustment to limit upward, downward, and horizontal travel to a maximum of 6 mm (1/4-inch) before contacting snubbers. Mountings shall have a minimum rating of one G coefficient of gravity as calculated and certified by a registered structural engineer.
 - b. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50 percent of the rated deflection. Mountings shall have ports for spring inspection. Provide an all directional neoprene cushion collar around the equipment bolt.
 - 4. Spring Isolators with Vertical Limit Stops (Type SP): Similar to spring isolators noted above, except include a vertical limit stop to limit upward travel if weight is removed and also to reduce movement and spring extension due to wind

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VIBRATION AND SEISMIC CONTROL FOR HVAC

loads. Provide clearance around restraining bolts to prevent mechanical short circuiting. // Isolators shall have a minimum seismic rating of one G.

5. Pads (Type D), Washers (Type W), and Bushings (Type L): Pads shall be felt, cork, neoprene waffle, neoprene and cork sandwich, neoprene and fiberglass, neoprene and steel waffle, or reinforced neoprene. Washers and bushings shall be reinforced neoprene. Size pads for a maximum load of 345 kPa (50 pounds per square inch).
 6. Seismic Pad (Type DS): Pads shall be felt, cork neoprene waffle, neoprene and cork sandwich, neoprene and fiberglass, neoprene and steel waffle, or reinforced neoprene, with steel top plate and drilled for an anchor bolt. Washers and bushings shall be reinforced neoprene. Size pads for a maximum load of 345 kPa (50 pounds per square inch).
- D. Hangers: Shall be combination neoprene and springs unless otherwise noted and shall allow for expansion of pipe.
1. Combination Neoprene and Spring (Type H): Vibration hanger shall contain a spring and double deflection neoprene element in series. Spring shall have a diameter not less than 0.8 of compressed operating spring height. Spring shall have a minimum additional travel of 50 percent between design height and solid height. Spring shall permit a 15 degree angular misalignment without rubbing on hanger box.
 2. Spring Position Hanger (Type HP): Similar to combination neoprene and spring hanger except hanger shall hold piping at a fixed elevation during installation and include a secondary adjustment feature to transfer load to spring while maintaining same position.
 3. Neoprene (Type HN): Vibration hanger shall contain a double deflection type neoprene isolation element. Hanger rod shall be separated from contact with hanger bracket by a neoprene grommet.
 4. Spring (Type HS): Vibration hanger shall contain a coiled steel spring in series with a neoprene grommet. Spring shall have a diameter not less than 0.8 of compressed operating spring height. Spring shall have a minimum additional travel of 50 percent between design height and solid height. Spring shall permit a 15 degree angular misalignment without rubbing on hanger box.
 5. Hanger supports for piping 50 mm (2 inches) and larger shall have a pointer and scale deflection indicator.
- E. Snubbers: Each spring mounted base shall have a minimum of four all-directional or eight two directional (two per side) seismic snubbers that are double acting. Elastomeric materials shall be shock absorbent neoprene bridge quality bearing pads, maximum 60

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durometer, replaceable and have a minimum thickness of 6 mm (1/4 inch). Air gap between hard and resilient material shall be not less than 3 mm (1/8 inch) nor more than 6 mm (1/4 inch). Restraints shall be capable of withstanding design load without permanent deformation.

- F. Thrust Restraints (Type THR): Restraints shall provide a spring element contained in a steel frame with neoprene pads at each end attachment. Restraints shall have factory preset thrust and be field adjustable to allow a maximum movement of 6 mm (1/4 inch) when the fan starts and stops. Restraint assemblies shall include rods, angle brackets and other hardware for field installation.

2.04 SEISMIC RESTRAINT REQUIREMENTS FOR EQUIPMENT

- A. Bolt pad mounted equipment, without vibration isolators, to the floor or other support using ASTM A307 standard bolting materials and methods.
- B. Floor mounted equipment, with vibration Isolators: Type SS. Where Type N isolators are used provide channel frame base horizontal restraints bolted to the floor, or other support, on all sides of the equipment size and material required for the base shall be as recommended by the isolator manufacturer.
- C. On all sided of suspended equipment, provide bracing for rigid supports and provide restraints for resiliently supported equipment. The slack cable restraint method, Mason Industries, or equal, is acceptable.

2.05 BASES

- A. Rails (Type R): Rails with isolator brackets shall be designed to reduce mounting height of equipment and cradle machines having legs or bases that do not require a complete supplementary base. To assure adequate stiffness, height of members shall be a minimum of 1/12 of longest base dimension but not less than 100 mm (4 inches). Where rails are used with neoprene mounts for small fans or close coupled pumps, extend rails to compensate overhang of housing.
- B. Integral Structural Steel Base (Type B): Design base with isolator brackets to reduce mounting height of equipment which require a complete supplementary rigid base. To assure adequate stiffness, height of members shall be a minimum of 1/12 of longest base dimension, but not less than 100 mm (four inches).
- C. Inertia Base (Type I): Base shall be a reinforced concrete inertia base. Pour concrete into a welded steel channel frame, incorporating pre-located equipment anchor bolts and pipe sleeves. Level the concrete to provide a smooth uniform bearing surface for equipment mounting. Provide grout under uneven supports. Channel depth shall be a minimum of 1/12 of longest dimension of base but not less than 150 mm (six inches). Form shall include 13-mm (1/2-inch) reinforcing bars welded in place on minimum of 203 mm (eight inch) centers running both ways in a layer 40 mm (1-1/2 inches) above

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bottom. Use height saving brackets in all mounting locations. Weight of inertia base shall be equal to or greater than weight of equipment supported to provide a maximum peak-to-peak displacement of 2 mm (1/16 inch).

- D. Curb Mounted Isolation Base (Type CB): Fabricate from aluminum to fit on top of standard curb with overlap to allow water run-off and have wind and water seals which shall not interfere with spring action. Provide resilient snubbers with 6 mm (1/4 inch) clearance for wind resistance. Top and bottom bearing surfaces shall have sponge type weather seals. Integral spring isolators shall comply with Spring Isolator (Type S) requirements.

PART 3 – EXECUTION

3.01 ISOLATOR PERFORMANCE

- A. Comply with minimum static deflection recommended ASHRAE including definitions of critical and non-critical locations, for selection and application of vibration isolation materials and devices.
- B. Comply with manufacturer's recommendations for selection and application of vibration isolation materials and units.

3.02 ISOLATOR INSTALLATION

- A. Anchor and attach unit to substrate and equipment as required for secure operation and to prevent displacement by seismic forces, and as indicated.
- B. Adjust leveling devices as required to distribute loading uniformly onto isolators. Shim units as required where leveling devices cannot be used to distribute loading properly. Install so that HVAC units are level.
- C. Adjust isolators to ensure that units do not exceed rate operating deflections or bottom out under loading, and are not short circuited by other contacts or bearing points. Remove space blocks and similar devices (if any) intended for temporary protection against overloading during installation.
 - 1. No metal-to-metal contact will be permitted between fixed and floating parts.
 - 2. Connections to Equipment: Allow for deflections equal to or greater than equipment deflections. Electrical, drain, piping connections, and other items made to rotating or reciprocating equipment (pumps, compressors, etc.) which rests on vibration isolators, shall be isolated from building structure for first three hangers or supports.
 - 3. Common Foundation: Mount each electric motor on same foundation as driven machine. Hold driving motor and driven machine in positive rigid alignment with provision for adjusting motor alignment and belt tension. Bases shall be level

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throughout length and width. Provide shims to facilitate pipe connections, leveling, and bolting.

4. Provide heat shields where elastomers are subject to temperatures over 38 degrees C (100 degrees F).
5. Extend bases for pipe elbow supports at discharge and suction connections at pumps. Pipe elbow supports shall not short circuit pump vibration to structure.
6. Non-rotating equipment such as heat exchangers and convertors shall be mounted on isolation units having the same static deflection as the isolation hangers or support of the pipe connected to the equipment.

3.03 ISOLATOR ADJUSTMENTS

- A. Adjust vibration isolators after piping systems are filled and equipment is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4 inch (6-mm) movement during start and stop.
- D. Adjust active height of spring isolators.
- E. Adjust snubbers according to manufacturer's recommendations.
- F. Adjust seismic restraints to permit free movement of equipment within normal mode of operation.
- G. Torque anchor bolts according to equipment manufacturer's recommendations to resist seismic forces.

3.04 DEFLECTION MEASUREMENTS

- A. At job close out prepare and submit to Engineer a record showing measured equipment deflection for each major item of equipment.

3.05 ACOUSTIC LINING INSTALLATION

- A. Acoustic linings shall be adhered to all interior sides of duct with minimum 100% coverage for fire-retardant adhesive similar to Benjamin Foster 4 and with weld pins and washer or equivalent mechanical fastening starting 3 inches from edges and sides, 12 inches on center, all sides. Minimum one row per side for duct size of 12 inches size or less. Mechanical fasteners shall cause quilting of surface. Neoprene coated surface

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shall be toward air stream. Before installing liner seal all butting edges and final edges with heavy coat of adhesive to seal off air between lining and duct. All exposed edges of lining shall be installed with sheet metal nosing 1-1/2" wide, two gauges heavier than duct. Installation shall be suitable for duct velocities up to 3,000 feet per minute.

3.06 BALANCING AND ALIGNMENT OF ROTATING EQUIPMENT

- A. Statically and dynamically balance all pumps, fans, compressors and drivers. Align shafts of pumps, fans, and drivers to limit noise and vibration to specified values. Level and anchor equipment as necessary to achieve and maintain proper alignment.

3.07 VIBRATION TESTS ON ROTATING EQUIPMENT

- A. Perform vibration tests on all pumps, fans, compressors and drivers during the pretest of the equipment. Tests shall be conducted by an experienced technician in the presence of an Owner representative.
- B. Perform tests at each bearing in axial, horizontal, and vertical positions.
- C. RMS vibration velocity shall not exceed 0.0025 m/s (0.10-inch per second). Correct the cause of excessive vibration and provide retest.
- D. Test instruments furnished by contractor:
 - 1. Portable, with output capability to print data.
 - 2. Frequency range, 600-150,000 CPM minimum.
 - 3. Amplitude range, 2.54 m/s (0-100 inches per second).
 - 4. Sensitivity, 0.00013 m/s (0.005-inch per second).
 - 5. Frequency filter "out" for tests.
- E. Submit tabulated vibration readings to the Owner representative.

3.08 SOUND LEVELS

- A. Sound level limitations apply to all burners, fans, blowers, pumps, compressors, control valves, pressure reducing valves, motors, and turbines.
- B. Sound levels shall not exceed 85 DBA when measured 1400 mm (4.5-feet) above the floor and 910 mm (3-feet) horizontally from each surface of the smallest imaginary rectangular box which could completely enclose the entire unit which contains the sound source. Sound level limitations apply to the operation of the equipment at all loads within the equipment requirements.

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- C. If sound levels exceed requirements, modify or replace the equipment as necessary to achieve required sound levels and other specified requirements.
 - 1. Submit all proposed modifications or replacements for review prior to starting the work.
 - 2. After completing the work, provide complete retest of equipment operation and performance.

END OF SECTION

SECTION 23 05 53
IDENTIFICATION FOR HVAC

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide complete HVAC system identification work for all equipment and ducting from point of connection at HVAC equipment to termination points. Types of HVAC identification shall consist of:
 - 1. Painted Identification Materials
 - 2. Plasticized Tags
 - 3. Engraved Plastic Laminate Signs
 - 4. Plastic Tape
- B. Lettering, Size, Colors, and viewing angles of identification devices shall comply with ANSI A13.1.
- C. All work of this section shall comply with Section 23 00 00 GENERAL REQUIREMENTS - HEATING, VENTILATING, AND AIR-CONDITIONING (HVAC)

PART 2 – PRODUCTS

2.01 HVAC IDENTIFICATION MATERIALS

- A. Painted Identification Materials:
 - 1. Stencils: Standard fiberboard stencils with letters not less than 1-1/4 inches high for ductwork and not less than 3/4" inches high for access door signs and similar operational instructions.
 - 2. Identification paint: Standard exterior type stenciling enamel of wither brushing grade or pressurized spray can form and grade.
 - 3. Identification Paint: Standard identification enamel.
- B. Plastic Tape
 - 1. General: Manufacturer's standard color-coded pressure sensitive self-adhesive vinyl tape, not less than 3 mils thick.
 - a. Width: Provide 1-1/2" inch wide tape markers on pipes with outside diameters (including insulation, if any) of less than 6 inches, 2-1/2 inch wide tape for larger pipes.

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- b. Color: By ANSI A13.1 designation except where other color selection is indicated.
- C. Engraved-Plastic Laminate Signs:
 - 1. General: Provide engraving stock melamine plastic laminate complying with FS L-P-387 in the size and thickness indicated, engraved with engraver's standard letter style of the size and working indicated, black with white core (letter core) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
 - a. Thickness: 1/6 inch for units up to 20 sq. in. or 8 inch in length; 1/8 inch for larger units.
 - b. Fasteners: Self-tapping stainless screws, except contact type permanent adhesive where screws cannot or should not penetrate the substrate.

PART 3 – EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- A. Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceiling and removable concealment.

3.02 GENERAL DUCTWORK IDENTIFICATION

- A. Identify air supply, return, exhaust, outside air and intake relief ducting with stenciled signs and arrows, showing ductwork service in direction of flow, in black or white (whichever provides best contrast)
- B. In each space where ductwork is exposed, or concealed by removable ceiling system, locate signs near points of ductwork origin or where the ducts continue on into concealed enclosures and at 50 ft. spacing along exposed runs.
 - 1. Access doors shall be provided with stenciled or plastic-laminate type signs on each access door in ductwork and housings, indicating purpose of access (to what equipment) and other maintenance and operating instructions and appropriate safety and procedural information.

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IDENTIFICATION FOR HVAC

3.03 HVAC EQUIPMENT IDENTIFICATION

- A. Install engraved plastic laminate signs on or near each equipment item and each operational device, if not otherwise specified for each item or device. Provide signs for the following general categories of equipment and operational devices:
 - 1. Package Units
 - 2. Exhaust Fans
 - 3. VAV Boxes
 - 4. Control Valves
 - 5. Significant Shut Off Valves (Isolation)
 - 6. Main control and operating dampers, including safety devices and hazardous units.
- B. Where lettering larger than 1 inch height is needed for proper identification, because of distance from normal location of required identification, stenciled signs may be provided in lieu of engraved plastic, at Installer's option.
- C. Minimum 1/4" high lettering for name of unit where viewing distance is less than 2 feet and 1/2" high for distances up to 6 feet and proportionately larger lettering for greater distances. Provide secondary lettering of 2/3 or 3/4 the size of the principal lettering.
- D. In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operating requirements, indicate safety and emergency precautions, and warn of hazard and improper operations.

END OF SECTION

SECTION 23 05 93
TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

- A. Work Included: This Section covers requirements for testing, adjusting, and balancing work for the air distribution systems and associated equipment and apparatus described herein.
- B. All work of this section shall comply with Section 23 00 00 GENERAL REQUIREMENTS - HEATING, VENTILATING, AND AIR-CONDITIONING (HVAC).

1.02 QUALITY ASSURANCE

- A. Engage the services of an independent balancing and testing agency specializing in the balancing and testing of heating, ventilating and air conditioning systems to perform the work.
- B. TAB Agency:
 - 1. The TAB agency shall be a subcontractor of the General Contractor and shall report to and be paid by the General Contractor.
 - 2. The TAB agency shall be a certified member of AABC to perform TAB service for HVAC, water balancing and vibrations and sound testing of equipment. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the agency loses subject certification during this period, the General Contractor shall immediately notify the Engineer of Record and submit another TAB firm for approval. Any agency that has been the subject of disciplinary action by AABC within the five years preceding Contract Award shall not be eligible to perform any work related to the TAB. All work performed in this Section and in other related Sections by the TAB agency shall be considered invalid if the TAB agency loses its certification prior to Contract completion, and the successor agency's review shows unsatisfactory work performed by the predecessor agency.
- C. TAB Specialist:
 - 1. The TAB specialist shall be a member of. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the Specialist loses subject certification during this period, the General Contractor shall immediately notify the Resident Engineer and submit another TAB Specialist for approval. Any individual that has been the subject of disciplinary action by the AABC within the five years preceding Contract Award shall not be eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections performed by the TAB specialist shall be considered invalid if the TAB Specialist loses its

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certification prior to Contract completion and must be performed by an approved successor.

2. TAB Specialist shall be identified by the General Contractor within 60 days after the notice to proceed. The TAB specialist will be coordinating, scheduling and reporting all TAB work and related activities and will provide necessary information as required by the Resident Engineer. The responsibilities would specifically include:
 - a. Shall directly supervise all TAB work.
 - b. Shall sign the TAB reports that bear the seal of the TAB standard. The reports shall be accompanied by report forms and schematic drawings required by the TAB standard, AABC.
 - c. Would follow all TAB work through its satisfactory completion.
 - d. Shall provide final markings of settings of all HVAC adjustment devices.
 - e. Permanently mark location of duct test ports.
3. All TAB technicians performing actual TAB work shall be experienced and must have done satisfactory work on a minimum of 3 projects comparable in size and complexity to this project. Qualifications must be certified by the TAB agency in writing.
4. Test Equipment Criteria: The instrumentation shall meet the accuracy/calibration requirements established by AABC National Standards. Provide calibration history of the instruments to be used for test and balance purpose.
5. Tab Criteria:
 - a. One or more of the applicable AABC or SMACNA publications, supplemented by ASHRAE Handbook "HVAC Applications" Chapter 36, and requirements stated herein shall be the basis for planning, procedures, and reports.
 - b. Flow rate tolerance: Following tolerances are allowed. For tolerances not mentioned herein follow ASHRAE Handbook "HVAC Applications", Chapter 36, as a guideline. Air Filter resistance during tests, artificially imposed if necessary, shall be at least 90 percent of final values for pre-filters and after-filters.
 1. Air handling unit and all other fans, cubic meters/min (cubic feet per minute): Minus 0 percent to plus 10 percent.

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2. Air terminal units (maximum values): Minus 2 percent to plus 10 percent.
 3. Exhaust hoods/cabinets: 0 percent to plus 10 percent.
 4. Minimum outside air: 0 percent to plus 10 percent.
 5. Individual room air outlets and inlets, and air flow rates not mentioned above: Minus 2 percent to plus 10 percent except if the air to a space is 100 CFM or less the tolerance would be 0 to plus 5 percent.
 6. Heating hot water pumps and hot water coils: Minus 5 percent to plus 5 percent.
- c. Systems shall be adjusted for energy efficient operation as described in PART 3.
- d. Typical TAB procedures and results shall be demonstrated to the Resident Engineer for one air distribution system (including all fans, three terminal units, three rooms) and one hydronic system (pumps and three coils) as follows:
1. When field TAB work begins.
 2. During each partial final inspection and the final inspection for the project if requested by VA.
- D. AABC Compliance: Comply with AABC's Manual MN-1 "AABC National Standards", as applicable to mechanical air distribution systems and associated equipment and apparatus, except as otherwise specified.
- E. Industry Standards: Comply with American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE) recommendations pertaining to measurements, instruments, and testing, adjusting and balancing, except as otherwise specified.

1.03 SUBMITTALS

- A. Comply with Submittal Requirements of Division 01.
- B. Submit names and qualifications of TAB agency and TAB specialists within 60 days after the notice to proceed. Submit information on three recently completed projects and a list of proposed test equipment.
- C. For use by the Resident Engineer staff, submit one complete set of applicable AABC publications that will be the basis of TAB work.
- D. Submit Following for Review and Approval:

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1. Design Review Report within 90 days for conventional design projects and within 60 days for design-build projects after the system layout on air and water side is completed by the Contractor.
 2. Systems inspection report on equipment and installation for conformance with design.
 3. Duct Air Leakage Test Report.
 4. Systems Readiness Report.
 5. Intermediate and Final TAB reports covering flow balance and adjustments, performance tests, vibration tests and sound tests.
 6. Include in final reports uncorrected installation deficiencies noted during TAB and applicable explanatory comments on test results that differ from design requirements.
 7. Submit certification that balancing personnel have been trained in accordance with AABC standards.
 8. Submit certification of test equipment calibration and currency.
 9. Maintenance Data: Include in maintenance manuals, copies of certified test reports.
 10. Submit certified test reports signed by the Test and Balance Supervisor who performed testing and balancing work. In addition, have report certified by a Registered Professional Engineer who is familiar with testing and balancing work and also with project.
- E. Prior to request for Final or Partial Final inspection, submit completed Test and Balance report for the area.
- F. Make all other submittals specified under this Section.

1.04 JOB CONDITIONS

- A. Do not proceed with TAB work until work has been completed and is operable. Ensure that there is no latent residual work still to be completed.
- B. Do not proceed until work scheduled for testing, adjusting, and balancing is clean and free from debris, dirt and discarded building materials.

PART 2 – PRODUCTS

2.01 GENERAL

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- A. PATCHING MATERIALS: Except as otherwise indicated, use same products as used by original installer for patching holes in insulation, ductwork and housings which have been cut or drilled for test purposes, including access for test instruments, attaching jigs, and similar purposes. In each case, patching shall be completed by original installer.
- B. TEST INSTRUMENTS: Utilize test instruments and equipment for testing and balancing work required, of type, precision, and capacity as recommended in AABC's Manual MN-1 "AABC National Standards".

2.02 PLUGS

- A. Provide plastic plugs to seal holes drilled in ductwork for test purposes.

2.03 INSULATION REPAIR MATERIAL

- A. Provide for repair of insulation removed or damaged for TAB work.

PART 3 – EXECUTION

3.01 GENERAL REQUIREMENTS

- A. Examine installed work and conditions under which testing is to be done to ensure that work has been completed, cleaned and is operable. Do not proceed with testing and balancing work until unsatisfactory conditions have been corrected in manner acceptable to Tester.
- B. Test, adjust and balance environmental systems and components, as indicated, in accordance with procedures outlined in applicable standards.
- C. Test, adjust and balance system during summer season for air conditioning systems and during winter season for heating systems, including at least period of operation at outside conditions within 5 °F (3 °C) wet bulb temperature of maximum summer design condition, and within 10 °F (6 °C) dry bulb temperature of minimum winter design condition. When seasonal operation does not permit measuring final temperatures, then take final temperature readings when seasonal operation does permit.
- D. Prepare report of test results, including instrumentation calibration reports, in format recommended by applicable standards.
- E. Patch holes in insulation, ductwork and housings, which have been cut or drilled for test purposes.
- F. Mark equipment settings, including damper control positions, valve indicators, fan speed control levers and similar controls and devices, to show final settings at completion of testing and balancing work. Provide markings with paint or other suitable permanent identification materials.

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- G. Prepare a report of recommendations for correcting unsatisfactory mechanical performances when system cannot be successfully balanced, including, where necessary, modifications which exceed requirements of the Contract Documents. Submit report to the Engineer for review. Carry out corrective modifications as approved by the Engineer.
- H. Retest, adjust, and balance systems subsequent to significant system modifications, and resubmit test results.
- I. Units shall not be operated without air filters. Air filters shall be replaced completely after construction is complete and just prior to air balancing.

3.02 BALANCING PROCEDURES - WATER SYSTEMS

- A. Prior to balancing the Contractor shall complete construction of piping systems with all components installed, and controls operative and calibrated. Schedule balancing for completion four calendar weeks prior to the completion of the building or the area the water system is servicing.
- B. Verify the following conditions prior to balancing:
 - 1. Piping systems have been flushed and treated in accordance with Hydronic Piping, Valves, and Specialties Section.
 - 2. Strainers have been cleaned.
 - 3. Inside of traps, reducing and regulating valves have been cleaned.
 - 4. Expansion tanks are not air bound.
 - 5. Piping systems are completely full of water, all air properly vented off.
 - 6. All coil and isolation shut off and balance valves are fully open.
 - 7. Check pumps:
 - a. Rotation
 - b. Pump factory impeller trimming by comparing shut off heads with pumps curves from approved submittals.
 - 1. Report discrepancies in shut off head to Owner's Representative and if impeller does not appear to be properly trimmed, wait for direction before proceeding with pump test and balance.
 - 8. DDC Operability:

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- a. Do not proceed with any of the following balancing procedures until the DDC system is capable of operating equipment such as fans, pumps, boiler, control valves, etc. in manual and automatic modes and capable of reading sensors such as differential pressure, flow rates, temperature, etc. of air and hydronic systems to be tested and balanced.
- C. Pumps:
1. Test and report for each pump:
 - a. Tag, manufacturer and model of pump, motor manufacturer, service, model and size.
 - b. Motor horsepower, volts, phase, full load amps.
 - c. Pump shut off head from curves and measured shut off head.
 - d. With all control valves open to coils:
 1. Volts and amps, measured with handheld meter, and calculated brake power.
 2. Entering and leaving gage pressure and difference in feet.
 3. Suction, discharge and total flow rates, deduced from pump curve.
- D. Hydronic system:
1. At three way valves, adjust balance valves in bypass leg as required to make pressure drop across the coil-valve assembly when valve is in full bypass position equal to that when the valve is in the through coil position. Leave isolation shut off valves full open.
 - a. Report:
 1. Coils:
 - a) Tags of coils with 3- way valves that are balanced.
 - b) Inlet, outlet, and pressure drop across the assembly with valve open to coil.
 - c) Pressure drop across the assembly with valve open to bypass before and after bypass valve balance.
 - d) Hot water return temperature.

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- e) Hot water supply temperature.
 - f) Coil flow rate.
 - g) Design and final inlet and outlet pressures.
2. Boiler:
- a) Design and measured differential pressure across boiler before and after balance.
 - b) Hot water return temperature.
 - c) Hot water supply temperature.
 - d) Design and final inlet and outlet pressures.
 - e) Calculated heating energy transferred to water, in btu/h.
 - f) Calculated efficiency (heat transferred to water divided by gas energy input).
3. Test control valve shutoff
- a) Close all control valves in the system. Run pumps individually, at full speed, dead headed.
 - b) Verify that all control valves remain shut with no measurable flow, as indicated by pump differential pressure, and any temperature rise across coils.
 - c) Do not run pumps dead headed for more than five minutes at any one time.
 - d) Report:
 - e) Tag of coils where flow is detected.
 - f) Measured pump inlet and outlet pressures, with differences converted to feet.

3.03 BALANCING PROCEDURES - AIR SYSTEMS

- A. Prior to balancing, the Contractor shall complete construction of air handling system with all components installed, and controls operative and calibrated. Schedule balancing for completion four calendar weeks prior to the completion of the building or the area the air system is servicing.

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- B. Before balancing, check alignment of fan and motor sheaves.
- C. Obtain copies of fan pressure volume power characteristics at rated speed. Prepare line drawings of systems with identifying designations for each section of the distribution systems and all outlets.
- D. Set all fans at rated speeds for design volumes and pressure. Simultaneously operate all supply and exhaust systems serving common areas on 100% outside air or full recirculation throughout the balancing period.
- E. Measure flow and pressure in ducts by means of pitot tube and manometer or U-gage having a minimum sensitivity of 0.02 inch of water.
- F. For rectangular ducts, take readings at the center point of equal rectangles with not less than 16 and a maximum of 64 readings. Center distances between rectangular areas shall be not more than 6 inches. Take readings as far downstream of fittings as is practicable up to an equivalent of seven duct diameters.
- G. Measure fan and motor speed with a direct reading tachometer and Strobe Tach. Measure amperage and voltage with direct connected or clamp-on instruments.
- H. Measure flow at air outlets and inlets with velometer in accordance with air outlet manufacturer's instructions.
- I. Submit to the Engineer duplicate copies of final test and balancing measurements, drawings and operating data on fan curves.
- J. Determine actual air volume delivery of all fans by measuring fan performance point on fan pressure volume curve.
 - 1. Measure and record fan performance data on Fan Data Sheet. Plot operating point on fan pressure volume curve. Plot BHP on fan power CFM curve.
 - 2. Measure total system flow in main supply duct by means of pitot tube traverse.
 - 3. If volumes determined by each method described in 1 and 2 above are within 5% of one another, continue test. If, in excess of 5% notify Engineer and have fan checked by manufacturer, then repeat pitot tube traverse.
 - 4. If measured volumes are within 5% of one another but at other than design volume, readjust fan speed for design volume delivery.
- K. Test and record static pressure drop across all filters and note the condition of the filter at the time of test.
- L. Test and record entering and leaving db and wb temperature after the air systems have been balanced. Note whether system is on the heating or ventilation cycle.

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- M. After all fans have been adjusted, proceed with balancing of systems. Adjust outside quantities by temperature of outside air, recirculated air and mixture on a day in which outside air is at least 30 °F colder than room air. Maximum and minimum air volumes through outdoor, return and exhaust air combination are to be adjusted in conjunction with automatic controls manufactured by means of linkage stops on damper motors.
- N. Balance systems to the following tolerances:
1. Fans: Design volume plus 5%
 2. Outlets: Design volume plus 5%
 3. Leakage: 3%
- O. Where duct joints present leakage, the contractor shall reseal joints with 3M EC-800 cement, or equal.
- P. The following data shall be measured and recorded for all systems after balancing and adjusting to within limits specified herein, for submission of balancing report:
1. Fan Data:
 - a. Manufacturer and model number (where available)
 - b. CFM, design
 - c. CFM, actual
 - d. RPM
 - e. Inlet static pressure
 - f. Discharge static pressure
 - g. Total static pressure
 - h. For purpose of balancing, fan BHP shall be calculated as follows:

Actual Amps X Actual Volts

$$\text{BHP} = \text{Nameplate Amps} \times \text{Nameplate Volts} \times \text{Nameplate HP}$$

- i. If more accurate reading is necessary for resolution of performance data conflict, use a calibrated wattmeter for measuring power.

2. Motor Data:

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- a. Manufacturer model number
 - b. Horsepower
 - c. Phase
 - d. Frequency
 - e. NEMA code letter
 - f. Rated volts
 - g. Actual volts
 - h. Rated amperes
 - i. Actual amperes
 - j. Calculated operating BHP
 - k. Locked rotor amperes
3. Hydronic Coils (where occurs):
- a. Coil tag or note to which air handler coil serves.
 - b. Airflow in CFM
 - c. Inlet air temperature
 - d. Outlet air temperature
 - e. Air inlet pressure
 - f. Air outlet pressure
4. Air Outlet Data:
- a. Schedule showing all air outlet locations and numbers assigned to outlets for purpose of test
 - b. Air outlet manufacturer and model number where available
 - c. Size
 - d. Actual free area
 - e. Manufacturers test factor

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- f. Measured velocity
- g. CFM, design
- h. CFM, actual
- i. CFM, percentage above or below design

5. Outdoor Air Data:

- a. Size and inlet
- b. Actual free area
- c. Manufacturers test factor
- d. Measured velocity
- e. Outdoor air temperature
- f. Return air temperature
- g. Mixed air temperature with averaged traverse readings

3.04 AUTOMATIC CONTROL DEVICES:

- A. Automatically operated devices that are pertinent to the adjustment of the air system shall be set and adjusted to deliver the required quantities of air. All control work shall be done in collaboration with the representative of the control device manufacturer.

3.05 PATCHING MATERIALS:

- A. Except as otherwise indicated, use the same products as used in the original installation for patching holes in insulation, ductwork and housings which have been cut or drilled for test purposes, including access for test instruments, attaching jigs, and similar purposes. In each case, patching is to be completed by original installer.

3.06 MARKINGS:

- A. Mark equipment settings, including damper control positions, valve indicators, fan speed control levers, and similar controls and devices, to show final settings at completion of testing, adjusting and balancing work. Provide markings with paint or other suitable permanent identification materials.

3.07 IDENTIFICATION OF TEST PORTS

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- A. The TAB Specialist shall permanently and legibly identify the location points of duct test ports. If the ductwork has exterior insulation, the identification shall be made on the exterior side of the insulation. All penetrations through ductwork and ductwork insulation shall be sealed to prevent air leaks and maintain integrity of vapor barrier.

3.08 RECOMMENDATIONS

- A. Prepare a report of recommendations to the Engineer for correcting unsatisfactory mechanical performance when systems cannot be successfully balanced, including, where necessary, modifications.
- B. Retest, adjust and balance systems subsequent to significant system modifications and resubmit test results.

END OF SECTION

SECTION 23 07 00

THERMAL INSULATION FOR MECHANICAL SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. The work covered under this section consists of providing all necessary labor, supervision, materials, equipment and services to completely execute the complete HVAC system insulation work for equipment, piping, ductwork and other items where shown on the drawings and required herein.
- B. Insulate equipment and products at the following locations;
 - 1. Where the fluid being transported is 60 degrees Fahrenheit or below in temperature.
 - 2. Where the fluid being transported is 100 degrees Fahrenheit or above in temperature.
 - 3. All hot surfaces above 120 degrees in temperature to prevent personnel burns.
 - 4. All piping, equipment, ducting, valves, etc., which require insulation but come uninsulated from the manufacturer.
 - 5. Hydronic piping insulation means insulation of all components of the piping system including, but not limited to, fittings, joints, flanges, equipment, valves, pump volutes, tanks, and all exposed surfaces subject to temperatures above 100 degrees or below 60 degrees, unless indicated otherwise elsewhere.
- C. All work of this section shall comply with Section 23 00 00 GENERAL REQUIREMENTS - HEATING, VENTILATING, AND AIR-CONDITIONING (HVAC).

1.02 REFERENCES

- A. Insulation work shall comply with the requirements of the 2013 California Energy Commission requirements.
- B. ASTM E84 – Standard Test Method for surface Burning Characteristics of Building Materials (NFPA 255).
- C. UL 723 – Test for Surface Burning Characteristics of Building Materials.
- D. UL 263 – Fire Tests of Building Construction and Materials.

SECTION 23 07 00

THERMAL INSULATION FOR MECHANICAL SYSTEMS

1.03 SUBMITTALS

- A. Comply with Division 01 requirements in addition to Section 23 00 00 for submittals and coordinated shop drawings.
- B. Submit product data on all insulation products inclusive of R-Value, flame spread rating, developed smoke rating and locations.

