SPECIFICATIONS
FINAL TURNOVER DOCUMENTS

ARS LABORATORY EXHAUST

Horticulture Crop Research Unit
USDA Agricultural Research Service
Corvallis, OR 97333

February 04, 2026

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TABLE OF CONTENTS

011000 – Summary
012500 – Substitution Procedures
012600 – Contract Modification Procedures
012900 – Payment Procedures
013100 – Project Management and Coordination
013300 – Submittal Procedures
014000 – Quality Requirements
014200 – References
015000 – Temporary Facilities and Controls
016000 – Product Requirements
017300 – Execution
017419 – Construction Waste Management and Disposal
017700 – Closeout Procedures
017823 – Operation and Maintenance Data
017839 – Project Record Documents
017900 – Demonstration and Training
024119 – Selective Demolition
075216 – SBS-Modified Bituminous Membrane Roofing

230500 – Common Work Results for HVAC
230550 – Identification for Piping and Equipment
230590 – Testing Adjusting and Balancing
230800 – Commissioning
230900 – Instrumentation and Control Systems
233100 – Metal Ducts and Casings
233300 – Air Duct Accessories
233400 – HVAC Fans
233600 – Air Terminal Units

SECTION 011000 - SUMMARY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Project information.
2. Work covered by Contract Documents.
3. Contractor's use of site and premises.
4. Coordination with occupants.
5. Work restrictions.
6. Specification and Drawing conventions.

B. Related Requirements:

1. Section 015000 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.

1.2 PROJECT INFORMATION

1. Project Location: Corvallis, Oregon.

B. Owner: USDA Agricultural Research Service.

1. Owner's Representative: Thomas Goebel, Program Project Manager.

C. Engineer: Coffman Engineers, Inc.

1. Engineer's Representative: Traci Hanegan, PE, Coffman Engineers, Inc.

D. Engineer's Consultants: Engineer has retained the following design professionals, who have prepared designated portions of the Contract Documents:

1. Structural Engineering: Coffman Engineers, Inc.
2. Mechanical Engineering: Coffman Engineers, Inc.
3. Electrical Engineering: Coffman Engineers, Inc.

1.3 WORK COVERED BY CONTRACT DOCUMENTS

A. The Work of Project is defined by the Contract Documents and consists of the following:

1. Project Background: The USDA research lab in Corvallis was constructed in 1971, expanded in 1993, and is missing critical laboratory exhaust to maintain negative air pressure.
2. This project will add a new exhaust fan at the research lab to maintain necessary lab pressurization.

1.4 CONTRACTOR'S USE OF SITE AND PREMISES

A. Limits on Use of Site: Limit use of Project site to areas within the Contract limits indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.

1. Limits on Use of Site: Confine construction operations to USDA site. Avoid residential and other campus areas.
2. Driveways, Walkways, and Entrances: Keep driveways loading areas, and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or for storage of materials.

B. Condition of Existing Building: Maintain portions of existing building affected by construction operations in a weathertight condition throughout construction period. Repair damage caused by construction operations.

C. Condition of Existing Grounds: Maintain portions of existing grounds, landscaping, and hardscaping affected by construction operations throughout construction period. Repair damage caused by construction operations.

1.5 COORDINATION WITH OCCUPANTS

A. Full Owner Occupancy: Owner will occupy site and existing building(s) during entire construction period. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with Owner's day-to-day operations. Maintain existing exits unless otherwise indicated.

1.6 WORK RESTRICTIONS

A. Comply with restrictions on construction operations.

1. Comply with limitations on use of public streets, work on public streets, rights of way, and other requirements of authorities having jurisdiction.

B. On-Site Work Hours: Limit work in the existing building to normal business working hours of 7:00 a.m. to 4:30 p.m., Monday through Friday, and 8:00 am to 2:00 pm Saturday and Sunday.

C. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after providing temporary utility services according to requirements indicated:

1. Notify Owner not less than 7 days in advance of proposed utility interruptions.
2. Obtain Owner's written permission before proceeding with utility interruptions.

D. Noise, Vibration, Dust, and Odors: Coordinate operations that may result in high levels of noise and vibration, dust, odors, or other disruption to Owner occupancy with Owner.

1. Notify Owner not less than 5 days in advance of proposed disruptive operations.
2. Obtain Owner's written permission before proceeding with disruptive operations.

E. Smoking and Controlled Substance Restrictions: Use of tobacco products, alcoholic beverages, and other controlled substances on Owner's property is not permitted.

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

G. Employee Screening: Comply with Owner's requirements for drug and background screening of Contractor personnel prior to working on Project site.

1. Maintain list of approved screened personnel with Owner's representative.

1.7 SPECIFICATION AND DRAWING CONVENTIONS

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

1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
2. Text Color: Text used in the Specifications, including units of measure, manufacturer and product names, and other text may appear in multiple colors or underlined as part of a hyperlink; no emphasis is implied by text with these characteristics.
3. Hypertext: Text used in the Specifications may contain hyperlinks. Hyperlinks may allow for access to linked information that is not residing in the Specifications. Unless otherwise indicated, linked information is not part of the Contract Documents.
4. Specification requirements are to be performed by Contractor unless specifically stated otherwise.

B. Division 00 Contracting Requirements: General provisions of the Contract, including General and Supplementary Conditions, apply to all Sections of the Specifications.

C. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.

PART 2 - PRODUCTS

2.1 All materials and major equipment shall meet the Buy American Act.

PART 3 - EXECUTION (Not Used)

END OF SECTION 011000

SECTION 012500 - SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for substitutions.

B. Related Requirements:

1. Section 016000 "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.

1.2 DEFINITIONS

A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.

1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
2. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

1.3 ACTION SUBMITTALS

A. Substitution Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. Substitution Request Form: Use form acceptable to Engineer.
2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:

a. Statement indicating why specified product or fabrication or installation method cannot be provided, if applicable.
b. Coordination of information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
c. Detailed comparison of significant qualities of proposed substitutions with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes, such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
e. Samples, where applicable or requested.
f. Certificates and qualification data, where applicable or requested.

g. List of similar installations for completed projects, with project names and addresses as well as names and addresses of Engineers and owners.
h. Material test reports from a qualified testing agency, indicating and interpreting test results for compliance with requirements indicated.
i. Research reports evidencing compliance with building code in effect for Project, from ICC-ES.
j. Detailed comparison of Contractor's construction schedule using proposed substitutions with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
k. Cost information, including a proposal of change, if any, in the Contract Sum.
l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents, except as indicated in substitution request, is compatible with related materials and is appropriate for applications indicated.
m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

3. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. Engineer will notify Contractor of acceptance or rejection of proposed substitution within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.

a. Forms of Acceptance: Change Order, Construction Change Directive, or Engineer's Supplemental Instructions for minor changes in the Work.
b. Use product specified if Engineer does not issue a decision on use of a proposed substitution within time allocated.

1.4 QUALITY ASSURANCE

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

1.5 PROCEDURES

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

1.6 SUBSTITUTIONS

A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.

1. Conditions: Engineer will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Engineer will return requests without action, except to record noncompliance with these requirements:

    a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
    b. Substitution request is fully documented and properly submitted.
    c. Requested substitution will not adversely affect Contractor's construction schedule.
    d. Requested substitution has received necessary approvals of authorities having jurisdiction.
    e. Requested substitution is compatible with other portions of the Work.
    f. Requested substitution has been coordinated with other portions of the Work.
    g. Requested substitution provides specified warranty.
    h. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

B. Substitutions for Convenience: Not allowed.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012500

SECTION 012600 - CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for handling and processing Contract modifications.

1.2 MINOR CHANGES IN THE WORK

A. Engineer will issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on USDA Form.

1. Work Change Proposal Requests issued by Engineer are not instructions either to stop work in progress or to execute the proposed change.

1.3 PROPOSAL REQUESTS

A. Owner-Initiated Proposal Requests: Engineer will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.

1. Work Change Proposal Requests issued by Engineer are not instructions either to stop work in progress or to execute the proposed change.

2. Within time specified in Proposal Request or 20 days, when not otherwise specified, after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.

a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
c. Include costs of labor and supervision directly attributable to the change.
d. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.

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

1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.

2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.

3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.

4. Include costs of labor and supervision directly attributable to the change.

5. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.

6. Comply with requirements in Section 012500 "Substitution Procedures" if the proposed change requires substitution of one product or system for product or system specified.

1.4 CHANGE ORDER PROCEDURES

A. On Owner's approval of a Work Change Proposal Request, Engineer will issue a Change Order for signatures of Owner and Contractor on USDA Form.

1.5 CONSTRUCTION CHANGE DIRECTIVE

A. Construction Change Directive: Engineer may issue a Construction Change Directive on USDA Form. Construction Change Directive instructs Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.

1. Construction Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.

B. Documentation: Maintain detailed records on a time and material basis of work required by the Construction Change Directive.

1. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012600

SECTION 012900 - PAYMENT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

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

1.2 SCHEDULE OF VALUES

A. Coordination: Coordinate preparation of the schedule of values with preparation of Contractor's construction schedule.

1. Coordinate line items in the schedule of values with items required to be indicated as separate activities in Contractor's construction schedule.
2. Submit the schedule of values to Engineer at earliest possible date, but no later than seven days before the date scheduled for submittal of initial Applications for Payment.

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

1. Arrange schedule of values consistent with format of AIA Document G703 or form provided by owner.
2. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Provide multiple line items for principal subcontract amounts in excess of five percent of the Contract Sum.
3. Provide a separate line item in the schedule of values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
   a. Differentiate between items stored on-site and items stored off-site.
4. Allowances: Provide a separate line item in the schedule of values for each allowance. Show line-item value of unit-cost allowances, as a product of the unit cost, multiplied by measured quantity. Use information indicated in the Contract Documents to determine quantities.
5. Overhead Costs: Include total cost and proportionate share of general overhead and profit for each line item.
6. Overhead Costs: Show cost of temporary facilities and other major cost items that are not direct cost of actual work-in-place as separate line items.
7. Closeout Costs. Include separate line items under Contractor and principal subcontracts for Project closeout requirements in an amount totaling five percent of the Contract Sum and subcontract amount.
8. Schedule of Values Revisions: Revise the schedule of values when Change Orders or Construction Change Directives result in a change in the Contract Sum. Include at least one separate line item for each Change Order and Construction Change Directive.

1.3 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments as certified by Engineer and paid for by Owner.

B. Payment Application Times: The date for each progress payment is indicated in the Agreement between Owner and Contractor. The period of construction work covered by each Application for Payment is the period indicated in the Agreement.

C. Payment Application Times: Submit Application for Payment to Engineer on or about the last day of the month. The period covered by each Application for Payment is one month, ending on the last day of the month.

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

D. Application for Payment Forms: Use USDA Forms to be provided as form for Applications for Payment.

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

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

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

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

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

1. Submit partial waivers on each item for amount requested in previous application, after deduction for retainage, on each item.
2. When an application shows completion of an item, submit conditional final or full waivers.
3. Owner reserves the right to designate which entities involved in the Work must submit waivers.
4. Submit final Application for Payment with or preceded by conditional final waivers from every entity involved with performance of the Work covered by the application who is lawfully entitled to a lien.
5. Waiver Forms: Submit executed waivers of lien on forms acceptable to Owner.

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

1. List of subcontractors.
2. Schedule of values.
3. Contractor's construction schedule (preliminary if not final).
4. Products list (preliminary if not final).
5. Sustainable design action plans, including preliminary project materials cost data.
6. Schedule of unit prices.
7. Submittal schedule (preliminary if not final).
8. List of Contractor's staff assignments.
9. List of Contractor's principal consultants.
10. Copies of building permits.
11. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
12. Initial progress report.
13. Report of preconstruction conference.
14. Certificates of insurance and insurance policies.
15. Performance and payment bonds.
16. Data needed to acquire Owner's insurance.

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

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

J. Final Payment Application: After completing Project closeout requirements, submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:

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

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012900

SECTION 013100 - PROJECT MANAGEMENT AND COORDINATION

GENERAL

1.1 SUMMARY

A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:

1. General coordination procedures.
2. Coordination drawings.
3. RFIs.
4. Digital project management procedures.
5. Project meetings.

B. Related Requirements:

1. Section 017300 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.

1.2 INFORMATIONAL SUBMITTALS

A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:

1. Name, address, telephone number, and email address of entity performing subcontract or supplying products.
2. Number and title of related Specification Section(s) covered by subcontract.
3. Drawing number and detail references, as appropriate, covered by subcontract.

1.3 GENERAL COORDINATION PROCEDURES

A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations included in different Sections that depend on each other for proper installation, connection, and operation.

1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
3. Make adequate provisions to accommodate items scheduled for later installation.
4. Contractor shall coordinate with Oregon State University parking division for work that will involve the parking lot or street access, to include crane setup and equipment deliveries.

B. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:

1. Preparation of Contractor's construction schedule.

2. Preparation of the schedule of values.
3. Installation and removal of temporary facilities and controls.
4. Delivery and processing of submittals.
5. Progress meetings.
6. Project closeout activities.
7. Startup and adjustment of systems.

1.4 REQUEST FOR INFORMATION (RFI)

A. General: Immediately on discovery of the need for additional information, clarification, or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.

1. Engineer will return without response those RFIs submitted to Engineer by other entities controlled by Contractor.
2. Coordinate and submit RFIs in a prompt manner to avoid delays in Contractor's work or work of subcontractors.

B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:

1. Owner name.
2. Owner's Project number.
3. Name of Engineer.
4. Engineer's Project number.
5. Date.
6. Name of Contractor.
7. RFI number, numbered sequentially.
8. RFI subject.
9. Specification Section number and title and related paragraphs, as appropriate.
10. Drawing number and detail references, as appropriate.
11. Field dimensions and conditions, as appropriate.
12. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
13. Contractor's signature.
14. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.

C. RFI Forms: AIA Document G716, or USDA Form to be provided, or software-generated form with substantially the same content as indicated above, acceptable to Engineer.

D. Engineer's Action: Engineer will review each RFI, determine action required, and respond. Allow seven days for Engineer's response for each RFI. RFIs received by Engineer after 1:00 PST p.m. will be considered as received the following working day.

1. The following Contractor-generated RFIs will be returned without action:

a. Requests for approval of submittals.
b. Requests for approval of substitutions.
c. Requests for approval of Contractor's means and methods.
d. Requests for coordination information already indicated in the Contract Documents.
e. Requests for adjustments in the Contract Time or the Contract Sum.

f. Requests for interpretation of Engineer's actions on submittals.
g. Incomplete RFIs or inaccurately prepared RFIs.

2. Engineer's action may include a request for additional information, in which case Engineer's time for response will date from time of receipt by Engineer of additional information.
3. Engineer's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 012600 "Contract Modification Procedures."

   a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Engineer in writing within five days of receipt of the RFI response.

E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly. Use software log that is part of web-based Project management software. Include the following:

1. Project name.
2. Name and address of Contractor.
3. Name and address of Engineer.
4. RFI number including RFIs that were returned without action or withdrawn.
5. RFI description.
6. Date the RFI was submitted.
7. Date Engineer's response was received.

F. On receipt of Engineer's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Engineer within seven days if Contractor disagrees with response.

1.5 DIGITAL PROJECT MANAGEMENT PROCEDURES

A. Engineer's Data Files Not Available: Engineer will not provide Engineer's CAD drawing digital data files for Contractor's use during construction.

B. PDF Document Preparation: Where PDFs are required to be submitted to Engineer, prepare as follows:

1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
2. Name file with submittal number or other unique identifier, including revision identifier.
3. Certifications: Where digitally submitted certificates and certifications are required, provide a digital signature with digital certificate on where indicated.

1.6 PROJECT MEETINGS

A. General: Schedule and conduct meetings and conferences at Project site unless otherwise indicated.

B. Preconstruction Conference: Owner will schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Engineer, but no later than 15 days after execution of the Agreement.

1. Attendees: Authorized representatives of Owner Engineer, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
2. Agenda: Discuss items of significance that could affect progress, including the following:

    a. Responsibilities and personnel assignments.
    b. Tentative construction schedule.
    c. Phasing.
    d. Critical work sequencing and long lead items.
    e. Designation of key personnel and their duties.
    f. Lines of communications.
    g. Use of web-based Project software.
    h. Procedures for processing field decisions and Change Orders.
    i. Procedures for RFIs.
    j. Procedures for testing and inspecting.
    k. Procedures for processing Applications for Payment.
    l. Distribution of the Contract Documents.
    m. Submittal procedures.
    n. Sustainable design requirements.
    o. Preparation of Record Documents.
    p. Use of the premises and existing building.
    q. Work restrictions.
    r. Working hours.
    s. Owner's occupancy requirements.
    t. Responsibility for temporary facilities and controls.
    u. Procedures for moisture and mold control.
    v. Procedures for disruptions and shutdowns.
    w. Construction waste management and recycling.
    x. Parking availability.
    y. Office, work, and storage areas.
    z. Equipment deliveries and priorities.
    aa. First aid.
    bb. Security.
    cc. Progress cleaning.

3. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.

C. Progress Meetings: Conduct progress meetings at biweekly intervals.

1. Coordinate dates of meetings with preparation of payment requests.
2. Attendees: In addition to representatives of Owner and Engineer, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.

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

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

      1) Review schedule for next period.

   b. Review present and future needs of each entity present, including the following:

      1) Interface requirements.
      2) Sequence of operations.
      3) Resolution of BIM component conflicts.
      4) Status of submittals.
      5) Status of sustainable design documentation.
      6) Deliveries.
      7) Off-site fabrication.
      8) Access.
      9) Site use.
      10) Temporary facilities and controls.
      11) Progress cleaning.
      12) Quality and work standards.
      13) Status of correction of deficient items.
      14) Field observations.
      15) Status of RFIs.
      16) Status of Proposal Requests.
      17) Pending changes.
      18) Status of Change Orders.
      19) Pending claims and disputes.
      20) Documentation of information for payment requests.

4. Minutes: Contractor will record and distribute the meeting minutes to each party present and to parties requiring information.

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

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013100

SECTION 013300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Submittal schedule requirements.
2. Administrative and procedural requirements for submittals.

1.2 DEFINITIONS

A. Action Submittals: Written and graphic information and physical samples that require Engineer's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."

B. Informational Submittals: Written and graphic information and physical samples that do not require Engineer's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."

1.3 SUBMITTAL SCHEDULE

A. Submittal Schedule: Submit, as an action submittal, a list of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Engineer and additional time for handling and reviewing submittals required by those corrections.

1.4 SUBMITTAL FORMATS

A. Submittal Information: Include the following information in each submittal:

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

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

B. Options: Identify options requiring selection by Engineer.

C. Deviations and Additional Information: On each submittal, clearly indicate deviations from requirements in the Contract Documents, including minor variations and limitations; include relevant additional information and revisions, other than those requested by Engineer on previous submittals. Indicate by highlighting on each submittal or noting on attached separate sheet.

D. Electronic Submittals: Prepare submittals as PDF package, incorporating complete information into each PDF file. Name PDF file with submittal number.

E. Submittals for Utilizing Web-Based Project Management Software: Prepare submittals as PDF files, or other format indicated by Project management software.

1.5 SUBMITTAL PROCEDURES

A. Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.

1. Email: Prepare submittals as PDF package, and transmit to Engineer by sending via email. Include PDF transmittal form. Include information in email subject line as requested by Engineer.
2. Web-Based Project Management Software: Prepare submittals in PDF form, and upload to web-based Project management software website. Enter required data in web-based software site to fully identify submittal.
3. Paper: Prepare submittals in paper form, and deliver to Engineer.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.

C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Engineer's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.

1. Initial Review: Allow 15 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Engineer will advise Contractor when a submittal being processed must be delayed for coordination.
2. Resubmittal Review: Allow 15 days for review of each resubmittal.

D. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.

E. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

F. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Engineer's action stamp.

1.6 SUBMITTAL REQUIREMENTS

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

1. If information must be specially prepared for submittal because standard published data are unsuitable for use, submit as Shop Drawings, not as Product Data.
2. Mark each copy of each submittal to show which products and options are applicable.
3. Include the following information, as applicable:

a. Manufacturer's catalog cuts.
b. Manufacturer's product specifications.
c. Standard color charts.
d. Statement of compliance with specified referenced standards.
e. Testing by recognized testing agency.
f. Application of testing agency labels and seals.
g. Notation of coordination requirements.
h. Availability and delivery time information.

4. For equipment, include the following in addition to the above, as applicable:

a. Wiring diagrams that show factory-installed wiring.
b. Printed performance curves.
c. Operational range diagrams.
d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.

5. Submit Product Data before Shop Drawings, and before or concurrent with Samples.

B. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data unless submittal based on Engineer's digital data drawing files is otherwise permitted.

1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:

a. Identification of products.
b. Schedules.
c. Compliance with specified standards.
d. Notation of coordination requirements.
e. Notation of dimensions established by field measurement.
f. Relationship and attachment to adjoining construction clearly indicated.
g. Seal and signature of professional engineer if specified.

C. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other materials.

1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
2. Identification: Permanently attach label on unexposed side of Samples that includes the following:

    a. Project name and submittal number.
    b. Generic description of Sample.
    c. Product name and name of manufacturer.
    d. Sample source.
    e. Number and title of applicable Specification Section.
    f. Specification paragraph number and generic name of each item.

3. Email Transmittal: Provide PDF transmittal. Include digital image file illustrating Sample characteristics, and identification information for record.
4. Web-Based Project Management Software: Prepare submittals in PDF form, and upload to web-based Project software website. Enter required data in web-based software site to fully identify submittal.
5. Paper Transmittal: Include paper transmittal including complete submittal information indicated.
6. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.

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

7. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.

    a. Number of Samples: Submit one full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Engineer will return submittal with options selected.

8. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.

    a. Number of Samples: Submit three sets of Samples. Engineer will retain two Sample sets; remainder will be returned. Mark up and retain one returned Sample set as a project record Sample.

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

2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.

D. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:

E. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of Engineers and owners, and other information specified.

F. Design Data: Prepare and submit written and graphic information indicating compliance with indicated performance and design criteria in individual Specification Sections. Include list of assumptions and summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Number each page of submittal.

G. Certificates:

1. Certificates and Certifications Submittals: Submit a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity. Provide a notarized signature where indicated.
2. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
3. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
4. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
5. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
6. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.

H. Test and Research Reports:

1. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for substrate preparation and primers required.
2. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
3. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.

4. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
5. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
6. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
    a. Name of evaluation organization.
    b. Date of evaluation.
    c. Time period when report is in effect.
    d. Product and manufacturers' names.
    e. Description of product.
    f. Test procedures and results.
    g. Limitations of use.

1.7 DELEGATED-DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
    1. If criteria indicated are insufficient to perform services or certification required, submit a written request for additional information to Engineer.

B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF file of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
    1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

1.8 CONTRACTOR'S REVIEW

A. Action Submittals and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Engineer.

B. Contractor's Approval: Indicate Contractor's approval for each submittal with a uniform approval stamp. Include name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.
    1. Engineer will not review submittals received from Contractor that do not have Contractor's review and approval.

1.9 ENGINEER'S REVIEW

A. Action Submittals: Engineer will review each submittal, indicate corrections or revisions required, and return it.

1. PDF Submittals: Engineer will indicate, via markup on each submittal, the appropriate action.

2. Submittals by Web-Based Project Management Software: Engineer will indicate, on Project management software website, the appropriate action.

B. Informational Submittals: Engineer will review each submittal and will not return it, or will return it if it does not comply with requirements. Engineer will forward each submittal to appropriate party.

C. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Engineer.

D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.

E. Engineer will discard submittals received from sources other than Contractor.

F. Submittals not required by the Contract Documents will be returned by Engineer without action.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013300

SECTION 014000 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for quality assurance and quality control.

B. Testing and inspection services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.

1. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and quality-control procedures that facilitate compliance with the Contract Document requirements.
2. Requirements for Contractor to provide quality-assurance and quality-control services required by Engineer, Owner, or authorities having jurisdiction are not limited by provisions of this Section.

1.2 DEFINITIONS

A. Experienced: When used with an entity or individual, "experienced" unless otherwise further described means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

B. Field Quality-Control Tests and Inspections: Tests and inspections that are performed on-site for installation of the Work and for completed Work.

C. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, assembly, and similar operations.

1. Use of trade-specific terminology in referring to a Work result does not require that certain construction activities specified apply exclusively to specific trade(s).

D. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria. Unless otherwise indicated, copies of reports of tests or inspections performed for other than the Project do not meet this definition.

E. Product Tests: Tests and inspections that are performed by a nationally recognized testing laboratory (NRTL) according to 29 CFR 1910.7, by a testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program (NVLAP), or by a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.

F. Source Quality-Control Tests and Inspections: Tests and inspections that are performed at the source; for example, plant, mill, factory, or shop.

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

H. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.

I. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Contractor's quality-control services do not include contract administration activities performed by Engineer.

1.3 DELEGATED-DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Engineer.

B. Delegated-Design Services Statement: Submit a statement, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

1.4 CONFLICTING REQUIREMENTS

A. Conflicting Standards and Other Requirements: If compliance with two or more standards or requirements is specified and the standards or requirements establish different or conflicting requirements for minimum quantities or quality levels, inform the Engineer regarding the conflict and obtain clarification prior to proceeding with the Work. Refer conflicting requirements that are different, but apparently equal, to Engineer for clarification before proceeding.

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

1.5 INFORMATIONAL SUBMITTALS

A. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility submitted to authorities having jurisdiction before starting work on the following systems:

1. Seismic-force-resisting system, designated seismic system, or component listed in the Statement of Special Inspections.

2. Main wind-force-resisting system or a wind-resisting component listed in the Statement of Special Inspections.

B. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.

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

1.6 REPORTS AND DOCUMENTS

A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:

1. Date of issue.
2. Project title and number.
3. Name, address, telephone number, and email address of testing agency.
4. Dates and locations of samples and tests or inspections.
5. Names of individuals making tests and inspections.
6. Description of the Work and test and inspection method.
7. Identification of product and Specification Section.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Record of temperature and weather conditions at time of sample taking and testing and inspection.
11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and reinspecting.

B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:

1. Statement on condition of substrates and their acceptability for installation of product.
2. Statement that products at Project site comply with requirements.
3. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
4. Results of operational and other tests and a statement of whether observed performance complies with requirements.
5. Other required items indicated in individual Specification Sections.

C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:

1. Statement that equipment complies with requirements.
2. Results of operational and other tests and a statement of whether observed performance complies with requirements.
3. Other required items indicated in individual Specification Sections.

1.7 QUALITY ASSURANCE

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

B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units. As applicable, procure products from manufacturers able to meet qualification requirements, warranty requirements, and technical or factory-authorized service representative requirements.

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

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

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

F. Specialists: Certain Specification Sections require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.

   1. Requirements of authorities having jurisdiction shall supersede requirements for specialists.

G. Testing and Inspecting Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspection indicated, as documented according to ASTM E329; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.

H. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

I. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:

   1. Contractor responsibilities include the following:

      a. Provide test specimens representative of proposed products and construction.
      b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.

c. Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.
d. When testing is complete, remove test specimens and test assemblies; do not reuse products on Project.

2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Engineer and Commissioning Authority, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.

1.8 QUALITY CONTROL

A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.

1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspection they are engaged to perform.
2. Costs for retesting and reinspecting construction that replaces or is necessitated by Work that failed to comply with the Contract Documents will be charged to Contractor.

B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities, whether specified or not, to verify and document that the Work complies with requirements.

1. Engage a qualified testing agency to perform quality-control services.

a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.

2. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspection will be performed.
3. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
4. Testing and inspection requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
5. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

C. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.

D. Testing Agency Responsibilities: Cooperate with Engineer, Commissioning Authority and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.

1. Notify Engineer, Commissioning Authority, and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
2. Determine the locations from which test samples will be taken and in which in-situ tests are conducted.
3. Conduct and interpret tests and inspections and state in each report whether tested and inspected Work complies with or deviates from requirements.

4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
6. Do not perform duties of Contractor.

E. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 013300 "Submittal Procedures."

F. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.

G. Contractor's Associated Requirements and Services: Cooperate with agencies and representatives performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:

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

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

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

1.9 SPECIAL TESTS AND INSPECTIONS

A. Special Tests and Inspections: Owner will engage a qualified testing agency to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner, and as follows:

1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviewing the completeness and adequacy of those procedures to perform the Work.
2. Notifying Engineer, Commissioning Authority, and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
3. Submitting a certified written report of each test, inspection, and similar quality-control service to Engineer and Commissioning Authority with copy to Contractor and to authorities having jurisdiction.
4. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.

5. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
6. Retesting and re-inspecting corrected Work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:

1. Date test or inspection was conducted.
2. Description of the Work tested or inspected.
3. Date test or inspection results were transmitted to Engineer.
4. Identification of testing agency or special inspector conducting test or inspection.

B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Engineer's, Commissioning Authority's, and authorities' having jurisdiction reference during normal working hours.

1. Submit log at Project closeout as part of Project Record Documents.

3.2 REPAIR AND PROTECTION

A. General: On completion of testing, inspection, sample taking, and similar services, repair damaged construction and restore substrates and finishes.

1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 017300 "Execution."

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

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

END OF SECTION 014000

SECTION 014200 - REFERENCES

PART 1 - GENERAL

1.1 DEFINITIONS

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

B. "Approved": When used to convey Architect's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.

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

D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."

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

F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.

G. "Install": Unload, temporarily store, unpack, assemble, erect, place, anchor, apply, work to dimension, finish, cure, protect, clean, and similar operations at Project site.

H. "Provide": Furnish and install, complete and ready for the intended use.

I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.2 INDUSTRY STANDARDS

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

B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

1. For standards referenced by applicable building codes, comply with dates of standards as listed in building codes.

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

1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

1.3 ABBREVIATIONS AND ACRONYMS

A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities indicated in Gale's "Encyclopedia of Associations: National Organizations of the U.S." or in Columbia Books' "National Trade & Professional Associations of the United States."

B. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Abbreviations and acronyms not included in this list shall mean the recognized name of the entities indicated in Gale's "Encyclopedia of Associations: National Organizations of the U.S." or in Columbia Books' "National Trade & Professional Associations of the United States." The information in this list is subject to change and is believed to be accurate as of the date of the Contract Documents.

1. AABC - Associated Air Balance Council; www.aabc.com.
2. AAMA - American Architectural Manufacturers Association; www.aamanet.org.
3. AAPFCO - Association of American Plant Food Control Officials; www.aapfco.org.
4. AASHTO - American Association of State Highway and Transportation Officials; www.transportation.org.
5. AATCC - American Association of Textile Chemists and Colorists; www.aatcc.org.
6. ABMA - American Bearing Manufacturers Association; www.americanbearings.org.
7. ABMA - American Boiler Manufacturers Association; www.abma.com.
8. ACI - American Concrete Institute; (Formerly: ACI International); www.concrete.org.
9. ACPA - American Concrete Pipe Association; www.concrete-pipe.org.
10. AEIC - Association of Edison Illuminating Companies, Inc. (The); www.aeic.org.
11. AF&PA - American Forest & Paper Association; www.afandpa.org.
12. AGA - American Gas Association; www.aga.org.
13. AHAM - Association of Home Appliance Manufacturers; www.aham.org.
14. AHRI - Air-Conditioning, Heating, and Refrigeration Institute (The); www.ahrinet.org.
15. AI - Asphalt Institute; www.asphaltinstitute.org.
16. AIA - American Institute of Architects (The); www.aia.org.
17. AISC - American Institute of Steel Construction; www.aisc.org.
18. AISI - American Iron and Steel Institute; www.steel.org.
19. AITC - American Institute of Timber Construction; www.aitc-glulam.org.
20. AMCA - Air Movement and Control Association International, Inc.; www.amca.org.
21. ANSI - American National Standards Institute; www.ansi.org.
22. AOSA - Association of Official Seed Analysts, Inc.; www.aosaseed.com.
23. APA - APA - The Engineered Wood Association; www.apawood.org.
24. APA - Architectural Precast Association; www.archprecast.org.
25. API - American Petroleum Institute; www.api.org.
26. ARI - Air-Conditioning & Refrigeration Institute; (See AHRI).
27. ARI - American Refrigeration Institute; (See AHRI).
28. ARMA - Asphalt Roofing Manufacturers Association; www.asphaltroofing.org.
29. ASCE - American Society of Civil Engineers; www.asce.org.

30. ASCE/SEI - American Society of Civil Engineers/Structural Engineering Institute; (See ASCE).
31. ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers; www.ashrae.org.
32. ASME - ASME International; (American Society of Mechanical Engineers); www.asme.org.
33. ASSE - American Society of Sanitary Engineering; www.asse-plumbing.org.
34. ASSP - American Society of Safety Professionals (The); www.assp.org.
35. ASTM - ASTM International; www.astm.org.
36. ATIS - Alliance for Telecommunications Industry Solutions; www.atis.org.
37. AVIXA - Audiovisual and Integrated Experience Association; (Formerly: Infocomm International); www.soundandcommunications.com.
38. AWEA - American Wind Energy Association; www.awea.org.
39. AWI - Architectural Woodwork Institute; www.awinet.org.
40. AWMAC - Architectural Woodwork Manufacturers Association of Canada; www.awmac.com.
41. AWPA - American Wood Protection Association; www.awpa.com.
42. AWS - American Welding Society; www.aws.org.
43. AWWA - American Water Works Association; www.awwa.org.
44. BHMA - Builders Hardware Manufacturers Association; www.buildershardware.com.
45. BIA - Brick Industry Association (The); www.gobrick.com.
46. BICSI - BICSI, Inc.; www.bicsi.org.
47. BIFMA - BIFMA International; (Business and Institutional Furniture Manufacturer's Association); www.bifma.org.
48. BISSC - Baking Industry Sanitation Standards Committee; www.bissc.org.
49. BWF - Badminton World Federation; (Formerly: International Badminton Federation); www.bissc.org.
50. CDA - Copper Development Association; www.copper.org.
51. CE - Conformite Europeenne; http://ec.europa.eu/growth/single-market/ce-marking/.
52. CEA - Canadian Electricity Association; www.electricity.ca.
53. CFFA - Chemical Fabrics and Film Association, Inc.; www.chemicalfabricsandfilm.com.
54. CFSEI - Cold-Formed Steel Engineers Institute; www.cfsei.org.
55. CGA - Compressed Gas Association; www.cganet.com.
56. CIMA - Cellulose Insulation Manufacturers Association; www.cellulose.org.
57. CISCA - Ceilings & Interior Systems Construction Association; www.cisca.org.
58. CISPI - Cast Iron Soil Pipe Institute; www.cispi.org.
59. CLFMI - Chain Link Fence Manufacturers Institute; www.chainlinkinfo.org.
60. CPA - Composite Panel Association; www.compositepanel.org.
61. CRI - Carpet and Rug Institute (The); www.carpet-rug.org.
62. CRRC - Cool Roof Rating Council; www.coolroofs.org.
63. CRSI - Concrete Reinforcing Steel Institute; www.crsi.org.
64. CSA - CSA Group; www.csa-group.org.
65. CSI - Construction Specifications Institute (The); www.csiresources.org.
66. CSSB - Cedar Shake & Shingle Bureau; www.cedarbureau.org.
67. CTA - Consumer Technology Association; www.cta.tech.
68. CTI - Cooling Technology Institute; (Formerly: Cooling Tower Institute); www.coolingtechnology.org.
69. CWC - Composite Wood Council; (See CPA).
70. DASMA - Door and Access Systems Manufacturers Association; www.dasma.com.
71. DHA - Decorative Hardwoods Association; (Formerly: Hardwood Plywood & Veneer Association); www.decorativehardwoods.org.

72. DHI - Door and Hardware Institute; www.dhi.org.
73. ECA - Electronic Components Association; (See ECIA).
74. ECAMA - Electronic Components Assemblies & Materials Association; (See ECIA).
75. ECIA - Electronic Components Industry Association; www.eciaonline.org.
76. EIA - Electronic Industries Alliance; (See TIA).
77. EIMA - EIFS Industry Members Association; www.eima.com.
78. EJMA - Expansion Joint Manufacturers Association, Inc.; www.ejma.org.
79. EOS/ESD Association; (Electrostatic Discharge Association); www.esda.org.
80. ESTA - Entertainment Services and Technology Association; (See PLASA).
81. ETL - Intertek (See Intertek); www.intertek.com.
82. EVO - Efficiency Valuation Organization; www.evo-world.org.
83. FCI - Fluid Controls Institute; www.fluidcontrolsinstitute.org.
84. FIBA - Federation Internationale de Basketball; (The International Basketball Federation); www.fiba.com.
85. FIVB - Federation Internationale de Volleyball; (The International Volleyball Federation); www.fivb.org.
86. FM Approvals - FM Approvals LLC; www.fmglobal.com.
87. FM Global - FM Global; (Formerly: FMG - FM Global); www.fmglobal.com.
88. FRSA - Florida Roofing, Sheet Metal Contractors Association, Inc.; www.floridaroof.com.
89. FSA - Fluid Sealing Association; www.fluidsealing.com.
90. FSC - Forest Stewardship Council U.S.; www.fscus.org.
91. GA - Gypsum Association; www.gypsum.org.
92. GANA - Glass Association of North America; (See NGA).
93. GS - Green Seal; www.greenseal.org.
94. HI - Hydraulic Institute; www.pumps.org.
95. HI/GAMA - Hydronics Institute/Gas Appliance Manufacturers Association; (See AHRI).
96. HMMA - Hollow Metal Manufacturers Association; (See NAAMM).
97. HPVA - Hardwood Plywood & Veneer Association; (See DHA).
98. HPW - H. P. White Laboratory, Inc.; www.hpwhite.com.
99. IAPSC - International Association of Professional Security Consultants; www.iapsc.org.
100. IAS - International Accreditation Service; www.iasonline.org.
101. ICBO - International Conference of Building Officials; (See ICC).
102. ICC - International Code Council; www.iccsafe.org.
103. ICEA - Insulated Cable Engineers Association, Inc.; www.icea.net.
104. ICPA - International Cast Polymer Alliance; www.icpa-hq.org.
105. ICRI - International Concrete Repair Institute, Inc.; www.icri.org.
106. IEC - International Electrotechnical Commission; www.iec.ch.
107. IEEE - Institute of Electrical and Electronics Engineers, Inc. (The); www.ieee.org.
108. IES - Illuminating Engineering Society; (Formerly: Illuminating Engineering Society of North America); www.ies.org.
109. IESNA - Illuminating Engineering Society of North America; (See IES).
110. IEST - Institute of Environmental Sciences and Technology; www.iest.org.
111. IGMA - Insulating Glass Manufacturers Alliance; www.igmaonline.org.
112. IGSHPA - International Ground Source Heat Pump Association; www.igshpa.org.
113. II - Infocomm International; (See AVIXA).
114. ILI - Indiana Limestone Institute of America, Inc.; www.iliai.com.
115. Intertek - Intertek Group; (Formerly: ETL SEMCO; Intertek Testing Service NA); www.intertek.com.
116. ISA - International Society of Automation (The); (Formerly: Instrumentation, Systems, and Automation Society); www.isa.org.

117. ISAS - Instrumentation, Systems, and Automation Society (The); (See ISA).
118. ISFA - International Surface Fabricators Association; (Formerly: International Solid Surface Fabricators Association); www.isfanow.org.
119. ISO - International Organization for Standardization; www.iso.org.
120. ISSFA - International Solid Surface Fabricators Association; (See ISFA).
121. ITU - International Telecommunication Union; www.itu.int/home.
122. KCMA - Kitchen Cabinet Manufacturers Association; www.kcma.org.
123. LMA - Laminating Materials Association; (See CPA).
124. LPI - Lightning Protection Institute; www.lightning.org.
125. MBMA - Metal Building Manufacturers Association; www.mbma.com.
126. MCA - Metal Construction Association; www.metalconstruction.org.
127. MFMA - Maple Flooring Manufacturers Association, Inc.; www.maplefloor.org.
128. MFMA - Metal Framing Manufacturers Association, Inc.; www.metalframingmfg.org.
129. MHIA - Material Handling Industry of America; www.mhia.org.
130. MIA - Marble Institute of America; (See NSI).
131. MMPA - Moulding & Millwork Producers Association; www.wmmpa.com.
132. MPI - Master Painters Institute; www.paintinfo.com.
133. MSS - Manufacturers Standardization Society of The Valve and Fittings Industry Inc.; www.mss-hq.org.
134. NAAMM - National Association of Architectural Metal Manufacturers; www.naamm.org.
135. NACE - NACE International; (National Association of Corrosion Engineers International); www.nace.org.
136. NADCA - National Air Duct Cleaners Association; www.nadca.com.
137. NAIMA - North American Insulation Manufacturers Association; www.naima.org.
138. NALP - National Association of Landscape Professionals; www.landscapeprofessionals.org.
139. NBGQA - National Building Granite Quarries Association, Inc.; www.nbgqa.com.
140. NBI - New Buildings Institute; www.newbuildings.org.
141. NCAA - National Collegiate Athletic Association (The); www.ncaa.org.
142. NCMA - National Concrete Masonry Association; www.ncma.org.
143. NEBB - National Environmental Balancing Bureau; www.nebb.org.
144. NECA - National Electrical Contractors Association; www.necanet.org.
145. NeLMA - Northeastern Lumber Manufacturers Association; www.nelma.org.
146. NEMA - National Electrical Manufacturers Association; www.nema.org.
147. NETA - InterNational Electrical Testing Association; www.netaworld.org.
148. NFHS - National Federation of State High School Associations; www.nfhs.org.
149. NFPA - National Fire Protection Association; www.nfpa.org.
150. NFPA - NFPA International; (See NFPA).
151. NFRC - National Fenestration Rating Council; www.nfrc.org.
152. NGA - National Glass Association (The); (Formerly: Glass Association of North America); www.glass.org.
153. NHLA - National Hardwood Lumber Association; www.nhla.com.
154. NLGA - National Lumber Grades Authority; www.nlga.org.
155. NOFMA - National Oak Flooring Manufacturers Association; (See NWFA).
156. NOMMA - National Ornamental & Miscellaneous Metals Association; www.nomma.org.
157. NRCA - National Roofing Contractors Association; www.nrca.net.
158. NRMCA - National Ready Mixed Concrete Association; www.nrmca.org.
159. NSF - NSF International; www.nsf.org.
160. NSI - National Stone Institute; (Formerly: Marble Institute of America); www.naturalstoneinstitute.org.

161. NSPE - National Society of Professional Engineers; www.nspe.org.
162. NSSGA - National Stone, Sand & Gravel Association; www.nssga.org.
163. NTMA - National Terrazzo & Mosaic Association, Inc. (The); www.ntma.com.
164. NWFA - National Wood Flooring Association; www.nwfa.org.
165. PCI - Precast/Prestressed Concrete Institute; www.pci.org.
166. PDI - Plumbing & Drainage Institute; www.pdionline.org.
167. PLASA - PLASA; (Formerly: ESTA - Entertainment Services and Technology Association); www.plasa.org.
168. RCSC - Research Council on Structural Connections; www.boltcouncil.org.
169. RFCI - Resilient Floor Covering Institute; www.rfci.com.
170. RIS - Redwood Inspection Service; www.redwoodinspection.com.
171. SAE - SAE International; www.sae.org.
172. SCTE - Society of Cable Telecommunications Engineers; www.scte.org.
173. SDI - Steel Deck Institute; www.sdi.org.
174. SDI - Steel Door Institute; www.steeldoor.org.
175. SEFA - Scientific Equipment and Furniture Association (The); www.sefalabs.com.
176. SEI/ASCE - Structural Engineering Institute/American Society of Civil Engineers; (See ASCE).
177. SIA - Security Industry Association; www.siaonline.org.
178. SJI - Steel Joist Institute; www.steeljoist.org.
179. SMA - Screen Manufacturers Association; www.smainfo.org.
180. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association; www.smacna.org.
181. SMPTE - Society of Motion Picture and Television Engineers; www.smpte.org.
182. SPFA - Spray Polyurethane Foam Alliance; www.sprayfoam.org.
183. SPIB - Southern Pine Inspection Bureau; www.spib.org.
184. SPRI - Single Ply Roofing Industry; www.spri.org.
185. SRCC - Solar Rating & Certification Corporation; www.solar-rating.org.
186. SSINA - Specialty Steel Industry of North America; www.ssina.com.
187. SSPC - SSPC: The Society for Protective Coatings; www.sspc.org.
188. STI - Steel Tank Institute; www.steeltank.com.
189. SWI - Steel Window Institute; www.steelwindows.com.
190. SWPA - Submersible Wastewater Pump Association; www.swpa.org.
191. TCA - Tilt-Up Concrete Association; www.tilt-up.org.
192. TCNA - Tile Council of North America, Inc.; www.tileusa.com.
193. TEMA - Tubular Exchanger Manufacturers Association, Inc.; www.tema.org.
194. TIA - Telecommunications Industry Association (The); (Formerly: TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance); www.tiaonline.org.
195. TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance; (See TIA).
196. TMS - The Masonry Society; www.masonrysociety.org.
197. TPI - Truss Plate Institute; www.tpinst.org.
198. TPI - Turfgrass Producers International; www.turfgrasssod.org.
199. TRI - Tile Roofing Institute; www.tileroofing.org.
200. UL - Underwriters Laboratories Inc.; www.ul.com.
201. UNI - Uni-Bell PVC Pipe Association; www.uni-bell.org.
202. USAV - USA Volleyball; www.usavolleyball.org.
203. USGBC - U.S. Green Building Council; www.usgbc.org.
204. USITT - United States Institute for Theatre Technology, Inc.; www.usitt.org.
205. WA - Wallcoverings Association; www.wallcoverings.org.

206. WASTEC - Waste Equipment Technology Association; www.wastec.org.
207. WCLIB - West Coast Lumber Inspection Bureau; www.wclib.org.
208. WCMA - Window Covering Manufacturers Association; www.wcmanet.org.
209. WDMA - Window & Door Manufacturers Association; www.wdma.com.
210. WI - Woodwork Institute; www.wicnet.org.
211. WSRCA - Western States Roofing Contractors Association; www.wsrca.com.
212. WWPA - Western Wood Products Association; www.wwpa.org.

C. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. This information is believed to be accurate as of the date of the Contract Documents.

1. DIN - Deutsches Institut fur Normung e.V.; www.din.de.
2. IAPMO - International Association of Plumbing and Mechanical Officials; www.iapmo.org.
3. ICC - International Code Council; www.iccsafe.org.
4. ICC-ES - ICC Evaluation Service, LLC; www.icc-es.org.

D. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Information is subject to change and is up to date as of the date of the Contract Documents.

1. COE - Army Corps of Engineers; www.usace.army.mil.
2. CPSC - Consumer Product Safety Commission; www.cpsc.gov.
3. DOC - Department of Commerce; National Institute of Standards and Technology; www.nist.gov.
4. DOD - Department of Defense; www.quicksearch.dla.mil.
5. DOE - Department of Energy; www.energy.gov.
6. EPA - Environmental Protection Agency; www.epa.gov.
7. FAA - Federal Aviation Administration; www.faa.gov.
8. FG - Federal Government Publications; www.gpo.gov/fdsys.
9. GSA - General Services Administration; www.gsa.gov.
10. HUD - Department of Housing and Urban Development; www.hud.gov.
11. LBL - Lawrence Berkeley National Laboratory; Environmental Energy Technologies Division; www.eetd.lbl.gov.
12. OSHA - Occupational Safety & Health Administration; www.osha.gov.
13. SD - Department of State; www.state.gov.
14. TRB - Transportation Research Board; National Cooperative Highway Research Program; The National Academies; www.trb.org.
15. USDA - Department of Agriculture; Agriculture Research Service; U.S. Salinity Laboratory; www.ars.usda.gov.
16. USDA - Department of Agriculture; Rural Utilities Service; www.usda.gov.
17. USDOJ - Department of Justice; Office of Justice Programs; National Institute of Justice; www.ojp.usdoj.gov.
18. USP - U.S. Pharmacopeial Convention; www.usp.org.
19. USPS - United States Postal Service; www.usps.com.

E. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and regulations in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.

1. CFR - Code of Federal Regulations; Available from Government Printing Office; www.govinfo.gov.
2. DOD - Department of Defense; Military Specifications and Standards; Available from DLA Document Services; www.quicksearch.dla.mil.
3. DSCC - Defense Supply Center Columbus; (See FS).
4. FED-STD - Federal Standard; (See FS).
5. FS - Federal Specification; Available from DLA Document Services; www.quicksearch.dla.mil.
    a. Available from Defense Standardization Program; www.dsp.dla.mil.
    b. Available from General Services Administration; www.gsa.gov.
    c. Available from National Institute of Building Sciences/Whole Building Design Guide; www.wbdg.org.
6. MILSPEC - Military Specification and Standards; (See DOD).
7. USAB - United States Access Board; www.access-board.gov.
8. USATBCB - U.S. Architectural & Transportation Barriers Compliance Board; (See USAB).

F. State Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.

1. CBHF; State of California; Department of Consumer Affairs; Bureau of Electronic and Appliance Repair, Home Furnishings and Thermal Insulation; www.bearhfti.ca.gov.
2. CCR; California Code of Regulations; Office of Administrative Law; California Title 24 Energy Code; www.calregs.com.
3. CDHS; California Department of Health Services; (See CDPH).
4. CDPH; California Department of Public Health; Indoor Air Quality Program; www.cal-iaq.org.
5. CPUC; California Public Utilities Commission; www.cpuc.ca.gov.
6. SCAQMD; South Coast Air Quality Management District; www.aqmd.gov.
7. TFS; Texas A&M Forest Service; Sustainable Forestry and Economic Development; www.txforestservice.tamu.edu.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 014200

SECTION 015000 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.

B. Related Requirements:

1. Section 011000 "Summary" for work restrictions and limitations on utility interruptions.

1.2 USE CHARGES

A. Installation, removal, and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities engaged in the Project to use temporary services and facilities without cost, including, but not limited to, Owner's construction forces, Engineer, occupants of Project, testing agencies, and authorities having jurisdiction.

B. Water and Sewer Service from Existing System: Water from Owner's existing water system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.

C. Electric Power Service from Existing System: Electric power from Owner's existing system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.

1.3 INFORMATIONAL SUBMITTALS

A. Site Utilization Plan: Show temporary facilities, temporary utility lines and connections, staging areas, construction site entrances, vehicle circulation, and parking areas for construction personnel.

B. Project Identification and Temporary Signs: Show fabrication and installation details, including plans, elevations, details, layouts, typestyles, graphic elements, and message content.

C. Fire-Safety Program: Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Indicate Contractor personnel responsible for management of fire-prevention program.

D. Moisture- and Mold-Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage and mold. Describe delivery, handling, storage, installation, and protection provisions for materials subject to water absorption or water damage.

1. Indicate procedures for discarding water-damaged materials, protocols for mitigating water intrusion into completed Work, and requirements for replacing water-damaged Work.

2. Indicate sequencing of work that requires water, such as sprayed fire-resistive materials, plastering, and terrazzo grinding, and describe plans for dealing with water from these operations. Show procedures for verifying that wet construction has dried sufficiently to permit installation of finish materials.
3. Indicate methods to be used to avoid trapping water in finished work.

1.4 QUALITY ASSURANCE

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

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

C. Accessible Temporary Egress: Comply with applicable provisions in the United States Access Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.

1.5 PROJECT CONDITIONS

A. Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

PART 2 - PRODUCTS

2.1 TEMPORARY FACILITIES (Not Used)

2.2 EQUIPMENT

A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.

B. HVAC Equipment: Unless Owner authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.

1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
2. Heating, Cooling, and Dehumidifying Units: Listed and labeled for type of fuel being consumed, by a qualified testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.
3. Permanent HVAC System: If Owner authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV of 8 at each return-air grille in system and remove at end of construction and clean HVAC system as required in Section 017700 "Closeout Procedures."

C. Air-Filtration Units: Primary and secondary HEPA-filter-equipped portable units with four-stage filtration. Provide single switch for emergency shutoff. Configure to run continuously.

PART 3 - EXECUTION

3.1 TEMPORARY FACILITIES, GENERAL

A. Conservation: Coordinate construction and use of temporary facilities with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.

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

3.2 INSTALLATION, GENERAL

A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.

B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.3 TEMPORARY UTILITY INSTALLATION

A. General: Install temporary service or connect to existing service.

1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.

B. Sewers and Drainage: Provide temporary utilities to remove effluent lawfully.

C. Water Service: Install water service and distribution piping in sizes and pressures adequate for construction.

D. Sanitary Facilities: Provide temporary toilets, wash facilities, safety shower and eyewash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.

E. Temporary Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.

1. Provide temporary dehumidification systems when required to reduce ambient and substrate moisture levels to level required to allow installation or application of finishes and their proper curing or drying.

F. Isolation of Work Areas in Occupied Facilities: Prevent dust, fumes, and odors from entering occupied areas.

G. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.

1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.

3.4 SUPPORT FACILITIES INSTALLATION

A. Traffic Controls: Comply with requirements of authorities having jurisdiction.

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

B. Parking: Use designated areas of Owner's existing parking areas for construction personnel.

C. Storage and Staging: Use designated areas of Project site for storage and staging needs.

D. Waste Disposal Facilities: Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."

E. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.

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

F. Existing Elevator Use: Use of Owner's existing elevators will be permitted, provided elevators are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore elevators to condition existing before initial use, including replacing worn cables, guide shoes, and similar items of limited life.

1. Do not load elevators beyond their rated weight capacity.
2. Provide protective coverings, barriers, devices, signs, or other procedures to protect elevator car and entrance doors and frame. If, despite such protection, elevators become damaged, engage elevator Installer to restore damaged work so no evidence remains of correction work. Return items that cannot be refinished in field to the shop, make required repairs and refinish entire unit, or provide new units as required.

G. Existing Stair Usage: Use of Owner's existing stairs will be permitted, provided stairs are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore stairs to condition existing before initial use.

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

3.5 SECURITY AND PROTECTION FACILITIES INSTALLATION

A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.

1. Where access to adjacent properties is required in order to affect protection of existing facilities, obtain written permission from adjacent property owner to access property for that purpose.

B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.

C. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.

D. Temporary Egress: Provide temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction. Provide signage directing occupants to temporary egress.

E. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.

1. Where heating or cooling is needed and permanent enclosure is incomplete, insulate temporary enclosures.

F. Temporary Partitions: Provide floor-to-ceiling dustproof partitions to limit dust and dirt migration and to separate areas occupied by Owner from fumes and noise.

1. Construct dustproof partitions with gypsum wallboard with joints taped on occupied side, and fire-retardant-treated plywood on construction operations side.
2. Where fire-resistance-rated temporary partitions are indicated or are required by authorities having jurisdiction, construct partitions according to the rated assemblies.
3. Provide walk-off mats at each entrance through temporary partition.

G. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage fire-prevention program.

1. Prohibit smoking in construction areas. Comply with additional limits on smoking specified in other Sections.
2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.
3. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
4. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

3.6 OPERATION, TERMINATION, AND REMOVAL

A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.

B. Maintenance: Maintain facilities in good operating condition until removal.

1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.

C. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.

D. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.

1. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.
2. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 017700 "Closeout Procedures."

END OF SECTION 015000

SECTION 016000 - 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 012500 "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. Salvaged items or items reused from other projects are not considered new products. Items that are manufactured or fabricated to include recycled content materials are considered new products, unless indicated otherwise.
3. Comparable Product: Product by named manufacturer that is demonstrated and approved through the comparable product submittal process described in Part 2 "Comparable Products" Article, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

B. Basis-of-Design Product Specification: A specification in which a single manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation. Published attributes and characteristics of basis-of-design product establish salient characteristics of products.

1. Evaluation of Comparable Products: In addition to the basis-of-design product description, product attributes and characteristics may be listed to establish the significant qualities related to type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other special features and requirements for purposes of evaluating comparable products of additional manufacturers named in the specification. Manufacturer's published attributes and characteristics of basis-of-design product also establish salient characteristics of products for purposes of evaluating comparable products.

C. Subject to Compliance with Requirements: Where the phrase "Subject to compliance with requirements" introduces a product selection procedure in an individual Specification Section, provide products qualified under the specified product procedure. In the event that a named product or product by a named manufacturer does not meet the other requirements of the specifications, select another named product or product from another named manufacturer that does meet the requirements of the specifications; submit a comparable product request or substitution request, if applicable.

D. Comparable Product Request Submittal: An action submittal requesting consideration of a comparable product, including the following information:

1. Identification of basis-of-design product or fabrication or installation method to be replaced, including Specification Section number and title and Drawing numbers and titles.
2. Data indicating compliance with the requirements specified in Part 2 "Comparable Products" Article.

E. Basis-of-Design Product Specification Submittal: An action submittal complying with requirements in Section 013300 "Submittal Procedures."

F. Substitution: Refer to Section 012500 "Substitution Procedures" for definition and limitations on substitutions.

1.3 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.

1.4 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.

1.5 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 standard warranty form furnished by individual manufacturer for a particular product and issued in the name of the Owner or endorsed by manufacturer to Owner.
2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner and issued in the name of the Owner or endorsed by manufacturer to 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 in the Project Manual, prepare a written document, using indicated form properly executed.
3. See other Sections for specific content requirements and particular requirements for submitting special warranties.

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 meeting requirements of the Contract Documents.
4. Where products are accompanied by the term "as selected," Engineer will make selection.
5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.

B. Product Selection Procedures:

1. Sole Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.

   a. Sole manufacturer/source may be indicated by the phrase "Subject to compliance with requirements, provide products by the following."

2. Limited List of Products: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.

   a. Limited list of products may be indicated by the phrase "Subject to compliance with requirements, provide one of the following."

3. Non-Limited List of Products: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed or an unnamed product that complies with requirements.

   a. Non-limited list of products is indicated by the phrase "Subject to compliance with requirements, available products that may be incorporated in the Work include, but are not limited to, the following."

b. Provision of an unnamed product is not considered a substitution, if the product complies with requirements.

4. Limited List of Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.

   a. Limited list of manufacturers is indicated by the phrase "Subject to compliance with requirements, provide products by one of the following."

5. Non-Limited List of Manufacturers: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed or a product by an unnamed manufacturer that complies with requirements.

   a. Non-limited list of manufacturers is indicated by the phrase "Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following."
   b. Provision of products of an unnamed manufacturer is not considered a substitution, if the product complies with requirements.

6. 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 may additionally indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.

   a. For approval of products by unnamed manufacturers, comply with requirements in Section 012500 "Substitution Procedures" for substitutions for convenience.

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

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

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

E. Sustainable Product Selection: Where Specifications require product to meet sustainable product characteristics, select products complying with indicated requirements. Comply with requirements in Division 01 sustainability requirements Section and individual Specification Sections.

   1. Select products for which sustainable design documentation submittals are available from manufacturer.

2.2 COMPARABLE PRODUCTS

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

1. Evidence that proposed product does not require revisions to the Contract Documents, is consistent with the Contract Documents, will produce the indicated results, and is compatible with other portions of the Work.
2. Detailed comparison of significant qualities of proposed product with those of the named basis-of-design product. Significant product qualities include attributes, such as type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other specific features and requirements.
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 Engineers and owners, if requested.
5. Samples, if requested.

B. Engineer's Action on Comparable Products Submittal: If necessary, Engineer will request additional information or documentation for evaluation, as specified in Section 013300 "Submittal Procedures."

1. Form of Approval of Submittal: As specified in Section 013300 "Submittal Procedures."
2. Use product specified if Engineer does not issue a decision on use of a comparable product request within time allocated.

