DAYTONA STATE COLLEGE CENTER FOR WOMEN & MEN REMODEL PROJECT

Specifications

100% Construction Documents
October 21, 2019
Orlando, Florida
RLF Project #17123
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1.1 DESIGN PROFESSIONALS OF RECORD

A. Architect
   Christopher Doig
   Rogers, Lovelock & Fritz, Inc.

B. Electrical Engineer
   Eric Braun, PE
   Rogers, Lovelock & Fritz, Inc.

C. Mechanical Engineer, Plumbing, Fire Protection
   Joshua Rose, PE
   Rogers, Lovelock & Fritz, Inc.
D. Plumbing Engineer  
Derek Reed, PE  
Rogers, Lovelock & Fritz, Inc.

E. Interior Designer  
Brenna Milne, ID  
Rogers, Lovelock & Fritz, Inc.
SECTION 011000

SUMMARY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Project information.
   2. Work covered by Contract Documents.
   3. Phased construction.
   4. Work under Owner's separate contracts.
   5. Owner-furnished/Contractor-installed (OFCI) products.
   6. Contractor's use of site and premises.
   7. Coordination with occupants.
   8. Work restrictions.

1.2 PROJECT INFORMATION

A. Project Identification: Center for Women & Men Remodel
   1. Project Location: 1200 W International Speedway Blvd
      Daytona Beach, Florida 32114.

B. Owner: Daytona State College.
   1. Owner's Representative: Steve Selig, St Facilities Planner
      email: steve.selig@daytonastate.edu
      phone: (386) 506-3169 >.

C. Architect: Rogers, Lovelock & Fritz, Inc..
   1. Architect's Representative: Tom DeSimone, Project Director
      email: tom.desimone@rlfae.com
      phone: (407) 730-8600

D. Web-Based Project Software: Project software will be used for purposes of managing
   communication and documents during the construction stage.
   1. See Section 013100 "Project Management and Coordination." for requirements for using
      web-based Project software.
1.3 WORK COVERED BY CONTRACT DOCUMENTS

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

1. The project consists of the interior remodeling to existing building 130 on the main campus of Daytona state college located in Daytona Beach, Florida. More specifically, the project is limited to mostly finish upgrades (very limited wall demolition & relocation, i.e., no structural revisions), new roofing, mechanical and information technology upgrades, as well as mechanical room re-location to open the entry lobby for increased visual monitoring. The existing kitchen area is existing to remain (not part of project scope) as is the area currently occupied by veteran’s center (which will remain in operation during construction). This project will include providing corridor access to existing restrooms adjacent to the kitchen from the veteran’s center.

B. Type of Contract:

1. Project will be constructed under a single prime contract.

1.4 CONTRACTOR’S USE OF SITE AND PREMISES

A. Unrestricted Use of Site: Contractor shall have full use of Project site for construction operations during construction period. Contractor's use of Project site is limited only by Owner's right to perform work or to retain other contractors on portions of Project.

B. Condition of Existing Building: Maintain portions of existing building affected by construction operations in a weather tight 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 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 8:00 a.m. to 5:00 p.m., Monday through Friday, unless otherwise indicated.

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 two 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 two 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: 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 working on Project site.

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

1.6 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 (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 011000
SECTION 012300

ALTERNATES

PART 1 - GENERAL

1.1 SUMMARY
   A. Section includes administrative and procedural requirements for alternates.

1.2 DEFINITIONS
   A. Alternate: An amount proposed by bidders and stated on the Bid Form for certain work defined in the bidding requirements that may be added to or deducted from the base bid amount if the Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.

      1. Alternates described in this Section are part of the Work only if enumerated in the Agreement.
      2. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternates into the Work. No other adjustments are made to the Contract Sum.

1.3 PROCEDURES
   A. Coordination: Revise or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.

      1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.

   B. Execute accepted alternates under the same conditions as other work of the Contract.

   C. Schedule: A schedule of alternates is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the work described under each alternate.
PART 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES

A. Alternate No Alternate 1. MISC. RENOVATIONS AT VETERANS SERVICES. Provide deductive bid alternate to exclude the renovation scope of work included in the Veterans Services area of the building. Refer to drawing GI100.

B. Alternate 2. STAFF TOILET AT BREAK ROOM. Provide deductive bid alternate to exclude the renovation scope of work in the “Staff Toilet” Room 113A. Refer to drawing GI100.

C. Alternate 3. NEW CEILINGS AND LIGHTS. Provide deductive bid alternate to exclude the renovation scope of work to add new ceilings and lights in the designated areas. Refer to drawing GI100.

D. Alternate 4. NEW PAVERS AND ENTRY CANOPY. Provide deductive bid alternate to exclude the scope of work to add a new exterior canopy, including associated civil, landscape and hardscape. Refer to drawing GI100.

END OF SECTION 012300
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 Architect.
   2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:

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

d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.

e. Samples, where applicable or requested.

f. Certificates and qualification data, where applicable or requested.

g. List of similar installations for completed projects, with project names and addresses as well as names and addresses of architects and owners.

h. Material test reports from a qualified testing agency, indicating and interpreting test results for compliance with requirements indicated.

i. Research reports evidencing compliance with building code in effect for Project.

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. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. Architect will notify Contractor of acceptance or rejection of proposed substitution within 15 days of receipt of request, or 7 days of receipt of additional information or documentation, whichever is later.


b. Use product specified if Architect 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: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect 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: Architect will consider requests for substitution if received within 60 days after the Notice of Award. Requests received after that time may be considered or rejected at discretion of Architect.

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

   a. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Architect for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
   b. Requested substitution does not require extensive revisions to the Contract Documents.
   c. Requested substitution is consistent with the Contract Documents and will produce indicated results.
   d. Substitution request is fully documented and properly submitted.
   e. Requested substitution will not adversely affect Contractor's construction schedule.
   f. Requested substitution has received necessary approvals of authorities having jurisdiction.
   g. Requested substitution is compatible with other portions of the Work.
   h. Requested substitution has been coordinated with other portions of the Work.
   i. Requested substitution provides specified warranty.
If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012500
SECTION 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. Architect will issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time.

1.3 PROPOSAL REQUESTS
   A. Owner-Initiated Proposal Requests: Architect 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 Architect are not instructions either to stop work in progress or to execute the proposed change.
   2. Within 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 Architect.

      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, Contractor will issue a Change Order for signatures of Owner. Architect/
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 Architect 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.
   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 Architect 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 Architect by the third Friday 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 Architect.

D. Application for Payment Forms: Use AIA Document G702 and AIA Document G703 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. Architect 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 Architect 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. Schedule of unit prices.
6. Submittal schedule (preliminary if not final).
7. List of Contractor's staff assignments.
8. List of Contractor's principal consultants.
11. Initial progress report.
13. Certificates of insurance and insurance policies.

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

J. Final Payment Application: After completing Project closeout requirements, submit final Application for Payment with releases and supporting documentation not previously submitted.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012900
SECTION 013100
PROJECT MANAGEMENT AND COORDINATION

PART 1 - 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.
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. Preinstallation conferences.
7. Project closeout activities.
8. Startup and adjustment of systems.

1.4 COORDINATION DRAWINGS

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

1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:

   a. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
   b. Indicate dimensions shown on Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternative sketches to Architect indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

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

1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire-protection, fire-alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings where required to adequately represent the Work.
2. Plenum Space: Indicate subframing for support of ceiling and wall systems, mechanical and electrical equipment, and related Work. Locate components within plenums to accommodate layout of light fixtures and other components indicated on Drawings. Indicate areas of conflict between light fixtures and other components.
3. Mechanical Rooms: Provide coordination drawings for mechanical rooms showing plans and elevations of mechanical, plumbing, fire-protection, fire-alarm, and electrical equipment.
4. Structural Penetrations: Indicate penetrations and openings required for all disciplines.
5. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door
floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.

6. Review: Architect will review coordination drawings to confirm that, in general, the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility. If Architect determines that coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, Architect will so inform Contractor, who shall make suitable modifications and resubmit.

C. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:

1. File Preparation Format: Same digital data software program, version, and operating system as original Drawings.
3. File Submittal Format: Submit or post coordination drawing files using PDF format.
4. BIM File Incorporation: Develop and incorporate coordination drawing files into BIM established for Project.
5. Architect will furnish Contractor one set of digital data files of Drawings for use in preparing coordination digital data files.
   a. Architect makes no representations as to the accuracy or completeness of digital data files as they relate to Drawings.
   b. Digital Data Software Program: Drawings are available in Autodesk Revit 2019.
   c. Contractor shall execute a data licensing agreement in the form of AIA Document C106.

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

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

1. Owner name.
2. Owner's Project number.
4. Architect'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.


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

1. The following Contractor-generated RFIs will be returned without action:
   a. Requests for approval of submittals.
   b. Requests for approval of substitutions.
   c. Requests for approval of Contractor's means and methods.
   d. Requests for coordination information already indicated in the Contract Documents.
   e. Requests for adjustments in the Contract Time or the Contract Sum.
   f. Requests for interpretation of Architect's actions on submittals.
   g. Incomplete RFIs or inaccurately prepared RFIs.

2. Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt by Architect or Construction Manager of additional information.

3. Architect'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 Architect 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. Include the following:

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

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

A. Use of Architect's Digital Data Files: Digital data files of Architect's BIM model will be provided by Architect for Contractor's use during construction.

1. Digital data files may be used by Contractor in preparing coordination drawings, Shop Drawings, and Project record Drawings.
2. Architect makes no representations as to the accuracy or completeness of digital data files as they relate to Contract Drawings.
4. Contractor shall execute a data licensing agreement in the form of AIA Document C106 Digital Data Licensing Agreement.
   a. Subcontractors, and other parties granted access by Contractor to Architect's digital data files shall execute a data licensing agreement in the form of AIA Document C106.

5. < Retain "Web-Based Project Management Software Package" Paragraph below if Contractor is required to use or to provide and administer web-based Project software. Revise to suit Project.

B. Web-Based Project Management Software Package: Provide, administer, and use web-based Project management software package for purposes of hosting and managing Project communication and documentation until Final Completion.

1. Web-based Project management software includes, at a minimum, the following features:
   a. Compilation of Project data, including Contractor, subcontractors, Architect, architect's consultants, Owner, and other entities involved in Project. Include names of individuals and contact information.
   b. Access control for each entity for each workflow process, to determine entity's digital rights to create, modify, view, and print documents.
   c. Document workflow planning, allowing customization of workflow between project entities.
   d. Creation, logging, tracking, and notification for Project communications required in other Specification Sections, including, but not limited to, RFIs, submittals, Minor Changes in the Work, Construction Change Directives, and Change Orders.
   e. Track status of each Project communication in real time, and log time and date when responses are provided.
   f. Procedures for handling PDFs or similar file formats, allowing markups by each entity. Provide security features to lock markups against changes once submitted.
   g. Processing and tracking of payment applications.
   h. Processing and tracking of contract modifications.
   i. Creating and distributing meeting minutes.
   j. Document management for Drawings, Specifications, and coordination drawings, including revision control.
   k. Management of construction progress photographs.
   l. Mobile device compatibility, including smartphones and tablets.
2. Provide up to three web-based Project management software user licenses for use of Owner, Architect, and Architect's consultants. Provide eight hours of software training at Architect's office for web-based Project software users.

3. At completion of Project, provide digital archive in format that is readable by common desktop software applications in format acceptable to Architect. Provide data in locked format to prevent further changes.

C. PDF Document Preparation: Where PDFs are required to be submitted to Architect, 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.

1.7 PROJECT MEETINGS

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

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

1. Attendees: Authorized representatives of Owner Architect, 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 RFI's.
   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.
   cc. Progress cleaning.

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

C. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity when required by other sections and when required for coordination with other construction.

1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect of scheduled meeting dates.

2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:

   b. Options.
   c. Related RFIs.
   d. Related Change Orders.
   e. Purchases.
   f. Deliveries.
   g. Submittals.
   h. Possible conflicts.
   i. Compatibility requirements.
   j. Time schedules.
   k. Weather limitations.
   l. Manufacturer's written instructions.
   m. Warranty requirements.
   n. Compatibility of materials.
   o. Acceptability of substrates.
   p. Temporary facilities and controls.
   q. Space and access limitations.
   r. Regulations of authorities having jurisdiction.
   s. Testing and inspecting requirements.
   t. Installation procedures.
   u. Coordination with other work.
   v. Required performance results.
   w. Protection of adjacent work.
   x. Protection of construction and personnel.
3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.

4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.

5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.

D. Progress Meetings: Conduct progress meetings at regular intervals, as coordinated with the Owner.

1. Coordinate dates of meetings with preparation of payment requests.

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

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

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

      1) Review schedule for next period.

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

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

4. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.

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

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013100
PART 1 - GENERAL

1.1 SUMMARY

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

1. Contractor's Construction Schedule.
2. Construction schedule updating reports.
3. Daily construction reports.
4. Site condition reports.

1.2 DEFINITIONS

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

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

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

C. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.

D. Event: The starting or ending point of an activity.

E. Float: The measure of leeway in starting and completing an activity.

1. Float time is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date.
2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.
3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.
1.3 INFORMATIONAL SUBMITTALS

A. Format for Submittals: Submit required submittals in the following format:
   2. PDF file.

B. Startup Network Diagram: Of size required to display entire network for entire construction period. Show logic ties for activities.

C. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.
   1. Submit a working digital copy of schedule, using software indicated, and labeled to comply with requirements for submittals.

D. CPM Reports: Concurrent with CPM schedule, submit each of the following reports. Format for each activity in reports shall contain activity number, activity description, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.
   1. Activity Report: List of activities sorted by activity number and then early start date, or actual start date if known.
   2. Logic Report: List of preceding and succeeding activities for each activity, sorted in ascending order by activity number and then by early start date, or actual start date if known.

E. Construction Schedule Updating Reports: Submit with Applications for Payment.

F. Daily Construction Reports: Submit at weekly intervals.

G. Site Condition Reports: Submit at time of discovery of differing conditions.

1.4 COORDINATION

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

1.5 CONTRACTOR'S CONSTRUCTION SCHEDULE

A. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules.
B. Time Frame: Extend schedule from date established for the Notice of Award to date of final completion.

1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.

C. Activities: Treat each floor or separate area as a separate numbered activity for each main element of the Work. Comply with the following:

1. Activity Duration: Define activities so no activity is longer than 20 days, unless specifically allowed by Architect.
2. Procurement Activities: Include procurement process activities for the following long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
4. Startup and Testing Time: Include no fewer than 15 days for startup and testing.
5. Commissioning Time: Include no fewer than 15 days for commissioning.
6. Substantial Completion: Indicate completion in advance of date established for Substantial Completion, and allow time for Architect's and Construction Manager's administrative procedures necessary for certification of Substantial Completion.
7. Punch List and Final Completion: Include not more than 30 days for completion of punch list items and final completion.

D. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.

1. Phasing: Arrange list of activities on schedule by phase.
2. Owner-Furnished Products: Include a separate activity for each product. Include delivery date indicated in Section 011000 "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
3. Work Restrictions: Show the effect of the following items on the schedule:
   a. Coordination with existing construction.
   b. Limitations of continued occupancies.
   c. Uninterruptible services.
   d. Partial occupancy before Substantial Completion.
   e. Use-of-premises restrictions.
   g. Seasonal variations.
   h. Environmental control.

E. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and final completion.

F. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:

1. Unresolved issues.
2. Unanswered Requests for Information.
3. Rejected or unreturned submittals.
4. Notations on returned submittals.
5. Pending modifications affecting the Work and the Contract Time.

G. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.

1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
3. As the Work progresses, indicate final completion percentage for each activity.

H. Recovery Schedule: When periodic update indicates the Work is 14 or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule. Indicate changes to working hours, working days, crew sizes, equipment required to achieve compliance, and date by which recovery will be accomplished.

I. Distribution: Distribute copies of approved schedule to Architect, Construction Manager, Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.

1. Post copies in Project meeting rooms and temporary field offices.
2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

1.6 GANTT-CHART SCHEDULE REQUIREMENTS

A. Gantt-Chart Schedule: Submit a comprehensive, fully developed, horizontal, Gantt-chart-type, Contractor's Construction Schedule within 15 days of date established for the Notice of Award.

B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line.

1. For construction activities that require three months or longer to complete, indicate an estimated completion percentage in 10 percent increments within time bar.

1.7 CPM SCHEDULE REQUIREMENTS

A. Prepare network diagrams using AON (activity-on-node) format.

B. Startup Network Diagram: Submit diagram within 14 days of date established for the Notice of Award. Outline significant construction activities for the first 90 days of construction. Include
skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

C. CPM Schedule: Prepare Contractor's Construction Schedule using a time-scaled CPM network analysis diagram for the Work.

1. Develop network diagram in sufficient time to submit CPM schedule so it can be accepted for use no later than 60 days after date established for the Notice of Award.
   a. Failure to include any work item required for performance of this Contract shall not excuse Contractor from completing all work within applicable completion dates.

2. Conduct educational workshops to train and inform key Project personnel, including subcontractors' personnel, in proper methods of providing data and using CPM schedule information.
3. Establish procedures for monitoring and updating CPM schedule and for reporting progress. Coordinate procedures with progress meeting and payment request dates.
4. Use "one workday" as the unit of time for individual activities. Indicate nonworking days and holidays incorporated into the schedule to coordinate with the Contract Time.

D. CPM Schedule Preparation: Prepare a list of all activities required to complete the Work. Using the startup network diagram, prepare a skeleton network to identify probable critical paths.

1. Activities: Indicate the estimated time duration, sequence requirements, and relationship of each activity in relation to other activities. Include estimated time frames for the following activities:
   a. Preparation and processing of submittals.
   b. Mobilization and demobilization.
   c. Purchase of materials.
   d. Delivery.
   e. Fabrication.
   f. Utility interruptions.
   g. Installation.
   h. Work by Owner that may affect or be affected by Contractor's activities.
   i. Testing and inspection.
   j. Commissioning.
   k. Punch list and final completion.
   l. Activities occurring following final completion.

2. Critical Path Activities: Identify critical path activities, including those for interim completion dates. Scheduled start and completion dates shall be consistent with Contract milestone dates.

3. Processing: Process data to produce output data on a computer-drawn, time-scaled network. Revise data, reorganize activity sequences, and reproduce as often as necessary to produce the CPM schedule within the limitations of the Contract Time.
4. Format: Mark the critical path. Locate the critical path near center of network; locate paths with most float near the edges.
a. Subnetworks on separate sheets are permissible for activities clearly off the critical path.

E. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using a network fragment to demonstrate the effect of the proposed change on the overall Project schedule.

F. Initial Issue of Schedule: Prepare initial network diagram from a sorted activity list indicating straight "early start-total float." Identify critical activities. Prepare tabulated reports showing the following:

1. Contractor or subcontractor and the Work or activity.
2. Description of activity.
3. Main events of activity.
4. Immediate preceding and succeeding activities.
5. Early and late start dates.
6. Early and late finish dates.
7. Activity duration in workdays.
8. Total float or slack time.
10. Dollar value of activity (coordinated with the schedule of values).

G. Schedule Updating: Concurrent with making revisions to schedule, prepare tabulated reports showing the following:

1. Identification of activities that have changed.
2. Changes in early and late start dates.
3. Changes in early and late finish dates.
5. Changes in the critical path.
6. Changes in total float or slack time.

1.8 REPORTS

A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:

1. List of subcontractors at Project site.
2. List of separate contractors at Project site.
3. Approximate count of personnel at Project site.
4. Equipment at Project site.
5. Material deliveries.
6. High and low temperatures and general weather conditions, including presence of rain or snow.
8. Accidents.
9. Meetings and significant decisions.
10. Stoppages, delays, shortages, and losses.
11. Meter readings and similar recordings.
13. Orders and requests of authorities having jurisdiction.
14. Change Orders received and implemented.
15. Construction Change Directives received and implemented.
16. Services connected and disconnected.
17. Equipment or system tests and startups.
18. Partial completions and occupancies.
19. Substantial Completions authorized.

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

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013200
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 Architect'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 Architect'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 Architect 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.
   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.
17. Signature of transmitter.

B. Options: Identify options requiring selection by Architect.

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 Architect on previous submittals. Indicate by highlighting on each submittal or noting on attached separate sheet.

D. Paper Submittals:
1. Place a permanent label or title block on each submittal item for identification; include name of firm or entity that prepared submittal.
2. Provide a space approximately 6 by 8 inches on label or beside title block to record Contractor's review and approval markings and action taken by Architect.
3. Action Submittals: Submit three paper copies of each submittal unless otherwise indicated. Architect will return two copies.
4. Informational Submittals: Submit two paper copies of each submittal unless otherwise indicated. Architect will not return copies.
5. Transmittal for Submittals: Assemble each submittal individually and appropriately for transmittal and handling. Transmit each submittal using AIA Document G810 transmittal form.

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

F. 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 Architect by sending via email. Include PDF transmittal form. Include information in email subject line as requested by Architect.
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.

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 Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.

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

2. Paper Sheet Size: Except for templates, patterns, and similar full-size Drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches, but no larger than 30 by 42 inches.
   a. Three opaque copies of each submittal. Architect will retain two copies; remainder will be returned.

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 4 full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect 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 4 sets of Samples. Architect will retain 2 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 architects and owners, and other information specified.

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

1. Certificates and Certifications Submittals: Submit a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity. Provide a notarized signature where indicated.

2. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.

3. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.

4. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.

5. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.


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 Architect.

B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF file 6 paper copies of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.

1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

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 Architect.

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. Architect will not review submittals received from Contractor that do not have Contractor's review and approval.

1.9 ARCHITECT'S REVIEW

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

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

2. Paper Submittals: Architect will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action.

a. Submittals by Web-Based Project Management Software: Architect will indicate, on Project management software website, the appropriate action.
B. Informational Submittals: Architect will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.

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

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

E. Architect will return without review submittals received from sources other than Contractor.

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

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013300
SECTION 013516
ALTERATION PROJECT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY
A. Section includes special procedures for alteration work.

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

A. Preliminary Conference for Alteration Work: Before starting alteration work, conduct conference at Project site.

1. Attendees: In addition to representatives of Owner, Architect, and Contractor, testing service representative, and chemical-cleaner manufacturer(s) shall be represented at the meeting.

2. Agenda: Discuss items of significance that could affect progress of alteration work, including review of the following:
   a. Fire-prevention plan.
   b. Governing regulations.
   c. Areas where existing construction is to remain and the required protection.
   d. Hauling routes.
   e. Sequence of alteration work operations.
   f. Storage, protection, and accounting for salvaged and specially fabricated items.
   g. Existing conditions, staging, and structural loading limitations of areas where materials are stored.

3. Reporting: Record conference results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from conference.

B. Coordination Meetings: Conduct coordination meetings specifically for alteration work at weekly intervals. Coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and preinstallation conferences.

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

2. Reporting: Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

1.4 MATERIALS OWNERSHIP

A. Historic items, relics, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, antiques, and other items of interest or value to Owner that may be encountered or uncovered during the Work, regardless of whether they were previously documented, remain Owner's property.

1.5 QUALITY ASSURANCE

A. Title X Requirement: Each firm conducting activities that disturb painted surfaces shall be a "Lead-Safe Certified Firm" according to 40 CFR 745, Subpart E, and use only workers that are trained in lead-safe work practices.

B. Alteration Work Program: Prepare a written plan for alteration work for whole Project, including each phase or process and protection of surrounding materials during operations. Show compliance with indicated methods and procedures specified in this and other Sections.
Coordinate this whole-Project alteration work program with specific requirements of programs required in other alteration work Sections.

1. Dust and Noise Control: Include locations of proposed temporary dust- and noise-control partitions and means of egress from occupied areas coordinated with continuing on-site operations and other known work in progress.
2. Debris Hauling: Include plans clearly marked to show debris hauling routes, turning radii, and locations and details of temporary protective barriers.

C. Fire-Prevention Plan: Prepare a written plan for preventing fires during the Work, including placement of fire extinguishers, fire blankets, rag buckets, and other fire-control devices during each phase or process. Coordinate plan with Owner's fire-protection equipment and requirements. Include fire-watch personnel's training, duties, and authority to enforce fire safety.

D. Safety and Health Standard: Comply with ANSI/ASSE A10.6.

1.6 STORAGE AND HANDLING OF SALVAGED MATERIALS

A. Salvaged Materials:
   1. Clean loose dirt and debris from salvaged items unless more extensive cleaning is indicated.
   2. Pack or crate items after cleaning; cushion against damage during handling. Label contents of containers.
   3. Store items in a secure area until delivery to Owner.
   4. Transport items to Owner's storage area designated by Owner.
   5. Protect items from damage during transport and storage.

B. Salvaged Materials for Reinstallation:
   1. Repair and clean items for reuse as indicated.
   2. Pack or crate items after cleaning and repairing; cushion against damage during handling. Label 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 unless otherwise indicated. Provide connections, supports, and miscellaneous materials to make items functional for use indicated.

C. Existing Materials to Remain: Protect construction indicated to remain against damage and soiling from construction work. Where permitted by Architect, items may be dismantled and taken to a suitable, protected storage location during construction work and reinstalled in their original locations after alteration and other construction work in the vicinity is complete.

D. Storage: Catalog and store items within a weathertight enclosure where they are protected from moisture, weather, condensation, and freezing temperatures.
   1. Identify each item for reinstallation with a nonpermanent mark to document its original location. Indicate original locations on plans, elevations, sections, or photographs by annotating the identifying marks.
2. Secure stored materials to protect from theft.
3. Control humidity so that it does not exceed 85 percent. Maintain temperatures $5 \text{ deg F} (3 \text{ deg C})$ or more above the dew point.

PART 2 - PRODUCTS - (Not Used)

PART 3 - EXECUTION

3.1 PROTECTION

A. Protect persons, motor vehicles, surrounding surfaces of building, building site, plants, and surrounding buildings from harm resulting from alteration work.

1. Use only proven protection methods, appropriate to each area and surface being protected.
2. Provide temporary barricades, barriers, and directional signage to exclude the public from areas where alteration work is being performed.
3. Erect temporary barriers to form and maintain fire-egress routes.
4. Erect temporary protective covers over walkways and at points of pedestrian and vehicular entrance and exit that must remain in service during alteration work.
5. Contain dust and debris generated by alteration work, and prevent it from reaching the public or adjacent surfaces.
6. Provide shoring, bracing, and supports as necessary. Do not overload structural elements.
7. Protect floors and other surfaces along hauling routes from damage, wear, and staining.
8. Provide supplemental sound-control treatment to isolate demolition work from other areas of the building.

B. Temporary Protection of Materials to Remain:

1. Protect existing materials with temporary protections and construction. Do not remove existing materials unless otherwise indicated.
2. Do not attach temporary protection to existing surfaces except as indicated as part of the alteration work program.

C. Comply with each product manufacturer's written instructions for protections and precautions. Protect against adverse effects of products and procedures on people and adjacent materials, components, and vegetation.

D. Utility and Communications Services:

1. Notify Owner, Architect, authorities having jurisdiction, and entities owning or controlling wires, conduits, pipes, and other services affected by alteration work before commencing operations.
2. Disconnect and cap pipes and services as required by authorities having jurisdiction, as required for alteration work.
3. Maintain existing services unless otherwise indicated; keep in service, and protect against damage during operations. Provide temporary services during interruptions to existing utilities.
E. Existing Drains: Prior to the start of work in an area, test drainage system to ensure that it is functioning properly. Notify Architect immediately of inadequate drainage or blockage. Do not begin work in an area until the drainage system is functioning properly.

1. Prevent solids such as adhesive or mortar residue or other debris from entering the drainage system. Clean out drains and drain lines that become sluggish or blocked by sand or other materials resulting from alteration work.
2. Protect drains from pollutants. Block drains or filter out sediments, allowing only clean water to pass.

3.2 PROTECTION FROM FIRE

A. General: Follow fire-prevention plan and the following:

1. Comply with NFPA 241 requirements unless otherwise indicated.
2. Remove and keep area free of combustibles, including rubbish, paper, waste, and chemicals, unless necessary for the immediate work.
   a. If combustible material cannot be removed, provide fire blankets to cover such materials.

B. Heat-Generating Equipment and Combustible Materials: Comply with the following procedures while performing work with heat-generating equipment or combustible materials, including welding, torch-cutting, soldering, brazing, removing paint with heat, or other operations where open flames or implements using high heat or combustible solvents and chemicals are anticipated:

1. Obtain Owner's approval for operations involving use of open-flame or welding or other high-heat equipment. Notify Owner at least 72 hours before each occurrence, indicating location of such work.
2. As far as practicable, restrict heat-generating equipment to shop areas or outside the building.
3. Do not perform work with heat-generating equipment in or near rooms or in areas where flammable liquids or explosive vapors are present or thought to be present. Use a combustible gas indicator test to ensure that the area is safe.
4. Use fireproof baffles to prevent flames, sparks, hot gases, or other high-temperature material from reaching surrounding combustible material.
5. Prevent the spread of sparks and particles of hot metal through open windows, doors, holes, and cracks in floors, walls, ceilings, roofs, and other openings.
6. Fire Watch: Before working with heat-generating equipment or combustible materials, station personnel to serve as a fire watch at each location where such work is performed. Fire-watch personnel shall have the authority to enforce fire safety. Station fire watch according to NFPA 51B, NFPA 241, and as follows:
   a. Train each fire watch in the proper operation of fire-control equipment and alarms.
   b. Prohibit fire-watch personnel from other work that would be a distraction from fire-watch duties.
   c. Cease work with heat-generating equipment whenever fire-watch personnel are not present.
d. Have fire-watch personnel perform final fire-safety inspection each day beginning no sooner than 30 minutes after conclusion of work to detect hidden or smoldering fires and to ensure that proper fire prevention is maintained.

e. Maintain fire-watch personnel at Project site until 60 minutes after conclusion of daily work.

C. Fire-Control Devices: Provide and maintain fire extinguishers, fire blankets, and rag buckets for disposal of rags with combustible liquids. Maintain each as suitable for the type of fire risk in each work area. Ensure that nearby personnel and the fire-watch personnel are trained in fire-extinguisher and blanket use.

D. Sprinklers: Where sprinkler protection exists and is functional, maintain it without interruption while operations are being performed. If operations are performed close to sprinklers, shield them temporarily with guards.

1. Remove temporary guards at the end of work shifts, whenever operations are paused, and when nearby work is complete.

3.3 PROTECTION DURING APPLICATION OF CHEMICALS

A. Protect motor vehicles, surrounding surfaces of building, building site, plants, and surrounding buildings from harm or spillage resulting from applications of chemicals and adhesives.

B. Cover adjacent surfaces with protective materials that are proven to resist chemicals selected for Project unless chemicals being used will not damage adjacent surfaces as indicated in alteration work program. Use covering materials and masking agents that are waterproof and UV resistant and that will not stain or leave residue on surfaces to which they are applied. Apply protective materials according to manufacturer's written instructions. Do not apply liquid masking agents or adhesives to painted or porous surfaces. When no longer needed, promptly remove protective materials.

C. Do not apply chemicals during winds of sufficient force to spread them to unprotected surfaces.

D. Neutralize alkaline and acid wastes and legally dispose of off Owner's property.

E. Collect and dispose of runoff from chemical operations by legal means and in a manner that prevents soil contamination, soil erosion, undermining of paving and foundations, damage to landscaping, or water penetration into building interior.

3.4 GENERAL ALTERATION WORK

A. Record existing work before each procedure (preconstruction), and record progress during the work. Use digital preconstruction documentation photographs or video recordings. Comply with requirements in Section 013233 "Photographic Documentation."