PART 2 – PRODUCTS

2.01 GENERAL

- A. The type of insulation and its installation shall be in accordance with this Specification for each service and the application technique shall be as recommended by the manufacturer.
- B. Fire Rating of all insulation shall have a composite (insulation, jacket/facing and adhesive used to adhere facing or jacket to insulation) fire and smoke hazard, as tested by ASTM E84, UL 263, and UL 723, not to exceed a flame spread of 25 and smoke developed by 50.
 - 1. Accessories such as adhesives, mastics, tapes, and cements shall have the same component ratings as listed herein.
 - 2. Products shall have integral factory labeling indicating that flame spread and developed smoke ratings do not exceed the above requirements.

2.02 HYDRONIC PIPING INSULATION

- A. Insulation shall be molded fiberglass with a minimum density of 3.5 pounds per cubic foot with a maximum thermal conductivity of 0.25 BTUH/sq. ft. deg. F/in at 75 degrees.
- B. Jacketing shall be factory applied, paintable, white kraft outer surface bonded to aluminum foil and reinforced with fiberglass yarn with self-sealing lap. Maximum vapor permeance shall be 0.02 perms with a minimum beach puncture of 50 units. Seal end joints with sealing strip or tape to provide vapor and weather tight installation.
- C. Fittings and valves insulation shall consist of pre-molded PVC fitting covers over pre-cut insulation of same thickness as adjacent piping.
- D. Expansion joints (where applicable) shall be insulated with factory made insulation covers specifically made for the purpose. Covers shall be pre-shaped, shall cover entire joints including flanges and shall allow the anticipated movement of the joints without breaking the insulation of jacketing. Covers shall also be removable to facilitate inspection of joints by maintenance personnel.

SECTION 23 07 00

THERMAL INSULATION FOR MECHANICAL SYSTEMS

- E. Piping insulation shall be 1 1/2" thick for 4 inch and smaller piping. Insulate all supply and return hydronic piping.
- F. Preformed calcium silicate blocks shall be used to isolate all piping from hangers and supports. Silicate blocks shall be held in place with metal sleeves/pipe saddles of type to match hanger and prevent galvanic action in case of wetting. Calcium silicate shall have a minimum density of 12.5 pounds per cubic foot with a maximum thermal conductivity of 0.40 BTUH/sq. ft. deg F/inch at 200 degrees.

SECTION 23 07 00

THERMAL INSULATION FOR MECHANICAL SYSTEMS

PART 3 – EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation products in accordance with the manufacturer's written instruction, commercial and industrial standards, and recognized industry practices to ensure that the insulation serves the intended purpose. Surfaces shall be thoroughly cleaned with all testing successfully completed prior to insulating.
- B. In addition to where specified, provide insulation by type and locations as indicated on the Drawings.
- C. After the installation of insulation protect the insulation from moisture and weather damage.
- D. Provide complete weather protection for all outdoor piping insulation.

3.02 INSULATION LOCATIONS

- A. Apply insulation by type and location as follows:
 - 1. Hydronic Piping Insulation
 - a. Insulate supply and return piping at all locations.
 - 1. Provide metal jacketing at locations exposed to weather.

3.03 PIPING APPLICATION

- A. Apply insulation to clean dry pipes after all pressure tests have been completed. Firmly butt all joints of insulation and seal all joints per manufacturer's recommendations.
- B. Flanges, strainers, and unions shall be insulated with pre-molded or shop fabricated rigid insulation of same material and thickness as specified for adjacent piping. Cover fiberglass insulation with pre-molded PVC covers, held in place with Johns Manville Zeston Z-tape. Covers and finish for foam glass and calcium silicate insulation shall be as specified for the adjacent pipe insulation. Ensure that insulation and covers for flanges, unions, strainers, and access plates shall be removable without damage to insulation or jackets.
 - 1. Insulate and cover all valves, tees, elbows, and other fittings the same as for flanges, strainers, and unions. Valve operators, pressure/temperature plus, meters, gauges and all other items which extend through required insulation shall be suitably insulated with removable caps to allow use without disturbing the insulation.

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THERMAL INSULATION FOR MECHANICAL SYSTEMS

- C. Hydronic piping shall be insulated with preformed fiberglass insulation with sealed lap joints using manufacturer's standard pressure sensitive self-sealing lap joint system. Seal butt joints using the manufacturer's standard pressure sensitive closure strip system. Butt strips shall be a minimum of 3 inches wide.
- D. Hangers and supports shall be provided with metal pipe saddles to hold calcium silicate blocks in position and provide an even transition between the insulation, blocking, pipe hanger and adjacent fiberglass insulation. Extend vapor barrier across all calcium silicate pipe blocking including through pipe hanger.
- E. Metal jacketing shall extend over PVC jacketing or vapor barrier, down through roof. Longitudinal seals shall provide a 3 inch overlap installed at the 9 o'clock or 3 o'clock positions to shed water. Butt joints shall be overlapped a minimum of 3 inches in a manner to prevent entry of water. Seal metal jacketing with $\frac{3}{4}$ inch stainless steel sealing bands installed on 12 inch centers, minimum, along the metal jacket. Locate strap joints to prevent personnel contact. Metal jacket on valves and flanges shall be removable without disturbing the adjacent jacket.
- F. Extend piping insulation without interruption through walls, floors and similar penetrations.
- G. Provide adequate ventilation during initial start-up of piping systems to remove smoke and odor given off when the organic binders in the insulation are initially heated.

3.04 AFTER INSTALLATION CHECK

- A. Visually inspect the complete installation and repair or replace any improperly sealed joints.
- B. Where there is evidence of vapor barrier failure or wet insulation after installation the damaged insulation shall be removed, the surfaces shall be cleaned and dried and the new insulation shall be installed.

END OF SECTION

SECTION 23 21 13

HYDRONIC PIPING, VALVES, AND SPECIALTIES

PART 1 – GENERAL

1.01 DESCRIPTION

- A. This Section covers the furnishing and installation of hydronic piping, valves, and specialties as indicated on the Contract Drawings and Schedules and as specified herein. Included, but not limited to the following, shall be thermometers, differential pressure sensors, air vents, strainers, pressure gauges, air separator, and flow control devices and complete factory assembly of all components.
- B. Unless otherwise noted, all devices shall be rated for 125 PSI working steam pressure (WSP) and shall be suitable for the systems maximum pressure.

PART 2 – PRODUCTS

2.01 PIPE

- A. Pipe shall be new, free from scale, and of the material and weight specified under the various services. Each length of pipe shall be properly marked at the mill for proper identification with name or symbol of manufacturer.
- B. Copper tubing shall be of weight as required for service specified, with conformance with ASTM B-88 for types "L" and "K" tubing, as manufactured by Chase, Anaconda, Revere, or equal, for piping 2 inches and smaller in size.
- C. Copper tubing shall be joined with 95-5 tin-antimony lead free solder as herein specified.
- D. Dielectric fittings for connecting piping of dissimilar metals shall be as manufactured by Epco, Inc., or equal.
- E. Pipe Schedule: Pipe for hot water heating shall be as follows:

<u>Service</u>	<u>Material</u>	<u>Schedule</u>
1. Overflow and Drain	Copper	Type K
2. Hot Water Heating	Copper	Type L
3. Vent (water discharge)	Copper Tubing	1/4 inch Type L

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HYDRONIC PIPING, VALVES, AND SPECIALTIES

displacement due to expansion. Such hangers shall be finally adjusted, both in the vertical and horizontal direction. Hangers in contact with copper pipe shall be copper plated steel. Piping supports shall conform to ANSI B31.1, Standard Code for Pressure Piping, and conform to the Manufacturer's Standardization Societies Standards, MSS-SP-58, MSS-SP-69, and MSS-SP-89. However, ANSI B31.1 shall take precedence.

- B. Pipe hangers shall be the clevis and pipe roll types, as scheduled below except where otherwise noted.

PIPE HANGER SCHEDULE

<u>PipeType of Hanger</u>	<u>Fig. No.</u>	<u>Grinnell Fig. No.</u>	<u>F&M Fig. No. & Paterson</u>	<u>Carpenter</u>
All sizes	Clevis Hanger	260	239	100

- C. Hangers supported from floor and roof steel shall be approved beam clamps. I-beam clamps for hangers supporting piping 2 inches and smaller shall be C & P Fig. No. 148 adjustable beam clamps.
- D. Vertical piping shall be anchored by means of heavy steel clamps securely bolted or welded to the piping, and with end extension bearing on the building's structural framing.
- E. Vertical piping shall be supported at each floor by use of clamps fastened to building structure.
- F. Vertical runs of pipe not over 15 feet long shall be supported by hangers placed not over one foot from the elbows on the connecting horizontal runs.
- G. For hot water heating piping 2 inches and smaller, provide "Insulshield" as made by Insulcoustic Corp. or pipe covering protection shield C & P Fig. 265P with steel shield minimum 9 inches long, with vapor barrier jacket at each support.
- H. Hanger rods shall be in accordance with the California Mechanical Code Table 316.
- I. Piping shall not be hung from other piping, ducts, conduits, or from equipment of other trades. Hanger rods shall not pierce ducts.
- J. Where additional steel is required for the support of hangers, furnish and install supplemental steel subject to the review of the Engineer.

2.04 VALVES

- A. Valves-General: Valves shall be of a design which the manufacturer lists for the service and shall be of materials allowed by the latest edition of the ASME Code for pressure piping for the pressure and temperature contemplated, unless a higher grade or quality

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HYDRONIC PIPING, VALVES, AND SPECIALTIES

is herein specified. However, 125 psig WSP shall be the minimum acceptable rating. Valves shall be of the same manufacturer, except for special applications.

- B. Valves 2 inches in diameter and smaller shall be all bronze with bronze bodies.
- C. Drain valves shall be provided on tanks, receivers, risers and where they may be required or necessary, for draining the lines and equipment. Drain valves of minimum one inch size shall be provided at the low points for proper drainage. Valves shall be provided with threaded ends for drain connections.
- D. Valves up to 2 inches in diameter shall have screw ends.
- E. Bronze valves shall be furnished with Teflon impregnated packing.
- F. Valves for hot water heating systems shall be of type and model number as specified below, except as otherwise noted.

G.

Hot Water Heating System Valves in Copper Tubing:

<u>TYPE</u>	<u>SIZE</u>	<u>CRANE NO.</u>	<u>JENKINS NO.</u>	<u>WALWORTH NO.</u>	<u>REMARKS</u>
Gate Valve	2 inch & Smaller	1320	1240	4-SJ150	125 lb. WSP, Bronze

<u>TYPE</u>	<u>SIZE</u>	<u>CRANE NO.</u>	<u>JENKINS NO.</u>	<u>WALWORTH NO.</u>	<u>REMARKS</u>
Swing Check	2 inch & Smaller	1303	---	406SJ	125 lb. WSP, Bronze

- H. Balancing Valves: 1/2 inch to 2 inch size: Model CB as manufactured by Bell and Gossett, or equal. Valves shall have differential pressure readout ports and one drain/purge port. Valves shall have memory stop feature and calibrated nameplates.
- I. Ball Valves:
 1. Ball Valves up to 2 inches may be used for all water services as an alternate to gate valves and globe valves.
 2. Ball valves shall be full port bronze body, bronze ball and stem Teflon seats and seals, threaded ends, 400 psig W.O.G. Nibco or equal
- J. Control Valve:

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2.05 THERMOMETERS

- A. Furnish and install, where indicated on the Drawings and where specified herein, separable well-type dial or 9-inch, mercury-adjustable, angle-type in glass stem, thermometers as manufactured by American, Trerice, Weksler, Weiss or equal.
- B. Instrument wells for controls and indicators furnished by the temperature control manufacturer shall be installed under this Section.
- C. Provide a thermometer at each automatic control sensor or bulb. Additional thermometers shall be provided where indicated on the Drawings.

2.06 EXPANSION JOINTS, LOOPS, ANCHORS, AND GUIDES

- A. Provisions for expansion in piping mains, branches, and risers shall be made by the installation of offsets, expansion loops, or compensators as indicated on the Drawings and as required. Every 100-foot-long horizontal run of hot water piping shall have expansion loop and anchors. Minimum loop shall be 8 feet by 6 feet if not indicated on the Drawings.
- B. Piping with loops or compensators shall be anchored so as to direct all expansion toward the loops or compensators.
- C. Guides shall be provided on both sides of each expansion loop and compensator. Guides shall be Flexonics pipe alignment guides or equal. Anchors and guides shall be secured to beams, columns or concrete slabs.
- D. Pipe hangers and rollers are not considered guides.

2.07 AIR VENTS

- A. High points and air pockets in water piping systems shall be kept to a minimum and shall be properly vented where unavoidable. Air elimination devices called for on the Drawings and in the Specification shall be provided and properly installed. In addition, furnish and install all other air elimination devices that may be required at air pockets in piping due to job conditions. Assume responsibility for a proper, continuous and automatic air elimination to assure even and balanced distribution of water to all equipment.
- B. Furnish and install an Armstrong No. 1 AV or Sarco 13W automatic air vent with test valve at each high point in the water piping mains and where indicated on the Drawings. Furnish and install a 125 psig rated valve on the system side of each automatic air vent. Vents on hot water lines shall have Hoke Fig. No. PY-271 valves or equal. Vents on all other water lines shall have Hoke Fig. No. RB-271 valves or equal.

2.08 STRAINERS FOR HOT WATER SYSTEM

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- A. Furnish and install a full-size Y-pattern strainer on the inlet of each control valve and each water pump, where indicated on the Drawings.
- B. The strainers shall be as manufactured by Spence, Sarco, Barnes and Jones, Elliot, Crane or Mueller.

2.09 DIFFERENTIAL PRESSURE SENSORS

- A. Furnish and install differential pressure sensors in accordance with manufacturer's instructions.
- B. Sensors shall be liquid compatible with temperatures and pressures for system they are installed within. Wetted materials shall be 316 or 316L stainless steel. Accuracy shall be plus or minus 0.5% with an upward temperature limit of 200F.
- C. Output signal shall be 4 to 20 mA and be converted to optional 0-10 VDC based upon control system input requirements.

2.10 PRESSURE AND TEMPERATURE TEST STATIONS

- A. Furnish and install in each supply and return runout to each hot water reheat coil and also where indicated on the Drawings, a 1/4 inch MPT fitting to receive either a temperature or pressure probe 1/8 inch OD. Fitting shall be solid brass with valve core of Nordel (Maximum 275°F), fitted with a color coded and marked cap with gasket, and shall be rated at 1000 psig.
- B. Provide one pressure and temperature test kit consisting of one 0-60 PSI water pressure gauge and one 0-30 PSI water pressure gauge each with No. 500 gauge adapter attached, a 25-125 degrees F pocket testing thermometer, a 0-220 degrees F pocket test thermometer, a No. 500 gauge adapter, and a protective carrying case. Provide one additional 0-60 PSI pressure gauge and one additional zero to 30 PSI pressure gauge.

2.11 CIRCUIT SETTER FLOW CONTROL VALVE

- A. Furnish and install flow control valves for balancing heating hot water flow through individual heating coils. Valves shall be of bronze body/brass ball construction with glass and carbon filled TFE seat rings. Valves shall be capable of operating at 300 psi and 250°F conditions.
- B. The flow control valves shall be manufactured by Belimo, for flow through heating coils as indicated on drawings. To assure calibrated accuracy a minimum length of unrestricted straight pipe adjacent to the valve should be maintained: allow at least 3.5 pipe diameters upstream of the circuit setter and 1.5 pipe diameters downstream of the circuit setter
 - 1. Control valve shall be manufactured by Belimo, 2-10V control type. Refer to Control Valve Schedule on M0.02 for full list of valve and associated actuator model numbers.

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PART 3 – EXECUTION

3.01 PREPARATION

- A. Contractor shall examine locations where the piping is to be installed and determine space conditions and Owner in writing of conditions detrimental to proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF PIPING

- A. Coordinate with other work as necessary to interface installation of piping with other components of systems.
- B. The Drawings indicate schematically the size and location of piping. Piping shall be set up and down and offset to meet field conditions and to provide adequate maintenance room and headroom in the boiler rooms.
- C. All exposed piping shall be run perpendicular and parallel to floors and interior walls. Piping and valves shall be grouped neatly and shall be run so as to avoid reducing headroom or passage clearance. Provide min. 7'-6" headroom under passageways in boiler rooms. Valves, controls and accessories concealed in furred spaces and requiring access for operation and maintenance shall be arranged to assure the use of a minimum number of access doors.
- D. Valves and specialties shall be so placed as to permit easy operation and access.
- E. Provide proper provisions for expansion and contraction in all portions of pipe work, to prevent undue strains on piping or apparatus connected therewith. Provide double swings at riser transfers and other offsets wherever possible, to take up expansion. Arrange riser branches to take up motion of riser.
- F. Piping connections to coils and equipment shall be made with offsets provided with screwed unions so arranged that the equipment can be serviced or removed without dismantling the piping.
- G. Install piping in accordance with the latest edition of the ANSI Code for Pressure Piping, B31.1.
- H. Dissimilar piping shall be connected with dielectric connectors.
- I. Support piping at all equipment and control valves to prevent strains or distortions in the connected equipment and control valves. Piping shall be supported to allow for

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removal of equipment, valves and accessories with a minimum of dismantling and without requiring additional supports after these items are removed.

3.03 FIELD QUALITY CONTROL

A. Test of water piping:

1. Test water piping at completion of roughing in, in accordance with the following schedule and show no loss in pressure or visible leaks after a minimum duration of four hours, or time indicated, at the test pressures indicated.
2. Make connections to existing systems with flanged connections. During testing of the new work, provide a slip-in plate to restrict test pressure to new systems only. Remove plate and complete connection to existing system at completion of testing.
3. Inspect pressure piping in accordance with procedures of ANSI B31.
4. For systems operating at less than 100 pounds per square inch operating pressure test hydrostatically to 150 pounds per square inch.
5. For systems operating at more than 100 pounds per square inch operating pressure test hydrostatically to 1-1/2 times operating pressure but do not exceed test pressure ANSI 16.1 basis.
6. Test Duration shall be for a minimum of two hours with system valves capped and pressure apparatus disconnected. Pressure change during test period shall be zero. Compensate for temperature change.
7. Leaks and defects shall be repaired or replaced as directed by the Owner's Representative at no additional cost to the Owner.

3.04 CLEANING

- A. During construction keep openings in piping closed to prevent entrance of foreign matter. Clean pipe, fittings and valves internally. Hammer welds to remove slag and beads.
- B. Clean system after pressure test. Do not let system sit filled with un-chemically treated water for more than 4 hours.
 1. Should any pipe be plugged or should foaming of water systems occur, disconnect piping, clean again, and reconnect at no additional cost to the Owner.

END OF SECTION

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METAL DUCTS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide complete materials, equipment, fabrications, installation and tests in conformity with applicable codes and authorities having jurisdiction for the following:
1. Ductwork and Plenums
 2. Fasteners and Sealants
 3. Access doors
 4. Balancing dampers
 5. Backdraft dampers
 6. All duct accessories

1.02 DEFINITIONS

- A. In addition to Section 23 00 00 GENERAL REQUIREMENTS - HEATING, VENTILATING, AND AIR-CONDITIONING the following abbreviations apply:
1. Seam: locks or weld applied longitudinally to close section of duct. Examples: longitudinal seam, spiral seam.
 2. Joint: abutting connection between duct sections for continuity of air passage. Examples: cross joint, transverse joint, coupling.
 3. Reinforcement: hardware applied to strengthen duct. Examples: girth angles, tie rods, fasteners (not connectors).
 4. Stiffening: folding, bending, cross-breaking or corrugating of sheets to achieve strength through shape. Examples: pocket lock secures joint and is transverse stiffener, with girth angle and/or fasteners applied (not connectors), joint or stiffener is reinforced.
- B. Duct Classifications:
1. Velocity:
 - a. Low: to 2,000 feet per minute.
 - b. High: above 2000 feet per minute.
 2. Pressure classification: except as noted:

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- a. Low: Up to 2 inches water gauge.
- b. Medium: Above 2 inches to maximum 6" water gauge.
- c. High: Above 6" water gauge.

1.03 QUALITY ASSURANCE

- A. In addition to Section 23 00 00 GENERAL REQUIREMENTS - HEATING, VENTILATING, AND AIR-CONDITIONING quality assurance requirements the ductwork shall:
 - 1. Entire ductwork system, including materials and installation shall be installed in accordance with NFPA 90A.
 - 2. Ductwork and components shall be listed as U.L. 181, Class 1 air duct, flame rating not to exceed 25 and smoke rating not to exceed 50.
 - 3. Fire Safety Code: Comply with NFPA 90A.
 - 4. Duct System Construction and Installation: Referenced SMACNA Standards are the minimum acceptable quality.
 - 5. Duct Sealing, Air Leakage Criteria, and Air Leakage Tests: Ducts shall be sealed as per duct sealing requirements of SMACNA HVAC Air Duct Leakage Test Manual for duct pressure classes shown on the drawings.
 - 6. Duct accessories exposed to the air stream, such as dampers of all types (except smoke dampers) and access openings, shall be of the same material as the duct or provide at least the same level of corrosion resistance.

1.04 SUBMITTALS

- A. Manufacturer's Literature and Data:
 - 1. Rectangular ducts:
 - a. Schedules of duct systems, materials and selected SMACNA construction alternatives for joints, sealing, gage and reinforcement.
 - b. Duct liner.
 - c. Sealants and gaskets.
 - d. Access doors.
 - 2. Round and flat oval duct construction details:
 - a. Manufacturer's details for duct fittings.

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- b. Duct liner.
 - c. Sealants and gaskets.
 - d. Access sections.
 - e. Installation instructions.
3. Volume dampers, back draft dampers.
 4. Upper hanger attachments.
 5. Fire dampers, fire doors, and smoke dampers with installation instructions.
 6. Sound attenuators, including pressure drop and acoustic performance.
 7. Flexible ducts and clamps, with manufacturer's installation instructions.
 8. Flexible connections.
 9. Instrument test fittings.
 10. Details and design analysis of alternate or optional duct systems.
- B. Coordination Drawings: Refer to article, SUBMITTALS, in Section 23 00 00.

1.05 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society for Testing and Materials (ASTM):
1. A167-99(2009) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
 2. A653-09 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy coated (Galvannealed) by the Hot-Dip process.
 3. A1011-09a Standard Specification for Steel, Sheet and Strip, Hot rolled, Carbon, structural, High-Strength Low-Alloy, High Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
 4. B209-07 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 5. C1071-05e1 Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).

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- 6. E84-09a Standard Test Method for Surface Burning Characteristics of Building Materials.
- C. National Fire Protection Association (NFPA):
 - 1. 90A-09 Standard for the Installation of Air Conditioning and Ventilating Systems.
 - 2. 96-08 Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- D. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
 - 1. 4th Edition HVAC Duct Construction Standards, Metal and Flexible.
 - 2. 2012 HVAC Air Duct Leakage Test Manual.
 - 3. 7th Edition Fibrous Glass Duct Construction Standards.
- E. F. Underwriters Laboratories, Inc. (UL):
 - 1. 181-08 Factory-Made Air Ducts and Air Connectors.
 - 2. 555-06 Standard for Fire Dampers.
 - 3. 555S-06 Standard for Smoke Dampers.

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METAL DUCTS

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Spiral round duct: McGill Airflow
- B. Duct Connection Systems: Ductmate Industries
- C. Flexible Connections: Ventfabrics
- D. Flexible Ducts: ATCO Rubber Products, Inc.
- E. Duct Sealants: Foster
- F. Flexible Duct Clamps: ATCO Rubber Products
- G. Spin-in fittings: Buckley Associates, Inc.
- H. Duct Access Doors at ducts: Ventfabrics
- I. Duct Access Doors at plenums: Ventfabrics
- J. Multi-blade volume dampers: Ruskin
- K. Backdraft Dampers: Ruskin
- L. Damper Hardware: Young Regulator Company

2.02 DUCT MATERIALS AND SEALANTS

- A. General: Except for systems specified otherwise, construct ducts, casings, and accessories of galvanized sheet steel, ASTM A653, coating G90; or, aluminum sheet, ASTM B209, alloy 1100, 3003 or 5052.
- B. Specified Corrosion Resistant Systems: Stainless steel sheet, ASTM A167, Class 302 or 304, Condition A (annealed) Finish No. 4 for exposed ducts and Finish No. 2B for concealed duct or ducts located in mechanical rooms.
- C. Joint Sealing: Refer to SMACNA HVAC Duct Construction Standards, paragraph S1.9.
 - 1. Sealant: Elastomeric compound, gun or brush grade, maximum 25 flame spread and 50 smoke developed (dry state) compounded specifically for sealing ductwork as recommended by the manufacturer. Generally provide liquid sealant, with or without compatible tape, for low clearance slip joints and heavy, permanently elastic, mastic type where clearances are larger. Oil base caulking and glazing compounds are not acceptable because they do not retain elasticity and bond.

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2. Tape: Use only tape specifically designated by the sealant manufacturer and apply only over wet sealant. Pressure sensitive tape shall not be used on bare metal or on dry sealant.
 3. Gaskets in Flanged Joints: Soft neoprene.
- D. Approved factory made joints may be used.

2.03 DUCT CONSTRUCTION AND INSTALLATION

- A. Regardless of the pressure classifications outlined in the SMACNA Standards, fabricate and seal the ductwork in accordance with the following pressure classifications:
- B. Duct Pressure Classification:
1. 2 inch
 2. > 2 inch to 3 inch
 3. > 3 inch to 4 inch
- C. Seal Class: All ductwork shall receive Class A Seal
- D. Round and Flat Oval Ducts: Furnish duct and fittings made by the same manufacturer to insure good fit of slip joints. When submitted and approved in advance, round and flat oval duct, with size converted on the basis of equal pressure drop, may be furnished in lieu of rectangular duct design shown on the drawings.
1. Elbows: Diameters 3 through 8 inches shall be two sections die stamped, all others shall be gored construction, maximum 18 degree angle, with all seams continuously welded or standing seam. Coat galvanized areas of fittings damaged by welding with corrosion resistant aluminum paint or galvanized repair compound.
 2. Provide bell mouth, conical tees or taps, laterals, reducers, and other low loss fittings as shown in SMACNA HVAC Duct Construction Standards.
 3. Ribbed Duct Option: Lighter gage round/oval duct and fittings may be furnished provided certified tests indicating that the rigidity and performance is equivalent to SMACNA standard gage ducts are submitted.
 - a. Ducts: Manufacturer's published standard gage, G90 coating, spiral lock seam construction with an intermediate standing rib.
 - b. Fittings: May be manufacturer's standard as shown in published catalogs, fabricated by spot welding and bonding with neoprene base cement or machine formed seam in lieu of continuous welded seams.

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4. Provide flat side reinforcement of oval ducts as recommended by the manufacturer and SMACNA HVAC Duct Construction Standard S3.13. Because of high pressure loss, do not use internal tie-rod reinforcement unless approved by the Engineer.
- E. Casings and Plenums: Construct in accordance with SMACNA HVAC Duct Construction Standards Section 6, including curbs, access doors, pipe penetrations, eliminators and drain pans. Access doors shall be hollow metal, insulated, with latches and door pulls, 20 inches wide by 48 - 54 inches high. Provide view port in the doors where shown. Provide drain for outside air louver plenum. Outside air plenum shall have exterior insulation. Drain piping shall be routed to the nearest floor drain.
- F. Volume Dampers: Single blade or opposed blade, multi-louver type as detailed in SMACNA Standards. Refer to SMACNA Detail Figure 2-12 for Single Blade and Figure 2.13 for Multi-blade Volume Dampers.
- G. Duct Hangers and Supports: Refer to SMACNA Standards Section IV. Avoid use of trapeze hangers for round duct.

2.04 DUCT LINER (Where indicated on drawings and noted below)

- A. Duct sizes shown on drawings for lined duct are clear opening inside lining.
- B. Rectangular Duct or Casing Liner: ASTM C1071, Type I (flexible), or Type II (board), 25 mm (one inch) minimum thickness, applied with mechanical fasteners and 100 percent coverage of adhesive in conformance with SMACNA, Duct Liner Application Standard.
- C. Round and Oval Duct Liner: Factory fabricated double-walled with two inch thick sound insulation and inner perforated galvanized metal liner. Construction shall comply with flame and smoke rating required by NFPA 90A. Metal liner shall be 1.0 to 0.60 mm (20 to 24 gage) having perforations not exceeding 2.4 mm (3/32 inch) diameter and approximately 22 percent free area. Metal liner for fittings need not be perforated. Assemblies shall be complete with continuous sheet Mylar liner, 2 mil thickness, between the perforated liner and the insulation to prevent erosion of the insulation. Provide liner couplings/spacer for metal liner. At the end of insulated sections, provide insulation end fittings to reduce outer shell to liner size. Provide liner spacing/concentricity leaving airway unobstructed.

2.05 DUCT ACCESS DOORS, PANELS AND SECTIONS

- A. Provide access doors, sized and located for maintenance work, upstream, in the following locations:
 1. Each duct mounted coil and humidifier.
 2. Each fire damper (for link service), smoke damper and automatic control damper.

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3. Each duct mounted smoke detector.
 4. For kitchen hood exhaust duct, locate access doors at 20 feet intervals and at each change in duct direction.
- B. Openings shall be as large as feasible in small ducts, 12 inch by 12 inch minimum where possible. Access sections in insulated ducts shall be double-wall, insulated. Transparent shatterproof covers are preferred for uninsulated ducts.
1. For rectangular ducts: Refer to SMACNA HVAC Duct Construction Standards (Figure 2-12).
 2. For round and flat oval duct: Refer to SMACNA HVAC duct Construction Standards (Figure 2-11).

2.06 FLEXIBLE AIR DUCT

- A. General: Factory fabricated, complying with NFPA 90A for connectors not passing through floors of buildings. Flexible ducts shall not penetrate any fire or smoke barrier which is required to have a fire resistance rating of one hour or more. Flexible duct length shall not exceed 5 feet. Provide insulated acoustical air duct connectors in supply air duct systems and elsewhere as shown.
- B. Flexible ducts shall be listed by Underwriters Laboratories, Inc., complying with UL 181. Ducts larger than 8 inches in diameter shall be Class 1. Ducts 8 inches in diameter and smaller may be Class 1 or Class 2.
- C. Insulated Flexible Air Duct: Factory made including mineral fiber insulation with maximum C factor of 0.25 at 24 degrees C (75 degrees F) mean temperature, encased with a low permeability moisture barrier outer jacket, having a puncture resistance of not less than 50 Beach Units. Acoustic insertion loss shall not be less than 3 dB per foot of straight duct, at 500 Hz, based on 6 inch duct, of 2500 fpm.
- D. Application Criteria:
1. Temperature range: -0 to 200 degrees F internal.
 2. Maximum working velocity: 4000 feet per minute.
 3. Minimum working pressure, inches of water gage: 10 inches positive, 2 inches negative.
- E. Duct Clamps: 100 percent nylon strap, 175 pounds minimum loop tensile strength manufactured for this purpose or stainless steel strap with cadmium plated worm gear tightening device. Apply clamps with sealant and as approved for UL 181, Class 1 installation.

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2.07 FLEXIBLE DUCT CONNECTIONS

- A. Where duct connections are made to fans and air handling units, install a non-combustible flexible connection of 29 ounce neoprene coated fiberglass fabric approximately 6 inches wide. For connections exposed to sun and weather provide "hypalon" coating in lieu of neoprene. Burning characteristics shall conform to NFPA 90A. Securely fasten flexible connections to round ducts with stainless steel or zinc-coated iron draw bands with worm gear fastener. For rectangular connections, crimp fabric to sheet metal and fasten sheet metal to ducts by screws 2 inches on center. Fabric shall not be stressed other than by air pressure. Allow at least one inch slack to insure that no vibration is transmitted.

2.08 PREFABRICATED ROOF CURBS

- A. Galvanized steel or extruded aluminum 12 inches above finish roof service, continuous welded corner seams, treated wood nailer, 1-1/2 inch thick, 3 pound/cubic feet density rigid mineral fiberboard insulation with metal liner, built-in cant strip (except for gypsum or tectum decks). For surface insulated roof deck, provide raised cant strip (recessed mounting flange) to start at the upper surface of the insulation. Curbs shall be constructed for pitched roof or ridge mounting as required to keep top of curb level.

2.09 ADAPTER CURBS

- A. Provide and install factory-fabricated adapter curb to allow new rooftop HVAC unit mounting on existing roof curb without disturbing the roof structure or weatherproofing.
- B. Acceptable manufacturers: MicroMetl or CanFab.
- C. Materials and Construction:
 - 1. Curb adapter shall be manufactured of heavy gauge galvanized steel, conforming to ASTM A653, minimum 14-16 gauge thickness, with fully welded corners for structural integrity.
 - 2. Internal surfaces exposed to airflow must be lined with 1-inch minimum, 1.5-pound density insulation meeting ASTM E84 requirements for flame/smoke spread ratings.
 - 3. Curbs shall include: Gasket material for weather-tight seal at duct and unit connections; Insulated supply and return air transitions matching new unit and existing curb configurations.
- D. Submit shop drawings with curb dimensions, material specifications, insulation details, and transition layouts. Provide manufacturer data sheets confirming compliance with these specifications.

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2.10 TURNING VANES

- A. Galvanized steel constructed per SMACNA HVAC Duct Construction Standards for:
1. Single wall vanes with $\frac{3}{4}$ inch trailing edges (double wall vanes not acceptable).
 2. Provide separate equal size sections for vane length greater than those indicated in SMACNA where occurs.
 3. Vane runners shall be Type 1 or 2.
 4. Vane radius shall be 2 inch for duct widths up to 36 inches and 4-1/2" for larger ducts.
 5. Low pressure round duct take-off fittings in rectangular ductwork:
 - a. Factory fabricated spin-in fitting of die-formed galvanized steel with integral balancing damper (spring loaded with locking regulator) and sealed at both ends to prevent leakage. Use no scoops. Buckley Associates, Inc.