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

D. Submittal Requirements, Single-Step Process: When acceptable to Engineer, incorporate specified submittal requirements of individual Specification Section in combined submittal for comparable products. Approval by the Engineer of Contractor's request for use of comparable product and of individual submittal requirements will also satisfy other submittal requirements.

PART 3 - EXECUTION (Not Used)

END OF SECTION 016000

SECTION 017300 - EXECUTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes general administrative and procedural requirements governing execution of the Work, including, but not limited to, the following:

1. Construction layout.
2. Field engineering and surveying.
3. Installation of the Work.
4. Cutting and patching.
5. Coordination of Owner's portion of the Work.
6. Coordination of Owner-installed products.
7. Progress cleaning.
8. Starting and adjusting.
9. Protection of installed construction.

B. Related Requirements:

1. Section 017700 "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, replacing defective work, and final cleaning.

1.2 DEFINITIONS

A. Cutting: Removal of in-place construction necessary to permit installation or performance of subsequent work.

B. Patching: Fitting and repair work required to restore construction to original conditions after installation of subsequent work.

1.3 QUALITY ASSURANCE

A. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.

1. Structural Elements: When cutting and patching structural elements, or when encountering the need for cutting and patching of elements whose structural function is not known, notify Engineer of locations and details of cutting and await directions from Engineer before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.
2. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety.
3. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety.

4. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Engineer's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

B. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of specified products and equipment.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Comply with requirements specified in other Sections.

1. For projects requiring compliance with sustainable design and construction practices and procedures, use products for patching that comply with sustainable design requirements.

B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.

1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Engineer for the visual and functional performance of in-place materials. Use materials that are not considered hazardous.

C. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.

1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

B. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:

1. Description of the Work, including Specification Section number and paragraph, and Drawing sheet number and detail, where applicable.
2. List of detrimental conditions, including substrates.

3. List of unacceptable installation tolerances.
4. Recommended corrections.

C. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Existing Utility Information: Furnish information to Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.

B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.

D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Engineer in accordance with requirements in Section 013100 "Project Management and Coordination."

3.3 INSTALLATION

A. Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.

1. Make vertical work plumb, and make horizontal work level.
2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
4. Maintain minimum headroom clearance of 96 inches in occupied spaces and 90 inches in unoccupied spaces, unless otherwise indicated on Drawings.

B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.

C. Install products at the time and under conditions that will ensure satisfactory results as judged by Engineer. Maintain conditions required for product performance until Substantial Completion.

D. Conduct construction operations, so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy of type expected for Project.

E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on-site and placement in permanent locations.

F. Tools and Equipment: Select tools or equipment that minimize production of excessive noise levels.

G. Templates: Obtain and distribute to the parties involved templates for Work specified to be factory prepared and field installed. Check Shop Drawings of other portions of the Work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.

H. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions with manufacturer.

1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Engineer.
2. Allow for building movement, including thermal expansion and contraction.
3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

I. Joints: Make joints of uniform width. Where joint locations in exposed Work are not indicated, arrange joints for the best visual effect, as judged by Engineer. Fit exposed connections together to form hairline joints.

J. Repair or remove and replace damaged, defective, or nonconforming Work.

1. Comply with Section 017700 "Closeout Procedures" for repairing or removing and replacing defective Work.

3.4 CUTTING AND PATCHING

A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.

1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.

B. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.

C. Temporary Support: Provide temporary support of Work to be cut.

D. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.

E. Adjacent Occupied Areas: Where interference with use of adjoining areas or interruption of free passage to adjoining areas is unavoidable, coordinate cutting and patching in accordance with requirements in Section 011000 "Summary."

F. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to minimize interruption to occupied areas.

G. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.

1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
4. Excavating and Backfilling: Comply with requirements in applicable Sections where required by cutting and patching operations.
5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
6. Proceed with patching after construction operations requiring cutting are complete.

H. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as practicable, as judged by Engineer. Provide materials and comply with installation requirements specified in other Sections, where applicable.

1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
   a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
   b. Restore damaged pipe covering to its original condition.
3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
   a. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat over entire unbroken surface containing the patch, corner to corner of wall and edge to edge of ceiling. Provide additional coats until patch blends with adjacent surfaces.
4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition and ensures thermal and moisture integrity of building enclosure.

I. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.5 PROGRESS CLEANING

A. Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.

1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F.
3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.

   a. Use containers intended for holding waste materials of type to be stored.

4. Coordinate progress cleaning for joint-use areas where Contractor and other contractors are working concurrently.

B. Site: Maintain Project site free of waste materials and debris.

C. Work Areas: Clean areas where Work is in progress to the level of cleanliness necessary for proper execution of the Work.

1. Remove liquid spills promptly.
2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.

D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.

F. Exposed Surfaces: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Section 017419 "Construction Waste Management and Disposal."

H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.

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

J. Limiting Exposures: Supervise construction operations to ensure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.6 STARTING AND ADJUSTING

A. Coordinate startup and adjusting of equipment and operating components with commissioning requirements.

B. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.

C. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.

D. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Manufacturer's Field Service: Comply with qualification requirements in Section 014000 "Quality Requirements."

3.7 PROTECTION AND REPAIR OF INSTALLED CONSTRUCTION

A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.

B. Repair Work previously completed and subsequently damaged during construction period. Repair to like-new condition.

C. Protection of Existing Items: Provide protection and ensure that existing items to remain undisturbed by construction are maintained in condition that existed at commencement of the Work.

D. Comply with manufacturer's written instructions for temperature and relative humidity.

END OF SECTION 017300

SECTION 017419 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 SUMMARY

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

1. Disposing of nonhazardous demolition and construction waste.

1.2 DEFINITIONS

A. Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.

B. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.

C. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.

D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.

E. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.

F. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

1.3 ACTION SUBMITTALS

A. Waste Management Plan: Submit plan within 30 days of date established for the Notice to Proceed.

1.4 INFORMATIONAL SUBMITTALS

A. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

1.5 WASTE MANAGEMENT PLAN

A. General: Develop a waste management plan according to ASTM E 1609 and requirements in this Section. Plan shall consist of waste identification, waste reduction work plan, and cost/revenue analysis. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.

B. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.

1. Salvaged Materials for Reuse: For materials that will be salvaged and reused in this Project, describe methods for preparing salvaged materials before incorporation into the Work.
2. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
3. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location where materials separation will be performed.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PLAN IMPLEMENTATION

A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.

B. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, recycled, reused, donated, and sold.
2. Comply with Section 015000 "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.

3.2 DISPOSAL OF WASTE

A. General: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.

1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Burning: Do not burn waste materials.

C. Burning: Burning of waste materials is permitted only at designated areas on Owner's property, provided required permits are obtained. Provide full-time monitoring for burning materials until fires are extinguished.

D. Disposal: Remove waste materials from Owner's property and legally dispose of them.

END OF SECTION 017419

SECTION 017700 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for Contract closeout, including, but not limited to, the following:

1. Substantial Completion procedures.
2. Final completion procedures.
3. Warranties.
4. Final cleaning.

B. Related Requirements:

1. Section 017823 "Operation and Maintenance Data" for additional operation and maintenance manual requirements.
2. Section 017839 "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
3. Section 017900 "Demonstration and Training" for requirements to train the Owner's maintenance personnel to adjust, operate, and maintain products, equipment, and systems.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of cleaning agent.

B. Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.

C. Certified List of Incomplete Items: Final submittal at Final Completion.

1.3 CLOSEOUT SUBMITTALS

A. Certificates of Release: From authorities having jurisdiction.

B. Certificate of Insurance: For continuing coverage.

C. Field Report: For pest-control inspection.

1.4 SUBSTANTIAL COMPLETION PROCEDURES

A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's "punch list"), indicating the value of each item on the list and reasons why the Work is incomplete.

B. Submittals Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.

1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction, permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
2. Submit closeout submittals specified in other Division 01 Sections, including Project Record Documents, operation and maintenance manuals, damage or settlement surveys, property surveys, and similar final record information.
3. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
4. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Engineer. Label with manufacturer's name and model number.
5. Submit testing, adjusting, and balancing records.
6. Submit sustainable design submittals not previously submitted.
7. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.

C. Procedures Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.

1. Advise Owner of pending insurance changeover requirements.
2. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
3. Complete startup and testing of systems and equipment.
4. Perform preventive maintenance on equipment used prior to Substantial Completion.
5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings specified in Section 017900 "Demonstration and Training."
6. Advise Owner of changeover in utility services.
7. Participate with Owner in conducting inspection and walkthrough with local emergency responders.
8. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
9. Complete final cleaning requirements.
10. Touch up paint and otherwise repair and restore marred exposed finishes to eliminate visual defects.

D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of 10 days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Engineer, that must be completed or corrected before certificate will be issued.

1.5 FINAL COMPLETION PROCEDURES

A. Submittals Prior to Final Completion: Before requesting final inspection for determining Final Completion, complete the following:

1. Submit a final Application for Payment in accordance with Section 012900 "Payment Procedures."
2. Certified List of Incomplete Items: Submit certified copy of Engineer's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Engineer. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.
4. Submit pest-control final inspection report.

B. Inspection: Submit a written request for final inspection to determine acceptance a minimum of 10 days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

1.6 LIST OF INCOMPLETE ITEMS

A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.

1. Organize list of spaces in sequential order, starting with exterior areas first and proceeding from lowest floor to highest floor, listed by room or space number.
2. Organize items applying to each space by major element, including categories for ceilings, individual walls, floors, equipment, and building systems.
3. Include the following information at the top of each page:

    a. Project name.
    b. Date.
    c. Name of Engineer.
    d. Name of Contractor.
    e. Page number.

1.7 SUBMITTAL OF PROJECT WARRANTIES

A. Time of Submittal: Submit written warranties on request of Engineer for designated portions of the Work where warranties are indicated to commence on dates other than date of Substantial Completion, or when delay in submittal of warranties might limit Owner's rights under warranty.

B. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.

C. Warranty Electronic File: Provide warranties and bonds in PDF format. Assemble complete warranty and bond submittal package into a single electronic PDF file with bookmarks enabling navigation to each item. Provide bookmarked table of contents at beginning of document.

1. Submit on digital media acceptable to Engineer.

D. Warranties in Paper Form:

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

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

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 - EXECUTION

3.1 FINAL CLEANING

A. Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.

1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:

a. Clean Project site of rubbish, waste material, litter, and other foreign substances.
b. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
c. Remove debris and surface dust from limited-access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
d. Clean flooring, removing debris, dirt, and staining; clean according to manufacturer's recommendations.
e. Vacuum and mop concrete.
f. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.
g. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Polish mirrors and glass, taking care not to scratch surfaces.

h. Remove labels that are not permanent.
i. Wipe surfaces of mechanical and electrical equipment, elevator equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
j. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
k. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
l. Clean ducts, blowers, and coils if units were operated without filters during construction or that display contamination with particulate matter on inspection.
    1) Clean HVAC system in compliance with NADCA ACR.
m. Clean luminaires, lamps, globes, and reflectors to function with full efficiency.
n. Clean strainers.
o. Leave Project clean and ready for occupancy.

C. Construction Waste Disposal: Comply with waste-disposal requirements in Section 017419 "Construction Waste Management and Disposal."

3.2 REPAIR OF THE WORK

A. Complete repair and restoration operations required by Section 017300 "Execution" before requesting inspection for determination of Substantial Completion.

END OF SECTION 017700

SECTION 017823 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:

1. Operation and maintenance documentation directory manuals.
2. Emergency manuals.
3. Systems and equipment operation manuals.
4. Systems and equipment maintenance manuals.
5. Product maintenance manuals.

1.2 CLOSEOUT SUBMITTALS

A. Submit operation and maintenance manuals indicated. Provide content for each manual as specified in individual Specification Sections, and as reviewed and approved at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.

1. Engineer and Commissioning Authority will comment on whether content of operation and maintenance submittals is acceptable.
2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.

B. Format: Submit operation and maintenance manuals in the following format:

1. Submit on digital media acceptable to Engineer. Enable reviewer comments on draft submittals.

C. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 15 days before commencing demonstration and training. Engineer and Commissioning Authority will return copy with comments.

1. Correct or revise each manual to comply with Engineer's and Commissioning Authority's comments. Submit copies of each corrected manual within 15 days of receipt of Engineer's and Commissioning Authority's comments and prior to commencing demonstration and training.

D. Comply with Section 017700 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

1.3 FORMAT OF OPERATION AND MAINTENANCE MANUALS

A. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.

1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.

2. File Names and Bookmarks: Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

1.4 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

A. Organization of Manuals: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:

1. Title page.
2. Table of contents.
3. Manual contents.

B. Title Page: Include the following information:

1. Subject matter included in manual.
2. Name and address of Project.
3. Name and address of Owner.
4. Date of submittal.
5. Name and contact information for Contractor.
6. Name and contact information for Engineer.
7. Name and contact information for Commissioning Authority.
8. Names and contact information for major consultants to the Engineer that designed the systems contained in the manuals.
9. Cross-reference to related systems in other operation and maintenance manuals.

C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.

D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.

E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

1.5 EMERGENCY MANUALS

A. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.

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

1. Type of emergency.

2. Emergency instructions.
3. Emergency procedures.

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

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

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

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

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

1.6 SYSTEMS AND EQUIPMENT OPERATION MANUALS

A. Systems and Equipment Operation Manual: Assemble a complete set of data indicating operation of each system, subsystem, and piece of equipment not part of a system. Include information required for daily operation and management, operating standards, and routine and special operating procedures.

B. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:

1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
2. Performance and design criteria if Contractor has delegated design responsibility.
3. Operating standards.
4. Operating procedures.
5. Operating logs.
6. Wiring diagrams.
7. Control diagrams.
8. Piped system diagrams.
9. Precautions against improper use.
10. License requirements including inspection and renewal dates.

C. Descriptions: Include the following:

1. Product name and model number. Use designations for products indicated on Contract Documents.

2. Manufacturer's name.
3. Equipment identification with serial number of each component.
4. Equipment function.
5. Operating characteristics.
6. Limiting conditions.
7. Performance curves.
8. Engineering data and tests.
9. Complete nomenclature and number of replacement parts.

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

1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Instructions on stopping.
6. Normal shutdown instructions.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures.

E. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

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

1.7 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

A. Systems and Equipment Maintenance Manuals: Assemble a complete set of data indicating maintenance of each system, subsystem, and piece of equipment not part of a system. Include manufacturers' maintenance documentation, preventive maintenance procedures and frequency, repair procedures, wiring and systems diagrams, lists of spare parts, and warranty information.

B. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranties and bonds, as described below.

C. Manufacturers' Maintenance Documentation: Include the following information for each component part or piece of equipment:

1. Standard maintenance instructions and bulletins; include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.

a. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.

2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
3. Identification and nomenclature of parts and components.
4. List of items recommended to be stocked as spare parts.

D. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:

1. Test and inspection instructions.
2. Troubleshooting guide.
3. Precautions against improper maintenance.
4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
5. Aligning, adjusting, and checking instructions.
6. Demonstration and training video recording, if available.

E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.

F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

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

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

H. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.

1.8 PRODUCT MAINTENANCE MANUALS

A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.

B. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.

C. Product Information: Include the following, as applicable:

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

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

1. Inspection procedures.

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

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

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

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

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 017823

SECTION 017839 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for Project Record Documents, including the following:

1. Record Drawings.
2. Record specifications.
3. Record Product Data.

B. Related Requirements:

1. Section 017823 "Operation and Maintenance Data" for operation and maintenance manual requirements.

1.2 CLOSEOUT SUBMITTALS

A. Record Drawings: Comply with the following:

1. Number of Copies: Submit one set(s) of marked-up record prints.
2. Number of Copies: Submit copies of Record Drawings as follows:

a. Initial Submittal:

1) Submit PDF electronic files of scanned record prints.
2) Engineer will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.

b. Final Submittal:

1) Submit PDF electronic files of scanned Record Prints.
2) Submit each drawing, whether or not changes and additional information were recorded.

B. Record Specifications: Submit annotated PDF electronic files of Project's Specifications, including addenda and Contract modifications.

C. Record Product Data: Submit annotated PDF electronic files and directories of each submittal.

1. Where record Product Data are required as part of operation and maintenance manuals, submit duplicate marked-up Product Data as a component of manual.

1.3 RECORD DRAWINGS

A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.

1. Preparation: Mark record prints to show the actual installation, where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.

    a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
    b. Accurately record information in an acceptable drawing technique.
    c. Record data as soon as possible after obtaining it.
    d. Record and check the markup before enclosing concealed installations.
    e. Cross-reference record prints to corresponding photographic documentation.

2. Content: Types of items requiring marking include, but are not limited to, the following:

    a. Dimensional changes to Drawings.
    b. Revisions to details shown on Drawings.
    c. Depths of foundations.
    d. Locations and depths of underground utilities.
    e. Revisions to routing of piping and conduits.
    f. Revisions to electrical circuitry.
    g. Actual equipment locations.
    h. Duct size and routing.
    i. Locations of concealed internal utilities.
    j. Changes made by Change Order or Construction Change Directive.
    k. Changes made following Engineer's written orders.
    l. Details not on the original Contract Drawings.
    m. Field records for variable and concealed conditions.
    n. Record information on the Work that is shown only schematically.

3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
4. Mark record prints with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
5. Mark important additional information that was either shown schematically or omitted from original Drawings.
6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.

1.4 RECORD SPECIFICATIONS

A. Preparation: Mark Specifications to indicate the actual product installation, where installation varies from that indicated in Specifications, addenda, and Contract modifications.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.

2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.

4. For each principal product, indicate whether Record Product Data has been submitted in operation and maintenance manuals instead of submitted as Record Product Data.

5. Note related Change Orders, Record Product Data, and Record Drawings where applicable.

B. Format: Submit record specifications as annotated PDF electronic file.

1.5 RECORD PRODUCT DATA

A. Recording: Maintain one copy of each submittal during the construction period for Project Record Document purposes. Post changes and revisions to Project Record Documents as they occur; do not wait until end of Project.

B. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
3. Note related Change Orders, Record Specifications, and Record Drawings where applicable.

C. Format: Submit Record Product Data as annotated PDF electronic file.

1. Include Record Product Data directory organized by Specification Section number and title, electronically linked to each item of Record Product Data.

1.6 MAINTENANCE OF RECORD DOCUMENTS

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

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 017839

SECTION 017900 - DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:

1. Instruction in operation and maintenance of systems, subsystems, and equipment.

1.2 INFORMATIONAL SUBMITTALS

A. Instruction Program: Submit outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.

1. Indicate proposed training modules using manufacturer-produced demonstration and training video recordings for systems, equipment, and products in lieu of video recording of live instructional module.

1.3 QUALITY ASSURANCE

A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.

B. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Section 014000 "Quality Requirements," experienced in operation and maintenance procedures and training.

1.4 COORDINATION

A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.

B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.

C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data have been reviewed and approved by Engineer.

1.5 INSTRUCTION PROGRAM

A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.

B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:

1. Basis of System Design, Operational Requirements, and Criteria: Include the following:

    a. System, subsystem, and equipment descriptions.
    b. Performance and design criteria if Contractor is delegated design responsibility.
    c. Operating standards.
    d. Regulatory requirements.
    e. Equipment function.
    f. Operating characteristics.
    g. Limiting conditions.
    h. Performance curves.

2. Documentation: Review the following items in detail:

    a. Emergency manuals.
    b. Systems and equipment operation manuals.
    c. Systems and equipment maintenance manuals.
    d. Product maintenance manuals.
    e. Project Record Documents.
    f. Identification systems.
    g. Warranties and bonds.
    h. Maintenance service agreements and similar continuing commitments.

3. Emergencies: Include the following, as applicable:

    a. Instructions on meaning of warnings, trouble indications, and error messages.
    b. Instructions on stopping.
    c. Shutdown instructions for each type of emergency.
    d. Operating instructions for conditions outside of normal operating limits.
    e. Sequences for electric or electronic systems.
    f. Special operating instructions and procedures.

4. Operations: Include the following, as applicable:

    a. Startup procedures.
    b. Equipment or system break-in procedures.
    c. Routine and normal operating instructions.
    d. Regulation and control procedures.
    e. Control sequences.
    f. Safety procedures.
    g. Instructions on stopping.
    h. Normal shutdown instructions.
    i. Operating procedures for emergencies.
    j. Operating procedures for system, subsystem, or equipment failure.
    k. Seasonal and weekend operating instructions.
    l. Required sequences for electric or electronic systems.
    m. Special operating instructions and procedures.

5. Adjustments: Include the following:

    a. Alignments.
    b. Checking adjustments.

c. Noise and vibration adjustments.
d. Economy and efficiency adjustments.

6. Troubleshooting: Include the following:

a. Diagnostic instructions.
b. Test and inspection procedures.

7. Maintenance: Include the following:

a. Inspection procedures.
b. Types of cleaning agents to be used and methods of cleaning.
c. List of cleaning agents and methods of cleaning detrimental to product.
d. Procedures for routine cleaning.
e. Procedures for preventive maintenance.
f. Procedures for routine maintenance.
g. Instruction on use of special tools.

8. Repairs: Include the following:

a. Diagnosis instructions.
b. Repair instructions.
c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
d. Instructions for identifying parts and components.
e. Review of spare parts needed for operation and maintenance.

1.6 PREPARATION

A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 017823 "Operation and Maintenance Data."

B. Set up instructional equipment at instruction location.

1.7 INSTRUCTION

A. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.

B. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.

C. Scheduling: Provide instruction at mutually agreed-on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.

1. Schedule training with Owner, through Engineer, with at least seven days' advance notice.

D. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.

E. Cleanup: Collect used and leftover educational materials and give to Owner. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

PART 2 - PRODUCTS

PART 3 - EXECUTION

END OF SECTION 017900

SECTION 024119 – SELECTIVE DEMOLITION

GENERAL

1.1 SUMMARY

A. Section Includes:

1. Demolition and removal of selected portions of building or structure.

1.2 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition waste becomes property of Contractor.

1.3 INFORMATIONAL SUBMITTALS

A. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and, for noise control. Indicate proposed locations and construction of barriers.

B. Schedule of selective demolition activities with starting and ending dates for each activity.

C. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician.

1.4 QUALITY ASSURANCE

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

1.5 FIELD CONDITIONS

A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.

B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

C. Notify Engineer of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.

1. The awarded contractor shall perform a hazardous materials survey prior to beginning demolition activities. This survey shall test the areas in scope of this project for (at a minimum): asbestos containing materials, lead paint and lead containing materials, polychlorinated biphenyls, and mercury.
2. The contractor shall provide a copy of the survey to the Owner and Engineer for review. Abatement required based on the survey results will be addressed as a contract modification or will be removed under a separate contract.

E. Storage or sale of removed items or materials on-site is not permitted.

F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

1. Maintain fire-protection facilities in service during selective demolition operations.

G. Arrange selective demolition schedule so as not to interfere with Owner's 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 and using approved contractors 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 ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

B. Perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.

C. Inventory and record the condition of items to be removed and salvaged.

3.2 PREPARATION

A. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction.

3.3 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems to Remain: Maintain services/systems indicated 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 utility services and mechanical/electrical systems serving areas to be selectively demolished.

1. Owner will arrange to shut off indicated services/systems when requested by Contractor.

2. Arrange to shut off utilities with utility companies.
3. 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.
4. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings to be removed.
    a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
    b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.
    c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
    d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
    e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
    f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
    g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.

3.4 PROTECTION

A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

B. Temporary Shoring: Design, 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.

C. Remove temporary barricades and protections where hazards no longer exist.

3.5 SELECTIVE DEMOLITION

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete 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. 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. Maintain fire watch during and for at least 3 hours after flame-cutting operations.

5. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
6. Dispose of demolished items and materials promptly. Comply with requirements in Section 017419 "Construction Waste Management and Disposal."

B. 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.

C. Removed and Reinstalled Items:

1. Clean and repair items to functional condition adequate for intended reuse.
2. Pack or crate items after cleaning and repairing. Identify contents of containers.
3. Protect items from damage during transport and storage.
4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

D. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Engineer, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.6 CLEANING

A. Remove demolition waste materials from Project site and recycle or dispose of them according to Section 017419 "Construction Waste Management and Disposal."

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. Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."

B. Burning: Do not burn demolished materials.

C. 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 024119

SECTION 075216 – SBS-MODIFIED BITUMINOUS MEMBRANE ROOFING (SBS ROOFING)

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. SBS-Modified bituminous roofing membrane – Existing.

B. Insulation, flat and tapered.

C. Cover Board.

D. Base flashings.

E. Roofing cant strips and accessories.

1.2 DEFINITIONS

A. Roofing Terminology: Refer to ASTM D1079 for definitions of terms related to roofing work not otherwise defined in this Section.

1.3 REFERENCE STANDARDS

A. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures Most Recent Edition Cited by Referring Code or Reference Standard.

B. ASTM C472 - Standard Test Methods for Physical Testing of Gypsum, Gypsum Plasters, and Gypsum Concrete 2020.

C. ASTM C473 - Standard Test Methods for Physical Testing of Gypsum Panel Products 2019.

D. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus 2021.

E. ASTM C728 - Standard Specification for Perlite Thermal Insulation Board 2017a (Reapproved 2022).

F. ASTM C1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board 2022a.

G. ASTM D1079 - Standard Terminology Relating to Roofing and Waterproofing 2020.

H. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber 2021.

I. ASTM D6163/D6163M - Standard Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Glass Fiber Reinforcements 2021.

J. ASTM E108 - Standard Test Methods for Fire Tests of Roof Coverings 2020a.

K. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2022.

L. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials 2022a.

M. FM 4470 - Single-Ply, Polymer-Modified Bitumen Sheet, Built-Up Roof (BUR) and Liquid Applied Roof Assemblies for Use in Class 1 and Noncombustible Roof Deck Construction 2016.

N. NRCA (RM) - The NRCA Roofing Manual 2022.

O. UL 790 - Standard for Standard Test Methods for Fire Tests of Roof Coverings Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. See Section 01 30 00 - Administrative Requirements, for pre-installation meeting procedures.

B. Preinstallation Meeting

1. Convene two weeks before starting work of this section.
2. Attendees:

   a. Installer of each component of associated work.
   b. Installers of deck or substrate construction to receive roofing work.
   c. Installers of rooftop units and other work in around roofing must precede or follow roofing work (including mechanical work if any).
   d. Architect.
   e. Owner.
   f. Roofing system manufacturer's representative.
   g. Other representatives directly concerned with performance of Work, including (where applicable) Owner's insurers, test agencies and governing authorities.

3. Agenda to include:

   a. Review foreseeable methods and procedures related to roofing work.
   b. Tour representative areas of roofing substrates (decks), inspect and discuss condition of substrate, roof drains, curbs, penetrations and other preparatory work performed by other trades.
   c. Review structural loading limitations of deck and inspect deck for loss of flatness and for required attachment.
   d. Review roofing system requirements (drawings, specifications and other contract documents).
   e. Review required submittals both completed and yet to be completed.
   f. Review and finalize construction schedule related to roofing work and verify availability of materials, Installer's personnel, equipment and facilities needed to make progress and avoid delays.
   g. Review required inspection, testing, certifying and material usage accounting procedures.
   h. Review weather and forecasted weather conditions and procedures for coping with unfavorable conditions, including possibility of temporary roofing.

i. Record discussion of conference including decisions and agreements 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.
j. Review notification procedures for weather or non-working days.

1.5 SUBMITTALS FOR REVIEW

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide manufacturer's catalog data for membrane and bitumen materials, base flashing materials.

1. Include data substantiating that materials comply with requirements.
2. Hydrofluorocarbon (HFC) and Global Warming Potential (GWP): Provide letter from insulation manufacturer stating products provided to job site meet State and Federal regulations related to HFC and GWP for the project location.

C. Shop Drawings: Indicate joint or termination detail conditions, conditions of interface with other materials, and mechanical fastener layout.

1. Include plans, sections, details, and attachments to other work, including for the following:

a. Crickets, saddles, and tapered edge strips, including slopes.

1.6 DOCUMENTATION FOR ON-SITE INFORMATION

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Documentation for On-Site Information shall be provided on site by Contractor for use by Contractor, subcontractors and installers. Documentation submitted to Architect will not be reviewed.

C. Retain the following documentation for on-site information:

1. Assembly Design Data: Provide Stamped engineered calculations licensed in the State the project is located, indicating roof assembly meets higher of either, Building Code or Owner's building insurance required values for wind uplift.

a. When Wind Tunnel testing values are provided, as basis for engineered calculations.

2. Installer's Qualification Statement.
3. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

a. Certify by PRI that products used meet or exceed manufacturer's criteria
b. Certificates of analysis to show test results of actual materials used on the project. Analysis to show minimum acceptable specification for material, actual test results of materials used on the project and the minimum test results for the batch or run of materials used.
c. Certificate of Analysis shows test results for the following properties:

1) Length and Width.
2) Thickness at Selvedge and Total Thickness.
3) Weight.
4) Selvedge width.
5) Low Temperature Flexibility: every 300 hundred rolls.

6) Granule Embedment: Every 300 hundred rolls.
7) Breaking Strength: Beginning and end of each production run.
8) Compound stability: Beginning and end of each production run.
9) Dimensional Stability: Every 300 hundred rolls (polyester carriers).

4. Test Reports:

   a. Based on evaluation of tests performed by manufacturer and witnessed by a qualified independent testing agency, indicate compliance of components of roofing system with published manufacturers data sheet criteria.

5. Manufacturer's Written Installation Instructions: Indicate special handling criteria, installation sequence, and cleaning procedures.
6. Manufacturer's Field Reports: Indicate procedures followed, ambient temperatures, humidity, wind velocity during application, and supplementary instructions given.

   a. Frequency of Manufacturer's Field Reports:

      1) Prior to roof vapor retarder application.
      2) Prior to membrane application.
      3) During membrane application.
      4) Upon completion of installation.