B. Perform surveys of Project site as the Work progresses to detect hazards resulting from alterations.
C. Notify Architect of visible changes in the integrity of material or components whether from environmental causes including biological attack, UV degradation, freezing, or thawing or from structural defects including cracks, movement, or distortion.

1. Do not proceed with the work in question until directed by Architect.

END OF SECTION 013516
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 Architect, 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. Mockups: Full-size physical assemblies that are constructed on-site either as freestanding temporary built elements or as part of permanent construction. Mockups are constructed to verify selections made under Sample submittals; to demonstrate aesthetic effects and qualities of materials and execution; to review coordination, testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances. Mockups are not Samples. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.
1. Laboratory Mockups: Full-size physical assemblies constructed and tested at testing facility to verify performance characteristics.

2. Integrated Exterior Mockups: Mockups of the exterior envelope constructed on-site as freestanding temporary built elements or as indicated in-place portions of permanent construction, consisting of multiple products, assemblies, and subassemblies, with cutaways enabling inspection of concealed portions of the Work.

3. Room Mockups: Mockups of typical interior spaces complete with wall, floor, and ceiling finishes; doors; windows; millwork; casework; specialties; furnishings and equipment; and lighting.

4. Product Mockups: Mockups that may include multiple products, materials, or systems specified in a single Section.

5. In-Place Mockups: Mockups constructed on-site in their actual final location as part of permanent construction.

E. 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.

F. 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.

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

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

I. 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.

J. 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 Architect[ or Construction Manager].

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 Architect.
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 Architect regarding the conflict and obtain clarification prior to proceeding with the Work. Refer conflicting requirements that are different, but apparently equal, to Architect 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 Architect 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.
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:

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; 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, mockups, and laboratory mockups; do not reuse products on Project.

2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect, 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, and the Contract Sum will be adjusted by Change Order.

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.


1. Notify Architect 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 Architect and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
3. Submitting a certified written report of each test, inspection, and similar quality-control service to Architect 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.

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 Architect.
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 Architect'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 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," Architect will make selection.

B. Product Selection Procedures:

1. Sole Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
   
a. Sole product may be indicated by the phrase "Subject to compliance with requirements, provide the following."

2. Sole Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
   
a. Sole manufacturer/source may be indicated by the phrase "Subject to compliance with requirements, provide products by the following."
3. Limited List of Products: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will be considered unless otherwise indicated.
   
a. Limited list of products may be indicated by the phrase "Subject to compliance with requirements, provide one of the following."

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

5. Limited List of Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will be considered unless otherwise indicated.
   
a. Limited list of manufacturers is indicated by the phrase "Subject to compliance with requirements, provide products by one of the following."

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

7. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications 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 Architect's sample," provide a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.
1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Section 012500 "Substitution Procedures" for proposal of product.

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

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: Architect will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Architect may return requests without action, except to record noncompliance with 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 architects and owners, if requested.
   5. Samples, if requested.

B. Architect's Action on Comparable Products Submittal: If necessary, Architect 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 Architect does not issue a decision on use of a comparable product request within time allocated.

C. Submittal Requirements, Two-Step Process: Approval by the Architect of Contractor's request for use of comparable product is not intended to satisfy other submittal requirements. Comply with specified submittal requirements.
PART 3 - EXECUTION (Not Used)

END OF SECTION 016000
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:

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.

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 Architect of locations and details of cutting and await directions from Architect 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 Architect'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 Architect 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.

1. Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities, mechanical and electrical systems, and other construction affecting the Work.

1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, gas service piping, and water-service piping; underground electrical services; and other utilities.
2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.

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

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

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

1. Description of the Work, 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.

D. 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 Architect through Construction Manager 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 Architect. 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 Architect.
   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 Architect. 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 Architect. 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.

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

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

C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
D. Manufacturer's Field Service: Comply with qualification requirements in Section 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. Recycling nonhazardous demolition and construction waste.
   2. Disposing of nonhazardous demolition and construction waste.

1.2 DEFINITIONS

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

B. Demolition Waste: Building, structure, and site improvement materials resulting from demolition operations.

C. Disposal: Removal of demolition or construction waste and subsequent salvage, sale, recycling, or deposit in landfill, incinerator acceptable to authorities having jurisdiction, or designated spoil areas on Owner’s property.

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

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

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

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

A. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit report. Include the following information:
   1. Material category.
   2. Generation point of waste.
3. Total quantity of waste in tons.
4. Quantity of waste salvaged, both estimated and actual in tons.
5. Quantity of waste recycled, both estimated and actual in tons.
6. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.

B. Waste Reduction Calculations: Before request for Substantial Completion, submit calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the Work.

C. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

1.5 QUALITY ASSURANCE

A. Waste Management Coordinator Qualifications: Experienced firm, or individual employed and assigned by General Contractor, with a record of successful waste management coordination of projects with similar requirements.

B. Waste Management Conference(s): Conduct conference(s) at Project site to comply with requirements in Section 013100 "Project Management and Coordination."

1.6 WASTE MANAGEMENT PLAN

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

B. Waste Identification: Indicate anticipated types and quantities of demolition and construction waste generated by the Work. Include estimated quantities and assumptions for estimates.

C. 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. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
   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 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. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work.
   1. Distribute waste management plan to everyone concerned within [three] <Insert number> days of submittal return.
   2. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.

C. 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 and recycled.
   2. Comply with Section 015000 "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.

3.2 SALVAGING DEMOLITION WASTE

A. Comply with requirements in Section 024119 "Selective Demolition" for salvaging demolition waste.

B. Salvaged Items for Owner's Use:
   1. Clean salvaged items.
   2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.
   3. Store items in a secure area until delivery to Owner.
   4. Transport items to Owner's storage area designated by Owner.
   5. Protect items from damage during transport and storage.

3.3 RECYCLING DEMOLITION AND CONSTRUCTION WASTE, GENERAL

A. General: Recycle paper and beverage containers used by on-site workers.
B. Preparation of Waste: Prepare and maintain recyclable waste materials according to recycling or reuse facility requirements. Maintain materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process.

C. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical according to approved construction waste management plan.

1. Provide appropriately marked containers or bins for controlling recyclable waste until removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.
   a. Inspect containers and bins for contamination and remove contaminated materials if found.

2. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
3. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
4. Store components off the ground and protect from the weather.
5. Remove recyclable waste from Owner's property and transport to recycling receiver or processor as often as required to prevent overfilling bins.

3.4 RECYCLING DEMOLITION WASTE

A. Wood Materials: Sort and stack members according to size, type, and length. Separate lumber, engineered wood products, panel products, and treated wood materials.

B. Metals: Separate metals by type.

1. Structural Steel: Stack members according to size, type of member, and length.
2. Remove and dispose of bolts, nuts, washers, and other rough hardware.

C. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location. Remove edge trim and sort with other metals. Remove and dispose of fasteners.

D. Acoustical Ceiling Panels and Tile: Stack large clean pieces on wood pallets and store in a dry location.

E. Metal Suspension System: Separate metal members, including trim and other metals from acoustical panels and tile, and sort with other metals.

F. Carpet and Pad: Roll large pieces tightly after removing debris, trash, adhesive, and tack strips.

1. Store clean, dry carpet and pad in a closed container or trailer provided by carpet reclamation agency or carpet recycler.

G. Carpet Tile: Remove debris, trash, and adhesive.
1. Stack tile on pallet and store clean, dry carpet in a closed container or trailer provided by carpet reclamation agency or carpet recycler.

H. Piping: Reduce piping to straight lengths and store by material and size. Separate supports, hangers, valves, sprinklers, and other components by material and size.

I. Conduit: Reduce conduit to straight lengths and store by material and size.

J. Lamps: Separate lamps by type and store according to requirements in 40 CFR 273.

3.5 RECYCLING CONSTRUCTION WASTE

A. Packaging:

1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.


3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.

4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.

B. Wood Materials:

1. Clean Cut-Offs of Lumber: Grind or chip into small pieces.

2. Clean Sawdust: Bag sawdust that does not contain painted or treated wood.

C. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location.

1. Clean Gypsum Board: Grind scraps of clean gypsum board using small mobile chipper or hammer mill. Screen out paper after grinding.

D. Paint: Seal containers and store by type.

3.6 DISPOSAL OF WASTE

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

1. Except as otherwise specified, do not allow waste materials that are to be disposed of to accumulate on-site.

2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. General: Except for items or materials to be salvaged or recycled, remove waste materials and legally dispose of at designated spoil areas on Owner’s property.
C. Burning: Do not burn waste materials.

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.

C. 

1.2 CLOSEOUT SUBMITTALS

A. Certificates of Release: From authorities having jurisdiction.

B. Certificate of Insurance: For continuing coverage.

C. Field Report: For pest-control inspection.

1.3 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.
CLOSEOUT PROCEDURES

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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 Architect. 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, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect 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 Architect, that must be completed or corrected before certificate will be issued.

1.4 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 Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. 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, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect 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.

1.5 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, 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 Architect.
   d. Name of Contractor.
   e. Page number.

4. Submit list of incomplete items in the following format:
   b. PDF Electronic File: Architect will return annotated file.

1.6 SUBMITTAL OF PROJECT WARRANTIES

A. Time of Submittal: Submit written warranties on request of Architect 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.

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.

1. Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.

PART 3 - EXECUTION

3.1 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.
CLOSEOUT PROCEDURES

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.
m. Clean luminaires, lamps, globes, and reflectors to function with full efficiency.
n. Clean strainers.
o. Leave Project clean and ready for occupancy.


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

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

1. Submit by uploading to web-based project software site. Enable reviewer comments on draft submittals.

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. Architect will return copy with comments.

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

B. Manuals, Paper Copy: Submit manuals in the form of hard-copy, bound and labeled volumes.

1. Binders: Heavy-duty, three-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
2. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
   a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
   b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

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.

B. Title Page: Include the following information:

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

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

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.
   5. Power failure.
   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:

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.
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.
   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 and one set(s) of file prints.
      2) Architect will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.
   b. Final Submittal:
      1) Submit PDF electronic files of scanned Record Prints and three set(s) of file prints.
      2) Print 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 Architect'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 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 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 Architect's reference during normal working hours.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 017839
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.
2. Demonstration and training video recordings.

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 CLOSEOUT SUBMITTALS

A. Demonstration and Training Video Recordings: Submit one copies within seven days of end of each training module.

1. At completion of training, submit complete training manual(s) for Owner's use prepared in same PDF file format required for operation and maintenance manuals specified in Section 017823 "Operation and Maintenance Data."

1.4 QUALITY ASSURANCE

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

B. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Section 014000 "Quality Requirements," experienced in operation and maintenance procedures and training.
C. Preinstruction Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination."

1.5 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 Architect.

1.6 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.

1.7 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.

1.8 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 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. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of a written performance-based test.

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

1.9 DEMONSTRATION AND TRAINING VIDEO RECORDINGS

A. General: Engage a qualified commercial videographer to record demonstration and training video recordings. Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice.

1. At beginning of each training module, record each chart containing learning objective and lesson outline.

B. Digital Video Recordings: Provide high-resolution, digital video in MPEG format, produced by a digital camera with minimum sensor resolution of 12 megapixels and capable of recording in full HD modewith vibration reduction technology.
1. Submit video recordings by uploading to web-based Project software site.

C. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to adequately cover area of demonstration and training. Display continuous running time.

D. Light Levels: Verify light levels are adequate to properly light equipment. Verify equipment markings are clearly visible prior to recording.

E. Preproduced Video Recordings: Provide video recordings used as a component of training modules in same format as recordings of live training.

PART 2 - PRODUCTS

PART 3 - EXECUTION

END OF SECTION 017900
SECTION 024119
SELECTIVE STRUCTURE DEMOLITION

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. Demolition and removal of selected portions of building or structure to accommodate new construction.

B. Related Requirements:
1. Division 01 Section “Construction Waste Management and Disposal” for disposal of demolished materials.
2. Refer to Demolition drawings for additional requirements.
3. Refer to Section 070150.19 “Preparation for Reroofing” for roof related demolition.

1.3 DEFINITIONS
A. Remove: Detach items from existing construction and legally dispose of them off-site, unless indicated to be removed and salvaged or removed and reinstalled.

B. Remove and salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Owner ready for reuse.

C. Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.

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

1.4 SUBMITTALS
A. Schedule of Selective Demolition Activities: Indicate the following:
1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's on-site operations are uninterrupted.
2. Interruption of utility services. Indicate how long utility services will be interrupted.
3. Coordination for shutoff, capping, and continuation of utility services.
4. Use of elevator and stairs.
5. Locations of proposed dust-, infection and noise-control temporary partitions and means of egress.
6. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.
7. Means of protection for items to remain and items in path of waste removal from building.

B. Inventory: After selective demolition is complete, submit a list of items that have been removed and salvaged.

C. Predemolition Photographs or Videotapes: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by selective demolition operations.

D. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

1. Comply with submittal requirements in Division 01 Section "Construction Waste Management and Disposal."

1.5 QUALITY ASSURANCE

A. Demolition Firm Qualifications: An experienced firm that has specialized in demolition work similar in material and extent to that indicated for this Project.

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

C. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

D. Standards: Comply with ANSI A10.6 and NFPA 241.

E. Predemolition Conference: Conduct conference at Project site. Review methods and procedures related to selective demolition including, but not limited to, the following:

1. Inspect and discuss condition of construction to be selectively demolished.
2. Review structural load limitations of existing structure.
3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
5. Review areas where existing construction is to remain and requires protection.
1.6 PROJECT 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. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

C. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
   1. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Owner will remove hazardous materials under a separate contract.

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

E. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
   1. Maintain fire-protection facilities in service during selective demolition operations.

1.7 COORDINATION

A. Infection Control: Coordinate with the requirements for infection control risk assessment and infection control plan as indicated on the Drawings prior to the start of demolition work.

1.8 WARRANTY

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

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped.

B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.

C. Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged.
D. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Architect.

E. Engage a professional engineer to survey 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 demolition operations.

F. Survey of Existing Conditions: Record existing conditions by use of measured drawings, preconstruction photographs and/or preconstruction videotapes.

1. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.

G. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems: Maintain services/systems indicated to remain and protect them against damage during selective demolition operations.

B. Service/System Requirements: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.

1. Arrange to shut off indicated utilities with utility companies as applicable.
2. If services/systems are required to be removed, relocated, or abandoned, before proceeding with selective demolition provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
3. Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing.

   a. Where entire wall is to be removed, existing services/systems may be removed with removal of the wall.

3.3 PREPARATION

A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

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

1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
4. Cover and protect furniture, furnishings, and equipment that have not been removed.

3.4 SELECTIVE DEMOLITION, GENERAL

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
4. Do not use cutting torches.
5. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
6. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
7. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
8. Dispose of demolished items and materials promptly. Comply with requirements in Division 01 Section "Construction Waste Management and Disposal."

B. Removed and Reinstalled Items:

1. Clean and repair items to functional condition adequate for intended reuse. Paint equipment to match new equipment.
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.

C. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, 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.
3.5 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

A. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals, using power-driven saw, then remove concrete between saw cuts.

B. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, and then remove masonry between saw cuts.

C. Resilient Floor Coverings: Remove floor coverings and adhesive according to recommendations in RFCI's "Recommended Work Practices for the Removal of Resilient Floor Coverings." Do not use methods requiring solvent-based adhesive strippers.

D. Roofing: Remove no more existing roofing than what can be covered in one day by new roofing and so that building interior remains watertight and weathertight. Comply with manufacturer’s recommendations for roofing modification requirements.

E. Air-Conditioning Equipment: Remove equipment without releasing refrigerants.

F. Door Hardware: For doors to be removed, Owner will remove door hardware and salvage.

3.6 DISPOSAL OF DEMOLISHED MATERIALS

A. General: Except for items or materials indicated to be recycled, reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
3. 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 Division 01 Section "Construction Waste Management and Disposal."

3.7 CLEANING

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

3.8 SELECTIVE DEMOLITION SCHEDULE

A. Existing Items to Be Removed and Reinstalled: As indicated on Drawings.

B. Existing Items to Remain: As indicated on Drawings.
3.9 CONSTRUCTION WASTE MANAGEMENT

A. Comply with the Waste Management Plan specified in Section 017419 Construction Waste Management and Disposal, for additional requirements.

END OF SECTION 024119
PART 1 - GENERAL

1.1 SUMMARY
   A. Section includes cast-in-place concrete, including reinforcement, concrete materials, mixture design, placement procedures, and finishes.

1.2 ACTION SUBMITTALS
   A. Product Data: For each type of product.

1.3 QUALITY ASSURANCE

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL
   A. Comply with ACI 301.
   B. Comply with ACI 117.

2.2 STEEL REINFORCEMENT
   A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
   B. Plain-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, plain, fabricated from as-drawn steel wire into flat sheets.

2.3 CONCRETE MATERIALS
   B. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
      1. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
   C. Water: ASTM C 94/C 94M.
2.4 RELATED MATERIALS

A. Vapor Retarder: Plastic sheet, ASTM E 1745, Class A or B.

B. Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber, or ASTM D 1752, cork or self-expanding cork.

2.5 CURING MATERIALS

A. Water: Potable.

B. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.

2.6 CONCRETE MIXTURES

A. Normal-Weight Concrete:

1. Minimum Compressive Strength: 3500 psi at 28 days.
2. Maximum W/C Ratio: 0.50.
3. Cementitious Materials: Use fly ash, pozzolan, slag cement, and blended hydraulic cement as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.
   a. Slump Limit: 8 inches plus or minus 1 inch for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture.
4. Air Content: Maintain within range permitted by ACI 301. Do not allow air content of trowel-finished floor slabs to exceed 3 percent.

2.7 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116, and furnish batch ticket information.

1. When air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 FORMWORK INSTALLATION

A. Design, construct, erect, brace, and maintain formwork according to ACI 301.
3.2 EMBEDDED ITEM INSTALLATION

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

3.3 VAPOR-RETARDER INSTALLATION

A. Install, protect, and repair vapor retarders according to ASTM E 1643; place sheets in position with longest dimension parallel with direction of pour.

   1. Lap joints 6 inches and seal with manufacturer's recommended adhesive or joint tape.

3.4 STEEL REINFORCEMENT INSTALLATION

A. Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

   1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

3.5 JOINTS

A. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness

B. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

   1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.

3.6 CONCRETE PLACEMENT

A. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.

B. Do not add water to concrete during delivery, at Project site, or during placement.

C. Consolidate concrete with mechanical vibrating equipment according to ACI 301.
3.7 FINISHING FORMED SURFACES

A. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defective areas. Remove fins and other projections exceeding 1/8 inch.

1. Apply to concrete surfaces exposed to public view, or to be covered with a coating or covering material applied directly to concrete.

B. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.8 FINISHING UNFORMED SURFACES

A. General: Comply with ACI 302.1R for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Screed surfaces with a straightedge and strike off. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane before excess moisture or bleedwater appears on surface.

1. Do not further disturb surfaces before starting finishing operations.

3.9 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and with ACI 305.1 for hot-weather protection during curing.

B. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

C. Curing Methods: Cure formed and unformed concrete for at least seven days by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
   a. Water.
   b. Continuous water-fog spray.

2. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

END OF SECTION 033053
SECTION 055000
METAL FABRICATIONS

PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section Includes:
      1. Miscellaneous metal fabrications.
   B. Products furnished, but not installed, under this Section:
      1. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated
         to be cast into concrete or built into unit masonry.
      2. Steel weld plates and angles for casting into concrete.
   C. Related Sections:
      1. Section 051200 "Structural Steel Framing".
      2. Section 054313.50 "Slotted Channel Equipment Support Framing".
      3. Section 077200 "Roof Accessories" for tieback anchors.

1.3 COORDINATION
   A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint
      and coating manufacturers' written recommendations to ensure that shop primers and topcoats
      are compatible with one another.
   B. Coordinate installation of metal fabrications that are anchored to or that receive other work.
      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.

1.4 SUBMITTALS
   A. Shop Drawings: Show fabrication and installation details for metal fabrications.
      1. Include plans, elevations, sections, and details of metal fabrications and their
         connections. Show anchorage and accessory items.
1.5 QUALITY ASSURANCE
   A. Welding Qualifications: Qualify procedures and personnel according to the following:
      1. AWS D1.2/D1.2M, “Structural Welding Code – Aluminum”.
      2. AWS D1.1/D1.1M, "Structural Welding Code - Steel.”

1.6 FIELD CONDITIONS
   A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
   A. Provide products with post-consumer recycled content plus one-half of pre-consumer recycled content to the greatest extent possible.
   B. Raw or recycled materials in metal fabrications shall be extracted, harvested, or recovered and manufactured or processed within 500 miles by air of the Project site.

2.2 METALS, GENERAL
   A. Metal Surfaces, General: Provide materials with smooth, flat surfaces without blemishes.

2.3 FERROUS METALS
   A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
   B. Steel Tubing: ASTM A 500, cold-formed steel tubing.
   C. Steel Pipe: ASTM A 53/A 53M, standard weight (Schedule 40) unless otherwise indicated.
   D. Stainless-Steel Sheet, Strip, and Plate: ASTM A 240/A 240M or ASTM A 666, Type 316L.
   E. Stainless-Steel Bars and Shapes: ASTM A 276m, Type 316L.

2.4 FASTENERS
   A. General: Unless otherwise indicated, provide Type 304 or Type 316 as specified or required stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, at exterior walls.
   B. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or
ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.

C. Post-Installed Anchors:

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.

2.5 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Use connections that maintain structural value of joined pieces.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges. Remove sharp or rough areas on exposed surfaces.

C. Weld corners and seams continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended.

D. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Locate joints where least conspicuous.

E. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

F. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors not less than 24 inches o.c.

2.6 MISCELLANEOUS METAL FABRICATIONS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

2.7 FINISHES, GENERAL

A. Finish metal fabrications after assembly.
B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

C. Shop priming: Shop prime steel items unless they are to be embedded in concrete, or masonry. See Section 099113 “Exterior Painting”, or Section 099123 “Interior Painting” for applicable primers.

2.8 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.2 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.
3.3 CONSTRUCTION WASTE MANAGEMENT

A. Comply with the Waste Management Plan specified in Section 017419 “Construction Waste management and Disposal” for additional requirements.

END OF SECTION 055000
SECTION 061000
ROUGH CARPENTRY

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. Wood blocking and nailers.
   2. Plywood backing panels.

1.3 DEFINITIONS
A. Dimension Lumber: Lumber of 2 inches nominal or greater but less than 5 inches nominal in least dimension.

1.4 SUBMITTALS
A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
   1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
   2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
B. Evaluation Reports: For the following, from ICC-ES:
   1. Wood-preservative-treated wood.
   2. Fire-retardant-treated wood.
   4. Post-installed anchors.
1.5 DELIVERY, STORAGE, AND HANDLING
   A. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

1.6 QUALITY ASSURANCE
   A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL
   A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, comply with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Grade lumber by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
      1. Factory mark each piece of lumber with grade stamp of grading agency.
      2. Dress lumber, S4S, unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED LUMBER
   A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with ground.
      1. Preservative Chemicals: Acceptable to authorities having jurisdiction.
   B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.
   C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
   D. Application: Treat materials where indicated.

2.3 FIRE-RETARDANT-TREATED MATERIALS
   A. General: Where fire-retardant-treated materials are indicated, materials shall be acceptable to authorities having jurisdiction, and have fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.
   B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant
progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.

1. Treatment shall not promote corrosion of metal fasteners.
2. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where indicated.

C. Kiln-dry lumber after treatment to maximum moisture content of 19 percent. Kiln-dry plywood after treatment to maximum moisture content of 15 percent.

D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.

2.4 MISCELLANEOUS LUMBER

A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

1. Blocking.
2. Nailers.

B. For items of dimension lumber size, provide Construction or No. 2 grade lumber with 15 percent maximum moisture content of any species.

C. For concealed boards, provide lumber with 15 percent maximum moisture content and any of the following species and grades:

1. Mixed southern pine, No. 2 grade; SPIB.

D. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.

E. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

2.5 PLYWOOD BACKING PANELS

A. Equipment Backing Panels: Plywood, DOC PS 1, Exterior, A-C fire-retardant treated, in thickness indicated or, if not indicated, not less than 3/4-inch nominal thickness.

2.6 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.
1. Where rough carpentry is pressure-preservative treated, or in area of high relative humidity, provide fasteners of Type 304 stainless steel.

B. Nails, Brads, and Staples: ASTM F 1667.

C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

D. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01, ICC-ES AC58, ICC-ES AC193 or ICC-ES AC308 as appropriate for the substrate.

   1. Material: Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry to other construction; scribe and cope as needed for accurate fit. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.

B. Do not splice members between supports, unless otherwise indicated.

C. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.

   1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches o.c.

D. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

E. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

   1. Use inorganic boron for items that are continuously protected from liquid water.
   2. Use copper naphthenate for items not continuously protected from liquid water.

F. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

   1. Table 2304.9.1, "Fastening Schedule," in Florida Building Code (FBC), except where otherwise indicated.
G. Use common wire nails, unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood; do not countersink nail heads, unless otherwise indicated.

3.2 WOOD BLOCKING, AND NAILER INSTALLATION

A. Install where indicated and where required for screeding or attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.

B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated.

3.3 PROTECTION

A. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

3.4 CONSTRUCTION WASTE MANAGEMENT

A. Comply with the Waste Management Plan specified in Section 017419 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL for additional requirements.

END OF SECTION 061000
SECTION 062023
INTERIOR FINISH CARPENTRY

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
   1. Decorative Wall Panels.
B. Related Requirements:
   1. Section 061000 "Rough Carpentry" for furring, blocking, and other carpentry work not exposed to view and for framing exposed to view.
   2. Section 099123 "Interior Painting" for priming and backpriming of interior finish carpentry.

1.3 DEFINITIONS
A. MDF: Medium-density fiberboard.
B. CNC: Computer Numerical Control.

1.4 SUBMITTALS
A. Product Data: For each type of process and factory-fabricated product. Indicate component materials, dimensions, profiles, textures, and colors and include construction and application details.
B. Shop drawings for decorative grilles showing size, layout and installation method.
C. Samples for Verification:
   1. For each decorative wall panel in each specified finish. Size to be minimum 12 by 12 inches or panel size if smaller.
D. Evaluation Reports: For fire-retardant-treated wood, from ICC-ES.
E. Sample Warranty: For manufacturer's warranty.
1.5 DELIVERY, STORAGE, AND HANDLING

A. Stack lumber, plywood, and other panels flat with spacers between each bundle to provide air circulation. Protect materials from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

B. Deliver interior finish carpentry materials only when environmental conditions meet requirements specified for installation areas. If interior finish carpentry materials must be stored in other than installation areas, store only where environmental conditions meet requirements specified for installation areas.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install interior finish carpentry materials until building is enclosed and weatherproof, wet work in space is completed and nominally dry, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

B. Do not install finish carpentry materials that are wet, moisture damaged, or mold damaged.

1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.

2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 DECORATIVE WALL PANELS (WP-1A, WP-1B, WP-2)

A. Decorative wall panels manufactured from MDF with 3 dimensional pattern cut utilizing CNC machining and advanced thermoforming capabilities.

B. Provide Products by the following manufacturer:

1. Basis of Design: 3Form.

C. Provide products that are Class 1 or Class A under ASTM E84-02011A

D. Size and Pattern: As indicated on drawings

E. Finish: Standard Finish as indicated on drawings.

F. Shape: As indicated on drawings

G. Thickness: As indicated on drawings

H. Fasten per manufacturer recommendation
2.2 MISCELLANEOUS MATERIALS

A. Fasteners for Interior Finish Carpentry: Nails, screws, and other anchoring devices of type, size, material, and finish required for application indicated to provide secure attachment, concealed where possible.

B. Glue: Aliphatic-resin, polyurethane, or resorcinol wood glue recommended by manufacturer for general carpentry use.

C. Multipurpose Construction Adhesive: Formulation complying with ASTM D 3498 that is recommended for indicated use by adhesive manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine finish carpentry materials before installation. Reject materials that are wet, moisture damaged, and mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrates of projections and substances detrimental to application.

B. Before installing decorative wall panels, condition materials to average prevailing humidity in installation areas for a minimum of 24 hours unless longer conditioning is recommended by manufacturer.

C. Install decorative wall panels as recommended per manufacturer.

3.3 INSTALLATION, GENERAL

A. Do not use materials that are unsound, warped, improperly treated or finished, inadequately seasoned, too small to fabricate with proper jointing arrangements, or with defective surfaces, sizes, or patterns.

B. Install interior finish carpentry level, plumb, true, and aligned with adjacent materials. Use concealed shims where necessary for alignment.

1. Scribe and cut interior finish carpentry to fit adjoining work. Refinish and seal cuts as recommended by manufacturer.

2. Where face fastening is unavoidable, countersink fasteners, fill surface flush, and sand unless otherwise indicated.
3. Install to tolerance of 1/8 inch in 96 inches for level and plumb. Install adjoining interior finish carpentry with 1/32-inch maximum offset for flush installation and 1/16-inch maximum offset for reveal installation.

4. Coordinate interior finish carpentry with materials and systems in or adjacent to it. Provide cutouts for mechanical and electrical items that penetrate interior finish carpentry.

3.4 CLEANING

A. Clean decorative wall panels on exposed and semiexposed surfaces. Restore damaged or soiled areas and touch up factory-applied finishes, if any.

3.5 PROTECTION

A. Protect installed products from damage from weather and other causes during construction.

3.6 CONSTRUCTION WASTE MANAGEMENT

A. Comply with the Waste Management Plan specified in Section 017419 Construction Waste Management and Disposal, for additional requirements.

END OF SECTION 062023
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Plastic-laminate-clad architectural cabinets.
   2. Wood furring, blocking, shims, and hanging strips for installing plastic-laminate-clad architectural cabinets that are not concealed within other construction.

B. Related Requirements:
   1. Section 061000 "Rough Carpentry" Section 061053 "Miscellaneous Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing cabinets that are concealed within other construction before cabinet installation.
   2. Section 123661.16 “Solid Surfacing Countertops”.

1.3 COORDINATION

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to support loads imposed by installed and fully loaded cabinets.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include data for fire-retardant treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.

B. Shop Drawings:
   1. Include plans, elevations, sections, and attachment details.
   2. Show large-scale details.
   3. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
4.  Show locations and sizes of cutouts and holes for items installed in plastic-laminate architectural cabinets.
5.  Apply AWI Quality Certification Program label to Shop Drawings.

C.  Samples: For each exposed product and for each color and texture specified, in manufacturer's or manufacturer's standard size.

D.  Samples for Initial Selection: For each type of exposed finish.

E.  Samples for Verification: For the following:

1.  Plastic Laminates: 8 by 10 inches, for each type, color, pattern, and surface finish required.
2.  Exposed Cabinet Hardware and Accessories: One full-size unit for each type and finish.

1.5 INFORMATIONAL SUBMITTALS

A.  Qualification Data: For manufacturer and Installer.

B.  Product Certificates: For the following:

1.  Composite wood and agrifiber products.
2.  High-pressure decorative laminate.

C.  Evaluation Reports: For fire-retardant-treated materials, from ICC-ES.

D.  Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A.  Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.

1.7 QUALITY ASSURANCE

A.  Manufacturer's Qualifications: Employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.

1.  Manufacturer's Certification: Licensed participant in AWI's Quality Certification Program.

B.  Installer Qualifications: Licensed participant in AWI's Quality Certification Program.

1.8 DELIVERY, STORAGE, AND HANDLING

A.  Do not deliver cabinets until painting and similar finish operations that might damage architectural cabinets have been completed in installation areas. Store cabinets in installation
areas or in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install cabinets until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F and relative humidity between 43 and 70 percent during the remainder of the construction period.