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METAL DUCTS

PART 3 – EXECUTION

3.01 GENERAL INSTALLATION

- A. Fabricate and install ductwork and accessories in accordance with referenced SMACNA Standards:
1. Drawings show the general layout of ductwork and accessories but do not show all required fittings and offsets that may be necessary to connect ducts to equipment, boxes, diffusers, grilles, etc., and to coordinate with other trades. Fabricate ductwork based on field measurements. Provide all necessary fittings and offsets at no additional cost to the owner. Coordinate with other trades for space available and relative location of HVAC equipment and accessories on ceiling grid. Duct sizes on the drawings are inside dimensions which shall be altered by Contractor to other dimensions with the same air handling characteristics where necessary to avoid interferences and clearance difficulties.
 2. Provide duct transitions, offsets and connections to dampers, coils, and other equipment in accordance with SMACNA Standards, Section II. Provide streamliner, when an obstruction cannot be avoided and must be taken in by a duct. Repair galvanized areas with galvanizing repair compound.
 3. Provide bolted construction and tie-rod reinforcement in accordance with SMACNA Standards.
 4. Construct casings, eliminators, and pipe penetrations in accordance with SMACNA Standards, Chapter 6. Design casing access doors to swing against air pressure so that pressure helps to maintain a tight seal.
- B. Install duct hangers and supports in accordance with SMACNA Standards, Chapter 4.
- C. Install fire dampers, smoke dampers and combination fire/smoke dampers in accordance with the manufacturer's instructions to conform to the installation used for the rating test. Install fire dampers, smoke dampers and combination fire/smoke dampers at locations indicated and where ducts penetrate fire rated and/or smoke rated walls, shafts and where required by the Resident Engineer. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges per UL and NFPA. Demonstrate re-setting of fire dampers and operation of smoke dampers to the Engineer.
- D. Seal openings around duct penetrations of floors and fire rated partitions with fire stop material as required by NFPA 90A.
- E. Flexible duct installation: Refer to SMACNA Standards, Chapter 3. Ducts shall be continuous, single pieces not over 5 feet long (NFPA 90A), as straight and short as feasible, adequately supported. Centerline radius of bends shall be not less than two duct diameters. Make connections with clamps as recommended by SMACNA. Clamp

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per SMACNA with one clamp on the core duct and one on the insulation jacket. Flexible ducts shall not penetrate floors, or any chase or partition designated as a fire or smoke barrier, including corridor partitions fire rated one hour or two hour. Support ducts SMACNA Standards.

- F. Where diffusers, registers and grilles cannot be installed to avoid seeing inside the duct, paint the inside of the duct with flat black paint to reduce visibility.
- G. Control Damper Installation:
 - 1. Provide necessary blank-off plates required to install dampers that are smaller than duct size. Provide necessary transitions required to install dampers larger than duct size.
 - 2. Assemble multiple sections dampers with required interconnecting linkage and extend required number of shafts through duct for external mounting of damper motors.
 - 3. Provide necessary sheet metal baffle plates to eliminate stratification and provide air volumes specified. Locate baffles by experimentation, and affix and seal permanently in place, only after stratification problem has been eliminated.
 - 4. Install all damper control/adjustment devices on stand-offs to allow complete coverage of insulation.
- H. Air Flow Measuring Devices (AFMD): Install units with minimum straight run distances, upstream and downstream as recommended by the manufacturer.
- I. Low Pressure Duct Liner: Install in accordance with SMACNA, Duct Liner Application Standard.
- J. Protection and Cleaning: Adequately protect equipment and materials against physical damage. Place equipment in first class operating condition, or return to source of supply for repair or replacement, as determined by Resident Engineer. Protect equipment and ducts during construction against entry of foreign matter to the inside and clean both inside and outside before operation and painting. When new ducts are connected to existing ductwork, clean both new and existing ductwork by mopping and vacuum cleaning inside and outside before operation.
- K. Ducts exposed to the weather:
 - 1. Make ducts watertight with tops sloped to shed water. Standing pools of water on top of ducts shall not be allowed.
 - a. Arrange seams to not act as dams.
 - b. Place longitudinal seams at bottom of ducts.

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- c. Insure water runoff by sloping entire top of duct down toward sides.
 - d. Longitudinal seams and non-bolted joints shall be sealed with SMACNA approved duct sealant for both interior and exterior applications.
 - e. Bolted duct joints: Top of duct shall have a continuous metal cleat from corner to corner to provide a weather cap. The sides, end and bottom shall have intermediate 6" pieces of metal cleats so that any water can drain away.
- L. Construct with gauges, joints, bracing, reinforcing, and other details per latest edition of the CMC, AHSRAE, SMACNA and NFPA. Comply with most stringent requirement. Provide ducts with CMC required gauges when penetrating rated construction.
- M. Provide for duct rigidity by either beading at 12 inches on center, maximum, or crossbreaking outward in ducts with positive pressures and crossbreaking inward for ducts having negative pressures. The exception is for ducts exposed to weather which shall crossbreak outward on top of duct.
- N. At exposed duct penetrations of walls, floors and ceilings provide sheet metal angle type escutcheons with no sharp corners or edges. For round ducts factory angle rings may be used.
- O. Frame, trim, caulk and seal all duct penetrations through acoustical walls and partitions.
- P. Tapers:
- 1. Pitch sides of ducts in diverging or converging airflow with a maximum 1 to 4 taper. Abrupt bushing type fitting shall not be permitted.
- Q. Duct openings:
- 1. Provide openings to accommodate instrumentation, thermometers, smoke detectors, controllers and miscellaneous components. Insert through airtight rubber grommets.
 - 2. Where openings are provided in insulated ductwork for insertion of instruments install insulation material inside metal ring for use as a plug.
 - 3. At fire dampers allow adequate length of duct to install access door.
- R. No exposed sharp metal shall be allowed.
- 1. All exposed pins, screws and sharp objects shall be covered with hardening silicon.

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METAL DUCTS

2. All exposed sheet metal edges shall be hemmed with exposed corners rounded smooth.
 3. Remove all sheet metal fish hooks.
- S. Flexible duct connectors:
1. Install at connections to fans and air handling units and where indicated on the drawings.
 2. Install with 2 inches of slack fabric to allow a minimum movement of 1 inch in each direction.
- T. Elbows:
1. Radius elbows shall have a centerline dimension not less than 1 duct width, unless otherwise noted.
 2. Where elbows with turning vanes are shown:
 - a. Install per SMACNA HVAC Duct Construction Standards
- U. Rectangular duct joints:
1. In medium pressure ductwork transverse joints shall be Ductmate. In low pressure ductwork transverse joints shall be Ductmate except that slip and drive may be used at contractor's option for ducts less than 24 inches longest side.
 2. Longitudinal seams shall be Pittsburge type. Snaplock shall not be allowed.
- V. Horizontal supports shall be one or two piece clamp band straps or as otherwise detailed on the drawings with one support minimum per sections and additional as required to prevent sagging.
- W. Vertical supports shall consist of a pedestal at base of vertical or clamp bands with knee bracing or clamp bands with extended ends supported by floor.
- X. Connections to air distribution (grilles, registers and diffusers) shall be by full radius elbow or by a straight duct connection for one duct diameter or greater.
1. Where space is tight use side inlet plenums (cans) fabricated of minimum 24 gauge galvanized sheet metal, at least as tall as the connecting duct, with turning vanes.
 2. Connections to air distribution shall be insulated just the same as for the ductwork.

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METAL DUCTS

3. Connections to air outlets shall be sealed with duct sealant.

Y. Duct hangers and supports

1. Support horizontal ducts with hangers of size and spacing per SMACNA HVAC Duct Construction Standards with attachments to suit structure type and seismic restraints where required.
 - a. See Hangers and Supports Section 23 05 29 for attachments to structure.
2. Horizontal supports:
 - a. Install hangers at each change in direction of duct.
 - b. Strap hangers:
 - c. Install in pairs on each side of duct, in symmetry, and extend down each side with turn in on bottom of min 2 inches. Metal screw hangers to ducts on bottom, upper and lower sides and no less than 12 inches on center.
 - d. Angle hangers:
 1. Provide angle hangers formed by extended vertical bracing angles or by rods connecting to bottom angles if size or bracing angles conform to SMACNA schedules.
 - e. Vertical supports:
 1. Support vertical ducts at every floor with angles or channels riveted to ducts. Set angles or channels on floor slab or structural steel members.

Z. Volume and Dampers shall be provided at locations shown on the drawings.

1. Volume dampers shall be installed as far away from air outlets as functionally reasonable to avoid noise in the occupied spaces.
2. Provide also in wyes and spin-ins to outlets whether shown on drawings or not, except:
 - a. Where dampers are not shown above inaccessible ceilings.
 - b. To sidewall outlets in exposed ducts (opposed blade dampers in outlets shall be provided).

3.02 DUCT LEAKAGE TESTS AND REPAIR

SECTION 23 31 13

METAL DUCTS

- A. Ductwork leakage testing shall be performed by the Testing and Balancing Contractor directly contracted by the General Contractor and independent of the Sheet Metal Contractor.
- B. Ductwork leakage testing shall be performed for the entire air distribution system (including all supply, return, exhaust and relief ductwork), section by section, including fans, coils and filter sections. Based upon satisfactory initial duct leakage test results, the scope of the testing may be reduced by the Engineer on ductwork constructed to the 2" WG duct pressure classification. In no case shall the leakage testing of ductwork constructed above the 2" WG duct pressure classification or ductwork located in shafts or other inaccessible areas be eliminated.
- C. Test procedure, apparatus and report shall conform to SMACNA Leakage Test manual. The maximum leakage rate allowed is 4 percent of the design air flow rate.
- D. All ductwork shall be leak tested first before enclosed in a shaft or covered in other inaccessible areas.
- E. All tests shall be performed in the presence of the Engineer and the Test and Balance agency. The Test and Balance agency shall measure and record duct leakage and report to the Resident Engineer and identify leakage source with excessive leakage.
- F. If any portion of the duct system tested fails to meet the permissible leakage level, the Contractor shall rectify sealing of ductwork to bring it into compliance and shall retest it until acceptable leakage is demonstrated to the Resident Engineer.
- G. All tests and necessary repairs shall be completed prior to insulation or concealment of ductwork.
- H. Make sure all openings used for testing flow and temperatures by TAB Contractor are sealed properly.

END OF SECTION

SECTION 23 80 00
DECENTRALIZED HVAC EQUIPMENT

PART 1 – GENERAL

1.01 DESCRIPTION

- A. This Section covers the furnishing and installation of Heating, Ventilating and Air Conditioning (HVAC) equipment as indicated on the contract drawings, schedules and as specified herein.
 - 1. RT-1
 - 2. CCV-1 thru 23
 - 3. EF-1
 - 4. EF-2
- B. All work of this section shall comply with Section 23 00 00 GENERAL REQUIREMENTS - HEATING, VENTILATING, AND AIR-CONDITIONING (HVAC).
- C. Definitions:
 - 1. Energy Efficiency Ratio (EER): (Btu hour/Watt) is equal to the measured cooling capacity of the unit by its electrical input.
 - 2. Unitary (ARI): A Unitary Air Conditioner consists of one or more factory-made assemblies which normally include an evaporator or cooling coil, a compressor and condenser combination, and may include a heating function as well. Where such equipment is provided in more than one assembly the separated assemblies are to be designed to be used together and the requirements of rating are based upon use of matched assemblies.

1.02 QUALITY ASSURANCE

- A. Safety Standards: ASHRAE Standard 15, Safety Code for Mechanical Refrigeration.

1.03 SUBMITTALS

- A. Manufacturer's literature and data:
 - 1. Sufficient information, including capacities, pressure drops and piping connections clearly presented, shall be included to determine compliance with drawings and specifications for units noted below:
 - a. RT-1
 - b. CCV-1 thru 23
 - c. EF-1

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- d. EF-2
 - 2. Unit Dimensions required clearances, operating weights accessories and start-up instructions.
 - 3. Electrical requirements, wiring diagrams, interlocking and control wiring showing factory installed and portions to be field installed.
 - 4. Mounting and flashing of the roof curb to the roofing structure with coordinating requirements for the roof membrane system.
- B. Certification: Submit proof of specified ARI Certification.
- C. Performance Rating: Submit catalog selection data showing equipment ratings and compliance with required sensible-to-heat-ratio, energy efficiency ratio (EER), and coefficient of performance (COP).
- D. Operating and Maintenance Manual: Submit three copies of Operating and Maintenance manual to Resident Engineer three weeks prior to final inspection.

1.04 APPLICABLE PUBLICATIONS

The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

- A. Air-Conditioning and Refrigeration Institute (ARI):
 - 1. 210/240-06 Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment
 - 2. 270-95 Sound Rating of Outdoor Unitary Equipment
 - 3. 310/380-04 Standard for Packaged Terminal Air-Conditioners and Heat Pumps (CSA-C744-04)
 - 4. 340/360-04 Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment
 - 5. 520-04 Positive Displacement Condensing Units
- B. Air Movement and Control Association (AMCA):
 - 1. 210-99 Laboratory Methods of Testing Fans for Aerodynamic Performance Rating (ANSI)
 - 2. 410-96 Recommended Safety Practices for Users and Installers of Industrial and Commercial Fans

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DECENTRALIZED HVAC EQUIPMENT

- C. American National Standards Institute (ANSI):
 - 1. S12.51-02 Acoustics - Determination of Sound Power Levels of Noise Sources Using Sound Pressure - Precision Method for Reverberation Rooms (same as ISO 3741:1999)
- D. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):
 - 1. 2004 Handbook HVAC Systems and Equipment
 - 2. 15-04 Safety Standard for Refrigeration Systems (ANSI)
- E. American Society of Testing and Materials (ASTM):
 - 1. B117-03 Standard Practice for Operating Salt Spray (Fog) Apparatus
- F. National Fire Protection Association (NFPA) Publications:
 - 1. 90A-02 Standard for the Installation of Air-Conditioning and Ventilating Systems

PART 2 – PRODUCTS

2.01 EQUIPMENT:

- A. Refer to M0.02 for equipment and associated schedules.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Roof Curb: Install where indicated on the Drawings, level and secure, according to ARI Guideline B. Secure rooftop units to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.
- B. Rooftop Unit Support: Install unit level on structural curbs, unless otherwise indicated on the Drawings. Coordinate wall penetrations and flashing with wall construction. Secure rooftop units to structural support with anchor bolts.
- C. Install units level and plumb maintaining manufacturer's recommended clearances and tolerances.
- D. Install water-cooled units with thermometer and pressure gage at the water supply and return connection.
- E. Install ground-mounting, compressor-condenser components on 4-inch thick, reinforced concrete base; 4 inches larger on each side than unit.
- F. Install seismic restraints.

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- G. Install and connect pre-charged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.
- H. Install wall sleeves in finished wall assembly and weatherproof. Install and anchor wall sleeves to withstand, without damage seismic forces as required by code.

3.02 CONNECTIONS

- A. Verify condensate drainage requirements.
- B. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain or as indicated on the Drawings.
- C. Install piping adjacent to units to allow service and maintenance.
- D. Install ducts to termination at top of roof curb. Cut roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
- E. Install return-air duct continuously through roof structure.
- F. Connect refrigerant piping to coils with shutoff valves on the suction and liquid lines at the coil and a union or flange at each connection at the coil and condenser.
- G. Install ducts to the units with flexible duct connections.

3.03 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections: After installing units and after electrical circuitry has been energized, test units for compliance with requirements. Inspect for and remove shipping bolts, blocks, and tie-down straps. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION

SECTION 23 90 23
DIRECT DIGITAL CONTROLS (ALC)

PART 1 - GENERAL

1.01 DESCRIPTION

- A. The Building Management System (BMS) manufacturer shall furnish and install a fully integrated building automation system, incorporating direct digital control (DDC) for energy management, equipment monitoring and control, and subsystems with open communications capabilities as herein specified.
- B. The installation of the control system shall be performed under the direct supervision of the manufacturer with the shop drawings, control diagrams, bill of materials, component designation or identification number and sequence of operation all bearing the name of the manufacturer. The installation contractor shall certify in writing that the shop drawings have been prepared by the equipment manufacturer and that the equipment manufacturer has supervised their installation. In addition, the equipment manufacturer shall certify, in writing, that the shop drawings were prepared by their company and that all temperature control equipment was installed under their direct supervision.
- C. All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems and not custom designed especially for this project. All systems and components shall have been thoroughly tested and proven in actual use for at least two years.
- D. BMS manufacturer shall be responsible for all BMS and Temperature Control wiring for a complete and operable system. All wiring shall be done in accordance with all local and national codes.
- E. All work of this section shall comply with Section 23 00 00 GENERAL REQUIREMENTS - HEATING, VENTILATING, AND AIR-CONDITIONING (HVAC)

1.02 WORK BY OTHERS

- A. The mechanical contractor installs all components, dampers, flow stations, etc. furnished by BMS manufacturer.
- B. Electrical Contractor provides:
 - 1. 120V power to all BMS an/or Temperature control panels
 - 2. Wiring of all power feeds through all disconnect starters to electrical motor.
 - 3. Wiring of any remote start/stop switches and manual or automatic motor speed control devices not furnished by BMS manufacturer.

1.03 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

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DIRECT DIGITAL CONTROLS (ALC)

- A. Refrigerant Piping
 - 1. Refrigerant leak detection system
- B. Fire Detection and Alarm
 - 1. Smoke Detectors/Fire Stats

1.04 RELATED WORK

- A. Division 01 General, Shop Drawings
- B. Division 23 HVAC
- C. Division 26 Electrical

1.05 COMMUNICATIONS WITH THIRD PARTY EQUIPMENT

- A. General: The BMS shall be capable of integrating to any third-party equipment using any of the following standard open protocols:
 - 1. BACnet (IP, SC, Arcnet, or MS/TP)
 - 2. Modbus (RTU or IP)
- B. The third-party equipment provider shall provide the details of the proposed interface including PICS for BACnet equipment, hardware and software identifiers for the interface points, network identifiers, wiring requirements, communication speeds, and required network accessories.
- C. The third-party equipment provider is responsible for furnishing and installing their interface pre-programmed and configured with the correct parameters to integrate with the BMS. These parameters include, but are not limited to the following:
 - 1. Communication protocol
 - 2. Correct communication protocol baud rate
 - 3. Points required to be viewed through the BMS. This includes ensuring the points are "in service" and visible to the BMS.
 - 4. Addressing of controller/interface. The BMS provider shall furnish the address.
- D. The third party equipment manufacturer shall include a minimum of 16 hours of onsite technical support for integration into the BMS.

1.06 QUALITY ASSURANCE

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DIRECT DIGITAL CONTROLS (ALC)

- A. The BMS system shall be designed and installed, commissioned, and serviced by manufacturer employed, factory trained personnel. The manufacturer shall have an in-place support facility within 50 miles of the site with technical staff, spare parts inventory and necessary test and diagnostic equipment. Distributors or licensed installing contractors are not acceptable.
- B. The manufacturer shall provide an onsite, experienced project manager for this work, responsible for direct supervision of the design, installation, and start up and commissioning of the BMS.
- C. The Bidder shall be regularly engaged in the manufacturing, installation, and maintenance of BMS systems and shall have a minimum of ten (10) years of demonstrated technical expertise and experience in the manufacture, installation and maintenance of B.M.S. systems similar in size and complexity to this project.
- D. Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer's latest standard design that complies with the specification requirements.
- E. All BMS peer-to-peer network controllers, central system controllers and local user displays shall be UL Listed under Standard UL 916, category PAZX; Standard ULC C100, category UUKL7; and under Standard UL 864, categories UUKL, UDTZ, and QVAX. and be so listed at the time of bid. All floor level controllers shall comply, at a minimum, with UL Standard UL 916 category PAZX; Standard UL 864, categories UDTZ, and QVAX. and be so listed at the time of Bid.
- F. The BMS peer-to-peer network controllers and local user display shall also comply with the Australian Electromagnetic Compatibility (EMC) Framework and bear the C-Tic Mark to show compliance. The purpose of the regulation is to minimize electromagnetic interference between electronic products, which may diminish the performance of electrical products or disrupt essential communications.
- G. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.
- H. The manufacturer of the building automation system shall provide documentation supporting compliance with ISO-9002 (Model for Quality Assurance in Production, Installation, and Servicing) and ISO-140001 (The application of well-accepted business management principles to the environment). The intent of this specification requirement is to ensure that the products from the manufacturer are delivered through a Quality System and Framework that will assure consistency in the products delivered for this project.
- I. This system shall have a documented history of compatibility by design for a minimum of 15 years. Future compatibility shall be supported for no less than 10 years.

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Compatibility shall be defined as the ability to upgrade existing field panels to current level of technology and extend new field panels on a previously installed network.

- J. Compatibility shall be defined as the ability for any existing field panel microprocessor to be connected and directly communicate with new field panels without bridges, routers or protocol converters.

1.07 CODES AND STANDARDS

- A. Work, materials, and equipment shall comply with the most restrictive of local, state, and federal authorities' codes and ordinances or these plans and specifications. As a minimum, the installation shall comply with the current editions in effect 30 days prior to the receipt of bids of the following codes:
 - 1. National Electric Code (NEC)
 - 2. International Building Code (IBC)
 - 3. International Mechanical Code (IMC)
 - 4. Underwriters Laboratories (UL/CUL)
 - 5. ANSI/ASHRAE Standard 135, BACnet - A Data Communication Protocol for Building Automation and Control Systems

1.08 SYSTEM PERFORMANCE

- A. Performance Standards. System shall conform to the following minimum standards over network connections. Systems shall be tested using manufacturer's recommended hardware and software for display through the user's web browser.
 - 1. Graphic Display. A graphic with 20 dynamic points shall display with current data within 10 sec.
 - 2. Graphic Refresh. A graphic with 20 dynamic points shall update with current data within 8 sec. and shall automatically refresh every 15 sec.
 - 3. Configuration and Tuning Screens. Screens used for configuring, calibrating, or tuning points, PID loops, and similar control logic shall automatically refresh within 6 sec.
 - 4. Object Command. Devices shall react to command of a binary object within 2 sec. Devices shall begin reacting to command of an analog object within 2 sec.
 - 5. Alarm Response Time. An object that goes into alarm shall be annunciated at the browser within 45 sec.

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6. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 sec.
7. Performance. Programmable controllers shall be able to completely execute DDC PID control loops at a frequency adjustable down to once per sec. Select execution times consistent with the mechanical process under control.
8. Multiple Alarm Annunciation. Each user, connected to network accessing the system through their browser (workstation), shall receive alarms within 5 seconds of one another.
9. Reporting Accuracy. BMS Manufacturer shall submit accuracy values with minimum end-to-end accuracy for all control devices and/or sensors.
10. Control Stability and Accuracy. BMS Manufacturer shall submit with minimum end-to-end accuracy for all control devices and/or sensors.

1.09 SUBMITTALS

- A. Product Data and Shop Drawings: The contractor shall provide shop drawings and product data on hardware, software, and equipment to be installed or provided. No work may begin on any segment of this project until submittals have been approved for conformity with design intent. Provide submittal data in a digital format on suitable digital media such as a USB drive. The submittal data shall be in standard Microsoft (Word, Excel, etc.) or PDF file formats. The shop drawings shall be formatted to fit on 11" x 17" pages and hardware/software product data shall be formatted to fit on 8.5" x 11" pages. When manufacturer's cutsheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawing shall clearly reference the specification and/or drawing that the submittal is to cover. General catalogs shall not be accepted as cutsheets to fulfill submittal requirements. Select and show submittal quantities appropriate to scope of work. Submittal approval does not relieve Contractor of responsibility to supply sufficient quantities to complete work. Submittals shall be provided within 12 weeks of contract award. Submittals shall include:

1. DDC System Hardware
 - a. A complete bill of materials to be used indicating quantity, manufacturer, model number, and relevant technical data of equipment to be used.
 - b. Manufacturer's description and technical data such as performance curves, product specifications, and installation and maintenance instructions for items listed below and for relevant items not listed below:

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1. Direct digital controllers (controller panels)
 2. Transducers and transmitters
 3. Sensors (including accuracy data)
 4. Actuators
 5. Valves
 6. Relays and switches
 7. Control panels
 8. Power supplies
 9. Batteries
 10. Operator interface equipment
 11. Wiring
- c. Wiring diagrams and layouts for each control panel. Show termination numbers.
- d. Schematic diagrams for all field sensors and controllers. Provide floor plans of all sensor locations and control hardware. Riser diagrams showing control network layout, communication protocol, and wire types.
2. Central System Hardware and Software
- a. A complete bill of material of equipment used indicating quantity, manufacturer, model number, and relevant technical.
 - b. Manufacturer's description and technical data such as product specifications and installation and maintenance instructions for items listed below and for relevant items furnished under this contract not listed below:
 1. Central Processing Unit (CPU) or web server
 2. Monitors
 3. Keyboards
 4. Power supplies
 5. Battery backups
 6. Interface equipment between CPU or server and control panels
 7. Operating System software – web server
 8. Color graphic software
 9. Third-party software

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- c. Schematic diagrams for all control, communication, and power wiring. Provide a schematic drawing of the central system installation. Label all cables and ports with computer manufacturers' model numbers and functions. Show interface wiring to control system.
 - d. Network riser diagrams of wiring between central control unit and control panels.
3. Controlled Systems
- a. Riser diagrams showing control network layout, communication protocol, and wire types.
 - b. A schematic diagram of each controlled system. The schematics shall have all control points labeled with point names shown or listed. The schematics shall graphically show the location of all control elements in the system.
 - c. A schematic wiring diagram of each controlled system. Label control elements and terminals. Where a control element is also shown on control system schematic, use the same name.
 - d. An instrumentation list (Bill of Materials) for each controlled system. List each control system element in a table. Show element name, type of device, manufacturer, model number, and product data sheet number.
 - e. A mounting, wiring, and routing plan-view drawing. The design shall take into account HVAC, electrical, and other systems' design and elevation requirements. The drawing shall show the specific location of all concrete pads and bases and any special wall bracing for panels to accommodate this work.
 - f. A complete description of the operation of the control system, including sequences of operation. The description shall include and reference a schematic diagram of the controlled system.
 - g. A point list for each control system. List I/O points and software points required to provide specified sequence of operations. Indicate alarmed and trended points.
4. Quantities of items submitted shall be reviewed but are the responsibility of the Contractor.
5. BACnet Protocol Implementation Conformance Statement (PICS) for each submitted type of controller and operator interface.

B. Project Documentation.

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1. Upon completion of installation, submit record (as-built) documents for approval before final completion. Provide record documents in a digital format on suitable digital media such as a USB drive. The record documents shall be in standard Microsoft (Word, Excel, etc.) or PDF file formats except as noted below. Record documentation shall include the following:
 - a. Project Record Drawings.
 - b. Testing and Commissioning Reports and Checklists.
 - c. Operation and Maintenance (O&M) Manual.
 - d. As-built versions of submittal product data.
 - e. Names, addresses, and telephone numbers of installing contractors and service representatives for equipment and control systems.
 - f. Operator's manual with procedures for operating control systems: logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing setpoints and variables.
 - g. Programming manual or set of manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
 - h. Engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points, panels, and other hardware; how to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware.
 - i. Documentation of programs operating in the system and object database that can be viewed using technician software tools furnished with system.
 - j. Graphic files, programs, and database to be viewed using technician software tools furnished with system.
 - k. List of recommended spare parts with part numbers and suppliers.
 - l. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.

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- m. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation or web server software, and graphics software.
 - n. Licenses, guarantees, and warranty documents for equipment and systems.
 - o. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
2. Load into the control system for access by the operator through any operator workstation closeout documentation. There shall be a menu or navigation tab to access the documentation. The documentation can be loaded into the control system in a pdf format. The following documentation shall be included:
- a. As-built control diagrams including wiring diagrams and sequences of operations for each controller/piece of equipment.
 - b. All IOM data as follows:
 - 1. IOM from each equipment manufacturer for each piece of equipment (AHUs, FCUs, Chillers, pumps etc.)
 - 2. IOM for each control module and end device installed in the system.
- C. Training Materials: Provide course outline and materials for each class at least six weeks before first class. Training shall be furnished via instructor-led sessions, computer-based training, or web-based training. Engineer will modify course outlines and materials if necessary to meet Owner's needs. Engineer will review and approve course outlines and materials at least three weeks before first class.

1.10 WARRANTY

- A. Provide all services, materials, and equipment necessary for the successful operation of the entire BMS system for a period of one year after system completion.
- B. Warrant work as follows:
 - 1. Warrant labor and materials for specified control system free from defects for a period of 12 months after final acceptance. Control system failures during warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner. Respond during normal business hours within 24 hours of Owner's warranty service request.
 - 2. Work shall have a single warranty date, even if Owner receives beneficial use due to early system start-up. If specified work is split into multiple contracts or a

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multi-phase contract, each contract or phase shall have a separate warranty start date and period.

3. If the engineer determines that equipment and systems operate satisfactorily at the end of final start-up, testing, and commissioning phase, the engineer will certify in writing that control system operation has been tested and accepted in accordance with the terms of this specification. Date of acceptance shall begin warranty period.
4. All Manufacturer's software/firmware for web server/workstation and controllers shall be updated to the latest versions that are available from the manufacturer within 30 days from the date of end of the warranty. These updates shall be installed and checked out before the end of the warranty.
5. Provide updates to web server software, project-specific software, graphic software, database software, and firmware that resolve the contractor-identified software deficiencies at no charge during warranty period. If available, Owner can purchase in-warranty service agreement to receive upgrades for functional enhancements associated with above-mentioned items. Do not install updates or upgrades without Owner's written authorization.
6. Exception: Contractor shall not be required to warrant reused devices except those that have been rebuilt or repaired and factory recertified. Installation labor and materials shall be warranted. Demonstrate operable condition of reused devices at time of Engineer's acceptance.

1.11 APPLICABLE PUBLICATIONS

The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

- A. American Society of Heating, Refrigeration and Air Conditioning Engineers.
- B. National Fire Protection Association (NFPA):
 1. 90A-09 Standard for the Installation of Air Conditioning and Ventilating Systems.
- C. Underwriters Laboratories, Inc. (UL):
 1. 181-08 UL Standard for Safety Factory-Made Air Ducts and Connectors.

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PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Automated Logic (ALC). Any proposed substitution must be pre-approved prior to bidding utilizing the pre-bid substitution form, if available. If not available, owner has deemed the product as a client-wide standards.
- B. No substitutions or equals will be accepted with pre-approval.

2.02 SYSTEM ARCHITECTURE

- A. The design of the BMS must connect to, and provide full operability, of the existing ALC network throughout the client properties to a single user interface, location as selected by owner.
- B. The system shall be configured as a distributed processing network(s) capable of expansion as specified below.
- C. The design of BMS shall allow the co-existence of new Primary controllers with existing Primary controllers in the same network without the use of gateways or protocol converters.
- D. Interbuilding LAN
 - 1. Interbuilding LAN: Used for communication between Primary Controller LANs located in each building, and multiple networked Operator Workstations located in selected buildings. The LAN will consist of using Ethernet backbone TCP/IP protocol. EMS workstation(s) shall employ native TCP/IP protocol with the Ethernet 10baseT (IEEE802.3) physical layer standard. The Apogee Ethernet Microserver (AEM) shall employ native TCP/IP on the Ethernet. The AEM should not require third party routers, gateways, or translators for TCP/IP protocol for Interbuilding and Primary LAN's.
 - 2. Primary Controller LAN: Used to control Primary Controllers which generally control central plant equipment, air handling within a building. This LAN may be Ethernet or a separate high-speed peer-to-peer network. The AEM shall employ native TCP/IP on the Ethernet.
 - 3. Secondary Controller LAN: Polling or peer-to-peer LAN to support Terminal Control Units/application specific controllers and interfaces to other third-party LANs. The secondary controller LAN shall interconnect with the Primary Controller LAN.

2.03 MATERIALS

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- A. Use new products the manufacturer is currently manufacturing and selling for use in new installations. Do not use this installation as a product test site unless explicitly approved in writing by Owner. Spare parts shall be available for at least five years after completion of this contract.

2.04 COMMUNICATION

- A. Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet internetwork. Controller and operator interface communication shall conform to ANSI/ASHRAE Standard 135, BACnet.
- B. All IP based controllers shall be capable of providing IPv4 and IPv6 protocol standards as defined by the Internet Data Communications Standard.
- C. The BMS contractor shall furnish and install all communication media, connectors, repeaters and network switches/routers, and network devices necessary to provide a complete and workable control network for both high speed Ethernet communications network/LAN and serial networks. The control network shall adhere to the owner's testing, labeling, administration, and documentation requirements established and presented for the site. The dedicated control's network shall be capable of connecting to a separate owner/customer LAN.
- D. Each controller shall have a communication port for temporary connection to a laptop computer or other operator interface. Connection shall support memory downloads and other commissioning and troubleshooting operations.
- E. Internetwork operator interface and value passing shall be transparent to internetwork architecture.
 - 1. An operator interface connected to a controller shall allow the operator to interface with each internetwork controller as if directly connected. Controller information such as data, status, and control algorithms shall be viewable and editable from each internetwork controller.
 - 2. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the internetwork. Program and test all cross-controller links required to execute specified sequences of operation. An authorized operator shall be able to edit cross-controller links by typing a standard object address or by using a point-and-click interface.
- F. BACnet Secure Connect (BACnet/SC). BACnet/SC is a datalink option that makes the full use of TLS WebSocket connections as defined by addendum to the ANSI/ASHRAE Standard 135.

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1. The BMS contractor shall furnish and install a network designed to allow for implementation of BACnet/SC. The network shall be installed with as many devices capable of using BACnet/SC at time of installation.
 2. The BMS contractor shall furnish and install all BACnet workstations/servers, routers, and building controllers capable of using BACnet/SC. Any BACnet workstations/servers, routers, or building controllers that do not have BACnet/SC capability at time of installation shall have the ability to provide BACnet/SC capability with a software/firmware update/patch. BACnet/SC capability shall not require the physical replacement of the BACnet workstation/server, router, or building controller hardware.
- G. Building Control Panels, and Controllers with real-time clocks shall use the BACnet Time Synchronization service. System shall automatically synchronize system clocks daily from an operator-designated device via the internetwork. The system shall automatically adjust for daylight saving and standard time as applicable.
- H. System shall be expandable to at least twice the required BACnet objects. No additional licensing/software fees shall be required to add controllers, associated devices, and wiring.
- I. System shall support Web services data exchange with any other system that complies with XML (extensible markup language) and SOAP (simple object access protocol) standards. Web services support shall as a minimum be provided at the workstation or web server level and shall enable data to be read from or written to the system.
1. System shall support Web services read data requests by retrieving requested trend data or point values (I/O hardware points, analog value software points, or binary value software points) from any system controller or from the trend history database.
 2. System shall support Web services write data request to each analog and binary object that can be edited through the system operator interface by downloading a numeric value to the specified object.
 3. For read or write requests, the system shall require user name and password authentication and shall support TLS (Transport Layer Security) or equivalent data encryption.
 4. System shall support discovery through a Web services connection or shall provide a tool available through the Operator Interface that will reveal the path/identifier needed to allow a third party Web services device to read data from or write data to any object in the system which supports this service.