7. Coordination Drawings.
8. Other types indicated.

1.7 SUBMITTALS FOR PROJECT CLOSEOUT

A. Submit following at project closeout in compliance with requirements of Section 01 78 00 - Closeout Submittals:

   1. Project record documents.
   2. Operation and maintenance data: Maintenance manuals for roofing system specified.
   3. Warranty: Sample copy of standard roofing manufacturer's warranty stating obligations, remedies, limitations, and exclusions of warranty.

      a. Warranted Assembly: Letter from manufacturer stating products meet or exceed criteria of this section, and assembly required is warrantable as an assembly.
      b. Provide documentation showing that the system has been tested by an accredited third party laboratory and passes the requirements set out in Part 2.

   4. Submittals for On-Site information
   5. Other types as indicated.

B. Submit for Owner's benefit during and after project completion.

1.8 QUALITY ASSURANCE

A. Perform work in accordance with NRCA Roofing and Waterproofing Manual and manufacturer's instructions.

B. Furnish products by/or approved by Roofing Manufacturer for entire roofing system.

C. Provide documentation that a Certificate of Analysis will be provided to the Owner with each shipment.

D. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum ten (10) years of documented experience.

E. Installer Qualifications: Company specializing in performing work of this section with minimum five (5) years experience and approved by manufacturer.

1. Installer to perform Work of this Section who to be specialized in installing roofing similar to that required for this Project and be in continuous business under same name for last five (5) years.
2. Installer to be approved, authorized, and licensed by roofing system manufacturer to install manufacturer's product prior to date of this Bid, in writing; and who is eligible to receive standard roofing manufacturer's warranty.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Store roofing materials in a dry, well-ventilated, weathertight location to ensure no significant moisture pickup and maintain at a temperature exceeding roofing system manufacturer's written instructions.

B. Store rolls of felt and other sheet materials on end on pallets or other raised surfaces.

1. Do not double-stack rolls.

C. Handle and store roofing materials and place equipment in a manner to avoid significant or permanent damage to deck or structural supporting members.

D. Do not leave materials on roof overnight or when roofing work is not in progress unless protected from weather and moisture and unless maintained at a temperature exceeding 50 deg F.

E. Deliver and store liquid materials in their original undamaged containers in a clean, dry, protected location and within temperature range required by roofing system manufacturer.

F. Protect roofing insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources.

1. Store in a dry location.

G. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

1.10 FIELD CONDITIONS

A. Coordinate work with installation of associated flashings and counterflashings installed by other sections as work of this section proceeds.

B. Weather Limitations: Proceed with roofing work only when existing and forecasted weather conditions permit roofing to be installed according to manufacturers' written instructions and warranty requirements.

C. Provide tarps or plastic sheeting to adequately protect opened roofs and flashings and to prevent entrance of moisture or rain water into structure until new materials have been applied and roof is in a watertight condition.

D. Do not start installation of any more roof surface at one time than can be adequately covered and protected in event of sudden unexpected rainfall.

E. Provide waterproof canvas tarp or plastic sheeting handy in case of emergency.

1.11 WARRANTY

A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

B. Standard Roofing Manufacturer's Warranty: Submit written warranty, with no dollar limit (NDL), signed by roofing system manufacturer agreeing to promptly repair leaks in roof membrane and base flashings resulting from defects in materials or workmanship, including approved insulation and related materials damaged due to membrane failure, for following warranty period, with no exclusion for ponded water.

1. Warranty Period: 20 years.

C. Roofing Installers Warranty: Submit roofing Installer's warranty, signed by Installer, covering Work of this Section, including watertightness, materials, workmanship, and repair of leaks for following warranty period:

1. Warranty Period: 2 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 ROOFING

A. Modified Bituminous Roofing:

1. Existing membrane to remain.

B. Acceptable Insulation Types - Tapered Application: Any of the types specified.

1. Tapered coated polyisocyanurate board.

2.2 AUXILIARY MEMBRANE MATERIALS

A. Furnish auxiliary materials recommended by roofing system manufacturer for intended use and compatible with SBS-modified bituminous roofing.

1. Furnish liquid-type auxiliary materials that meet VOC limits of authorities having jurisdiction.

B. Vapor Retarder:

1. Dual purpose product when fused to substrate or base layer meets requirements for a vapor barrier and temporary dry-in roof area with a slip resistant surface for protected traffic.

a. One layer SBS modified bitumen base sheet; adhered.

1) SBS polymer-modified bitumen sheet, reinforced with non-woven fabric, complying with ASTM D6163/D6163M, Type I, Grade S.
2) Product: SA Vapor Retarder by Siplast.

C. Resin Flashing System: Liquid-applied, fully reinforced, multi-component acrylic membrane installed over a prepared or primed substrate.

1. Flashing system consists of following:

a. Catalyzed polymethyl methacrylate primer (PMMA).
b. Basecoat and topcoat, combined with a non-woven polyester fleece.
c. Use of flashing system shall be specifically approved in advance by membrane manufacturer for each application.

2. Product: Parapro 123 Flashing System by Siplast.

D. Mastic Sealant: Polyisobutylene, plain or modified bituminous, nonhardening, nonmigrating, nonskinning, and nondrying.

E. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions of FM 4470; designed for fastening base sheets, base-ply felts, and base flashings and for backnailing modified bituminous membrane to substrate; tested by manufacturer for required pullout strength; and acceptable to roofing system manufacturer.

F. Metal Flashing Sheet: Metal flashing sheet is specified in Section 07 62 00

G. Composite Flashing Sheet: High melt asphalt base with fiberglass reinforcement and finish ply of aluminum foil. Type as recommended by manufacturer.

H. Sealant in Contact with Roof Membrane Materials: Type approved by roofing membrane manufacturer.

I. Pipe Flashings: Resin Flashing system.

J. Miscellaneous Accessories: Type recommended by roofing system manufacturer for intended use.

K. Sealant:

1. Application: Membrane penetrations and as noted on drawings.
2. Product: Elastomeric sealant, PS-715NS by Siplast.

2.3 COVER BOARD

A. Cover Board: Glass mat faced gypsum panels, per ASTM C473 and ASTM C518 fire resistant type, 1/4 inch thick.

1. Application: Over insulation and under membrane.
2. Manufacturer:

a. Basis of Design: DensDeck Prime with Eonic Technology manufactured by G-P Gypsum Corp; www.densdeck.com.
b. Dexcell manufactured by National Gypsum; www.nationalgypsum.com.
c. Substitutions: See Section 01 60 00 - Product Requirements.

3. Properties:

a. Width: 4 feet
b. Length: 4 feet
c. Weight: 2.0 lb/sq. ft.
d. Surfacing: Primed Fiberglass Mat.

e. Flexural Strength, Parallel (ASTM C473): 80 lbf, minimum.
f. Permeance (ASTM E96/E96M): Greater than 23 perms.
g. R-Value (ASTM C518): 0.56.
h. Water Absorption (ASTM C473): Less than 5 percent of weight
i. Surface Water Absorption (ASTM C473): Nominal 1.0 grams.
j. Compressive Strength (Applicable Sections of ASTM C472): Nominal 900 psi.
k. Flame Spread/Smoke Development (ASTM E84): Not more than 0 Flame Spread, 0 Smoke Development.
l. Fire resistance rating (UL 790 and ASTM E108): Class A
m. Mold Resistance (ASTM D3273): Scored a 10.

2.4 INSULATION MATERIALS

A. Provide preformed, roofing insulation boards that comply with requirements, selected from manufacturer's standard sizes and of thicknesses indicated.

1. Preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain.
2. Fabricate to slopes indicated.

B. Polyisocyanurate Board Insulation: Rigid and Tapered cellular foam, complying with ASTM C1289, Type II, Class 2, (CGF) Coated Glass Facer both faces; Grade 2, and with following characteristics:

1. Compressive Strength: 25 psi
2. Board Size: 48 x 48 inch.
3. Board Thickness: 1-1/2 inch maximum per board with joints staggered. See drawings for overall thickness.
4. Thermal Resistance: LTTR-value of 5.60 per inch.
5. Board Edges: Square.
6. Manufacturers:

a. Basis of Design: Paretherm CG by Siplast; www.siplast.com.
b. Substitutions: See Section 016000 - Product Requirements.

2.5 INSULATION ACCESSORIES

A. Furnish roofing insulation accessories recommended by insulation manufacturer for intended use and compatible with sheet roofing material.

B. Low Rise Foam Adhesive:

1. Single component, moisture cure, solvent free, polyurethane rigid insulation and cover board adhesive.
2. Dispensed form a portable, disposable pre-pressurized metal container using a flexible wand.

C. Cants and Tapered Edge Strips: Rigid, perlite insulation board, complying with ASTM C728.

D. Sealants: As recommended by membrane manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions under which roofing will be applied, with installer present, for compliance with requirements.

B. Verify that roof openings and penetrations are in place and set and braced and that roof drains are properly clamped into position.

C. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at roof penetrations and terminations and match thicknesses of insulation required.

D. Verify that deck is securely fastened with no projecting fasteners and with no adjacent units in excess of 1/16 inch out of plane.

E. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrate of dust, debris, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.

B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

3.3 INSTALLATION

A. Start installation of resin flashing roofing system in presence of roofing system manufacturer's technical personnel.

B. Cant Strips: Install and secure preformed 45-degree cant strips at junctures of modified bituminous membrane roofing system with vertical surfaces or angle changes greater than 45 degrees.

C. Cooperate with inspecting and testing agencies engaged or required to perform services for installing resin flashing roofing system.

D. Coordinate installing roofing system components so insulation and resin flashing soofing are not exposed to precipitation or left exposed at end of workday or when rain is forecast.

1. Provide cutoffs at end of each day's work to cover exposed insulation with a course of coated felt with joints and edges sealed.
2. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system.
3. Remove and discard temporary seals before beginning work on adjoining roofing.

3.4 ROOF VAPOR RETARDER INSTALLATION

A. Roof Vapor Retarder: Apply to deck surface in accordance with roofing and roof vapor retarder manufacturers' instructions.

1. Extend vapor retarder under cant strips and blocking.

3.5 INSULATION INSTALLATION

A. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at end of workday.

B. Comply with roofing system manufacturer's written instructions for installing roofing insulation.

C. Install one or more layers of insulation to achieve required thickness.

1. When overall insulation thickness is 2 inches or greater, install required thickness in 2 or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches in each direction.

D. Install tapered insulation to conform to slopes indicated and to Shop Drawings.

E. Install tapered edge strips at perimeter edges of roof that do not terminate at vertical surfaces.

F. Install insulation with long joints of insulation in continuous straight lines with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch with insulation.

1. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.

G. Attached Insulation: Install each layer of insulation and secure to deck or other insulation layers using adhesive.

H. Install cover board over insulation with long joints in continuous straight lines with end joints staggered between rows.

1. Loosely butt cover boards together and secure with low rise foam adhesive according to roofing system manufacturer's written instructions for wind specified uplift.

3.6 FLASHING AND STRIPPING INSTALLATION

A. Install base flashing system over cant strips and other sloping and vertical surfaces, at roof edges, and secure to substrates according to roofing system manufacturer's written instructions and as follows:

1. Base Flashing Application: Adhere base flashing to substrate with adhesive, applied to substrate and back of base flashing at rate required by roofing system manufacturer.
2. Extend base flashing up wall a minimum of 8 inches above roof membrane and 4 inches onto field of roof membrane.

B. Resin Flashing:

1. Install at penetrations and openings per manufacturer's written installation instructions.

3.7 FIELD QUALITY CONTROL

A. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion and submit report to Architect.

1. Notify Architect and Owner 72 hours in advance of date and time of inspection.

B. Manufacturer's Quality Control:

1. Technical representative of manufacturer to periodically (minimum 3 visits) observe Work in progress.
2. Representative, as a minimum, to be present to observe deck preparation, general installation procedures and final completion.
3. Notify Architect and Owner's Representative at least twenty-four (24) hours prior to any roofing Work.
4. Work not to proceed until such observations have been made in field report and conditions have been approved in writing by Architect.
5. Upon completion of installation to ascertain that entire systems has been installed according to manufacturer's specifications and approved details.

3.8 PROTECTION

A. Protect resin flashing roofing from damage and wear during remainder of construction period.

1. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.

B. Correct deficiencies in or remove resin flashing roofing that does not comply with requirements specified or required for warranty, repair substrates, reinstall roofing, and repair base flashings to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

END OF SECTION 075216

SECTION 230500 – COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 specification sections, apply to this section.

1.2 SUMMARY

A. Requirements under this section include required work that is common to multiple sections in Division 23 and shall be complied with by all suppliers and subcontractors.

1.3 DEFINITIONS

A. A/E: Prime design consultant responsible for preparation of these specifications.

B. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

C. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

D. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

E. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.

F. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

G. The following are industry abbreviations for plastic materials:

1. CPVC: Chlorinated polyvinyl chloride plastic.
2. PE: Polyethylene plastic.
3. PVC: Polyvinyl chloride plastic.

H. The following are industry abbreviations for rubber materials:

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

1.4 SUBMITTALS

A. Provide submittals per Division 01, Section 013300, “Submittal Procedures.”

B. Product Data: Submit product data for each type of product indicated herein. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Required in the following areas: Mechanical Rooms, Pump Rooms, shafts, and congested areas required for coordination. Include as a minimum all piping and ductwork.
2. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Wiring Diagrams: For power, signal, and control wiring.

D. Operation and Maintenance Data:

1. Ductwork system accessories including, but not limited to; fire and smoke dampers, backdraft dampers, terminal units, etc.
2. All equipment that includes an electrical connection and/or has recommended maintenance, along with all related accessories.
3. All controls.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings from an applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

D. 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.

E. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics (such as larger motor horsepower) may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 PROJECT CONDITIONS

A. Do not install products or materials that are wet, moisture damaged, or mold damaged.

B. Field Measurements: Verify actual dimensions of site conditions by field measurements before fabrication.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.8 TRANSITIONS AND OFFSETS BEYOND THE SCOPE OF WORK

A. Check drawings of other trades to verify spaces in which work will be installed. Establish exact locations of piping and ducts in such a manner as to conform to structure, avoid obstructions, and keep openings and passageways clear. Lines that must pitch, or that must have a constant elevation, shall have the right-of-way over lines not so restricted. Maintain maximum headroom. If space conditions appear inadequate, notify the A/E before proceeding with the work. Make reasonable modifications in the work without extra cost as needed to prevent conflict with work of other trades and for proper execution of the work.

B. If the total additional weight of sheet metal or piping materials (including associated fittings, hangers, seismic restraints and insulation) required for piping offsets which are not indicated or inferred on the contract documents exceeds nine percent (9%) of the total weight of the piping system, the amount exceeding this percentage may be considered to be beyond the requirements of these documents.

C. In order for additional compensation to be considered for transitions and offsets in excess of the amount stated in Paragraph B above, the Contractor shall submit to the A/E a detailed take-off of all materials indicated on the contract documents. The Contractor shall also submit a separate take-off along with coordination drawings or marked-up contract drawings with yellow highlighting indicating specifically the transitions and offsets considered to be "extra work." Additional compensation will only be considered if take-offs and drawings are received by the A/E four weeks in advance of the fabrication of conflicting work in the area of concern so that the A/E may be able to determine ways to minimize or eliminate the extra work.

1.9 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08.

PART 2 - PRODUCTS

2.1 STEEL PIPE HANGERS AND EQUIPMENT SUPPORTS

A. Description: MSS SP-58-2009; **"**Pipe Hangers and support– Materials, Design, Manufacture, Selection, Application and Installation"**:** Types 1 through 59, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

1. Basis of Design: Anvil.
2. Manufacturers:

a. Anvil.
b. B-Line Systems, Inc.
c. ERICO/Michigan Hanger Co.
d. Hubbard Enterprises/HOLDRITE®
e. PHD Manufacturing, Inc.

B. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

C. Nonmetallic Coatings: Plastic coating, jacket, or liner.

D. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.2 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

1. Basis of Design: Unistrut Corp.; Tyco International, Ltd.
2. Manufacturers:

a. B-Line Systems, Inc.; a division of Cooper Industries.
b. ERICO/Michigan Hanger Co.; ERISTRUT Div.
c. Hubbard Enterprises/HOLDRITE®
d. PHD Manufacturing, Inc.
e. Unistrut Corp.; Tyco International, Ltd.

B. Coatings: Manufacturer's standard finish unless bare metal surfaces are indicated.

C. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.3 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated or stainless steel, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Basis of Design: Hilti, Inc.
2. Manufacturers:

a. Hilti, Inc.
b. Hubbard Enterprises/HOLDRITE®

c. ITW Ramset/Red Head.
d. Powers Fasteners.

2.4 EQUIPMENT SUPPORTS

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

2.5 MISCELLANEOUS MATERIALS

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

2.6 MATERIALS FOR ANCHORS

A. Indicate alignment-guide length and maximum spider travel on Drawings.

B. Description: Steel, factory fabricated, with bolted two-section outer cylinder and base for alignment of piping and two-section guiding spider for bolting to pipe.

C. Steel Shapes and Plates: ASTM A 36/A 36M.

D. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel, hex head.

E. Washers: ASTM F 844, steel, plain, flat washers.

F. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened Portland cement concrete, and tension and shear capacities appropriate for application.

1. Stud: Threaded, zinc-coated carbon steel.
2. Expansion Plug: Zinc-coated steel.
3. Washer and Nut: Zinc-coated steel.

G. Chemical Fasteners: Insert-type-stud bonding system anchor for use with hardened Portland cement concrete, and tension and shear capacities appropriate for application.

1. Bonding Material: ASTM C 881, Type IV, Grade 3, 2-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
2. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
3. Washer and Nut: Zinc-coated steel.

H. Concrete: Portland cement mix, 3000 psi minimum. Comply with requirements in Division 03 Section "Cast-in-Place Concrete" for formwork, reinforcement, and concrete.

2.7 TEST PLUGS

A. Manufacturers

1. Peterson Equipment Co., Inc.
2. Sisco Manufacturing Co.
3. Or equal.

B. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem beyond insulation for units to be installed in insulated piping.

C. Minimum Pressure and Temperature Rating: 500 psig at 200-degree F.

D. Core Inserts: One or two self-sealing neoprene, valves gasketed orifice, suitable for inserting a 1/8” OD probe assembly.

1. Insert material for air, water, oil, or gas service at 20 to 200-degree F shall be CR.
2. Insert material for air or water service at minus 30 to plus 275-degree F shall be EPDM.

PART 3 - EXECUTION

3.1 DEMOLITION

A. Refer to Division 01, Section 017329, "Cutting and Patching" and Division 02, Section 024119, "Selective Structure Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed.

1. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
2. Equipment to Be Removed: Disconnect and cap services and remove equipment.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.3 HANGER AND SUPPORT APPLICATIONS

A. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

B. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

C. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod.
8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

D. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

E. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

F. Install building attachments within concrete slabs or attach to structural steel. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

G. Do not use piping, ductwork, and equipment to support other piping, ductwork, equipment, or devices such as j-boxes and controls sensors. Provide independent supports. Do not drill holes, screws, or make similar penetrations into equipment such as sound attenuators and AHU casings.

3.4 PAINTING

A. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.5 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.6 COMMISSIONING

A. Notify the Commissioning Agent one week prior to start up of equipment.

B. Submit to the Commissioning Agent a Verification of Completion form with the pre-functional check off sheet for each component when it is ready for functional testing.

C. Assist the Commissioning Agent as required to perform the functional testing on the system components and the system as a whole.

END OF SECTION 230500

SECTION 230550 – IDENTIFICATION FOR PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 specification sections, apply to this section.

1.2 SUBMITTALS

A. Product Data: Submit for each type of product indicated.

B. Valve numbering scheme.

C. Valve Schedules: For each piping system to include in maintenance manuals.

1.3 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustic ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch-thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160-degree F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surface of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.3 COMMISSIONING

A. Notify the Commissioning Agent one week prior to startup of equipment.

B. Submit to the Commissioning Agent a Verification of Completion form with the pre-functional check off sheet for each component when it is ready for functional testing.

C. Assist the Commissioning Agent as required to perform the functional testing on the system components and the system as a whole.

END OF SECTION 230550

SECTION 230590 – TESTING ADJUSTING AND BALANCING

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.

B. Division 23, Section 230500 is directly related. Other sections are indirectly related and shall be reviewed.

1.2 SUMMARY

A. Work under this section shall include furnishing all labor, materials, tools, and equipment necessary for testing, adjusting, and balancing (TAB) necessary to place all systems and items of equipment, specified in Division 23, in proper operating condition. All work shall be completely tested as required by this section and applicable city, county, and state codes and ordinances.

B. Submit copies of all testing, adjusting, and balancing data to A/E.

C. Leak and pressure testing of piping and duct systems and rotational testing of motors shall be performed by the installing contractor.

D. TAB shall include the following:

1. Air Systems:

a. Constant-volume air systems.
b. Variable-air-volume systems.

2. HVAC equipment quantitative-performance settings.
3. Verifying that automatic control devices are functioning properly.
4. Reporting results of activities and procedures specified in this Section.

1.3 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. Air Systems: Includes all outside air, supply air, return air, transfer air, exhaust air, relief air and make-up air systems.

C. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.

D. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.

E. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

F. Flow rate tolerance: The allowable percentage variation, minus to plus, of actual flow rate from values (design) in the contract documents.

G. Hydronic Systems: Includes chilled water, condenser water, heating hot water, and glycol-water systems, and heat recovery water systems.

H. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

I. RC: Room criteria.

J. Report Forms: Test data sheets for recording test data in logical order.

K. Smoke-Control System: An engineered system that uses fans to produce airflow and pressure differences across barriers to limit smoke movement.

L. Smoke-Control Zone: A space within a building that is enclosed by smoke barriers and is a part of a zoned smoke-control system.

M. Stair Pressurization System: A type of smoke-control system that is intended to positively pressurize stair towers with outdoor air by using fans to keep smoke from contaminating the stair towers during an alarm condition.

N. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

O. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.

P. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

Q. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

R. TAB: Testing, adjusting, and balancing.

S. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

T. Terminal Unit: A device that controls the temperature and/or volume of air that enters or leaves a zone.

U. Test: A procedure to determine quantitative performance of systems or equipment.

V. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

W. Zone: The space that is controlled by a terminal unit or other temperature controlling device.

1.4 SUBMITTALS

A. Qualification Data: Within 30 days from Contractor's Notice to Proceed, submit two copies of evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.

C. Warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Contracting: The TAB agency shall be a subcontractor of the General Contractor and shall report to and be paid by the General Contractor.

B. TAB Firm Qualifications:

1. The TAB agency shall be either a certified member of AABC or certified by the NEBB 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 A/E and submit another TAB firm for approval. Any agency that has been the subject of disciplinary action by either the AABC or the NEBB 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.
2. TAB Specialist: The TAB specialist shall be either a member of AABC or an experienced technician of the Agency certified by NEBB. 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 A/E and submit another TAB Specialist for approval.
3. TAB Specialist Responsibilities:

    a. The General Contractor, within 60 days after the notice to proceed, shall identify TAB specialist who would be responsible for supervising, coordinating, scheduling and reporting all TAB work and related activities and provide necessary information as required by the A/E.
    b. All TAB work shall be performed under the direct supervision of the TAB specialist.
    c. The reports shall be accompanied by report forms and schematic drawings required by the TAB standard, AABC or NEBB. The reports shall be signed by the TAB specialist and shall bear the seal of the TAB standard.
    d. The TAB Specialist would follow all TAB work through its satisfactory completion.
    e. Final markings of settings of all HVAC adjustment devices.
    f. Permanently mark location of duct test ports.

4. All TAB technicians performing actual TAB work shall be experienced and must have done satisfactory work on a minimum of three projects comparable in size and complexity of this project and must be certified so by the TAB agency in writing.

C. Test Equipment Criteria: The basic instrumentation requirements and accuracy/calibration required by AABC, National Standards or by NEBB Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems and instrument manufacturer. Provide calibration history of the instruments to be used for test and balance purpose.

1. Instrumentation Calibration: Calibrate instruments at least every year or more frequently if required by instrument manufacturer.
2. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

D. Tab Criteria and Tolerances:

1. One or more of the applicable AABC or NEBB publications, supplemented by ASHRAE Handbook "2019 HVAC Applications" Chapter 39, and requirements stated herein shall be the basis for planning, procedures, and reports.
2. Flow rate tolerance: Following tolerances are allowed. For tolerances not mentioned herein follow ASHRAE Handbook "2019 HVAC Applications", Chapter 39 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.

   a. Air handling unit and all other fans, cubic feet per minute: Minus 5 percent to plus l0 percent.
   b. Minimum outside air: 0 percent to plus 10 percent.

3. Systems shall be adjusted for energy efficient operation as described in PART 3.
4. Typical TAB procedures and results shall be demonstrated to the A/E for one air distribution system as follows:

   a. When field TAB work begins.
   b. During each partial final inspection and the final inspection for the project if requested by Owner.

C. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use standard forms from AABC’s "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB’s "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."

E. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems or NEBB's " Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems, " Section II, " Required Instrumentation for NEBB Certification."

1.6 PROJECT CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

B. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.8 WARRANTY

A. Special Guarantee: Provide a guarantee on NEBB forms stating that NEBB will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee shall include the following provisions:

1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
2. Systems are balanced to optimum performance capabilities within design and installation limits.

1.9 APPLICABLE PUBLICATIONS

A. The following publications form a part of this specification to the extent indicated by the reference thereto. In text, the publications are referenced to by the initials of the organization.

B. ASHRAE: 2019 HVAC Applications ASHRAE Handbook, Chapter 39, Testing, Adjusting, and Balancing and Chapter 49, Noise and Vibration.

C. Associated Air Balance Council (AABC): 2016 7th Edition AABC National Standards for Total System Balance

D. National Environmental Balancing Bureau (NEBB): 2019 9th Edition Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems

E. Sheet Metal and Air Conditioning Contractors National Association (SMACNA): 2002 3rd Edition HVAC SYSTEMS-Testing, Adjusting and Balancing.

PART 2 - PRODUCTS

2.1 PLUGS

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

2.2 INSULATION REPAIR MATERIAL

A. See Division 23, Section 230700, "HVAC Insulation Systems". Provide for repair of insulation removed or damaged for TAB work.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

1. Contract Documents are defined in the General and Supplementary Conditions of Contract.
2. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

B. Examine approved submittal data of HVAC systems and equipment.

C. Examine Project Record Documents described in Division 01,017839, Section "Project Record Documents."

D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.

F. Examine system and equipment test reports.

G. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

H. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

I. Examine automatic temperature system components to verify the following:

1. Dampers, valves, and other controlled devices are operated by the intended controller.
2. Dampers and valves are in the position indicated by the controller.
3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.

5. Spot-check thermostats to determine if they have been calibrated by the Control Contractor.
6. Sensors are located to sense only the intended conditions.
7. Controller set points are set at indicated values.
8. Interlocked systems are operating.
9. Changeover from heating to cooling mode occurs according to indicated values.

J. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system readiness checks and prepare system readiness reports. Verify the following:

1. Permanent electrical power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance, smoke, and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. General: During TAB, all related system components shall be in full operation. Fan and pump rotation, motor loads and equipment vibration shall be checked and corrected as necessary before proceeding with TAB. Set controls and/or block off parts of distribution systems to simulate design operation of variable volume air or water systems for test and balance work.

B. Coordinate TAB procedures with any phased construction completion requirements for the project. Provide TAB reports for each phase of the project prior to partial final inspections of each phase of the project.

C. Allow sufficient time in construction schedule for TAB and submission of all reports for an organized and timely correction of deficiencies.

D. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.

E. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.

F. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

G. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. For variable-air-volume systems, develop a plan to simulate diversity.

C. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

D. Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.

E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

F. Verify that motor starters are equipped with properly sized thermal protection.

G. Check dampers for proper position to achieve desired airflow path.

H. Check for airflow blockages.

I. Check condensate drains for proper connections and functioning.

J. Check for proper sealing of air-handling unit components.

K. Check for proper sealing of air duct system.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total pre-construction airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure fan static pressures to determine actual static pressure as follows:

    a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
    b. Measure static pressure directly at the fan outlet or through the flexible connection.
    c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
    d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.
3. Obtain approval from A/E for adjustment of fan speed higher or lower than indicated speed. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.

4. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to pre-construction airflows within specified tolerances.

1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure terminal outlets and inlets without making adjustments. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust terminal outlets and inlets for each space to original pre-construction airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.

3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Pressure-Independent, variable-air-volume terminal units shall be calibrated by pitot tube traverse in the branch duct prior to the terminal.

B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set outside-air dampers at minimum and return- and exhaust-air dampers at a position that simulates full-cooling load.
2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
3. Measure total system airflow. Adjust to within indicated airflow.
4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the original pre-construction maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment.
5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.
7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
8. Record the final fan performance data.

3.7 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer, model, and serial numbers.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

3.8 PROCEDURES FOR TEMPERATURE MEASUREMENTS

A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.

B. Measure outside-air, wet- and dry-bulb temperatures.

3.9 TEMPERATURE-CONTROL VERIFICATION

A. Verify that controllers are calibrated and commissioned.

B. Check transmitter and controller locations and note conditions that would adversely affect control functions.

C. Record controller settings and note variances between set points and actual measurements.

D. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).

E. Check free travel and proper operation of control devices such as damper and valve operators.

F. Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.

G. Check the interaction of electrically operated switch transducers.

H. Check the interaction of interlock and lockout systems.

I. Note operation of electric actuators using spring return for proper fail-safe operations.

3.10 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.11 FINAL REPORT

A. General: Digital PDF file and computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer. Include a list of instruments used for procedures, along with proof of calibration.