B. Field Measurements: Where cabinets are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1. Locate concealed framing, blocking, and reinforcements that support cabinets by field measurements before being enclosed/concealed by construction, and indicate measurements on Shop Drawings.

C. Established Dimensions: Where cabinets are indicated to fit to other construction, establish dimensions for areas where cabinets are to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

PART 2 - PRODUCTS

2.1 PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

A. Quality Standard: Unless otherwise indicated, comply with the Architectural Woodwork Standards for grades of cabinets indicated for construction, finishes, installation, and other requirements.

1. Provide labels and certificates from AWI certification program indicating that woodwork and installation complies with requirements of grades specified.

B. Architectural Woodwork Standards Grade: Premium.

C. Type of Construction: Frameless.

D. Door and Drawer-Front Style: Flush overlay.

1. Reveal Dimension: 1/4 inch.

E. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or if not indicated, as required by quality standard.

1. Manufacturers: Subject to compliance with requirements.

F. Laminate Cladding for Exposed Surfaces:
1. Horizontal Surfaces: Grade HGS.
2. Postformed Surfaces: Grade HGP.
3. Vertical Surfaces: Grade VGS.
4. Edges: Grade HGS, Grade VGS.
5. Pattern Direction: Vertically for doors and fixed panels, horizontally for drawer fronts.

G. Materials for Semiexposed Surfaces:

1. Surfaces Other Than Drawer Bodies: High-pressure decorative laminate, NEMA LD 3, Grade VGS.
   a. Edges of Plastic-Laminate Shelves: PVC edge banding, 0.12-inch thick, matching laminate in color, pattern, and finish.
   b. Edges of Thermoset Decorative Panel Shelves: PVC or polyester edge banding.
   c. For semiexposed backs of panels with exposed plastic-laminate surfaces, provide surface of high-pressure decorative laminate, NEMA LD 3, Grade VGS.

2. Drawer Sides and Backs: Solid-hardwood lumber.
3. Drawer Bottoms: Hardwood plywood.

H. Dust Panels: 1/4-inch plywood or tempered hardboard above compartments and drawers unless located directly under tops.

I. Concealed Backs of Panels with Exposed Plastic-Laminate Surfaces: High-pressure decorative laminate, NEMA LD 3, Grade BKL.

J. Drawer Construction: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.

1. Join subfronts, backs, and sides with glued dovetail joints.

K. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:

1. As indicated on drawings.

2.2 WOOD MATERIALS

A. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.

1. Wood Moisture Content: 8 to 13 percent.

B. Composite Wood and Agrifiber Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.
2.3 FIRE-RETARDANT-TREATED MATERIALS

A. Fire-Retardant-Treated Materials, General: Where fire-retardant-treated materials are indicated, use materials that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

1. Use treated materials that comply with requirements of referenced quality standard. Do not use materials that are warped, discolored, or otherwise defective.
2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
3. Identify fire-retardant-treated materials with appropriate classification marking of qualified testing agency in the form of removable paper label or imprint on surfaces that will be concealed from view after installation.

B. Fire-Retardant-Treated Lumber and Plywood: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.

1. Kiln-dry lumber and plywood after treatment to a maximum moisture content of 19 and 15 percent, respectively.
2. For items indicated to receive a stained or natural finish, use organic resin chemical formulation.
3. Mill lumber after treatment within limits set for wood removal that do not affect listed fire-test-response characteristics, using a woodworking shop certified by testing and inspecting agency.
4. Mill lumber before treatment and implement procedures during treatment and drying processes that prevent lumber from warping and developing discolorations from drying sticks or other causes, marring, and other defects affecting appearance of architectural cabinets.

2.4 CABINET HARDWARE AND ACCESSORIES

A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets except for items specified in Section 087100 "Door Hardware."

B. Butt Hinges: 2-3/4-inch, five-knuckle steel hinges made from 0.095-inch-thick metal, and as follows:

1. Semiconcealed Hinges for Flush Doors: BHMA A156.9, B01361.
2. Semiconcealed Hinges for Overlay Doors: BHMA A156.9, B01521.

C. Frameless Concealed Hinges (European Type): BHMA A156.9, B01602, 100 degrees of opening.

D. Back-Mounted Pulls: BHMA A156.9, B02011.

E. Wire Pulls: Back mounted, solid metal, as indicated on drawings.
F. Catches: Magnetic catches, BHMA A156.9, B03141.

G. Adjustable Shelf Standards and Supports: BHMA A156.9, B04071; with shelf rests, B04081 for mounting at ends of shelves; BHMA A156.9, B04102; with shelf brackets, B04112 for mounting at rear of shelves.

H. Shelf Rests: BHMA A156.9, B04013; metal two-pin plastic with shelf hold-down clip.

I. Drawer Slides: BHMA A156.9.
   1. Grade 1 and Grade 2: Side mounted and extending under bottom edge of drawer.
      a. Type: Full extension.
      b. Material: Zinc-plated steel with polymer rollers.
   2. Grade 1HD-100 and Grade 1HD-200: Side mounted; full-extension type; zinc-plated-steel ball-bearing slides.
   3. For drawers not more than 3 inches high and not more than 24 inches wide, provide Grade 1.
   4. For drawers more than 3 inches high, but not more than 6 inches high and not more than 24 inches wide, provide Grade 1.
   5. For drawers more than 6 inches high or more than 24 inches wide, provide Grade 1HD-100.

J. Slides for Sliding Glass Doors: BHMA A156.9, B07063; aluminum.

K. Door Locks: BHMA A156.11, E07121.

L. Drawer Locks: BHMA A156.11, E07041.

M. Door and Drawer Silencers: BHMA A156.16, L03011.

N. Grommets for Cable Passage: 2-inch OD, molded-plastic grommets and matching plastic caps with slot for wire passage.
   1. Color: Match color to countertop finish.

O. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.

P. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.

2.5 MISCELLANEOUS MATERIALS

A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber Fire-retardant-treated softwood lumber, kiln-dried to less than 15 percent moisture content.
B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.

C. Adhesive for Bonding Plastic Laminate: Per manufacturer’s recommendations.

2.6 FABRICATION

A. Fabricate architectural cabinets to dimensions, profiles, and details indicated.

B. Complete fabrication, including assembly and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

1. Notify Architect seven days in advance of the dates and times architectural cabinet fabrication will be complete.

2. Trial fit assemblies at manufacturer's shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements before disassembling for shipment.

C. Shop-cut openings to maximum extent possible to receive hardware, appliances, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

PART 3 - EXECUTION

3.1 PREPARATION

A. Before installation, condition cabinets to humidity conditions in installation areas for not less than 72 hours.

3.2 INSTALLATION

A. Architectural Woodwork Standards Grade: Install cabinets to comply with quality standard grade of item to be installed.

B. Assemble cabinets and complete fabrication at Project site to extent that it was not completed in the shop.

C. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Secure with wafer-head cabinet installation screws.
D. Install cabinets level, plumb, and true in line to a tolerance of 1/8 inch in 96 inches using concealed shims.

1. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
2. Install cabinets without distortion so doors and drawers fit openings and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
3. Fasten wall cabinets through back, near top and bottom, and at ends not more than 16 inches o.c. with No. 10 wafer-head sheet metal screws through metal backing or metal framing behind wall finish.

3.3 FIELD QUALITY CONTROL

A. Inspections: Provide inspection of installed Work through AWI's Quality Certification Program certifying that woodwork, including installation, complies with requirements of the Architectural Woodwork Standards for the specified grade.

1. Inspection entity shall prepare and submit report of inspection.

3.4 ADJUSTING AND CLEANING

A. Repair damaged and defective cabinets, where possible, to eliminate functional and visual defects. Where not possible to repair, replace architectural cabinets. Adjust joinery for uniform appearance.

B. Clean, lubricate, and adjust hardware.

C. Clean cabinets on exposed and semiexposed surfaces.

END OF SECTION 064116
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Tear-off of existing roofing system, metal flashings, metal gutters and downspouts, and related components as indicated on Drawings.

B. Related Requirements:

1. Section 075216 "Styrene-Butadiene-Styrene (SBS) Modified Bituminous Membrane Roofing" for new roofing system.
2. Section 077100 “Roof Specialties” for new roof-edge drainage systems, new roof-edge flashings and new reglets and counterflashings.

1.3 DEFINITIONS

A. Roofing Terminology: Definitions in ASTM D1079 and glossary of NRCA's "The NRCA Roofing Manual: Membrane Roof Systems" apply to work of this Section.

1.4 PREINSTALLATION MEETINGS


1. Meet with Owner, Architect, Construction Manager, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing tear-off, including, but not limited to, the following:

   a. Reroofing preparation, including roofing system manufacturer's written instructions.
   b. Existing roof drainage during each stage of reroofing.
c. Construction schedule and availability of materials, Installer's personnel, equipment, and facilities needed to avoid delays.

d. Existing roof deck conditions requiring Architect notification.

e. Structural loading limitations of roof deck during reroofing.

f. Special roofing details, drainage, and condition of other construction that affect reroofing.

g. Governing regulations and requirements for insurance and certificates if applicable.

h. Existing conditions that may require Architect notification before proceeding.

1.5 SUBMITTALS

A. Product Data and Shop Drawings and Other Submittals: Refer to Section 075216 "Styrene-Butadiene-Styrene (SBS) Modified Bituminous Membrane Roofing" for new roofing system.

B. Photographs and Video Recordings: Provide photographs and video recordings of existing conditions before and after existing roofing system, metal flashing, gutters and downspouts, and related components have been removed.

C. Landfill Records: Indicate receipt and acceptance of demolished roofing materials and hazardous wastes, such as asbestos-containing materials, by a landfill facility licensed to accept them.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Refer to Section 075216 "Styrene-Butadiene-Styrene (SBS) Modified Bituminous Membrane Roofing”.

B. Regulatory Requirements:

1. Comply with governing EPA notification regulations before beginning roofing removal.

2. Comply with hauling and disposal regulations of authorities having jurisdiction.

1.7 FIELD CONDITIONS

A. Owner will not occupy portions of building immediately below reroofing area.

B. Protect building to be reroofed, adjacent buildings, walkways, site improvements, exterior plantings, and landscaping from damage or soiling from reroofing operations.

C. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities.

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

E. Limit construction loads on existing roof areas to remain, and existing roof areas scheduled to be reroofed to 300 lbs. for rooftop equipment wheel loads and 50 psf for uniformily distributed live loads.
F. Weather Limitations: Proceed with reroofing preparation only when existing and forecasted weather conditions permit Work to proceed without water entering existing roofing system or building.
   1. Remove only as much roofing in one day as can be made watertight in the same day.

PART 2 - PRODUCTS

2.1 MATERIALS

   A. Refer to Section 075216 "Styrene-Butadiene-Styrene (SBS) Modified Bituminous Membrane Roofing".

PART 3 - EXECUTION

3.1 PREPARATION

   A. Protection of In-Place Conditions:
      1. Protect existing roofing system that is not to be reroofed.
      2. Limit traffic and material storage to areas of existing roofing that is not to be reroofed.
      3. Maintain temporary protection, as required, and leave in place until replacement roofing has been completed. Remove temporary protection on completion of reroofing.

   B. Seal or isolate windows that may be exposed to airborne substances created in removal of existing materials.

   C. During removal operations, have sufficient and suitable materials on-site to facilitate rapid installation of temporary protection in the event of unexpected rain.

   D. Notify Architect immediately should any hazardous materials be encountered in the area of the Work.
      1. Do not proceed with installation until directed by Architect.

3.2 ROOFING MATERIALS TEAR-OFF

   A. Remove existing roofing system and related components as indicated on Drawings. Lower removed roofing materials to ground using dust-tight chutes or other acceptable means of removing materials from roof areas.

   B. Inspect existing wood blocking and nailers for deterioration and damage.
      1. If wood blocking and nailers are deteriorated, immediately notify Architect.
      2. Remove existing fasteners from deck.
3.3 METAL FLASHING, AND METAL GUTTERS AND DOWNSPOUTS REMOVAL
   A. Remove existing metal flashing, and metal gutters and downspouts as indicated on Drawings. Lower removed metal flashing, and metal gutters and downspouts to ground using dust-tight chutes or other acceptable means of removing materials from roof areas.

3.4 DECK PREPARATION
   A. Inspect existing lightweight insulating concrete roof deck after tear-off of roofing system.
   B. If existing lightweight insulating concrete roof deck surface is unsuitable for receiving new roofing or if structural integrity of roof deck is suspect, immediately notify Architect.
      1. Do not proceed with installation until directed by Architect.

3.5 TEMPORARY ROOFING
   A. Refer to Section 075216 "Styrene-Butadiene-Styrene (SBS) Modified Bituminous Membrane Roofing".

3.6 DISPOSAL
   A. Collect demolished materials and place in containers.
      1. Promptly dispose of demolished materials.
      2. Do not allow demolished materials to accumulate on-site.
      3. Storage or sale of demolished items or materials on-site is not permitted.
   B. Transport and legally dispose of demolished materials off Owner's property.

3.7 CONSTRUCTION WASTE MANAGEMENT
   A. Comply with the Waste Management Plan specified in Section 017419 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL for additional requirements.

END OF SECTION 070150.19
SECTION 072100
THERMAL INSULATION

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. Glass-Fiber blanket insulation.
   B. Related Sections include the following:
      1. Division 07 Section “Firestopping” for insulation as part of a fire-resistive joint system.
      2. Division 09 Section “Gypsum Board” for sound attenuation blankets.
      3. Applicable Division 22 Sections for Plumbing insulation.
      4. Applicable Division 23 Sections for HVAC insulation.

1.3 SUBMITTALS
   A. Product Data: For each type of product indicated.
   B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified
      testing agency for insulation products.

1.4 QUALITY ASSURANCE
   A. Source Limitations: Obtain each type of building insulation through one source from a single
      manufacturer.
   B. Fire-Test-Response Characteristics: Provide insulation and related materials with the fire-test-
      response characteristics indicated, as determined by testing identical products per test method
      indicated below by UL or another testing and inspecting agency acceptable to authorities having
      jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting
      agency.
1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect insulation materials from physical damage and from deterioration by moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

PART 2 - PRODUCTS

2.1 RECYCLED CONTENT OF PRODUCTS

A. Provide products with post-consumer recycled content plus one-half of pre-consumer recycled content to the greatest extent possible.

2.2 GLASS-FIBER BLANKET INSULATION

A. Unfaced, Glass-Fiber Blanket Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics. Thickness as indicated or required.

2.3 SOUND ATTENUATION BLANKETS

A. See Section 09 29 00 Gypsum Board.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements of Sections in which substrates and related work are specified and for other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrates of substances harmful to insulation or vapor retarders, including removing projections capable of puncturing vapor retarders or of interfering with insulation attachment.

3.3 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and application indicated.
B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed at any time to ice, rain, and snow.

C. Extend insulation in thickness indicated to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

D. Water-Piping Coordination: If water piping is located within insulated exterior walls, coordinate location of piping to ensure that it is placed on warm side of insulation and insulation encapsulates piping.

3.4 INSTALLATION OF GENERAL BUILDING INSULATION

A. Apply insulation units to substrates complying with manufacturer's written instructions.

3.5 PROTECTION

A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

3.6 CONSTRUCTION WASTE MANAGEMENT

A. Comply with the Waste Management Plan specified in Section 017419 Construction Waste Management and Disposal for additional requirements.

END OF SECTION 072100
SECTION 075216

STYRENE-BUTADIENE-STYRENE (SBS) MODIFIED
BITUMINOUS MEMBRANE ROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes:

1. SBS-modified bituminous membrane roofing system.

B. Related Sections:

1. Section 061000 "Rough Carpentry" for wood nailers and blocking.
2. Section 070150.19 “Preparation For Roofing” for removal of existing roofing system, metal flashings, metal gutters and downspouts, and related components.
3. Section 077100 “Roof Specialties” for new roof-edge drainage systems, new roof-edge flashings and new reglets and counterflashings.

1.3 SUBMITTALS

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

B. Delegated-Design Submittal: For SBS-modified bituminous roofing system indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified registered Professional Engineer responsible for their preparation.

C. Miami Dade Acceptance or Florida Product Approval: Submit documentation for Notice of Acceptance (NOA) from the Miami Dada County Building Code Compliance Office (BCCO), or Florida Product Approval. Each NOA or Florida Product Approval letter shall show the product name, product description and valid NOA or Florida Product Approval number with expiration date.

D. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work, including:

1. Base flashings and membrane terminations.
2. Roof plan showing fastening spacings, and patterns for mechanically fastened base sheet of roofing system.
3. Roof plan showing locations of one-way roof vents.
E. Qualification Data: For qualified Installer.

F. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
   1. Submit evidence of compliance with performance requirements.

G. Maintenance Data: For roofing system to include in maintenance manuals.

H. Warranties: Sample of special warranties.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by membrane roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

B. Source Limitations: Obtain components including roof insulation fasteners for membrane roofing system from same manufacturer as membrane roofing.

C. Exterior Fire-Test Exposure: ASTM E 108, Class A; for application and roof slopes indicated, as determined by testing identical membrane roofing materials by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing manufacturer. Protect stored liquid material from direct sunlight.
   1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

1.6 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

1.7 WARRANTY
A. Special Warranty: Submit manufacturer's warranty, without monetary limitation (or “no dollar limit”), in which manufacturer agrees to repair or replace components of membrane roofing system that fail in materials or workmanship within specified warranty period.

1. Special warranty includes membrane roofing, base flashings, fasteners, cover boards, roofing accessories, walkway products, and other components of membrane roofing system.
2. Warranty Period: 20 years from date of Substantial Completion.

B. Special Project Warranty: Submit roofing Installer's warranty, signed by Installer, covering the Work of this Section, including all components of membrane roofing system such as membrane roofing, base flashing, LWIC roof insulation, fasteners, cover boards, substrate boards, roofing accessories, walkway products, and other components of membrane for the following warranty period:

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified registered Professional Engineer, as defined in Section 014000 "Quality Requirements," to design installation of specified roofing system.

B. General Performance: Installed membrane roofing and base flashings shall withstand specified wind load criteria, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Membrane roofing and base flashings shall remain watertight.

C. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by membrane roofing manufacturer based on testing and field experience.

D. Structural Loads:

1. Wind Loads: Unless criteria is otherwise indicated on Drawings, establish criteria for the following for the Project location and design in accordance with 2017 Florida Building Code (FBC) and ASCE 7-10 requirements for Components and Cladding:
   a. Ultimate wind speed (3-second gust).
   b. Nominal wind speed (3-second gust).
   c. Wind exposure.
   d. Wind pressures.

2. Miami Dade Acceptance or Florida Product Approval: Provide specified roofing system for the building exterior having a Notice of Acceptance (NOA) letter from the Miami Dade County Building Code Compliance Office (BCCO) or Florida Product Approval letter.
2.2 SBS-MODIFIED ASPHALT-SHEET MATERIALS

A. Roofing Membrane Sheet: ASTM D 6163, Grade S, Type I or II, SBS-modified asphalt sheet (reinforced with glass fibers) or ASTM D 6162, Grade S, Type I or II, SBS-modified asphalt sheet (reinforced with a combination of polyester fabric and glass fibers); smooth surfaced; suitable for application method specified.

B. Granule-Surface Roofing Membrane Cap Sheet: ASTM D 6164, Grade G, Type I or II, SBS-modified asphalt sheet (reinforced with polyester fabric) or ASTM D 6162, Grade G, Type I or II, SBS-modified asphalt sheet (reinforced with a combination of polyester fabric and glass fibers); granular surfaced; suitable for application method specified.

1. Granule Color: White, unless otherwise indicated.

2.3 BASE-SHEET MATERIALS

A. Base Sheet: ASTM D 4897/D 4897M, Type II, venting, nonperforated, heavyweight, asphalt-impregnated and -coated, glass-fiber base sheet with coarse granule surfacing or embossed venting channels on bottom surface.

2.4 BASE FLASHING SHEET MATERIALS

A. Granule-Surfaced Flashing Sheet: ASTM D 6164, Grade G, Type I or II, SBS-modified asphalt sheet (reinforced with polyester fabric) or ASTM D 6162, Grade G, Type I or II, SBS-modified asphalt sheet (reinforced with a combination of polyester fabric and glass fibers); granular surfaced; suitable for application method specified, and as follows:


2.5 AUXILIARY ROOFING MEMBRANE MATERIALS

A. General: Auxiliary materials recommended by roofing manufacturer for intended use and compatible with roofing membrane.

B. Asphalt Primer: ASTM D 41.

C. Roofing Asphalt: ASTM D 312, Type III or IV as recommended by roofing manufacturer for application.

D. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required by roofing manufacturer for application.

E. Mastic Sealant: Polyisobutylene, plain or modified bitumen, nonhardening, nonmigrating, nonskinning, and nondrying.

F. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening roofing membrane components to substrate, and acceptable to roofing system manufacturer.

H. Miscellaneous Accessories: Provide those recommended by roofing system manufacturer.

I. One-Way Roof Vents:
   1. Material: Manufacturer’s standard heavy gauge spun aluminum.
   2. Configuration and Size: Manufacturer’s standard.
   3. Installation Rate: Minimum one vent per 10 squares of roofing area.

2.6 ROOF INSULATION

A. Existing lightweight insulating concrete (LWIC) roof insulation system.

B. Cover (protection) board: ASTM C 1177/C 1177M, glass mat, water resistant gypsum substrate, 1/2 inch thick or as required by membrane manufacturer.

2.7 WALKWAYS

A. Walkway Pads: Reinforced asphaltic composition pads with slip-resisting mineral-granule surface manufactured as a traffic pad for foot traffic and acceptable to roofing system manufacturer, 3/8 inch thick, minimum.
   1. Pad Size: Manufacturer’s standard per configurations indicated on Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:
   1. Verify that roof openings and penetrations are in place and curbs are set and braced and that roof drain bodies are securely clamped in place.
   2. Verify that wood cants, blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrate of dust, debris, moisture, 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 **INSULATION INSTALLATION**

A. Cover Boards: Where required per roofing membrane system manufacturer’s recommendations, install specified cover boards over existing lightweight insulating concrete roof insulation system in accordance with roofing membrane system manufacturer’s written instructions.

1. Mechanically fasten cover boards to resist uplift pressure at corners, perimeter, and field of roof.

3.4 **ROOFING MEMBRANE INSTALLATION, GENERAL**

A. Install roofing membrane system according to roofing system manufacturer's written instructions and applicable recommendations in ARMA/NRCA's "Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing."

B. Where roof slope exceeds 1/2 inch per 12 inches, install roofing membrane sheets parallel with slope.

1. Backnail roofing membrane sheets to nailer strips according to roofing system manufacturer's written instructions.

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

D. Coordinate installing roofing system so components of the roofing membrane system not permanently exposed are not subjected to precipitation or left uncovered at the end of the workday or when rain is forecast.

1. Provide tie-offs at end of each day's work to cover exposed roofing membrane sheets with a course of coated felt set in roofing cement or hot roofing asphalt 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.

E. Roofing Asphalt: Apply roofing asphalt according to roofing system manufacturer's written instructions.

F. Substrate-Joint Penetrations: Prevent roofing asphalt from penetrating substrate joints, entering building, or damaging roofing system components or adjacent building construction.

3.5 **BASE-SHEET INSTALLATION**

A. Install lapped base sheet course, extending sheet over and terminating beyond cants. Attach base sheet as follows:

1. Mechanically fasten to substrate.
3.6 MODIFIED BITUMINOUS MEMBRANE INSTALLATION

A. Install modified bituminous roofing membrane sheet and cap sheet according to roofing manufacturer's written instructions, starting at low point of roofing system. Extend roofing membrane sheets over and terminate beyond cants.

1. Adhere to substrate in a solid mopping of hot roofing asphalt applied at not less than 425 deg F.

2. Unroll roofing membrane sheets and allow them to relax for minimum time period required by manufacturer.

B. Laps: Accurately align roofing membrane sheets, without stretching, and maintain uniform side and end laps. Stagger end laps. Completely bond and seal laps, leaving no voids.

1. Repair tears and voids in laps and lapped seams not completely sealed.

2. Apply roofing granules to cover exuded bead at laps while bead is hot.

C. Install roofing membrane sheets so side and end laps shed water.

D. Adhere in a solid mopping of hot roof asphalt.

3.7 FLASHING AND STRIPPING INSTALLATION

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

1. Prime substrates with asphalt primer if required by roofing system manufacturer.

2. Backer Sheet Application: Mechanically fasten backer sheet to walls or parapets. Adhere backer sheet over roofing membrane at cants in a solid mopping of hot roofing asphalt.

3. Flashing Sheet Application: Adhere flashing sheet to substrate in a solid mopping of hot roofing asphalt applied at not less than 425 deg F. Apply hot roofing asphalt to back of flashing sheet if recommended by roofing system manufacturer.

B. Extend base flashing up walls or parapets a minimum of 8 inches above roofing membrane and 4 inches onto field of roofing membrane.

C. Mechanically fasten top of base flashing securely at terminations and perimeter of roofing.


D. Install roofing membrane cap-sheet stripping where metal flanges and edgings are set on membrane roofing according to roofing system manufacturer's written instructions.

E. Roof Drains: Set 30-by-30-inch metal flashing in bed of roofing-manufacturer-approved asphaltic adhesive on completed roofing membrane. Cover metal flashing with roofing membrane cap-sheet stripping and extend a minimum of 6 inches beyond edge of metal flashing.
onto field of roofing membrane. Clamp roofing membrane, metal flashing, and stripping into roof-drain clamping ring.

1. Install stripping according to roofing system manufacturer's written instructions.

F. One-Way Roof Vents: Install per manufacturer’s written instructions.

3.8 WALKWAY INSTALLATION

A. Walkway Pads: Install specified walkway pads according to walkway pad manufacturer’s written instructions.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to inspect substrate conditions, surface preparation, membrane application, flashings, protection, and drainage components, and to furnish reports to Architect.

1. Electric Field Vector Mapping (EFVM): Testing agency shall survey entire roof area for potential leaks using electric field vector mapping (EFVM).

B. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.

1. Notify Architect and Owner 48 hours in advance of date and time of inspection.

C. Roofing system will be considered defective if it does not pass tests and inspections.

1. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.10 PROTECTING AND CLEANING

A. Protect roofing system from damage and wear during remainder of construction period. 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 roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

3.11 CONSTRUCTION WASTE MANAGEMENT

A. Comply with the Waste Management Plan specified in Section 017419 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL for additional requirements.

END OF SECTION 075216

DAYTONA STATE COLLEGE
FOR MEN AND WOMEN

STYRENE-BUTADIENE-STYRENE (SBS) MODIFIED BITUMINOUS MEMBRANE ROOFING

075216 - 8
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes the following manufactured products:

1. Roof-edge drainage systems.
2. Roof-edge flashings.
3. Reglets and counterflashings.
4. Underlayment materials.
5. Insulated metal cap.

B. Related Sections:

1. Section 061000 “Rough Carpentry" for wood nailers and blocking.
2. 070150.19 “Preparation For Reroofing” for removal requirements for existing metal gutters and downspouts and roof-edge flashings.

1.3 PERFORMANCE REQUIREMENTS

A. General: Roof specialties as indicated shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed roof specialties shall not rattle, leak, or loosen, and shall remain watertight.

B. Delegated Design: Engage a qualified registered Professional Engineer, as defined in Section 014000 “Quality Requirements”, to design exterior manufactured roof specialties.

C. Structural Loads:

1. Wind Loads: Unless criteria is otherwise indicated on Drawings, establish criteria for the following for the Project location and design in accordance with 2017 Florida Building Code (FBC) and ASCE 7-10 requirements for Components and Cladding:

   a. Ultimate wind speed (3-second gust).
   b. Nominal wind speed (3-second gust).
   c. Wind exposure.
d. Wind pressures.

2. Miami Dade Acceptance or Florida Product Approval: Provide roof specialties for the building exterior having a Notice of Acceptance (NOA) letter from the Miami Dade County Building Code Compliance Office (BCCO) or Florida Product Approval letter.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of thermal movements. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: Show fabrication and installation layouts of roof specialties, including plans, elevations, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled work. Include project-specific information for the following:

1. Identification of material, thickness, weight, and finish for each item and location in Project.
2. Details for forming roof specialties, including profiles, shapes, seams, and dimensions.
3. Details for joining, supporting, and securing roof specialties, including layout of fasteners, cleats, clips, and other attachments. Include pattern of seams.
4. Details of termination points and assemblies, including fixed points.
5. Details of edge conditions, including eaves and counterflashings as applicable.
6. Details of special conditions.
7. Details of connections to adjoining work.
8. Detail formed flashing and trim at a scale of not less than 3 inches per 12 inches.
9. Details of gutter attachment to existing downspouts.

C. Delegated-Design Submittal: For all exterior manufactured roof specialties indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified registered Professional Engineer responsible for their preparation.

1. Detail securing exterior manufactured roof specialties items to building structure. Indicate coordinating requirements with roofing system.
2. Wind-Restraint Details: Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.

D. Miami Dade Acceptance or Florida Product Approval: Submit documentation for Notice of Acceptance (NOA) from the Miami Dada County Building Code Compliance Office (BCCO), or Florida Product Approval. Each NOA or Florida Product Approval letter shall show the product name, product description and valid NOA or Florida Product Approval number with expiration date.
E. Samples for Verification: For roof specialties made from 12-inch lengths of full-size components including fasteners, cover joints, accessories, and attachments.

F. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for roof specialties.

G. Maintenance Data: For roof specialties to include in maintenance manuals.

H. Warranty: Sample of special warranty.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Do not store roof specialties in contact with other materials that might cause staining, denting, or other surface damage. Store roof specialties away from uncured concrete and masonry.

B. Protect strippable protective covering on roof specialties from exposure to sunlight and high humidity, except to extent necessary for the period of roof specialties installation.

1.6 WARRANTY

A. Special Warranty on Factory-Finishes: Manufacturer agrees to repair finish or replace roof specialties that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:

   a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
   b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
   c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

B. Finish Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 EXPOSED METALS

A. Aluminum Sheet: ASTM B 209, alloy as standard with manufacturer for finish required, with temper to suit forming operations and performance required.

   1. Surface: Smooth, flat finish.
   2. Finish: Two-coat fluoropolymer.

2.2 CONCEALED METALS

A. Manufacturer’s standard corrosion-resistant metal compatible with specified exposed metals.
2.3 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.

B. Fasteners: Non-magnetic stainless-steel, corrosion-resistant, nonstaining, nonbleeding fasteners, compatible with adjacent materials, suitable for application and designed to meet performance requirements.

C. Elastomeric Sealant: ASTM C 920, elastomeric silicone polymer sealant of type, grade, class, and use classifications required by roofing-specialty manufacturer for each application.

D. Bituminous Paint: Cold-applied asphalt-mastic paint containing no asbestos, formulated for 30-mil thickness per coat.


F. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

2.4 UNDERLAYMENT MATERIALS

A. Self-Adhering, High-Temperature Underlayment Sheet: Minimum 30 mils thick, consisting of a slip-resistant polyethylene- or polypropylene-film top surface laminated to a layer of butyl- or SBS-modified asphalt adhesive, with release-paper backing; specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer according to written recommendations of underlayment manufacturer.

2. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F or lower.