2.05 OPERATOR INTERFACE

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- A. Operator Interface. The web server shall reside on high-speed network with building controllers. Web pages generated by this server shall be compatible with the latest versions of Microsoft Internet Explorer or Edge, Google Chrome, Mozilla Firefox, and Apple Safari browsers. Any of these supported browsers connected to the server shall be able to access all system information. Mobile devices shall be recognized by the web server and shall supply the appropriate system content as needed. The Operator Interface (web server with client devices) shall conform to the BACnet Operator Workstation (B-OWS) or BACnet Advanced Workstation (B-AWS) device profile as specified in ASHRAE/ANSI 135 BACnet Annex L. This includes the ability to configure and/or reconfigure the system from the client device (change programs, graphics, labels, etc.).
- B. Communication. Web server and controllers shall communicate using BACnet protocol, including BACnet/SC. Web server and control network backbone shall communicate using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specified in ANSI/ASHRAE 135, BACnet Annex J. Communication between the web server and client (workstation) shall be HTTP or HTTPS protocol utilizing HTML5 language. Use of Adobe Flash in any part of the communication infrastructure is not acceptable.
- C. Hardware.
 - 1. Web server and/or workstation. Industry-standard hardware shall meet or exceed DDC system manufacturer's recommended specifications and shall meet response times specified elsewhere in this document. The web server may also be configured in client/server fashion to accommodate a "workstation" definition. In "workstation" configuration, the workstation will also perform as a server supplying additional clients as needed. The following hardware requirements apply:
 - a. System storage shall have sufficient memory to accommodate:
 - 1. All required system software.
 - 2. A DDC database to accommodate, as a minimum, twice the size of the delivered system database.
 - 3. One year of archival trend data based on the points specified to be trended at their specified trend intervals.
 - b. Provide additional hardware (communication ports, video drivers, network interface cards, cabling, etc.) to facilitate all control functions and software requirements specified for the DDC system.
 - c. Minimum hardware configuration shall include the following:
 - 1. Quad Core Processor
 - 2. 4-24 GB RAM (size dependent on size of system)

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3. 500 GB hard disk providing data at 3.0 Gb/sec (size dependent on historical data storage requirements)
4. 16x DVD+/-RW drive
5. Qwerty Keyboard
6. Optical Mouse
7. 24-inch LED Color monitor with 75Hz refresh rate and 1080P resolution to provide a minimum screen resolution of 1920 x 1080 pixels.
8. Serial (USB) and network communication ports, with cables as required for proper DDC system operation.

D. System Software.

1. Operating System. Web server shall have an industry-standard professional-grade operating system. Operating system shall meet or exceed the BMS manufacturer's minimum requirements for their software. Acceptable systems include Microsoft Windows 8.1 or 10, Windows Server 2012 R2 or 2016 or 2019 or 2020, Red Hat Enterprise Linux 8.3, or Ubuntu Desktop 18.04 or 20.04 LTS.
2. Security. The web server application shall support Transport Layer Security (TLS) 1.3 capable of encryption of up to 256 bit elliptical curve for transmitting private information over the Internet using HTTPS. Additionally, the web server shall have SHA-2 certificate support capability.
3. Database. System shall support any JDBC (Java Database Connectivity) compliant engine. This includes: MS SQL, My SQL, Apache Derby, PostgreSQL and Oracle.
4. The BMS system shall allow an unlimited number of concurrent users.
5. The BMS manufacturer shall provide all software and tools necessary to provide the following capabilities:
 - a. Create and/or edit any programming used in controllers
 - b. Create and/or edit any graphics used in the system
 - c. Software shall not be subscription based and be given to owner at time of turnover. If software is subscription based, manufacturer shall include 10 years of subscription service.
 - d. The owner shall have the ability to install software on a minimum of five (5) additional owner furnished computers without additional licenses or fees.

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6. System Graphics. The operator interface software shall be graphically based and shall include at least one graphic per piece of equipment or occupied zone, graphics for each chilled water and hot water system, and graphics that summarize conditions on each floor of each building included in this contract. Indicate thermal comfort on floor plan summary graphics using dynamic colors to represent zone temperature relative to zone setpoint.
 - a. Minimum graphics resolution shall be 1920 x 1080 for display of detailed system graphics.
 - b. Floor Plan Graphics. Floor plan graphics shall be capable of allowing the floor plan graphic to dynamically size relative to the end user's monitor resolution.
 - c. Functionality. Graphics shall allow operator to monitor system status, to view a summary of the most important data for each controlled zone or piece of equipment, to use point-and-click navigation between zones or equipment, and to edit setpoints and other specified parameters.
 - d. Animation. Graphics shall be able to animate by displaying different image files for changed object status.
 - e. Alarm Indication. Indicate areas or equipment in an alarm condition using color or other visual indicator.
 - f. Format. Graphics shall be saved in an industry-standard format such as BMP, JPEG, PNG, GIF, or SVG. Web-based system graphics shall be viewable on browsers compatible with World Wide Web Consortium browser standards. Web graphic format shall require no plug-in or shall only require widely available no-cost plug-ins.
 7. Custom Graphics. Custom graphic files shall be created with the use of a graphics generation package furnished with the system. The graphics generation package shall be a graphically based system used to create and modify graphics that are saved in the same formats as are used for system graphics.
 8. Graphics Library. Furnish a complete library of standard HVAC equipment graphics such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. This library also shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. The library shall be furnished in a file format compatible with the graphics generation package program.
- E. System Applications. System shall provide the following functionality to authorized operators as an integral part of the operator interface or as stand-alone software programs. If furnished as part of the interface, the tool shall be available from each workstation or web browser interface. If furnished as a stand-alone program, software

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shall be installable on a standard PC type personal computer with no limit on the number of copies that can be installed under the system license.

1. Automatic System Database Configuration. Each workstation or web server shall store on its hard disk a copy of the current system database, including controller firmware and software. Stored database shall be automatically updated with each system configuration or controller firmware or software change.
2. Manual Controller Memory Download. Operators shall be able to download memory from the system database to each controller.
3. System Configuration. The workstation software shall provide a method of configuring the system. This shall allow for future system changes or additions by users under proper password.
4. On-Line Help. Provide a context-sensitive, on-line help system to assist the operator in operating and editing the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext.
5. Security. Each operator shall be required to log on to the system with user name and password in order to view, edit, add, or delete data.
 - a. Operator Access. The user name and password combination shall define accessible viewing, editing, adding, and deleting privileges for that operator. Users with system administrator rights shall be able to create new users and edit the privileges of all existing users. System administrators shall also be able to vary and deny each operator's privileges based on the geographic location, such as the ability to edit operating parameters in Building A, to view but not edit parameters in Building B, and to not even see equipment in Building C.
 - b. Password Policy Rules. System administrator shall invoke policies for minimum password strength, including number of characters, special characters and numbers, upper and lower case, etc.
 - c. Automatic Log Out. Automatically log out each operator if no keyboard or mouse activity is detected. This auto logoff time period shall be user-adjustable.
 - d. Encrypted Security Data. Store system security data including operator passwords in an encrypted format. System shall not display operator passwords.
6. System Diagnostics. The system shall automatically monitor the operation of all building management panels and controllers. The failure of any device shall be annunciated to the operator.

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7. Alarm Processing. System input and status objects shall be configurable to alarm on departing from and on returning to normal state. Operator shall be able to enable or disable each alarm and to configure alarm limits, alarm limit differentials, alarm states, and alarm reactions for each system object. Configure and enable alarm points as required by sequences of operation. Alarms shall be BACnet alarm objects and shall use BACnet alarm services. BMS system shall be capable of assigning alarm sources to categories such as HVAC Critical, or HVAC General. The BMS shall include at a minimum HVAC and FDD categories. BMS system shall allow user to create custom alarm categories.
8. Alarm Messages. Alarm messages shall use the English language descriptor for the object in alarm in such a way that the operator will be able to recognize the source, location, and nature of the alarm without relying on acronyms or mnemonics.
9. Alarm Reactions. Operator shall be able to configure (by object) what, if any actions are to be taken during an alarm. As a minimum, the workstation or web server shall be able to log, print, start programs, display messages, send e-mail, send SMS text, and audibly annunciate.
10. Alarm and Event log. Operators shall be able to view all system alarms and changes of state from any location in the system. Events shall be listed chronologically. An operator with the proper security level may acknowledge and delete alarms, and archive closed alarms to the workstation or web server hard disk.
11. Trend Logs. The operator shall be able to configure trend sample or change of value (COV) interval, start time, and stop time for each system data object and shall be able to retrieve data for use in spreadsheets and standard database programs. Controller shall sample and store trend data and shall be able to archive data to the hard disk. Configure trends as specified by the sequences of operation. Trends shall be BACnet trend objects.
12. Object and Property Status and Control. Provide a method for the operator to view, and edit if applicable, the status of any object or property in the system. The status shall be available by menu, on graphics, or through custom programs.
13. Reports and Logs. Operator shall be able to select, to modify, to create, and to print reports and logs. Operator shall be able to store report data in a format accessible by standard spreadsheet and word processing programs.
14. Audit and Security Detail. All users accessing the system shall have their actions recorded. Information recorded shall include:
 - a. Login/logout time and date
 - b. System modifications - with before and after values

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- c. Ability to report user activity based on individual and/or date and time.
15. Standard Reports. Furnish the following standard system reports:
- a. Objects. System objects and current values filtered by object type, by status (in alarm, locked, normal), by equipment, by geographic location, or by combination of filter criteria.
 - b. Alarm Summary. Current alarms and closed alarms. System shall retain closed alarms for an adjustable period.
 - c. Logs. System shall log the following to a database or text file and shall retain data for an adjustable period:
 - 1. Alarm History.
 - 2. Trend Data. Operator shall be able to select trends to be logged.
16. Custom Reports. Operator shall be able to create custom reports that retrieve data, including archived trend data, from the system, that analyze data using common algebraic calculations, and that present results in tabular or graphical format. Reports shall be launched from the operator interface. Operator shall be able to schedule reports to automatically run and be emailed to recipients on a recurring basis from the BMS system.
- F. Workstation Application Editors. Each PC or browser workstation shall support editing of all system applications. The applications shall be downloaded and executed at one or more of the controller panels.
- 1. Controller. Provide a full-screen editor for each type of application that shall allow the operator to view and change the configuration, name, control parameters, and set points for all controllers.
 - 2. Scheduling. An editor for the scheduling application shall be provided at each workstation. Provide a method of selecting the desired schedule and schedule type. Exception schedules and holidays shall be shown clearly on the calendar. The start and stop times for each object shall be adjustable from this interface.
 - 3. Custom Application Programming. Provide the tools to create, edit, debug, and download custom programs. System shall be fully operable while custom programs are edited, compiled, and downloaded. Programming language shall have the following features:
 - a. Language. Language shall be graphically based or English oriented. If graphically based, language shall use function blocks arranged in a logic diagram that clearly shows control logic flow. Function blocks shall directly provide functions listed below, and operators shall be able to create custom or compound function blocks. If English language

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oriented, language shall be based on the syntax of BASIC, FORTRAN, C, or PASCAL, and shall allow for free-form programming that is not column-oriented or “fill-in-the-blanks.”

- b. Programming Environment. Tool shall provide a full-screen, cursor-and-mouse-driven programming environment that incorporates word processing features such as cut and paste. Operators shall be able to insert, add, modify, and delete custom programming code, and to copy blocks of code to a file library for reuse in other control programs.
- c. Independent Program Modules. Operator shall be able to develop independently executing program modules that can disable, enable and exchange data with other program modules.
- d. Debugging and Simulation. Operator shall be able to step through the program observing intermediate values and results. Operator shall be able to adjust input variables to simulate actual operating conditions. Operator shall be able to adjust each step’s time increment to observe operation of delays, integrators, and other time-sensitive control logic. Debugger shall provide error messages for syntax and for execution errors.
- e. Conditional Statements. Operator shall be able to program conditional logic using compound Boolean (AND, OR, and NOT) and relational (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.
- f. Mathematical Functions. Language shall support floating-point addition, subtraction, multiplication, division, and square root operations, as well as absolute value calculation and programmatic selection of minimum and maximum values from a list of values.
- g. Variables. Operator shall be able to use variable values in program conditional statements and mathematical functions.
 - 1. Time Variables. Operator shall be able to use predefined variables to represent time of day, day of the week, month of the year, and date. Other predefined variables or simple control logic shall provide elapsed time in seconds, minutes, hours, and days. Operator shall be able to start, stop, and reset elapsed time variables using the program language.
 - 2. System Variables. Operator shall be able to use predefined variables to represent status and results of Controller Software and shall be able to enable, disable, and change setpoints of Controller Software as described in Controller Software section.

2.06 CONTROLLER SOFTWARE

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- A. All controller software applications shall reside and operate in the system controllers.
- B. All application software in controllers furnished by BMS manufacturer shall be editable through operator workstation, web browser interface, or workstation.
- C. Each controller furnished by BMS manufacturer shall have all of its local on-board software applications backed up and saved to the BMS web server. In the event of a controller failure, the BMS server shall download backed up software applications to replacement controller. Controllers furnished by others and integrated into the BMS are not required to be backed up to BMS server.
- D. Furnish the following applications for building and energy management:
 - 1. System Security
 - 2. Scheduling. Provide the capability to execute control functions according to a user created or edited schedule. Each schedule shall provide the following schedule options as a minimum:
 - a. Weekly Schedule. Provide separate schedules for each day of the week. Each schedule shall be able to include up to 5 occupied periods (5 start-stop pairs or 10 events).
 - b. Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule. Exception schedules may be defined up to a year in advance. Once an exception schedule has executed, the system shall discard and replace the exception schedule with the standard schedule for that day of the week.
 - c. Holiday Schedules. Provide the capability for the operator to define up to 24 special or holiday schedules. These schedules will be repeated each year. The operator shall be able to define the length of each holiday period.
 - 3. System Coordination. Operator shall be able to group related equipment based on function and location and to use these groups for scheduling and other applications.
 - 4. Binary Alarms. Each binary object shall have the capability to be configured to alarm based on the operator-specified state. Provide the capability to automatically and manually disable alarming.
 - 5. Analog Alarms. Each analog object shall have both high and low alarm limits. The operator shall be able to enable or disable these alarms.

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6. Alarm Reporting. The operator shall be able to determine the action to be taken in the event of an alarm. An alarm shall be able to start programs, print, be logged in the event log, generate custom messages, and display on graphics.
7. Remote Communication. System shall automatically contact operator workstation or server on receipt of critical alarms. If no network connection is available, system shall use a modem connection.
8. Demand Limiting.
 - a. The demand-limiting program shall monitor building power consumption from a building power meter (provided by others) which generates pulse signals or a BACnet communications interface. An acceptable alternative is for the system to monitor a watt transducer or current transformer attached to the building feeder lines.
 - b. When power consumption exceeds adjustable levels, system shall automatically adjust setpoints, de-energize low-priority equipment, and take other programmatic actions to reduce demand as specified in sequences of operation. When demand drops below adjustable levels, system shall restore loads as specified.
9. Maintenance Management. The system shall be capable of generating maintenance alarms when equipment exceeds adjustable runtime, equipment starts, or performance limits. Configure and enable maintenance alarms as specified in sequences of operation.
10. Sequencing. Application software shall sequence chillers, boilers, and pumps as specified in sequences of operation.
11. PID Control. System shall provide direct- and reverse-acting PID (proportional-integral-derivative) algorithms. Each algorithm shall have anti-windup and selectable controlled variable, setpoint, and PID gains. Each algorithm shall calculate a time-varying analog value that can be used to position an output or to stage a series of outputs. The calculation interval, PID gains, and other tuning parameters shall be adjustable by a user with the correct security level.
12. Staggered Start. System shall stagger controlled equipment restart after power outage. Operator shall be able to adjust equipment restart order and time delay between equipment restarts.
13. Energy Calculations.
 - a. The system shall accumulate and convert instantaneous power (kW) or flow rates (L/s [gpm]) to energy usage data.

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- b. The system shall calculate a sliding-window average (rolling average). Operator shall be able to adjust window interval to 15 minutes, 30 minutes, or 60 minutes.
- 14. Anti-Short Cycling. All binary output objects shall be protected from short cycling by means of adjustable minimum on-time and off-time settings.
- 15. On and Off Control with Differential. Provide an algorithm that allows a binary output to be cycled based on a controlled variable and a setpoint. The algorithm shall be direct-acting or reverse-acting.
- 16. Runtime Totalization. Provide software to totalize runtime for each binary input and output. Operator shall be able to enable runtime alarm based on exceeded adjustable runtime limit. Configure and enable runtime totalization and alarms as required by sequences of operation.
- 17. Fault Detection and Diagnostics (FDD). The system shall follow NIST and ASHRAE standards for enhanced monitoring and alarming. The FDD shall reside in the controller and be integral to the programming. Overlay software for primary FDD reporting is not acceptable. FDD capabilities shall include diagnostics for: Simultaneous Heating and Cooling; Continuous Operation; Fraction of Outdoor Air; Analog Output Cycling; Discrete Output Cycling; Sensor Failures; and Run Requests Analytics. These FDD alarms must be fully programmed, configured and active within the system. It is not acceptable for the system to have simply have the capability for FDD alarming, the alarming must be fully functional. The alarms shall be categorized and displayed on the BMS system. The FDD alarms shall categorized into one of the following four categories:
 - a. FDD Comfort
 - b. FDD Critical
 - c. FDD Energy
 - d. FDD Maintenance

2.07 CONTROLLERS

- A. General. Provide an adequate number of Building Controllers (BC), Advanced Application Controllers (AAC), Application Specific Controllers (ASC), Smart Actuators (SA), and Smart Sensors (SS) as required to achieve performance specified by system performance. Every device in the system which executes control logic and directly controls HVAC equipment must conform to a standard BACnet Device profile as specified in ANSI/ASHRAE 135, BACnet Annex L. Unless otherwise specified, hardwired actuators and sensors may be used in lieu of communicating actuators, communicating sensors, BACnet Smart Actuators and BACnet Smart Sensors.

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B. BACnet.

1. Building Controllers (BCs). Each BC shall conform to BACnet Building Controller (B-BC) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-BC in the BACnet Testing Laboratories (BTL) Product Listing.
2. Advanced Application Controllers (AACs). Each AAC shall conform to BACnet Advanced Application Controller (B-AAC) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-AAC in the BACnet Testing Laboratories (BTL) Product Listing.
3. Application Specific Controllers (ASCs). Each ASC shall conform to BACnet Application Specific Controller (B-ASC) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-ASC in the BACnet Testing Laboratories (BTL) Product Listing.
4. Smart Actuators (SAs). An actuator which is controlled by a network connection rather than a binary or analog signal (0-10v, 4-20mA, relay, etc.). Each SA shall conform to BACnet Smart Actuator (B-SA) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-SA in the BACnet Testing Laboratories (BTL) Product Listing.
5. Smart Sensors (SSs). A sensor which provides information to the BAS via network connection rather than a binary or analog signal (0-10000 ohm, 4-20mA, dry contact, etc.). Each SS shall conform to BACnet Smart Sensor (B-SS) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-SS in the BACnet Testing Laboratories (BTL) Product Listing.
6. BACnet Communication.
 - a. Building Controllers (BC). Each BC shall connect to a network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol using BACnet/IP or BACnet/SC.
 - b. BACnet routing shall be performed by BCs or other BACnet device routers as necessary to connect BCs to networks of AACs and ASCs.
 - c. Each AAC shall connect to a network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol using BACnet/IP or BACnet/SC.
 - d. Each ASC shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
 - e. Each SA shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.

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- f. Each SS shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using ARCNET or MS/TP Data Link/Physical layer protocol.
- C. Security.
- 1. Provide BACnet firewall capability, as defined in the BACnet standard.
- D. Building Controllers (BC)
- 1. Communication
 - a. Network Connection. Controller shall support a single point ethernet connection.
 - b. Ethernet Port. Provide one (1) Gig-E port capable of full duplex communication up to 1000 Mbps
 - c. Service Port. Provide one (1) ethernet port for connection to a Portable Operator's Terminal.
 - d. Serial Port. Provide two (2) serial ports for communication to serial BACnet or serial Modbus networks.
 - e. Signal Management. BC shall have the ability to manage input and output communication signals to allow distributed controllers to share real and virtual object information and to allow for central monitoring and alarms.
 - f. Data Sharing. Each BC and AAC shall share data as required with each networked BC and AAC.
 - g. Stand-Alone Operation. Each piece of equipment shall be controlled by a single controller to provide stand-alone control in the event of communication failure. All I/O points specified for a piece of equipment shall be integral to its controller. Provide stable and reliable stand-alone control using default values or other method for values normally read over the network such as outdoor air conditions, supply air or water temperature coming from source equipment, etc.
 - 2. Environment. Controller hardware shall be suitable for anticipated ambient conditions.
 - a. Controllers used outdoors or in wet ambient conditions shall be mounted in waterproof enclosures and shall be rated for operation at -29°C to 60°C (-20°F to 140°F).

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read over the network such as outdoor air conditions, supply air or water temperature coming from source equipment, etc.

2. Environment. Controller hardware shall be suitable for anticipated ambient conditions.
 - a. Controllers used outdoors or in wet ambient conditions shall be mounted in waterproof enclosures and shall be rated for operation at -29°C to 60°C (-20°F to 140°F).
 - b. Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).
3. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to a field-removable modular terminal strip or to a termination card connected by a ribbon cable. Each BC and AAC shall continually check its processor and memory circuit status and shall generate an alarm on abnormal operation. System shall continuously check controller network and generate alarm for each controller that fails to respond.
4. Real-time Clock. Controller shall have a real-time clock to keep track of time in the event of a power failure for up to three (3) days.
5. Memory
 - a. Controller memory shall support operating system, database, and programming requirements.
 - b. Each AAC shall use nonvolatile memory and shall retain BIOS and application programming in the event of power loss. System shall automatically download dynamic control parameters following power loss.
- F. Immunity to Power and Noise. Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage.
- G. Transformer. Power supply shall be fused or current limiting and shall be rated at a minimum of 125% of controller power consumption.

2.08 INPUT AND OUTPUT INTERFACE

- A. General. Hard-wire input and output points to BCs, AACs, or ASCs.
- B. Protection. All input points and output points shall be protected such that shorting of the point to itself, to another point, or to ground shall cause no damage to the

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controller. All input and output points shall be protected from voltage up to 24 V of any duration, such that contact with this voltage will cause no controller damage.

- C. Binary Inputs. Binary inputs shall allow the monitoring of ON/OFF signals from remote devices. Binary inputs shall sense dry contact closure without application of power external to the controller.
- D. Pulse Accumulation Inputs. Pulse accumulation inputs shall conform to binary input requirements and shall also accumulate up to 10 pulses per second.
- E. Analog Inputs. Analog inputs shall monitor low-voltage (0–10 Vdc), current (4–20 mA), or resistance (thermistor or RTD) signals. Analog inputs shall be compatible with and field configurable to commonly available sensing devices.
- F. Binary Outputs. Binary outputs shall provide for ON/OFF operation or a pulsed low-voltage signal for pulse width modulation control. Binary outputs on Building Controllers shall have three-position (on-off-auto) override switches and status lights. Outputs shall be selectable for normally open or normally closed operation.
- G. Analog Outputs. Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0–10 Vdc or a 4–20 mA signal as required to properly control output devices. Each Building Controller analog output shall have a two-position (auto-manual) switch, a manually adjustable potentiometer, and status lights. Analog outputs shall not drift more than 0.4% of range annually.
- H. Tri-State Outputs. Control three-point floating electronic actuators without feedback with tri-state outputs (two coordinated binary outputs). Tri-State outputs may be used to provide analog output control in zone control and terminal unit control applications such as VAV terminal units, duct-mounted heating coils, and zone dampers.
- I. Universal Inputs and Outputs. Inputs and outputs that can be designated as either binary or analog in software shall conform to the provisions of this section that are appropriate for their designated use.
- J. Operator Displays. Provide a 4", 7", or 10" operator display as noted on drawings for each controller. Operator displays shall be as follows:

- 1. Physical Display. The display shall be a fully customizable capacitive multi-touch color display unit with the following minimum capabilities:

	• 4" Display	• 7" Display	• 10" Display
• Display Size (diagonal)	• 4"	• 7"	• 10.1"
• Resolution (pixels)	• 480 x 272	• 1024 x 600	• 1280 x 800
• Brightness (cd/m2)	• 400	• 320	• 350
• Contrast Ratio	• 1000:1	• 1000:1	• 800:1

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2. Power. Display shall be powered by 24Vdc power.
3. Maximum Colors: The display shall provide 8 bit capability for 16.7 million colors.
4. Touch Screen: The screen shall be a capacitive multi-touch screen using Projected Capacitive Touch (PCAP) technology.
5. Environmental: The display shall operate in conditions of -4° to 140°F with a front IP65 water and dustproof rating and a rear IP20 water and dustproof rating.
6. Communication: The following communication ports shall be provided:
 - a. Ethernet LAN port
 - b. Serial Port
 - c. USB Port
 - d. USB OTG Port
7. System/Memory: The display shall have a dual core processor, flash memory, and a 365-day real time clock/calendar with time and date maintained for a minimum of 72 hours after loss of power(at room temperature).
8. User Interface: Display shall provide the following user interface capabilities:
 - a. Multi-level password protection for security
 - b. Access virtually any point in the controller
 - c. View trends
 - d. View and edit BACnet time schedules
 - e. Change setpoints

2.09 POWER SUPPLIES AND LINE FILTERING

- A. Power Supplies. Control transformers shall be listed by UL. Furnish Class 2 current-limiting type or furnish over-current protection in primary and secondary circuits for Class 2 service in accordance with NEC requirements. Limit connected loads to 80% of rated capacity.
 1. DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100-

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microsecond response time for 50% load changes. Unit shall have built-in over-voltage and over-current protection and shall be able to withstand 150% current overload for at least three seconds without trip-out or failure.

- a. Unit shall operate between 0°C and 50°C (32°F and 120°F). EM/RF shall meet FCC Class B and VDE 0871 for Class B and MILSTD 810C for shock and vibration.
- b. Line voltage units shall be UL recognized and CSA listed.

B. Power Line Filtering.

1. Provide internal or external transient voltage and surge suppression for workstations and controllers. Surge protection shall have:
 - a. Dielectric strength of 1000 V minimum
 - b. Response time of 10 nanoseconds or less
 - c. Transverse mode noise attenuation of 65 dB or greater
 - d. Common mode noise attenuation of 150 dB or greater at 40–100 Hz

2.10 LOCAL CONTROL PANELS

- A. All indoor control cabinets shall be fully enclosed NEMA 1 construction with (hinged door) key-lock latch and removable subpanels. A single key shall be common to all field panels and subpanels.
- B. Interconnections between internal and face-mounted devices shall be prewired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL listed for 600 volt service, individually identified per control/interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.
- C. Provide ON/OFF power switch with overcurrent protection for control power sources to each local panel.

2.11 WIRING AND RACEWAYS

- A. General. Provide copper wiring, plenum cable, conduit, and raceways as specified in applicable sections of Division 26.
- B. Insulated wire shall use copper conductors and shall be UL listed for 90°C (200°F) minimum service.

2.12 PERSONAL COMPUTER OPERATOR WORKSTATION HARDWARE

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- A. New system graphics will reside on (E) computer database server.

2.13 MISCELLANEOUS DEVICES

- A. Thermostats

- 1. Room thermostats shall be of the gradual acting type with adjustable sensitivity.
- 2. They shall have a bi-metal sensing element capable of responding to a temperature change of one-tenth of one degree. (Provide all thermostats with limit stops to limit adjustments as required.)
- 3. Thermostats shall be arranged for either horizontal or vertical mounting.
- 4. In the vertical position thermostat shall fit on a mullion of movable partitions without overlap.

- B. Freeze stats:

- 1. Install freeze stats as indicated on the plans and provide protection for every square foot of coil surface area with one linear foot of element per square foot of coil.
 - a. Upon detection of low temperature, the freeze stats shall stop the associated supply fans and return the automatic dampers to their normal position. Provide manual reset.

- C. Current Sensing Relay:

- 1. Provide solid-state, adjustable, current operated relay. Provide a relay which changes switch contact state in response to an adjustable set point value of current in the monitored A/C circuit.
- 2. Adjust the relay switch point so that the relay responds to motor operation under load as an "on" state and so that the relay responds to an unloaded running motor as an "off" state. A motor with a broken belt is considered an unloaded motor.
- 3. Provide a status device for all fans and pumps.

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PART 3 – EXECUTION

3.01 EXAMINATION

- A. The project plans shall be thoroughly examined for control device and equipment locations. Any discrepancies, conflicts, or omissions shall be reported to the architect/engineer for resolution before rough-in work is started.
- B. The contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the engineer for resolution before rough-in work is started.
- C. The contractor shall examine the drawings and specifications for other parts of the work. If headroom or space conditions appear inadequate—or if any discrepancies occur between the plans and the contractor’s work and the plans and the work of others—the contractor shall report these discrepancies to the engineer and shall obtain written instructions for any changes necessary to accommodate the contractor’s work with the work of others. Any changes in the work covered by this specification made necessary by the failure or neglect of the contractor to report such discrepancies shall be made by—and at the expense of—this contractor.

3.02 PROTECTION

- A. The contractor shall protect all work and material from damage by his/her work or employees and shall be liable for all damage thus caused.
- B. The contractor shall be responsible for his/her work and equipment until finally inspected, tested, and accepted. The contractor shall protect any material that is not immediately installed. The contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.03 COORDINATION

- A. Site
 - 1. Where the mechanical work will be installed in close proximity to, or will interfere with, work of other trades, the contractor shall assist in working out space conditions to make a satisfactory adjustment. If the contractor installs his/her work before coordinating with other trades, so as to cause any interference with work of other trades, the contractor shall make the necessary changes in his/her work to correct the condition without extra charge.
 - 2. Coordinate and schedule work with other work in the same area and with work dependent upon other work to facilitate mutual progress.
- B. Test and Balance.

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1. The contractor shall furnish a single set of all tools necessary to interface to the control system for test and balance purposes.
 2. The contractor shall provide training in the use of these tools. This training will be planned for a minimum of 4 hours.
 3. In addition, the contractor shall provide a qualified technician to assist in the test and balance process, until the first 20 terminal units are balanced.
 4. The tools used during the test and balance process will be returned at the completion of the testing and balancing.
- C. Life Safety.
1. Duct smoke detectors required for air handler shutdown are provided under Division 28. Interlock smoke detectors to air handlers for shutdown as specified in sequences of operation.
 2. Smoke dampers and actuators required for duct smoke isolation are provided under Division 23. Interlock smoke dampers to air handlers as specified in sequences of operation.
 3. Fire and smoke dampers and actuators required for fire-rated walls are provided under Division 23. Fire and smoke damper control is provided under Division 28.
- D. Coordination with controls specified in other sections or divisions. Other sections and/or divisions of this specification include controls and control devices that are to be part of or interfaced to the control system specified in this section. These controls shall be integrated into the system and coordinated by the contractor as follows:
1. All communication media and equipment shall be provided as specified in Section 23 09 23 Article 2.2 (Communication).
 2. Each supplier of a controls product is responsible for the configuration, programming, start up, and testing of that product to meet the sequences of operation described in Section 23 09 93.
 3. The contractor shall coordinate and resolve any incompatibility issues that arise between control products provided under this section and those provided under other sections or divisions of this specification.
 4. The contractor is responsible for providing all controls described in the contract documents regardless of where within the contract documents these controls are described.

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5. The contractor is responsible for the interface of control products provided by multiple suppliers regardless of where this interface is described within the contract documents.

3.04 GENERAL WORKMANSHIP

- A. Install equipment, piping, and wiring/raceway parallel to building lines (i.e. horizontal, vertical, and parallel to walls) wherever possible.
- B. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
- C. Install equipment in readily accessible locations as defined by Chapter 1 Article 100 Part A of the National Electrical Code (NEC).
- D. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.
- E. All equipment, installation, and wiring shall comply with industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

3.05 FIELD QUALITY CONTROL

- A. All work, materials, and equipment shall comply with rules and regulations of applicable local, state, and federal codes and ordinances as identified in Section 23 09 23 Article 1.8 (Codes and Standards).
- B. Contractor shall continually monitor the field installation for code compliance and quality of workmanship.
- C. Contractor shall have work inspection by local and/or state authorities having jurisdiction over the work.

3.06 WIRING

- A. All control and interlock wiring shall comply with national and local electrical codes, and Division 26 of this specification, Where the requirements of this section differ from Division 26, the requirements of this section shall take precedence.
- B. All NEC Class 1 (line voltage) wiring shall be UL listed in approved raceway according to NEC and Division 26 requirements.
- C. All low-voltage wiring shall meet NEC Class 2 requirements. Low-voltage power circuits shall be sub-fused when required to meet Class 2 current limit.

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- D. Where NEC Class 2 (current-limited) wires are in concealed and accessible locations, including ceiling return air plenums, approved cables not in raceway may be used provided that cables are UL listed for the intended application.
- E. All wiring in mechanical, electrical, or service rooms – or where subject to mechanical damage – shall be installed in raceway at levels below 3 m (10ft).
- F. Do not install Class 2 wiring in raceways containing Class 1 wiring. Boxes and panels containing high-voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two (e.g. relays and transformers).
- G. Do not install wiring in raceway containing tubing.
- H. Where Class 2 wiring is run exposed, wiring is to be run parallel along a surface or perpendicular to it and neatly tied at 3 m (10 ft) intervals.
- I. Where plenum cables are used without raceway, they shall be supported from or anchored to structural members. Cables shall not be supported by or anchored to ductwork, electrical raceways, piping, or ceiling suspension systems.
- J. All wire-to-device connections shall be made at a terminal block or terminal strip. All wire-to-wire connections shall be at a terminal block.
- K. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.
- L. Maximum allowable voltage for control wiring shall be 120 V. If only higher voltages are available, the contractor shall provide step-down transformers.
- M. All wiring shall be installed as continuous lengths, with no splices permitted between termination points.
- N. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations.
- O. Size of raceway and size and type of wire type shall be the responsibility of the contractor in keeping with the manufacturer's recommendations and NEC requirements, except as noted elsewhere.
- P. Include one pull string in each raceway 2.5 cm (1 in.) or larger.
- Q. Use color-coded conductors throughout with conductors of different colors.
- R. Control and status relays are to be located in designated enclosures only. These enclosures include packaged equipment control panel enclosures unless they also contain Class 1 starters.