C. Final Report Contents: In addition to certified field report data, include the following:

1. Fan curves.
2. Manufacturers' test data.
3. Field test reports prepared by system and equipment installers.
4. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.

D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:

1. Title page.
2. Name and address of TAB firm.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB firm who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.

13. Notes to explain why certain final data in the body of reports varies from indicated values.
14. Test conditions for fan performance forms including the following:
    a. Settings for outside-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils.
    e. Fan drive settings including settings and percentage of maximum pitch diameter.
    f. Settings for supply-air, static-pressure controller.
    g. Other system operating conditions that affect performance.

E. System Diagrams: Include schematic layouts of air distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outside, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

F. Air-Handling Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data: Include the following:
    a. Unit identification.
    b. Location.
    c. Make and type.
    d. Model number and unit size.
    e. Manufacturer's serial number.
    f. Unit arrangement and class.
    g. Discharge arrangement.
    h. Sheave make, size in inches, and bore.
    i. Sheave dimensions, center-to-center, and amount of adjustments in inches.
    j. Number of belts, make, and size.
    k. Number of filters, type, and size.
2. Motor Data:
    a. Make and frame type and size.
    b. Horsepower and rpm.
    c. Volts, phase, and hertz.
    d. Full-load amperage and service factor.
    e. Sheave make, size in inches, and bore.
    f. Sheave dimensions, center-to-center, and amount of adjustments in inches.
3. Test Data (Indicated and Actual Values):
    a. Total airflow rate in cfm.
    b. Total system static pressure in inches wg.
    c. Fan rpm.
    d. Discharge static pressure in inches wg.
    e. Filter static-pressure differential in inches wg.
    f. Preheat coil static-pressure differential in inches wg.

g. Cooling coil static-pressure differential in inches wg.
h. Heating coil static-pressure differential in inches wg.
i. Outside airflow in cfm.
j. Return airflow in cfm.
k. Outside-air damper position.
l. Return-air damper position.

G. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

a. System and air-handling unit number.
b. Location and zone.
c. Traverse air temperature in degree F.
d. Duct static pressure in inches wg.
e. Duct size in inches.
f. Duct area in square feet.
g. Indicated airflow rate in cfm.
h. Indicated velocity in fpm.
i. Actual airflow rate in cfm.
j. Actual average velocity in fpm.
k. Barometric pressure in psig.

H. Air-Terminal-Device Reports:

1. Unit Data:

a. System and air-handling unit identification.
b. Location and zone.
c. Test apparatus used.
d. Area served.
e. Air-terminal-device make.
f. Air-terminal-device number from system diagram.
g. Air-terminal-device type and model number.
h. Air-terminal-device size.

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm.
b. Air velocity in fpm.
c. Preliminary airflow rate as needed in cfm.
d. Preliminary velocity as needed in fpm.
e. Final airflow rate in cfm.
f. Final velocity in fpm.
g. Space temperature in degree F.

3.12 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the Final Report.

2. Randomly check the following for each system:

    a. Measure airflow of at least 10 percent of air outlets.
    b. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
    c. Verify that balancing devices are marked with final balance position.
    d. Note deviations to the Contract Documents in the Final Report.

B. Final Inspection:

1. After initial inspection is complete and evidence by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Owner.
2. TAB firm test and balance engineer shall conduct the inspection in the presence of Owner.
3. Owner shall randomly select measurements documented in the final report to be rechecked. The rechecking shall be limited to either 10 percent of the total measurements recorded, or the extent of measurements that can be accomplished in a normal eight-hour business day.
4. If the rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
6. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.
7. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

3.13 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near-peak summer and winter conditions.

3.14 COMMISSIONING

A. Notify the Commissioning Agent one week prior to start of TAB.

B. Submit to the Commissioning Agent a Verification of Completion form with the pre-functional check off sheet for each component when it is ready for functional testing.

C. Assist the Commissioning Agent as required to perform the functional testing on the system components and the system as a whole.

END OF SECTION 230590

SECTION 230800 – COMMISSIONING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes requirements for commissioning the HVAC system, its subsystems and equipment, and parts of the Electrical System. This includes the existing systems that are being renovated. This Section supplements the general requirements specified in Division 01 Section "General Commissioning Requirements."

B. See Division 01 Section "General Commissioning Requirements" for general requirements for commissioning processes that apply to this Section.

C. The owner is committed to commissioning this facility to systematically optimize the building and ancillary systems so that they operate efficiently and effectively in accordance with the Owners Project Requirements, and that the facility staff has adequate system documentation, and training. It is the intent of the owner to ensure that the fundamental systems are calibrated and operating as required to deliver functional and efficient performance.

D. The CxA will plan, manage, perform, and report on the commissioning activities, utilizing the reporting formats and standardized forms provided by the CxA. The CxA will submit deliverable report to USDA ARS according to a project schedule set by CxA and agreed upon by ARS. It is extremely important that all commissioning tasks be conducted in a transparent manner and involve the building engineer and operations staff to the greatest degree possible.

1.2 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced.

1. ASHRAE

a. ASHRAE Guideline 0-2019: The Commissioning Process
b. ASHRAE Guideline 1.1-2007: HVAC&R Technical Requirements for the Commissioning Process

2. ANSI

a. ANSI/ASHRAE/IES Standard 202-2013: The Commissioning Process for Buildings and Systems

1.3 DEFINITIONS

A. Acceptable Performance: A component or system being able to meet specified design parameters under actual load including satisfactory documented completion of functional performance tests, control system trending and resolution of outstanding issues.

B. Acceptance Phase: The phase of construction after startup and initial checkout when functional performance tests, O&M documentation review and operations & maintenance staff training occurs.

C. Basis of Design (BOD): A document prepared by the Designer of Record that records concepts, calculations, decisions, and product selections used to meet the Owner's Project Requirements (OPR) and to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process.

D. Building Envelope: Products, assemblies, equipment and systems that comprise the building exterior; including but not limited to foundations, floors, walls, doors, windows, openings, skylights, roof, and air barriers.

E. Commissioning (Cx): Documented confirmation that building systems function in compliance with criteria set forth in the Contract Documents and OPR.

F. Commissioning Authority (CxA): An independent entity designated by the Owner, not associated with the General Contractor. This entity oversees and recommends approval of the completion of all General Contractor commissioning activities.

G. Commissioning Coordinator (CC): A representative responsible for coordinating commissioning activities on behalf of the subcontractor. Each CC will participate as a member of the project Commissioning Team.

H. Commissioning Plan: A document prepared by the CxA that outlines the Cx team organization, communication paths, schedule, allocation of resources, matrix of responsibilities, installation/testing requirements, and documentation requirements of the commissioning process.

I. Commissioning Report: A document prepared by the CxA at completion of the project.

J. Commissioning Specialist (CxS): Individual designated by the Contractor as the construction team primary point of contact for coordination of commissioning activities with the subcontractors, Owner and CxA.

K. Commissioning Team: Owner and Contractor entities/individuals that participate in the commissioning process.

L. Contractor: The construction team including the prime contractor, subcontractors, vendors, suppliers and other construction entities associated with the General Contractor’s contract.

M. Functional Performance Test (FPT): A test used to verify and document the full range of components, systems, and assemblies function in accordance with the Contract Documents.

N. Issue: A condition in the installation or function of a component, piece of equipment, or system that does not appear to be in compliance with the contract documents or Owner Project Requirements (OPR).

O. Issues Log: A list of systems/equipment installation or performance issues that have been noted. The list is prepared by the CxA. It includes the current disposition of each issue and the date and description of final resolution.

P. Owner: Entity with the highest level of responsibility for directing the project.

Q. Owner Project Requirements (OPR): Non-technical document developed by the Owner. It is updated at regular intervals to state the intended concepts, goals, budget, performance, and other criteria to which the completed project must conform. It includes expectations of how the building will be used and operated. This document is the basis for building commissioning. It is used to develop the basis of design documentation.

R. Pre-functional Checklist (PFC): Criteria used to verify that equipment/system/assembly installations, start-up, and operation comply with the Contract Documents, equipment submittals, and manufacturers' instructions.

S. Seasonal Performance Tests: Functional tests that are scheduled at such time when system design conditions can be replicated or simulated.

T. Start-up: The initial start-up or activation of dynamic equipment.

U. Subcontractor: Member of the Contractor construction team providing a service or product.

V. Systems Manual: A manual that provides information needed to understand, operate, and maintain the equipment/systems/assemblies.

W. Trending: Monitoring of equipment and sequences using the building control system or data loggers.

1.4 CONTRACTOR'S RESPONSIBILITIES

A. Each Contractor:

1. Attend procedures meeting for TAB Work.
2. Perform commissioning tests at the direction of the CxA.
3. Attend controls coordination meeting.
4. Participate in systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.
5. Perform commissioning tests at the direction of the CxA.
6. Provide information requested by the CxA for final commissioning documentation.
7. Certify that TAB Work is complete.

B. Mechanical Contractor:

1. Attend TAB verification testing.
2. Provide measuring instruments and logging devices to record test data, and data acquisition equipment to record data for the complete range of testing for the required test period.
3. HVAC Instrumentation and Control Contractor: With the CxA, review control designs for controllability with respect to actual equipment to be installed, and recommend adjustments to control designs and sequence of operation descriptions.

C. TAB Contractor:

1. Contract Documents Review: With the CxA, review the Contract Documents before developing TAB procedures.
2. Verify the following:

a. Accessibility of equipment and components required for TAB Work.

b. Adequate number and placement of duct balancing dampers to allow proper balancing while minimizing sound levels in occupied spaces.
c. Adequate number and placement of balancing valves to allow proper balancing and recording of water flow.
d. Adequate number and placement of test ports and test instrumentation to allow reading and compilation of system and equipment performance data needed to conduct both TAB and commissioning testing.

3. This review of the Contract Documents by the TAB Subcontractor satisfies requirements for a design review report as specified in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."
4. Additional Responsibilities: Participate in tests specified in Division 23 Sections "Instrumentation and Control for HVAC".

D. Electrical Contractor:

1. With the Mechanical Contractor, coordinate installations and connections between and among electrical and HVAC systems.
2. Attend TAB verification testing of electrical equipment.

1.5 QUALITY CONTROL

A. General Contractor Commissioning Specialist (CxS): The General Contractor shall designate a CxS to lead and coordinate all commissioning activities for the Contractor.

1. CxS shall possess the qualifications of an individual experienced with the commissioning of building systems of similar scope and complexity to those included under this contract. Experience as a construction project manager or superintendent is desirable.
2. Upon request, qualifications of the proposed CxS shall be submitted to the Owner for review and approval. The Owner will notify the Contractor if a change of CxS is required. If a change of CxS becomes necessary, the Contractor shall submit qualifications of the replacement CxS for review and approval.
3. CxS presence at all scheduled commissioning meetings is required.
4. CxS shall coordinate and supervise all commissioning related activities with the Subcontractors, Vendors, CxA and Owner.

B. Subcontractor Commissioning Coordinators (CC) – Individual assigned as the lead on each subcontractor team and responsible to coordinate commissioning activities with the CxS.

1. Contractor is required to identify a CC on each subcontractor team and delegate all commissioning responsibilities through subcontracts.
2. CC presence at all scheduled commissioning meetings is required.
3. CC provides regular input on commissioning activities and issues resolution.
4. Alternates shall be identified during CC absences.

C. Commissioning Meetings:

1. CxA will organize and lead regular commissioning meetings.
2. Meeting agendas typically include general status discussion, commissioning schedule updates, status of the electronic data management documentation progress, installation & testing progress, Issues Log review, and issues resolution.
3. CxS will provide meeting minutes to the Owner for distribution to the Contractor.
4. Contractor shall require CxS and CC attendance at the meetings to coordinate commissioning activities and resolve issues.

1.6 COMMISSIONING DOCUMENTATION

A. Test Checklists: CxA, shall develop test checklists for HVAC systems, subsystems, and equipment, including interfaces and interlocks with other systems. CxA shall prepare separate checklists for each mode of operation and provide space to indicate whether the mode under test responded as required.

1. Calibration of sensors and sensor function.
2. Testing conditions under which test was conducted, including (as applicable) ambient conditions, set points, override conditions, and status and operating conditions that impact the results of test.
3. Control sequences for HVAC systems.
4. Responses to control signals at specified conditions.
5. Sequence of response(s) to control signals at specified conditions.
6. Expected performance of systems, subsystems, and equipment at each step of test.
7. Narrative description of observed performance of systems, subsystems, and equipment. Notation to indicate whether the observed performance at each step meets the expected results.
8. Interaction of auxiliary equipment.
9. Issues log.

1.7 SUBMITTALS

A. Testing Procedures: CxA shall submit detailed testing plan, procedures, and checklists for each series of tests. Submittals shall include samples of data reporting sheets that will be part of the reports.

B. Certificate of Readiness: CxA shall compile certificates of readiness from each Contractor certifying that systems, subsystems, equipment, and associated controls are ready for testing.

C. Certificate of Completion of Installation, and Startup: CxA shall certify that installation, prestart, and startup activities have been completed. Certification shall include completed checklists provided by TAB Contractor as specified in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

D. Test and Inspection Reports: CxA shall compile and submit test and inspection reports and certificates, and shall include them in systems manual and commissioning report.

E. Corrective Action Documents: CxA shall submit corrective action documents.

F. Certified TAB Reports: CxA shall submit verified, certified TAB reports.

1.8 THE SYSTEMS TO BE COMMISSIONED ARE:

A. New laboratory general exhaust fan and associated exhaust terminal units.

B. Air handling unit serving laboratory area in scope of project.

C. Variable speed drives on AHU fan and exhaust fan.

D. Ductwork, including balancing dampers in supply and return, and general exhaust.

E. Testing, Adjusting and Balancing work.

F. Building automation system (controlled devices, control loops and system integration).

G. Electrical system – Feeders and spot check circuits for this project.

PART 2 - PRODUCTS

2.1 TESTING EQUIPMENT

A. The Contractor shall provide all equipment and tools to facilitate testing and access to commissioned equipment including lighting, safety equipment, lifts and ladders, two-way radios, etc. Equipment shall be maintained in good repair and operational condition throughout the duration of use on the project.

2.2 TESTING EQUIPMENT PROVIDED

A. The Contractor shall provide all test equipment necessary to perform startup, initial checkout, and required functional performance tests. Special equipment, tools, and instruments available only from the vendor, specific to a piece of equipment, and required for testing shall be included in the base bid price and shall become the property of the Owner after testing has been completed, except for stand-alone data logging equipment. Data logging equipment and software required to test equipment shall not become the property of the Owner.

2.3 EQUIPMENT CALIBRATION

A. The Contractor is responsible for testing equipment calibration. Prior to testing, the Contractor shall provide documentation that the equipment has current calibration which can be traced to National Institute of Standards and Technology (NIST) calibration. All testing equipment shall be of sufficient quality and accuracy to test and measure system performance within the tolerances specified. Unless otherwise noted, the following minimum requirements apply:

1. Temperature sensors and digital thermometers shall have a certified calibration within the past year to accuracy of 0.9 degrees F and resolution of plus or minus 0.2 degrees F.
2. Pressure sensors shall have an accuracy of plus or minus 2.0 percent of the value range being measured (not the full range of the meter) and have been calibrated within the last year.
3. All equipment shall be calibrated according to the manufacturer's recommended intervals and recalibrated when dropped or damaged. Calibration tags shall be affixed or certificates readily available during testing.
4. Submit calibration documentation of all testing equipment with each testing episode. Serial numbers of equipment and standards used for Quality Control, zeroing, and calibration shall be included.

PART 3 - EXECUTION

3.1 GENERAL

A. Commissioning is required as one quality measure of the construction of this building in order to assure that the final building meets the original intent of the owner's design. Following is a summary of the commissioning process and scope of work the owner requests for this project.

1. Testing Preparation

a. Certify that plumbing, electrical and HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
b. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
c. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.
d. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
e. Inspect and verify the position of each device and interlock identified on checklists.
f. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
g. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

2. Testing and Balancing Verification

a. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.
b. Notify the CxA at least 10 days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.
c. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC&R systems at the direction of the CxA.

1) The CxA will notify testing and balancing Contractor 10 days in advance of the date of field verification. Notice will not include data points to be verified.
2) The testing and balancing Contractor shall use the same instruments (by model and serial number) that were used when original data were collected.
3) Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report.
4) Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3. General Testing Requirements

a. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
b. Scope of HVAC&R testing shall include laboratory HVAC system. Testing shall include measuring capacities and effectiveness of operational and control functions.

c. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
d. The CxA along with the plumbing contractor, electrical contractor, HVAC&R Contractor, testing and balancing Contractor, and HVAC&R Instrumentation and Control Contractor shall prepare detailed testing plans, procedures, and checklists for systems, subsystems, and equipment.
e. Tests will be performed using design conditions whenever possible.
f. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
g. The CxA may direct that set points be altered when simulating conditions is not practical.
h. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
i. If tests cannot be completed because of a deficiency outside the scope of the system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
j. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.2 COMMISSIONING PROCESS DURING THE CONSTRUCTION PHASE

A. The commissioning process activities accomplished by the commissioning authority during the construction phase include:

1. Organize the commissioning process components and conduct a pre-construction meeting where the commissioning process requirements are reviewed with the commissioning team.
2. Coordinate and direct commissioning activities in a logical, sequential and efficient manner using consistent protocols, clear and regular communications and consultations with all necessary parties, frequently updated timelines, schedules, and technical expertise.
3. Perform site visits to observe component and system installations. Accomplish a statistical review of construction focusing on the owner's design intent and the quality process. Perform a static inspection of the installation to ensure that it is conforming to the drawings and specification. Submit checklists for these regular inspections as part of the commissioning plan.
4. Attend selected planning and job-site meetings to obtain information on construction progress. Review construction-meeting minutes for revisions/substitutions relating to the owner's design intent. Assist in resolving any discrepancies.
5. With necessary assistance and review from the installing contractors, develop and write construction checklists. Submit to GC and owner for approval.
6. Organize and conduct periodic commissioning team meetings necessary to plan, develop the scope, coordinate, schedule activities and resolve problems.
7. Review submittals concurrent with the design professional’s review.
8. Work with contractors in completing construction checklists and tracking of checklist completion.
9. Statistically sample completion of construction checklists on a periodic basis to verify that contractor’s quality process is achieving the owner's project requirements.

10. Approve systems startup by reviewing start-up reports and by selected site observation.
11. With necessary assistance and review from installing contractors, write the test procedures. Submit to A/E and owner for review and approval.
12. Assist GC in direction of the contractor to execute the tests.
13. Coordinate witness and recommend approval of test procedure performed by installing contractors. Coordinate retesting as necessary until satisfactory performance is achieved.
14. Recommend approval of air and water systems balancing through statistical sampling of the report and separate field verification.
15. Maintain a master issues log and a separate testing record. Provide both the GC and the owner with written progress reports and test results with recommended actions.
16. Document the correction and retesting of non-compliance items by the contractor.
17. Reviews the systems manual for achieving the owner's project requirements.
18. Review, recommend pre-approval, and verify the training provided by the contractors.

3.3 COMMISSIONING PROCESS DURING THE OCCUPANCY AND OPERATIONS PHASE

A. The commissioning process activities accomplished by the commissioning authority during the occupancy and operations phase include:

1. Schedule and verify deferred and seasonal testing by the contractor.
2. Verify continuing training.
3. Complete the final Commissioning Process Report.

3.4 COMMISSIONING AUTHORITY RESPONSIBILITIES

A. In addition to duties described above, the commissioning authority (CxA) will have the following responsibilities and authority:

1. Issue deficiency notices and verify that they have been corrected. An Issues Log will be maintained and reviewed at the commissioning meetings. Deficiencies that are not corrected in a timely manner will be reported to the owner.
2. The commissioning authority (CxA) is not required to:

   a. Establish design concept, design criteria, compliance with codes, design or general construction scheduling, cost estimating, or construction management. The CxA may assist with problem-solving or resolving non-conformance or deficiencies, but ultimately that responsibility resides with the general contractor and the design team. The CxA will report to the owner any deficiencies or discrepancies.
   b. Issue change orders; they do review change orders for compliance with the construction documents. Non-compliances will be reported to the owner.

3.5 OBSERVATION AND TESTING REQUIREMENTS

Equipment or Systems	Sampling Rate
HVAC Systems	
Air Handling Unit	100%
New exhaust fan	100%
VFDs	100%
Ductwork – supply, return, and exhaust	40%

Building Automation Systems	
Pressure Sensors and Controllers	100%
Sequence of Operation	100%
Airflow Stations	100%
Damper/Valve Actuators	100%

END OF SECTION 230800

SECTION 230900 – INSTRUMENTATION AND CONTROL 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.

B. Division 23, Section 230500, "Common Work Results for HVAC" is directly related to work included in this section. Other sections are indirectly related and shall be reviewed.

1.2 SUMMARY

1. Provide all software, hardware and cabling necessary for communication between operator stations, controllers, sensors, actuators, and other devices.
2. Provide all miscellaneous software, wiring, parts, and labor required in establishing a complete and working system that is an interoperable network capable of communicating with the existing BAS.
3. Controls contractor shall be responsible for connecting all BACnet compatible equipment to the EMCS network. The connection may be via the contractor's specific network or ethernet. The controls contractor is not required to add BACnet translation devices for equipment that does not include a BACnet option by its manufacturer.

1.3 APPROVED MANUFACTURERS

A. Provide an HVAC control system with distributed processing units, input/output units, firmware, and standard operating software.

1. Design, component selection, installation, custom programming, documentation, testing, training, and warranty service shall be the direct responsibility of the manufacturer or their local representative.
2. New equipment and software shall be selected for compatibility with systems that might be presently installed at the site.

1.4 DEFINITIONS

A. BAS: Building Automation System

B. BACnet: A communication protocol for building automation and control networks that use the ASHRAE, ANSI, and ISO 16484-5 standards protocol

C. DDC: Direct digital control.

D. I/O: Input/output.

E. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.

F. MS/TP: Master slave/token passing.

G. PC: Personal computer.

H. PID: Proportional plus integral plus derivative.

I. RTD: Resistance temperature detector.

1.5 SYSTEM PERFORMANCE

A. Comply with the following performance requirements:

1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within eight seconds.
3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
6. Program Execution Frequency: Run capability of applications as often as five seconds but selected consistent with mechanical process under control.
7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:

    a. Water Temperature: Plus or minus one-degree F.
    b. Water Flow: Plus or minus five percent of full scale.
    c. Water Pressure: Plus or minus two percent of full scale.
    d. Space Temperature: Plus or minus one-degree F.
    e. Ducted Air Temperature: Plus or minus one-degree F.
    f. Outside Air Temperature: Plus or minus two-degrees F.
    g. Dew Point Temperature: Plus or minus three-degrees F.
    h. Temperature Differential: Plus or minus 0.25-degrees F.
    i. Relative Humidity: Plus or minus five percent.
    j. Airflow (Pressurized Spaces): Plus or minus three percent of full scale.
    k. Airflow (Measuring Stations): Plus or minus five percent of full scale.
    l. Airflow (Terminal): Plus or minus 10 percent of full scale.
    m. Air Pressure (Space): Plus or minus 0.005-inch wg.
    n. Air Pressure (Ducts): Plus or minus 0.1-inch wg.
    o. Carbon Monoxide: Plus or minus five percent of reading.
    p. Carbon Dioxide: Plus or minus 50 ppm.
    q. Electrical: Plus or minus five percent of reading.

1.6 SUBMITTALS

A. Provide a complete set of reproducible control drawings using computer aided design and drafting (CADD) technology. Include the following information:

1. Show general physical arrangement of component devices installed in the panels. Indicate applicable detailed drawing reference.
2. Provide a typical schematic drawing of each control circuit.

3. Identify equipment and devices by the reference designations shown on the drawings and by unique point identification used in system software. Provide a material list with or on each drawing.
4. Supply block diagrams and schematics showing riser diagrams, the layout of equipment, communication cabling, and wire type.
5. Provide system diagrams showing the general mechanical system layout with all sensors/devices of each mechanical system.
6. Supply floor plan drawings showing the location of all controlled equipment and devices used for sensing and control.
7. Provide a schematic drawing of each control circuit, complete with individual wire identifications. Typical drawings are acceptable.
8. Provide LAN truck riser diagram showing cable routing and location of all repeaters.

B. Provide descriptions of operation detailing all control strategies, including initial setpoints and referencing all points by the point name used in the BAS programming. These descriptions of operation shall also be provided in the record drawings.

C. Provide a complete list of equipment to be furnished, which includes a manufacturer's catalog sheet for each item on the material list.

1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of description of Operation including schematic diagram.
4. Provide a damper schedule with one line per damper. Provide for each damper: The project TAG, the size, the model of the damper, the type and model of the actuator, and whether the damper fails open, closed, or in place.
5. Provide a valve schedule with one line per valve. Provide for each valve: The project TAG, the size, the model of the valve, the pressure rating, the model and type of the actuator, the valve Cv, and whether the valve fails open, closed, or in place.

D. Provide a detailed test plan describing the specific procedures used to complete and document the "Owner-witnessed Testing" described in the Final Acceptance requirement.

1. Test plans shall include a complete schedule for tracking each phase of the testing, e.g. zone testing by floor, fan testing by system, chiller interface testing, heating system testing, etc.
2. The vendor is required to supplement the planned work effort to meet the progress dates given in the schedule.
3. Provide printout of programming code.
4. Show initial setpoints.
5. Provide all documentation necessary to interpret programming related submittals.

E. As part of the submittal process, the vendors shall meet with representatives of the Owner's engineering and operations divisions, giving them a thorough briefing on the BAS programming design. This briefing shall describe in detail the methods the control programmer has used to meet the requirements of the description of operations.

F. Submit the point-to-point (PTP) and description-of-operation verification test plans at least 30 days prior to the scheduled beginning of testing. PTP testing shall be part of the construction schedule.

1.7 QUALITY ASSURANCE

A. All materials and equipment used shall be new, standard components, regularly manufactured and not custom-designed or fabricated specifically for this project.

B. All components and software shall have been previously tested and proven in regular use. Minimum in-use requirements are 24 months for hardware and 12 months for major software (whole number revision) releases.

C. Modularity. The HVAC control system shall possess a modular architecture, permitting expansion through the addition of more distributed processing units, input/output units, sensors, actuators, and operator stations.

D. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. Comply with ASHRAE 135 for DDC system components.

G. System Software: Update to latest version of software at Project completion.

H. Approval: Vendor shall submit and receive approval for all submittals including materials, floor plan, schematics, and programming prior to installation.

1.8 COORDINATION

A. Coordinate location of thermostats, carbon dioxide sensors, and other exposed control sensors with plans and room details before installation.

B. Coordinate equipment with Division 28, Section 283111, "Fire Detection and Alarm" to achieve compatibility with equipment that interfaces with that system.

C. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.

D. Coordinate equipment with Division 26, Section "Electrical Power Monitoring and Control" to achieve compatibility of communication interfaces.

E. Coordinate equipment with Division 26, Section 260913, "Panelboards" to achieve compatibility with starter coils and annunciation devices.

F. Coordinate equipment with Division 26, Section 262419, "Motor-Control Centers" to achieve compatibility with motor starters and annunciation devices.

1.9 FINAL ACCEPTANCE REQUIREMENTS

A. Provide corrected documentation to show changes made to correct deficiencies discovered during commissioning tests. Reassemble manuals and drawing packages to reflect corrected documentation records.

B. Drawings and software:

1. Submit shop drawings reflecting final "as-built" condition.

   a. Provide record drawings on AutoCAD 2021. Deliver two copies of data on two CDs without compression, or compatible electronic media.
   b. Provide 3 copies of reproducible record drawings.
   c. These record drawings shall accurately depict the final as-built conditions and shall be on Architectural/Mechanical backgrounds provided by the A/E.
   d. These drawings shall include accurate depiction of location of sensors and controlled equipment (motor starters, valves, chillers, dampers, AHUs, etc.)
   e. Insert one copy of applicable shop drawings, panel layout drawing, and points list at each enclosure's documentation holder.

C. Operation and Maintenance (O&M) Manuals: Provide two paper copies of material required and five copies on CDs in MS Word or PDF format. Describe operation, maintenance and servicing requirements of the HVAC control system and associated equipment. Provide the following information in separate sections, each with an index:

1. Technical literature for all equipment, including catalog sheets, calibration, adjustments and operation instructions, and installation instructions
2. Hardware and software manuals, including information supplied by the original product developer, on the application programs and on the computers and controllers provided by vendor
3. System description and complete description of operation
4. Reduced size (11" x 17") copies of record drawings
5. Input/Output (I/O) summary forms for the system, listing all connected analog and binary input and output functions and the number and types of points. Indicate spare input/output capacity
6. Completed point-to-point checkout plan used in Owner-witnessed testing, and the completed data sheets showing the results of the point-to-point testing.

D. Owner-Witnessed Testing

1. All parts of the testing described in this section are to be performed as point-to-point tests and control description verification. The Owner may choose to have this testing witnessed by a member of the Owner's staff, by an independent commissioning agent, by a member of the A/E team, or otherwise.

   a. One copy of the preliminary as-built documents shall be provided to support this testing.
   b. After receipt of all system documentation by the Owner, notify Owner 10 working days before testing begins.

c. Testing shall be performed by the manufacturer or its local representative. The procedure for the test must provide a format for documenting the results, comments, vendor repair activity, vendor's initials, and retest witnessing. Provide data sheets with one line for each physical point on the system, and columns to record the results, dates, and initials of witnesses for both pretests and witness tests.

d. The Contractor shall perform point-to-point pretests before the witnessed tests and shall fill out data sheets during pretests to demonstrate successful performance prior to witnessed tests.