2.5 INSULATED METAL CAP

A. Provide insulated metal cap in sizes and configurations indicated, consisting of the following materials:

1. Aluminum Sheet: Formed metal cap, minimum 0.050 inch thick.
2. Polyisocyanurate Board Insulation: Minimum 1-1/2 inches thick, unless otherwise indicated. ASTM C1289, Type II, Class 1, Grade 3, glass-fiber mat facer on both major surfaces; compressive strength, 25 psi.
4. Fasteners: Stainless-steel, of sizes and quantities as required to meet specified performance requirements; securely fastened to existing roof curb wood nailers.
2.6 ROOF-EDGE DRAINAGE SYSTEMS

A. Gutters: Manufactured in uniform section lengths not exceeding 12 feet, unless otherwise indicated or required to match existing, with matching corner units, ends, outlet tubes, and other accessories. Elevate back edge at least 1 inch above front edge, unless otherwise indicated or required to match existing. Furnish gutter straps, gutter brackets, expansion joints, and expansion-joint covers fabricated from same metal as gutters.

1. Aluminum Sheet: Formed, minimum 0.050 inch thick.
2. Gutter Profile: Match size and configuration as indicated.
4. Gutter Supports: Gutter brackets and straps as indicated with finish matching the gutters.
5. Gutter Accessories: Stainless steel wire ball downspout strainer.

B. Downspouts: Match size and configuration as indicated. Manufactured downspouts with smooth-curve elbows from the following exposed metal. Furnish with metal hangers, from same material as downspouts, and corrosion-resistant anchors.

1. Aluminum Sheet: Formed, minimum 0.050 inch thick.

2.7 REGLETS AND COUNTERFLASHINGS

A. Reglet System: Manufactured units formed to provide secure interlocking of separate reglet and counterflashing pieces.

1. Aluminum Sheet: Formed, minimum 0.050 inch thick.
2. Corners: Factory mitered and mechanically clinched and sealed watertight.
3. Stucco Type, Embedded: Provide reglets with upturned fastening flange and extension leg of length to match thickness of applied finish materials.
4. Surface-Mounted Type: Provide reglets with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.

B. Counterflashings: Manufactured units of heights to overlap top edges of base flashings by 4 inches and in lengths not exceeding 12 feet designed to snap into reglets and compress against base flashings with joints lapped, from the following exposed metal:

1. Aluminum Sheet: Formed, minimum 0.032 inch thick.

C. Accessories:

1. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where reglet is provided separate from metal counterflashing.
2. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing lower edge.
2.8 ROOF-EDGE FLASHINGS

A. Drip Edge/Fascia System: Manufactured drip edge/fascia system in sizes and configurations indicated on the Drawings in section lengths not exceeding 12 feet. Provide matching corner units.

1. Aluminum Sheet: Formed, minimum 0.050 inch thick.
2. Face leg hooked to continuous cleat.
4. Splice Plates: Concealed, of same material, finish and shape as fascia cover.

2.9 GENERAL FINISH REQUIREMENTS

A. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Coil-Coated Aluminum Sheet Finishes:

1. High-Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   a. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   b. Color: As selected by Architect, unless otherwise indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.

B. Examine walls, roof edges, and parapets for suitable conditions for roof specialties.

C. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 UNDERLAYMENT INSTALLATION

A. Self-Adhering High-Temperature Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Cover underlayment within 14 days.
1. Apply continuously under roof-edge flashings, and elsewhere as indicated.
2. Coordinate application of self-adhering sheet underlayment under roof specialties with requirements for continuity with adjacent air barrier materials.

3.3 INSTALLATION, GENERAL

A. General: Install roof specialties according to manufacturer's written instructions and to delegated-design criteria in conformance with specified performance requirements. Anchor roof specialties securely in place, with provisions for thermal and structural movement. Use fasteners, protective coatings, separators, sealants, and other miscellaneous items as required for complete installation of roof specialties.

1. Install roof specialties level, plumb, true to line and elevation; with limited oil-canning and without warping, jogs in alignment, buckling, or tool marks.
2. Provide uniform, neat seams with minimum exposure of sealant.
3. Install roof specialties to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before manufacture.
4. Torch cutting of roof specialties is not permitted.
5. Do not use graphite pencils to mark metal surfaces.

B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.

1. Coat concealed side of uncoated aluminum roof specialties with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
2. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof specialties for waterproof performance.


1. Space movement joints at a maximum of 12 feet with no joints within 18 inches of corners or intersections unless otherwise shown on Drawings.
2. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures.

D. Fasteners: Install in accordance with manufacturer's written instructions and with specified performance requirements criteria.

E. Seal joints as required for watertight construction. Place sealant to be completely concealed in joint. Do not install sealants at temperatures below 40 deg F.

3.4 ROOF-EDGE DRAINAGE-SYSTEM INSTALLATION

A. General: Install components to produce a complete roof-edge drainage system according to manufacturer's written instructions and to specified performance requirements criteria. Coordinate installation of roof-edge flashings with installation of roof-edge drainage system.
B. Gutters and Downspouts: Connect new gutters and new downspouts as indicated according to manufacturer’s written instructions and to specified performance requirements criteria.

3.5 REGLET AND COUNTERFLASHING INSTALLATION

A. General: Coordinate installation of reglets and counterflashings with installation of base flashings.

B. Counterflashings: Insert counterflashings into reglets or other indicated receivers; ensure that counterflashings overlap 4 inches over top edge of base flashings. Lap counterflushing joints a minimum of 4 inches and bed with elastomeric sealant. Fit counterflashings tightly to base flashings.

3.6 ROOF-EDGE FLASHING INSTALLATION

A. Install cleats, cants, and other anchoring and attachment accessories and devices with concealed fasteners.

B. Anchor roof edgings with manufacturer’s required devices, fasteners and fastener spacing to meet performance requirements.

3.7 CLEANING AND PROTECTION

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean and neutralize flux materials. Clean off excess sealants.

C. Remove temporary protective coverings and strippable films as roof specialties are installed. On completion of installation, clean finished surfaces including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain roof specialties in a clean condition during construction.

D. Replace roof specialties that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

3.8 CONSTRUCTION WASTE MANAGEMENT

A. Comply with the Waste Management Plan specified in Section 017419 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL for additional requirements.

END OF SECTION 077100
SECTION 077200
ROOF ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Roof curbs.

B. Related Sections:
   1. Division 06 Section “Rough Carpentry” for wood nailers, curbs, and blocking.
   2. Division 07 Section “Sheet Metal Flashing and Trim” for formed and manufactured products.

1.3 COORDINATION

A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.

B. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

1.4 SUBMITTALS

A. Product Data: For each type of roof accessory indicated.

B. Shop Drawings: Show fabrication and installation details for roof accessories.
   1. Include plans, elevations, keyed details, and attachments to other work. Indicate dimensions, loadings, and special conditions. Distinguish between plant- and field-assembled work.

C. Delegated-Design Submittal: Submit calculations and engineering analysis signed and sealed by a qualified registered Professional Engineer for design loading and anchorage of roof accessories indicating compliance with specific performance requirements.
1. Detail mounting, securing, and flashing of roof-mounted items to roof structure. Indicate coordinating requirements with roof membrane system.

2. Wind-Restraint Details: Detail fabrication and attachment of wind restraints. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.

D. Coordination Drawings: Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items. Show the following:

1. Size and location of roof accessories specified in this Section.
2. Method of attaching roof accessories to roof or building structure.
3. Other roof-mounted items including mechanical and electrical equipment, ductwork, piping, and conduit.
4. Required clearances.

E. Sample Warranties: For manufacturer's special warranties.

F. Operation and Maintenance Data: For roof accessories to include in operation and maintenance manuals.

1.5 PERFORMANCE REQUIREMENTS

A. General: Roof accessories shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

B. Delegated Design: Design roof accessories to meet wind load criteria indicated on the Structural drawings in accordance with the Florida Building Code (FBC) and ASCE 7 requirements for Components and Cladding.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers listed in other Part 2 articles.

2.2 METAL MATERIALS

A. Aluminum Sheet: ASTM B 209, alloy and temper recommended by manufacturer for type of use and mill finish.

B. Wire Rope and Fittings:

1. Stainless Steel Wire Rope: Wire rope made from wire complying with ASTM A 492, Type 316. Size and configurations as required to suit conditioners.
2. Wire-Rope Fittings: Connectors of types indicated, and as required to suit conditions, fabricated from stainless steel, and with capability to sustain, without failure, a load equal to minimum breaking strength of wire rope with which they are used.

2.3 ROOF CURBS

A. Roof Curbs: Provide metal roof curbs, internally reinforced and capable of supporting superimposed live and dead loads, including equipment loads and other construction to be supported on roof curbs. Fabricate with welded or sealed mechanical corner joints, with integral formed mounting flange at perimeter bottom. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

1. Manufacturers:
   a. Custom Curb, Inc.
   b. Pate Company (The).
   c. ThyCurb; Div. of Thybar Corporation.

2. Load Requirements: See paragraph entitled “Performance Requirements.”
3. Material: Aluminum sheet, minimum 0.090 inch thick.
   a. Finish: Mill.

4. Liner: Same material as curb, of manufacturer's standard thickness and finish.
5. Factory install wood nailers at tops of curbs.
6. Factory insulate curbs with 1-1/2-inch thick, glass-fiber board insulation.
7. Curb shall be supported by roof structure as indicated with a minimum clear height of 12 inches above finish roof membrane unless otherwise indicated or required.
8. Curb-Mounted Pipe Portal: Weathertight curb cover with single or multiple collared openings and pressure-sealed conically shaped EPDM protective rubber caps sized for piping indicated, with stainless-steel snaplock swivel clamps.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install roof accessories according to manufacturer's written instructions. Anchor roof accessories securely in place and capable of resisting forces specified. Use stainless steel fasteners, separators, sealants, and other miscellaneous items as required for completing roof accessory installation. Install roof accessories to resist exposure to weather without failing, rattling, leaking, and fastener disengagement.

B. Install roof accessories to fit substrates and to result in watertight performance.

C. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
1. Coat concealed side of uncoated aluminum roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.

D. Install roof accessories level, plumb, true to line and elevation, and without warping, jogs in alignment, excessive oil canning, buckling, or tool marks.

E. Seal joints with sealant as required by manufacturer of roof accessories.

3.2 CONSTRUCTION WASTE MANAGEMENT

A. Comply with the Waste Management Plan specified in Section 017419 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL for additional requirements.
SECTION 078413

FIRESTOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Penetrations in fire-resistance-rated walls, horizontal assemblies and/or in smoke barriers.
   2. Joints in or between fire-resistance-rated constructions, at exterior curtain-wall/floor intersections, and/or in smoke barriers.
   3. Fire containment insulation.

1.3 SUBMITTALS

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

B. Product Schedule: For each type of penetration firestopping and/or fire-resistive joint systems. Include location, illustration of firestopping system, and design designation of qualified testing and inspecting agency.

   1. Engineering Judgements: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular firestopping system, submit illustration, with modification marked, approved by firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly. Obtain written approval of authorities having jurisdiction prior to submittal.

C. Qualification Data: For qualified Installer.

D. Installer Certificates: From Installer indicating firestopping has been installed in compliance with requirements and manufacturer's written recommendations.

E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for firestopping.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: A firm experienced in installing firestopping similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction
with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its firestopping products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

B. Fire-Test-Response Characteristics: Penetration firestopping shall comply with the following requirements:

1. Firestopping tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.
2. Firestopping is identical to those tested per testing standards specified. Provide rated systems complying with the following requirements:
   a. Firestopping products bear classification marking of qualified testing and inspecting agency.
   b. Classification markings on firestopping correspond to designations listed by the following:
      1) UL in its "Fire Resistance Directory."
      2) FM Global in its "Building Materials Approval Guide."

1.5 PROJECT CONDITIONS

A. Environmental Limitations: Do not install firestopping when ambient or substrate temperatures are outside limits permitted by firestopping manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.

B. Install and cure firestopping per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.6 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that firestopping is installed according to specified requirements.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate firestopping.

C. Notify Owner's testing agency at least seven days in advance of firestopping installations; confirm dates and times on day preceding each series of installations.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide firestopping that is produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-
resistance rating of construction penetrated and/or assemblies in or between which fire-resistant joint systems are installed.

1. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of the assembly.
2. T-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.

B. Accessories: Provide components for each firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by firestopping manufacturer and approved by qualified testing and inspecting agency for firestopping indicated.

1. Permanent forming/damming/backing materials, including the following:
   a. Slag-wool-fiber or rock-wool-fiber insulation.
   b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
   c. Fire-rated form board.
   d. Fillers for sealants.
2. Temporary forming materials.
5. Steel sleeves.

2.2 PENETRATION FIRESTOPPING

A. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

1. Penetrations in Fire-Resistance-Rated Walls: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.
2. Penetrations in Horizontal Assemblies: Provide firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.
3. W-Rating: Provide firestopping showing no evidence of water leakage when tested according to UL 1479.
4. Exposed Penetration Firestopping: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

B. Penetration Fill Materials

1. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.
2. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.
3. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.


5. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.


7. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.

8. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.

9. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

10. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:

   a. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces, and nonsag formulation for openings in vertical and sloped surfaces, unless indicated firestopping limits use of nonsag grade for both opening conditions.

2.3 FIRE-RESISTIVE JOINT SYSTEMS

A. Fire-resistive joint systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.

B. Joints in or between Fire-Resistance-Rated Construction: Provide fire-resistive joint systems with ratings determined per ASTM E 1966 or UL 2079:

C. Exposed Fire-Resistive Joint Systems: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

D. Firestopping Material or Fire Containment Insulation: ASTM C 665, Type I (without membrane facing); consisting of rock- or slag-wool-fibers; with maximum flame-spread and smoke-developed indexes of 0 and 0, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics. Provide Type II, Class A, dark-faced were indicated.

2.4 SMOKE BARRIERS

A. Penetrations in Smoke Barriers: Provide firestopping with ratings determined per UL 1479.

   1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of opening at 0.30-inch wg at both ambient and elevated temperatures.
B. Joints in Smoke Barriers: Provide fire-resistive joint systems with ratings determined per UL 2079.

1. L-Rating: Not exceeding 5.0 cfm/ft of joint at 0.30 inch wg at both ambient and elevated temperatures.

2.5 MIXING

A. For those products requiring mixing before application, comply with firestopping manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

2.6 IDENTIFICATION

A. Preprinted metal or plastic labels that can be permanently attached to surfaces of rated partitions. Provide either placards with mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Identification shall include the following information:

1. The following message or as directed by authority having jurisdiction
   a. "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS"

2. Penetrations and joint identification shall include:
   a. Contractor's name, address, and phone number.
   b. Designation of applicable testing and inspecting agency.
   c. Date of installation.
   d. Manufacturer's name.
   e. Installer's name.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 PREPARATION

A. Surface Cleaning: Clean out openings immediately before installing firestopping to comply with manufacturer's written instructions and with the following requirements:

1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of firestopping.
2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with firestopping. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Priming: Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent firestopping from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing firestopping's seal with substrates.

3.3 INSTALLATION

A. General: Install firestopping to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestopping.

C. Install fill materials for firestopping by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

D. Fire Containment Insulation: Install at curtain wall systems and other locations as indicated on Drawings.
3.4 IDENTIFICATION

A. Attach labels permanently to surfaces at the following locations unless otherwise directed by the authority having jurisdiction

1. Rated Walls or Partitions:
   a. Be located in accessible concealed floor, floor-ceiling or attic spaces.
   b. Be repeated at intervals not exceeding 30 feet measured horizontally along the wall or partition

2. Penetrations or Joints: Adjacent to and within 6 inches of firestopping edge so labels will be visible to anyone seeking to remove penetrating items or firestopping.

3.5 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform tests and inspections.

B. Where deficiencies are found or firestopping is damaged or removed because of testing, repair or replace firestopping to comply with requirements.

C. Proceed with enclosing firestopping with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTION

A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by firestopping manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure that firestopping is without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated firestopping and install new materials to produce systems complying with specified requirements.

3.7 CONSTRUCTION WASTE MANAGEMENT

A. Comply with the Waste Management Plan specified in Section 017419 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL for additional requirements.

END OF SECTION 078413
SECTION 079200
JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Nonstaining silicone joint sealants.
2. Mildew-resistant joint sealants.

1.2 PREINSTALLATION MEETINGS

1.3 ACTION SUBMITTALS

A. Product Data: For each joint-sealant product.
B. Samples: For each kind and color of joint sealant required.
C. Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.

1.4 INFORMATIONAL SUBMITTALS

A. Sample warranties.

1.5 QUALITY ASSURANCE

1.6 PRECONSTRUCTION TESTING

1.7 WARRANTY

A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.
B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

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

PART 2 - PRODUCTS

2.1 NONSTAINING SILICONE JOINT SEALANTS

A. Nonstaining Joint Sealants: No staining of substrates when tested according to ASTM C 1248.

B. Silicone, Nonstaining, S, NS, 100/50, NT: Nonstaining, single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 100/50, Use NT.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   b. Pecora Corporation.
   c. Sika Corporation; Joint Sealants.
   d. Tremco Incorporated.

C. Silicone, Nonstaining, S, NS, 100/50, T, NT: Nonstaining, single-component, nonsag, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 100/50, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. The Dow Chemical Company.

2.2 MILDEW-RESISTANT JOINT SEALANTS

A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.

B. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   b. Pecora Corporation.
c. Sherwin-Williams Company (The).
d. Tremco Incorporated.

2.3 JOINT-SEALANT BACKING

A. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

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

a. Adfast.
b. Alcot Plastics Ltd.
c. BASF Corporation.
d. Construction Foam Products; a division of Nomaco, Inc.

B. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer.

2.4 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove laitance and form-release agents from concrete.
2. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience.
C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces.

3.2 INSTALLATION OF JOINT SEALANTS

A. General: Comply with ASTM C 1193 and joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

C. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

D. Install sealants using proven techniques that comply with the following and at the same time backings are installed:

   1. Place sealants so they directly contact and fully wet joint substrates.
   2. Completely fill recesses in each joint configuration.
   3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

E. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants to form smooth, uniform beads of configuration indicated. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.

   1. Provide concave joint profile per Figure 8A in ASTM C 1193 unless otherwise indicated.

3.3 JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Interior joints in horizontal traffic surfaces <JS-#>.

   1. Joint Locations:

      a. Control and expansion joints in tile flooring.
      b. .

   2. Joint Sealant: Silicone, S, NS, 100/50, T.

   3. Joint-Sealant Color: Match or complement adjacent surfaces as approved by the Architect from manufacturer's full range of colors.


   1. Joint Locations:
a. Tile control and expansion joints.
b. Vertical joints on exposed surfaces of walls and partitions.
c. 

2. Joint Sealant: Silicone, S, NS, 100/50, NT.
3. Joint-Sealant Color: Match or complement adjacent surfaces as approved by the Architect from manufacturer's full range of colors.

C. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces <JS-#>.

1. Joint Locations:
   a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
   b. Tile control and expansion joints where indicated.
   c. 

3. Joint-Sealant Color: Match or complement adjacent surfaces as approved by the Architect from manufacturer's full range of colors.

END OF SECTION 079200
SECTION 079219 - ACOUSTICAL JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY
   A. Section includes acoustical joint sealants.

1.2 ACTION SUBMITTALS
   A. Product Data: For each acoustical joint sealant.
   B. Samples: For each kind and color of acoustical joint sealant required.
   C. Acoustical-Joint-Sealant Schedule: Include the following information:
      1. Joint-sealant application, joint location, and designation.
      2. Joint-sealant manufacturer and product name.

1.3 INFORMATIONAL SUBMITTALS
   A. Sample warranties.

1.4 WARRANTY
   A. Special Installer's Warranty: Installer agrees to repair or replace acoustical joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
      1. Warranty Period: [Two] Five years from date of Substantial Completion.
   B. Special Manufacturer's Warranty: Manufacturer agrees to furnish acoustical joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
      1. Warranty Period: Twenty years from date of Substantial Completion.
PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Provide acoustical joint-sealant products that effectively reduce airborne sound transmission through perimeter joints and openings in building construction, as demonstrated by testing representative assemblies according to ASTM E 90.

2.2 ACOUSTICAL JOINT SEALANTS

A. Acoustical Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex acoustical sealant complying with ASTM C 834.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Hilti, Inc.
   b. Pecora Corporation.
   c. Tremco Incorporated.
   d. USG Corporation.

2. Colors of Exposed Acoustical Joint Sealants: As selected by Architect from manufacturer's full range of colors.

B. Primer: Material recommended by acoustical-joint-sealant manufacturer where required for adhesion of sealant to joint substrates.

C. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials.

D. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing acoustical joint sealants to comply with joint-sealant manufacturer's written instructions.

B. Joint Priming: Prime joint substrates where recommended by acoustical-joint-sealant manufacturer.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces.
3.2 INSTALLATION OF ACOUSTICAL JOINT SEALANTS

A. Comply with acoustical joint-sealant manufacturer's written installation instructions unless more stringent requirements apply.

B. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical joint sealant. Install acoustical joint sealants at both faces of partitions, at perimeters, and through penetrations. Comply with ASTM C 919, ASTM C 1193, and manufacturer's written recommendations for closing off sound-flanking paths around or through assemblies, including sealing partitions to underside of floor slabs above acoustical ceilings.

C. Acoustical Ceiling Areas: Apply acoustical joint sealant at perimeter edge moldings of acoustical ceiling areas in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.

END OF SECTION 079219
PART 1 - GENERAL

1.1 SUMMARY

A. Section includes acoustical joint sealants.

1.2 ACTION SUBMITTALS

A. Product Data: For each acoustical joint sealant.

B. Samples: For each kind and color of acoustical joint sealant required.

C. Acoustical-Joint-Sealant Schedule: Include the following information:
   1. Joint-sealant application, joint location, and designation.
   2. Joint-sealant manufacturer and product name.

1.3 INFORMATIONAL SUBMITTALS

A. Sample warranties.

1.4 WARRANTY

A. Special Installer's Warranty: Installer agrees to repair or replace acoustical joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer agrees to furnish acoustical joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
   1. Warranty Period: Twenty years from date of Substantial Completion.
PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Provide acoustical joint-sealant products that effectively reduce airborne sound transmission through perimeter joints and openings in building construction, as demonstrated by testing representative assemblies according to ASTM E 90.

2.2 ACOUSTICAL JOINT SEALANTS

A. Acoustical Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex acoustical sealant complying with ASTM C 834.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Hilti, Inc.
   b. Pecora Corporation.
   c. Tremco Incorporated.
   d. USG Corporation.

2. Colors of Exposed Acoustical Joint Sealants: As selected by Architect from manufacturer's full range of colors.

B. Primer: Material recommended by acoustical-joint-sealant manufacturer where required for adhesion of sealant to joint substrates.

C. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials.

D. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing acoustical joint sealants to comply with joint-sealant manufacturer's written instructions.

B. Joint Priming: Prime joint substrates where recommended by acoustical-joint-sealant manufacturer.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces.
3.2 INSTALLATION OF ACOUSTICAL JOINT SEALANTS

A. Comply with acoustical joint-sealant manufacturer's written installation instructions unless more stringent requirements apply.

B. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical joint sealant. Install acoustical joint sealants at both faces of partitions, at perimeters, and through penetrations. Comply with ASTM C 919, ASTM C 1193, and manufacturer's written recommendations for closing off sound-flanking paths around or through assemblies, including sealing partitions to underside of floor slabs above acoustical ceilings.

C. Acoustical Ceiling Areas: Apply acoustical joint sealant at perimeter edge moldings of acoustical ceiling areas in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.

END OF SECTION 079219
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Standard hollow metal doors and frames.
   2. Sound control doors and window assemblies.

B. Related Sections:
   1. Division 04 Section "Unit Masonry" for embedding anchors for hollow metal work into masonry construction.
   2. Division 08 Section "Door Hardware" for door hardware for hollow metal doors.
   3. Division 09 painting Sections for field painting hollow metal doors and frames.

1.3 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings.

B. Standard Hollow Metal Work: Hollow metal work fabricated according to ANSI/SDI A250.8.

1.4 SUBMITTALS

A. General: Group submittals of complementary and related products and materials as needed to represent total assemblies and facilitate concurrent coordination review. Example: Submit doors, door frames and door hardware together. The Architect may withhold action on submittals requiring coordination with other submittals until related submittals are received.

B. Product Data: For each type of product indicated. Include construction details, material descriptions, core descriptions, fire-resistance rating, temperature-rise ratings, and finishes.

C. Shop Drawings: Include the following:
   1. Elevations of each door design.
   2. Details of doors, including vertical and horizontal edge details and metal thicknesses.
   3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
4. Locations of reinforcement and preparations for hardware.
5. Details of each different wall opening condition.
6. Details of anchorages, joints, field splices, and connections.
7. Details of accessories.

D. Schedule: Provide a schedule of hollow metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with door hardware schedule.

E. Oversize Construction Certification: For assemblies required to be fire rated and exceeding limitations of labeled assemblies.

F. Performance Criteria: Submit calculations for design loading and anchorage of exterior steel door and frame assemblies, indicating compliance with wind load criteria indicated on the Structural drawings in accordance with the Florida Building Code and ASCE 7 requirements for Components and Cladding.

   1. Certificates: Submit written certificate, signed and sealed by a Florida registered Professional Engineer, certifying that design and anchorage of exterior steel door and frame assemblies complies with specified performance criteria.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain hollow metal work from single source from single manufacturer.

B. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing according to NFPA 252.

   1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.

   2. Temperature-Rise Limit: At vertical exit enclosures and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F above ambient after 30 minutes of standard fire-test exposure.

C. Smoke-Control Door Assemblies: Comply with NFPA 105 or UL 1784.

D. Preinstallation Conference: Conduct conference at Project site.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow metal work palletized, wrapped, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.

   1. Provide additional protection to prevent damage to finish of factory-finished units.
B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions. Spread bars to be carefully removed and the frame ground smooth, then primed.

C. Store hollow metal work under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4-inch high wood blocking. Do not store in a manner that traps excess humidity.

1. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.8 COORDINATION

A. Coordinate installation of anchorages for hollow metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 RECYCLED CONTENT OF PRODUCTS

A. Provide products with post-consumer recycled content plus one-half of pre-consumer recycled content to the greatest extent possible.

2.2 PERFORMANCE REQUIREMENTS

A. Sound Rating: Where indicated, provide sound control door and window assemblies identical to those of assemblies tested as sound-retardant units by an acoustical testing agency, and have the following minimum rating:

1. STC Rating: Unless indicated otherwise, provide STC rating of 45 as calculated by ASTM E 413 when tested in an operable condition according to ASTM E 90.

2.3 MANUFACTURERS

A. Basis-of-Design: CECO Doors; an Assa Abloy Company, or comparable products by other manufacturers subject to Architect’s approval.
2.4 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 metallic coating.

D. Frame Anchors: ASTM A 591/A 591M, Commercial Steel (CS), 40Z coating designation; mill phosphatized.
   1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.

E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.

F. Powder-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow metal frames of type indicated.

G. Grout at Masonry Walls Only: ASTM C 476, except with a maximum slump of 4 inches, as measured according to ASTM C 143/C 143M.

H. Glazing: Comply with requirements in Division 08 Section "Glazing."

I. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.5 STANDARD HOLLOW METAL DOORS

A. General: Provide doors of design indicated, minimum 1-3/4 inches thick, unless otherwise indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces unless otherwise indicated. Comply with ANSI/SDI A250.8.
   1. Design: Flush panel, except where otherwise indicated.
   2. Core Construction: Manufacturer's standard kraft-paper honeycomb, polystyrene, polyurethane, polyisocyanurate, mineral-board, or vertical steel-stiffener core.
      a. Fire Door Core: As required to provide fire-protection and temperature-rise ratings indicated.
      b. Thermal-Rated (Insulated) Doors: Where indicated, provide doors fabricated with thermal-resistance value (R-value) of not less than 4.0 deg F x h x sq. ft./Btu when tested according to ASTM C 1363.
         1) Locations: Exterior doors and interior doors where indicated.

5. Top and Bottom Edges: Closed with flush or inverted 0.042-inch thick, end closures or channels of same material as face sheets.

B. Interior Doors: Face sheets fabricated from cold-rolled steel sheet. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:

1. General Use: Level 1 and Physical Performance Level C (Standard Duty), Model 1 (Full Flush); minimum face sheet thickness of 0.032-inch.
2. Where Indicated: Level 3 and Physical Performance Level A (Extra Heavy Duty), Model 1 (full flush); minimum face sheet thickness of 0.053-inch.

C. Exterior Doors: Face sheets fabricated from metallic-coated steel sheet. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:

1. Level 3 and Physical Performance Level A (Extra Heavy Duty), Model 2 (Seamless); minimum face sheet thickness of 0.053-inch.

D. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.
E. Fabricate concealed stiffeners and hardware reinforcement from either cold- or hot-rolled steel sheet.

2.6 STANDARD HOLLOW METAL FRAMES

A. General: Comply with ANSI/SDI A250.8 and with details indicated for type and profile.

B. Interior Frames: Fabricate from uncoated steel sheet.
   1. Fabricate frames with mitered or coped corners.
   2. Fabricate frames as full profile welded.
   3. Frames: 0.0747-inch minimum thickness.

   1. Fabricate frames with mitered or coped corners.
   2. Fabricate frames as full profile welded.
   3. Frames for Level 3 Steel Doors: 0.0747-inch minimum thickness.

D. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcement plates from same material as frames.
2.7 STEEL SOUND CONTROL DOORS AND WINDOW ASSEMBLIES

A. Doors: Flush-design sound control doors, thickness as required to provide specified STC rating, of seamless construction; with manufacturer's standard sound-retardant core as required to provide STC rating indicated. Construct doors with smooth, flush surfaces without visible joints or seams on exposed faces or stile edges. Fabricate according to NAAMM-HMMA 865.

1. Hardware Reinforcement: Same material as face sheets.
2. Finish: Same as standard doors.

B. Frames: Fabricate sound control door and window frames with corners mitered, reinforced, and continuously welded the full depth and width of frame. Fabricate according to NAAMM-HMMA 865.

1. Weld frames according to NAAMM-HMMA 820.
2. Interior Frames: Fabricate from cold-rolled steel sheet, thickness as required to provide specified STC rating.
3. Hardware Reinforcement: Fabricate according to NAAMM-HMMA 865 of same material as face sheets.
4. Finish: Same as standard frames.
5. Glazing for Windows Assemblies: Refer to Section 088000 “Glazing” for sound control, insulating-laminated glass.

2.8 FRAME ANCHORS

A. Jamb Anchors:

1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.042 inch thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.
2. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042 inch thick.
3. Postinstalled Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.

B. Floor Anchors: Formed from same material as frames, not less than 0.042 inch thick, and as follows:

1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.
2. Separate Topping Concrete Slabs: Adjustable-type anchors with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at finish floor surface.

2.9 STOPS AND MOLDINGS

A. Moldings for Glazed Lites in Doors: Minimum 0.032 inch thick, fabricated from same material as door face sheet in which they are installed.
B. Fixed Frame Moldings: Formed integral with hollow metal frames, a minimum of 5/8 inch high unless otherwise indicated.

C. Loose Stops for Glazed Lites in Frames: Minimum 0.032 inch thick, fabricated from same material as frames in which they are installed.

2.10 ACCESSORIES

A. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.

B. Ceiling Struts: Minimum 1/4-inch-thick by 1-inch wide steel.

C. Grout Guards: Formed from same material as frames, not less than 0.016 inch thick.

2.11 FABRICATION

A. Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

B. Tolerances: Fabricate hollow metal work to tolerances indicated in SDI 117.

C. Hollow Metal Doors:

1. Exterior Doors: Provide weep-hole openings in bottom of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.
2. Astragals: Provide overlapping astragal on one leaf of pairs of doors where indicated. Extend minimum 3/4 inch beyond edge of door on which astragal is mounted.