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- S. Conceal all raceways except within mechanical, electrical, or service rooms. Install raceway to maintain a minimum clearance of 15 cm (6 in.) from high-temperature equipment (e.g. steam pipes or flues).
- T. Secure raceways with raceway clamps fastened to the structure and spaced according to code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be run on or attached to ductwork.
- U. Adhere to this specification's Division 26 requirements where raceway crosses building expansion joints.
- V. Install insulated bushings on all raceway ends and openings to enclosures. Seal top end of vertical raceways.
- W. The contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.
- X. Flexible metal raceways and liquid-tight flexible metal raceways shall not exceed 1 m (3 ft) in length and shall be supported at each end. Flexible metal raceway less than ½ in. electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal raceways shall be used.
- Y. Raceway must be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Raceway sections shall be joined with couplings (according to code). Terminations must be made with fittings at boxes, and ends not terminating in boxes shall have bushings installed.

3.07 COMMUNICATION WIRING

- A. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling
- B. Do not install communication wiring in raceways and enclosures containing Class 1 or other Class 2 wiring.
- C. Maximum pulling, tension, and bend radius for the cable installation, as specified by the cable manufacturer, shall not be exceeded during installation.
- D. Contractor shall verify the integrity of the entire network following cable installation. Use appropriate test measures for each particular cable.
- E. When a cable enters or exits a building, a lightning arrestor must be installed between the lines and ground. The lightning arrestor shall be installed according to manufacturer's instructions.
- F. All runs of communication wiring shall be unspliced length when that length is commercially available.

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- G. All communication wiring shall be labeled to indicate origination and destination data.
- H. Grounding of coaxial cable shall be in accordance with NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."
- I. BACnet IP, Arcnet, or MS/TP communications wiring shall be installed in accordance with ASHRAE/ANSI Standard 135. This includes but is not limited to:
 - 1. IP
 - a. The network shall use Cat5e or greater cabling for connections.
 - b. Custom made patch cables must use either the T568A or T568 wiring standard and must use the same standard on both ends of the cable.
 - 2. Arcnet
 - a. The network shall use shielded, twisted-pair cable with characteristic impedance between 100 nominal. Distributed capacitance between conductors shall be less than 12.5 pF per foot (41 pF per meter.)
 - b. The maximum length of an Arcnet segment is 610 meters (2000 ft) with AWG 22 cable.
 - c. The maximum number of nodes per segment shall be 32, as specified in the EIA 485 standard. Additional nodes may be accommodated by the use of repeaters.
 - d. An Arcnet network shall have no T connections
 - 3. MS/TP
 - a. The network shall use shielded, twisted-pair cable with characteristic impedance between 100 and 120 ohms. Distributed capacitance between conductors shall be less than 100 pF per meter (30 pF per foot.)
 - b. The maximum length of an MS/TP segment is 1200 meters (4000 ft) with AWG 18 cable. The use of greater distances and/or different wire gauges shall comply with the electrical specifications of EIA-485.
 - c. The maximum number of nodes per segment shall be 32, as specified in the EIA 485 standard. Additional nodes may be accommodated by the use of repeaters.
 - d. An MS/TP EIA-485 network shall have no T connections.

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3.08 FIBER OPTIC CABLE

- A. Maximum pulling tensions as specified by the cable manufacturer shall not be exceeded during installation. Post-installation residual cable tension shall be within cable manufacturer's specifications.
- B. All cabling and associated components shall be installed in accordance with manufacturers' instructions. Minimum cable and unjacketed fiber bend radii, as specified by cable manufacturer, shall be maintained.

3.09 INSTALLATION OF SENSORS

- A. Install sensors in accordance with the manufacturer's recommendations.
- B. Mount sensors rigidly and adequately for environment within which the sensor operates.
- C. Room temperature sensors shall be installed on concealed junction boxes properly supported by wall framing.
- D. All wires attached to sensors shall be sealed in their raceways or in the wall to stop air transmitted from other areas from affecting sensor readings.
- E. Sensors used in mixing plenums and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner vertically across the duct. Each bend shall be supported with a capillary clip.
- F. Low-limit sensors used in mixing plenums shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip. Provide 3 m (10 ft) of sensing element for each 1 m² (1 ft²) of coil area.
- G. Do not install temperature sensors within the vapor plume of a humidifier. If installing a sensor downstream of a humidifier, install it at least 3 m (10 ft) downstream.
- H. All pipe-mounted temperature sensors shall be installed in wells. Install liquid temperature sensors with heat-conducting fluid in thermal wells.
- I. Install outdoor air temperature sensors on north wall, complete with sun shield at designated location.
- J. Differential Air Static Pressure.
 - 1. Supply Duct Static Pressure. Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the high-pressure tap tubing of the corresponding building static pressure sensor (if applicable) or to the location of the duct high-pressure tap and leave open to the plenum.

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2. Return Duct Static Pressure. Pipe high-pressure tap to duct using a pitot tube. Pipe the low-pressure port to a tee in the low-pressure tap tubing of the corresponding building static pressure sensor.
 3. Building Static Pressure. Pipe the low-pressure port of the pressure sensor to the static pressure port located on the outside of the building through a high-volume accumulator. Pipe the high-pressure port to a location behind a thermostat cover.
 4. The piping to the pressure ports on all pressure transducers shall contain a capped test port located adjacent to the transducer.
 5. All pressure transducers, other than those controlling VAV boxes, shall be located in field device panels, not on the equipment monitored or on ductwork. Mount transducers in a location accessible for service without use of ladders or special equipment.
 6. All air and water differential pressure sensors shall have gauge tees mounted adjacent to the taps. Water gauges shall also have shut-off valves installed before the tee.
- K. Smoke detectors, freezestats, high-pressure cut-offs, and other safety switches shall be hard-wired to de-energize equipment as described in the sequence of operation. Switches shall require manual reset. Provide contacts that allow DDC software to monitor safety switch status.
1. Smoke detectors utilized for fan shutdown shall be addressable and signal to the fire-alarm control panel upon activation.
- L. Install humidity sensors for duct mounted humidifiers at least 3 m (10 ft) downstream of the humidifier. Do not install filters between the humidifier and the sensor.

3.10 FLOW SWITCH INSTALLATION

- A. Use correct paddle for pipe diameter.
- B. Adjust flow switch according to manufacturer's instructions.

3.11 ACTUATORS

- A. General. Mount and link control damper actuators according to manufacturer's instructions.
 1. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, and then tighten the linkage.

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2. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
 3. Provide all mounting hardware and linkages for actuator installation.
- B. Electric/Electronic
1. Dampers: Actuators shall be direct mounted on damper shaft or jackshaft unless shown as a linkage installation. For low-leakage dampers with seals, the actuator shall be mounted with a minimum 5° travel available for tightening the damper seal. Actuators shall be mounted following manufacturer's recommendations.
 2. Valves: Actuators shall be connected to valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following the actuator manufacturer's recommendations.

3.12 WARNING LABELS

- A. Permanent warning labels shall be affixed to all equipment that can be automatically started by the control system.
1. Labels shall use white lettering (12-point type or larger) on a red background.
 2. Warning labels shall read as follows.
 - a. **C A U T I O N:** This equipment is operating under automatic control and may start or stop at any time without warning. Switch disconnect to "Off" position before servicing.
- B. Permanent warning labels shall be affixed to all motor starters and control panels that are connected to multiple power sources utilizing separate disconnects.
1. Labels shall use white lettering (12-point type or larger) on a red background.
 2. Warning labels shall read as follows.
 - a. **C A U T I O N:** This equipment is fed from more than one power source with separate disconnects. Disconnect all power sources before servicing.

3.13 IDENTIFICATION OF HARDWARE AND WIRING

- A. All wiring and cabling, including that within factory-fabricated panels shall be labeled at each end within 5 cm (2 in.) of termination with control system address or termination number.

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- B. All pneumatic tubing shall be labeled at each end within 5 cm (2 in.) of termination with a descriptive identifier.
- C. Permanently label or code each point of field terminal strips to show the instrument or item served.
- D. Identify control panels with minimum 1 cm (½ in.) letters on laminated plastic nameplates.
- E. Identify all other control components with permanent labels. All plug-in components shall be labeled such that label removal of the component does not remove the label.
- F. Identify room sensors related to terminal boxes or valves with nameplates.
- G. Manufacturers' nameplates and UL or CSA labels shall be visible and legible after equipment is installed.
- H. Identifiers shall match record documents.

3.14 CONTROLLERS

- A. Provide a separate controller for each AHU or other HVAC system. A DDC controller may control more than one system provided that all points associated with the system are assigned to the same DDC controller. Points used for control loop reset, such as outside air or space temperature, are exempt from this requirement.
- B. Building Controllers and Custom Application Controllers shall be selected to provide the required I/O point capacity required to monitor all of the hardware points listed in sequences of operation.

3.15 PROGRAMMING

- A. Provide sufficient internal memory for the specified sequences of operation and trend logging.
- B. Point Naming. Coordinate with owner for point naming conventions. Name points as shown on the equipment points list provided with each sequence of operation or as directed by owner. If character limitations or space restrictions make it advisable to shorten the name, abbreviations as coordinated with owner may be used. Where multiple points with the same name reside in the same controller, each point name may be customized with its associated Program Object number. For example, "Zone Temp 1" for Zone 1, "Zone Temp 2" for Zone 2.
- C. Software Programming.
 - 1. Provide programming for the system and adhere to the sequences of operation provided. All other system programming necessary for the operation of the

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system, but not specified in this document, also shall be provided by the contractor. Embed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequences of operation. Use the appropriate technique based on the following programming types:

- a. Text-based:
 - 1. Must provide actions for all possible situations
 - 2. Must be modular and structured
 - 3. Must be commented
- b. Graphic-based:
 - 1. Must provide actions for all possible situations
 - 2. Must be documented
- c. Parameter-based:
 - 1. Must provide actions for all possible situations
 - 2. Must be documented.

D. Operator Interface.

- 1. Standard Graphics. Provide graphics for all mechanical systems and floor plans of the building. This includes each chilled water system, hot water system, chiller, boiler, air handler, and all terminal equipment. Point information on the graphic displays shall dynamically update. Show on each graphic all input and output points for the system. Also show relevant calculated points such as setpoints. As a minimum, show on each equipment graphic the input and output points and relevant calculated points as indicated on the applicable Points List or sequence of operation.
- 2. The contractor shall provide all the labor necessary to install, initialize, start up, and troubleshoot all operator interface software and its functions as described in this section. This includes any operating system software, the operator interface database, and any third-party software installation and integration required for successful operation of the operator interface.

3.16 CONTROL SYSTEM CHECKOUT AND TESTING

- A. Startup Testing. All testing listed in this article shall be performed by the contractor and shall make up part of the necessary verification of an operating control system. This testing shall be completed before the owner's representative is notified of the system demonstration.

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1. The contractor shall furnish all labor and test apparatus required to calibrate and prepare for service of all instruments, controls, and accessory equipment furnished under this specification.
2. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
3. Enable the control systems and verify calibration of all input devices individually. Perform calibration procedures according to manufacturers' recommendations.
4. Verify that all binary output devices (relays, solenoid valves, two-position actuators and control valves, magnetic starters, etc.) operate properly and that the normal positions are correct.
5. Verify that all analog output devices (I/Ps, actuators, etc.) are functional, that start and span are correct, and that direction and normal positions are correct. The contractor shall check all control valves and automatic dampers to ensure proper action and closure. The contractor shall make any necessary adjustments to valve stem and damper blade travel.
6. Verify that the system operation adheres to the sequences of operation. Simulate and observe all modes of operation by overriding and varying inputs and schedules. Tune all DDC loops.
7. Alarms and Interlocks:
 - a. Check each alarm separately by including an appropriate signal at a value that will trip the alarm.
 - b. Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.
 - c. Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.

3.17 **ERROR! BOOKMARK NOT DEFINED.**CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

A. Demonstration.

1. Prior to acceptance, the control system shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the Contractor has completed the installation, started up the system, and performed his/her own tests.
2. The tests described in this section are to be performed in addition to the tests that the contractor performs as a necessary part of the installation, start-up,

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and debugging process and as specified in the "Control System Checkout and Testing" article in Part 3 of this specification. The engineer will be present to observe and review these tests. The engineer shall be notified at least 10 days in advance of the start of the testing procedures.

3. The demonstration process shall follow that approved in Part 1, "Submittals." The approved checklists and forms shall be completed for all systems as part of the demonstration.
4. The contractor shall provide at least two persons equipped with two-way communication and shall demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure modes. The purpose is to demonstrate the calibration, response, and action of every point and system. Any test equipment required to prove the proper operation shall be provided by and operated by the contractor.
5. As each control input and output is checked, a log shall be completed showing the date, technician's initials, and any corrective action taken or needed.
6. Demonstrate compliance with Part 1, "System Performance."
7. Demonstrate compliance with sequences of operation through all modes of operation.
8. Demonstrate complete operation of operator interface.
9. Additionally, the following items shall be demonstrated:
 - a. DDC loop response. The contractor shall supply trend data output in a graphical form showing the step response of each DDC loop. The test shall show the loop's response to a change in set point, which represents a change of actuator position of at least 25% of its full range. The sampling rate of the trend shall be from 10 seconds to 3 minutes, depending on the speed of the loop. The trend data shall show for each sample the set point, actuator position, and controlled variable values. Any loop that yields unreasonably under-damped or over-damped control shall require further tuning by the Contractor.
 - b. Demand limiting. The contractor shall supply a trend data output showing the action of the demand limiting algorithm. The data shall document the action on a minute-by-minute basis over at least a 30-minute period. Included in the trend shall be building kW, demand limiting set point, and the status of sheddable equipment outputs.
 - c. Optimum start/stop. The contractor shall supply a trend data output showing the capability of the algorithm. The change-of-value or change-

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of-state trends shall include the output status of all optimally started and stopped equipment, as well as temperature sensor inputs of affected areas.

- d. Interface to the building fire alarm system.
 - e. Operational logs for each system that indicate all set points, operating points, valve positions, mode, and equipment status shall be submitted to the architect/engineer. These logs shall cover three 48-hour periods and have a sample frequency of not more than 10 minutes. The logs shall be provided in both printed and disk formats.
10. Any tests that fail to demonstrate the operation of the system shall be repeated at a later date. The contractor shall be responsible for any necessary repairs or revisions to the hardware or software to successfully complete all tests.

B. Acceptance.

- 1. All tests described in this specification shall have been performed to the satisfaction of both the engineer and owner prior to the acceptance of the control system as meeting the requirements of completion. Any tests that cannot be performed due to circumstances beyond the control of the contractor may be exempt from the completion requirements if stated as such in writing by the engineer. Such tests shall then be performed as part of the warranty.
- 2. The system shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved as required in Part 1, "Submittals."

3.18 **ERROR! BOOKMARK NOT DEFINED.**CLEANING

- A. The contractor shall clean up all debris resulting from his/her activities daily. The contractor shall remove all cartons, containers, crates, etc., under his/her control as soon as their contents have been removed. Waste shall be collected and placed in a designated location.
- B. At the completion of work in any area, the contractor shall clean all work, equipment, etc., keeping it free from dust, dirt, and debris, etc.
- C. At the completion of work, all equipment furnished under this section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to match the adjacent areas. Any cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

3.19 **ERROR! BOOKMARK NOT DEFINED.**TRAINING

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- A. Provide training for a designated staff of Owner's representatives. Training shall be provided via self-paced training, web-based or computer-based training, classroom training, or a combination of training methods.
- B. Training shall enable students to accomplish the following objectives.
 - 1. Day-to-day Operators:
 - a. Proficiently operate the system
 - b. Understand control system architecture and configuration
 - c. Understand DDC system components
 - d. Understand system operation, including DDC system control and optimizing routines (algorithms)
 - e. Operate the workstation and peripherals
 - f. Log on and off the system
 - g. Access graphics, point reports, and logs
 - h. Adjust and change system set points, time schedules, and holiday schedules
 - i. Recognize malfunctions of the system by observation of the printed copy and graphical visual signals
 - j. Understand system drawings and Operation and Maintenance manual
 - k. Understand the job layout and location of control components
 - l. Access data from DDC controllers and ASCs
 - m. Operate portable operator's terminals
 - 2. Advanced Operators:
 - a. Make and change graphics on the workstation
 - b. Create, delete, and modify alarms, including annunciation and routing of these
 - c. Create, delete, and modify point trend logs and graph or print these both on an ad-hoc basis and at user-definable time intervals
 - d. Create, delete, and modify reports

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- e. Add, remove, and modify system's physical points
 - f. Create, modify, and delete programming
 - g. Add panels when required
 - h. Add operator interface stations
 - i. Create, delete, and modify system displays, both graphical and others
 - j. Perform DDC system field checkout procedures
 - k. Perform DDC controller unit operation and maintenance procedures
 - l. Perform workstation and peripheral operation and maintenance procedures
 - m. Perform DDC system diagnostic procedures
 - n. Configure hardware including PC boards, switches, communication, and I/O points
 - o. Maintain, calibrate, troubleshoot, diagnose, and repair hardware
 - p. Adjust, calibrate, and replace system components
3. System Managers/Administrators:
- a. Maintain software and prepare backups
 - b. Interface with job-specific, third-party operator software
 - c. Add new users and understand password security procedures
- C. Organize the training into sessions or modules for the three levels of operators listed above. (Day-to-Day Operators, Advanced Operators, System Managers and Administrators). Students will receive one or more of the training packages, depending on knowledge level required.
- D. Provide course outline and materials according to the "Submittals" article in Part 1 of this specification. Provide one copy of training material per student.
- E. The instructor(s) shall be factory-trained and experienced in presenting this material.
- F. Classroom training shall be done using a network of working controllers representative of installed hardware.

3.20 CONTROL VALVE INSTALLATION

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- A. Valve submittals shall be coordinated for type, quantity, size, and piping configuration to ensure compatibility with pipe design. Refer also to schedule on M0.02.
- B. Slip-stem control valves shall be installed so that the stem position is not more than 60 degrees from the vertical up position. Ball type control valves shall be installed with the stem in the horizontal position.
- C. Valves shall be installed in accordance with the manufacturer's recommendations.
- D. Control valves shall be installed so that they are accessible and serviceable and so that actuators may be serviced and removed without interference from structure or other pipes and/or equipment.
- E. Isolation valves shall be installed so that the control valve body may be serviced without draining the supply/return side piping system. Unions shall be installed at all connections to screw-type control valves.
- F. Provide tags for all control valves indicating service and number. Tags shall be brass, 1.5 inch in diameter, with ¼ inch high letters. Securely fasten with chain and hook. Match identification numbers as shown on approved controls shop drawings.

3.21 **ERROR! BOOKMARK NOT DEFINED.**CONTROL DAMPER INSTALLATION

- A. Damper submittals shall be coordinated for type, quantity, and size to ensure compatibility with sheet metal design.
- B. Duct openings shall be free of any obstruction or irregularities that might interfere with blade or linkage rotation or actuator mounting. Duct openings shall measure ¼ in. larger than damper dimensions and shall be square, straight, and level.
- C. Individual damper sections, as well as entire multiple section assemblies, must be completely square and free from racking, twisting, or bending. Measure diagonally from upper corners to opposite lower corners of each damper section. Both dimensions must be within 0.3 cm (1/8 in.) of each other.
- D. Follow the manufacturer's instructions for field installation of control dampers. Unless specifically designed for vertical blade application, dampers must be mounted with blade axis horizontal.
- E. Install extended shaft or jackshaft according to manufacturer's instructions. (Typically, a sticker on the damper face shows recommended extended shaft location. Attach shaft on labeled side of damper to that blade.)
- F. Damper blades, axles, and linkage must operate without binding. Before system operation, cycle damper after installation to ensure proper operation. On multiple section assemblies, all sections must open and close simultaneously.

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- G. Provide a visible and accessible indication of damper position on the drive shaft end.
- H. Support ductwork in area of damper when required to prevent sagging due to damper weight.
- I. After installation of low-leakage dampers with seals, caulk between frame and duct or opening to prevent leakage around perimeter of damper.

3.22 **ERROR! BOOKMARK NOT DEFINED.**SMOKE DAMPER INSTALLATION

- A. The contractor shall coordinate all smoke and smoke/fire damper installation, wiring, and checkout to ensure that these dampers function properly and that they respond to the proper fire alarm system general, zone, and/or detector trips. The contractor shall immediately report any discrepancies to the engineer no less than two weeks prior to inspection by the code authority having jurisdiction.
- B. Provide complete submittal data to controls system subcontractor for coordination of duct smoke detector interface to HVAC systems.

3.23 **ERROR! BOOKMARK NOT DEFINED.**DUCT SMOKE DETECTION

- A. Submit data for coordination of duct smoke detector interface to HVAC systems as required in Part 1, "Submittals."
- B. This Contractor shall provide a dry-contact alarm output in the same room as the HVAC equipment to be controlled.

3.24 START-UP AND CHECKOUT PROCEDURES

- A. Start up, check out, and test all hardware and software and verify communication between all components.
 - 1. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
 - 2. Verify that all analog and binary input/output points read properly.
 - 3. Verify alarms and interlocks.
 - 4. Verify operation of the integrated system.

3.25 PROJECT MANAGEMENT

- A. Provide a designated project manager who will be responsible for the following:
 - 1. Construct and maintain project schedule.

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2. On-site coordination with all applicable trades, subcontractors, and other integration vendors
3. Authorized to accept and execute orders or instructions from owner/architect.
4. Make necessary field decisions relating to this scope of work.
5. Coordination/Single point of contact

3.26 COMMISSIONING, TESTING AND ACCEPTANCE

- A. Perform commissioning procedure consisting of field I/O commissioning. Document all commissioning information on commissioning data sheets which shall be submitted prior to acceptance testing. Commissioning work which requires shutdown of system or deviation from normal function shall be performed when the operation of the system is not required. The commissioning must be coordinated with the owner and construction manager to ensure systems are available when needed. Notify the operating personnel in writing of the testing schedule so that authorized personnel from the owner and construction manager are present throughout the commissioning procedure.
- B. Prior to system program commissioning, verify that each control panel has been installed according to plans, specifications, and approved shop drawings.
- C. Submit for approval, a detailed acceptance test procedure designed to demonstrate compliance with contractual requirements. This Acceptance test procedure will take place after the commissioning procedure but before final acceptance, to verify that sensors and control devices maintain specified accuracies and the system performance does not degrade over time.
- D. Refer to HVAC commissioning specification for additional information.

3.27 SEQUENCE OF OPERATIONS:

- A. RT-1: Prior to removal of existing ALC equipment controller, contractor shall export existing sequence logic and trend log data as a text base file using manufacturer preferred methods.
- B. VAV: Maintain existing sequence of operations for existing VAV boxes.

END OF SECTION

DIVISION 26

ELECTRICAL

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PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Work included in this Section: "Provide" indicates all materials, labor, equipment, services, and incidentals necessary to install the Electrical Work indicated on the contract drawings and these specifications. Work includes, but is not limited to the following:

1. Electrical and telephone services stub-outs and coordination.
2. Distribution feeders, branch circuit wiring, wiring devices and connections to all equipment requiring electrical service.
3. Interior and exterior building lighting fixtures, controls and connections complete.
4. Coordination with Vendor's associated with the construction of the project.
5. All necessary incidental work not specifically mentioned herein or shown on the drawings shall be provided for complete and functioning systems.

B. Work specified in Division 26, 27, 28:

1. Section 260519: Low-Voltage Electrical Power Conductors and Cables
2. Section 260526: Grounding and Bonding for Electrical Systems
3. Section 260529: Hangers and Supports for Electrical Systems
4. Section 260533: Raceway and Boxes for Electrical Systems
5. Section 260544: Sleeves and Sleeve Seals for Electrical Raceways and Cabling
6. Section 260548.16: Seismic Controls for Electrical Systems
7. Section 260553: Identification for Electrical Systems
8. Section 260943: Wireless Network Lighting Controls
9. Section 265119: LED Interior Lighting
10. Section 283111: Digital Addressable Fire Alarm System

1.2 INCORPORATED DOCUMENTS

A. Requirements of the General Conditions, Supplementary Conditions, and Division 1 Sections apply to all work in this Section, unless modified herein.

B. Provide equipment and materials which conform to, and perform the installation thereof in accordance with the following codes and industry standards. The applicable version of each shall be that in effect as of the date of the Contract:

1. California Electrical Code, latest edition (CEC).
2. California Building Code, latest edition (CBC)
3. Underwriters' Laboratories, Inc. (UL).
4. NFPA 101, Life Safety Code.
5. Titles 8, 19 and 24 of the California Code of Regulations (CCR).
6. American National Standards Institute (ANSI).
7. California State Fire Marshal (CSFM).
8. National Electrical Manufacturers' Association (NEMA).

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9. Institute of Electrical and Electronics Engineers (IEEE).
 - a. National Electrical Safety Code (NESC).
 - i. Electrical Safety Orders.
 - ii. Other applicable local codes and ordinances.

10. All local, State and Municipal Codes and Ordinances.

- C. Where the authority-having-jurisdiction makes an interpretation or decision, as is their prerogative in accordance with the Code, such direction shall be considered a part of these Contract Documents as if contained herein. With respect to completing the intent of the Contract Documents, comply with any and all requirements of the authority-having-jurisdiction and utility company field inspectors, at no additional cost.
- D. The above referenced codes and standards are considered to be absolute minimum requirements. The Drawings and Specifications shall take precedence over the above referenced codes and standards where materials or workmanship of higher quality or larger size is indicated. Nothing in these Drawings or Specifications shall be construed to allow work not conforming to the applicable codes and standards

1.3 REVIEW OF CONTRACT DOCUMENTS

- A. Examine all relevant Contract Documents including Drawings, Specifications, and Shop Drawings in order to become acquainted with the Work of other installers whose activities will adjoin or be affected by the Electrical Work.

1.4 PERMITS, LICENSES, AND FEES

- A. Procure and pay for all permits, licenses and fees that are required to carry out and complete the Electrical Work.
- B. Pay for building department imposed inspection fees.
- C. Pay utility company charges for normal or after hours shutdowns, service calls, repairs, and cable locating that are directly related to the installation of the Electrical Work.

1.5 SITE VERIFICATION OF INFORMATION

- A. Visit the project site prior to submitting a bid and verify the condition, 6250 Lynne Conde Way, Rohnert Park, Ca and dimensions of buildings, equipment, and facilities. The act of submitting a bid shall indicate the Contractor to have familiarized themselves with all discernible conditions and has no exceptions to the existing conditions. There shall be no extra payment approved for work required due to existing conditions, whether specifically mentioned or not.

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- B. Verify at the project site, the accuracy of information shown on the Drawings regarding existing equipment, materials, and facilities. This includes but is not limited to: size, type, rating, quality, age, and serviceability. No allowance will be made on behalf of the Contractor for extra expenses resulting from the failure to discover conditions affecting the Work.
- C. Lines of other services that are damaged as a result of this work shall promptly be repaired complete to the satisfaction of the Owner at no additional expense to the contract.

1.6 WORKING SPACE

- A. Maintain adequate work space around, and access to, electrical and mechanical equipment in strict accordance with the applicable Codes. Verify during the course of construction that sufficient space will be available for the installation equipment, fixtures, etc.

1.7 QUALITY ASSURANCE

A. Conformance:

1. The Contractor shall notify the Owner's Representative, prior to submission of bid, about any part of the design which fails to comply with abovementioned requirements.
2. If after contract is awarded, minor changes and additions are required by aforementioned authorities, even though such work is not shown on drawings or covered in the specifications, they shall be included at Contractor's expense.

B. Coordination:

1. The Contractor shall become familiar with the conditions at the job site, contract drawings and specifications and plan the installation of the electrical work to conform with the existing conditions and that shown and specified so as to provide the best possible assembly of the combined work of all trades.
2. The Contractor shall work out in advance all "tight" conditions, involving all trades and if found necessary, supplementary drawings shall be prepared by this Contractor, for the Owner's Representative approval before work proceeds in these areas. No additional costs will be considered for work which must be relocated due to conflicts with the work of other trades.

1.8 MATERIALS AND SUBSTITUTIONS

- A. Materials shall be new, high quality, free from defects, of standard make, and of the brand or grade as shown on the Drawings or specified herein. Specific trade names are used in the Drawings and Specifications in order to establish the standard grade and characteristics of said items. This does not imply the right upon the part of the Contractor to use other materials or methods without the approval of the Owner's Representative.

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- B. Electrical materials and equipment shall bear the label of, or be listed by, the Underwriters' Laboratories (UL) wherever standards have been established and label service is regularly furnished by that agency. Comply with the installation and application requirements of UL as documented in their published directories.
- C. Unless specifically noted, equipment and systems shall be the product of a manufacturer who has been in the manufacture of, and has nationally distributed catalogs covering the ratings and specifications of, said equipment or systems, for a period of not less than five (5) years.
- D. Maintain uniformity throughout the Project by making use of only one make or brand of material for each material used.
- E. Substitutions of materials or methods will only be allowed if such items are approved in writing by the Owner's Representative as equal in quality and utility to the specified items. Submit a list of proposed substitutions within thirty (30) days of the award of the Contract. Include on the list the original manufacturer's name and model number, the proposed manufacturer's name and model number, catalog cut sheets, ratings, sizes, performance curves, shop drawings, and other data as may be required to demonstrate equality to the specified item.
- F. The approval of a substitution does not authorize any deviation from the utility, size, function, or durability of the specified item unless specifically pointed out and requested in the proposed substitution list, and said deviation is approved in writing by the Owner's Representative. Responsibility of the Contractor for dimensional considerations or space conflicts is not relieved by the approval of a substitution.
- G. If requested by the Owner's Representative, submit samples of materials and equipment for approval prior to installation.
- H. Any and all additional costs incurred by the substitution of electrical material or equipment, or installation thereof, whether Owner's Representative, structural, plumbing, mechanical or electrical, shall be borne by the Contractor under this Section.
- I. Burden of proof of equality of any substitution for a specified product is the responsibility of this Contractor.
- J. Where required by Owner's Representative to ascertain equality of substitute product, Contractor may be requested to provide the specified item and the submitted substitution for comparison, at no additional cost to the Owner.

1.9 ELECTRICAL SUBMITTALS

- A. See the General Conditions for conditions of submittal approval and general requirements for submission of shop drawings.
- B. Submit electrical shop drawings and manufacturer's cut sheets for equipment and materials as noted in each Division 26 specification section. Bind the submittals as com-

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plete volumes according to classification of equipment such as power, lighting, etc. When possible, make all electrical submittals at the same time.

- C. Submit shop drawings and supporting data as instruments of the Contractor. Stamp each item in the submittal documents with the Contractor's stamp, thereby stating that the equipment meets all requirements and conditions of the Drawings and Specifications. In particular, certify that the items shown on the shop drawings conform to the dimensional, environmental, and space restrictions as pertains to all work under this Contract and the work of other parties in conjunction with this Project.
- D. Provide a blank space on the title page of each submittal classification for the Owner's Representative's or Engineers approval stamp and comment field. The minimum size of such space shall be eight inches wide by five inches high.
- E. Arrange panelboard submittals to show bussing, circuit numbering, and branch circuit protective devices similar the schedules on the Drawings. Show elevations of switchboards, motor control centers, and distribution centers indicating the layout of devices, meters, handles, etc. Provide device ratings, circuit numbers, and nameplate descriptions in table form. Include terminal strip mounting arrangements on elevations for terminal cabinets.

1.10 DRAWINGS AND SPECIFICATIONS

- A. The data and information contained on the Drawings is as accurate as was reasonably possible at the time they were produced, but absolute accuracy is not guaranteed. Exact 6250 Lynne Conde Way, Rohnert Park, Ca, distances, elevations, etc., will be dictated by the actual building and the conditions at the site.
- B. The layout of electrical equipment, wiring, and accessories is shown in a diagrammatic fashion (not pictorially) in order to achieve clarity and legibility. Although the size and 6250 Lynne Conde Way, Rohnert Park, Ca of electrical equipment is drawn to scale wherever possible, refer to all data in the Contract Documents and field verify this information as the project progresses. Examine Owner's Representative, structural, mechanical, and other drawings to determine the exact 6250 Lynne Conde Way, Rohnert Park, Ca of conduits, outlets, fixtures, and equipment and to note any conditions which may affect the electrical work.
- C. The Drawings and Specifications may be superseded by later detail drawings and specifications prepared by the Owner's Representative. Conform to such detail drawings, specifications, addenda, change orders, other reasonable changes as if they are contained herein. See the General Conditions for change order cost considerations.
- D. Because the Electrical Drawings may be distorted for clarity of representation, it may be necessary to field verify the exact 6250 Lynne Conde Way, Rohnert Park, Ca of electrical outlets, lights, switches, etc. in order to conform to the architectural elements. The Owner's Representative reserves the right to make minor changes to the 6250 Lynne Conde Way, Rohnert Park, Cas of equipment, devices, and wiring shown on the Drawings, at no additional cost, providing the changes are ordered before the rough-in of conduit, boxes, or related items is completed, and no extra material are required.

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- E. For dimensional and 6250 Lynne Conde Way, Rohnert Park, Caal purposes, the Architectural Drawings take precedence over the Electrical Drawings. Determine the appropriate 6250 Lynne Conde Way, Rohnert Park, Ca of lighting fixtures, outlets, wall-mounted devices, etc. by studying the reflected ceiling plans, building sections, and interior elevations. Report conflicting conditions to the Owner's Representative before rough-in for adjustments to the 6250 Lynne Conde Way, Rohnert Park, Cas.
- F. Conduit quantities, sizes, termination points, and wiring are depicted on the Electrical Drawings. However, not all conduit bends or routing details are necessarily shown. Route conduit so as to conform to the structural conditions, avoid obstructing other trades, maintain space restrictions and keep circulation areas and access openings clear.
- G. Thoroughly examine the Contract Documents prior to submitting a bid in order to determine electrical requirements which are not necessarily indicated on the Electrical Drawings. Include sufficient allowance in the bid sum to cover the costs of these other requirements.
- H. Should the Contractor perceive that the Drawings and Specifications do not sufficiently define the intent of electrical work, contact the Owner's Representative for clarification or additional information. The absence of such contact will be considered as evidence of understanding, on the part of the Contractor, of the intended Electrical Work and the required installation thereof.