E. Installation verification tests:

1. Verify operation, location, and identification of power sources, including circuit breakers and control power transformers.
2. Start/stop points: Issue start and stop commands from an operator station. Verify that controlled equipment responds appropriately and that the start/stop status is accurately reflected at the operator station.
3. Analog points: Analog inputs and outputs shall be verified at both extremes of their ranges and at the midpoint. Verify tight shutoff and full opening of dampers and valves.
4. Binary points: Verify that both commanded conditions (on/off, open/closed, etc.) are accurately reflected at the operator station.
5. Test fan failure alarms by turning off the motor at the HOA switch and observing the run-state indication at the operator station.
6. Temperature points: Verify calibration of sensors by comparing displayed temperature values with the reading of an independent measuring device located in the same flow. Test liquid temperature sensors as installed in piping thermowells to verify effectiveness of heat conducting compound.
7. Pressure points: Verify calibration of sensors by comparing displayed pressure with the reading of an independent measuring device located in the same flow stream. Retain the services of the balancer as required to confirm readings.
8. Control valves: Verify tight shutoff by comparing water or air temperatures entering and leaving the heat transfer device.
9. Operator response and sequencing: Demonstrate that descripted or modulated valves and dampers position accurately in response to posit multiple operators to provide simultaneous modulation of parallel dampers or valve assemblies.
10. Control signal stability, general: Demonstrate that control loops are tuned so that the output does not change until the controlled system has had time to respond to the last output signal.
11. Control signal stability, response to step input: Demonstrate that control loops are tuned so that they are stable without excessive hunting following a step input of not less than 20% of the operating/reset range of the controlled variable.
12. Control signal stability, floating point devices: Verify that minimum pulse output duration is no less than the value required to assure repositioning of the controlled device.
13. Demonstrate the capability of the controls system to execute the complete description of Operation as given in the mechanical design documents.
14. Verify tight shut-off of all actuated control valves (for three-way valves, demonstrate capacity for 100% by-pass of coil).

F. Operator station tests:

1. Override test: Verify manual override capability for start/stop and modulated point types.
2. Control logic:

   a. Exercise all control logic packages.
   b. Check response to upset, change in setpoint.

3. Supervisory function:

   a. Verify content of time clock schedules.
   b. Verify alarm's reporting capabilities.

4. Failure modes:

   a. Verify all stand-alone operation by disconnecting communication lines between stand-alone control units and verifying continued operation.
   b. Disconnect and reconnect controller power to confirm proper recovery from power failure (sample).

G. Other software tests:

1. Trend logging
2. Report generation
3. Remote access
4. Test the ability of the control system to automatically restart all the connected systems following a power restoration and fire alarm recovery.

1.10 SERVICE AND GUARANTEE

A. The complete control system shall be warranted to be free of defects in manufacturing, workmanship, and materials for one year. Temperature sensor accuracy shall be warranted for three years. Software and documentation shall be revised to reflect system changes required to meet warranty obligations.

B. During the warranty period, provide emergency service telephone number where a qualified service technician, familiar with the installed system, may be reached and will respond within 12 hours.

1. This technician shall have the capability of remote communication with the control system for troubleshooting and program alterations.
2. The vendor shall pay all costs to provide communications for remote access.
3. A fully equipped, qualified repair technician shall be at the job site within four hours of a request for emergency service.

C. All replacement parts must be available on site within 48 hours during the term of the warranty.

D. Provide free of charge during the warranty period four DDC software sequence modifications (up to 24 hours engineering time) as instructed by the Owner. Modification shall be in software only.

1.11 POST-INSTALLATION TRAINING AND MATERIALS

A. The manufacturer and control contractor shall train operating personnel (FOMs) in the operation and maintenance of the system as follows:

1. The controls subcontractor shall provide the Owner's system operators complete training for proper control of the system under all modes of operation. These modes shall include but not be limited to summer/winter, energy management and alarm event description. The training shall be conducted during normal working hours, Monday through Friday at the job site. Training shall consist of both classroom and hands-on training. Provide a minimum of 16 hours of on-site training for a total of three people. Provide each trainee with a copy of the description of operations and the graphics during each training session. Training will be refined based on the successful bidder and may address the following subjects:

   a. Sensor/actuator operation.
   b. System architecture and basic theory of operation.
   c. Operator level (password level 1) interface to system for password access, alarm handling, point addressing, manual commands and statistical data acquisition.
   d. Program level (password level two) operation for command control and definition of energy management parameters.
   e. Configuration level (password level three) for all database entry and modification.
   f. Review of description of operations.
   g. System troubleshooting.
   h. Emergency service support.
   i. Fire alarm interface.
   j. System restart after power failure.
   k. Replacement procedures of each system component.
   l. Calibration and initialization procedures.
   m. Regeneration procedures on all installed programming at operator’s control stations.

2. Provide one each of the following:

   a. Complete reference materials (manuals) that would be used by a factory trained master technician.
   b. Test instruments, and software manufactured or modified by the manufacturer for use in the installation, troubleshooting, and repairs of installed devices. Include unique portable test terminal, test boxes, circuit card extenders, calibration modules, etc.

3. The Owner will be allowed to video tape any or all the training sessions.

1.12 SYSTEM COMMISSIONING

A. Provide assistance, staff, and materials to support the commissioning activities.

1. This includes all testing apparatus in use by the BAS contractor to test and calibrate or verify calibration of the control system.
2. Assistance includes but is not limited to reviewing test procedures and providing software enhancements to accommodate testing methods.

B. Provide staff and materials to support the point-to-point testing, also referred to as Owner-witnessed Testing and described under Final Acceptance Requirements.

C. Operate the control system for any commissioning tests specified in other specification sections.

1.13 DESCRIPTION OF OPERATION

A. See Drawings.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide as required for a complete and operating building automation system, all software, hardware, input/output devices, wiring and control power not shown in electrical bid documents, actuated dampers, actuated valves, actuators, operation and maintenance training, special maintenance tools and aids, supervision of labor, and warranty.

B. The system shall be built only of standard components kept in stock by the supplier.

1. All replacement parts shall be available on site within 48 hours.
2. The components shall not require customizing other than setting jumpers and switches, or adding firmware or software modules, or on-site software programming to do required functions.

C. System display should meet the following requirements:

1. The system is to be fully menu-driven.
2. All system titles, prompts, and instructions are to be in the English language.
3. All entries to be in natural units, i.e., a setpoint value shall be entered in its actual control unit of value, such as 74º F.
4. The primary means of information display and system management shall be graphic display. Use the same style of display as is currently used throughout the facility.
5. Each display will contain comment sections to indicate area served (if area-specific) and contain a graphical presentation for all other interlocked systems.

2.2 BASIC SYSTEM FEATURES

A. Zone-by-zone control of space temperature, usage scheduling, and equipment failure reporting (A zone is the area served by one HVAC terminal unit, fan coil, heat pump, air terminal, etc.)

B. For all controllers and other devices that do not automatically and immediately resume normal operation after loss of power and then restoration of power, provide Werner Electric Stabiline UPS (Uninterruptable Power Supply) model SW1500 (or approved equal having five year battery life and battery hot swappable capability) for all cabinets having a mounting area over 120 square inches and containing controllers. These cabinets shall be provided with a fused duplex receptacle to be used as a source for UPS power. Cabinet shall draw power from the UPS. Provide shelf for UPS.

C. All control power shall be provided from 120 VAC emergency power sources located in the “low voltage” closets on each floor and in the mechanical rooms.

D. Tamper-proof room wall mounted sensors installed with Allen, Bristol, or similar hardware with local temperature setpoint adjustment (limited range). The maximum allowed temperature range shall be set from an operator's station. Program the local control ranges as follows:

1. Standard thermostats - 70°F to 75°F
2. Mechanical and electrical rooms - 50°F to 85°F

E. Space temperature control in specifically identified locations will use return/exhaust duct mounted sensors and setpoint will be adjusted with computer interface.

F. Individually assignable priority password security system to prevent unauthorized use. Provide at least four levels including the following: Information only, change of setpoint & ON/OFF, programmer, and a fourth master level for assigning appropriate local access.

G. Equipment monitoring and alarm function including information for diagnosing equipment problems.

1. All system points shall be programmed to report alarm conditions by fully expanded point names that are tailored and specific to this project.
2. Assign alarm limits at 10% above highest expected level and at 10% below lowest expected level (subject to control description design) or as requested by Owner.
3. Interlock all alarm points to system status to lock out alarms when the system is not operational by schedule or operator command.

H. Auto-restart, without operator intervention, the operator stations and all controlled equipment to the control state that would be in effect if the power failure or fire alarm event had not occurred. Start/stop outputs shall continue to command the affected device while motor power is unavailable and allow for equipment restart, as previously commanded or scheduled, upon restoration of motor power.

I. Equipment run-time totalization of motor driven equipment.

J. Interactive displays of all input and output points: As a minimum, each of 200 screens on the monitor shall be able to display 25 interactive points and custom text.

K. Operator shall be able to, through keyboard interface, disable any control logic for any output or setpoint, temporarily substitute the value for any input/output, and introduce a different value or state for all inputs, outputs and setpoints.

L. Individual controllers shall be programmed with nonvolatile stand-alone control logic necessary to maintain appropriate HVAC equipment operation. While in temporary stand-alone mode, energy efficiency can be sacrificed to maintain temperature control and operational conditions that will not damage equipment or compromise health and safety.

M. Controllers shall, upon loss of valid programming, be capable of requesting and receiving a programming download of all required program code from the system management server.

N. Owner personnel shall be able to create and modify control software in any facility computer utilizing menu-driven programming. Owner personnel shall be able to store the programming on a removable computer disk and preprogram a nonvolatile, transportable memory storage device, which can be used for replacement of the programming in system controllers.

2.3 SYSTEM ARCHITECTURE

A. The BAS shall consist of a network of controllers providing full stand-alone operation of the building. The controllers shall contain the necessary programming to accomplish the description of operations for building control.

B. Controllers shall normally execute the control strategy to use peer-to-peer communication capabilities. Upon loss of communication, the stand-alone control unit shall be able to execute its own stand-alone programming. This distribution of control authority is mandated so that the lost communications capability shall not cause a complete loss of control for affected systems.

C. Operator station shall not be necessary to sustain building operation.

D. All BAS equipment installed in this project shall be interoperable to interface with the existing BAS. All control products provided for this project shall comprise a BACnet internetwork.

E. The Contractor shall provide all communication media, connectors, repeaters, hubs, and routers necessary for the internetwork.

F. All controllers shall have a communication port for connections with the operator interfaces using the BACnet Data Link/Physical layer protocol.

G. Communication services over the internetwork shall result in operator interface and value passing that is transparent to the internetwork architecture as follows:

1. Connection of an operator interface device to any one controller on the internetwork will allow the operator to interface with all other controllers as if that interface were directly connected to the other controllers. Data, status information, reports, system software, custom programs, etc., for all controllers shall be available for viewing and editing from any one controller on the internetwork.
2. All database values (e.g., objects, software variables, custom program variables) of any one controller shall be readable by any other controller on the internetwork. This value passing shall be automatically performed by a controller when a reference to an object name not located in that controller is entered into the controller's database. An operator/installer shall not be required to set up any communication services to perform internetwork value passing.

H. Dedicated Controllers: All sensing points and controlled outputs associated with a sub-system or piece of equipment shall be wired to and processed within one controller. A sub-system is defined as a group of equipment items that are directly controlled together, such as the components associated with an air handler. A “reset” signal may come from another subsystem controller. When supply terminal units are to be tracked by an exhaust terminal unit, all supply and exhaust monitoring and control points shall be processed by the same controller.

2.4 GRAPHICS

A. General: Provide complete graphics for all systems. Graphic completeness, appearance and quality shall be the best available from the approved manufacturer. All system shall be diagrammed in the graphics with measured values indicated at the appropriate location on the diagrammatic graphic. Setpoint, on-off-auto and similar adjustable shall be at the appropriate location on the diagrammatic graphic.

2.5 DDC EQUIPMENT

A. OPERATOR STATIONS

1. Local Access: Operator interface with the installed BAS equipment and the entire campus BAS shall be performed with portable computers and desktop computers using site licensed software.
2. WEB Access: It shall be possible to interface with the BAS from remote computers equipped with a web browser via the Internet.
    a. Operators shall be able to access information through user interfaces at the application controller and the plant controller levels, as well as at the master display.
    b. System shall be an open, interoperable system supporting LonWorks®, BACnet® and/or other protocols.
3. Operator interface with the BAS includes the ability to operate and program all campus BAS equipment. The ability to look, adjust/override and program will be controlled using access levels.
4. Overall management of the BAS, storage of programs, data, trends, access control, graphics.
5. Application Software:
    a. I/O capability from operator station.
    b. System security for each operator via software password and access levels.
    c. Automatic system diagnostics; monitor system and report failures.
    d. Database creation and support.
    e. Automatic and manual database save and restore.
    f. Dynamic color graphic displays with up to 10 screen displays at once.
    g. Custom graphics generation and graphics library of HVAC equipment and symbols.
    h. Alarm processing, messages, and reactions.
    i. Trend logs retrievable in spreadsheets and database programs.
    j. Alarm and event processing.
    k. Object and property status and control.
    l. Automatic restart of field equipment on restoration of power.
    m. Data collection, reports, and logs. Include standard reports for the following:
        1) Current values of all objects.
        2) Current alarm summary.
        3) Disabled objects.
        4) Alarm lockout objects.
        5) Logs.
    n. Custom report development.
    o. Utility and weather reports.
    p. Workstation application editors for controllers and schedules.
    q. Maintenance management.
6. Custom Application Software:
    a. English language oriented.
    b. Full-screen character editor/programming environment.
    c. Allow development of independently executing program modules with debugging/ simulation capability.

d. Support conditional statements.
e. Support floating-point arithmetic with mathematic functions.
f. Contains predefined time variables.

B. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.

1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.
2. Stand-alone mode control functions operate regardless of network status. Functions include the following:

a. Global communications.
b. Discrete/digital, analog, and pulse I/O.
c. Monitoring, controlling, or addressing data points.
d. Software applications, scheduling, and alarm processing.
e. Testing and developing control algorithms without disrupting field hardware and controlled environment.

3. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.

C. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.

1. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.
2. Stand-alone mode control functions operate regardless of network status. Functions include the following:

a. Global communications.
b. Discrete/digital, analog, and pulse I/O.
c. Monitoring, controlling, or addressing data points.

3. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.

D. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.

1. Binary Inputs: Allow monitoring of on-off signals without external power.
2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation.
5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (four to 20 Ma).
6. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
7. Universal I/Os: Provide software selectable binary or analog outputs.

E. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:

1. Output ripple of 5.0 mV maximum peak to peak.
2. Combined one percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least three seconds without failure.

F. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:

1. Minimum dielectric strength of 1000 V.
2. Maximum response time of 10 nanoseconds.
3. Minimum transverse-mode noise attenuation of 65 dB.
4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

2.6 UNITARY CONTROLLERS

A. Each controller shall operate as part of the control system and as an independent unit when not in communication with other controllers or an operator station. Global controllers shall be able to share Global information on a peer-to-peer basis without relying on an operator station.

B. It shall be possible to define control strategies at each controller from any operator station. Each controller shall be able to interface directly with an operator station.

C. Each controller shall include its own microprocessor, power supply, and, if necessary, battery with automatic charger. Upon loss of system power, the controller memory shall be maintained for a minimum of 72 hours with no external source of power. Upon restoration of system power, the control unit shall resume full operation without operator intervention.

D. Provide control programming logic at each controller for proportional and/or proportional plus integral control capabilities as necessary to assure complete and stable control of each controlled variable.

E. Each controller shall maintain and perform its own stand-alone control strategy upon communications failure. The controller stand-alone control program shall be adequate to maintain the basic control function and provide protection from inappropriate equipment operation. The controller shall retain its programming during a power failure and resume operation without program reloading from another device.

F. The controllers shall be powered by 24 VAC.

G. Each controller shall be isolated (optically or by other means) from the communication trunk and have fuse or overload protection.

H. The controller point monitoring and control capabilities shall include but not be limited to the following as required to accomplish specified sequence of operation:

1. Binary inputs (contact closures)
2. Analog inputs (use only resistive, 0-10 volt, and 4-20 ma. inputs; provide A/D conversion of 10 bits, minimum)

3. Binary output (start/stop or latching and momentary contacts)
4. Floating point control
5. Analog outputs (must include 4-20 ma. @ 10 VDC minimum, 0 -10 VDC; provide A/D conversion of 12 bits, minimum).

2.7 ALARM PROGRAM

A. For each alarm input, provide the following assignable alarm responses:

1. Display English language point description in addition to system point identification.
2. Print out alarm description and operator-created alarm message.
3. Require acknowledgment by operator and print occurrence if directed by Owner.

2.8 LOGS

A. Trend log: As a minimum, provide capacity for 50 trend logs. Provide for review of data on monitor and printer. Each trend log shall have assignable start/stop times/dates.

B. Current alarm log: Display all points currently in alarm. Operator activity log: Record operator activity by operator account identification and work performed during a minimum of the last 10 log-in sessions or last 20 commands.

2.9 ANALOG CONTROLLERS

A. Step Controllers: 6- or 10-stage type, with heavy-duty switching rated to handle loads and operated by electric motor.

B. Electric, Outdoor-Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable set point, scale range minus 10 to plus 70-degree F, and single- or double-pole contacts.

C. Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.

D. Fan-Speed Controllers: Solid-state model providing field-adjustable proportional control of motor speed from maximum to minimum of 55 percent and on-off action below minimum fan speed. Controller shall briefly apply full voltage, when motor is started, to rapidly bring motor up to minimum speed. Equip with filtered circuit to eliminate radio interference. Remote-control-point adjustment shall be plus or minus 20 percent of sensor span, input signal of 3 to 13 psig.

2.10 FAILURE MODE

A. Upon failure of any global controller, the operator station shall display off-line occurrence for each affected point and provide communication verification to each controller for each I/O channel.

B. In the event of communication failure, controller shall continue to operate equipment using appropriate backup values for missing global information. If sensor information is necessary for proper stand-alone function, then that sensor shall be attached directly to the appropriate controller. Provide failure mode programming to accomplish safe operation of equipment in case of communications failure on local trunk.

C. Upon return of primary power after a power failure of up to 72 hours, the system shall automatically return to completely normal operation with no action required from operating personnel.

D. Unless otherwise indicated in the design documents, provide the following failure modes, (that is, the position that the controlled device attains under failure due to loss of power, loss of air pressure, or loss of communications) for valves and dampers:

1. All Fan cooling water valves shall fail closed.
2. All central cooling water differential pressure control valves shall fail closed.
3. All fan exhaust air and outside air dampers shall fail closed.
4. All fan recirculation dampers shall fail open.
5. Zone-level air terminal unit dampers may fail in place.

2.11 ENERGY REDUCTION AND SPECIAL OPERATION SOFTWARE

A. The system shall be designed to control energy-consuming loads. Provide engineering, consulting, and programming to develop and set up the following energy reduction software:

1. Time schedules: Software should provide at least 16-time schedules. Each schedule is to be an 8-day type, capable of six entries minimum per day. Time program shall provide ON/OFF commands and reset SETPOINT capabilities.
2. Holiday time programs: Provide a holiday time schedule capability.
3. Optimal start/stop: Provide the ability to optimize start/stop times to attain and maintain temperature setpoint only during occupied times. The system shall be self tuning, with compensation for weekends and holidays.
4. Setpoint reset: Provide a means of automatically resetting heating water, chilled water and ventilation air temperatures, volumes, and pressures.
5. Provide a program to automatically restart all DDC controlled equipment upon the resumption of power or return from fire alarm condition. Equipment shall be restarted according to a prearranged, prioritized, and staggered restart schedule.
6. For loads that have been turned off at the Motor Control Center, either by positioning of the HOA switch or the line disconnect; provide a restart strategy that automatically restarts load upon the reset of switches to their normal on-line positions.
7. Provide capability to adjust the setpoints of main mechanical systems from an operator station using simple ‘point and click’ command windows.

2.12 ELECTRONIC SENSORS

A. Temperature sensors:

1. Sensors shall be completely precalibrated with no electrical adjustments or calibration required for standard installation conditions.
2. The temperature displayed at an operator station shall be accurate to within 1º F. This accuracy shall be warranted (parts and labor) for a minimum of three years.

3. Wall-mounted sensors shall be tamperproof. Wall mounted sensors for zone controls shall provide jack for operations laptop connection. That connection shall allow communication with system for monitoring and adjusting at least the zone-level equipment serving that zone. Wall sensors shall include temperature readout and shall provide basic control description diagnostic and reset features and local setpoint adjust and after-hours override.
4. Freeze protection sensors shall be non-averaging.
5. Thermowells shall be bronze, brass, or stainless steel with 1-inch NPT threads.
6. Install piping temperature sensors adjacent to temperature gauge or test port.
    a. Use heat-conducting compound in thermowells.
    b. Strap-on fluid temperature sensors will not be allowed.
7. Mount outside air sensors inside the outside air intake to avoid solar influence and directly sense the average temperature of the air entering the air handling unit(s).

B. Air velocity transmitter: Shall provide air velocity information independent of the effects of static pressure. Transmitter shall operate at rated accuracy from 0º F to 120° F. The minimum accuracy of displayed value at an operator station shall be 95% through the range of 20% to 100% of sensed airflow, with a drift rate no greater than one percent per year. The proportional output shall be 4 to 20 ma.

C. Differential and static pressure transmitter: Transmitter shall operate from 50% of minimum to 150% of maximum anticipated pressure. The maximum error of displayed value at an operator station shall be 2% through the range of 20% to 150% of the intended maximum setpoint. Minimum pressure tolerance shall be 150% of the maximum pressure expected in normal operation. The maximum drift rate shall be no greater than one percent per year. The proportional output shall be 4 to 20 ma. Provide designed pressure pitot sensor Dwyer type A-301/A 302 or approved equal.

D. Current sensors shall convert AC to proportional DC (4 to 20 ma). Response time: 300 milliseconds to 99% of final value. Manufacturer: Neilson-Kuljian or approved equal. Controls will be programmed to indicate equipment failure if motor current goes above or below normal conditions.

E. Averaging elements shall be mounted to cross a minimum of 80% of the plenum width and shall be located to provide an indication of temperature within +/- 1° F. Provide support at 36 inches maximum such that there will be no metal to metal contact between the sensing element and other equipment.

F. Outside air sensors shall be a waterproof assembly protected from solar radiation. Span shall cover the range of 0º F to 100° F or better and not exceed a 150° F span. Typically, mount sensor inside an outside air intake that draws air 24/7.

G. SPECIAL CONTROLLERS

1. Laboratory rooms and the fume hoods in those rooms shall be controlled to allow for a variable flow of conditioned air into the room, general exhaust from the room, and exhaust through the fume hood while maintaining a safe face velocity at the hood sash opening and proper space pressurization.

2. Room Differential Pressure Controller: The basis of design controller is Triateck FMS-2000. Approved alternates will be considered. The differential pressure in laboratory rooms shall be maintained by controlling the quantity of air exhausted from the room. A sensor-controller shall measure and control the velocity of air flowing into or out of the room through a sampling tube installed centered above the door in the wall separating the room from the adjacent space and display the value on its monitor. The sensor-controller shall meet the following as a minimum:

   a. Operating range: -0.25 to +0.25 inches of water column
   b. Resolution: 5 percent of reading
   c. Accuracy: +/- 10 percent of reading +/- 0.005 inches of water column
   d. Analog output: 0-10 VDC or 4-20 ma
   e. Operating temperature range: 32°F-120°F

H. Pressure Transmitters/Transducers:

1. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.

   a. Accuracy: Two percent of full scale with repeatability of 0.5 percent.
   b. Output: 4 to 20 mA.
   c. Duct Static-Pressure Range: 0- to 5-inch wg (0 to 1240 Pa).
   d. Manufacturer:

      1) Tek-air Systems Inc., Ultra low series
      2) Setra Systems
      3) Veltron
      4) Modus “low flow T” series
      5) Ultratech Inc.

2. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential. Manufacturer:

   a. Tek-air Systems Inc., Ultra low series
   b. Veltron
   c. Modus `low flow T' series
   d. Ultratech Inc

3. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA.

2.13 STATUS SENSORS

A. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg.

B. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.

C. Voltage Transmitter: Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and one percent full-scale accuracy.

D. Power Monitor: Three-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.

E. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.

F. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.

2.14 THERMOSTATS

A. Thermostats shall be low-voltage, thermistor sensor, touch screen operated, with 55 to 85-degree F set-point range, minimum. Thermostats shall be programmed so the user can adjust temperature higher or lower a pre-determined range (coordinate range with owner). A 5-degree dead band between heating and cooling shall be programmed.

2.15 ACTUATORS

A. Actuator type: Electronic actuators shall be used for all water control valves and air dampers.

B. Electronic actuators shall be Belimo, Delta, or approved equal selected from the vendor's standard product line.

1. Sized for torque required for damper seal at load conditions.
2. All electronic actuators shall be powered by 24 VAC (smoke damper are powered by 120 volts as per specification 233300).
3. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
4. Proportional electronic actuators shall use 0 to 10 VDC, 4 to 20 ma. or floating-point control.
5. Floating point actuators shall have position indicated by potentiometer so the control system will always know exact position.
6. Temperature Rating: Minus 22 to plus 122-degree F**,** (Minus 22 to plus 250-degree F for smoke dampers).
7. Multiple electronic actuators may be powered by one separately fused 24 VAC transformer, providing the transformer size does not exceed 100 VA.
8. No more than two electronic actuators may drive a common shaft.
9. All electronic actuators shall have field manual positioning capability to allow manual positioning of valve or damper in absence of control power.
10. Two integral built-in auxiliary end switches.
11. Actuator shall have positioning feedback.

C. Actuators shall be capable of providing 150% of the minimum valve or damper manufacturer's published torque requirements for complete shutoff.

D. Actuators shall 'Fail in Last Position' unless otherwise noted.

E. Valve actuators shall have clutch and manual positioning handle/wheel at all locations where a separate isolation valve is not provided immediately adjacent to the controlled valve.

2.16 DAMPERS

A. See Section 233300 - Air Duct Accessories.

2.17 Variable Frequency Drives (VFDs)

A. VFDs for division 23 equipment shall be provided as per the schedules on the Drawings.

B. Division 26 contractor shall provide power to factory mounted VFDs once they are installed in the field.

2.18 ENCLOSURES

A. All enclosures to be NEMA 1, unless otherwise required for intended service. All controls and instruments shall be logically assembled at one or more panels, have hinged doors, and be marked with engraved melamine labels.

B. All enclosures used as a mounting site for control devices shall also contain a documentation holder located on the inside of the door.

C. All enclosures shall be provided with locks.

D. Label each equipment panel furnished with 120 VAC power with power source label showing identification of power panel and breaker.

2.19 WIRING AND CONDUIT

A. Install wiring and conduit in accordance with Division 26 requirements.

B. Minimum wire size shall be based on the manufacturer's recommendations based on the specific application. Single conductor wire insulation shall be THHN. All wires shall be sized in accordance with the NEC for the load serviced. A single conductor shall not be used for more than one leg of an input or output device circuit (no "common" conductors) unless approved by Owner.

C. All wiring shall be stranded. Exceptions will be made for wiring used in preassembled factory crimped cables, 20 g and smaller, where connectors provide support to the insulated cable jacket at the point of connection.

D. All low voltage energy limited wiring (except 24 VAC power), installed in open tray or installed as open wiring, shall be in jacketed cables dedicated to individual devices.

E. Junction box covers shall be labeled "DDC" or show the vendor logo.

F. Splicing shall be minimized and shall be done only in accessible outlet, junction, or cabinet boxes that are clearly shown on the "as-built" record drawings. Splicing shall be made with 3M "Scotchloc" spring connectors with steel cap and PVC insulation, Thomas & Betts, or a crimp on butt-splice, or approved equal. When splicing is necessary, the insulation colors shall match, and the conductors shall be mechanically secured to each other so that no stress is applied to the splice. Splicing of long runs shall be accomplished by means of a fully insulated crimped barrel connector.

G. Wire pulls by powered mechanical means will not be permitted. Conduit shall be cleaned of foreign material just before pulling the wire or cable. Lubricants shall be compounds specifically prepared for cable pulling and shall not contain petroleum or other products that will affect cable insulation.

H. Wire that has scrapes, nicks, gouges, or crushed insulation shall not be used and shall be removed when present.

I. Groups of conductors, where installed in cabinets and wire trays, shall be neatly grouped with wire ties or equal.

J. All wiring contained in metal wireways shall be in wireways dedicated to low voltage service.

K. Low voltage energy-limited wiring shall not be run in the same wireways with, or closely parallel to, high voltage or switched power wiring. Interposing relays shall be used for all switched power loads and shall be located so that the switched power conductors do not run in the same wireway as the interposing relay coil power or any other energy-limited low voltage conductors.

L. All wire shall be new and brought on the jobsite in original packages bearing Underwriter's label and the date of manufacture.

M. Aluminum wire is prohibited.

N. No conduit shall be filled so that the maximum bundled cross-sectional dimension exceeds 40 % of conduit inside diameter. No raceway shall be filled to more than 40% and maximum fill for "wiremold" (surface raceway) shall be 20%.

O. No wire run or circuit shall be longer than 80% of the maximum allowable length or power consumption for the wire size and application. No output circuit shall exceed 80% of the maximum load capacity specified by the manufacturer.

P. Wiring and conduit shall comply with Division 26 specifications.

1. The basic wiring method shall be in conduit unless otherwise permitted in this section.
2. Where conduit direct connection is not possible, all permitted open wiring shall be plenum rated.
3. Permitted open wiring is limited to the following applications:

    a. Wiring from a zone airflow control unit to a nearby temperature sensor not to exceed 50 feet
    b. Wiring from a zone airflow terminal control unit to a nearby water control valve not to exceed six feet

Q. Wiring from any controller to a device which has otherwise been approved for installation and cannot accept conduit connection shall meet the following requirements:

1. Conduit shall be used to within 12 inches of the device.
2. Install in wireway all trunk communication wiring between the operator station and the controllers, and between controllers. Open wiring is not otherwise permitted.