D. Hollow Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.

1. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.
2. Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.
3. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
4. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
5. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
6. Jamb Anchors: Provide number and spacing of anchors as follows:
   a. Masonry Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:
1) Two anchors per jamb up to 60 inches high.
2) Three anchors per jamb from 60 to 90 inches high.
3) Four anchors per jamb from 90 to 120 inches high.
4) Four anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 120 inches high.

b. Stud-Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:

1) Three anchors per jamb up to 60 inches high.
2) Four anchors per jamb from 60 to 90 inches high.
3) Five anchors per jamb from 90 to 96 inches high.
4) Five anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 96 inches high.
5) Two anchors per head for frames above 42 inches wide and mounted in metal-stud partitions.

c. Postinstalled Expansion Type: Locate anchors not more than 6 inches from top and bottom of frame. Space anchors not more than 26 inches o.c.

7. Door Silencers: Except on weather-stripped doors, drill stops to receive door silencers as follows. Keep holes clear during construction.

a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.

b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

E. Fabricate concealed stiffeners, edge channels, and hardware reinforcement from either cold- or hot-rolled steel sheet.

F. Hardware Preparation: Factory prepare hollow metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates furnished as specified in Division 08 Section "Door Hardware."

1. Locate hardware as indicated, or if not indicated, according to ANSI/SDI A250.8.
2. Reinforce doors and frames to receive non templated, mortised and surface-mounted door hardware.
3. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.
4. Coordinate locations of conduit and wiring boxes for electrical connections with Division 26 Sections.

G. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints.

1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow metal work.
2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.
4. Provide loose stops and moldings on inside of hollow metal work.
5. Coordinate rabbet width between fixed and removable stops with type of glazing and type of installation indicated.

2.12 STEEL FINISHES

A. Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.

1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.

C. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.

B. Prior to installation, adjust and securely brace welded hollow metal frames for squareness, alignment, twist, and plumbness to the following tolerances:

1. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
2. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
3. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
4. Plumbness: Plus or minus 1/16 inch, measured at jambs on a perpendicular line from head to floor.

C. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
3.3 INSTALLATION

A. General: Install hollow metal work plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.

B. Hollow Metal Frames: Install hollow metal frames of size and profile indicated. Comply with ANSI/SDI A250.11.

1. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
   a. At fire-protection-rated openings, install frames according to NFPA 80.
   b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
   c. Install frames with removable glazing stops located on secure side of opening.
   d. Install door silencers in frames before grouting.
   e. Remove temporary braces necessary for installation only after frames have been properly set and secured.
   f. Check plumbness, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
   g. Field apply bituminous coating to backs of frames that are filled with grout containing antifreezing agents.

2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.
   a. Floor anchors may be set with powder-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.

3. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.

4. Concrete Walls: Solidly fill space between frames and concrete with grout. Take precautions, including bracing frames, to ensure that frames are not deformed or damaged by grout forces.

5. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.


7. In-Place Gypsum Board Partitions: Secure frames in place with postinstalled expansion anchors through floor anchors at each jamb. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.

8. Ceiling Struts: Extend struts vertically from top of frame at each jamb to overhead structural supports or substrates above frame unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction. Provide adjustable wedged or bolted anchorage to frame jamb members.

9. Installation Tolerances: Adjust hollow metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
10. Installation Tolerances: Adjust hollow metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
   a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
   b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
   c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
   d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.

C. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.
   1. Non-Fire-Rated Standard Steel Doors:
      a. Jambs and Head: 1/8 inch plus or minus 1/16 inch.
      b. Between Edges of Pairs of Doors: 1/8 inch plus or minus 1/16 inch.
      c. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch.
   2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
   3. Smoke-Control Doors: Install doors according to NFPA 105.

D. Glazing: Comply with installation requirements in Division 08 Section "Glazing" and with hollow metal manufacturer's written instructions.
   1. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

3.4 ADJUSTING AND CLEANING
   A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.
   B. Remove grout and other bonding material from hollow metal work immediately after installation.
   C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.
   D. Metallic-Coated Surfaces: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

3.5 CONSTRUCTION WASTE MANAGEMENT
   A. Comply with the Waste Management Plan specified in Section 017419 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL for additional requirements.
SECTION 081216
ALUMINUM FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Re-use of existing interior aluminum frames for doors installed in gypsum board partitions.
2. Interior aluminum frames for glazing installed in gypsum board partitions.

1.2 PREINSTALLATION MEETINGS

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Shop Drawings: For aluminum frames:
   1. Include elevations, sections, and installation details for each wall-opening condition.
C. Samples: For each exposed product and for each color and texture specified.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.2 COMPONENTS

A. Aluminum Framing: ASTM B 221, with alloy and temper required to suit structural and finish requirements, and not less than 0.062 inch thick.
B. Glazing Frames: Extruded aluminum, for indicated glass thickness.
C. Doors: As specified in Section 081416 "Flush Wood Doors."
D. Frame and Trim Finish: Clear-anodized aluminum.
2.3 ACCESSORIES

A. Glass: As specified in Section 088000 "Glazing."

2.4 FABRICATION

A. Provide concealed corner reinforcements and alignment clips for accurately fitted hairline joints at butted and mitered connections.

B. Factory prepare aluminum frames to receive templated mortised hardware; include cutouts, reinforcements, mortising, drilling, and tapping, according to the Door Hardware Schedule and templates furnished as specified in

1. Locate hardware cutouts and reinforcements as required by fire-rated label for assembly.

C. Fabricate frames for glazing with removable stops to allow glazing replacement without dismantling frame.

1. Locate removable stops on the inside of spaces accessed by keyed doors.

D. Fabricate components to allow secure installation without exposed fasteners.

PART 3 - EXECUTION

3.1 EXISTING CONDITIONS

A. Notify Architect in writing of any defects or damage in existing aluminum frames to be reused, before removal and salvage. For items not reported, at no additional cost to the Owner, repair defective or damaged frames to acceptance of the Architect or replace with new aluminum frames as specified.

3.2 INSTALLATION

A. Install aluminum frames plumb, rigid, properly aligned, and securely fastened in place; according to manufacturer's written instructions.

1. At fire-protection-rated openings, install fire-rated frames according to NFPA 80.

B. Install frame components in the longest possible lengths with no piece less than 48 inches; components 96 inches 120 inches or shorter shall be one piece.

C. Glass: Install glass according to Section 088000 "Glazing" and aluminum-frame manufacturer's written instructions.

D. Doors: Install doors aligned with frames and fitted with required hardware.
3.3 ADJUSTING

A. Clean exposed frame surfaces promptly after installation, using cleaning methods recommended in writing by frame manufacturer and according to AAMA 609 and 610.

B. Touch Up: Repair marred frame surfaces to blend inconspicuously with adjacent unrepaired surface so touchup is not visible from a distance of 48 inches as viewed by Architect. Remove and replace frames with damaged finish that cannot be satisfactorily repaired.

END OF SECTION 081216
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Five-ply flush wood veneer-faced doors for transparent finish.
   2. Factory finishing flush wood doors.
   3. Factory fitting flush wood doors to frames and factory machining for hardware.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product, including the following:
   1. Door core materials and construction.
   2. Door edge construction.
   3. Door face type and characteristics.
   4. Door trim for openings.
   5. Factory-machining criteria.

B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each type of door; construction details not covered in Product Data; and the following:
   1. Door schedule indicating door location, type, size, fire protection rating, and swing.
   2. Door elevations, dimension and locations of hardware.
   3. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
   4. Dimensions and locations of blocking for hardware attachment.
   5. Clearances and undercuts.
   6. Requirements for veneer matching.
   7. Apply AWI Quality Certification Program label to Shop Drawings.

C. Samples: For factory-finished doors.

1.3 INFORMATIONAL SUBMITTALS

1.4 CLOSEOUT SUBMITTALS

A. Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.
1.5 QUALITY ASSURANCE

A. Manufacturer's Certification: Licensed participant in AWI's Quality Certification Program.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Rated Wood Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated on Drawings, based on testing at positive pressure in accordance with UL 10C or NFPA 252.

1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.

2.2 FLUSH WOOD DOORS, GENERAL

A. Quality Standard: In addition to requirements specified, comply with "Architectural Woodwork Standards."

2.3 SOLID-CORE, FIVE-PLY FLUSH WOOD VENEER-FACED DOORS FOR TRANSPARENT FINISH

A. Interior Doors:

1. Performance Grade: ANSI/WDMA I.S. 1A Heavy Duty.


3. Faces: Single-ply wood veneer not less than 1/50 inch thick.

   a. Species: Match existing adjacent wood doors at project site, as approved by Architect.
   b. Cut: Quarter sliced.
   c. Match between Veneer Leaves: Book match.
   d. Assembly of Veneer Leaves on Door Faces: Balance match.
   e. Pair and Set Match: Provide for doors hung in same opening.
   f. Room Match: Match door faces within each separate room or area of building. Corridor-door faces do not need to match where they are separated by 10 feet or more.
   g. Room Match: Provide door faces of compatible color and grain within each separate room or area of building.
   h. Blueprint Match: Where indicated, provide doors with faces produced from same flitches as adjacent wood paneling and arranged to provide blueprint match with
wood paneling. Comply with requirements in Section 064216 "Flush Wood Paneling."

4. Exposed Vertical Edges: Same species as faces - Architectural Woodwork Standards edge Type A.
   a. Fire-Rated Single Doors: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed vertical edges.
   b. Fire-Rated Pairs of Doors: Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals. Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.
   c. Mineral-Core Doors: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.
      1) Screw-Holding Capability: 475 lbf in accordance with WDMA T.M. 10.

5. Core for Fire-Rated Doors: As required to achieve fire-protection rating indicated on Drawings.
   a. Blocking for Mineral-Core Doors: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated on Drawings as needed to eliminate through-bolting hardware.

6. Construction: Five plies, hot-pressed bonded (vertical and horizontal edging is bonded to core), with entire unit abrasive planed before veneering.

2.4 FABRICATION

A. Factory fit doors to suit frame-opening sizes indicated.
   1. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
   2. Comply with NFPA 80 requirements for fire-rated doors.

B. Openings: Factory cut and trim openings through doors.
   1. Light Openings: Trim openings with moldings of material and profile indicated.
   2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Section 088000 "Glazing."

2.5 FACTORY FINISHING

A. Comply with referenced quality standard for factory finishing.
1. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
2. Finish faces, all four edges, edges of cutouts, and mortises.
3. Stains and fillers may be omitted on top and bottom edges, edges of cutouts, and mortises.

B. Factory finish doors.

C. Transparent Finish:
   4. Effect: Filled finish.
   5. Sheen: Satin.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Hardware: For installation, see Section 087100 "Door Hardware."

B. Install doors to comply with manufacturer's written instructions and referenced quality standard, and as indicated.

C. Install frames level, plumb, true, and straight.
   1. Shim as required with concealed shims. Install level and plumb to a tolerance of 1/8 inch in 96 inches.
   2. Anchor frames to anchors or blocking built in or directly attached to substrates.
      a. Secure with countersunk, concealed fasteners and blind nailing.
      b. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork.
         1) For factory-finished items, use filler matching finish of items being installed.
   3. Install fire-rated doors and frames in accordance with NFPA 80.
   4. Install smoke- and draft-control doors in accordance with NFPA 105.

D. Job-Fitted Doors:
   1. Align and fit doors in frames with uniform clearances and bevels as indicated below.
      a. Do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors.
3. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.

4. Clearances:
   a. Provide 1/8 inch at heads, jambs, and between pairs of doors.
   b. Provide 1/8 inch from bottom of door to top of decorative floor finish or covering unless otherwise indicated on Drawings.
   c. Where threshold is shown or scheduled, provide 1/4 inch from bottom of door to top of threshold unless otherwise indicated.
   d. Comply with NFPA 80 for fire-rated doors.

5. Bevel non-fire-rated doors 1/8 inch in 2 inches at lock and hinge edges.

6. Bevel fire-rated doors 1/8 inch in 2 inches at lock edge; trim stiles and rails only to extent permitted by labeling agency.

E. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.

F. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

3.2 ADJUSTING

A. Operation: Rehang or replace doors that do not swing or operate freely.

B. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if Work complies with requirements and shows no evidence of repair or refiniishing.

END OF SECTION 081416
PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Aluminum-framed storefront systems.
   2. Aluminum-framed entrance door systems.

1.2 ACTION SUBMITTALS
A. Product Data: For each type of product.
B. Shop Drawings: For aluminum-framed entrances and storefronts. Include plans, elevations, sections, full-size details, and attachments to other work.
   1. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
   2. Include point-to-point wiring diagrams.
C. Entrance Door Hardware Schedule: Prepared by or under supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams.

1.3 QUALITY ASSURANCE
A. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
   1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

1.4 WARRANTY
A. Special Warranty: Manufacturer agrees to repair or replace components of aluminum-framed entrances and storefronts that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Two years from date of Substantial Completion.
B. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of baked-enamel, powder-coat, or organic finishes within specified warranty period.

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

C. Special Finish Warranty, Anodized Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of anodized finishes within specified warranty period.

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed entrances and storefronts representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.

1. Aluminum-framed entrances and storefronts shall withstand movements of supporting structure, including, but not limited to, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
2. Failure also includes the following:
   a. Thermal stresses transferring to building structure.
   b. Glass breakage.
   c. Noise or vibration created by wind and thermal and structural movements.
   d. Loosening or weakening of fasteners, attachments, and other components.
   e. Failure of operating units.

2.2 STOREFRONT SYSTEMS

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

1. EFCO Corporation.
2. Kawneer North America, an Arconic company.
4. YKK AP America Inc.

B. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.

1. Interior Vestibule Framing Construction: Nonthermal.
2. Glazing System: Retained mechanically with gaskets on four sides.
3. Finish: Clear anodic finish.
4. Fabrication Method: Field-fabricated stick system.
5. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
6. Steel Reinforcement: As required by manufacturer.

C. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.

D. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

2.3 ENTRANCE DOOR SYSTEMS

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

1. EFCO Corporation.
2. Kawneer North America, an Arconic company.
4. YKK AP America Inc.

B. Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing or automatic operation.

1. Door Construction: 1-3/4-inch overall thickness, with minimum 0.125-inch-thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.

2. Door Design: Medium stile; 3-1/2-inch nominal width.
   a. Provide nonremovable glazing stops on outside of door.

2.4 ENTRANCE DOOR HARDWARE

A. Entrance Door Hardware: Hardware not specified in this Section is specified in

B. General: Provide entrance door hardware and entrance door hardware sets indicated in door and frame schedule for each entrance door, to comply with requirements in this Section.

1. Entrance Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and named manufacturers' products.
2. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.
3. Opening-Force Requirements:
a. Egress Doors: Not more than 15 lbf to release the latch and not more than 30 lbf to set the door in motion and not more than 15 lbf to open the door to its minimum required width.

b. Accessible Interior Doors: Not more than 5 lbf to fully open door.

C. Designations: Requirements for design, grade, function, finish, quantity, size, and other distinctive qualities of each type of entrance door hardware are indicated in "Entrance Door Hardware Sets" Article. Products are identified by using entrance door hardware designations as follows:

1. Named Manufacturers' Products: Manufacturer and product designation are listed for each door hardware type required for the purpose of establishing minimum requirements. Manufacturers' names are abbreviated in "Entrance Door Hardware Sets" Article.
2. References to BHMA Standards: Provide products complying with these standards and requirements for description, quality, and function.

D. Butt Hinges: BHMA A156.1, Grade 1, radius corner.

1. Nonremovable Pins: Provide setscrew in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while entrance door is closed.
2. Exterior Hinges: Stainless steel, with stainless-steel pin.
3. Quantities:
   a. For doors up to 87 inches high, provide three hinges per leaf.

E. Strikes: Provide strike with black-plastic dust box for each latch or lock bolt; fabricated for aluminum framing.

F. Operating Trim: BHMA A156.6.

G. Closers: BHMA A156.4, Grade 1, with accessories required for a complete installation, sized as required by door size, exposure to weather, and anticipated frequency of use; adjustable to comply with field conditions and requirements for opening force.

H. Door Stops: BHMA A156.16, Grade 1, floor or wall mounted, as appropriate for door location indicated, with integral rubber bumper.

2.5 GLAZING

A. Glazing: Comply with Section 088000 "Glazing."

B. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.

C. Glazing Sealants: As recommended by manufacturer.

2.6 MATERIALS

A. Sheet and Plate: ASTM B209.
2.7 FABRICATION

A. Form or extrude aluminum shapes before finishing.

B. Fabricate components that, when assembled, have the following characteristics:

1. Profiles that are sharp, straight, and free of defects or deformations.
2. Accurately fitted joints with ends coped or mitered.
3. Physical and thermal isolation of glazing from framing members.
4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
5. Provisions for field replacement of glazing from exterior.
6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

C. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.

D. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.

E. Entrance Doors: Reinforce doors as required for installing entrance door hardware.

F. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.

G. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.8 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Comply with manufacturer's written instructions.

B. Do not install damaged components.

C. Fit joints to produce hairline joints free of burrs and distortion.
D. Rigidly secure nonmovement joints.

E. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.

F. Seal perimeter and other joints watertight unless otherwise indicated.

G. Metal Protection:
   1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or by installing nonconductive spacers.
   2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

H. Set continuous sill members and flashing in full sealant bed, as specified in Section 079200 "Joint Sealants," to produce weathertight installation.

I. Install joint filler behind sealant as recommended by sealant manufacturer.

J. Install components plumb and true in alignment with established lines and grades.

3.2 INSTALLATION OF GLAZING

A. Install glazing as specified in Section 088000 "Glazing."

3.3 INSTALLATION OF ALUMINUM-FRAMED ENTRANCE DOORS

A. Install entrance doors to produce smooth operation and tight fit at contact points.
   1. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather stripping.
   2. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door hardware according to entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.

END OF SECTION 084113
SECTION 087100

DOOR HARDWARE

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. Commercial door hardware.

B. Related Sections include the following:

1. Division 08 Section “Hollow Metal Doors and Frames”
2. Division 08 Section “Wood Doors”
3. Division 08 Section “Aluminum Entrances”

C. Products furnished and General Contractor installed, under this Section include the following. Coordinating, purchasing, delivering, and scheduling remain requirements of this Section.

1. Permanent cores and keys.

1.3 SUBMITTALS

A. Product Data: Include construction and installation details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Other Action Submittals:

1. Door Hardware Sets: Prepared by or under the supervision of Architectural Hardware Consultant, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final door hardware sets with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

   a. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule." Double space entries, and number and date each page.

   b. Format: Use same scheduling sequence and format and use same door numbers as in the Contract Documents.
c. Content: Include the following information:
   1) Identification number, location, hand, fire rating and material of each door and frame.
   2) Type, style, function, size, quantity, and finish of each door hardware item
   3) Complete designations of every item required for each door or opening including name and manufacturer.
   4) Fastenings and other pertinent information.
   5) Location of each door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
   6) Explanation of abbreviations, symbols, and codes contained in schedule.
   7) Mounting locations for door hardware.
   8) Door and frame sizes and materials.

d. Submittal Sequence: Submit the final door hardware sets at earliest possible date, particularly where approval of the door hardware sets must precede fabrication of other work that is critical in Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the door hardware sets.

2. Keying Schedule: Prepared by or under the supervision of Architectural Hardware Consultant, detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations.

1.4 QUALITY ASSURANCE

A. Architectural Hardware Consultant Qualifications: A person who is currently certified by DHI as an Architectural Hardware Consultant and who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project.

B. Source Limitations: Obtain each type and variety of door hardware from a single manufacturer, unless otherwise indicated.

C. Electrified Door Hardware: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use. Provide to the greatest extent possible plug connector applications. Furnish wire harnesses for internal transfers and as required for access system final connections up to 15-foot above opening with stripped-end wire termination.

   1. Provide electrified door hardware from same manufacturer as mechanical door hardware, unless otherwise indicated. Manufacturers that perform electrical modifications and that are listed by a testing and inspecting agency acceptable to authorities having jurisdiction are acceptable.

D. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 252 UBC Standard 7-2.

   1. Test Pressure: After 5 minutes into the test, neutral pressure level in furnace shall be established at 40 inches or less above the sill.
2. Comply with self-latching / self-closing procedures and verify exceptions listed are acceptable. Provide additional hardware at no additional cost for compliance.

E. Keying Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." In addition to Owner Contractor, and Architect, conference participants shall also include Architectural Hardware Consultant. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including, but not limited to, the following:

1. Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
2. Preliminary key system schematic diagram.
3. Requirements for key control system.
4. Address for delivery of keys.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.

B. Tag each item or package separately with identification related to the final door hardware sets, and include basic installation instructions, templates, and necessary fasteners with each item or package.

C. Deliver keys and permanent cores to Owner by registered mail or overnight package service.

1.6 COORDINATION

A. Templates: Distribute door hardware templates for doors, frames, and other work specified to be factory prepared for installing door hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Structural failures including excessive deflection, cracking, or breakage.
   b. Faulty operation of operators and door hardware.
   c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

2. Warranty Period: Two years from date of Substantial Completion, except as follows:
a. Mechanical Locksets and Cylinders: Ten years from date of Substantial Completion.
b. Exit Devices: Five years Mechanical.
c. Manual Closers: 10 years from date of Substantial Completion.

1.8 MAINTENANCE SERVICE

A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

A. General: Provide door hardware for each door to comply with requirements in this Section and door hardware sets indicated in Part 3 "Door Hardware Sets" Article.

1. Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and products equivalent in function and comparable in quality to named products from the approved list or otherwise approved by addendum.

B. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in Part 3 "Door Hardware Sets" Article. Products are identified by using door hardware designations, as follows:

1. Named Manufacturers' Products: Manufacturer and product designation are listed for each door hardware type required for the purpose of establishing minimum requirements. Manufacturers' names are abbreviated in Part 3 "Door Hardware Sets" Article.

2.2 HINGES, GENERAL

A. Quantity: Provide the following, unless otherwise indicated:

1. Two Hinges: For doors with heights up to 60 inches.
2. Three Hinges: For doors with heights 61 to 90 inches.
3. Four Hinges: For doors with heights 91 to 120 inches.
4. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.

B. Template Requirements: Except for hinges and pivots to be installed entirely (both leaves) into wood doors and frames, provide only template-produced units.

C. Hinge Weight: Unless otherwise indicated, provide the following:

1. Doors with Closers: Standard-weight hinges.
3. Doors with exit devices: Heavy-weight hinges.
D. Hinge Base Metal: Unless otherwise indicated, provide the following:

1. Exterior Hinges: Stainless Steel.
2. Interior Hinges: Steel, with steel pin.
3. Hinges for Fire-Rated Assemblies: Steel, with steel pin.

E. Hinge Options: Where indicated in door hardware sets or on Drawings:

1. Nonremovable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for out-swinging exterior doors and out-swinging corridor doors with locks.
2. Corners: Square.

F. Fasteners: Comply with the following:

2. Wood Screws: For wood doors and frames.
3. Threaded-to-the-Head Wood Screws: For fire-rated wood doors.
4. Screws: Phillips flat-head; machine screws (drilled and tapped holes) for metal doors, wood screws for wood doors and frames. Finish screw heads to match surface of hinges.

2.3 HINGES

A. Butts and Hinges: BHMA A156.1. Five knuckle design.

B. Template Hinge Dimensions: BHMA A156.7.

C. Available Manufacturers:

1. Bommer Industries. BB5000 Series
2. Hager Companies. BB1100, 1200 Series
3. McKinney Manufacturing. TA Series
4. Stanley Commercial Hardware; FBB Series

2.4 LOCKS AND LATCHES, GENERAL

A. Accessibility Requirements: Where indicated to comply with accessibility requirements, comply with ANSI A117.1. FED-STD-795, "Uniform Federal Accessibility Standards."

1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf.

B. Latches and Locks for Means of Egress Doors: Comply with NFPA 101. Latches shall not require more than 15 lbf to release the latch. Locks shall not require use of a key, tool, or special knowledge for operation.

C. Compliance with Florida Building Codes for Hurricane (NOA) for Exterior Openings.

D. Lock Trim:
1. Levers: Cast
2. Escutcheons: Wrought
3. Lockset Designs: Provide design indicated.

E. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:
   1. Bored Locks: Minimum 1/2-inch (13-mm) latchbolt throw. 3/4-inch (14-mm) at all pairs and as indicated.

F. Backset: 2-3/4 inches, unless otherwise indicated.

G. Strikes: Manufacturer's standard strike with strike box for each latchbolt or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, and as follows:
   1. Strikes for Locks and Latches: BHMA A156.2

2.5 MECHANICAL LOCKS AND LATCHES

A. Lock Functions: Function numbers and descriptions indicated in door hardware sets comply with the following:

B. Bored Locks: BHMA A156.2; Grade 1; Series 4000.
   1. Required Manufacturer:
      a. Schlage Lock; an Allegion Group company. ND Series

2.6 EXIT DEVICES

A. Exit Devices: BHMA A156.3, Grade 1,

B. Exit Devices for Means of Egress Doors: Comply with NFPA 101. Exit devices shall not require more than 15 lb (67 N) to release the latch. Locks shall not require use of a key, tool, or special knowledge for operation.

C. Panic Exit Devices: Listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305.

D. Panic Exit Devices: Listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305. Compliance with Florida Building Codes for Hurricane (NOA) for Exterior Openings.

E. Outside Trim: Pull with Cylinder, Lever with cylinder; material and finish to match locksets, unless otherwise indicated.

F. Through Bolts: For all exit devices and trim, unless otherwise indicated.

G. Acceptable Manufacturers:

2.7 LOCK CYLINDERS

A. Cylinders: Manufacturer's pin tumbler type, constructed from brass or bronze, and complying with the following:
   1. Number of Pins: Six as required.
   2. Mortise Type: Threaded cylinders with rings and straight- or clover-type cam.
   3. Rim Type: Cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.

2.8 KEYING

A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, Appendix A. Incorporate decisions made in keying conference, and as follows:

B. Permanent Cores: Manufacturer's standard; finish face to match lockset; complying with the following:
   1. Removable Cores: Schlage Lock Primus in keyway as directed, removable by use of a special key; for use only with core manufacturer. Coordinate with Owners Representative for type required prior to submittals.

C. Construction Keying: Comply with the following:
   1. Construction Cores: Provide all locks and cylinders with keyed construction cores that are replaceable by permanent cores. Provide 10 construction master keys, 2 construction control keys.

   2. General Contractor, in presence of owner representative, will replace construction cores with permanent cores, confirm locking hardware is operational, and turn over all construction cores and keys to the Hardware Supplier.

2.9 CLOSERS

A. Accessibility Requirements: Where handles, pulls, latches, locks, and other operating devices are indicated to comply with accessibility requirements, comply with ANSI A117.1. FED-STD-795, "Uniform Federal Accessibility Standards."

   1. Comply with the following maximum opening-force requirements:
      a. Interior, Non-Fire-Rated Hinged Doors: 5 lbf applied perpendicular to door.
      b. Fire Doors: 15 lbf Maximum opening force or as allowable by authorities having jurisdiction.

B. Door Closers for Means of Egress Doors: Comply with NFPA 101. Door closers shall not require more than 30 lbf to set door in motion and not more than 5 lbf to open door to minimum required width.
C. Surface Closers: BHMA A156.4, Grade 1 Cast Iron cases, full rack and pinion. Provide type of arm required for closer to be located on non-public side of door, unless otherwise indicated.

D. Through Bolts: For all closers, unless otherwise indicated

   1. Required Manufacturer:
      a. LCN Closer; an Allegion Group company. 4040XP Series

2.10 AUTO OPERATORS:


B. Provide this model of automatic operators only at locations specified in hardware groups. Furnish complete with drop plates, brackets, adapters or extensions for arms as required to suit details. Provide wall-mounted actuator switches by the same manufacturer as the operator for complete functional installation.

   1. Available Manufacturers:
      a. LCN Closers; an Allegion Group company. 4640 Series

2.11 PROTECTIVE TRIM UNITS

A. Size: 2 inches less than door width on push side and 1 inch less than door width on pull side, by height specified in door hardware sets.

B. Fasteners: Manufacturer's oval head Phillips sheet metal screws.

C. Metal Protective Trim Units: BHMA A156.6; beveled all 4 sides; fabricated from the following material:

   1. Material: 0.050-inch- (1.3-mm-) thick stainless steel, unless otherwise indicated.
   2. Available Manufacturers:
      a. Burns Manufacturing Incorporated.
      b. Don-Jo Manufacturing
      c. Hager Companies.
      d. Rockwood Manufacturing Company.
      e. Trimco.

2.12 STOPS AND HOLDERS

A. Stops and Bumpers: BHMA A156.16, Grade 1 unless Grade 2 is indicated.
1. Provide floor stops for doors unless wall or other type stops are scheduled or indicated. Do not mount floor stops where they will impede traffic. Where floor or wall stops are not appropriate, provide overhead holders.

B. Silencers for Metal Door Frames: BHMA A156.16, Grade 1; neoprene or rubber, minimum diameter 1/2 inch; fabricated for drilled-in application to frame.

C. Available Manufacturers:
   1. ABH Manufacturing.
   2. Burns Manufacturing Incorporated.
   3. Don-Jo Manufacturing
   4. Door Controls International.
   5. Hiawatha, Inc.
   7. Trimco.

2.13 FLUSH BOLTS

A. Automatic and Self-Latching Flush Bolts: BHMA A156.3, Grade 1 designed for mortising into door edge. Provide type required by UL listing.

B. Manual-Extension Flush Bolts: BHMA A156.16, Grade 1, fabricated from extruded brass or bronze, with 12-inch (305-mm) rod actuated by flat lever; listed and labeled for fire-rated doors. Provide with matching dustproof strike.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Burns Manufacturing Incorporated.
   b. Door Controls International, Inc.
   c. Hager Companies.
   d. Rockwood Manufacturing Company.
   e. Trimco.

2.14 DOOR GASKETING

A. Standard: BHMA A156.22.

B. General: Provide smoke, light, or sound gasketing on interior doors where indicated or scheduled. Provide noncorrosive fasteners as indicated.

   1. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
   2. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

C. Air Leakage: Not to exceed 0.50 cfm per foot of crack length for gasketing other than for smoke control, as tested according to ASTM E 283.
D. Fire-Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 252.

E. Smoke-Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke-control ratings indicated, based on testing according to UL 1784.

1. Provide smoke-labeled gasketing on 20-minute-rated doors and on smoke-labeled doors.
2. Test Pressure: After 5 minutes into the test, neutral pressure level in furnace shall be established at 40 inches or less above the sill.

F. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.


H. Available Manufacturers:
   1. DHSI Seals, Inc.
   2. National Guard Products.
   3. Reese Enterprises.

2.15 THRESHOLDS

A. Standard: BHMA A156.21

B. Accessibility Requirements: Where thresholds are indicated to comply with accessibility requirements, comply with ANSI A117.1.

   1. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch (13 mm) high.

C. Thresholds for Means of Egress Doors: Comply with NFPA 101. Maximum 1/2 inch (13 mm) high.

D. Provide stainless steel fasteners and lead shields for all thresholds.

E. Available Manufacturers:

   1. National Guard Products.
   2. Pemko Manufacturing
   3. Reese Enterprises.

2.16 MISCELLANEOUS DOOR HARDWARE

A. Auxiliary Hardware: BHMA A156.16, Grade 1 unless Grade 2 is indicated.

   1. Available Manufacturers:
2.17 FABRICATION

A. Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location except in conjunction with required fire-rated labels and as otherwise approved by Architect.

1. Manufacturer's identification is permitted on rim of lock cylinders only.

B. Base Metals: Produce door hardware units of base metal, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18. Do not furnish manufacturer's standard materials or forming methods if different from specified standard.

C. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.

1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.