1.11 WORKMANSHIP

- A. Constantly supervise the work personally or through an authorized and competent representative. Keep the same foreman or supervisor on the project from commencement through completion.
- B. Perform the Electrical work using the highest caliber craftsman available. Workmanship shall be first class and of the best quality available to insure a long and trouble free service life. Allow only experienced and competent workmen on the job.

1.12 COOPERATION AND COORDINATION

- A. Consult with the other installers and trades in coordinating the Work so as to avoid conflicts, omissions and delays. Cooperate with other contractors, third parties, and the Owner in order to expedite the project and provide for the proper execution of the building as a whole. Work performed without regard to other trades or the overall project scheme, may necessarily be required to be moved at the Contractor's expense.

1.13 MANUFACTURER'S DIRECTIONS

- A. Adhere to the manufacturer's directions regarding the proper installation and configuration of electrical equipment where those directions cover points not included in these Drawings and Specifications.

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1.14 PROTECTION AND STORAGE

- A. Use all means necessary to protect the materials of this Division before, during, and after installation and to protect the work and materials of all trades.
- B. Deliver electrical materials to the site new, and in unbroken packages. Provide for the temporary storage of such materials, equipment, and construction tools in accordance with the General Conditions and in strict accordance with approved manufacturers' recommendations. Protect electrical equipment and materials during transit, storage and handling to prevent damage, soiling and deterioration.
- C. During shipping storage and handling protect electrical materials from damage of any type including dust, water, over-spray, and temperature.
- D. Avoid damage during construction to the work and materials of other trades as well as the electrical work and material. Repair or replace, at the Contractor's expense, defective or damaged items such that the entire Work is completed in a condition satisfactory to the Owner's Representative.
- E. Replacements: In the event of damage, immediately make all repairs and replacements necessary to the approval of the Owner's Representative and at no additional cost to the Owner.
- F. This Contractor shall personally, or through an authorized representative, check all materials upon receipt at jobsite for conformance with approved shop drawings and/or plans and specifications.

1.15 EXCAVATION, CUTTING, PATCHING, AND REPAIR

- A. Perform excavation and backfill required for the installation of electrical sub-structures. Restore grounds, walkways, roadways, curbs, walls, and other existing underground facilities to their original condition.
- B. Conform to the applicable requirements of Division 2, Earthwork for Utilities, in the selection, placement, and compaction of backfill material and finished surfaces.
- C. Cut, core-drill, and demolish existing walls, floors, ceilings and other building surfaces as required for the installation of Electrical Work. Obtain the approval of the Owner's Representative prior to performing any operation which may affect any structural elements of the building.
- D. Patch and repair wood, plaster, tile, or concrete surfaces which have been damaged by the installation of the Electrical Work so that the finished surface matches the surrounding conditions.

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1.16 FLASHING, WATERPROOFING AND SEALING

- A. In general, install in an approved watertight manner, Electrical Work which pierces exterior walls or waterproofing membranes. Flash and counter-flash roof and wall penetrations in a manner described in other applicable sections of this Specification and as approved by the Owner's Representative.
- B. Fit conduits passing through finished walls with steel escutcheon plates of brass, chrome, or painted finish as directed by the Owner's Representative. Grout penetrations of floor slabs, concrete or masonry walls with an approved grout or silicone elastomeric caulk.

1.17 CLEANING, ADJUSTING, AND TOUCH-UP

- A. Remove on a daily basis electrical debris, scraps, packaging material and other rubbish. Dispose of such items off-site in an approved manner and debris. Maintain the site free from physical hazards at all times. See the General Conditions for additional requirements.
- B. After installation, completely clean electrical equipment, fixtures, and materials of excess paint, over-spray, plaster, cement, insulating products, and other foreign matter. Leave the Electrical Work in a clean, finished, dry, level, like new condition.
- C. Touch-up paint scratches and scuffs on electrical equipment and lighting fixtures with paint recommended by the manufacturer and matching the original item finish.
- D. Make setting, adjustments, and programming in accordance with the manufactures' operating and installation instructions. Settings and program variables will be issued by the Owner's Representative prior to commissioning of the electrical system.

1.18 AS-BUILT DRAWINGS

- A. Throughout the project, maintain accurate and current record documents. Show on the record drawings deviations from the Electrical Drawings, 6250 Lynne Conde Way, Rohnert Park, Cas of underground conduits and pull-boxes, and concealed equipment which is not readily apparent. Dimension the record drawings using permanent, readily identified benchmarks such as column or wall lines.
- B. At the completion of the project, present one clearly legible set of the record drawings to the Owner's Representative.

1.19 SCHEDULING/SEQUENCING

- A. Place orders for all equipment in time to prevent any delay in construction schedule or completion of project. If any materials or equipment are not ordered in time, additional charges made by equipment manufacturers to complete their equipment in time to

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meet the construction schedule, together with any special handling charges, shall be borne by this Contractor.

- B. The Contractor shall coordinate production and delivery schedule for all Owner-supplied equipment with the equipment suppliers to ensure that all Owner-supplied equipment is delivered to site in coordination with the construction schedule and in such a manner as to cause no delays in completion of the Contract as scheduled.

1.20 INSPECTIONS AND TESTING

- A. Arrange for the inspection of the Work at various stages of completion by the Authority Having Jurisdiction, utility company representatives, and the Owner's Representative. Comply with all directions and remedial measures issued thereby. Any objections to these orders on the part of the Contractor must be presented to the Owner's Representative in writing within forty eight (48) hours of the inspection report.
- B. Coordinate the installation of the Work so that observation of all rough-in, concealed, or underground Work can take place by the Owner's Representative. Provide a minimum of seventy two (72) hours notice to the Owner's Representative prior to covering up the work. Uncover Work that has not been properly observed and make repairs to restore the Work and adjoining surfaces to their proper condition at no additional cost.
- C. Perform tests of the electrical system during the course of the project and at project completion to ensure safe and proper function in accordance with the Contract Documents, manufacturers' recommendations, and applicable codes. Provide complete documentation of all test results to the Owner's Representative prior to project completion. Testing shall include, but not necessarily be limited to, the following:
 - 1. Test for short circuits, open circuits, neutral leakage, and improper grounds on feeders and branch circuits. Perform this test with mains in disconnect from feeders, branch circuits closed, fixtures and devices permanently connected, lamps removed from sockets and wall switches closed.
 - 2. Provide insulation resistance tests of all phase and neutral circuit conductors using a 500 Volt Megger for circuits of 240 Volt rating and below, and a 1000 Volt Megger for circuits of 277 volts and above. Minimum acceptable insulation resistance is one (1) megohm.
 - 3. Perform a ground resistance test of each main grounding electrode system, ground rod, and supplemental grounding electrode. Utilize a calibrated, direct reading, earth ground test set and make the tests using the "Three-terminal, Fall-of-Potential" method. The maximum allowable earth ground resistance is 25 ohms.
 - 4. Test for proper phase-to-phase and phase-to-neutral operating voltage on the main service and on each separately derived system. Perform this test at full load and at no load. With all circuits at full operating conditions, test the phase and neutral load currents using a clamp-on ammeter.
 - 5. When series rated circuit breakers are used, provide a letter from the manufacturer of the equipment confirming that U.L. series rating exists for all protective devices. State the available fault current from the Utility Company and indicate

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that the overcurrent devices exceed the available fault current at the respective point of protection.

6. Tests as required by other sections of these Specifications.
7. Tests as prescribed by individual equipment manufacturers whether or not described in these Specifications.

- D. At project completion, demonstrate to the Owner's Representative that the entire installation is complete, in proper operation condition and that the Contract has been properly and fully executed. Activate all circuits, lights, devices, and controls under full load and normal operating conditions. Identify faulty items and immediately replace or repair defective equipment, workmanship, and materials to like new condition and retest in the presence of the Owner's Representative.
- E. At the completion of the Project, demonstrate to the Owner's Representative that the entire electrical system is free from short circuits and improper grounds, or upon request of the Owner's Representative anytime, make necessary tests under the observation of the Owner's Representative which will ensure that electrical equipment, materials and installation methods are as specified.

1.21 IDENTIFICATION

- A. Each branch circuit of panelboards to have a permanently fixed number with one word directory, mounted under celluloid on inside of cabinet door, showing circuit numbers and typewritten description of equipment supplied by breakers, including 6250 Lynne Conde Way, Rohnert Park, Ca.
1. All existing panelboards touched shall be updated with new panel schedules.
 2. All existing equipment on existing panel schedules shall be transferred to new panel schedules.
- B. Provide label on all motors: "*Caution. Automatic equipment .May start at any time.*"
- C. Provide identification of all pull boxes, junction boxes, and conduit stub-ups on the project as outlined below:
1. For Power Feeders:
 - a. Stencil cover with identifying circuit number.
 - b. Lettering 1" high.
 - c. Color of lettering black.
 - d. Place lettering on cover in neat manner; run parallel to long sides of box.
 2. For branch circuits, grounding, communication, signal, and control systems boxes and blank conduit stub-outs. Paint inside back of each j-box, front of each cover, and ends of each blank conduit stub-out with identifying system color as listed below:

<u>System</u>	<u>Color</u>
277/480 volt	Orange
120/208 volt	Blue

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Telephone/Data	Grey
Ground system	Green
Clock	Brown
Fire Alarm	Red
Audio/Visual	Yellow
Security	White
Low voltage lighting control	Orange/White

1.22 GUARANTEE

- A. In accordance with Division 1 requirements.

1.23 PERMITS AND INSPECTIONS

- A. This Contractor shall obtain and pay for all required permits and arrange for all inspections required.
- B. Do not allow or cause any of the work to be covered or enclosed until it has been tested and/or inspected.

1.24 WARRANTIES, CERTIFICATES, AND OPERATING MANUALS

- A. Properly fill out and deliver to the Owner, all warranties, guarantees, certificates, etc. for equipment and materials that are furnished and installed under this Section of the Work. The effective date on each item shall be the date of acceptance of the work by the Owner.
- B. Deliver to the Owner, a minimum of two (2) copies of the manufacturers' operating and maintenance manuals for major items of equipment.

1.25 ELECTRICAL DEMOLITION

- A. General: Perform electrical demolition in accordance with the Contract Documents, applicable codes, and facility requirements. Carefully remove, disconnect, and cap all existing electrical equipment, conductors, raceways, devices, and components designated for demolition.
- B. B. Protection of Active Systems: Maintain operation of existing electrical systems that are required to remain active. Provide temporary supports, shoring, and protection for all active feeders, branch circuits, and communications cabling that pass through demolition areas. Coordinate all shutdowns with the Owner with a minimum of 72-hour notice.
- C. Remove abandoned conductors, raceways, boxes, luminaires, lighting controls, electrical equipment, panelboards, switchgear, motor controllers, transformers, and associated hardware back to the nearest active and accessible junction point unless otherwise

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noted. Disconnect and remove lighting fixtures, lamps, ballasts, drivers, and support hardware. Remove transformers in accordance with all applicable safety and environmental regulations, including proper handling, labeling, and disposal of fluids or materials requiring special management. Cap and secure any remaining feeder or branch-circuit conduits after removal. Dispose of all demolished materials legally and in compliance with federal, state, and local regulations. Recycle copper conductors, metal raceways, fixtures, and equipment where practical.

- D. Make Safe / Terminations: De-energize and lock out/tag out all electrical circuits prior to demolition. Provide insulated, code-compliant terminations for conductors that remain in place. Install blank covers on boxes left in accessible 6250 Lynne Conde Way, Rohnert Park, Cas.
- E. Restoration: Restore surfaces affected by demolition to match existing adjacent finishes. Patch openings resulting from removal of electrical devices or equipment. Restore grounding and bonding continuity where disturbed.
- F. Documentation: Identify and record any unforeseen electrical conditions discovered during demolition. Notify the Owner and provide recommendations for corrective actions.

END OF SECTION 26 05 00

SECTION 26 05 19
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in CEC, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with CEC.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Wire and Cable (600V)
 - a. American Wire Company
 - b. Belden
 - c. General Wire and Cable Corporation
 - d. Okonite Company
 - e. Rome Cable Corporation
 - f. Cerrowire
 - g. American Insulated Wire
 - h. AFC Cable Systems

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- i. Essex
 - j. Simplex Wire and Cable Company
2. Solderless Lugs and Grounding Connections
- a. Burndy Engineering Company, Inc.
 - b. O.Z. Gedney Company, Inc.
 - c. Penn Union Electric Corporation
 - d. Thomas and Betts Company, Inc.

2.2 CONDUCTORS AND CABLES

- A. Copper Conductors: Comply with NEMA WC 70.
- B. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN and XHHW.

2.3 CONNECTORS AND SPLICES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Hubbell Power Systems, Inc.
 - 3. O-Z/Gedney; EGS Electrical Group LLC.
 - 4. 3M; Electrical Products Division.
 - 5. Tyco Electronics Corp.
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- C. 600-volt class, insulation color coded, minimum No. 12 AWG for branch circuits, No. 14 AWG for control circuits.

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3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. All branch circuits for equipment electrical power, receptacles and lighting shall be concealed spaces where possible. Wiring method shall be MC Cable (copper) with home runs routed in EMT conduit.
- B. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
- C. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
- D. Class 1 Control Circuits: Type THHN-THWN, in raceway.
- E. Class 2 Control Circuits: Type THHN-THWN, in raceway.
- F. Insulation type:
 - 1. Standard locations: #12 to #1 AWG: THWN for wet locations and THHN for dry locations. #1/0 through #4/0 AWG: XHHW (55 Mils). 250MCM and larger: XHHW (65 Mils). All wire sizes used shall be based on a 75 degree insulation rating, unless specifically used with 90 degree rated breakers and devices.
 - 2. High temperature and non-standard locations: Provide wire type and insulation category suitable for area of use as defined in CEC table 310-13.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- D. Support cables according to Division 26 Sections "Hangers and Supports for Electrical Systems."
- E. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- F. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

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LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

- G. Install all wiring (low voltage and line voltage) in conduit unless noted otherwise in the drawings, but do not pull into conduit until plastering and taping have been completed and conduits and outlets have been thoroughly cleaned and swabbed as necessary to remove water and debris.
- H. Approximately balance branch circuits about the neutral conductors in panels.
- I. Connections to devices from "thru-feed" branch circuit conductors to be made with pigtails, with no interruption of the branch circuit conductors.
- J. Neutral conductor identified by white outer braid, with different tracers of "EZ" numbering tags used where more than one neutral conductor is contained in a single raceway.
- K. Neatly arrange and "marlin" wires in panels and distribution panelboards with "T and B Ty-rap" or approved equal plastic type strapping.
- L. All wire and cable shall bear the Underwriters' Label, brought to the job in unbroken packages; wire color-coded as follows:

Voltage	Phasing	A	B	C	N
120/208	3PH-4W	Black	Red	Blue	White
208	3PH-3W	Black	Red	Blue	--
277/480	3PH-4W	Brown	Orange	Yellow	White
480	3PH-3W	Brown	Orange	Yellow	--
120/240	3PH-4W	Black	Red	Blue	White
240	3PH-3W	Black	Red	Blue	--

- M. The equipment grounding conductor shall be insulated copper; where it is insulated, the insulation shall be colored green.
- N. Label each wire of each electrical system in each pull box, junction box, outlet box, terminal cabinet, and panelboard in which it appears with "EZ" numbering tags indicating the connected circuit numbers.
- O. Properly identify the "high leg" of 4-wire delta connected systems (in each accessible location) as required by CEC 215-8 and 230-56.

3.4 INSTALLATION OF DICONNECTS, CONNECTORS, AND LUGS

- A. Equipment Disconnects: All disconnects shall be located to allow proper code required clearance in each area. Locations shown on drawings are diagrammatic only. The contractor shall coordinate exact locations in the field (with other trades) prior to rough-in to insure proper clearances.
 - 1. Motor Disconnect Switches and Safety Switches: General Electric Company Heavy Duty Type "THD", cover interlocked with operating handle so that cover cannot be opened with switch in closed position and switch cannot be closed with

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cover in open position. 240V or 480V rating, single or multi-pole as required or as noted on drawings, in Nema 1 enclosure indoors or Nema 3R enclosure outdoors unless otherwise noted. Provide dual element motor circuit fuses sized as recommended by equipment manufacturer (for final equipment actually installed).

2. Code required disconnects: Provide a local disconnect in addition to the branch circuit protection device for all equipment as required by code (whether shown or not). Disconnects shall consist of a motor rated switch (or disconnect) for all motor loads less than 3/4HP or other suitable disconnect sized to match branch circuit conductors and load current of equipment, with number of poles as required.

B. Lugs and Connectors: Thomas and Betts "lock-tite", for No. 4 and larger wire; "Scotchlock" fixed spring type with insulator for No. 6 and smaller wire.

1. All splices made up with wire nut connectors shall be solidly twisted together with electricians pliers before connector is installed to ensure a proper connection in the event of wire nut failure. No exceptions.
2. Connectors listed or labeled for "no wire twisting required" are not an acceptable substitute for actual wire twisting.
3. Utilize porcelain type connectors in all high temperature environments (above 105 degrees Celsius).

C. Splice Insulation: "Scotch" electrical tape with vinyl plastic backing or rubber tape with protective friction tape for interior work.

1. Provide watertight cast splices for all conductors in site pull boxes or wet locations.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Division 26 Section "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.6 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section "Penetration Firestopping."

B. Fire stopping: 3M Fire Protection Products or equal.

1. Fire-rated and smoke barrier construction: Maintain barrier and structural floor fire and smoke resistance ratings including resistance to cold smoke at all penetrations, connections with other surfaces or types of construction, at

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separations required to permit building movement and sound vibration absorption, an at other construction gaps.

2. Systems or devices listed in the UL Fire Resistance Directory under categories XHCR and XHEZ may be used, providing that it conforms to the construction type, penetration type, annular space requirements and fire rating involved in each separate instance, and that the system be symmetrical for wall penetrations. Systems or devices must be asbestos free.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.
 - a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
 - b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

C. Test Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 26 05 19

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Grounding systems and equipment.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in CEC, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.
 - 4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
 - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - 6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
 - 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

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2.2 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.
 - 1. Pipe Connectors: Clamp type, sized for pipe.

- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUND RODS

- A. Copper clad steel size 5/8 inch in diameter and 96 inches in length.

2.4 Test Wells

- A. Provide handholes "Christy G5" or equal, with cast iron traffic lid and hold down screws.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

- B. Underground Grounding Conductors: Install bare copper conductor, No. 4/0 AWG minimum. Bury at least 24 inches below grade.

- C. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 4. Connections to Structural Steel: Welded connectors.

3.2 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with the following items, in addition to those required by CEC:

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1. Feeders and branch circuits.
 2. Lighting circuits.
 3. Receptacle circuits.
 4. Single-phase motor and appliance branch circuits.
 5. Three-phase motor and appliance branch circuits.
 6. Flexible raceway runs.
 7. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
- B. Signal and Communication Equipment: In addition to grounding and bonding required by CEC, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.
1. For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
 2. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-4-by-12-inch grounding bus.
 3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

3.3 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Install ground wires in rigid conduit.
- C. All grounding electrode conductor connections "thermite" or "cad-weld" welded.
- D. Use approved pressure type solderless connector or use fusion welding for all connections to and bonding of grounding electrode system. All connections shall be visible, readily accessible for testing purposes. Grounding electrode conductor between the grounding electrode and service equipment.
- E. Terminate grounding conduits at equipment with ground bushing, with ground wire connected through bushing.
- F. Other than for isolated ground receptacles, provide No. 12 stranded (green) THHN conductor from outlet box to ground screw of every receptacle.
- G. Ground all isolated sections of metallic raceways.
- H. Provide #12 minimum stranded (green) THHN conductor sized per CEC, or as noted, connected continuously throughout branch circuit for all circuits, bonded to panel ground bus, and to all electrical devices and equipment enclosures

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GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

- I. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

3.4 LABELING

- A. Comply with requirements in Division 26 Section "Requirements for Electrical Installations" The label or its text shall be green.
- B. Install labels at the telecommunications bonding conductor and grounding equalizer and at the grounding electrode conductor where exposed.
 1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Make tests at ground rods before any conductors are connected.
 4. Test system using the three-point fall of potential method only. Record results and submit to Owner's Representative for approval.
- B. Report measured ground resistances that exceed the following values:
 1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
 2. Power Distribution Units or Panelboards Serving Electronic Equipment: 3ohm(s).
- C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Owner's Representative promptly and include recommendations to reduce ground resistance.

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GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

END OF SECTION 26 05 26

SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Hangers and supports for electrical equipment and systems.

1.2 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- B. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.3 ACTION SUBMITTALS

- A. Product Data: For steel slotted support systems.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
 1. Trapeze hangers. Include Product Data for components.
 2. Steel slotted channel systems. Include Product Data for components.
 3. Equipment supports.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with CEC.

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PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut; Tyco International, Ltd.
 - g. Wesanco, Inc.
 - h. General Electric Company
 - i. Republic Steel Corporation
 2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 5. Channel Dimensions: Selected for applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

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- a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Hilti Inc.
 - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 - 4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
 3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 6. Toggle Bolts: All-steel springhead type.
 7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

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- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by CEC. Minimum rod size shall be 1/4 inch in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with two-bolt conduit clamps.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts
 - 6. To Light Steel: Sheet metal screws.
 - 7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.
- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touchup: Comply with requirements in Division 09 Section "Exterior Paints" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 26 05 29

SECTION 26 05 33
RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 SUMMARY

- A. All branch circuits for electrical equipment, receptacles and lighting shall be copper wiring routed in EMT conduit home runs and MC cable from device to device.

1.2 RELATED SECTIONS

- A. Section 260500: Common Work Results for Electrical
- B. Section 260519: 600-Volt Power Conductors and Cables
- C. Section 260526: Grounding and Bonding for Electrical Systems
- D. Section 260553: Identification for Electrical Systems

1.3 REFERENCES - CODES AND STANDARDS

- A. ANSI C80.1 Rigid Steel Conduit, Zinc Coated.
- B. ANSI C80.3 Electrical Metallic Tubing, Zinc Coated.
- C. ANSI C80.6 American National Standard for Electrical Intermediate Metal Conduit.
- D. ASTM A 48 Standard Specification for Grey Iron Castings.
- E. NECA (National Electrical Contractor's Association) – "Standard of Installation."
- F. NEMA FB 1 (National Electrical Manufacturers Association) – Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
- G. NEMA OS 1 (National Electrical Manufacturers Association) – Sheet-steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
- H. NEMA OS 2 (National Electrical Manufacturers Association) – Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports.
- I. NEMA RN 1 (National Electrical Manufacturers Association) – Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
- J. NEMA TC 2 – Electrical Polyvinyl Chloride (PVC) Conduit.
- K. NEMA TC 3 (National Electrical Manufacturers Association) – PVC Fittings for Use with Rigid PVC Conduit and Tubing.

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- L. NEMA TC 6 - Non-Metallic Conduit.
- M. NEMA 250 (National Electrical Manufacturers Association) – Enclosures for Electrical Equipment (1,000 Volts Maximum).
- N. CEC California Electrical Code (CEC). Latest approved edition
- O. UL 1 Flexible Metal Conduit
- P. UL 6 Rigid Metal Conduit
- Q. UL 514B Conduit, Tubing and Cable Fittings.
- R. UL 651 Rigid Non-Metallic Conduit
- S. UL 797 Electrical Metallic Tubing
- T. UL 1242 Intermediate Metal Conduit

1.4 SYSTEM DESCRIPTION

- A. Raceway, boxes and manholes located as indicated on drawings and at other locations required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements. Raceway, boxes and manholes are shown in approximate locations unless dimensioned. Provide raceway for complete wiring system.
- B. All branch circuits for equipment electrical power, receptacles and lighting shall be concealed spaces where possible. Wiring method shall be MC Cable (copper) with home runs routed in EMT conduit.
- C. In or Under Slab: Provide Schedule 40 non-metallic conduit.
- D. Underground more than 5 feet (1,500 mm) outside foundation wall: Provide Schedule 40 non-metallic conduit.
- E. Underground within 5 feet from foundation wall: Provide rigid steel or Schedule 80 non-metallic conduit.
- F. Provide Schedule 80 or Galvanized Steel with tape wrap rigid steel factory bends greater than 22.5 degrees and for stub-ups through concrete slabs.
- G. Outdoor Locations, Above Grade: Provide EMT conduit painted to match surface(s). Provide cast metal gasketed outlet, pull, and junction boxes.
- H. Concealed Dry Locations: Provide electrical metallic tubing for sizes less than 2-inches. Provide galvanized rigid steel or intermediate steel conduit in sizes 2-inches or larger. Provide cast or sheet metal boxes.

SECTION 26 05 33
RACEWAYS AND BOXES

1.5 DESIGN REQUIREMENTS

- A. Minimum Raceway Size: 3/4 inch (19 mm) unless otherwise specified.

1.6 SUBMITTALS

- A. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by product testing agency having jurisdiction. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- B. Submit detailed conduit routing plan, for review and approval, prior to installation as follows:
 - 1. Exposed and/or concealed in building walls for conduits larger than 2-inch outside diameter.
 - 2. All underground conduits (3/4-inch and larger) in duct bank; concealed in floor slabs, equipment pads and concrete slabs.
- C. Product Data: Submit for the following:
 - 1. Rigid Steel Conduit.
 - 2. Electrical Metallic Tubing (EMT).
 - 3. Liquid tight flexible metal conduit.
 - 4. Nonmetallic conduit.
 - 5. Raceway fittings.
 - 6. Conduit bodies.
 - 7. Surface raceway.
 - 8. Pull boxes, junction boxes.
- D. Manufacturer's Installation Instructions:
 - 1. Submit application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements.
 - 2. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.7 CLOSEOUT SUBMITTALS

- A. Project Record Documents:
 - 1. Record actual routing of conduits. Provide record (as-built) drawings marked in red to show actual routing of the underground raceway and cable when different from the original contract drawings. Prepare on new, clean set of contract drawings.
 - 2. Record actual locations and mounting heights of outlet, pull boxes, junction boxes and manholes.

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RACEWAYS AND BOXES

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
- B. Protect PVC and PVC-coated metallic conduit from sunlight.

PART 2 - PRODUCTS

2.1 CONDUIT

- A. Galvanized Rigid Steel Conduit (GRSC or RGS), couplings and elbows shall be hot-dip galvanized, rigid mild steel in accordance with ANSI C80.1 and UL 6. The conduit interior and exterior surfaces shall have a continuous zinc coating with a transparent overcoat of enamel, lacquer, or zinc chromate. Conduit shall be formed with continuous welded seams with a uniform wall thickness, in minimum 10-foot lengths, with threaded ends.
- B. Electrical Metallic Tubing (EMT). Electrical metallic tubing, including elbows and bends, shall be zinc coated, mild steel in accordance with the requirements of ANSI C80.3 and UL 797. The interior and exterior surfaces of the tubing shall have a continuous zinc coating. Conduit shall be formed with a continuous welded seam, with a uniform wall thickness, in minimum 10-foot lengths.
- C. Liquid-Tight Flexible Metal Conduit shall be plastic-jacketed, galvanized steel, "Sealtite" Type EF for general service areas or Type HC for high-temperature when used under raised floor or in air plenums. Conduit shall be UL listed.
- D. Non-Metallic Conduit shall be as follows:
 - 1. Schedule 40: Conduit shall be 90 degree Celsius, polyvinyl chloride in conformance with NEMA TC-2 and UL 651 requirements.
 - 2. Spacers used in duct bank installations shall be high impact plastic, interlocking bases, and intermediate type spacers. Place spacers between 6 and 10 feet apart.

2.2 RACEWAY FITTINGS

- A. Couplings and Thread Protectors. Each length of threaded conduit shall be provided complete from the manufacturer with a coupling on one end and a thread protector on the other. The thread protector shall have sufficient mechanical strength to protect the threads during normal handling and storage.
- B. Metal Conduit Fittings shall conform to the requirements of UL 514B where this standard applies. Galvanized steel fittings shall be used with steel conduit. Threaded fittings shall engage a minimum of five threads made up wrench-tight and be compatible with conduit. EMT fittings shall be compression type, UL approved for rain tight applications.

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RACEWAYS AND BOXES

- C. Liquid-Tight Flexible Conduit Fittings shall be galvanized steel, T&B 53XX series insulated throat, and shall bear the UL label. Die-cast malleable fittings are not acceptable.
- D. Non-Metallic Conduit Fittings shall be of same material and strength characteristics as the conduit and shall be solvent welded as recommended by manufacturer. End bells shall be plastic, high impact, tapered to fit. Where conduit transition from non-metallic to metallic is required, provide non-metallic female "terminal" adapter. Non-metallic "male" adapters are not acceptable.
- E. Bushings shall be provided for the termination of all conduits not terminated in hubs, couplings or insulated throat connectors. Grounding type insulated bushings with insulating inserts in metal housings shall be provided for conduit 1-1/4 inches and larger. Standard bushings shall be galvanized steel or malleable iron in all sizes.
- F. Locknuts. One interior and one exterior locknut shall be provided for all conduit terminations not provided with threaded hubs and couplings. Locknuts shall be designed to securely bond with the conduit to the box when tightened. Locknuts shall be so constructed that they will not be loosened by vibration.

2.3 CONDUIT BODIES

- A. Malleable iron conduit bodies shall be cast malleable iron with tensile strength meeting ASTM A 48, Class 30A requirements. Malleable conduit bodies shall be finished with an epoxy powder coating. Cover shall be malleable iron with captive screws.
- B. All conduit bodies' entrances shall be machined NPT threads with a smooth, rounded, internal conduit stop bushing.
- C. All conduit bodies shall be equipped with a sealed and gasketed cover. Cover shall be secured using stainless steel machine screws.
- D. Conduit bodies shall be manufactured by Crouse-Hinds, Appleton, or approved equal.

2.4 CONDUIT SUPPORTS

- A. Conduit supports shall be furnished and installed in accordance with other section of these specifications. Conduits shall be supported so that fittings are accessible. Support systems shall be limited to electrical conduits only.
- B. Hanger rods shall be 3/8-inch diameter galvanized threaded steel rods, minimum. Conduit racks over 18-inch wide, over one level, or supporting 2-inch RSC or larger, shall be 1/2-inch diameter rod minimum.
- C. Conduit Clamps. Conduits in single runs or groups of two shall be supported by steel clamps and clamp backs. They shall be galvanized malleable iron or approved equal cast ferrous metal for steel conduit or tubing.

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- D. Support Channels. Supports for banks of three or more conduits shall be constructed of formed steel support channels (Unistrut, Kindorf, Superstrut, B-Line or approved equal) with associated conduit or tubing clips. Support channels shall be steel, hot-dip galvanized after fabrication with galvanized steel clips for steel conduit or tubing.
- E. Wall Penetrations. All conduits, raceways, cables and sleeve penetrations through fire rated and hazardous location walls, shafts, floor, ceilings, etc., shall be sealed with a UL-approved fire stopping system, in accordance with specification Section 16060 – Basic Electrical Materials and Methods.

2.5 OUTLET BOXES AND SWITCH BOXES

- A. Manufacturers: Firms regularly engaged in the manufacturing of electrical raceways of the types and capacities required, whose products have been in satisfactory use in similar service for not less than 3 years.
- B. Sheet Metal Outlet Boxes: ANSI/NEMA OS 1, galvanized flat rolled sheet steel outlet wiring boxes of types, shapes and sizes, including box depths, to suit each respective location and installation; construct with stamped knockouts in back and sides, and with threaded screw holes with corrosion-resistant screws for securing box covers and wiring devices.
- C. Outlet boxes used in wet outdoor locations, surface mounted shall be cast metal (FS or FD type) with mounting lugs and gasketed covers.
- D. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported, per CEC requirements.
- E. Outlet Box Accessories: Provide outlet box accessories as required for each installation, including mounting brackets, wallboard hangers, extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, which are compatible with outlet boxes being used and meeting requirements of individual wiring situations.

2.6 PULL BOXES, JUNCTION BOXES, HANDHOLES AND MANHOLES

- A. Sheet Metal Boxes shall be NEMA OS 1, NEMA rating as indicated on drawings. Minimum 16 gauge galvanized steel construction with stainless steel hinged cover and neoprene gasket. Cover shall be secured to the body with a continuous, full length, piano type hinge and stainless steel pin on one side and captive screw on the other side. Door shall be equipped with padlock hasp with sealing hole provisions.
 - 1. Provide #10-32 tapped hole provisions for optional ground lug kit.
 - 2. Provide 0.375-16 collar studs for mounting optional panel.
 - 3. Provide external mounting feet for secure wall mounting.
 - 4. Finish: Wash and phosphate undercoat with ANSI 61 gray polyester powder finish.
- B. Surface-Mounted Cast Metal Box: NEMA 250, NEMA Type 3R or 4 as indicated, flat-flanged, surface-mounted junction box:

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1. Material: Cast Iron.
2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.

2.7 CLOSURE FOAM

- A. All conduit, raceways, cables and sleeves penetrations through fire rated and hazardous location walls, shafts, floor, ceilings, etc., shall be sealed by closure foam as in Dow Corning #3-6548 silicone RTV, GE RTV 850 silicone foam, or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify outlet locations and routing and termination locations of raceway prior to rough in.

3.2 INSTALLATION OF RACEWAYS

A. Routing

1. Install raceway and boxes in accordance with NECA "Standard of Installation."
2. Conduit routing shown on drawings is diagrammatic only. Contractor shall field route conduit and raceways between equipment and devices as required to obtain a complete wiring system.
3. Conduit shall not be exposed unless specifically mentioned on the drawings or accepted by the architect.
4. All exposed conduits shall be installed parallel or perpendicular to dominant surfaces with right-angle turns made of symmetrical bends or fittings.
5. Conduit shall not be installed on the outside face of exposed columns, but shall be routed on the web or on the inside of a flange of the column.
6. Except where prevented by the location of other work, a single conduit or a conduit group shall be centered on structural members.
7. Conduit shall be located at least 6 inches from hot water or steam pipes and from other hot surfaces

B. Moisture Pockets

1. Moisture pockets shall be eliminated from conduits. If water cannot drain to the natural opening in the conduit system, a hole shall be drilled in the bottom of a pull box or a "C-type" conduit fitting provided in the low point of the conduit run.