R. Conduits shall be provided with appropriate bushings and end fittings to protect cabling from sharp conduit edges.

S. Conduit size shall be ¾-inch minimum for all wiring groups consisting of six or more conductors. NEC requirements shall apply as though conductors were used to their full current carrying and thermal capacity.

T. Wireway runs shall be level, plumb, parallel, or perpendicular to walls, pipes and sides of openings. Wireways shall follow the contours of the support surface. Passageways for access and servicing shall not be blocked.

U. All wiring between global controllers and trunk, N2 and LAN cables longer than 300 feet shall be 100% backed up with spare conductors.

V. All conductors that become bundled or pass from an enclosure shall be identified with typed or machine lettered labels, Briade or approved equal. Tag numbers shall agree with wire numbers assigned on wiring diagrams and the installation drawings.

W. Wires shall be labeled with mechanically prepared labels at their connection point to each apparatus point of connection.

X. UL/ULC Listed Flexible Metal Conduit shall be used for vibration isolation and shall be limited to 3 feet in length when terminating to vibrating equipment. Flexible Metal Conduit may be used within partition walls and for final connection to equipment.

Y. Open wiring, when permitted, shall be installed in compliance with WAC 296-46-725 with reference to NEC 336-15 and shall also be installed as follows:

1. All open wiring that penetrates through walls and crosses structural ceilings shall do so within 18 inches of the structural ceiling surface.
2. Wiring shall be attached to vertical supports at attachment points prepared by a protective wrap of electrical tape around the support. This wrap shall create a surface free of sharp edges.
3. Absolutely no wire is to be attached to pipe work or conduit of any kind.
4. Wire ties, if used, shall be trimmed to reduce sharp edges.
5. The vendor shall provide required cabling attachment points for control's use if the ceiling structure does not provide acceptable attachment points.

2.20 CONTROL RELAYS

A. Panel relays shall be plug-in type with contacts rated at twice the amperage rating of circuit requirements: Minimum temperature range –25º C to +70º C. Enclosure: Clear dust cover and shock resistant, rated for minimum of 2.5 million mechanical operations and 100,000 electrical operations at full load.

B. Remote/interposing relays shall be used for all remote switched loads.

1. They shall be housed in a NEMA-rated enclosure. Where two or more relays are mounted in the same enclosure, provide a hinged cover.
2. Besides meeting panel relay requirements, relays shall have 24 VDC coils and form C dry contacts with a minimum rating of 5 amperes @ 240 VAC.
3. Relays controlling inductive loads shall be equipped with coil transient suppression devices to limit transients to 150% of rated coil voltage.

2.21 TRANSFORMERS

A. 120V AC to 24V AC transformers shall be supplied to provide control voltage to the control system. The incoming 120V AC power shall be fused. Transformers shall be supplied with suitable mounting plates and mounted in separate electrical panel boxes with hinged covers adjacent to control system panels.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS.

A. General: All work under this section shall be a subcontract by an authorized agent of the manufacturer.

B. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to description of operation.

C. Notations at Instruments: A typewritten notation shall be provided at each instrument stating its use; at thermostats, the proper setting. In finished spaces these notations shall be secured to the inside of the case; in other areas, shall be secured by adhesive to the duct or other adjacent surface and shellacked over. Instruments and equipment, whose use is self-evident, such as ordinary room thermostats, radiator valves, or similar unitary equipment valves, will not require such notations.

D. Penetrations of Ducts: All penetrations shall be properly sealed to prevent leakage around the opening; shall include a stuffing box type of closure or similar approved method.

E. Pipe Wells: Provide pipe wells for insertion of temperature sensors in water lines. Temperature sensing wells shall be of sufficient length to reach midway into pipe, with extension necks where installed or insulated piping. Wells shall be brass or stainless steel; installed in lines using tees or thread-o-lets.

F. Insertion Thermostats: Provide for all duct and water temperature sensing; capillary connected if averaging bulb type; capillary or rod and tube type for other units; nonbleed; throttling range as required for service; on water circuits, separable socket type; remote readjusting type where specified, adjustable ratio, straight line action, adjustable limit stops.

G. The freezestats used on fan shut-down control shall be wired to stop the fan in both the Auto and Hand positions of the HOA switch. Freezestats shall be overridden by the fire alarm controls.

H. Wall mounted temperature sensors shall be mounted on electrical boxes, and all wire penetrations shall be sealed to prevent thermal convection.

I. It is the responsibility of the controls vendor to ensure that all sensors are placed in the measurable flow path to accurately measure the sensed variable.

J. Sensors installed for outside air measurement and pressurization shall be located to optimize the accuracy of the measurement. Coordinate with Mechanical Consultant.

K. All devices shall be mounted within enclosures. Cable trays and external cabinet surfaces shall not be used as mounting surfaces. Proof of run for both fans and pumps shall be by current sensing devices rather than differential pressure switches.

L. All pressure indicating/measuring devices shall be installed with capped tee devices to permit attachment of test meters.

M. Controls Mounting: Controls shall be grouped by systems, areas, or other appropriate basis concealed in locking-type wall-mounted cabinets, with proper labeling as to functions and settings marked on the front thereof, located no more than 6'-0" above the floor unless specifically approved by Owner. Control cabinets shall not be installed on ductwork or plenum walls. Mount all relays, switches, contacts, etc., in common panels. Tag each instrument by use of approved labels corresponding to symbols used on control drawings.

N. Location of Room Sensors: Where sensors are mounted at light switches, locate on centerline of the electrical outlet box, as directed. Sensors shall not be located above dimmer switches. Exact location of sensors shall be verified with final casework and furniture layouts.

O. Verify location of thermostats, CO2 sensors and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches or 60 inches above the floor. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

P. Install guards on thermostats in the following locations:

1. Entrances.
2. Public areas.

Q. Install automatic dampers according to Division 23, Section 233300, "Air Duct Accessories."

R. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

S. Install labels and nameplates to identify control components according to Division 23, Section 220550, "Identification for HVAC Piping and Equipment."

T. Install duct volume-control dampers according to Division 23 Sections specifying air ducts.

3.2 CONTROL SOFTWARE PROGRAMMING

A. Control of equipment as described in the description of operations and shall include:

1. Time and holiday schedules
2. Alarm limits and histories
3. Summary of data for each zone
4. Trend logs and historical data
5. All setpoints
6. Master menu
7. Dynamic color graphic Interface

B. The following Points Descriptions of Operation shall be enhanced as necessary and included as part of the control drawings to expand and clarify information shown in the drawings.

1. Points information shall be displayed and organized by system in dynamic graphic form at the operator stations.
2. The energy reduction software and miscellaneous functions shall manage all points.
3. It shall be possible to "disconnect" any output or setpoint from the AUTOMATIC control logic and enter a MANUAL value or state from any Operator Station.
4. It shall be possible to replace any input with a MANUAL value from any Operator Station.
5. All control loop parameters for each loop shall be displayed on one display.

C. Where a point or device is indicated on a drawing, it shall be provided even if not required in a Description of Operation (Description). Where a point or device is required for a description, it shall be provided even if it is not shown on a diagram or plan.

D. All setpoints indicated in the descriptions are suggested initial setpoints. Actual setpoints shall be determined and programmed during system balancing and commissioning process. If actual setpoint determined during this process is substantially different from the initial suggested setpoint, request confirmation of acceptability from the A/E.

E. All setpoints and values indicated in the descriptions shall be adjustable with authorized access. Owner shall determine/confirm the appropriate access level during Owner training. It shall be possible to have multiple access levels with limited range of adjustability for each level.

F. All descriptions shall apply when the Operator (with proper access) allows automatic control via an Operators Station. It shall be possible to override to prevent automatic operation and take manual control of any system or equipment item. If automatic start-stop operation is not discussed in description for a particular device, then there shall be a manual "on-off" command feature at the Operators Station.

G. Displays: Every control device indicated on the drawings or specifications and every point required in the descriptions of operation shall have information displayed at the Operators Station(s). All information displayed shall have a simple and concise description of what the information is and means. Certain display requirements are indicated in the descriptions. To avoid unnecessary duplication, other more typical display requirements are <u>not</u> indicated in every description but shall be provided for every device or point as follows:

1. Every device or equipment item that has a start-stop, open-closed, on-off or similar binary output from the BAS shall have an operational status display. Display shall include multiple pieces of information, as follows:

   a. Current "on-off" command from BAS.
   b. Current "on-off" condition as sensed by proof switch (where available).
   c. Virtual "on-off" condition if a proof switch is not available, but other sensors can provide a reasonable verification of equipment operation. For example, such a reasonable verification may include using an analog pressure sensor downstream of a fan where a sensed value above a certain level could only occur if the fan was in operation.
   d. Indication as to if control is in automatic mode (controlled per description) or in manual mode.

2. Every device or equipment item that has a binary (open-closed contact) input to the BAS shall have an operational status display. Display shall include:

   a. Current condition.

3. Every device or equipment item that has an analog control output from the BAS shall have an operational status display. Display shall include multiple pieces of information, as follows:

   a. Current setpoint.
   b. Commanded output (percent of maximum).
   c. Display of the measured value at the controlling sensor or VFD.
   d. Indication as to if control is in automatic mode (controlled per description) or in manual (override) mode.

4. Every device or equipment item that has an analog input to the BAS shall have an operational status display. Display shall include:

   a. Current measured condition.
   b. Whether alarm feature is active.
   c. Current setpoint for high and low alarm conditions.

5. Unless indicated otherwise in the descriptions, all stated values shall be assumed to use units of measurement displayed (at operator workstations) as follows:

   a. Temperature in degree F.
   b. Humidity in relative humidity (percent).
   c. Air pressure (and differential pressure) in inches water column.
   d. Water or steam pressure (and differential pressure) in PSIG.
   e. Water flow rate in GPM.
   f. Air flow rate in CFM.
   g. Speed as percent of maximum RPM (when motor is driven at 60 hertz by VFD).

6. The following points shall be displayed using calculated values based upon commanded position unless exact values, as indicated by a feedback signal, are required by control strategy:

   a. Fan speed (percent of full speed)
   b. Damper positions (percent of full open)
   c. Heating and cooling valve position (percent of full open)

H. Trend Logs: Provide trend log programming and setup for individual points as requested by the Owner up to a maximum of three percent of all inputs provided on the project.

I. Alarms: Certain special alarm requirements are indicated in the descriptions. To avoid unnecessary duplication, all necessary alarm requirements are not indicated in every description. In addition to the listed alarms, every point shall be equipped to (potentially) have the following alarms. Each alarm shall include specific text (on screen) describing the nature of the alarm, and the source of the alarm information (such as “current sensing relay”, “differential pressure switch”, etc.) Each point shall be capable (with only programming and setup required) to alarm as follows:

1. Every device or equipment item that has a start-stop, open-closed, on-off or similar command from the BAS shall have an alarm to identify failure to operate as commanded. This alarm shall use available proof switches or other sensors that can be used as a “virtual proof”. Provide suitable delays to accommodate equipment startup times, etc.
2. Every device that has a binary (open-closed) input to the BAS that would normally be used as an alarm or service-requirement indicator (such as a differential pressure switch at a filter) shall provide suitable alarm annunciation.

3. Every device or equipment item that has an analog control output from the BAS shall have an alarm to identify failure of system to maintain setpoint at the controlling sensor. Provide suitable delays to accommodate equipment startup times, etc. Establish reasonable high and low condition alarm trigger points to accommodate normal and reasonable variations in system output.
4. Every VFD shall have an alarm contact monitored by the BAS to acknowledge any faults. It shall also have an additional alarm contact monitored by the BAS to acknowledge if it is in bypass mode.

J. Alarm Programming: Provide alarm programming and setup for all alarms specifically indicated in the descriptions of operation, and at additional points as requested by the Owner up to a maximum of 20% of all inputs provided on the project. Assign operator high and low alarm limits according to design data or as Owner requests. It is assumed that Owner will want alarms to be set up for all filter switches and at all inputs indicated, but not addressed in the descriptions.

3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. All electrical control wiring and terminations for the control system shall be provided by the controls subcontractor,

B. Install raceways, boxes, and cabinets according to Division 26, Section 260533, "Raceway and Boxes for Electrical Systems."

C. Install building wire and cable according to Division 26, Section 260519, "Low-Voltage Electrical Power Conductors and Cables."

D. Install signal and communication cable according to Division 27, Section 271500, "Communications Horizontal Cabling."

1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
2. Install exposed cable in raceway.
3. Install concealed cable in raceway.
4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.

E. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

F. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.4 WORK BY OTHERS

A. The mechanical subcontractor shall install all wells, pressure tappings for flow sensors, etc., and shall set all control valves in place under the manufacturer's supervision. Pressure taps shall include service valves and calibration taps.

B. The sheet metal subcontractor shall approve or correct the submitted schedule of required control damper quantities and sizes before dampers are ordered from the factory. Sheet metal Contractor shall receive dampers at the job site, set dampers in place under the manufacturer's supervision and provide an access door for each damper. Dampers shall be mounted square within the duct without twisting or distortion to ensure proper damper operation. The damper shaft shall be extended at a location that provides space for the actuator.

C. Patching and painting required for the control system installation will be accomplished by the General Contractor.

D. All line voltage wiring required for control panels, alternators, motor starters are to be furnished and installed by the electrical subcontractor.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
2. Test and adjust controls and safeties.
3. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
4. Pressure test control air piping at 30 psig or 1.5 times the operating pressure for 24 hours, with maximum 5-psig loss.
5. Test each point through its full operating range to verify that safety and operating control set points are as required.
6. Test each control loop to verify stable mode of operation and compliance with description of operation. Adjust PID actions.
7. Test each system for compliance with description of operation.
8. Test software and hardware interlocks.

C. DDC Verification:

1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
2. Check instruments for proper location and accessibility.
3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
4. Check instrument tubing for proper fittings, slope, material, and support.
5. Check installation of air supply for each instrument.
6. Check flow instruments. Inspect tag number and line and bore size and verify that inlet side is identified and that meters are installed correctly.

7. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
8. Check temperature instruments and material and length of sensing elements.
9. Check control valves. Verify that they are in correct direction.
10. Check air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.
11. Check DDC system as follows:
    a. Verify that DDC controller power supply is from emergency power supply, if applicable.
    b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
    c. Verify that spare I/O capacity has been provided.
    d. Verify that DDC controllers are protected from power supply surges.

D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.6 ADJUSTING

A. Calibrating and Adjusting:
1. Calibrate instruments.
2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
4. Control System Inputs and Outputs:
    a. Check analog inputs at 0, 50, and 100 percent of span.
    b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
    c. Check digital inputs using jumper wire.
    d. Check digital outputs using ohmmeter to test for contact making or breaking.
    e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.
5. Flow:
    a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
    b. Manually operate flow switches to verify that they make or break contact.
6. Pressure:
    a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
    b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
7. Temperature:
    a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
    b. Calibrate temperature switches to make or break contacts.

8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
10. Provide diagnostic and test instruments for calibration and adjustment of system.
11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature set points.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions.

3.7 DEMONSTRATION AND ACCEPTANCE.

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Division 01, Section 017900, "Demonstration and Training."

B. The building controls system subcontractor shall submit a proposed Acceptance Test Agreement for testing the system's functionality and the accuracy of all sensors and actuators.

C. The system installation shall be complete in all respects and tested for proper operation prior to acceptance testing for the Owner's authorized representative. A letter shall be submitted to the Engineer requesting system acceptance. This letter shall certify all controls are installed and the software programs have been completely exercised for proper equipment operation. Acceptance testing will commence at a mutually agreeable time within 30 calendar days of the request. When the system has been deemed satisfactory in whole or in part by the Owner's representative, the system will be accepted for beneficial use which will start the warranty period for the commissioned portion.

3.8 COMMISSIONING

A. Notify the Commissioning Agent one week prior to startup of equipment.

B. Submit to the Commissioning Agent a Verification of Completion form with the pre-functional check off sheet for each component when it is ready for functional testing.

C. Assist the Commissioning Agent as required to perform the functional testing on the system components and the system as a whole.

END OF SECTION 230900

SECTION 233100 - METAL DUCTS AND CASINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes metal ducts for supply, return, outside, and exhaust air-distribution systems in pressure classes from minus 2- to plus 4-inch wg and metal casings. Metal ducts include the following:

1. Rectangular ducts and fittings.
2. Duct liner.
3. Turning vanes.

B. Related Sections include the following:

1. Division 23, Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, and flexible ducts.

1.3 SYSTEM DESCRIPTION

A. Duct system design, as indicated, has been used to select size and type of air-moving and - distribution equipment and other air system components.

1.4 SUBMITTALS

A. Submit shop standard for ductwork construction utilized on this project. Include proposed duct gage, reinforcement interval, seam and joint construction for all sizes and pressure classes of ductwork. Submit construction standard for all plenums and fittings.

B. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. NFPA Compliance:

1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 General requirements – Ductwork and Plenums

A. Construction: Primary air duct construction, fittings, reinforcements, pressure and seal classifications and metal gauges shall conform to SMACNA HVAC/DCS, 2005 Edition including Addendum No. 1, 2005 SMACNA Duct Construction Standards and NFPA90A unless noted otherwise.

B. Ducts and accessories shall not pulsate or vibrate when in operation.

C. Test Ports: Provide instrument test holes with screw cap and gasket. Instrument test holes shall be attached to ducts and plenums with bolts. Seal around bolt head with duct sealant. Provide gasket to fit duct shape as needed. Provide all such test holes in ducts with instrument adapter as required for static pressure readings; exact location to be coordinated with air balancing contractor.

1. Available Manufacturer: Ventfabrics No. 699

D. Stuffing Boxes: Provide airtight stuffing boxes at all penetrations for instrumentation, such as sensors, thermostats, thermometers, pipes, etc.; use rubber grommets or U-channel rubber extrusions to create airtight seal.

1. Available Manufacturer: “Rubbercraft”.

E. At connections to building construction, use steel angles fastened to the sheet metal by sheet metal screws, attached using anchor bolts embedded in the wall or slab, with sealant under the angle, angles 2"x2"x3/16" minimum.

2.3 SHEETMETAL DUCTWORK

A. General: All ductwork shall be of sheet metal construction.

B. Pressure and Seal Classification: Unless otherwise indicated, construct ducts according to the following:

1. Supply ducts from outlet of air handlers and fans to terminal units: +4-in wg. Seal Class A.
2. Return ducts: Negative 2-in wg, except ductwork from last volume damper to grille may be negative 1-in wg. Seal class A.
3. Exhaust ducts: Negative 2-in wg. Seal Class A.
4. Any ductwork upstream of any fire, smoke or combination fire/smoke damper conveying more than half of the total terminal airflow: +4-in wg. Seal Class A.

C. Material schedule:

1. All ducts shall be galvanized steel unless otherwise specified.

D. Galvanized Steel: Steel sheets, G-60 zinc-coated (galvanized) or zinc-iron alloy coated (galvannealed) by the hot dip process, conforming ASTM A653 unless noted otherwise.

E. Stainless Steel: Comply with ASTM A 480/A 480M, Type 304 OR 316L, cold rolled, annealed, sheet.

F. Pressure classes refer to both positive and negative ducts in absolute numbers unless noted otherwise.

G. Round or Oval Elbow Construction: Round or oval segmented or mitered elbows shall be minimum 3-gore for 45°, 4-gore for 60°, and 5-gore for 90°. Adjustable round elbows are not permitted.

H. Bellmouth transitions shall be used on round connections to air handling units and plenums.

I. Rectangular Elbows shall be radius or short radius with vanes, type RE 1 and RE 3 in the SMACNA manual. Mitered elbows with turning vanes and other types shall not be used, use short radius elbows with vanes where space is limited. Construct vanes per pages 4.5 and 4.6 (Figures 4-3 and 4-4) of the SMACNA manual.

J. Turning vanes for rectangular elbows:

1. Turning vanes shall be welded to runners at velocities exceeding 2,500 fpm.
2. All sheet metal duct pressure classes and velocities: Airfoil Turning Vane is acceptable. Non-adjustable, double wall 26-gauge hot dipped galvanized steel, true airfoil type air turning vanes at square duct elbows. Factory runner, 24-gauge, with vanes 2.4” o.c.

    a. Available Manufacturer: “Aero Dyne Company”, Model HEP.

3. 2” wg. Pressure Class ducts or lower with velocities at or below 1500 fpm: 2” single width vanes, spaced 1.5” o.c. may be used when spanned lengths are 36” or less. Non-adjustable, single wall 24-gauge vane per SMACNA Fig. 4-3 & 4-4. Rail shall be 24-gauge.

    a. Available Manufacturer: “Duro Dyne”, “Ductmate” Monorail.

4. 3” wg. Pressure Class or higher ducts at any velocity and where duct velocities in any pressure class exceed 1500 fpm: 2” double width vanes, spaced 2.125” o.c. shall be used when spanned lengths are 48” or less. This vane is acceptable at lower pressure classes and velocities. Non-adjustable, double wall 26-gauge vane per SMACNA Fig. 4-3 & 4-4. The 22-gauge vane runner shall be of the tabbed style and shall have bent, or winged tabs. Straight tabs are not permitted.

    a. Available Manufacturer: “C.L. Ward & Family Inc.” Turning Vane and Speedy Rail, “Ductmate” Turning Vane and PROrail.

5. 3” wg. Pressure Class or higher ducts at any velocity and where duct velocities in any pressure class exceed 1500 fpm: 4.5” double width vanes, spaced 3.25” o.c. may be used when spanned lengths are 72” or less. Provide tie-rods for spans more than 72”. This vane is acceptable at lower pressure classes and velocities. Non-adjustable, double wall 24-gauge vane per SMACNA Fig. Fig. 4-3 & 4-4. Vane runner shall be of the tabbed style and shall have bent, or winged tabs. Straight tabs are not permitted.

    a. Available Manufacturer: “C.L. Ward & Family Inc.” Turning Vane and Speedy Rail, “Ductmate” PROrail.

K. Seams: All seams shall conform to SMACNA standards for the corresponding pressure and seal class and to the requirements in this specification.

1. Round and oval duct seams shall be spiral seam or continuous butt weld construction only.
2. Rectangular seams for 3-in wg pressure class or higher shall be SMACNA L-1 Pittsburgh Lock or continuous butt weld only.
3. Rectangular seams for 2-in wg pressure class or lower shall be continuous butt weld, SMACNA L-1 Pittsburgh Lock, or SMACNA L-2 Button Punch Snap Lock.
4. Do not use standing seams for ducts other than plenums.

L. Joints: All joints shall conform to SMACNA standards for the corresponding pressure and seal class and to the requirements in this specification.

M. Rectangular Joints: Provide prefabricated slide-on transverse duct connectors and components. Install per manufacturer guidelines for sheet gauge, intermediate reinforcement size and spacing, and joint reinforcement(s). Formed-on SMACNA flanges T-25a (T.D.C.) or T-25b (T.D.F.) will not be accepted.

1. Acceptable Manufacturers:

   a. “Ductmate Industries” 25, 35, and 45
   b. “Nexus” G and J
   c. “W.D.C.I.” J and H

2. Rectangular joints for 2-in wg pressure class or lower may also be SMACNA

   a. T-24 flanged with gasket
   b. T-1 Drive Slip with T-5, T-6, T-10, T-11, or T-12 S Slip

N. Round Joints: Factory fabricated transverse spiral and round duct joints conforming to SMACNA standards RT-1 through RT-6 are acceptable for ducts 20” in diameter and under. Prefabricated connectors for duct joints are permitted as noted below. Install per manufacturer guidelines for sheet gauge, intermediate reinforcement size and spacing, and joint reinforcement(s).

1. 3”-14” Diameter: Install duct with a one piece round duct connector that includes a polyethylene gasket liner and single bolt closure. “Ductmate Industries” Quick-Sleeve Round Duct Connector, “Ward Industries” Quick Connect Model QCC (up to 12” only) or approved equal.
2. 14”-72” Diameter: Install duct using a three-piece, gasket flanged joint consisting of two internal flanges, with integral mastic sealant and one external closure band, which compresses the gasket between the internal flanges. “Ductmate Industries” Spiralmate or approved equal.

O. See Duct Fitting Requirements detail on drawings for acceptable configurations for offsets, transitions, and take-offs.

P. Diagonal Creasing for ducts 3-in wg or lower: Provide on all panels wider than 18". At Contractor's option, in place of diagonal creasing required for panels wider than 18", all such panels may have machine-formed transverse ribbed stiffening on 12" centers, provided such stiffening accomplishes stiffness and freedom from buckling or breathing, and does not lessen airtightness at seams and joints.

Q. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

R. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Characteristics: Type S, Grade NS, Class 25, Use O.

S. Gaskets in Flanged Ducts: Use soft neoprene or extruded butyl.

2.4 SHEETMETAL MATERIALS

A. Galvanized Steel: Steel sheets, G-60 zinc-coated (galvanized) or zinc-iron alloy coated (galvannealed) by the hot dip process, conforming ASTM A653 unless noted otherwise.

B. Stainless Steel: Unless indicated otherwise, Type 316L stainless steel, not to exceed 0.03% carbon, conforming to ASTM A240/A240M.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Coordination: Sheet metal duct installation shall be coordinated with other trades prior to installation to avoid conflict with the following other building elements:

1. Ceiling suspension assembly members.
2. Systems installed in same space as ducts (piping, electrical conduits, equipment, etc.).
3. Ceiling- and wall-mounting access doors and panels required to provide access to dampers and other operating devices.
4. Ceiling-mounting items, including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

B. Fabricate and install ductwork and accessories in accordance with SMACNA Duct Construction Standards, Metal and Flexible.

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, terminal units, diffusers, grilles, etc., and to coordinate with other trades. Fabricate ductwork based on field measurements. Provide 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 the contractor to other dimensions with

the same air handling characteristics (not less than same free area and pressure drop) where necessary to avoid interferences and clearance difficulties.

C. Provide Duct transitions, offsets and connections to dampers, coils, and other equipment in accordance with SMACNA Duct Construction Standards, Metal and Flexible and with Duct Fitting Requirements detail on drawings.

1. When an obstruction cannot be avoided and must be taken in by the duct, comply with SMACNA “Obstructions". Repair galvanized areas with galvanizing repair compound.
2. Construct casings, plenums, eliminators, and pipe penetrations in accordance with SMACNA Standards, install plenum access doors to swing against air pressure so that pressure helps to maintain a tight seal.

D. Install ducts with the fewest possible joints.

E. Provide test holes at fan inlets and outlets, where required for balancing, and elsewhere as indicated.

F. Install fabricated fittings for changes in directions, size, and shape and for connections.

G. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches, with a minimum of 3 screws in each coupling.

H. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.

I. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

J. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

K. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.

L. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.

M. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.

N. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures.

O. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches.

P. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers, sleeves, and firestopping sealant. Fire and smoke dampers are specified in Division 23 Section "Air Duct Accessories." Firestopping materials and installation methods are specified in Division 07 Section "Penetration Firestopping."

Q. New Ductwork Protection and Cleaning**:**

1. Each piece of shop-fabricated ductwork shall be cleaned of contaminants and oil residue before being sent to the job site.
2. Each piece of field-fabricated ductwork shall be cleaned of contaminants and oil residue It shall then either be promptly installed or sealed with visqueen or “Ductcap Products Inc” caps and stored.
3. All ductwork stored on the jobsite shall remain sealed until it is installed. Unsealed sections of ductwork shall not be permitted to be stored or lying about the jobsite.
4. All ductwork shall always be protected from moisture.
5. All ends of installed ductwork shall be sealed with visqueen or “Ductcap Products Inc” caps at the end of each workday.

R. Existing Ductwork Protection and Cleanliness Evaluation:

1. All ends of existing ductwork that are exposed after demolition shall be sealed with visqueen at the end of each workday.
2. Notify A/E when the majority of existing ductwork demolition has been completed and remaining existing ductwork is available for evaluation. The Owner or their designated representative will evaluate the cleanliness of the existing ductwork. The Owner may then elect to hire a contractor to clean the existing ductwork before connections are made to the new system.

3.2 SEAM AND JOINT SEALING

A. Seal duct seams and joints according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for duct pressure and seal class indicated in Part 2 of this specification section.

B. Seal ducts before external insulation is applied.

C. Adhesive-backed cloth or metallic furnace tape will not be acceptable.

3.3 CONNECTIONS

A. Make connections to equipment with flexible connectors according to Division 23 Section "Air Duct Accessories."

3.4 FIELD QUALITY CONTROL

A. Air Supply and Distribution Systems: The air supply, return, and exhaust and distribution systems and its components shall be given an operational test.

3.5 COMMISSIONING

A. Notify the Commissioning Agent one week prior to startup of equipment.

B. Submit to the Commissioning Agent a Verification of Completion form with the pre-functional check off sheet for each component when it is ready for functional testing.

C. Assist the Commissioning Agent as required to perform the functional testing on the system components and the system as a whole.

END OF SECTION 233100

SECTION 233300 – AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 specification sections, apply to this section.

1.2 SUMMARY

A. This Section includes the following:

1. Volume dampers.
2. Motorized dampers.
3. Duct-mounted access doors.
4. Casing and Plenum access doors.
5. Flexible connectors.

B. Related Sections include the following:

1. Division 23, Section 230900, "Instrumentation and Control for HVAC" for electric damper actuators.
2. Division 23, Section “HVAC Ductwork and Casings” for test ports, stuffing boxes, turning vanes, joint sealant, and safety relief access doors.

1.3 SUBMITTALS

A. Product Data: Submit for the following:

1. Volume dampers.
2. Motorized dampers.
3. Duct-mounted access doors.
4. Casing and plenum access doors.
5. Flexible connectors.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

PART 2 - PRODUCTS

2.1 SHEETMETAL MATERIALS

A. Galvanized Steel: Steel sheets, G-60 zinc-coated (galvanized) or zinc-iron alloy coated (galvannealed) by the hot dip process, conforming ASTM A653 unless noted otherwise.