2. Steel Machine or Wood Screws: For the following fire-rated applications:

   a. Mortise hinges to doors.
   b. Strike plates to frames.
   c. Closers to doors and frames.

3. Steel Through Bolts: For the following applications:

   a. Surface hinges to doors.
   b. Surface mounted Overhead stop and holders.
   c. Closers to doors and frames.
   d. Exit Devices to doors and frames.

2.18 FINISHES

A. Standard: BHMA A156.18, as indicated in door hardware sets.
B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Steel Doors and Frames: Comply with DHI A115 Series.

1. Surface-Applied Door Hardware: Drill and tap doors and frames according to ANSI A250.6.

3.3 INSTALLATION

A. Mounting Heights: Mount door hardware units at heights indicated as follows unless otherwise indicated or required to comply with governing regulations.


B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 09 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.

1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.

2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

C. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than the number recommended by manufacturer for application indicated or one hinge for every 30 inches of door height, whichever is more stringent, unless other equivalent means of support for door, such as pivots, are provided.
D. Stops: Provide wall or other type stops indicated in door hardware schedule. Do not mount floor stops where they will impede traffic.

E. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame. Do not cut, notch or otherwise destroy the integrity of aluminum housing mounted seals. Install before other surface mounted hardware and template accordingly.

F. Thresholds: Set thresholds for exterior doors in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants."

G. Door Bottoms: Apply to bottom of door, forming seal when door is closed.

3.4 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

1. Door Closers: Unless otherwise required by authorities having jurisdiction, adjust sweep period so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches from the latch, measured to the leading edge of the door.

3.5 CLEANING AND PROTECTION

A. Clean adjacent surfaces soiled by door hardware installation.

B. Clean operating items as necessary to restore proper function and finish.

C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

3.6 DOOR HARDWARE SETS
### Manufacturer List

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### Option List

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## Hardware Sets

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<td>1192-3 x J MTG</td>
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<td>TR</td>
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<tr>
<td>Closer</td>
<td>4040 XP EDA</td>
<td>AL</td>
<td>LC</td>
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<td>Adapter Plate</td>
<td>4040XP 18PA</td>
<td>AL</td>
<td>LC</td>
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<tr>
<td>Spacer</td>
<td>4040XP-61</td>
<td>AL</td>
<td>LC</td>
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<tr>
<td>Door Stop</td>
<td>1214</td>
<td>626</td>
<td>TR</td>
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<tr>
<td>Premeter Gasket</td>
<td>BY FRAME MFG</td>
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<td>BY</td>
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<tr>
<td>Threshold</td>
<td>8433 V x SSMS/LA - PR</td>
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### SET #100 - WD - Mech Rm PR

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<tr>
<td>Hinges</td>
<td>FBB179 4 1/2 X 4 1/2</td>
<td>US26D</td>
<td>ST</td>
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<tr>
<td>Flush Bolt</td>
<td>3917-12</td>
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<td>TR</td>
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<tr>
<td>Lockset</td>
<td>ND80RD RHO 10-025 13-247 ICX</td>
<td>626</td>
<td>SC</td>
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<tr>
<td>Perm Core</td>
<td>20-740</td>
<td>626</td>
<td>SC</td>
</tr>
<tr>
<td>Floor Stop</td>
<td>1211</td>
<td>626</td>
<td>TR</td>
</tr>
<tr>
<td>Dustproof Strike</td>
<td>3910</td>
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<td>TR</td>
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<td>Astragal</td>
<td>158 NA (MTG OUTSIDE IN-ACTIVE LEAF)</td>
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<td>Gasketing</td>
<td>5040 B (HEAD &amp; JAMBS)</td>
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### SET #101 - WD - Storage

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<td>US26D</td>
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<tr>
<td>Lockset</td>
<td>ND53RD RHO 10-025 13-247 ICX</td>
<td>626</td>
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<td>Wall Bumper</td>
<td>1270CV</td>
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<td>Door Silencers</td>
<td>1229A</td>
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SET #102 - WD - Conf. Rm / MP Rm

3 Hinges          FBB179 4 1/2 X 4 1/2 NRP  US26D ST
1 Lockset        ND53RD RHO 10-025 13-247 ICX  626 SC
1 Perm Core      20-740 626 SC
1 Closer | Stop   4040 XP CUSH TBWMS  AL LC
1 Kick Plate     K0050 - 10” x 2” LDW CSK  630 TR
1 Gasketing      5040 B (HEAD & JAMBS) NA

SET #103 - WD - Office

3 Hinges          FBB179 4 1/2 X 4 1/2  US26D ST
1 Lockset        ND53RD RHO 10-025 13-247 ICX  626 SC
1 Perm Core      20-740 626 SC
1 Wall Bumper    1270CV 626 TR
1 Gasketing      5040 B (HEAD & JAMBS) NA

SET #104 - WD - RR

3 Hinges          FBB179 4 1/2 X 4 1/2  US26D ST
1 Privacy Set    ND40S RHO 10-025 13-248  626AM SC
1 Closer | HO    4040 XP H TBWMS  AL LC
1 Kick Plate     K0050 - 10” x 2” LDW CSK  630 TR
1 Wall Bumper    1270CV 626 TR
3 Door Silencers 1229A  GREY TR

END OF SECTION
SECTION 088000

GLAZING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Glass for doors storefront framing.
2. Glazing sealants and accessories.

1.2 COORDINATION

A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.3 ACTION SUBMITTALS

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Guardian Glass; SunGuard.
3. Viracon, Inc.

2.2 GLASS PRODUCTS, GENERAL

A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.

1. GANA Publications: "Glazing Manual."

B. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than the thickness indicated.

C. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass as needed to comply with "Performance Requirements"
Article. Where heat-strengthened float glass is indicated, provide heat-strengthened float glass or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where fully tempered float glass is indicated, provide fully tempered float glass.

2.3 GLASS PRODUCTS

A. Clear Annealed Float Glass: ASTM C1036, Type I, Class 1 (clear), Quality-Q3.

B. Fully Tempered Float Glass: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.

C. Heat-Strengthened Float Glass: ASTM C1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.

2.4 MISCELLANEOUS GLAZING MATERIALS

A. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

PART 3 - EXECUTION

3.1 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.

C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

F. Provide spacers for glass lites where length plus width is larger than 50 inches.

G. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
3.2 GASKET GLAZING (DRY)

A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

E. Install gaskets so they protrude past face of glazing stops.

3.3 CLEANING AND PROTECTION

A. Immediately after installation remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.

1. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.

C. Remove and replace glass that is damaged during construction period.

3.4 MONOLITHIC GLASS SCHEDULE

A. Glass Type: Clear fully tempered float glass.

1. Minimum Thickness: 6 mm.
SECTION 092216
NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Non-load-bearing steel framing systems for interior partitions.
2. Suspension systems for interior ceilings and soffits.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated on Drawings, according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

2.2 FRAMING SYSTEMS

A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.

1. Steel Sheet Components: Comply with ASTM C 645 requirements for steel unless otherwise indicated.

B. Studs and Tracks: ASTM C 645. Use either conventional steel studs and tracks or embossed, high-strength steel studs and tracks.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. ClarkDietrich.
   b. SCAFCO Steel Stud Company.
   c. Steel Construction Systems.

2. Minimum Base-Steel Thickness: 0.0329 inch unless otherwise indicate.
3. Depth: 3-5/8 inches unless otherwise indicated.

C. Slip-Type Head Joints: Where indicated, provide the following:

1. Clip System: Clips designed for use in head-of-wall deflection conditions that provide a positive attachment of studs to tracks while allowing 1-1/2-inch minimum vertical movement.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) ClarkDietrich.
      2) Fire Trak Corp.
      3) SCAFCO Steel Stud Company.

2. Deflection Track: Steel sheet top track manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) ClarkDietrich.
      2) SCAFCO Steel Stud Company.
      3) Steel Construction Systems.

D. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ClarkDietrich.
   b. SCAFCO Steel Stud Company.
   c. Steel Construction Systems.

2. Minimum Base-Steel Thickness: 0.0329 inch.

2.3 SUSPENSION SYSTEMS

A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch diameter wire, or double strand of 0.048-inch diameter wire.

B. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.16 inch in diameter.

C. Carrying Channels (Main Runners): Cold-rolled, commercial-steel sheet with a base-steel thickness of 0.0538 inch and minimum 1/2-inch wide flanges.

   1. Depth: 1-1/2 inches.

D. Furring Channels (Furring Members):
1. Cold-Rolled Channels: 0.0538-inch uncoated-steel thickness, with minimum 1/2-inch-wide flanges, 3/4 inch deep.
2. Steel Studs and Tracks: ASTM C 645. Use either conventional steel studs and tracks or embossed, high-strength steel studs and tracks.
   a. Minimum Base-Steel Thickness: 0.0329 inch.
   b. Depth: 3-5/8 inches.
   a. Minimum Base-Steel Thickness: 0.0329 inch.
4. Resilient Furring Channels: 1/2-inch-deep members designed to reduce sound transmission.
   a. Configuration: Asymmetrical or hat shaped.

2.4 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards.

1. Fasteners for Steel Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

B. Isolation Strip at Exterior Walls: Provide the following:


PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Installation Standard: ASTM C 754.

1. Gypsum Plaster Assemblies: Also comply with requirements in ASTM C 841 that apply to framing installation.
2. Portland Cement Plaster Assemblies: Also comply with requirements in ASTM C 1063 that apply to framing installation.
3. Gypsum Veneer Plaster Assemblies: Also comply with requirements in ASTM C 844 that apply to framing installation.
4. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.

B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.
C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

D. Install bracing at terminations in assemblies.

E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

### 3.2 INSTALLING FRAMED ASSEMBLIES

A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

C. Install tracks at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts that penetrate partitions above ceiling.

1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install track section (for cripple studs) at head and secure to jamb studs.
   a. Install two studs at each jamb unless otherwise indicated.
   b. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.

3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.

D. Direct Furring:

1. Screw to wood framing.
2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.

E. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

### 3.3 INSTALLING CEILING SUSPENSION SYSTEMS

A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.
C. Suspend hangers from building structure as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
   a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.

2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
   a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.

3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.

4. Do not attach hangers to steel roof deck.

5. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.

6. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.

7. Do not connect or suspend steel framing from ducts, pipes, or conduit.

D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.

E. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION 092216
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Interior gypsum board.
   2. Tile backing panels.

1.2 ACTION SUBMITTALS

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.

2.2 GYPSUM BOARD, GENERAL

A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.3 INTERIOR GYPSUM BOARD

A. Gypsum Wallboard: ASTM C1396/C1396M.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. CertainTeed Corporation.
      b. Georgia-Pacific Gypsum LLC.
      c. National Gypsum Company.
      d. USG Corporation.
2. Thickness: 1/2 inch.
3. Long Edges: Tapered and featured (rounded or beveled) for prefilling.

B. Gypsum Board, Type X: ASTM C1396/C1396M.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   
   a. CertainTeed Corporation.
   b. Georgia-Pacific Gypsum LLC.
   c. National Gypsum Company.
   d. USG Corporation.

2. Thickness: 5/8 inch.
3. Long Edges: Tapered and featured (rounded or beveled) for prefilling.

2.4 SPECIALTY GYPSUM BOARD

2.5 TILE BACKING PANELS

A. Glass-Mat, Water-Resistant Backing Board: ASTM C1178/C1178M, with manufacturer's standard edges.

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

   a. CertainTeed Corporation.
   b. Georgia-Pacific Gypsum LLC.
   c. National Gypsum Company.
   d. USG Corporation.

2. Core: 5/8 inch, Type X.
3. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

2.6 TRIM ACCESSORIES

A. Interior Trim: ASTM C1047.

1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
2. Shapes:
   
   a. Cornerbead.
   b. LC-Bead: J-shaped; exposed long flange receives joint compound.
   c. Expansion (control) joint.
2.7 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C475/C475M.

B. Joint Tape:

1. Interior Gypsum Board: Paper.
2. Tile Backing Panels: As recommended by panel manufacturer.

C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.

1. Prefilling: At open joints and damaged surface areas, use setting-type taping compound.
2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use drying-type, all-purpose compound.
   a. Use setting-type compound for installing paper-faced metal trim accessories.
3. Fill Coat: For second coat, use drying-type, all-purpose compound.
4. Finish Coat: For third coat, use setting-type, sandable topping compound.
5. Skim Coat: For final coat of Level 5 finish, use setting-type, sandable topping compound.

D. Joint Compound for Tile Backing Panels:

1. Glass-Mat, Water-Resistant Backing Panel: As recommended by backing panel manufacturer.

2.8 AUXILIARY MATERIALS

A. Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.

B. Steel Drill Screws: ASTM C1002 unless otherwise indicated.

1. Use screws complying with ASTM C954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION AND FINISHING OF PANELS

A. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

B. Comply with ASTM C840.
C. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch-wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

D. For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

E. Prefill open joints and damaged surface areas.

F. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.

G. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C840:

1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
2. Level 2: Panels that are substrate for acoustical tile.
3. Level 3: In mechanical and electrical rooms.
4. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
   a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."
5. Level 5: At locations to receive Wallcovering, or specialty finishes like markerboard.
   a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."

H. Glass-Mat Faced Panels: Finish according to manufacturer's written instructions.

3.2 PROTECTION

A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

B. Remove and replace panels that are wet, moisture damaged, and mold damaged.

END OF SECTION 092900
SECTION 093013
TILING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Porcelain tile.
   2. Tile backing panels.
   3. Waterproof membrane for thinset applications.
   5. Metal edge strips.

B. Related Requirements:
   1. Section 079200 "Joint Sealants" for sealing of expansion, contraction, control, and
      isolation joints in tile surfaces.

1.3 DEFINITIONS

A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1
   apply to Work of this Section unless otherwise specified.

B. ANSI A108 Series: ANSI A108.01, ANSI A108.02, ANSI A108.1A, ANSI A108.1B,
   ANSI A108.1C, ANSI A108.4, ANSI A108.5, ANSI A108.6, ANSI A108.8, ANSI A108.9,
   ANSI A108.10, ANSI A108.11, ANSI A108.12, ANSI A108.13, ANSI A108.14,
   ANSI A108.15, ANSI A108.16, and ANSI A108.17, which are contained in its "Specifications
   for Installation of Ceramic Tile."

C. Module Size: Actual tile size plus joint width indicated.

D. Face Size: Actual tile size, excluding spacer lugs.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.

C. Samples for Verification:
   1. Full-size units of each type and composition of tile and for each color and finish required.
   2. Full-size units of each type of trim and accessory for each color and finish required.
   3. Metal edge strips in 6-inch lengths.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Master Grade Certificates: For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.

C. Product Certificates: For each type of product.

D. Product Test Reports: For tile-setting and -grouting products.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.

   1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated.
   2. Grout: Furnish quantity of grout equal to 3 percent of amount installed for each type, composition, and color indicated.

1.7 QUALITY ASSURANCE

A. Installer Qualifications:

   1. Installer is a five-star member of the National Tile Contractors Association or a Trowel of Excellence member of the Tile Contractors' Association of America.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.

B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.

C. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.
D. Store liquid materials in unopened containers and protected from freezing.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations for Tile: Obtain tile of each type and color or finish from single source or producer.
   1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.

B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from single manufacturer and each aggregate from single source or producer.
   1. Obtain setting and grouting materials, except for unmodified Portland cement and aggregate, from single manufacturer.

C. Source Limitations for Other Products: Obtain each of the following products specified in this Section from a single manufacturer:
   1. Waterproof membrane.
   2. Crack isolation membrane.
   3. Cementitious backer units.
   4. Metal edge strips.

2.2 PRODUCTS, GENERAL

A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.
   1. Provide tile complying with Standard grade requirements unless otherwise indicated.

B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.

C. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.
D. Mounting: For factory-mounted tile, provide back- or edge-mounted tile assemblies as standard with manufacturer unless otherwise indicated.

1. Where tile is indicated for installation in wet areas, do not use back- or edge-mounted tile assemblies unless tile manufacturer specifies in writing that this type of mounting is suitable for installation indicated and has a record of successful in-service performance.

2.3 TILE PRODUCTS

A. Ceramic Tile Type PFT-1, PWT-1, PTB-1: Through body porcelain.

1. Manufacturer: Basis of Design: Mosa.
2. Certification: Tile certified by the Porcelain Tile Certification Agency.
3. Face Size: 5.75 x 5.75 inches.
5. Thickness: 0.30 inches.
6. Face: Plain with square or cushion edges.
7. Dynamic Coefficient of Friction: Not less than 0.42.
8. Tile Color, Glaze, and Pattern: As indicated on drawings.
9. Grout Color: As indicated on drawings.

   a. Cove Base (PTB-1): Surface bullnose, with cove module size same as adjoining flat tile.
   b. External Corners: Metal trim, as indicated on drawings.
   c. Internal Corners: Field-butted square corners.
   d. Tapered Transition Tile: Shape designed to effect transition between thickness of tile floor and adjoining floor finishes of different thickness, tapered to provide reduction in thickness from 1/2 to 1/4 inch across nominal 4-inch dimension.

2.4 THRESHOLDS

A. General: Fabricate to sizes and profiles indicated or required to provide transition between adjacent floor finishes.

1. Bevel edges at 1:2 slope, with lower edge of bevel aligned with or up to 1/16 inch above adjacent floor surface. Finish bevel to match top surface of threshold. Limit height of threshold to 1/2 inch or less above adjacent floor surface.

B. Metal Trim Thresholds

1. As indicated on drawings.

2.5 TILE BACKING PANELS

A. Fiber-Cement Backer Board: ASTM C 1288, in maximum lengths available to minimize end-to-end butt joints.
2.6 WATERPROOF MEMBRANE

A. General: Manufacturer's standard product that complies with ANSI A118.10 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.

B. Chlorinated Polyethylene Sheet: Nonplasticized, chlorinated polyethylene faced on both sides with nonwoven polyester fabric. Nominal thickness 0.030 inch.

2.7 CRACK ISOLATION MEMBRANE

A. General: Manufacturer's standard product that complies with ANSI A118.12 for high performance and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.

B. Chlorinated Polyethylene Sheet: Nonplasticized, chlorinated polyethylene faced on both sides with nonwoven polyester fabric; 0.030-inch nominal thickness.

1. Noble Company (The); Nobleseal CIS.

2.8 SETTING MATERIALS

A. Modified Dry-Set Mortar (Thinset): ANSI A118.4.

1. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.

2. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.

2.9 GROUT MATERIALS

A. High-Performance Tile Grout: ANSI A118.7.

1. Mapei, Flexcolor CQ.

2. Polymer Type: Ethylene vinyl acetate or acrylic additive, in dry, redispersible form, prepackaged with other dry ingredients.

3. Polymer Type: Acrylic resin or styrene-butyadiene rubber in liquid-latex form for addition to prepackaged dry-grout mix.

2.10 MISCELLANEOUS MATERIALS

A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.

B. Vapor-Retarder Membrane: Polyethylene sheeting, ASTM D 4397, 4.0 mils thick.
C. Metal Edge Strips: Angle or L-shaped, height to match tile and setting-bed thickness, metallic or combination of metal and PVC or neoprene base, designed specifically for flooring applications; stainless-steel, ASTM A 666, 300 Series exposed-edge material.

   1. Schluter Systems

D. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

E. Floor Sealer: Manufacturer's standard product for sealing grout joints and that does not change color or appearance of grout.

2.11 MIXING MORTARS AND GROUT

A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.

B. Add materials, water, and additives in accurate proportions.

C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

   1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.

   2. Verify that concrete substrates for tile floors installed with adhesives, bonded mortar bed or thinset mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.

      a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.

      b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.

   3. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
4. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with thinset mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.

B. Where indicated, prepare substrates to receive waterproofing by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1/4 inch per foot toward drains.

C. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

3.3 CERAMIC TILE INSTALLATION

A. Comply with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.

1. For the following installations, follow procedures in the ANSI A108 series of tile installation standards for providing 95 percent mortar coverage:
   a. Tile floors consisting of tiles 8 by 8 inches or larger.
   b. Tile floors consisting of rib-backed tiles.

B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.

C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.

D. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.

E. Where accent tile differs in thickness from field tile, vary setting-bed thickness so that tiles are flush.

F. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize
the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.

1. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so joints between sheets are not apparent in finished work.
2. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
3. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.

G. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:

1. Porcelain Tile: 1/8 inch.

H. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.

I. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.

   1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.

J. Metal Edge Strips: Install at locations indicated on drawings.

K. Floor Sealer: Apply floor sealer to cementitious grout joints in tile floors according to floor-sealer manufacturer's written instructions. As soon as floor sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.

3.4 TILE BACKING PANEL INSTALLATION

A. Install panels and treat joints according to ANSI A108.11 and manufacturer's written instructions for type of application indicated. Use modified dry-set mortar for bonding material unless otherwise directed in manufacturer's written instructions.

3.5 WATERPROOFING INSTALLATION

A. Install waterproofing to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness that is bonded securely to substrate.

B. Allow waterproofing to cure and verify by testing that it is watertight before installing tile or setting materials over it.

3.6 CRACK ISOLATION MEMBRANE INSTALLATION

A. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness that is bonded securely to substrate.

B. Allow crack isolation membrane to cure before installing tile or setting materials over it.
3.7 ADJUSTING AND CLEANING

A. Remove and replace tile that is damaged or that does not match adjoining tile. Provide new matching units, installed as specified and in a manner to eliminate evidence of replacement.

B. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
   1. Remove grout residue from tile as soon as possible.
   2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.

3.8 PROTECTION

A. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.

B. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.

C. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

3.9 INTERIOR CERAMIC TILE INSTALLATION SCHEDULE

A. Interior Floor Installations, Concrete Subfloor:
   1. Tile Installation: TCNA F125-Full; thinset mortar on crack isolation membrane.
      a. Tile Type: As indicated on drawings.
      b. Thinset Mortar: Modified dry-set mortar.
      c. Grout: As indicated on drawings.

B. Interior Wall Installations, Masonry or Concrete:
   1. Tile Installation: TCNA W202; thinset mortar.
      a. Tile Type: As indicated on drawings.
      b. Thinset Mortar: Modified dry-set mortar.
      c. Grout: As indicated on drawings.

END OF SECTION 093013
SECTION 095113
ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section includes acoustical panels and exposed suspension systems for interior ceilings.
   B. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling
      attachment devices to be cast in concrete.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product.
   B. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of sizes indicated below:
      1. Acoustical Panels: Set of 6-inch-square Samples of each type, color, pattern, and texture.

1.4 CLOSEOUT SUBMITTALS
   A. Maintenance Data: For finishes to include in maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS
   A. Furnish extra materials, from the same product run, that match products installed and that are
      packaged with protective covering for storage and identified with labels describing contents.
      1. Acoustical Ceiling Units: Full-size panels equal to 2 percent of quantity installed.
      2. Suspension-System Components: Quantity of each exposed component equal to 2 percent
         of quantity installed.
      3. Hold-Down Clips: Equal to 2 percent of quantity installed.
      4. Impact Clips: Equal to 2 percent of quantity installed.
1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver acoustical panels, suspension-system components, and accessories to Project site and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.

1.7 FIELD CONDITIONS

A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical panel ceiling installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain each type of acoustical ceiling panel and its supporting suspension system from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: Class A according to ASTM E 1264.
2. Smoke-Developed Index: 50 or less.

B. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL or from the listings of another qualified testing agency.

2.3 ACOUSTICAL PANELS (ACT-1)

A. Manufacturer: Basis of Design, Armstrong Ceilings.
B.  Acoustical Panel Standard: Provide manufacturer's standard panels according to ASTM E 1264 and designated by type, form, pattern, acoustical rating, and light reflectance unless otherwise indicated.

C.  Classification: Provide panels as follows:

   1.  Type and Form: Type III, Wet-formed mineral fiber with factory applied pained finish Form 2, water felted.

D.  Color: White.

E.  Light Reflectance (LR): Not less than 0.81.

F.  Ceiling Attenuation Class (CAC): Not less than 35.

G.  Noise Reduction Coefficient (NRC): Not less than 0.55.

H.  Articulation Class (AC): Not less than 150.

I.  Edge/Joint Detail: Square Lay-in.

J.  Thickness: 5/8 inch.

K.  Modular Size: 24 by 24 inches.

2.4 METAL SUSPENSION SYSTEM

A.  Manufacturer as indicated on drawings.

B.  Metal Suspension-System Standard: Provide manufacturer's standard, direct-hung, metal suspension system and accessories according to ASTM C 635/C 635M and designated by type, structural classification, and finish indicated.

   1.  High-Humidity Finish: Where indicated, provide coating tested and classified for "severe environment performance" according to ASTM C 635/C 635M.

C.  Wide-Face, Aluminum-Capped, Double-Web, Hot-Dip Galvanized, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; hot-dip galvanized, with prefinished, 15/16-inch-wide aluminum caps on flanges.

   1.  Structural Classification: Intermediate, Heavy-duty system.
   2.  Face Design: Flat, flush.
   3.  Cap Finish: As indicated on drawings.

2.5 ACCESSORIES

A.  Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
1. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing according to ASTM E 488/E 488M or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.
   
a. Type: Cast-in-place anchors.
b. Corrosion Protection: Carbon-steel components zinc plated according to ASTM B 633, Class SC 1 (mild) service condition.
c. Corrosion Protection: Stainless-steel components complying with ASTM F 593 and ASTM F 594, Group 1 Alloy 304 or 316.

2. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing according to ASTM E 1190, conducted by a qualified testing and inspecting agency.

B. Wire Hangers, Braces, and Ties: Provide wires as follows:

   2. Stainless-Steel Wire: ASTM A 580/A 580M, Type 304, nonmagnetic.
   4. Size: Wire diameter sufficient for its stress at three times hanger design load (ASTM C 635/C 635M, Table 1, "Direct Hung") will be less than yield stress of wire, but not less than 0.135-inch-diameter wire.

C. Hanger Rods: Mild steel, zinc coated or protected with rust-inhibitive paint.

D. Flat Hangers: Mild steel, zinc coated or protected with rust-inhibitive paint.

E. Angle Hangers: Angles with legs not less than 7/8 inch wide; formed with 0.04-inch-thick, galvanized-steel sheet complying with ASTM A 653/A 653M, G90 coating designation; with bolted connections and 5/16-inch-diameter bolts.

2.6 METAL EDGE MOLDINGS AND TRIM

A. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.

   1. Edge moldings shall fit acoustical panel edge details and suspension systems indicated and match width and configuration of exposed runners unless otherwise indicated.
   2. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.
B. Extruded-Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's extruded-aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips, complying with seismic design requirements.

1. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.
2. Baked-Enamel or Powder-Coat Finish: Minimum dry film thickness of 1.5 mils. Comply with ASTM C 635/C 635M and coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.

B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders unless otherwise indicated, and comply with layout shown on reflected ceiling plans.

B. Layout openings for penetrations centered on the penetrating items.

3.3 INSTALLATION

A. Install acoustical panel ceilings according to ASTM C 636/C 636M and manufacturer's written instructions.

B. Suspend ceiling hangers from building's structural members and as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard
suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.

4. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly to structure or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.

5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.

6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.

7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.

8. Do not attach hangers to steel deck tabs.

9. Do not attach hangers to steel roof deck. Attach hangers to structural members.

10. Space hangers not more than 48 inches o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.

11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.

C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.

D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.

1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.

2. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends. Miter corners accurately and connect securely.

3. Do not use exposed fasteners, including pop rivets, on moldings and trim.

E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

F. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide precise fit.

1. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension-system runners and moldings.

2. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.
3. Protect lighting fixtures and air ducts according to requirements indicated for fire-
resistance-rated assembly.

3.4 ERECTION TOLERANCES
A. Suspended Ceilings: Install main and cross runners level to a tolerance of 1/8 inch in 12 feet,
non-cumulative.
B. Moldings and Trim: Install moldings and trim to substrate and level with ceiling suspension
system to a tolerance of 1/8 inch in 12 feet, non-cumulative.

3.5 FIELD QUALITY CONTROL
A. Special Inspections: Engage a qualified special inspector to perform the following special
inspections:
1. Periodic inspection during the installation of suspended ceiling grids according to
ASCE/SEI 7.
B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
C. Perform the following tests and inspections of completed installations of acoustical panel
ceiling hangers and anchors and fasteners in successive stages and when installation of ceiling
suspension systems on each floor has reached 20 percent completion, but no panels have been
installed. Do not proceed with installations of acoustical panel ceiling hangers for the next area
until test results for previously completed installations of acoustical panel ceiling hangers show
compliance with requirements.
1. Within each test area, testing agency will select one of every 10 power-actuated fasteners
and postinstalled anchors used to attach hangers to concrete and will test them for 200 lbf
of tension; it will also select one of every two postinstalled anchors used to attach bracing
wires to concrete and will test them for 440 lbf of tension.
2. When testing discovers fasteners and anchors that do not comply with requirements,
testing agency will test those anchors not previously tested until 20 pass consecutively
and then will resume initial testing frequency.
D. Acoustical panel ceiling hangers, anchors, and fasteners will be considered defective if they do
not pass tests and inspections.
E. Prepare test and inspection reports.

3.6 CLEANING
A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and
suspension-system members. Comply with manufacturer's written instructions for cleaning and
touchup of minor finish damage.
B. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 095113
SECTION 096513
RESILIENT BASE AND 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. Section Includes:

1. Thermoset-rubber base.
2. Resilient molding accessories.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples for Verification: For each type of product indicated and for each color, texture, and pattern required in manufacturer's standard-size Samples, but not less than 12 inches long.

C. Product Schedule: For resilient base and accessory products. Use same designations indicated on Drawings.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Furnish not less than 10 linear feet for every 500 linear feet or fraction thereof, of each type, color, pattern, and size of resilient product installed.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F.
1.6 FIELD CONDITIONS

A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive resilient products during the following periods:

1. 48 hours before installation.
2. During installation.
3. 48 hours after installation.

B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.

C. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 THERMOSET-RUBBER BASE (RB-1)

A. Manufacturer: Basis of Design, Flexco.

B. Product Standard: ASTM F 1861, Type TS (rubber, vulcanized thermoset), Group I (solid, homogeneous).

1. Style and Location:
   a. Style B, Cove: Provide as scheduled on drawings.

C. Thickness: 0.125 inch.

D. Height: 4 inches.

E. Lengths: Coils in manufacturer's standard length.

F. Outside Corners: Job formed or preformed.

G. Inside Corners: Job formed or preformed.

H. Colors: As indicated on drawings.

2.2 RESILIENT MOLDING ACCESSORY (TS-1)

A. Manufacturer: Basis of Design, Flexco.

B. Description: Vinyl floor transition.

C. Profile and Dimensions: As indicated.

D. Locations: Provide resilient molding accessories in areas indicated.
E. Colors and Patterns: As indicated on drawings.

2.3 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.

C. Metal Edge Strips: Extruded aluminum with mill finish, nominal 2 inches wide, of height required to protect exposed edges of flooring, and in maximum available lengths to minimize running joints.

D. Floor Polish: Provide protective, liquid floor-polish products recommended by resilient stair-tread manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
   1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.

B. Proceed with installation only after unsatisfactory conditions have been corrected.
   1. Installation of resilient products indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.

B. Concrete Substrates for Resilient Stair Accessories: Prepare horizontal surfaces according to ASTM F 710.
   1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
   2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 pH.

4. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft., and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
   a. Anhydrous Calcium Chloride Test: ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
   b. Relative Humidity Test: Using in-situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.

C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.

D. Do not install resilient products until materials are the same temperature as space where they are to be installed.
   1. At least 48 hours in advance of installation, move resilient products and installation materials into spaces where they will be installed.

E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.3 RESILIENT BASE INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient base.