C. Couplings and Unions

1. Metal conduit shall be joined by threaded conduit couplings, with the conduit ends butted.

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2. The use of running threads, Erickson type couplings, split couplings or similar unions are not permitted.

D. Conduit Bodies

1. Conduit bends shall meet the requirements of CEC, minimum bend radius of the cable installed or as indicated on the drawings, whichever is greater.
2. Conduits or tubing deformed or crushed in any way shall be removed from the job site.

E. Bends and Offsets

1. Changes in direction of conduits shall be made with fittings or bends.
2. Conduit bends shall meet the requirements of CEC, minimum bend radius of the cable installed or as indicated on the drawings, whichever is greater.
3. Bends shall be made using appropriate tools or mechanical equipment. The use of a pipe tee or vise for bending conduit or tubing will not be permitted.
4. For non-metallic conduit or plastic coated steel, approved factory bends and offsets shall be used.
5. Conduits or tubing deformed or crushed in any way shall be removed from the job site.
6. Install no more than the equivalent of three 90 degree bends between boxes or outlets

F. Cutting and Threading

1. The plane of all conduit ends shall be square with the centerline.
2. Where threads are required, they shall be cut and cleaned prior to conduit reaming.
3. The ends of all conduit and tubing shall be reamed to remove all rough edges and burrs.
4. Cutting oil shall be used in threading operations; the dies shall be kept sharp, and provisions shall be made for chip clearance.
5. Threads on conduits and fittings shall be lubricated with conducting and sealing compound.
6. All steel conduits shall be coated after threading with cold-galvanized zinc coating. The Contractor shall supply this protective material and shall apply it in the field prior to installing conduit or fittings.

- G. All steel conduit, exposed to weather or in contact with earth, shall be re-galvanized after threading with "Galvanizing Powder M-321" as manufactured by the American Solder and Flux Company of Philadelphia, Pennsylvania; "Zincilate 810" as manufactured by Industrial Metal Protectives, Inc., of Dayton, Ohio; "Zinc Rich" coating as manufactured by ZRC Chemical Products Company, Quincy, Massachusetts; or approved equal. The Contractor shall supply this protective material and shall apply it in the field.

H. Connections to Boxes and Cabinets

1. Conduit shall be securely fastened to all boxes and cabinets.

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2. Threads on metallic conduit shall project through the wall of the box to allow the bushing to butt against the end of the conduit.
 3. The locknuts, both inside and outside, shall then be tightened sufficiently to bond the conduit securely to the box.
 4. Locknuts on connectors shall be tightened securely to bond the connectors.
- I. All conduits entering enclosures outdoors or in wet areas shall enter through Meyer's hubs, or approved equal, or threaded openings.
- J. Cleaning
1. Precautions shall be taken to prevent the accumulation of water, dirt, or concrete in the conduit.
 2. Conduit in which water or other foreign materials have been permitted to accumulate shall be thoroughly cleaned or, where such accumulation cannot be removed by methods acceptable to the Owner /Engineer, the conduit shall be replaced.
 3. For conduits sizes 3 inches and larger, draw a flexible testing mandrel approximately 12 inches long with a diameter less than the inside diameter of the conduit through the conduit. After which, draw a stiff bristle brush through until conduit is clear of particles of foreign materials. For conduits less than 3 inches, draw a stiff bristle brush through until conduit is clear of particles and foreign material.
- K. Empty Conduit
1. All conduits installed for future use shall have a polypropylene pull line with a minimum tensile strength of 200 lbs., Jet Line, Cat. No. 232, polyolefin, or approved equal. Pull line shall be secured at both ends to ensure future accessibility.
- L. Rooftop Conduits
1. Provide redwood sleepers on waterproof mastic base for all conduit runs exposed on roofs.
- M. Identification
1. All conduits shall be identified in accordance with other section of these specifications.
- N. Grounding
1. All conduits shall be grounded in accordance with specification Section 16050 – Basic Electrical Materials and Methods.
 2. A solid or stranded bare copper or green insulated copper solid or stranded ground wire shall be provided in all conduits and raceways.
- O. Galvanized Rigid Steel Conduit

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1. Galvanized rigid steel conduit shall be installed in areas exposed to weather, vehicle traffic, in hazardous classified areas, for penetrations through foundations, and 10 feet before transition from below grade to 8 feet above grade, unless otherwise noted on the drawings.
 2. Steel conduit in contact with earth shall be protected by "Scotchwrap" 10 mil tape applied in double thickness using 50 percent lap turns to 6 inches above grade and 6 inches beyond transition.
 3. Expansion joints shall be used where required.
- P. Polyvinyl Chloride (PVC) Coated Galvanized Rigid Steel Conduits and Intermediate Steel Conduit
1. PVC -coated, steel conduit and fittings shall be installed where highly corrosive conditions exist, indoors or outdoors.
 2. The Contractor shall patch any damaged coating according to the manufacturer's instructions.
- Q. Electrical Metallic Tubing
1. Electrical metallic tubing shall be installed for all circuits, indoors above concrete slab, where not subject to conditions outlined for rigid galvanized steel conduits.
- R. Liquid-Tight Flexible Metal Conduit
1. Liquid-tight flexible metal conduit shall be used in place of regular flexible conduit for connections to motors and transformers, in areas exposed to weather, moisture or oil, and under raised floors.
 2. Liquid-tight flexible metal conduit may be used in place of flexible metal conduit where not otherwise required.
- S. Non-Metallic Conduit
1. Schedule 40 shall be used for all power, signal feeders and branch circuits, in earth or enclosed in concrete, unless otherwise noted on the drawings. Conduits must be buried in earth in accordance with the CEC.
- T. Conduit Support
1. Fasten conduit supports to building structures and surfaces in accordance with Section 16050 – Basic Electrical Materials and Methods.
 2. Support raceway using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.
 3. Do not use wire, ceiling support wires or perforated pipe straps to support conduit. Remove any temporary installation support wire.
- U. Spacing of Supports
1. All conduit runs shall be rigidly supported, except where buried in concrete,.
 2. Each conduit shall be supported within one (1) foot of junction boxes and fittings.

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3. Spacers used in duct bank installations shall be placed no more than 6 to 10 feet apart.
4. Support spacing along conduit runs shall be as follows.

Conduit Size	Maximum Distance Between Supports
½ inch through 1-1/4 inch	5 feet
1-1/2 inch and larger	8 feet

- V. Ground and bond raceway and boxes in accordance with Section 16050 – Basic Electrical Materials and Methods.

3.3 CABINET AND BOX INSTALLATION

- A. Install electrical boxes as shown on drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.
- B. Locate boxes and conduit bodies so as to ensure ready accessibility of electrical wiring, maintain headroom and to present neat mechanical appearance.
- C. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only. In inaccessible ceiling areas, install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.
- D. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices with each other.
- E. Use flush mounting outlet boxes in finished areas.
 1. Do not install flush mounting boxes back-to-back in walls.
 2. Provide minimum 6-inch separation between adjacent boxes.
 3. Provide minimum 24-inch separation in acoustic rated walls.
 4. Use stamped steel bridges to fasten flush mounting outlet box between studs.
 5. Secure flush mounting box to interior wall and partition studs.
 6. Accurately position to allow for surface finish thickness.
 7. Install flush mounting box without damaging wall insulation or reducing its effectiveness.
 8. Use adjustable steel channel fasteners for hung ceiling outlet box.
- F. Support boxes independently of conduits.
- G. Use code sized gang box where more than one device is mounted together. Do not use sectional box. Use code sized gang box with plaster ring for single device outlets.
- H. Use cast outlet box in exterior locations where exposed to the weather and wet locations (interior or exterior).

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- I. Coordinate installation of electrical boxes and fittings with cable and raceway installation work. Provide knockout closures to cap unused knockout holes where blanks have been removed.
- J. Avoid using round boxes where conduit must enter box through side of box, which would result in difficult and insecure connections where fastened with a locknut or bushing on rounded surface.
- K. Fasten boxes rigidly to substrate or structural surfaces to which they are being mounted, or solidly embed electrical boxes in concrete or masonry as appropriate.
- L. Except as prevented by the location of other work, all junction boxes and outlet boxes shall be centered on structures.
- M. Conduit openings in boxes shall be made with a hole saw or shall be punched.
- N. Cabinets and boxes shall be rigidly mounted.
 - 1. Mounting on concrete shall be secured by self-drilling anchors.
 - 2. Mounting on steel shall be by drilled and tapped screw holes, or by special support channels welded to the steel, or by both.
 - 3. Cabinets shall be leveled and fastened to the mounting surface with not less than ¼-inch air space between the enclosure and mounting surface.
 - 4. All mounting holes in the enclosure shall be used.
- O. Large Pull Boxes - Boxes larger than 100 cubic inches in volume or 12 inches in any dimension.
 - 1. Interior Dry Locations - Use hinged enclosure.
 - 2. Other Locations - Use surface mounted box of appropriate location classification.

3.4 ANCHORS

- A. Where supports for raceways, boxes, and cabinets are mounted on concrete surfaces, they shall be fastened with self-drilling tubular expansion shell anchors with externally split expansion shells, single-cone expanders, and annular break-off grooved chucking cones. Anchors shall be Phillips "Red Head" or approved equal.

3.5 ADJUSTING

- A. Install knockout closures in unused openings in boxes.

3.6 CLEANING

- A. Clean interior of boxes to remove dust, debris, and other material.
- B. Clean exposed surfaces and restore manufacturer's finish.

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END OF SECTION 26 05 33

SECTION 26 05 44
SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

B. Related Requirements:

1. Division 07 Section "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. Sleeves for Rectangular Openings:

1. Material: Galvanized sheet steel.
2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches thickness shall be 0.052 inch.
 - b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

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2.2 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Advance Products & Systems, Inc.
 - b. CALPICO, Inc.
 - c. Metraflex Company (The).
 - d. Pipeline Seal and Insulator, Inc.
 - e. Proco Products, Inc.
 2. Sealing Elements: Nitrile (Buna N) rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 3. Pressure Plates: Carbon steel.
 4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Presealed Systems.

2.4 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

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SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

2.5 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
 - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
 - 2. Sealant shall have VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 3. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
 - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint.
 - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.
 - 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 - 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

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SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior/interior concrete walls and slabs-on-grade at raceway entries into building or as shown on drawings.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

- A. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- B. Secure nailing flanges to concrete forms.
- C. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 26 05 44

SECTION 26 05 48.16
SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Restraint channel bracings.
2. Restraint cables.
3. Seismic-restraint accessories.
4. Mechanical anchor bolts.
5. Adhesive anchor bolts.

- B. Related Requirements:

1. Section 260529 "Hangers and Supports for Electrical Systems" for commonly used electrical supports and installation requirements.

1.3 ACTION SUBMITTALS

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

1. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
 - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
 - b. Annotate to indicate application of each product submitted and compliance with requirements.

- B. Delegated-Design Submittal: For each seismic-restraint device.

1. Include design calculations and details for selecting seismic restraints complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
2. Design Calculations: Calculate static and dynamic loading caused by equipment weight, operation, and seismic forces required to select seismic restraints and for designing vibration isolation bases.

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- a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
- 3. Seismic Restraint Details:
 - a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
 - c. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints.
- B. Welding certificates.
- C. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Comply with seismic-restraint requirements in the CBC unless requirements in this Section are more stringent.
- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis. They shall bear anchorage preapproval from OSHPD in addition to preapproval, showing maximum seismic-restraint ratings, by ICC-ES or another agency acceptable to authorities having jurisdiction. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) that support seismic-restraint designs must be signed and sealed by a qualified professional engineer.
- D. Comply with CEC.

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SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

1. Building Classification Category: III.

B. Seismic-Restraint Loading:

1. Site Class as Defined in the CBC: D.
2. Assigned Seismic Use Group or Building Category as Defined in the CBC: III.
 - a. Component Importance Factor: 1.0.
 - b. Component Response Modification Factors:
 - 1) Panel boards, instrumentation cabinets: 6.0.
 - 2) Lighting fixtures: 1.5.
 - 3) Communication equipment: 2.5.
 - 4) Electrical conduit and cable trays: 6.0
 - c. Component Amplification Factors:
 - 1) Panel boards, instrumentation cabinets: 2.5.
 - 2) Lighting fixtures: 1.0.
 - 3) Communication equipment: 1.0.
 - 4) Electrical conduit and cable trays: 2.5
3. Design Spectral Response Acceleration at Short Periods (0.2 Second).
4. Design Spectral Response Acceleration at 1.0-Second Period.

2.2 RESTRAINT CHANNEL BRACINGS

- A. Description: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end, with other matching components, and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.3 RESTRAINT CABLES

- A. Restraint Cables: ASTM A 603 galvanized steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

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SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

2.4 SEISMIC-RESTRAINT ACCESSORIES

- A. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.
- B. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.
- C. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchor bolts and studs.
- D. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices used.
- E. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.5 MECHANICAL ANCHOR BOLTS

- A. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.6 ADHESIVE ANCHOR BOLTS

- A. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

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3.2 APPLICATIONS

- A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods caused by seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Equipment and Hanger Restraints:
 - 1. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
 - 2. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- B. Install cables so they do not bend across edges of adjacent equipment or building structure.
- C. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- D. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- E. Drilled-in Anchors:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - 4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of

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the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.

5. Set anchors to manufacturer's recommended torque using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where connection is terminated to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform the following tests and inspections:
 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
 5. Test to 90 percent of rated proof load of device.
- C. Seismic controls will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 26 05 48.16

SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. The extent of the electrical systems and equipment requiring identification is shown on the drawings, and the extent of identification required is specified herein and in individual sections of work requiring identification. The types of electrical identification specified in this section include the following:
1. Exposed conduit color banding.
 2. Cable/conductor identification.
 3. Operational instructions and warnings.
 4. Equipment/system identification signs.

1.2 REFERENCES - CODES AND STANDARDS

- A. ANSI Z535.1 - Safety Color Code
- B. APWA ULCC - Uniform Color Code for Buried Utilities.
- C. CEC California Electrical Code (CEC). Latest approved edition.

1.3 SYSTEM DESCRIPTION

- A. Label the following electrical equipment with nameplates which clearly identify each item, the function or use of the item, and the circuit identification of the feed to the item:
1. All transformers shall be identified by 1-inch high block letters cut in stencil and applied with yellow paint on a flat-black background. The transformer number, primary and secondary voltages, and the kVA shall be shown.
 2. All Distribution Panelboards, Power and Lighting Panels, Local Control Panels, Terminal Cabinets and all electrical equipment enclosure shall be identified using laminated plastic nameplates. The equipment number, voltage rating, current rating, number of phases, connection type, short circuit interrupting rating, and circuit number shall be shown
 3. All motors, starters, disconnect switches, Time Switches, Special Function Pushbuttons and Switches, and miscellaneous control devices shall be identified by function and circuit number, with 1/4-inch high black characters on a 1/2-inch wide white stick-on tape where installed indoors and engraved plastic nameplates where installed outdoors.
 4. All underground raceway or cable shall be marked with buried warning tape along its entire length.
 5. All exposed raceway longer than 10 feet in length shall be identified.

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IDENTIFICATION FOR ELECTRICAL SYSTEMS

6. Panelboard Directories: Furnish all panelboards with a complete typewritten directory mounted in the inner door under a clear plastic cover set in a metal frame.

B. Branch circuits and devices:

1. Label all individual receptacle outlets and light switches at their faceplate to indicate the panelboard of origin and branch circuit number, as shown on drawings. Labels shall be self adhesive, thermal machine printed type such as Brothers, Panduit, or T&B and shall be clear plastic with black lettering.
2. All branch circuits in outlet boxes shall be identified with circuit number using wrap-around labels (T&B, BRADY or 3M).
3. As an alternative to separate nameplates, device plates may be engraved directly with lettering filled with black enamel.

1.4 SUBMITTALS

- A. Catalog data for nameplates, labels, and markers.
- B. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under regulatory requirements. Include instructions for storage, handling, protection, examination, preparation and installation of product.

1.5 REGULATORY REQUIREMENTS

- A. Conform to requirements of CEC – California Electrical Code.
- B. Furnish products listed and classified by Underwriters' Laboratories, Inc. (UL), Electrical Testing Laboratories, Inc. (ETL), or other recognized, approved testing and listing agencies as suitable for the purpose specified and shown.

PART 2 - PRODUCTS

2.1 NAMEPLATES AND LABELS

A. Nameplates

1. Engraved three-layer laminated plastic, white letters on black background for normal power and white letters on red background for emergency power. Communications and control cabinets shall be labeled with white letters on green background.
2. Locations
 - a. Each electrical distribution board, panelboard and control equipment enclosure.

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IDENTIFICATION FOR ELECTRICAL SYSTEMS

b. Communication cabinets.

3. Letter Size

- a. Use 1/8-inch letters for identifying individual equipment and loads.
- b. Use 1/4-inch letters for identifying grouped equipment, loads, panelboards, and transfer switches.
- c. Use 1/2-inch letters for identifying the main switchboard, motor control centers, transformers and large distribution switchboards.

B. Labels

1. Embossed adhesive tape, with 3/16-inch white letters on colored background to match color scheme of plastic laminate labels in 2.1.1. Use only for identification of individual wall switches and receptacles, control device stations, and multi-outlet devices.
2. Thickness
 - a. 1/16-inch for units up to 20 square inches or 8-inch length; 1/8-inch for larger units.

2.2 WIRE MARKERS

A. Manufacturers

1. Brady
2. Thomas & Betts
3. 3-M Co.

B. Description: Cloth, tape, split sleeve, or tubing type wire markers, self-adhesive.

C. Locations: Each conductor at panelboard gutters, pull boxes, outlet and junction boxes, control panels, motor controllers and starters, and each load connection.

D. Legend

1. Power and Lighting Circuits: Branch circuit or feeder feed from.
2. Control Circuits: Control wire number indicated on shop drawings.
3. Neutral Conductors: Clearly indicate the branch circuit or feeder number the neutral serves. In multi-wire circuits where the neutral is shared, mark the neutral with the circuit number of the "A" phase.

2.3 CONDUIT MARKERS

A. Provide manufacturer's standard preprinted, flexible or semi-rigid, permanent, plastic-sheet conduit markers, minimum of 3 mils thick and 1-1/2-inch wide extending 360 degrees around conduits; designed for self-adhesive attachment to conduit. Except as otherwise indicated, provide lettering that indicates the voltage of the conductor(s) in

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IDENTIFICATION FOR ELECTRICAL SYSTEMS

the conduit. Provide 8-inch minimum length for 2-inch and smaller conduit, 12-inch minimum length for larger conduit.

- B. Location: Furnish markers for each conduit longer than 10 feet.
- C. Spacing: 20 feet on center.
- D. Color: Unless otherwise indicated or required by governing regulation, provide orange markers with black letters.
 - 1. Fire Alarm System: Red w/black letters.
 - 2. Telephone System: Green w/yellow letters.
 - 3. Data/Communication. System: White w/black letters.
 - 4. Emergency System: Orange w/black letters.
- E. Legend:
 - 1. 208 Volt System: Normal 208/120-volts.
 - 2. Fire Alarm System: Fire alarm.
 - 3. Telephone System: Telephone.
 - 4. Data/Communication System: Data/communications.

2.4 FASTENERS

- A. Secure all labels and nameplates with self-tapping stainless steel screws. Use contact type permanent adhesive where screws cannot or should not penetrate the substrate.

2.5 LETTERING AND GRAPHICS

- A. Coordinate names, abbreviations and other designations used in the electrical identification work, with the corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of the electrical systems and equipment.

2.6 UNDERGROUND WARNING TAPE

- A. Three-inch minimum width, 5 mil thickness, foil bonded polyethylene tape, detectable type, with suitable continuous warning legend describing buried electrical lines. Tape color shall conform to APWA uniform color code using ANSI Z535.1 safety colors. Text shall be black, 2-inch minimum letters.
- B. Identify underground conduits using underground warning tape. Install one tape per trench at 3 inches below finished grade.

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IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 3 - EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive nameplates and labels.
- B. Coordination: Where identification is to be applied to surfaces that require finish, install identification after completion of painting.
- C. Regulations: Comply with governing regulations and the requests of governing authorities for the identification of electrical work.

3.2 APPLICATION

- A. Install nameplate and label parallel to equipment lines.
- B. Secure nameplate to equipment front using screws, rivets, or adhesive.
- C. Secure nameplate to outside moveable surface of door on panelboard.
- D. Conduit Identification:
 - 1. Where electrical conduit is exposed in spaces with exposed mechanical piping, which is identified by a color-coded method, apply color-coded identification on the electrical conduit in a manner similar to the piping identification. Except as otherwise indicated, use orange as the coded color for conduit.
 - 2. Paint red band or provide red tape on each fire alarm conduit longer than 10 feet, minimum 20 feet on center.
- E. Cable/Conductor Identification:
 - 1. Apply cable/conductor identification on each cable and conductor in each box/enclosure/cabinet where the wires of more than one circuit or communication/signal system are present, except where another form of identification (such as color-coded conductors) is provided.
 - 2. Match identification with marking system used in panelboards, shop drawings, contract documents, and similar previously established identification for project electrical work.
- F. Operational Identification and Warnings
 - 1. Wherever reasonably required to ensure safe and efficient operation and maintenance of the electrical systems, and electrically connected mechanical systems and general systems and equipment, including the prevention of misuse of electrical facilities by unauthorized personnel, install self-adhesive plastic signs or similar equivalent identification, instruction or warnings on switches, outlets and other controls, devices and covers of electrical enclosures. Where detailed in-

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structions or explanations are needed, provide plasticized tags with clearly written messages adequate for the intended purposes.

END OF SECTION 260553

SECTION 26 09 43.19
WIRELESS-NETWORK LIGHTING CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. System Software Interfaces.
2. System Backbone and Integration Equipment.
3. Wireless Networked Devices.

B. Related Requirements:

1. Div. 26: Section 260000 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 DEFINITIONS

- A. Data Bus: A wired interface used to communicate with connected devices.
- B. Device: A collective term for bus or wireless connected devices, including fluorescent ballasts, LED drivers, incandescent luminaires, manual switches, switching relays, sensors, and similar.
- C. Global: Communication between devices in otherwise separate spaces using a bridging device or system controller.
- D. Group: A set of devices that communicate together.
- E. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.
- F. RF: Radio-frequency.
- G. Scene: Digital light level associated with a preset.
- H. System Backbone: Devices used to connect and manage otherwise separate spaces, including bridging devices and gateways or system controllers. Used to expose devices to software configuration via TCP/IP.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at 130 Avram Ave, Rohnert Park, Ca.

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WIRELESS-NETWORK LIGHTING CONTROLS

- B. Preinstallation Coordination Meeting(s): For digital-network lighting controls. Conduct meeting(s) at Project Site, 130 Avram Ave, Rohnert Park, Ca before final acceptance of installation.
1. Attendees: Installers, fabricators, representatives of manufacturers, and administrators for field tests and inspections.
 2. Engage factory-authorized service representative to attend preinstallation conference and review the submittal drawing, sequence of operation, and device installation best practices with the Project team.
 3. Engage factory-authorized service representative to perform cellular signal strength measurements during site walk through and compare to Project plans to verify the placement of cellular antennas and quantity of lighting control system RF access points.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Bill of Materials necessary to install the networked lighting control system.
2. Product Specification Sheets indicating general device descriptions, dimensions, electrical specifications, wiring details, and nomenclature.
3. Information Technology (IT) connection information pertaining to interconnection with facility IT networking equipment and third-party systems.
4. Other Diagrams and Operational Descriptions - as needed to indicate system operation or interaction with other system(s).

B. Shop Drawings:

1. Riser Diagrams showing device wiring connections of system backbone and typical per room/area type.

1.5 INFORMATIONAL SUBMITTALS

- A. Contractor Startup/Commissioning Worksheet.
- B. Service Specification Sheets indicating general service descriptions, including startup, training, post-startup support, and service contract terms.
- C. Field quality-control reports.
- D. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Contracts:

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WIRELESS-NETWORK LIGHTING CONTROLS

1. Hardware and Software Operation Manuals.
2. Maintenance service agreement.
3. Software service agreement.

B. Warranty documentation.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Phone Support: Toll-free technical support available from manufacturer through an online tool to schedule a technical support appointment and provide 24/7 emergency support.
2. Remote Support: Manufacturer capable of providing remote support and ability to virtually connect with customers to address issues with visual guidance overlaid on images of real-world objects.
3. Cellular Connectivity: Manufacturer capable of cellular connectivity to a networked lighting control system available to provide remote support within the continental United States.
4. On Site Support: Manufacturer capable of providing a 72-hour, onsite response time within the continental United States.
5. Service Contracts: Manufacturer capable of providing service contracts for continued onsite and remote support of the lighting control system post installation for terms up to 10 years from substantial completion, including:
 - a. Remote and on-site emergency response.
 - b. Remote system performance checks.
 - c. Remote diagnostics.
 - d. Replacement parts.

1.8 WARRANTY

A. Warranty: Manufacturer and Installer warrant that installed lighting control devices perform in accordance with specified requirements and agree to repair or replace, including labor, materials, and equipment, devices that fail to perform as specified within extended warranty period.

1. Failures include, but are not limited to, the following:
 - a. Faulty operation of lighting control hardware.
 - b. Faulty operation of lighting control firmware.
2. Minimum Warranty Period: Five years from date of shipment.
3. Extended Warranty Period: 2 year(s) from date of shipment.

SECTION 26 09 43.19
WIRELESS-NETWORK LIGHTING CONTROLS

PART 2 - PRODUCTS

2.1 SYSTEM COMPLIANCE

- A. System components manufactured in accordance with UL 916 and UL 924 standards where applicable.
- B. System components manufactured in accordance with CFR Title 47, Part 15 standards where applicable.
- C. System components manufactured in accordance with ISED Canada RSS-247 standards where applicable.
- D. System components manufactured in accordance with IFT-008-2015 and NOM-208-SCFI-2016 standards where applicable.
- E. System listed as qualified under DesignLights Consortium Networked Lighting Control System Specification v5.0.
- F. Performance Criteria:
 - 1. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 SYSTEM PERFORMANCE REQUIREMENTS

- A. System Architecture:
 - 1. System architecture based upon the following concepts:
 - a. Networkable intelligent lighting control devices.
 - b. Standalone lighting control zones using distributed intelligence.
 - c. Optional system backbone for remote, time-based, and global operation.
 - 2. Intelligent lighting control devices with individually addressable network communication capability and having one or more basic lighting control components including: occupancy sensor, photosensor, relay, dimming output, contact closure input, analog 0-10 V(dc) input, and manual wall station capable of indicating switching, dimming, and/or scene control. Combining one or more of these components into a single device enclosure permissible to minimize overall system device count.
 - 3. System capable of interfacing directly with networked luminaires such that either low-voltage network cabling or wireless RF communication is used to interconnect networked luminaires with control components such as sensors, switches, and system backbone.

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WIRELESS-NETWORK LIGHTING CONTROLS

4. Networked luminaires and intelligent lighting control devices support individual (unique) configuration of device settings and properties, with such configuration residing within the networked luminaires and intelligent control devices.
 5. Lighting control zones consisting of one or more networked luminaires and intelligent lighting control devices capable of providing automatic control from sensors (occupancy and/or photosensor) and manual control from local wall stations without requiring connection to a higher-level system backbone.
 - a. Lighting control zones support at least 128 devices per zone.
 - b. Capable of being networked with a higher-level system backbone to provide time-based control, control from inputs or systems external to control zone, and remote configuration and monitoring through a software interface.
 6. Networked luminaires and intelligent lighting control devices with distributed intelligence programming stored in non-volatile memory, such that following any loss of power the lighting control zones operate according to their defined default settings and sequence of operations.
 7. System to include one or more system controllers that provide time-based control.
 8. System controller provides means of connecting the lighting control system to a system software interface and building management systems (BMS) via BACnet/IP or BACnet MS/TP protocol.
 9. System controller supports both low-voltage wired and wireless RF communication within a single controller device.
 10. System devices support firmware update, either remotely or from within the application space, for purposes of upgrading functionality at a later date.
 11. System capable of reporting lighting system events and performance data to management software for display and analysis.
- B. Wireless Networked Control Zone Characteristics:
1. No wired connections between networked devices required for the purposes of system communications.
 2. Multiple wireless networking protocols supported:
 - a. Standards-based, distributed star topology type of protocol for 900 MHz communication, to support lighting control applications and IoT applications.
 - b. Bluetooth standard protocol for 2.4 GHz communication that supports direct connection to smartphone or tablet, to support device configuration, control applications, and IoT without requiring the use of a system backbone.
 3. Wireless network must be self-healing, such that the loss of backbone or local communication between devices does not result in the loss of local control of lights in the space.

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WIRELESS-NETWORK LIGHTING CONTROLS

4. Wireless network communication must support uniform and instant response such that all luminaires in a lighting control zone respond immediately and synchronously in response to a sensor or wall station signal.
5. Communication of control signals from sensors and wall stations to networked luminaires and wireless load-control devices occurs directly, without any communication, interpretation, or translation of information through a backbone device such as a wireless access point, communication bridge, or gateway.
6. All wireless communication between lighting control components supports the following five tiers of security measures.
 - a. Data encryption.
 - b. Firmware protection.
 - c. Tamper-proof hardware.
 - d. Authenticated user access.
 - e. Mutual device authentication.
7. Wireless devices use Advanced Encryption Standard (AES) encryption to secure communication with a unique encryption key generated for each programmed site.
8. Wireless devices use signed firmware to ensure that unmodified, authentic software is always installed.
9. Wireless networked devices capable of communicating a minimum distance of **150 ft. (45 m)** between devices under typical site conditions accounting for typical environmental conditions and building construction materials encountered within commercial indoor lighting environments.
10. Minimum Line-of-Sight Communication Range: **1000 ft. (304 m)** under ideal environmental conditions.
11. Wireless devices self-identify when communication to system controller cannot be accomplished or when communication to the system controller is lost.
 - a. Self-identification not required for wireless switches or battery-powered devices.
12. Wireless devices self-establish connection to system controller through other devices if direct communication cannot be accomplished or when communication to system controller is lost.
 - a. Communication path formation to utilize existing, wireless networked devices located between system controller and respective end devices.
 - b. No additional hardware for formation of networked communication path between a system controller and end devices required.
 - c. Automatic connection not required for wireless switches or battery-powered devices.
13. Networked control devices suitable for control of egress or emergency light sources without additional, externally mounted UL 924 shunting or 0-10 V(dc) disconnect devices, to provide a compliant sequence of operation while reducing the overall installation and wiring costs of the system. Capable of supporting the following sequence of operation:

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- a. Line-Voltage Power Sensing: Devices listed as UL 924 emergency relays that automatically close load-control relay and provide 100 percent light output upon detection of loss of power sensed via line voltage connection to normal power.
- b. Normal-Power-Broadcast Sensing: Devices listed as UL 924 emergency relays that automatically close load-control relay and provide 100 percent light output upon loss of a wireless normal-power broadcast from devices connected to normal power.

C. System Integration Capabilities:

- 1. Capable of interface with third-party BMS to support two-way communication using BACnet/IP protocol, BACnet MS/TP protocol, and RESTful API including the following system integration capabilities:
 - a. "Write" messages for control of individual devices, including control of relay and dimming output.
 - b. "Write" messages for control of groups of devices through a single command, including control of relay and dimming output of all devices.
 - c. "Read" messages for individual device status information.
 - 1) Available status will vary based on device type and capabilities, which may include relay state, dimming output, power measurement, occupancy sensor status, and photosensor light measurement.
 - d. "Read" messages for group status information for occupancy, relay state, and dimming output.
 - e. Activation of pre-defined system Global Profiles.
- 2. Activation of Global Profiles from third-party systems via dry contact closure output signals or digital commands via RS-232 or RS-485.
- 3. Activation of demand response levels from Demand Response Automation Servers (DRAS) via OpenADR 2.0a protocol.

D. Supported Sequence of Operations:

- 1. Control Zones:
 - a. Local Control Zones: Networked luminaires and intelligent lighting control devices installed in an area (also referred to as a group of devices) capable of transmitting and tracking occupancy sensor, photosensor, and manual switch information within at least 48 unique control zones to support different and reconfigurable sequences of operation within area. These will also be referred to as local control zones.
 - b. Adjacent Control Zones: Networked luminaires and intelligent lighting control devices capable of tracking occupancy broadcasts from adjacent zones. When this feature is enabled, luminaire output for a vacant zone will reduce to a configurable dimmed state if one or more adjacent zones are

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occupied. Luminaires will turn off when both primary and adjacent zones are vacant.

- c. Global Control Zones: Networked luminaires and intelligent lighting control devices located in different areas able to transmit and track information within at least 128 system-wide control zones to support required sequences of operation that may span across multiple areas. Occupancy, photosensor inhibit, and switch commands available across multiple controllers.
2. Wall Station Capabilities:
 - a. Wall stations support the following capabilities:
 - 1) On/Off of a local or global control zone.
 - 2) Continuous dimming control of light level of a local or global control zone.
 - b. Multi-Way Control: Multiple wall stations capable of controlling the same local or global control zones, to support "multi-way" switching and dimming control.
3. Occupancy Sensing Capabilities:
 - a. Occupancy sensors configurable to control a local or global zone.
 - b. Multiple occupancy sensors capable of controlling the same local or global zones. This capability combines occupancy sensing coverage from multiple sensors without consuming multiple control zones.
 - c. Occupancy sensing sequence of operation modes:
 - 1) On/Off Occupancy Sensing.
 - 2) Partial-On Occupancy Sensing.
 - 3) Partial-Off Occupancy Sensing.
 - 4) Vacancy Sensing (Manual-On/Automatic-Off).
 - d. On/Off, Partial-On, and Partial-Off Occupancy Sensing Modes Sequence of Operation:
 - 1) Occupancy automatically turn lights on to a designated level when occupancy is detected. Designated occupied light level support at least 100 dimming levels.
 - 2) Occupancy sensors automatically turn lights off or to a dimmed state (Partial-Off) when vacancy occurs or if sufficient daylight is detected. Designated unoccupied dim level support at least 100 dimming levels.
 - 3) System capable of combining Partial-Off and Full-Off operation by dimming lights to a designated level when vacant and turning the lights off completely after an additional time delay.