B. Stainless Steel: Unless indicated otherwise, Type 316L stainless steel, not to exceed 0.03% carbon, conforming to ASTM A240/A240M.

2.2 VOLUME DAMPERS

A. General Description: All volume dampers shall be factory fabricated with hardware and accessories. Stiffen damper blades for stability and include locking device to hold single-blade dampers in a fixed position without vibration. Dampers shall be free from any sharp edges that would produce excessive turbulence. Dampers must be rated for the service pressure drop, velocity, and temperature.

B. Damper and Accessory Material: Same as metal duct.

C. Single Blade Volume Dampers:

1. Permitted only for rectangular ducts up to 36” wide and 12” high or round ducts up to 12” diameter.
2. Rated for velocities up to 1500 fpm and pressure drops across damper of 1 in. wg. or less.
3. Damper blade shall be minimum 22-gauge steel and shall be as close to full size as possible without binding. Both leading and leaving edges hemmed; side edges flanged 1/2"; placed so air strikes the smooth face.
4. Damper shaft shall be minimum 3/8” square rod. Shafts shall be full length.
5. Frame shall be min. 20-gauge steel channels with mitered and welded corners.
6. Manufacturers:

   a. McGill AirFlow Corporation Models UVC8 and UVC9.
   b. Greenheck Models MBD-10 and MBDR-50
   c. Ruskin
   d. Young Regulator Company

D. Rectangular and Square Opposed-Blade Volume Dampers:

1. Provide for rectangular ducts over 36” wide or 12” high or round ducts over 12” diameter and where specifically designated on the drawings.

   a. May be used in place of single blade volume dampers at contractor’s option.
   b. Rated for velocities up to 2000 fpm and pressure drops across damper of 2 in. wg. or less.
   c. Damper must be rated for the service pressure drop, velocity, and temperature.

2. Round ducts shall be provided with transitions into and out of the square damper assembly.
3. Damper blades shall be minimum 16-gauge galvanized steel. Both leading and leaving edges hemmed; side edges flanged 1/2"; placed so air strikes the smooth face.
4. Damper shafts shall be minimum 1/2” square rod. Shafts shall be full length.
5. Frames shall be min. 16-gauge galvanized steel structural or formed channels with mitered and welded corners.
6. Manufacturers:

   a. McGill AirFlow Corporation Model UVC21
   b. Greenheck Model VCD-18
   c. Ruskin
   d. Young Regulator Company

E. Bearings:

1. Provide end bearings or other seals for ducts with axles full length of damper blades and bearings at both ends of operating shaft.

2. Bearings shall be molded synthetic, oil-impregnated bronze, Zytel, or stainless steel.
3. Manufacturers:

    a. Ventfabrics HiVel Ventlok
    b. Young Regulator Company

F. Quadrants:

1. Provided with a dial regulator, heavy gauge handle, and locking nut. Size to match shaft size.
2. Provide elevated stand-off for use on all externally insulated ductwork.
3. Manufacturer:

    a. Ventfabrics Ventline Quadrant
    b. Young Regulator Company

G. Quadrants for Dampers in Ducts Concealed Behind Walls and Above Non-Removable Ceilings:

1. Direct Controlled Dampers: Where possible, use direct controlled dampers. Damper regulator shall be cast into a box for flush mounting in ceilings. Cover telescopes into base to allow for expansion. Cover shall be secured by two screws to facilitate removal for adjustment of the damper. The regulator shall be made to accommodate 3/8" and 1/2" square rod.

    a. Manufacturers:

        1) Young Regulator No. 301
        2) Ventfabrics No. 666
        3) Ruskin
        4) Nailor

2. Cable Controlled Dampers: Balancing dampers in ducts concealed behind walls and non-removable ceilings shall be provided with cable-controls if access to the regulator cannot be immediately adjacent to the damper. Damper controller and cable shall be concealed above the ceiling. Cable shall consist of Bowden cable 0.054" stainless steel control wire encapsulated in 1/16" flexible galvanized spiral wire sheath. Control kit shall consist of 2-5/8" diameter die cast aluminum housing with three-inch diameter cover, and 14-gauge steel rack and pinion gear drive converting rotary motion to push-pull motion. Control kit shall be imbedded in the ceiling flush with the finished surface. Control kit shall be manually operated with a wrench.

    a. Manufacturers:

        1) Young Regulator Model 270-301 control kit and Model 030-12 wrench.
        2) Ventfabrics

2.3 MOTORIZED DAMPERS

A. Control Dampers: AMCA-rated, opposed blade design; 0.125-inch minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall be heavy gage extruded aluminum, airfoil type, with maximum blade width of 6 inches and length of 48 inches.

1. Secure blades to 1/2-inch diameter, zinc-plated axles using zinc-plated hardware, blade-linkage hardware of zinc-plated steel and brass, ends sealed against molded synthetic blade bearings.
2. Operating Temperature Range: From minus 40 to plus 200 deg F.

3. Edge Seals, Low-Leakage: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 8 cfm per sq. ft. of damper area at differential pressure of four inch w.g. and a maximum of 3 cfm per sq.ft. at one inch w.g. when tested according to AMCA 500D.

B. Large damper assemblies shall be made of individually driven segments that are small enough to ensure reliable operation and uniform closure across the entire damper assembly. Actuators shall be operated independently so that if one damper segment or actuator becomes inoperable, the others remain operable (provide multiple end switches wired together so if a section fails, end switch will acknowledge). Jack shafts and linkages should not be necessary and can only be used if approved by Owner.

C. See the failure mode section above for actuator responses under failure due to loss of power, loss of control air, or loss of communication. Where an actuator is to fail open or fail closed, provide spring return. Actuators shall not be dependent on batteries or capacitors to stroke to the power fail position upon loss of power.

D. Permanently stamp or scribe position indication on the end of driven shaft unless damper is visible from same location as end of shaft.

E. Actuators: See Section 230900 - INSTRUMENTATION AND CONTROL SYSTEMS.

F. Manufacturer: Ruskin, American Warming and Ventilation or approved equal dampers.

1. Control damper - Ruskin Industries Model CD50
2. Smoke damper - Ruskin Industries Model SD50

2.4 DUCT-MOUNTED ACCESS DOORS

A. General Description: Fabricate doors airtight and suitable for duct pressure class.

B. Rectangular Duct Door: Double wall, duct mounting, and rectangular; fabricated of galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class. Include vision panel where indicated**.** Include 1-by-1-inch butt or piano hinge and cam latches.

1. Basis of Design: Ductmate Industries, Inc. “Square Framed Access Doors, Hinged and Cammed Model”.
2. Manufacturers:
   a. Ductmate Industries, Inc. “Square Framed Access Doors, Hinged and Cammed Model”.
   b. Air Balance Inc. “Series FSA”
   c. Greenheck
   d. McGill AirFlow Corporation Model ARB
   e. Ruskin “SMACNA Standard”
3. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
4. Provide number of hinges and locks as follows:
   a. Less Than 12 Inches Square: Secure with two sash locks.
   b. Up to 18 Inches Square: Two hinges and two sash locks.
   c. Up to 24 by 48 Inches: Three hinges and two compression latches**.**
   d. Sizes 24 by 48 Inches and Larger: One additional hinge.

C. Round Duct Door: Double wall, duct mounting, and round; fabricated of galvanized sheet metal with insulation fill and 1-inch thickness. Include cam latches.

1. Basis of Design: Ductmate Industries, Inc. “Sandwich Access Door”.
2. Manufacturers:

   a. Ductmate Industries, Inc. “Sandwich Access Door”
   b. McGill AirFlow Corporation

3. Frame: Galvanized sheet steel, with spin-in notched frame.

D. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.

E. Insulation: One-inch- thick, fibrous-glass or polystyrene-foam board.

2.5 Access Doors in Casings and Plenums:

A. Construct in accordance with SMACNA 2005 HVAC Duct Construction Standards, Fig. 9-16. Doors shall be double-wall insulated type and shall be equipped with three heavy duty zinc plated steel strap type T-hinges and two latches with lever handle on outside and inside. Doors shall be gasketed.

1. Basis of Design: Ductmate Industries, Inc. “Square Framed Access Doors, Hinged and Cammed Model”
2. Manufacturers:

   a. Ductmate Industries, Inc
   b. Ventfabrics, Inc. "Ventlok"
   c. Air Balance, Inc. Series FSA

B. Latches shall have lever handle and stud to accommodate door thickness with inside beveled flange to work against door frame to give compression. Latch escutcheon shall be sponge rubber gasketed, heavy duty zinc plated steel

2.6 FLEXIBLE CONNECTORS

A. Basis of Design: Ductmate Industries, Inc. “Proflex”.

B. Manufacturers:

1. Ductmate Industries, Inc. “Proflex”
2. Ventfabrics, Inc. “Ventglas” (Indoor Installations) and “Ventlon” (Outdoor Installations).
3. Duro Dyne Corp.

C. General: Provide fabric-type flexible connectors between fans and ducts or casings, fans, and plenums, and where ducts are of dissimilar metals, as indicated and where required. Fabric shall comply with UL Standard 214 and shall be accepted by NFPA for vibration isolation connectors in duct systems per NFPA Standard 90.

D. Connectors at Indoor Installations: Connectors shall be made of heavy glass fabric double-coated with neoprene, weighing approximately 30 oz. per square yard. Flexible connections shall be securely fastened by zinc-coated iron cinch-type draw bands for round ducts. For rectangular ducts, the flexible connections locked to metal collars shall be installed using normal duct construction standards and according to SMACNA 2005 HVAC Duct Construction Standards.

E. Connectors at Outdoor Installations: Connectors shall be same as specified for indoor installations except fabric shall be made of heavy glass fabric double coated with Hypalon, weighing approximately 26 oz. per square yard.

PART 3 - EXECUTION

3.1 APPLICATION AND INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible".

B. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel except when another material is specifically specified (Example: aluminum made damper in galvanized duct), stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Volume Dampers:

1. Contractor shall set and lock all dampers in the "Full Open" position prior to balancing work.
2. Mount volume damper quadrants and end bearings so that the fasteners do not limit full damper travel.
3. Provide volume dampers at points on supply, return, and exhaust systems where branches lead from larger ducts as required for air balancing.
4. Install volume dampers as far from the outlet as possible while maintaining at a minimum of two duct widths from branch takeoff. Install at a point where the duct is accessible, if possible, axis of the blade the long dimension.

D. Access doors are required, but not typically shown on the drawings.

1. Install duct access doors on side of duct to allow for inspecting, adjusting, and maintaining accessories and terminal units as follows:

   a. Upstream of duct mounted coils, smoke detectors, and humidifiers.
   b. Adjacent to back draft dampers, providing access to adjust counterbalances.
   c. Adjacent to automatic control dampers.
   d. At turning vanes in return and exhaust ductwork.

2. Install the following sizes for duct-mounting, rectangular access doors:

   a. One-Hand or Inspection Access: 8 by 5 inches.
   b. Two-Hand Access: 12 by 6 inches.
   c. Head and Hand Access: 18 by 10 inches.
   d. Head and Shoulders Access: 21 by 14 inches.
   e. Body Access: 25 by 14 inches.
   f. Body Plus Ladder Access: 25 by 17 inches.

3. Install the following sizes for duct-mounting, round access doors:

   a. One-Hand or Inspection Access: 8 inches in diameter.
   b. Two-Hand Access: 10 inches in diameter.
   c. Head and Hand Access: 12 inches in diameter.
   d. Head and Shoulders Access: 18 inches in diameter.
   e. Body Access: 24 inches in diameter.

4. Label access doors according to Division 23, Section 230553, "Identification for HVAC Piping and Equipment."

E. Flexible Connectors:

1. Install immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.
2. For fans developing static pressures of 5-inch wg and higher, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

3.2 INSTALLATION-devices furnished under other sections

A. Motorized Dampers: Install all motorized dampers. Coordinate best location prior to ductwork fabrication and provide damper-manufacturer recommended straight duct length upstream and downstream. Dampers in ductwork and in plenums shall be provided with sheet metal closures all around the dampers frame, including mullions. Seal perimeter of damper frame closures with fire-retardant mastic for airtight closure. Construction and airtightness must be suitable for duct pressure class used. Multiple damper sections shall be bolted together and reinforced at joints with steel angles or channel mullions.

B. Smoke Detectors: Electrical contractor shall install all smoke detectors furnished by the electrical contractor. Review smoke detector submittals and advise manufacturer of anticipated air velocity range. Coordinate best location prior to ductwork fabrication and provide detector-manufacturer recommended straight duct length upstream and downstream. Provide adequate clearance for service and removal.

C. Air Flow Measuring Devices:

1. Install units specified as part of this section or as furnished by others.
2. Install with minimum straight run distances, upstream and downstream as recommended by the manufacturer. Notify engineer at submittal time if required distances do not appear to be sufficient.

3.3 EQUIPMENT AND MATERIALS PROTECTION

A. Adequately protect equipment and materials against physical damage. Place equipment and materials in first class operating condition or return to source of supply for repair or replacement, as determined by the engineer. Protect all equipment and materials from moisture, at all times. Protect during construction against entry of foreign matter to the inside and clean both inside and outside before operation and painting.

3.4 ADJUSTING

A. Adjust duct accessories for proper settings.

B. Final positioning of manual-volume dampers is specified in Division 23, Section 230593, "Testing, Adjusting, and Balancing for HVAC."

3.5 COMMISSIONING

A. Notify the Commissioning Agent one week prior to startup of equipment.

B. Submit to the Commissioning Agent a Verification of Completion form with the pre-functional check off sheet for each component when it is ready for functional testing.

C. Assist the Commissioning Agent as required to perform the functional testing on the system components and the system as a whole.

END OF SECTION 233300

SECTION 233400 – HVAC FANS

PART 1 - GENERAL

1.1 PERFORMANCE REQUIREMENTS

1.2 SUBMITTALS

A. In addition to submitting information to the mechanical engineer, submit fan anchorage and curb drawings and calculations to structural engineer for coordination and approval of roof penetration and roof curb and fan anchorage to the structure.

B. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:

1. Certified fan performance curves with system operating conditions indicated.
2. Certified fan sound-power ratings.
3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
4. Material thickness and finishes, including color charts.
5. Dampers, including housings, linkages, and operators.

C. Shop Drawings: For each fan, Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.
4. Wiring Diagrams: For power, signal, and control wiring.
5. Operation and maintenance data:

1.3 QUALITY ASSURANCE

A. Single Source Responsibility: Comply with the requirements specified in Division 1.

B. Standardization: Provide air-handling units of the same manufacturer throughout where possible.

C. 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.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

1.5 WARRANTY

A. Warranty Period: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 AIR MOVING EQUIPMENT—GENERAL REQUIREMENTS

A. Criteria:

1. Performance data for all fans shall be determined in accordance with the provisions of AMCA Standard 210.
2. Sound power level ratings of ducted fans shall comply with AMCA Standard 330 and shall be the results of tests made in accordance with AMCA Standard 300.
3. Unit construction shall conform to applicable standards contained in AMCA Standard Handbook Publications and to requirements specified herein.

B. Safety: Safety provisions for power transmission equipment and non-ducted fan inlets and outlets shall include guards and screens, unless other provisions are required, and constructed in accordance with applicable provisions of ANSI/ASME B15.1, the recommendations of the National Safety Council and requirements specified herein. Safety provisions shall not present obstacles to measurement of driver and driven shaft speeds with revolution counter. Installation shall be such that fan vibration isolation provisions are not negated.

C. Nameplate: Provide a metallic, corrosion-resistant, embossed, or stamped nameplate for each fan. Nameplate data shall include selection point capacity conditions, rpm and bhp. Permanently affix in a conspicuous location.

D. Horsepower: Motor brake horsepower input to each proposed fan shall not exceed scheduled brake horsepower.

E. Alignment: All fan wheels shall be statically and dynamically balanced. Fans shall be properly protected during shipment so that bearings are not damaged.

F. Rigging: Field-rigging methods shall not negate balancing. Lifting eyes shall be used. Shafts shall not be bent.

G. Bearings:

1. Bearings shall be heavy-duty self-aligning foot-mounted ball or roller pillow block type. Bearings shall have a certified ANSI/AFBMA L10 minimum rated life of 80,000 hours unless otherwise specified. Bearings shall have dust-tight seals suitable for lubricant pressures encountered. Housings shall be cast iron, unless otherwise specified or approved.
2. Bearings shall be grease lubricated. Lubrication provisions shall be such as to preclude overheating due to excess lubricant or seal blowout due to excess pressure. Grease supply fittings shall be surface ball check type. Provide manual or automatic grease pressure relief fittings as necessary to comply with specified requirements. Bearing and seal construction permitting, relief fittings shall be located on the side opposite to the supply fitting. Relief shall be visible from normal maintenance locations. Lubrication provisions shall include extension tubes where necessary to facilitate safe maintenance while equipment is operating.

3. Permanently sealed pre-lubricated antifriction bearings, which conform to above-specified materials and ANSI/AFBMA L10 life requirements, may be provided for air moving equipment with nameplate horsepower requirements less than 1/2 in lieu of relubricable bearings.

2.2 FAN DRIVES AND GUARDS

A. Provide speed controller for direct drive fans.

B. Guards:

1. Guards for each fan drive, except utility set type fans for which the guards are specified with the fan, shall be four-sided guards and shall also cover exposed parts of fan shafts. Size of guards shall also accommodate ultimate capacities shown.
2. Guards shall meet safety standards of AMCA 410, OSHA**.** Guards shall be provide with 1/2" mesh No. 14-gauge screen in steel angle frame; removable by unbolting sections of the guard for ease of belt replacement; supported on upper isolated base, or from the fan; shall not transmit vibration from fan or motor to the building structure.
3. Size of guards shall be adequate for present fan speed and for future increased fan speeds where two speeds are shown.
4. Guards for roof-mounted fans shall be solid galvanized steel panels, 20-gauge minimum with screen over midsection of top and bottom of belts for inspection and shall be weathertight construction.

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
3. Provide electronically commutated motors or motors with 70% motor efficiency.

2.4 FUME EXHAUST FAN-HIGH PLUME LABORATORY EXHAUST

A. General: Provide the roof mounted fume exhaust fans where shown on the drawings; size and capacity as indicated. Motor horsepowers and outlet velocities shall not be exceeded. All fans shall be AMCA Certified for both Air and Sound Performance. Only AMCA Certified fans are acceptable.

1. Base fan performance at standard conditions (density 0.075 Lb. /ft3).
2. Fans selected shall be capable of accommodating static pressure and flow variations of +/- 15% of scheduled values.
3. Each fan shall be direct drive.
4. Each fan to be equipped with 316 stainless steel lifting lugs for corrosion resistance.
5. Fasteners exposed to corrosive exhaust shall be stainless steel.
6. Fan assembly shall be designed for a minimum of 125 MPH wind loading, without the use of guy wires.

B. Basis of design: Greenheck Vektor-H

C. Manufacturers:

1. Greenheck
2. Cook
3. Twin City

D. Fan Housing and Outlet: Fan housing to be aerodynamically designed with high-efficiency inlet, engineered to reduce incoming air turbulence.

1. Fan housing shall be welded steel and meet corrosion resistant coating as described in this specification. No uncoated metal fan parts shall be acceptable.
2. Load bearing or structural fan components that are fabricated of polypropylene or fiberglass that have lower mechanical properties than steel, have rough interior surfaces in which corrosive, hazardous compounds can collect, and/or which chalk and structurally degrade due to the UV component of the sunlight shall not be acceptable.
3. A high velocity conical discharge nozzle shall be supplied by the fan manufacturer and be designed to efficiently handle an outlet velocity of up to 6000 FPM. Discharge nozzles shall be steel with corrosion resistant coating or chemical resistant medium density polyethylene with UV inhibitors to prevent chalking and have smooth interior surfaces. Discharge stack caps or hinged covers, impeding exhaust flow shall not be permitted.
4. Provide housing drain for removal of rain and condensation.
5. Motor compartment shall be sealed from the contaminated airstream and have integral cooling vents to fan exterior housing to prevent heat build-up.
6. Housing shall have a bolted and gasketed access panel allowing for inspection of impeller.
7. Impeller, inlet cone and motor shall be removable in a single cartridge from the exterior of the fan housing without removal of the fan housing from plenum or roof curb.

E. Fan Impeller: shall be centrifugal, backward curved, with laminar blade geometry and non-stall characteristics. The impeller shall be electronically balanced both statically and dynamically per AMCA Standard 204.

1. Fan impeller shall be manufactured of aluminum (AMCA type B spark resistant) and meet corrosion resistant coating as described in this specification.
2. Aluminum centrifugal impellers shall be coated with Hi Pro polyester resin

F. Protective Coatings: All steel fan and system components (fan, nozzle, windband and plenum) shall receive factory-applied finish for resistance to chemicals and corrosive agents.

1. All parts shall be cleaned and chemically prepared for coating using a multistage wash system which includes acid pickling to remove oxide.
2. The first powder coat shall be a partial cure epoxy primer. The second powder coat of polyester resin shall be electrostatically applied and then be cured simultaneously at a uniform temperature of 400°F.
3. The coating system shall not be less than a total thickness of 6 mils, shall not be affected by the UV component of sunlight (does not chalk), and have superior corrosion resistance to acid, alkali, and solvents. Coating system shall exceed 4000 hour ASTM B117 Salt Spray Resistance.

G. Bypass Air Plenum: A bypass air plenum shall be provided to achieve fan nozzle outlet velocity. The plenum shall be equipped with a bypass air damper and intake air hood with bird screen for introducing outside air at roof level upstream of the fan.

1. The plenum shall be constructed of fully welded steel, meet corrosion resistant coating as described in this specification, and mount on roof curb. Plenums that are fabricated of plastics or resins that are combustible and have mechanical properties less than steel shall not be acceptable.
2. The bypass air plenum shall be mounted on factory fabricated roof curb provided by the fan manufacturer, as described in this specification. Fan designs that use inlet flexible connectors that can leak causing loss of lab exhaust shall not be accepted.
3. Bypass air dampers shall be opposed-blade design, and coated with up to 4 mils of Hi-Pro polyester resin, electrostatically applied and baked.
4. Fan isolation damper of parallel blade design, two position actuated, fabricated of steel or aluminum and coated with minimum 4 mils of Hi-Pro polyester resin, electrostatically applied and baked, shall be provided.
5. Blower / Plenum vibration isolation shall be limited to neoprene / cork vibration pads.

H. Curb: Exhaust system manufacturer shall supply a structural support curb for the plenum, of specified height, as shown on the drawings.

1. Curb shall be fabricated of a minimum of 14 gauge of corrosion resistant coated steel and structurally reinforced.
2. Curbs shall be insulated.
3. When properly anchored to the roof structure, the standard curb / plenum / blower assembly shall withstand wind loads of up to 125 mph without additional structural support.

I. Fan Motors and Disconnect: Motors shall be premium efficiency, standard NEMA frame, 1800 or 3600 RPM, Totally Enclosed Fan Cooled (TEFC) with a 1.15 service factor on line (sinewave) frequency. Motor shall be labeled for use with a VFD with 10:1 VT and 1.0 service factor.

1. Motor bearings shall be sealed for life and require no lubrication maintenance.
2. Motor shall be equipped with internal shaft grounding ring protect motor bearings from the shaft voltages.
3. Motor bearings shall be sized for an L-10 life of no less than 100,000 hours in vertical shaft down application.
4. A factory-mounted NEMA 3R disconnect switch shall be provided for each fan.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fans before installation. Reject fans that are wet, moisture damaged, or mold damaged.

3.2 INSTALLATION-FANS

A. General: The installation of the fans shall conform to local codes and ordinances, NFPA 90A, and SMACNA. Mounting and supporting of all equipment including accessories and appurtenances shall be provided, including but not limited to structural supports, hangers, vibration isolators**,** stands, clamps, and brackets.

B. Installation of Equipment: Installation shall conform to equipment manufacturer's recommendations, unless otherwise indicated. Equipment shall be installed, leveled and located so that working clearance is available under overhead lines and so that working space is available for all necessary servicing such as shaft removal, replacing or adjusting drives and motors, lubrication, and access to automatic controls.

3.3 ELECTRICAL WORK

A. General: Electric motor-driven equipment specified in this section shall be provided complete with motors and controls. Electric equipment and wiring shall comply with requirements of NFPA 70 and Division 26, "Electrical Work".

B. Starters: Motor starters and disconnects, unless otherwise specified or indicated shall be furnished and installed by Division 26 Contractor.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section 260553, "Identification for Electrical Systems."

3.5 COMMISSIONING

A. Notify the Commissioning Agent one week prior to start up of equipment.

B. Submit to the Commissioning Agent a Verification of Completion form with the pre-functional check off sheet for each component when it is ready for functional testing.

C. Assist the Commissioning Agent as required to perform the functional testing on the system components and the system as a whole.

END OF SECTION 233400

SECTION 233600 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Tracking Return/Exhaust terminal units.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated, include rated capacities, furnished specialties, sound-power ratings, and accessories.

B. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data" include the following:
   1. Instructions for resetting minimum and maximum air volumes.
   2. Instructions for adjusting software set points.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of air terminal units and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. NFPA Compliance: Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

1.5 COORDINATION

A. Coordinate layout and installation of air terminal units and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Approved Manufacturers:
   1. Envirotech/Johnson Controls
   2. Krueger
   3. Nailor
   4. Price
   5. Titus
   6. Trane

2.2 AIR TERMINAL UNITS

A. Terminal Unit Types:
   1. Exhaust Terminal Units: Furnish and install the single duct variable-air volume terminal units as scheduled or indicated on the drawings. Units shall be pressure independent with DDC controls.

B. General Requirements:
   1. The entire exhaust terminal unit shall be designed and built as a single unit.
   2. The units shall be provided with a variable air volume damper that controls the air quantity in response to a control signal.
   3. The units shall also include all options such as attenuators and access doors.
   4. Exhaust units shall feature a venturi valve inlet with integrated flow sensor for optimized airflow performance and reduced pressure drop.
   5. The terminal unit shall be capable of operation as described on the drawings Sequence of Operation with a minimum inlet static pressure that shall not exceed 0.37" w.g. (92 Pa) at 2000 fpm (10.2 m/s) inlet velocity for unit sizes 4 through 16. Gauge tap ports shall be supplied in the piping between the flow pick up and the controller.
   6. The unit shall be capable of being changed from Right Hand to Left Hand configuration by flipping the unit over. No controls, field adjustments, nor field re-assembly shall be required to accomplish this. The unit shall be listed by UL or ETL under UL 1995 to operate in either orientation.
   7. Each unit shall be constructed with single point electrical connections. All electrical components shall be ETL or UL listed or recognized and installed in accordance with the National Electrical Code. All electrical components shall be installed in a control box. The entire assembly shall be ETL listed and so labeled.

C. Terminal Casing:
   1. Unit casing shall be 22 ga. (.86) galvanized steel with rectangular inlet and outlet connections, configured for slip and drive connections.
   2. Basic valve assembly shall not exceed 30" (762) in length.
   3. Casing leakage downstream of the damper shall not exceed 1% @ 1" w.g. (250 Pa). High side leakage shall not exceed 2% @ 3" w.g. (746 Pa).

E. Terminal Lining: Each unit shall be internally lined with ¾" (19) dual density fiberglass insulation. Edges shall be sealed against airflow erosion. Units shall meet NFPA 90A and UL 181 standards.

F. Sound Performance: All sound data shall be compiled in an independent laboratory and in accordance with the latest version of AHRI Standard 880 and ANSI/ASHRAE Standard 130. All units shall be AHRI certified and bear the AHRI certification label.

G. Primary Air Damper Assembly:
   1. Damper assemblies of 16 ga. (1.6) galvanized steel shall be multiple opposed blade construction arranged to close at 45 degrees from full open to minimize air turbulence and provide near linear operation.
   2. Damper blades shall be fitted with flexible seals for tight closure and minimized sound generation.
   3. Damper blades shall be screwed through the shaft to insure that no slippage occurs. Blade shafts shall pivot on corrosion free bearings. In the fully closed position, air leakage past the closed damper shall not exceed 2% of the nominal catalog rating at 3" w.g. (746 Pa) inlet static pressure as rated by ASHRAE Standard 130.

H. Digital Controls
   1. The terminals shall be equipped with pressure independent direct digital controller furnished and mounted by the control contractor. The control contractor shall provide data sheets on all components to be mounted, indicating component dimensions, mounting hardware, and methods, as well as wiring and piping diagrams for each application identified by unit tag per the schedule on the drawings.

2.3 SOURCE QUALITY CONTROL

A. Identification: Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, and ARI certification seal.

B. Verification of Performance: Rate air terminal units according to ARI 880.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

B. Electric isolation shall be provided between dissimilar metals for the purpose of minimizing galvanic corrosion.

C. Each terminal unit shall be identified in accordance with the identification system indicated on the schedule or drawings with labels complying with Division 23 Section “Identification for HVAC Piping and Equipment”. Identification on unit shall be readable from the floor through the primary service access opening.

3.2 CONNECTIONS

A. Connect ducts to air terminal units according to Division 23 Section "Metal Ducts and Casings."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. 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.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:
   1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
   2. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup check(s) according to manufacturer's written instructions and do the following:
      a. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
      b. Verify that controls and control enclosure are accessible.
      c. Verify that control connections are complete.
      d. Verify that nameplate and identification tag are visible.
      e. Verify that controls respond to inputs as specified.

3.5 DEMONSTRATION

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

3.6 COMMISSIONING

A. Notify the Commissioning Agent one week prior to startup of equipment.

B. Submit to the Commissioning Agent a Verification of Completion form with the pre-functional check off sheet for each component when it is ready for functional testing.

C. Assist the Commissioning Agent as required to perform the functional testing on the system components and the system as a whole.

END OF SECTION 233600