B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required, unless noted otherwise on drawings.

C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.

D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

E. Do not stretch resilient base during installation.

F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.

G. Job-Formed Corners:
   1. Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 12inches in length.
a. Form without producing discoloration (whitening) at bends.

2. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 6 inches in length.
   a. Miter corners to minimize open joints.

3.4 RESILIENT ACCESSORY INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient accessories.

B. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed.

3.5 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.

B. Perform the following operations immediately after completing resilient-product installation:
   1. Remove adhesive and other blemishes from surfaces.
   2. Sweep and vacuum horizontal surfaces thoroughly.
   3. Damp-mop horizontal surfaces to remove marks and soil.

C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

D. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION 096513
SECTION 096519
RESILIENT TILE FLOORING

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
   1. Solid vinyl floor tile.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.
B. Samples for Verification 6 x 6 inch size units of each color and pattern of floor tile required.
C. Product Schedule: For floor tile. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS
A. Qualification Data: For Installer.

1.5 CLOSEOUT SUBMITTALS
A. Maintenance Data: For each type of floor tile to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS
A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Floor Tile: Furnish one box for every 50 boxes or fraction thereof, of each type, color, and pattern of floor tile installed.
1.7 QUALITY ASSURANCE
   A. Installer Qualifications: An entity that employs installers and supervisors who are competent in techniques required by manufacturer for floor tile installation and seaming method indicated.
      1. Engage an installer who employs workers for this Project who are trained or certified by floor tile manufacturer for installation techniques required.

1.8 DELIVERY, STORAGE, AND HANDLING
   A. Store floor tile and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F. Store floor tiles on flat surfaces.

1.9 FIELD CONDITIONS
   A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive floor tile during the following periods:
      1. 48 hours before installation.
      2. During installation.
      3. 48 hours after installation.
   B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.
   C. Close spaces to traffic during floor tile installation.
   D. Close spaces to traffic for 48 hours after floor tile installation.
   E. Install floor tile after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
   A. Fire-Test-Response Characteristics: For resilient floor tile, as determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
      1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

2.2 SOLID VINYL FLOOR TILE (LVT-1, LVT-2)
   A. Manufacturer: Basis of Design, Mannington.
   B. Tile Standard: ASTM F 1700.
1. Class: Class III, Printed Film Vinyl Tile.
2. Type: B, Embossed Surface.

C. Thickness: 0.098 inch.

D. Wear Layer Thickness: 20 mil.

E. Size: 6 by 36 inches.

F. Colors and Patterns: As indicated on drawings.

2.3 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by floor tile manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by floor tile and adhesive manufacturers to suit floor tile and substrate conditions indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of floor tile.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare substrates according to floor tile manufacturer's written instructions to ensure adhesion of resilient products.

B. Concrete Substrates: Prepare according to ASTM F 710.

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by floor tile manufacturer. Do not use solvents.
3. Alkalinity and Adhesion Testing: Perform tests recommended by floor tile manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 pH.
4. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft., and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.

   a. Anhydrous Calcium Chloride Test: ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.

   b. Relative Humidity Test: Using in-situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.

C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.

D. Do not install floor tiles until materials are the same temperature as space where they are to be installed.

   1. At least 48 hours in advance of installation, move resilient floor tile and installation materials into spaces where they will be installed.

E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient floor tile.

3.3 FLOOR TILE INSTALLATION

A. Comply with manufacturer's written instructions for installing floor tile.

B. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.

   1. Lay tiles square with room axis, unless noted otherwise on drawings.

C. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.

   1. Lay tiles as indicated on drawings.

D. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.

E. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.

F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent marking device.
G. Install floor tiles on covers for telephone and electrical ducts, building expansion-joint covers, and similar items in installation areas. Maintain overall continuity of color and pattern between pieces of tile installed on covers and adjoining tiles. Tightly adhere tile edges to substrates that abut covers and to cover perimeters.

H. Adhere floor tiles to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

3.4 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protecting floor tile.

B. Perform the following operations immediately after completing floor tile installation:
   1. Remove adhesive and other blemishes from surfaces.
   2. Sweep and vacuum surfaces thoroughly.
   3. Damp-mop surfaces to remove marks and soil.

C. Protect floor tile from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

D. Cover floor tile until Substantial Completion.

END OF SECTION 096519
SECTION 096723

RESINOUS FLOORING

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section includes resinous flooring systems, one with epoxy body.

1.3 SUBMITTALS
A. Product Data: For each type of product. Include manufacturer's technical data, application instructions, and recommendations for each resinous flooring component required.
B. Samples for Verification: For each resinous flooring system required, 6 inches square, applied to a rigid backing by Installer for this Project.
C. Installer Certificates: Signed by manufacturer certifying that installers comply with specified requirements.
D. Material Certificates: For each resinous flooring component, from manufacturer.
E. Material Test Reports: For each resinous flooring system, by a qualified testing agency.
F. Maintenance Data: For resinous flooring to include in maintenance manuals.

1.4 QUALITY ASSURANCE
A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
B. Engage an installer who is certified in writing by resinous flooring manufacturer as qualified to apply resinous flooring systems indicated.

1.5 DELIVERY, STORAGE, AND HANDLING
A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage and mixing with other components.

RESINOUS FLOORING  096723 - 1
1.6 FIELD CONDITIONS

A. Environmental Limitations: Comply with resinous flooring manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting resinous flooring application.

B. Lighting: Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during resinous flooring application.

C. Close spaces to traffic during resinous flooring application and for 24 hours after application unless manufacturer recommends a longer period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Flammability: Self-extinguishing according to ASTM D 635.

2.2 MANUFACTURERS

A. Source Limitations: Obtain primary resinous flooring materials, including primers, resins, hardening agents, grouting coats, and topcoats, from single source from single manufacturer. Obtain secondary materials, including patching and fill material, joint sealant, and repair materials, of type and from manufacturer recommended in writing by manufacturer of primary materials.

2.3 RESINOUS FLOORING (EPR-1)

A. Description: Epoxy and urethane-based waterproof membrane resinous floor system.


B. System Characteristics:

2. Wearing Surface: Manufacturer’s standard wearing surface.
3. Overall System Thickness: 30 TO 40 mil.

C. Primer Coat:

2. Resin: (2) two component epoxy.
3. Formulation Description: 100 percent solids.
5. Number of Coats: One.

D. Primer Coat 2:
2. Resin: (3) three component epoxy, with 90 grit silica.
3. Formulation Description: 100 percent solids.
5. Number of Coats: One.

E. Body Coat(s):

1. Material Basis: Stonproof ME7
2. Resin: Urethane Membrane.
3. Formulation Description: 100% solids elastomeric.
5. Number of Coats: One.

F. Patching and Fill Material: Resinous product of or approved by resinous flooring manufacturer and recommended by manufacturer for application indicated.

G. Topcoats: Stonkote GS4, general service sealing.

1. Material Basis: Stonkote GS4
2. Resin: Epoxy.
3. Formulation Description: 100% solids, epoxy.
4. Type: pigmented.
6. Number of Coats: one.

H. System Physical Properties: Provide resinous flooring system with the following minimum physical property requirements when tested according to test methods indicated:

1. Elongation: 200% per ASTM D 412.
2. Tensile Strength: 1,200 psi per ASTM D 412.
3. Hardness: 70, Shore D per ASTM D 2240.

PART 3 - EXECUTION

3.1 PREPARATION

A. Prepare and clean substrates according to resinous flooring manufacturer's written instructions for substrate indicated. Provide clean, dry, and neutral Ph substrate for resinous flooring application.

B. Concrete Substrates: Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with resinous flooring.

1. Roughen concrete substrates as follows:
a. Shot-blast surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
b. Comply with ASTM C 811 requirements unless manufacturer's written instructions are more stringent.

2. Repair damaged and deteriorated concrete according to resinous flooring manufacturer's written instructions.

3. Verify that concrete substrates are dry and moisture-vapor emissions are within acceptable levels according to manufacturer's written instructions.
   a. Anhydrous Calcium Chloride Test: ASTM F 1869. Proceed with application of resinous flooring only after substrates have maximum moisture-vapor-emission rate of 7lb of water / 1000 sq. ft. of slab area in 24 hours.
   b. Plastic Sheet Test: ASTM D 4263. Proceed with application only after testing indicates absence of moisture in substrates.
   c. Relative Humidity Test: Use in situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.

4. Alkalinity and Adhesion Testing: Verify that concrete substrates have pH within acceptable range. Perform tests recommended by manufacturer. Proceed with application only after substrates pass testing.

C. Patching and Filling: Use patching and fill material to fill holes and depressions in substrates according to manufacturer's written instructions.

   1. Control Joint Treatment: Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through resinous flooring according to manufacturer's written instructions.

D. Resinous Materials: Mix components and prepare materials according to resinous flooring manufacturer's written instructions.

3.2 APPLICATION

A. Apply components of resinous flooring system according to manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness indicated.

   1. Coordinate application of components to provide optimum adhesion of resinous flooring system to substrate, and optimum intercoat adhesion.
   2. Cure resinous flooring components according to manufacturer's written instructions. Prevent contamination during application and curing processes.
   3. Expansion and Isolation Joint Treatment: At substrate expansion and isolation joints, comply with resinous flooring manufacturer's written instructions.

B. Install flooring before casework is installed.
3.3 FIELD QUALITY CONTROL

A. Material Sampling: Owner may, at any time and any number of times during resinous flooring application, require material samples for testing for compliance with requirements.

1. Owner will engage an independent testing agency to take samples of materials being used. Material samples will be taken, identified, sealed, and certified in presence of Contractor.
2. Testing agency will test samples for compliance with requirements, using applicable referenced testing procedures or, if not referenced, using testing procedures listed in manufacturer's product data.
3. If test results show applied materials do not comply with specified requirements, pay for testing, remove noncomplying materials, prepare surfaces coated with unacceptable materials, and reapply flooring materials to comply with requirements.

B. Apply primer where required by resinous system, over prepared substrate at manufacturer's recommended spreading rate.

C. Membrane Base: Mix and apply membrane base over fully cured primer using manufacturer's specially designed squeegees and rollers

D. Apply topcoat(s) in number of coats indicated for flooring system and at spreading rates recommended in writing by manufacturer.

3.4 PROTECTION

A. Protect resinous flooring from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by resinous flooring manufacturer.

END OF SECTION 096723
SECTION 096813
TILE CARPETING

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section includes modular carpet tile.
B. Related Requirements:
   1. Section 096513 "Resilient Base and Accessories" for resilient wall base and accessories installed with carpet tile.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
   2. Include manufacturer's written installation recommendations for each type of substrate.
B. Shop Drawings: For carpet tile installation, plans showing the following:
   1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet tiles.
   2. Carpet tile type, color, and dye lot.
   3. Type of subfloor.
   4. Type of installation.
   5. Pattern of installation.
   6. Pattern type, location, and direction.
   7. Pile direction.
   8. Type, color, and location of insets and borders.
   9. Type, color, and location of edge, transition, and other accessory strips.
   10. Transition details to other flooring materials.
C. Samples for Verification: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.
2. Exposed Edge, Transition, and Other Accessory Stripping: 12-inch-long Samples.

D. Product Schedule: For carpet tile. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For carpet tile, for tests performed by a qualified testing agency.

C. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For carpet tiles to include in maintenance manuals. Include the following:
   1. Methods for maintaining carpet tile, including cleaning and stain-removal products and
      procedures and manufacturer's recommended maintenance schedule.
   2. Precautions for cleaning materials and methods that could be detrimental to carpet tile.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are
   packaged with protective covering for storage and identified with labels describing contents.
   1. Carpet Tile: Full-size units equal to 5 percent of amount installed for each type indicated,
      but not less than 10 sq. yd..

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who is certified by the International Certified
   Floorcovering Installers Association at the Commercial II certification level.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Comply with CRI's "CRI Carpet Installation Standard."

1.9 FIELD CONDITIONS

A. Comply with CRI's "CRI Carpet Installation Standard" for temperature, humidity, and
   ventilation limitations.

B. Environmental Limitations: Do not deliver or install carpet tiles until spaces are enclosed and
   weathertight, wet-work in spaces is complete and dry, and ambient temperature and humidity
   conditions are maintained at levels planned for building occupants during the remainder of the
   construction period.
C. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.

D. Where demountable partitions or other items are indicated for installation on top of carpet tiles, install carpet tiles before installing these items.

1.10 WARRANTY

A. Special Warranty for Carpet Tiles: Manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.

1. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.

2. Failures include, but are not limited to, the following:
   a. More than 10 percent edge raveling, snags, and runs.
   b. Dimensional instability.
   c. Excess static discharge.
   d. Loss of tuft-bind strength.
   e. Loss of face fiber.
   f. Delamination.
   g. Edge ravel
   h. Zippering
   i. Backing resiliency loss.

3. Warranty Period: Lifetime limited warranty from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CARPET TILE (CPT-1)

A. Provide products by the manufacturer indicated on drawings.

B. Color: As indicated on drawings.

C. Pattern: As indicated on drawings.

D. Fiber Content: 100 percent solution dyed nylon.

E. Fiber Type: Patcraft Eco Solution Q Nylon.

F. Pile Characteristic: Multi-Level Patterned Loop pile.

G. Pile Thickness: 0.116 inches.

H. Stitches: 12 per inch.
DAYTONA STATE COLLEGE
FOR MEN AND WOMEN

I. Gage: 1/10 per inch.

J. Surface Pile Weight: 18 ounces per square yard.

K. Primary Backing/Backcoating: Non-woven synthetic fiber.

L. Backing System: Patcraft Ecoworx Tile.

M. Size: 24 by 24 inches.

N. Performance Characteristics:
   1. Traffic Class: Severe (TARR)
   2. Antimicrobial Assessment: Passes (AATCC-174) (When installed using Shaw 5036 adhesive)
   3. Methenamine Pill Test: Passes (DOCFF-1-70)
   4. Radiant Panel: Class I (ASTM E-648)
   5. NBS Smoke: Less than 450 (ASTM-E-662)
   6. Electrostatic Propensity: Less than 3.5 kV (AATCC-134)
   7. CRI Green Label Plus: Certified GLP9968
   8. ADA Compliance: Product must meet the guidelines as set forth in the Americans with Disabilities Act for minimum static coefficient of friction of 0.6 for accessible routes.

2.2 CARPET TILE (CPT-2)

A. Manufacturer indicated on drawings.

B. Color: As indicated on drawings.

C. Pattern: As indicated on drawings.

D. Fiber Content: Type 6,6 Nylon.

E. Fiber Type: Certified Wearon.

F. Pile Characteristic: Cut and loop.

G. Density: Average Density 7,200.

H. Pile Thickness: .185 inches

I. Stitches: 10 per inch.

J. Gauge: 1/12 per inch.

K. Tufted Yarn Weight: 36 ounces per square yard.

L. Primary Backing/Backcoating: 100% synthetic.
M. Secondary Backing: Infinity Modular Reinforced Composite Closed Cell Polymer with Recycled Content.

N. Size: 18 by 36 inches.

O. Performance Characteristics:

1. Radiant Panel: (ASTM E-648): Class I (Direct Glue)
2. Smoke Chamber: (ASTM E-662): Less than 450 (Flaming Mode)
4. Dimensional Stability AACHEN Test: Passes
5. Electrostatic Propensity (AATCC 134): Less than 3.0 KV

2.3 INSTALLATION ACCESSORIES

A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.

B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that comply with flammability requirements for installed carpet tile, and are recommended by carpet tile manufacturer for releasable installation.

C. Metal Edge/Transition Strips: Provide as indicated on drawings and as specified in Section 096513 RESILIENT BASE AND ACCESSORIES.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance.

B. Examine carpet tile for type, color, pattern, and potential defects.

C. Concrete Slabs: Verify that finishes comply with requirements specified in Section 033000 "Cast-in-Place Concrete" and that surfaces are free of cracks, ridges, depressions, scale, and foreign deposits.

1. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft. and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.

   a. Anhydrous Calcium Chloride Test: ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
b. Relative Humidity Test: Using in situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.

c. Perform additional moisture tests recommended in writing by adhesive and carpet tile manufacturers. Proceed with installation only after substrates pass testing.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. General: Comply with CRI's "Carpet Installation Standards" and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile.

B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch wide or wider, and protrusions more than 1/32 inch unless more stringent requirements are required by manufacturer's written instructions.

C. Concrete Substrates: Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by adhesive and carpet tile manufacturers.

D. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.3 INSTALLATION

A. General: Comply with CRI's "CRI Carpet Installation Standard," Section 18, "Modular Carpet" and with carpet tile manufacturer's written installation instructions.

B. Installation Method: As recommended in writing by carpet tile manufacturer.

C. Maintain dye-lot integrity. Do not mix dye lots in same area.

D. Maintain pile-direction patterns recommended in writing by carpet tile manufacturer.

E. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.

F. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings, unless noted otherwise.

G. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on carpet tile as marked on subfloor. Use nonpermanent, nonstaining marking device.

H. Install pattern as indicated on drawings.
3.4 CLEANING AND PROTECTION

A. Perform the following operations immediately after installing carpet tile:
   1. Remove excess adhesive and other surface blemishes using cleaner recommended by carpet tile manufacturer.
   2. Remove yarns that protrude from carpet tile surface.

B. Protect installed carpet tile to comply with CRI's "Carpet Installation Standard," Section 20, "Protecting Indoor Installations."

C. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION 096813
SECTION 099123
INTERIOR PAINTING

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section includes surface preparation and the application of paint systems on the following interior substrates:
   1. Steel and iron.
   2. Galvanized metal.
   3. Wood.
B. Related Requirements:
   1. Section 051200 "Structural Steel Framing" for shop priming structural steel.
   2. Section 055000 "Metal Fabrications" for shop priming metal fabrications.
   3. Section 055113 "Metal Pan Stairs" for shop priming metal pan stairs.
   4. Section 099300 "Staining and Transparent Finishing" for surface preparation and the application of wood stains and transparent finishes on interior wood substrates.

1.3 DEFINITIONS
A. MPI Gloss Level 1: Not more than five units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.
B. MPI Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
C. MPI Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
D. MPI Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.
E. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.
F. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.
1.4 QUALITY ASSURANCE

A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Architect will select one surface to represent surfaces and conditions for application of each paint system.
   a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft.
   b. Other Items: Architect will designate items or areas required.

2. Final approval of color selections will be based on mockups.
   a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.

3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.6 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.

B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 PAINT, GENERAL

A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."
B. Material Compatibility:

1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.

C. Colors: As selected by Architect from manufacturer's full range.

2.2 SOURCE QUALITY CONTROL

A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:

1. Owner will engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
2. Testing agency will perform tests for compliance with product requirements.
3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Wood: 15 percent.
2. Gypsum Board: 12 percent.

C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.

D. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.

E. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.
3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

D. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

E. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

F. Wood Substrates:

1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
2. Sand surfaces that will be exposed to view, and dust off.
3. Prime edges, ends, faces, undersides, and backsides of wood.
4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."

1. Use applicators and techniques suited for paint and substrate indicated.
2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

E. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:

1. Paint the following work where exposed in occupied spaces:
   a. Pipe hangers and supports.
   b. Metal conduit.
   c. Fire protection piping.
   d. Underside of metal deck

2. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.

1. Contractor shall touch up and restore painted surfaces damaged by testing.
2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.
3.6 INTERIOR PAINTING SCHEDULE

A. Steel Substrates:

1. Latex System, Alkyd Primer MPI INT 5.1Q: Door Frames.
   a. Prime Coat: Primer, alkyd, quick dry, for metal, MPI #76.
   b. Topcoat: Latex, interior, flat, semi-gloss (MPI Gloss Level 4.5), MPI #54.

2. Latex System, Alkyd Primer MPI INT 5.1Q: Other.
   a. Prime Coat: Primer, alkyd, quick dry, for metal, MPI #76.
   b. Topcoat: Latex, interior, flat, (MPI Gloss Level 1), MPI #53.

B. Galvanized-Metal Substrates:

1. Latex System MPI INT 5.3J:
   a. Prime Coat: Primer, galvanized, water based, MPI #134.
   b. Topcoat: Latex, interior, flat (MPI Gloss Level 1), MPI #53.

C. Wood Substrates: Wood trim.

1. Latex over Latex Primer System MPI INT 6.3T:
   a. Prime Coat: Primer, latex, for interior wood, MPI #39.
   b. Topcoat: Latex, interior, semi-gloss (MPI Gloss Level 5), MPI #54.

D. Gypsum Board Substrates:

1. Latex over Latex Sealer System MPI INT 9.2A:
   b. Topcoat: Latex, interior (MPI Gloss Level 2), MPI #44.

END OF SECTION 099123
SECTION 102600
WALL AND DOOR PROTECTION

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
   1. Corner guards.
   2. Abuse-resistant wall coverings.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Submit manufacturer’s product data, including surface preparation and installation instructions.
B. Samples for Verification: For each type of exposed finish on the following products, prepared on Samples of size indicated below:
   1. Submit manufacturer’s samples of each pattern and color of wall coverings specified minimum 8 inches by 10 inches.

1.4 CLOSEOUT SUBMITTALS
A. Maintenance Data: For each type of wall protection product to include in maintenance manuals.
   1. Include recommended methods and frequency of maintenance for maintaining best condition of plastic covers under anticipated traffic and use conditions. Include precautions against using cleaning materials and methods that may be detrimental to finishes and performance.

1.5 MAINTENANCE MATERIAL SUBMITTALS
A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Wall-Guard Covers: Full-size plastic covers of maximum length equal to 2 percent of each type, color, and texture of cover installed, but no fewer than two, 48-inch-long units.

2. Abuse-resistant Wall covering: Provide two runs (of full width) from same dye lot, equal to the longest run length required at installation.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store wall protection in original undamaged packages and containers inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

1. Maintain room temperature within storage area at not less than 70 deg F during the period plastic materials are stored.

2. Keep plastic materials out of direct sunlight.

3. Store plastic wall- and door-protection components for a minimum of 72 hours, or until plastic material attains a minimum room temperature of 70 deg F.

   a. Store corner-guard covers in a vertical position.

   b. Store wall-guard covers in a horizontal position.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of wall- and door-protection units that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Structural failures including detachment of components from each other or from the substrates, delamination, and permanent deformation beyond normal use.

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain wall-protection products of each type from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Surface Burning Characteristics: Comply with ASTM E84 or UL 723; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

   1. Flame-Spread Index: 25 or less.

   2. Smoke-Developed Index: 450 or less.
2.3 CORNER GUARDS (CG-1)

A. Surface-Mounted, Plastic-Cover Corner Guards: Manufacturer's standard, assembly consisting of snap-on, resilient plastic cover installed over retainer; including mounting hardware; fabricated with 90- or 135-degree turn to match wall condition.

1. Manufacturer: Basis of Design, In-Pro Corporation
2. Cover: Extruded rigid plastic, minimum 0.078-inch wall thickness; in dimensions and profiles indicated on Drawings.
3. Continuous Retainer: Minimum 0.060-inch-thick, one-piece, extruded aluminum.
4. Retainer Clips: Manufacturer's standard impact-absorbing clips.
5. Top and Bottom Caps: Prefabricated, injection-molded plastic; color matching cover; field adjustable for close alignment with snap-on cover.

2.4 ABUSE-RESISTANT WALL COVERINGS

A. Abuse-Resistant Sheet Wall Covering WC-1: Fabricated from semirigid, plastic sheet wall-covering material.

1. Manufacturer: Basis of Design, In-Pro Corporation
2. Size: 48 by 120 inches for roll.
3. Sheet Thickness: .033 inches.
4. Color and Texture: As indicated on the drawings.
5. Height: Full wall.
6. Trim and Joint Moldings: Extruded rigid plastic that matches wall-covering color.
8. Surface Properties: Must meet the following requirements:
   a. Impact Resistance – ASTM D-5420 – Gardener Drop Dart – 44 to 112+ inch-lbs
   b. Abrasion Resistance ASTM D-4060 Taber CS-10f wheel 500 gram load – 200 cycles, 0.02% weight loss.
   c. Chemical Resistance – ASTM D-1308 – 10 cleaning agents, 10 staining agents, after 7 days, no change.
   d. Stain Resistance – ASTM D-1308 - 10 cleaning agents, 10 staining agents, after 7 days, no change.

2.5 FABRICATION

A. Fabricate wall protection according to requirements indicated for design, performance, dimensions, and member sizes, including thicknesses of components.

B. Factory Assembly: Assemble components in factory to greatest extent possible to minimize field assembly. Disassemble only as necessary for shipping and handling.

C. Quality: Fabricate components with uniformly tight seams and joints and with exposed edges rolled. Provide surfaces free of wrinkles, chips, dents, uneven coloration, and other imperfections. Fabricate members and fittings to produce flush, smooth, and rigid hairline joints.
2.6 FINISHES

A. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and wall areas, with Installer present, for compliance with requirements for installation tolerances, fire rating, and other conditions affecting performance of the Work.

B. Examine walls to which wall protection will be attached for blocking, grounds, and other solid backing that have been installed in the locations required for secure attachment of support fasteners.

   1. For wall protection attached with adhesive, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Complete finishing operations, including painting, before installing wall and door protection.

B. Before installation, clean substrate to remove dust, debris, and loose particles.

3.3 INSTALLATION

A. Installation Quality: Install wall and door protection according to manufacturer's written instructions, level, plumb, and true to line without distortions. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished Work.

B. Mounting Heights: Install wall and door protection in locations and at mounting heights indicated on Drawings.

C. Accessories: Provide splices, mounting hardware, anchors, trim, joint moldings, and other accessories required for a complete installation.

   1. Provide anchoring devices and suitable locations to withstand imposed loads.
   2. Where splices occur in horizontal runs of more than 20 feet, splice aluminum retainers and plastic covers at different locations along the run, but no closer than 12 inches apart.
   3. Adjust end caps as required to ensure tight seams.
D. Abuse-Resistant Wall Covering: Install top and edge moldings, corners, and divider bars as required for a complete installation.

3.4 CLEANING

A. Immediately after completion of installation, clean plastic covers and accessories using a standard ammonia-based household cleaning agent.

B. Remove excess adhesive using methods and materials recommended in writing by manufacturer.

END OF SECTION 102600
SECTION 104413
FIRE PROTECTION CABINETS

PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section Includes:
      1. Fire protection cabinets for the following:
         a. Portable fire extinguishers.
   B. Related Requirements:
      1. Section 104416 “Fire Extinguishers” for portable fire extinguishers and mounting brackets.

1.3 SUBMITTALS
   A. Product Data: For each type of product. Show door hardware, cabinet type, trim style, and panel style. Include roughing-in dimensions and details showing recessed- and semirecessed-method and relationships of box and trim to surrounding construction.
   B. Shop Drawings: For fire-protection cabinets. Include plans, elevations, sections, details, and attachments to other work.
   C. Product Schedule: For fire-protection cabinets. Indicate whether recessed, semirecessed, or surface mounted.
   D. Maintenance Data: For fire protection cabinets to include in maintenance manuals.

1.4 COORDINATION
   A. Coordinate size of fire protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.
   B. Coordinate sizes and locations of fire protection cabinets with wall depths.
1.5 PERFORMANCE REQUIREMENTS

A. Fire-Rated Fire-Protection Cabinets: Listed and labeled to comply with requirements in ASTM E 814 for fire-resistance rating of walls where they are installed.

B. Sustainable Design Requirements:
   1. Provide products with post-consumer recycled content plus one-half of pre-consumer recycled content to the greatest extent possible.

PART 2 - PRODUCTS

2.1 FIRE PROTECTION CABINETS

A. Cabinet Type: Suitable for the following.
   1. Portable fire extinguisher.

B. Basis-of-Design Products: Provide products specified herein as manufactured by J.L. Industries, Inc., a division of Activar Construction Products Group, or comparable products by other fire protection cabinet manufacturers, subject to the Architect’s approval in compliance with Division 01 Section “Product Requirements”.
   2. Fire Protection Cabinet for Two Portable Fire Extinguishers: “Cosmopolitan Series”. Tub inside dimensions sized as required to hold both multipurpose dry-chemical type extinguisher and carbon dioxide type extinguisher specified in Section 104416 “Fire Extinguishers”.

C. Source Limitations: Obtain fire protection cabinets from single source from single manufacturer.

D. Cabinet Construction: Nonrated, except where cabinets are installed in rated walls.
   1. Nonrated Cabinets: Manufacturer’s standard.
   2. Fire-Rated Cabinets: Construct fire-rated cabinets with double walls fabricated from 0.043-inch thick cold-rolled steel sheet lined with minimum 5/8-inch thick fire-barrier material, except as required my manufacturer to suit conditions. Provide factory-drilled mounting holes.

E. Cabinet Material: Stainless Steel.
   1. Shelf: Same metal and finish as cabinet.

F. Recessed and Semirecessed Cabinets: For drywall partitions; provide as indicated.
   1. Rolled-Edge Trim: Backbend depth as required to suit conditions.
G. Cabinet Trim Material: Same material and finish as door.

H. Door Material: Stainless Steel.

I. Door Style: Fully glazed panel with frame.

J. Door Glazing: Tempered float glass (clear).

K. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.

L. Accessories:
   1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire-protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
   2. Lettered Door Handle: One-piece, cast-iron door handle with the word "FIRE" embossed into face.
   3. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location.
      a. Identify fire extinguisher in fire-protection cabinet with the words "FIRE EXTINGUISHER".
         1) Location: Applied to cabinet glazing.
         2) Application Process: Manufacturer’s standard.
         3) Lettering Color: Red.
         4) Orientation: Horizontal.

M. Materials:
   1. Stainless Steel: ASTM A 666, Type 304.
      a. Finish: No. 4 directional satin finish.
   2. Tempered Float Glass: ASTM C 1048, Kind FT, Condition A, Type I, Quality q3, 3 mm thick, Class 1 (clear).

2.2 FIRE EXTINGUISHER LOCATION SIGN

A. Fire extinguisher location signs shall be minimum 1/8-inch thick rigid white acrylic in a V-shape (70-degrees), approximately 6-inches tall, 9- inches wide, and 5-inches deep. Signs shall be mounted with minimum of two screws of the type appropriate for the substrate per side edge at a height of 84-inches above finish floor to the bottom of the sign, or higher as coordinated with area finishes, for the best visibility. Where multiple signs are visible their heights shall be in vertical alignment. Background color shall be red and the words FIRE EXTINGUISHER with graphic of extinguisher in white, with arrow pointing down to the extinguisher.
2.3 FABRICATION
   A. Fire Protection Cabinets, Doors and Trim: Manufacturer's standard.

2.4 GENERAL FINISH REQUIREMENTS
   A. Protect mechanical finishes on exposed surfaces of fire-protection cabinets from damage by applying a strippable, temporary protective covering before shipping.
   B. Finish fire-protection cabinets after assembly.
   C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Examine walls and partitions for suitable framing depth and blocking where semirecessed cabinets will be installed.
   B. Examine fire extinguishers for proper charging and tagging.
   C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION
   A. Prepare recesses for semirecessed fire protection cabinets as required by type and size of cabinet and trim style.

3.3 INSTALLATION
   A. General: Install fire-protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction:
      1. Fire Protection Cabinets: 54 inches above finished floor to top of cabinet.
   B. Fire-Protection Cabinets: Fasten cabinets to structure, square and plumb.
      1. Fasten mounting brackets to inside surface of fire-protection cabinets, square and plumb.
   C. Identification: Apply decals and vinyl lettering at locations indicated.
   D. Fire Extinguisher Location Sign: Provide at each fire protection cabinet for fire extinguishers. Install in accordance with manufacturer’s printed instructions.
3.4 ADJUSTING AND CLEANING

A. Remove temporary protective coverings and strippable films, if any, as fire protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.