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- 4) Photosensor readings, if enabled in occupancy sensing control zone, automatically adjust light levels during occupied or unoccupied conditions as necessary.
 - 5) Wall station activation changes the dimming level or turns lights off as selected by the occupant. Lights optionally remain in this manually specified light level until the zone becomes vacant. Upon vacancy, normal sequence of operation resumes.
- e. Vacancy Sensing or Manual-On/Automatic-Off Mode Sequence of Operation:
- 1) Activation of a wall station is required turn lights on. System capable of programming the zone to turn on to either a designated light level or a previous user-set light level. Initially occupying the space without using a wall station must not result in lights turning on.
 - 2) Occupancy sensors automatically turn lights off or to a dimmed state (Partial-Off) when vacancy occurs or if sufficient daylight is detected. Designated unoccupied dim level support at least 100 dimming levels.
 - 3) System capable of dimming the lights when vacant and then turning the lights off completely after an additional time delay.
 - 4) System capable of an "automatic grace period" immediately following detection of vacancy, during which time any detected occupancy results in the lights reverting to the previous level. After the grace period has expired, the use of a wall station is required to turn lights on.
 - 5) Photosensor readings, if enabled in the Occupancy Sensing control zone, capable of automatically adjusting the light level during occupied or unoccupied conditions as necessary.
 - 6) Wall station interaction changes the dimming level or turns lights off as selected by occupant. Lights remain at manually specified light level until zone becomes vacant; normal sequence of operation resumes upon vacancy.
- f. Occupancy time delays before dimming or shutting off lights separately programmable for all control zones from 15 seconds to two hours.
4. Photosensor Sensing Capabilities (Automatic Daylight Sensing):
- a. Photosensor devices configurable to control a local zone.
 - b. Photosensor-Based Control:
 - 1) Continuous Dimming: Control zone automatically adjusts dimming output in response to photosensor readings, to maintain a minimum light level consisting of both electric light and daylight sources. Photosensor response configurable to adjust set point and dimming rates.
5. Schedule Capabilities:

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- a. System capable of time schedules for time-of-day to override devices including offsets from dusk and dawn.
 - b. System capable of providing a visible "blink warning" five minutes prior to the end of the schedule.
 - c. Wall stations may be programmed to provide timed extensions/overrides that turn the lights on for an additional time period.
 - 1) Timed override/extension duration programmable for each individual device, zone of devices, or customized group of devices, from five minutes to 12 hours.
6. Global Profile Capabilities:
- a. System capable of automatically modifying the sequence of operation for selected devices in response to any of the following:
 - 1) Time-of-day schedule.
 - 2) Contact closure input state.
 - 3) Manually triggered wired wall station input.
 - 4) RS-232/RS-485 command to wired input device.
 - 5) BACnet input command.
 - b. Global Profile Capabilities:
 - 1) Global Profiles stored within and executed from the system controller (via internal time clock). Dedicated software host or server is not required to be online to support automatic scheduling and/or operation of Global Profiles.
 - 2) Global Profile time-of-day schedules capable of recurrence settings including daily, specific days of week, every "n" number of days, weekly, monthly, and yearly. Lighting control global profile schedules support definition of start date, end date, end after "n" recurrences, or never ending.
 - 3) Daylight savings time adjustments capable of being performed automatically, if desired.
 - 4) Global Profile holiday schedules follow recurrent settings for specific U.S. holiday dates regardless if they always occur on a specific date or are determined by day/week of the month.
 - 5) Global Profiles capable of being scheduled to run according to timed offsets relative to sunrise or sunset. Sunrise/sunset times automatically derived from location information using an astronomical clock.
 - 6) Software management interface capable of displaying a graphic calendar view of profile schedules for each control zone.
 - 7) Global Profiles capable of manual activation directly from system controller, specially programmed wireless input devices, scene-capable wireless wall stations, and software management interface.
 - 8) Global Profiles selectable to apply to a single device, zone of devices, or customized group of devices.

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9) Global Profile Configurable Parameters:

- a) Fixture light level.
- b) Occupancy time delay.
- c) Response to occupancy sensors (including enabling/disabling response).
- d) Response to daylight sensors (including enabling/disabling response).
- e) Enabling/disabling of wall stations.

c. Local and Global Profiles backed up and stored on software's host server such that Profile backup can be applied to a replacement system controller or wireless wall station.

7. System supports automated demand response capabilities with automatic reduction of light level to at least three levels of demand response, configurable for each output device.

2.3 SYSTEM SOFTWARE INTERFACES:

A. Management Interface:

- 1. Web-based management interface for remote system control, live status monitoring, and configuration of lighting control settings and schedules.
- 2. Compatible with industry-standard web browser clients.
- 3. Minimum of 100 unique password-protected user accounts.
- 4. Minimum of three user permission levels: read-only, read and change settings, and full administrative system access.
- 5. Capable of restricting access for user accounts to specific devices within the system.
- 6. All system devices capable of being given user-defined names.
- 7. Device identification information displayed in the Management interface including:
 - a. Model number.
 - b. Model description.
 - c. Serial number or network ID.
 - d. Manufacturing date code.
 - e. Custom label.
 - f. Parent network device.
- 8. Management interface capable of displaying live status of a networked luminaire or intelligent control device including:
 - a. Luminaire on/off status.
 - b. Dim level.
 - c. Power consumption.
 - d. Device temperature.
 - e. Passive infrared (PIR) occupancy sensor status.

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- f. Microphonic occupancy sensor status.
 - g. Remaining occupancy time delay.
 - h. Photosensor reading.
 - i. Active Profiles.
9. Management interface capable of displaying and modifying the current active settings of a networked luminaire or intelligent control device including:
- a. Dimming trim levels.
 - b. Occupancy sensor and photosensor enable/disable.
 - c. Occupancy sensor time delay and light level settings.
 - d. Occupancy sensor response (normal or vacancy).
 - e. Photosensor setpoints and transition time delays.
10. Management interface capable of applying settings changes for a zone of devices or a group of selected devices using a single action that does not require the user to apply settings changes for each individual device.
11. Management interface capable of compiling a printable network inventory report.
12. Management interface capable of compiling a printable report detailing all system profiles.
13. All sensitive information stored encrypted.
14. System software updates available for automatic download and installation via the Internet.
- B. System Energy Analysis and Reporting:
1. Intuitive graphical screens to facilitate simple viewing of system energy performance.
 2. Energy Scorecard: Summarized display that indicates calculated energy savings in dollars or KWh.
 3. Software calculates allocation of energy savings by control measures including occupancy sensors, photosensors, and manual switching.
 4. Energy savings data calculated for the system as a whole.
 5. Time-scaled graph showing all relay transitions.
 6. Time-scaled graph showing zone occupancy time delays.
 7. Time-scaled graph showing the total light level.
 8. Software capable of storing information remotely onto an open-source, object-relational database, such as PostgreSQL.
 9. Data stored in the database will be accessed utilizing an open standard, application programming interface, such as Open Database Connectivity (ODBC).
- C. Visualization and Programming Interfaces
1. System provides an optional web-based visualization interface that displays a graphical floor plan.
 2. Graphical floor plan will offer the following types of system visualization:

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- a. Full Device Option: Master graphic of entire building, by floor, showing each control device installed with zones outlined including:
 - 1) Controls embedded light fixtures.
 - 2) Controls devices not embedded in light fixtures.
 - 3) Daylight sensors.
 - 4) Occupancy sensors.
 - 5) Wall switches and dimmers.
 - 6) Scene controllers.
 - 7) Networked relays.
 - 8) System Controllers.
 - 9) Group outlines.
 - b. Group-Only Option: Master graphic of the entire building, by floor, showing only control groups outlined.
 - c. Pan and zoom commands supported to allow smaller areas to be displayed on a larger scale simply by panning and zooming each floor's master graphic.
 - d. Selecting any control device displays the following as applicable:
 - 1) Device catalog number.
 - 2) Device name and custom label.
 - 3) Device diagnostic information.
 - 4) Link to further information on device including status or current configuration.
3. Programming capabilities through the application will include the following:
- a. Switch, occupancy sensor, and photosensor zone configuration.
 - b. Manual-on or automatic-on modes.
 - c. Turn-on and dim to dimming levels.
 - d. Occupancy sensor time delays and PIR sensitivity.
 - e. Dual-technology occupancy sensor sensitivity.
 - f. Photosensor calibration adjustment and auto-setpoint.
 - g. Multiple photosensor zone offset.
 - h. Trim level settings.
 - i. Preset scene creation and copy for scene-capable devices.
 - j. Application of custom device labels to the Bluetooth Low Energy Programming Devices and individual connected lighting control devices.
 - k. Fade rate settings.
- D. Smartphone Programming Interface for Wireless Devices:
1. Interface provided for both Apple iOS and Android operating systems that allows configuration of lighting control settings.
 2. Application supports configuration of wireless networked control devices.
 - a. Application access granted with valid user name and password.

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- b. Access to program information governed by permission system that allows users to share access with other users and restrict access to those who should not be able to reconfigure the equipment.
 - c. Indication of signal strength where multiple Bluetooth Low-Energy Programming Devices are available for configuration.
3. Programming Capabilities:
- a. Switch, occupancy sensor, and photosensor group configuration.
 - b. Manual-on or automatic-on modes.
 - c. Turn-on and dim to dimming levels.
 - d. Occupancy sensor time delays and PIR sensitivity.
 - e. Dual-technology occupancy sensor sensitivity.
 - f. Photosensor calibration adjustment and auto-setpoint.
 - g. Multiple photosensor zone offset.
 - h. Trim level settings.
 - i. Preset scene creation.
 - j. Application of custom device labels for individual connected lighting control devices.
 - k. Fade rate settings.

2.4 SYSTEM BACKBONE AND SYSTEM INTEGRATION EQUIPMENT:

- A. System Controller: Multi-tasking, real-time digital control processor consisting of modular hardware with plug-in enclosed processors, communication controllers, and power supplies.
- 1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; nECY or comparable product by one of the following:
 - a. [Cooper Industries, Inc.](#)
 - b. [Leviton Manufacturing Co., Inc.](#)
 - 2. System Controller Processor: 32-bit microprocessor operating at a minimum of 1 GHz.
 - 3. System Controller Memory: Minimum of 512MB memory, with a minimum of 4GB non-volatile flash, to support operating system and databases.
 - 4. System Controller Functions:
 - a. Time-based control of downstream wireless network devices.
 - b. Linking into an Ethernet network.
 - c. Integration with BMS and Heating, Ventilation and Air Conditioning (HVAC) equipment.
 - d. Connection to various software interfaces, including management interface, historical database and analytics interface, and visualization interface.
 - 5. Integral web server to support system controller configuration and diagnostics with control and visualization of connected devices.

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- a. Web Server Control Interface:
 - 1) Display associated devices within the context of a graphical floor plan.
 - 2) Provide control of output-capable devices through virtual sliders, toggle buttons, preset level widgets, and transparent layers on floor plan.
 - 3) Control Capabilities:
 - a) Control of individual output devices, including control of relay state and analog dimming level where applicable.
 - b) Control of local lighting control zones, including control of relay state and analog dimming level where applicable.
 - c) Control of global lighting control zones, including control of relay state and analog dimming level where applicable.
 - d) Control of Global Profiles.

- b. Visualization Interface:
 - 1) Customizable display with the ability to superimpose colored, transparent layers representing real-time property values, including occupancy status, dimming level status, light level status, and online or offline status where applicable.
 - 2) Ad hoc display of trended information via an intuitive values-over-time graph.
 - 3) Report Creation:
 - a) Reports accept and graphically display trended status datasets for creator-selected devices or zones of devices.
 - b) Report information displayed over a user-defined interval and date range.
 - c) Reports exportable to a standard comma-separated values (CSV) format.

6. Graphical touch screen to support configuration and diagnostics.
7. Minimum of three RJ-45 networked lighting control ports for connection to any of the following:
 - a. Graphical touch screen.
 - b. Direct connection to networked luminaires and intelligent lighting control devices (up to 128 total devices per port).

8. Device will automatically detect all network-connected devices.
9. Capable of managing and operating a minimum of 750 networked devices per system controller.
10. Multiple System Controllers capable of connection via local area network (LAN) for scalability to a minimum of 20,000 networked devices.
11. Supports BACnet/IP and BACnet MS/TP protocols to directly interface with BMS and HVAC equipment without additional protocol translation gateways.

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- a. BACnet MS/TP Connection Speed: 9600 to 115200 baud rate.
 - b. BACnet Testing Laboratory (BTL listed) using Device Profile BACnet Building Controller (B-BC) with outlined enhanced features.
12. Integral FIPS 140-2, Level 1 cryptographic module.
 13. Supports RESTful API for control of BACnet objects, user management, date and time, and file management.
 14. NEMA 1 enclosure with Class 1 and Class 2 separation.
 - a. Power Supply Voltage: 120 to 277 V(ac).
 15. Automatic algorithm to eliminate redundant, wireless networked paths to streamline communication between the system controller and end devices.
 16. System Controller Security Provisions:
 - a. Disallow the use of default passwords and require passwords to be updated prior to use.
 - b. Support user role-based access, such as administrator, user, and viewer.
 - c. Signed firmware to ensure that unmodified, authentic software is always installed.
 - d. IP-based communication protected with strong encryption algorithms such as AES or TLS1.2+.
 - e. Prevent rollback of firmware to firmware versions with known, critical vulnerabilities.
 - f. Valid cybersecurity listing through a third party.
 17. Cellular Remote Access: Cellular router and modem for remote access.
 - a. Router supports remote access to at least five system controllers on its LAN or network subnet.
 - b. Remote access capable of device setting updates, schedule updates, system performance optimization, and diagnostics.
 - c. Remote access enabled through outbound communication from router to an outside source. Solutions that begin communication via inbound requests for network access are unacceptable.
 - d. Router supports outbound communication to manufacturer-hosted portal using TLS1.2 or greater in-transit encryption over a cellular or Ethernet connection.
 - e. Router with integral firewall to prevent unauthorized access to devices connected to its LAN port.
 - f. Router includes cellular SIM capable of connection to AT&T, T-Mobile, Sprint, US Cellular, Alaska Wireless, Telefonica, Tellus, Bell, or Sasktel networks where carrier service is available.
 - g. Outbound communication from the router limited to whitelisted endpoints. Devices that allow unrestricted communication are unacceptable.
 - h. Outbound communication from router includes only lighting control system information.

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2.5 WIRELESS NETWORKED DEVICES:

A. Wireless Networked Wall Switches, Dimmers:

1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; rPOD series or comparable product by one of the following:
 - a. [Cooper Industries, Inc.](#)
 - b. [Leviton Manufacturing Co., Inc.](#)
2. Mounting: Suitable for installation in single-gang switch box.
3. Wireless Communication:
 - 1) Dual 900 MHz IEEE 802.15.4 based and 2.4 GHz, Version 4.0+ Bluetooth.
 - 2) Security: AES-128 bit.
4. Power Supply: Battery powered with 10 year minimum expected battery life.
5. Mechanical push buttons provide tactile and LED user feedback during button press.
6. Mechanical push buttons available with custom button labeling.
7. Wall Switches and Dimmer Options:
 - a. Number of Control Zones: 2.
 - b. Control Types Supported: On/Off and On/Off/Dimming.
8. Scene Switch Options:
 - a. Number of Scenes: 2.
 - b. Control Types Supported: On/Off, On/Off/Dimming, and Preset Level Scene Type.
9. Color: White.

B. Wireless Networked Embedded Fixture Control Devices:

1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; rIO or comparable product by one of the following:
 - a. [Cooper Industries, Inc.](#)
 - b. [Leviton Manufacturing Co., Inc.](#)
2. Wireless Communication:
 - a. Dual 900 MHz IEEE 802.15.4 based and 2.4 GHz, Version 4.0+ Bluetooth.
 - b. Security: AES-128 bit.

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3. Power Supply: Standard low-voltage wiring typically associated with an LED driver.
4. Suitable for installation within a luminaire such that the control device is not visible on the luminaire face.
5. Devices available with integrated and remote antennas such that devices can be installed within sealed container without detriment to wireless strength.
6. Antenna Color: White.
7. Dimming Output: 0-10v.
8. Power loss detection, where unit powers and controls the emergency circuit. Loss of wireless broadcasts from a dedicated normal-power-connected device forces unit to shunt closed, go to full bright, and ignore all system commands until main power is restored.

C. Wireless Networked Indoor Load Controller with Occupancy and Photosensors:

1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; rLSXR or comparable product by one of the following:
 - a. [Cooper Industries, Inc.](#)
 - b. [Leviton Manufacturing Co., Inc.](#)
2. Wireless Communication:
 - a. Dual 900 MHz IEEE 802.15.4 based and 2.4 GHz, Version 4.0+ Bluetooth.
 - b. Security: AES-128 bit.
3. Detects the presence of human activity within space and fully control the on/off function of lights.
4. Utilizes PIR technology, which detects occupant motion, to initially turn lights on from an off state, thus preventing false on conditions. Ultrasonic and Microwave-based sensing technologies are unacceptable.
5. Dual-technology sensors used in locations where a second method of sensing is necessary to adequately detect maintained occupancy (such as in rooms with obstructions).
6. Dual-technology sensors must have one sensing technology not motion dependent to detect occupancy. Acceptable dual technology includes PIR/Microphonics (also known as Passive Dual Technology or PDT), which detects both occupant motion and sounds indicating occupants. Sensors where both technologies detect motion (PIR/Ultrasonic) are unacceptable.
7. All sensing technologies are acoustically passive, meaning they do not transmit sound waves of any frequency (for example in the Ultrasonic range), as these technologies have the potential for interference with other electronic devices within the space (such as electronic white board readers and hearing devices). Acceptable detection technologies include PIR and/or Microphonic technology. Ultrasonic and Microwave-based sensing technologies are unacceptable.
8. Sensor programming parameters available and configurable remotely.
9. Ceiling-, fixture-, and junction-box-mounted sensors available, with multiple lens options available customized for specific applications.

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10. Dry Contact Output: One integrated dry contact switching relay, capable of switching 100 mA at 24 V, resistive only.
11. Integral daylight photosensor for programmable daylight harvesting.
12. Photosensor includes adjustable illumination set point and dead band to prevent the artificial light from cycling. Set point and dead band capable of automatically calibrating through an "Automatic Set-Point Programming" procedure. Min and max dimming settings and set point may be manually entered or modified.
13. Dead-band setting verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).
14. Power loss detection, where unit powers and controls the emergency circuit. Loss of wireless broadcasts from a dedicated normal-power-connected device forces unit to shunt closed, go to full bright, and ignore all system commands until main power is restored.
15. Power Monitoring: Integral current measurements on output with 3 percent accuracy when measuring loads 225 mA or greater.

D. Wireless Networked Indoor Occupancy and Photosensors:

1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.
2. Wireless Communication:
 - a. Dual 900 MHz IEEE 802.15.4 based and 2.4 GHz, Version 4.0+ Bluetooth.
 - b. Security: AES-128 bit.
3. Detects the presence of human activity within space and fully control the on/off function of lights.
4. Utilizes PIR technology, which detects occupant motion, to initially turn lights on from an off state, thus preventing false on conditions. Ultrasonic and Microwave-based sensing technologies are unacceptable.
5. Dual-technology sensors used in locations where a second method of sensing is necessary to adequately detect maintained occupancy (such as in rooms with obstructions).
6. Dual-technology sensors must have one sensing technology not motion dependent to detect occupancy. Acceptable dual technology includes PIR/Microphonics (also known as PDT, which detects both occupant motion and sounds indicating occupants. Sensors where both technologies detect motion (PIR/Ultrasonic) are unacceptable.
7. All sensing technologies acoustically passive, meaning they do not transmit sound waves of any frequency (for example in the Ultrasonic range), as these technologies have the potential for interference with other electronic devices within the space (such as electronic white board readers and hearing devices). Acceptable detection technologies include PIR and/or Microphonic technology. Ultrasonic and Microwave-based sensing technologies are unacceptable.
8. Sensor programming parameters available and configurable remotely.
9. Ceiling-, fixture-, and junction-box-mounted sensors available, with multiple lens options available customized for specific applications.

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10. Dry Contact Output: One integrated dry contact switching relay, capable of switching 100 mA at 24 V, resistive only.
11. Integral daylight photosensor for programmable daylight harvesting.
12. Photosensor includes adjustable illumination set point and dead band to prevent the artificial light from cycling. Set point and dead band capable of automatically calibrating through an "Automatic Set-Point Programming" procedure. Min and max dimming settings and set point may be manually entered or modified.
13. Dead-band setting verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).

E. Wireless Networked Indoor Embedded Sensors:

1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.
2. Wireless Communication:
 - a. Dual 900 MHz IEEE 802.15.4 based and 2.4 GHz, Version 4.0+ Bluetooth.
 - b. Security: AES-128 bit.
3. Sensors consisting of occupancy sensors and dimming photosensor suitable for installation within a luminaire such that only the lens is visible on luminaire face.
4. Power Supply: Standard low-voltage wiring typically associated with an LED driver.
5. Devices available with integrated and remote antennas such that devices can be installed within sealed container without detriment to wireless strength.
6. Antenna Color: White.
7. Dimming Output: 0-10v.
8. Detects the presence of human activity within space and fully control the on/off function of lights.
9. Utilizes PIR technology, which detects occupant motion, to initially turn lights on from an off state, thus preventing false on conditions. Ultrasonic and Microwave-based sensing technologies are unacceptable.
10. Sensors detect valid communication and blink a unique LED pattern to visually indicate a potential issue.
11. Sensor programming parameters available and configurable remotely.
12. Available with multiple lens options available for various mounting heights.
13. Integral daylight photosensor for programmable daylight harvesting.
14. Photosensor includes adjustable illumination set point and dead band to prevent artificial light from cycling. Set point and dead band capable of automatically calibrating through an "Automatic Set-Point Programming" procedure. Min and max dimming settings and set point may be manually entered or modified.
15. Dead-band setting verified and modified by sensor automatically every time lights cycle to accommodate physical changes in space (i.e., furniture layouts, lamp depreciation, or lamp outages).
16. Power loss detection, where unit powers and controls the emergency circuit. Loss of wireless broadcasts from a dedicated normal-power-connected device forces unit to shunt closed, go to full bright, and ignore all system commands until main power is restored.

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F. Wireless Networked Power Packs:

1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.; rPP series or comparable product by one of the following:
 - a. [Cooper Industries, Inc.](#)
 - b. [Leviton Manufacturing Co., Inc.](#)
2. Wireless Communication:
 - a. Dual 900 MHz IEEE 802.15.4 based and 2.4 GHz, Version 4.0+ Bluetooth.
 - b. Security: AES-128 bit.
3. Plenum rated.
4. Supply Voltage: 120 to 277 V(ac).
5. Relay Output: Class 1 relay rated for 20 A and 1.5 HP at 120 to 277 V(ac) and 5 A and 0.5 HP at 480 V(ac).
6. Dimming Output: 0-10 V(dc) dimming output.
7. Sink Current: 150 mA at 0-10 V(dc).
8. Antenna Type: Integrated.
9. Programming parameters available and configurable remotely.
10. Mounting: Integral **1/2-inch (16-mm)** chase nipple. Plastic clips into junction box are unacceptable.
11. Power Pack Options:
 - a. Power Pack capable of full 20-Amp switching of all normal power lighting load types, with optional 0-10V dimming output capable of up to 150mA of sink current.
 - b. Power Packs capable of full 20-Amp switching of general purpose receptacle (plug-load) control.
 - c. Listing: UL 924 for control of emergency lighting circuits, field configurable for two distinct sequence of operation:
 - 1) Power sense of normal power feed, where unit powers and controls emergency circuit, and loss of the normal power sense circuit forces the power pack to shunt closed, go to full bright, and ignore all system commands until normal power is restored.
 - 2) Power loss detection, where unit powers and controls the emergency circuit. Loss of wireless broadcasts from a dedicated normal-power-connected device forces unit to shunt closed, go to full bright, and ignore all system commands until main power is restored.

G. Wireless Networked Communication Adapter:

1. Basis-of-Design Product: Subject to compliance with requirements, provide nLight; Acuity Brands Lighting, Inc.
2. Wireless Communication:
 - a. Dual 900 MHz IEEE 802.15.4 based and 2.4 GHz, Version 4.0+ Bluetooth.

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- b. Security: AES-128 bit.
- 3. Capable of supporting a minimum of 750 networked wireless devices per adapter.
- 4. Interface: USB connection.
- 5. Ingress Protection: Minimum IP66.
- 6. Mounting: Integral 1/2-inch (16-mm) chase nipple. Minimum 16 ft. (4.8 m) USB cable and optional cable extenders for remote mounting.

PART 3 - EXECUTION

3.1 INSTALLATION OF WIRING

- A. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260523 "Control-Voltage Electrical Power Cables." Minimum conduit size is 1/2 inch (13 mm).
 - 1. Comply with requirements for cable trays specified in Section 260536 "Cable Trays for Electrical Systems."
 - 2. Comply with requirements for raceways and boxes specified in Section 260533.13 "Conduits for Electrical Systems," and Section 260533.16 "Boxes and Covers for Electrical Systems,"
- B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.2 IDENTIFICATION

- A. Identify system components, wiring, cabling, boxes, cabinets, and terminals. Comply with identification requirements specified in Section 260553 "Identification for Electrical Systems."
- B. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with Section 260553 "Identification for Electrical Systems."
- C. Identify all controls with device address.
- D. Label each device cable within 6 inch (152 mm) of connection to bus power supply or termination block.

3.3 FIELD QUALITY CONTROL

- A. Acceptance Testing Preparation:
 - 1. Test continuity of each circuit.

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- B. Field tests and inspections must be witnessed by authorities having jurisdiction City of Rohnert Park.
- C. Tests and Inspections: Engage a factory-authorized service representative to perform field test report.
 - 1. Test each zone using local and remote control hardware.
 - 2. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
- D. Nonconforming Work:
 - 1. Lighting controls will be considered defective if they do not pass tests and inspections.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- E. Field Test Reports: Engage a factory-authorized service representative to perform field test reports.
 - 1. Prepare functionality and inspection reports, including a certified report that identifies controls included and describes test results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.
 - 2. Include list of all points created from actual tests of all addressed control points for lamps, ballasts, manual controls, and sensors.

3.4 REMOTE ACCESS

- A. Digital network lighting control system capable of remote access by manufacturer with the following features:
 - 1. System diagnostics including detection of fault condition in hardware or connected devices.
 - 2. Access to all connected devices for complete programming including scheduling of time-of-day events and device parameters necessary to meet required sequence of operations.
 - 3. Browser-based interface to verify system functionality.
 - 4. On-demand access to manufacturer technical support for remote troubleshooting, diagnostics, configuration, and programming.
 - 5. Owner training on the digital network lighting control system available remotely.
- B. Remote access system fully functional over commercial cellular connection or Internet-connected Ethernet network.
- C. All hardware associated with remote access including cellular modem and cellular antenna are to remain on-site regardless of warranty or cellular contract status.

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3.5 SYSTEM STARTUP

A. Perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's published instructions.
2. Activate luminaires and verify that all maximum output levels match output levels detailed in an Owner-approved sequence of operations.
3. Confirm correct communications wiring, initiate communications between control devices and controller/gateways, and program the lighting control system in accordance with approved configuration schedules, time-of-day schedules, and input override assignments.
4. Program network devices to meet required sequence of operations.
5. Program and verify all sequence of operations.
6. Create backup of system programming.
7. Assist in installation of system software on customer-provided workstation or server.
8. Verify bidirectional communication of manufacturer-provided cellular router with manufacturer-managed remote access portal.
9. Commissioning Walkthrough: Engage factory-authorized service representative to collaborate with third-party commissioning agent to demonstrate lighting control system functionality and verify the system meets the specified Project requirements.

3.6 CLOSEOUT ACTIVITIES

- A. Enhanced Documentation: Engage lighting system manufacturer to provide comprehensive system documentation including detailed programming, sequence of operation data per Project specifications, and related code requirements.
- B. Training: Engage lighting system manufacturer to provide comprehensive system overview, software overview, and documentation relating to system operation and maintenance.

3.7 PROTECTION

- A. After installation, protect digital network lighting controls from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.8 MAINTENANCE

- A. Engage a factory-authorized service representative to perform on-site system adjustments.

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1. On-Site Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site settings adjustments to suit actual occupied conditions. Provide up to 2 visits to Project during other-than-normal occupancy hours for this purpose.
 2. Prepare and submit report after each visit that details activities performed.
- B. Engage a factory-authorized service representative to perform remote system adjustments.
1. Remote Occupancy Adjustments: When requested within 12 months from date of Substantial Completion and project registration with lighting control system manufacturer, provide remote settings adjustments to suit actual occupied conditions. Provide up to 2 sessions to Project during other-than-normal occupancy hours for this purpose.
 2. Prepare and submit report after each session that details activities performed.
- C. Maintenance Service Agreement:
1. Beginning at Substantial Completion, verify that maintenance service agreement includes 12 months' full maintenance by manufacturer's authorized service representative.
 2. Preventative maintenance to include:
 - a. System diagnostic reports.
 - b. System performance checks.
 - c. Device firmware updates.
 - d. Programming adjustment as required for proper lighting system operation.
 - e. Expedited factory direct warranty processing, replacement, and programming of defective components.
 3. Verify that parts and supplies are manufacturer's authorized replacement parts and supplies.

END OF SECTION 260943.19

SECTION 26 51 19
LED INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes the following types of LED luminaires:
 - 1. Cylinder.
 - 2. Downlight.
 - 3. Lowbay.
 - 4. Strip light.
 - 5. Surface mount, linear.
 - 6. Surface mount, nonlinear.
 - 7. Suspended, linear.
 - 8. Suspended, nonlinear.
 - 9. Materials.
 - 10. Finishes.
 - 11. Luminaire support.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. LED: Light-emitting diode.
- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

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

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1. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaires.
4. Include emergency lighting units, including batteries and chargers.
5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
6. Photometric data and adjustment factors based on laboratory tests, complying with IES Lighting Measurements Testing and Calculation Guides, of each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project.

- a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing laboratory providing photometric data for luminaires.
- B. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Product Certificates: For each type of luminaire.
- D. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.
- E. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
 1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

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1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Lamps: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
 - 2. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
 - 3. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
- B. Provide luminaires from a single manufacturer for each luminaire type.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.10 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
- B. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE 7.
 - 1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."

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2.2 LUMINAIRE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Standards:
 - 1. ENERGY STAR certified.
 - 2. California Title 24 compliant.
 - 3. UL Listing: Listed for damp location.
 - 4. Recessed luminaires shall comply with NEMA LE 4.
 - 5. User Replaceable Lamps:
 - a. Bulb shape complying with ANSI C78.79.
 - b. Lamp base complying with ANSI C81.61.
- C. CRI of minimum 80. CCT of 4000 K or as shown on the Lighting Fixture Schedule
- D. Rated lamp life of 35,000 hours to L70.
- E. Lamps dimmable from 100 percent to 0 percent of maximum light output.
- F. Internal driver.
- G.
 - 1. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.
- H. Housings:
 - 1. Extruded-aluminum housing and heat sink.
 - 2. Clear, anodized, or powder-coat painted finish.

2.3 CYLINDER

- A. Manufacturer and model as listed on the Lighting Fixture Schedule.
- B. With integral mounting provisions.

2.4 DOWNLIGHT

- A. Manufacturer and model as listed on the Lighting Fixture Schedule.
- B. Universal mounting bracket.
- C. Integral junction box with conduit fittings.

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D. Optics:

1. Fixed or Adjustable lens as scheduled.
2. Spot, Medium, or Wide light distribution as scheduled.

2.5 LOWBAY

- A. Manufacturer and model as listed on the Lighting Fixture Schedule.
- B. Universal mounting bracket.

2.6 STRIP LIGHT

- A. Manufacturer and model as listed on the Lighting Fixture Schedule.
- B. Integral junction box with conduit fittings.

2.7 SURFACE MOUNT, LINEAR

- A. Manufacturer and model as listed on the Lighting Fixture Schedule.
- B. Integral junction box with conduit fittings.

2.8 SURFACE MOUNT, NONLINEAR

- A. Manufacturer and model as listed on the Lighting Fixture Schedule.
- B. Integral junction box with conduit fittings.

2.9 SUSPENDED, LINEAR

- A. Manufacturer and model as listed on the Lighting Fixture Schedule.

2.10 SUSPENDED, NONLINEAR

- A. Manufacturer and model as listed on the Lighting Fixture Schedule.
- B. Integral junction box with conduit fittings.

2.11 MATERIALS

- A. Metal Parts:

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1. Free of burrs and sharp corners and edges.
 2. Sheet metal components shall be steel unless otherwise indicated.
 3. Form and support to prevent warping and sagging.
- B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- C. Diffusers and Globes:
1. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 2. Glass: Annealed crystal glass unless otherwise indicated.
 3. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.
- D. Housings:
1. Extruded-aluminum housing and heat sink.
 2. Clear, anodized, or powder-coat painted finish.
- E. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
1. Label shall include the following lamp characteristics:
 - a. "USE ONLY" and include specific lamp type.
 - b. Lamp diameter, shape, size, wattage, and coating.
 - c. CCT and CRI for all luminaires.

2.12 METAL FINISHES

- A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.13 LUMINAIRE SUPPORT

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).

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- D. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.
- E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

- A. If approved by the Superintendent, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.3 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install lamps in each luminaire.
- D. Supports:
 - 1. Sized and rated for luminaire weight.
 - 2. Able to maintain luminaire position after cleaning and relamping.
 - 3. Provide support for luminaire without causing deflection of ceiling or wall.
 - 4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.
- E. Flush-Mounted Luminaire Support:
 - 1. Secured to outlet box.

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2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
3. Trim ring flush with finished surface.

F. Wall-Mounted Luminaire Support:

1. Attached to structural members in walls or attached to a minimum 20 gauge backing plate attached to wall structural members.
2. Do not attach luminaires directly to gypsum board.

G. Ceiling-Mounted Luminaire Support:

1. Ceiling mount with two 5/32-inch- (4-mm-) diameter aircraft cable supports.
2. Ceiling mount with pendant mount with 5/32-inch- (4-mm-) diameter aircraft cable supports.
3. Ceiling mount with hook mount.

H. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and wire support for suspension for each unit length of luminaire chassis, including one at each end.
4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

I. Ceiling-Grid-Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

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- B. Luminaire will be considered defective if it does not pass operation tests and inspections.
- C. Prepare test and inspection reports.

3.5 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
 - 1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
 - 2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 - 3. Adjust the aim of luminaires in the presence of the Superintendent.

END OF SECTION 26 51 19