B. Adjust fire protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.

C. On completion of fire protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.

3.5 CONSTRUCTION WASTE MANAGEMENT

A. Comply with the Waste Management Plan specified in Section 017419 “Construction Waste Management and Disposal”, for additional requirements.
SECTION 104416
FIRE EXTINGUISHERS

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.

1.3 PREINSTALLATION MEETINGS
A. Preinstallation Conference: Conduct conference at Project site.
   1. Review methods and procedures related to fire extinguishers including, but not limited to, the following:
      a. Schedules and coordination requirements.

1.4 SUBMITTALS
A. Product Data: For each type of product. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets.
B. Product Schedule: For fire extinguishers. Coordinate final fire-extinguisher schedule with fire-protection cabinet schedule to ensure proper fit and function. Use same designations indicated on Drawings.
C. Warranty: Sample of special warranty.
D. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

1.5 WARRANTY
A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
   a. Failure of hydrostatic test according to NFPA 10.
   b. Faulty operation of valves or release levers.

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

   A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

   B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

   1. Provide fire extinguishers approved, listed, and labeled by FM Global.

2.2 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

   A. Fire Extinguishers: Type, size, and capacity for each mounting bracket indicated.

   3. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B.
   4. Fire extinguishers to be tagged by Contractor within 3 months of date of Certificate of Occupancy.
   5. Basis-of-Design Products: Provide product manufactured by Amerex, Badger and J.L. Industries, Inc., or comparable product by other manufacturers subject to the Owner’s written approval.

   B. Multipurpose Dry-Chemical Type in Steel Container: UL-rated 3-A:40-B:C, 5-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

   C. Carbon Dioxide Type: UL-rated, 5-B:C, 5-lb nominal capacity, with carbon dioxide in enameled steel container.

2.3 MOUNTING BRACKETS

   A. Mounting Brackets: Manufacturer's standard galvanized steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or red baked-enamel finish.
2.4 FIRE EXTINGUISHER LOCATION SIGN

A. Fire extinguisher location signs shall be minimum 1/8-inch thick rigid white acrylic in a V-shape (70-degrees), approximately 6-inches tall, 9- inches wide, and 5-inches deep. Signs shall be mounted with minimum of two screws of the type appropriate for the substrate per side edge at a height of 84-inches above finish floor to the bottom of the sign, or higher as coordinated with area finishes, for the best visibility. Where multiple signs are visible their heights shall be in vertical alignment. Background color shall be red and the words FIRE EXTINGUISHER with graphic of extinguisher in white, with arrow pointing down to the extinguisher. Location signs shall comply with current UCF Design and Construction Standards.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fire extinguishers for proper charging and tagging.

   1. Remove and replace damaged, defective, or undercharged fire extinguishers.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.

   1. Mounting Brackets: 54 inches above finished floor to top of fire extinguisher.

B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

C. Fire Extinguisher Location Sign: Provide at each fire extinguisher. Install in accordance with manufacturer’s printed instructions

3.3 CONSTRUCTION WASTE MANAGEMENT

A. Comply with the Waste Management Plan specified in Section 017419 “Construction Waste Management and Disposal” for additional requirements.

END OF SECTION 104416
SECTION 107326
WALKWAY COVERINGS AND CANOPIES

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 DESCRIPTION OF CANOPY SYSTEM
A. Dimensions: Canopy system dimensions shall be as standard with manufacturer, not less than those indicated, but exceeding the indicated dimensions only by the amount of the closest standard size thereto.
B. Framing: Provide canopy system with single slope roof as indicated.

1.3 PERFORMANCE REQUIREMENTS
A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design canopy system.
B. MBMA “Metal Building Systems Manual”, for loading combinations and definitions with the exceptions of wind load and special collateral loads. Design for each component shall be as specified by the Design Authority as listed in MBMA “Metal Building Systems Manual”.
1. Wind Loads: Unless criteria is otherwise indicated on Drawings, establish criteria for the following for the Project location and design in accordance with 2017 Florida Building Code (FBC) and ASCE 7-10 requirements for Components and Cladding:
   a. Ultimate wind speed (3-second gust).
   b. Nominal wind speed (3-second gust).
   c. Wind exposure.
   d. Wind pressures.
2. Miami Dade Acceptance or Florida Product Approval: Provide canopy system for the building exterior having a Notice of Acceptance (NOA) letter from the Miami Dade County Building Code Compliance Office (BCCO) or Florida Product Approval letter.
3. Deflection:
   a. Structural Members: The maximum deflection of main framing members shall not exceed 1/240 of their respective spans. The maximum deflection due to live load in roof panels and purlins shall not exceed 1/180 of their respective spans
b. Roof Panels: The design analysis shall establish that the roof when deflected under dead loads plus live load, will not result in a negative gradient. Maximum deflections shall be based on sheets continuous across two or more supports with sheets unfastened and fully free to deflect. In addition, the roof panels shall be designed for a 200 pound concentrated load at midspan on a 12 inch wide section of deck.

1.4 SUBMITTALS

A. Shop Drawings:
   1. Canopy system, detailed erection instructions and diagrams.
   2. Template for anchor bolts: Submit as necessary to erect the canopy system and install components.

B. Product Data:
   1. Canopy System: Submit sufficient data indicating conformance to specified requirements on materials provided under this Section.

C. Samples:
   1. Factory color finish: Submit one sample of each color indicated for verification that the color matches the colors indicated.

D. Delegated-Design Submittal: For canopy system, including support structures and foundations, indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified registered Professional Engineer responsible for their preparation.

E. Miami Dade Acceptance or Florida Product Approval: Submit documentation for Notice of Acceptance (NOA) from the Miami Dade County Building Code Compliance Office (BCCO), or Florida Product Approval. Each NOA or Florida Product Approval letter shall show the product name, product description and valid NOA or Florida Product Approval number with expiration date.

F. Warranties: Special warranties specified in this Section.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle manufactured items so that materials remain dry and undamaged. Do not store in contact with materials that might cause staining.

1.6 WARRANTY

A. Special Warranty on Metal Panel Finishes: Manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
   a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
   b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
   c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 10 years from date of Substantial Completion.

B. Special Weathertightness Warranty for Metal Roof Panels: Manufacturer agrees to repair or replace metal roof panel assemblies that leak or otherwise fail to remain weathertight within specified warranty period.

   1. Warranty Period: 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PANEL MATERIALS

A. MBMA “Metal Building Systems Manual” except as specified otherwise herein. Manufacturer shall design canopy panels, support structure, accessories, and flashings to be completely weathertight and free of abrasions, loose fasteners, and deformations.

B. Coated Aluminum Alloy Panels

   1. Shape: Standard corrugated type having 2.67 inch pitch and 0.875 inch overall depth exclusive of coating.
   2. Material and Coating: Form sheets of Alloy 3004 or Alclad 3004 conforming to ASTM B 209/B 209M having proper temper to suit respective forming operations.
   3. Thickness: Minimum 0.040 inch nominal, but in no case thinner than that required to meet specified performance requirements.

2.2 FRAMING AND STRUCTURAL MEMBERS

A. Aluminum:

   1. Aluminum Alloy Extrusions: ASTM B 221, 6063, temper T5.
   2. Aluminum-Alloy Sheets and Plates: ASTM B 209/B 209M, alloy 3003, temper H16, except aluminum-alloy sheets and plates to receive specified coating shall be the aluminum alloy and temper recommended by the aluminum producer for the specified coating, and shall have mechanical properties equal to, or exceeding, those of alloy 5005, temper H16.

B. Sizes of Aluminum Framing and Structural Members: As indicated, except where engineering analysis requires larger sizes to comply with specified performance requirements.
2.3 MISCELLANEOUS ITEMS

A. Strips and Plates: Form eave and edge strips, fascia strips, miscellaneous flashings, and miscellaneous sheet metal accessories from the same material and thickness as the canopy panels. Wall plates, base angles or base channels, and other miscellaneous framing members may be standard structural shapes as recommended by the canopy system manufacturer.

B. Closure Strips: Provide closure strips of closed-cell or solid-cell synthetic rubber or neoprene, or polyvinyl chloride premolded to match configuration of the canopy panels. Closure strips shall not absorb or retain water.

C. Sealant: ASTM C 920, elastomeric silicone polymer sealant of type, grade, class, and use classifications required by canopy system manufacturer for each application. Concealed sealant may be the nonhardening type.

D. Gaskets and Insulating Compounds: Provide nonabsorptive gaskets and insulating compounds suitable for insulating contact points of incompatible materials. Insulating compounds shall be non-running after drying.

E. Fasteners: Provide fasteners of stainless steel. Fasteners for structural connections and accessories shall be the manufacturer's standard type and size. Exposed canopy panels fasteners shall be gasketed or have gasketed washers on the exterior side of the covering to waterproof the fastener penetration. Washer material shall be canopy system shall be manufacturer's standard for the system provided.

F. Anchor Bolts:
   1. Bolts: ASTM A 307, Grade A. The bolt heads and the nuts of the supplied fasteners must be marked with the manufacturer's identification mark, the strength grade and type specified by ASTM specifications.

2.4 GUTTERS

A. Provide integral gutter system complete with mitered corners, end pieces, and special pieces that may be required. Provide water tight seal at all other joints.

2.5 DOWNSPOUTS

A. Canopy system manufacturer’s standard concealed downspouts.

2.6 FINISH

A. Aluminum Components and Accessories:
   1. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to
exposed metal surfaces to comply with coating and resin manufacturers’ written instructions.

2. Color: As selected by Architect, unless otherwise indicated.

PART 3 - EXECUTION

3.1 ERECTION

A. Erect canopy system in accordance with the manufacturer's written instructions and approved shop drawings. Install closure strips, flashing, sealing material, and other accessories in accordance with canopy system manufacturer's written instructions to provide a weathertight system, free of abrasions, loose fasteners, and deformations.

B. Minimum Fastener Spacing: Space fasteners as determined by engineering calculations for loads indicated and in accordance with manufacturer's written instructions.

3.2 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect completed canopy system installation, including accessories.

B. Remove and replace any components where inspections indicate that they do not comply with specified requirements.

3.3 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as canopy system components are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of installation, clean finished surfaces as recommended by manufacturer. Maintain in a clean condition during construction.

3.4 CONSTRUCTION WASTE MANAGEMENT

A. Comply with the Waste Management Plan specified in Section 017419 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL for additional requirements.

END OF SECTION 107326
SECTION 123216

MANUFACTURED PLASTIC-LAMINATE-CLAD CASEWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Plastic-laminate-clad casework.
   2. Casework hardware and accessories.

B. Related Requirements:
   1. Section 061000 "Rough Carpentry" for wood blocking for anchoring casework.
   2. Section 092216 "Non-Structural Metal Framing" for reinforcements in metal-framed partitions for anchoring casework.
   3. Section 096513 "Resilient Base and Accessories" for resilient base applied to plastic-laminate-clad casework.

1.3 DEFINITIONS

A. Definitions in the AWI/AWMAC/WI's "Architectural Woodwork Standards" apply to the Work of this Section.

1.4 COORDINATION

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that casework can be supported and installed as indicated.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For plastic-laminate-clad casework.
   1. Include plans, elevations, sections, and attachments to other work including blocking and reinforcements required for installation.
2. Indicate types and sizes of casework.
3. Indicate manufacturer's catalog numbers for casework.
4. Show fabrication details, including types and locations of hardware.
5. Indicate locations of and clearances from adjacent walls, doors, windows, other building components, and equipment.
6. Apply AWI's Quality Certification Program label to Shop Drawings.

C. Keying Schedule: Include schematic keying diagram, and index each key set to unique designations that are coordinated with the Contract Documents.

D. Samples: For casework and hardware finishes.

E. Samples for Initial Selection: For casework and hardware finishes.

F. Samples for Verification: For the following:
   1. Plastic Laminates: 8 by 10 inches, for each type, color, pattern, and surface finish required.

1.6 INFORMATIONAL SUBMITTALS
A. Qualification Data: For casework manufacturer and Installer.
B. Sample Warranty: For special warranty.
C. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

1.8 QUALITY ASSURANCE
A. Installer Qualifications: Licensed participate in AWI's Quality Certification Program.

1.9 DELIVERY, STORAGE, AND HANDLING
A. Protect finished surfaces during handling and installation with protective covering of polyethylene film or other suitable material.

1.10 FIELD CONDITIONS
A. Environmental Limitations: Do not deliver or install casework until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during remainder of construction period. Maintain temperature and relative humidity during remainder of construction period in
range recommended for Project location by the AWI/AWMAC/WI's "Architectural Woodwork Standards."

B. Established Dimensions: Where casework is indicated to fit to other construction, establish dimensions for areas where casework is to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

C. Field Measurements: Where casework is indicated to fit to existing construction, verify dimensions of existing construction by field measurements before fabrication and indicate measurements on Shop Drawings. Provide fillers and scribes to allow for trimming and fitting.

D. Locate concealed framing, blocking, and reinforcements that support casework by field measurements before enclosing them, and indicate measurements on Shop Drawings.

1.11 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of casework that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Delamination of components or other failures of glue bond.
   b. Warping of components.
   c. Failure of operating hardware.

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer: Basis of Design, Case Systems, Inc.

B. Source Limitations: Obtain from single source from single manufacturer.

2.2 GENERAL REQUIREMENTS FOR CASEWORK

A. Quality Standard: Unless otherwise indicated, comply with the AWI/AWMAC/WI's "Architectural Woodwork Standards" for grades of casework indicated for construction, finishes, installation, and other requirements.

1. Grade: Premium.

2. Provide labels and certificates from AWI certification program indicating that casework complies with requirements of grades specified.
   a. Contractor shall register the Work under this Section with AWI's Quality Certification Program at www.awiqcp.org or by calling 855-345-0991.
B. Product Designations: Drawings indicate sizes, configurations, and finish materials of manufactured plastic-laminate-clad casework by referencing designated manufacturer's catalog numbers. Other manufacturers' casework of similar sizes and door and drawer configurations, of same finish materials, and complying with the Specifications may be considered. See Section 016000 "Product Requirements."

C. Product Designations: Drawings indicate configurations of manufactured plastic-laminate-clad casework by referencing designations of Casework Design Series numbering system in the Appendix of the AWI/AWMAC/WI's "Architectural Woodwork Standards."

2.3 PLASTIC-LAMINATE-CLAD CASEWORK

A. Design: Frameless cabinet construction with the following door and drawer-front style:

1. Flush overlay.

B. Grain Direction for Wood-Grain Plastic Laminate:

1. Doors: Vertical with continuous vertical matching.
2. Drawer Fronts: Horizontal.
3. Face Frame Members: Lengthwise.
5. Bottoms and Tops of Units: Side to side.

C. Exposed Materials:

1. Plastic-Laminate Grade: HGS.
   a. Colors and Patterns: As indicated on drawings.

D. Semiexposed Materials:

1. Plastic Laminate: Grade VGS unless otherwise indicated. Provide plastic laminate for semiexposed surfaces unless otherwise indicated.
   a. Colors and Patterns: As indicated on drawings.
   b. Provide plastic laminate of same grade as exposed surfaces for interior faces of doors and drawer fronts and other locations where opposite side of component is exposed.
2. Hardboard: Use only for cabinet backs where exterior side of back is not exposed.
3. Metal for Steel Drawer Pans: Cold-rolled, carbon-steel sheet complying with ASTM A1008/A1008M; matte finish; suitable for exposed applications.
4. Unless otherwise indicated, provide specified edgebanding on all semiexposed edges.

E. Concealed Materials:
1. Solid Wood: With no defects affecting strength or utility.
3. Plastic Laminate: Grade BKL.
4. Particleboard.
5. MDF.
6. Hardboard.

2.4 CABINET HARDWARE AND ACCESSORIES

A. Hardware, General: Unless otherwise indicated, provide manufacturer's standard satin-finish, commercial-quality, heavy-duty hardware.
   1. Use threaded metal or plastic inserts with machine screws for fastening to particleboard except where hardware is through-bolted from back side.

B. Butt Hinges: Stainless steel, semiconcealed, five-knuckle hinges complying with ANSI/BHMA A156.9, Grade 1, with antifriction bearings and rounded tips. Provide two hinges for doors less than 48 inches high, and provide three hinges for doors more than 48 inches high.

C. Frameless Concealed Hinges (European Type): ANSI/BHMA A156.9, Type B01602. Provide two hinges for doors less than 48 inches high, and provide three hinges for doors more than 48 inches high.
   1. Degrees of Opening: 100 degrees.

D. Door and Drawer Bumpers: Self-adhering, clear silicone rubber.
   1. Doors: Provide one bumper at top and bottom of closing edge of each swinging door.
   2. Drawers: Provide one bumper on back side of drawer front at each corner.

E. Drawer Slides: ANSI/BHMA A156.9, Type B05091.
   1. Standard Duty (Grade 1, Grade 2, and Grade 3): Side mounted and extending under the bottom edge of drawer.
      a. Extension Type: Full.
      b. Material: Zinc-plated steel with polymer rollers.
   2. Heavy Duty (Grade 1HD-100 and Grade 1HD-200): Side mounted; full-extension type; zinc-plated, steel ball-bearing slides.
   3. Box Drawer Slides: Grade 1HD-100, for drawers not more than 6 inches high and 24 inches wide.
   4. File Drawer Slides: Grade 1HD-100, for drawers more than 6 inches high or 24 inches wide.
   5. Pencil Drawer Slides: Grade 1, for drawers not more than 3 inches high and 24 inches wide.
F. Drawer and Hinged-Door Locks: Cylindrical (cam) type, five-pin tumbler, brass with chrome-plated finish, and complying with ANSI/BHMA A156.11, Grade 1.

1. Provide a minimum of two keys per lock and six master keys.
2. Provide locks where indicated on drawings.

G. Sliding-Door Hardware Sets: Manufacturer's standard, to suit type and size of sliding-door unit.

H. Adjustable Shelf Supports: Single-pin metal shelf rests complying with ANSI/BHMA A156.9, Type B04013.

I. Adjustable Shelf Supports: Mortise-type, powder-coated steel standards and shelf rests complying with ANSI/BHMA A156.9, Type B04071 and Type B04091.

2.5 MATERIALS

A. Maximum Moisture Content for Lumber: 7 percent for hardwood and 12 percent for softwood.

B. Hardwood Plywood: HPVA HP-1, particleboard core except where veneer core is indicated.


D. Particleboard: ANSI A208.1, Grade M-2.

E. Particleboard: Straw-based particleboard complying with ANSI A208.1, Grade M-2, except for density.

1. Source Limitations: Obtain from single source from single manufacturer.

F. MDF: Medium-density fiberboard, ANSI A208.2, Grade 130.

G. Hardboard: ANSI A135.4, Class 1 tempered.

H. Plastic Laminate: High-pressure decorative laminate complying with NEMA LD 3.

1. Source Limitations: Obtain from single source from single manufacturer.

I. PVC Edgebanding for Plastic Laminate: Rigid PVC extrusions, through color with satin finish, 3.0 mm thick at doors and drawer fronts, 1.0 mm thick elsewhere.

2.6 FABRICATION

A. Plastic-Laminate-Clad Cabinet Construction: As required by referenced quality standard, but not less than the following:

1. Bottoms and Ends of Cabinets, and Tops of Wall Cabinets and Tall Cabinets: 3/4-inch particleboard.
2. Shelves: 3/4-inch-thick plywood.
3. Backs of Casework: 1/2-inch-thick particleboard or MDF where exposed, 1/4-inch-thick hardboard or 1/4-inch-thick, veneer-core hardwood plywood dadoed into sides, bottoms, and tops where not exposed.


5. Drawer Sides and Backs: 1/2-inch-thick solid-wood or veneer-core hardwood plywood with glued dovetail or multiple-dowel joints.

6. Drawer Bottoms: 1/4-inch-thick hardwood plywood glued and dadoed into front, back, and sides of drawers. Use 1/2-inch material for drawers more than 24 inches wide.

7. Drawer Bodies: Steel drawer pans formed from 0.0359-inch-thick metal, metallic phosphate treated, and finished with manufacturer's standard two-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat with a minimum dry film thickness of 1 mil for topcoat and 2 mils for system.

8. Doors 48 Inches High or Less: 3/4 inch thick, with particleboard or MDF cores and solid-wood stiles and rails.


B. Filler Strips: Provide as needed to close spaces between casework and walls, ceilings, and equipment. Fabricate from same material and with same finish as casework.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances, location of framing and reinforcements, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Grade: Install casework to comply with same quality standard grade as item to be installed.

B. Install casework level, plumb, and true in line; shim as required using concealed shims. Where casework abuts other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical.

C. Base Cabinets: Set cabinets straight, level, and plumb. Adjust subtops within 1/16 inch of a single plane. Align similar adjoining doors and drawers to a tolerance of 1/16 inch. Bolt adjacent cabinets together with joints flush, tight, and uniform.

D. Wall Cabinets: Hang cabinets straight, level, and plumb. Adjust fronts and bottoms within 1/16 inch of a single plane. Fasten cabinets to hanging strips, masonry, framing, wood blocking, or reinforcements in walls and partitions. Align similar adjoining doors to a tolerance of 1/16 inch.

E. Fasten casework to adjacent units and to masonry, framing, wood blocking, or reinforcements in walls and partitions to comply with the AWI/AWMAC/WT's "Architectural Woodwork Standards."
F. Install hardware uniformly and precisely. Set hinges snug and flat in mortises unless otherwise indicated. Adjust and align hardware so moving parts operate freely and contact points meet accurately. Allow for final adjustment after installation.

G. Adjust operating hardware so doors and drawers operate smoothly without warp or bind. Lubricate operating hardware as recommended by manufacturer.

3.3 FIELD QUALITY CONTROL

A. Inspections: Provide inspection of installed Work through AWI's Quality Certification Program certifying that woodwork, including installation, complies with requirements of the Architectural Woodwork Standards for the specified grade.

1. Inspection entity shall prepare and submit report of inspection.

3.4 CLEANING

A. Repair or remove and replace defective work as directed on completion of installation.

B. Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.

END OF SECTION 123216
PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
   1. Solid surface material countertops.

1.3 ACTION SUBMITTALS
A. Product Data: For countertop materials.
B. Shop Drawings: For countertops. Show materials, finishes, edge and backsplash profiles, methods of joining, and cutouts for plumbing fixtures.
   1. Show locations and details of joints.
   2. Show direction of directional pattern, if any.
C. Samples for Verification: For the following products:
   1. Countertop material, 6 inches square.

1.4 INFORMATIONAL SUBMITTALS
A. Qualification Data: For fabricator.

1.5 CLOSEOUT SUBMITTALS
A. Maintenance Data: For solid surface material countertops to include in maintenance manuals. Include Product Data for care products used or recommended by Installer and names, addresses, and telephone numbers of local sources for products.
1.6 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate countertops similar to that required for this Project, and whose products have a record of successful in-service performance.

B. Installer Qualifications: Fabricator of countertops.

1.7 FIELD CONDITIONS

A. Field Measurements: Verify dimensions of countertops by field measurements after base cabinets are installed but before countertop fabrication is complete.

1.8 COORDINATION

A. Coordinate locations of utilities that will penetrate countertops or backsplashes.

PART 2 - PRODUCTS

2.1 SOLID SURFACE COUNTERTOP MATERIALS

A. Solid Surface Material: Homogeneous-filled plastic resin complying with ICPA SS-1.
   
   1. Manufacturer: Basis of Design, Corian.
   2. Type: Provide Standard type unless Special Purpose type is indicated.
   3. Colors and Patterns: As indicated on the drawings.

B. Particleboard: ANSI A208.1, Grade M-2.

C. Plywood: Exterior softwood plywood complying with DOC PS 1, Grade C-C Plugged, touch sanded.

2.2 COUNTERTOP FABRICATION

A. Fabricate countertops according to solid surface material manufacturer's written instructions and to the AWI/AWMAC/WI's "Architectural Woodwork Standards."
   
   1. Grade: Premium.

B. Configuration: As indicated on drawings.

C. Countertops: 1/2-inch thick, solid surface material with front edge built up with same material.

D. Fabricate tops with shop-applied edges and backsplashes unless otherwise indicated. Comply with solid surface material manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
1. Fabricate with loose backsplashes for field assembly.

E. Joints: Fabricate countertops in sections for joining in field, with joints at locations indicated.

   1. Joint Locations: Not within 18 inches of a sink and not where a countertop section less than 36 inches long would result, unless unavoidable.
   2. Splined Joints: Accurately cut kerfs in edges at joints for insertion of metal splines to maintain alignment of surfaces at joints. Make width of cuts slightly more than thickness of splines to provide snug fit.

2.3 INSTALLATION MATERIALS

A. Adhesive: Product recommended by solid surface material manufacturer.

B. Sealant for Countertops: Comply with applicable requirements in Section 079200 "Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates to receive solid surface material countertops and conditions under which countertops will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of countertops.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install countertops level to a tolerance of 1/8 inch in 8 feet, 1/4 inch maximum. Do not exceed 1/64-inch difference between planes of adjacent units.

B. Fasten countertops by screwing through corner blocks of base units into underside of countertop. Predrill holes for screws as recommended by manufacturer. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

C. Fasten subtops to cabinets by screwing through subtops into cornerblocks of base cabinets. Shim as needed to align subtops in a level plane.

D. Secure countertops to subtops with adhesive according to solid surface material manufacturer's written instructions. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
E. Bond joints with adhesive and draw tight as countertops are set. Mask areas of countertops adjacent to joints to prevent adhesive smears.

1. Install metal splines in kerfs in countertop edges at joints. Fill kerfs with adhesive before inserting splines and remove excess immediately after adjoining units are drawn into position.

2. Clamp units to temporary bracing, supports, or each other to ensure that countertops are properly aligned and joints are of specified width.

F. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts to prevent damage while cutting. Make cutouts to accurately fit items to be installed, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.

1. Seal edges of cutouts in particleboard subtops by saturating with varnish.

G. Apply sealant to gaps at walls; comply with Section 079200 "Joint Sealants."

END OF SECTION 123661.16
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. Piping materials and installation instructions common to most piping systems.
      2. Transition fittings.
      3. Dielectric fittings.
      4. Escutcheons.
      5. Equipment installation requirements common to equipment sections.
      6. Painting and finishing.
      7. Concrete bases.
      8. Supports and anchorages.

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

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

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

   D. The following are industry abbreviations for plastic materials:
      2. CPVC: Chlorinated polyvinyl chloride plastic.
      3. PE: Polyethylene plastic.
      4. PVC: Polyvinyl chloride plastic.

   E. The following are industry abbreviations for rubber materials:
      1. EPDM: Ethylene-propylene-diene terpolymer rubber.
      2. NBR: Acrylonitrile-butadiene rubber.
1.4 QUALITY ASSURANCE

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

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

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

C. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics 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.

1.5 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.

1.6 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing 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 plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.
2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 22 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
   a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
   b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.

1. Manufacturers:
   b. Dresser Industries, Inc.; DMD Div.
   c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
   d. JCM Industries.
   e. Smith-Blair, Inc.
   f. Viking Johnson.

2. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.
4. Aboveground Pressure Piping: Pipe fitting.

2.5 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

1. Manufacturers:
   a. Capitol Manufacturing Co.
   b. Central Plastics Company.
   c. Epco Sales, Inc.

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

1. Manufacturers:
   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Central Plastics Company.
   d. Pipeline Seal and Insulator, Inc.

2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

E. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

1. Manufacturers:
   a. Perfection Corp.
   b. Precision Plumbing Products, Inc.
   c. Sioux Chief Manufacturing Co., Inc.
   d. Victaulic Co. of America.

2.6 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.
   1. Finish: Polished chrome-plated.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
   1. Finish: Polished chrome-plated.

E. One-Piece, Stamped-Steel Type: With set screw and chrome-plated finish.

F. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw and chrome-plated finish.

G. One-Piece, Floor-Plate Type: Cast-iron floor plate.

H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.7 MISCELLANEOUS INSTALLATION MATERIALS

A. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.

B. Provide Coordination Drawing plans, schematics, and diagrams to indicate general location and arrangement of piping systems overlaid with HVAC/Elec./Fire/Systems for coordination. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.
H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

   1. Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
      b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
      c. Insulated Piping: One-piece, stamped-steel type with spring clips.
      d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
      e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
      f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
      g. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

M. Sleeves are not required for core-drilled holes.

N. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations.

O. Verify final equipment locations for roughing-in.

P. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

Q. Coat exterior surfaces of pipe within below grade wall penetrations with a heavy coat of bituminous paint.

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.

B. Ream ends of pipes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.


F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.3 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:
   1. Install unions, in piping NPS 2nd smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
   3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.

3.4 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 plumbing 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.
3.5 PAINTING

A. Painting of plumbing systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.6 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.

2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.

3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

5. Install anchor bolts to elevations required for proper attachment to supported equipment.

6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.8 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

END OF SECTION 220500
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
   2. Specialty valves.

1.3 SUBMITTALS

A. Product Data: For the following products:
   1. Specialty valves.
   2. All fittings.
   3. Couplings.
   4. Backflow preventers and vacuum breakers.
   5. Water penetration systems.


C. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 61 for potable domestic water piping and components.

1.5 PROJECT CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
1. Notify Construction Manager and Owner no fewer than seven days in advance of proposed interruption of water service.
2. Do not proceed with interruption of water service without Construction Manager's and Owner's written permission.

1.6 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.

4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
5. Copper Pressure-Seal-Joint Fittings:
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Elkhart Products Corporation; Industrial Division.
      2) NIBCO INC.
      3) Viega; Plumbing and Heating Systems.
   b. NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.
   c. NPS 2-1/2 to NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber O-ring seal in each end.

B. Soft Copper Tube: ASTM B 88, Type K and ASTM B 88, Type L water tube, annealed temper.

2. Copper Pressure-Seal-Joint Fittings:
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Elkhart Products Corporation; Industrial Division.
2) NIBCO INC.
3) Viega; Plumbing and Heating Systems.

b. NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.

2.3 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free, unless otherwise indicated; full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.4 SPECIALTY VALVES

A. Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty metal valves.

B. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves, drain valves, backflow preventers, and vacuum breakers.

2.5 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.

B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Central Plastics Company.
   c. EPCO Sales, Inc.
   d. Hart Industries International, Inc.
   e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   f. Zurn Plumbing Products Group; Wilkins Water Control Products.

2. Description:
   a. Pressure Rating: 150 psig at 180 deg F.
b. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   
   b. Central Plastics Company.
   c. EPCO Sales, Inc.
   d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
   
   a. Factory-fabricated, bolted, companion-flange assembly.
   b. Pressure Rating: 150 psig minimum.
   c. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Kits:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   
   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Central Plastics Company.
   d. Pipeline Seal and Insulator, Inc.

2. Description:
   
   a. Nonconducting materials for field assembly of companion flanges.
   b. Pressure Rating: 150 psig.
   c. Gasket: Neoprene or phenolic.
   d. Bolt Sleeves: Phenolic or polyethylene.
   e. Washers: Phenolic with steel backing washers.

E. Dielectric Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   
   a. Calpico, Inc.
   b. Lochinvar Corporation.

2. Description:
   
   a. Galvanized-steel coupling.
   b. Pressure Rating: 300 psig at 225 deg F.
   c. End Connections: Female threaded.
   d. Lining: Inert and noncorrosive, thermoplastic.
F. Dielectric Nipples:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Perfection Corporation; a subsidiary of American Meter Company.
   b. Precision Plumbing Products, Inc.
   c. Victaulic Company.

2. Description:
   a. Electroplated steel nipple complying with ASTM F 1545.
   b. Pressure Rating: 300 psig at 225 deg F.
   c. End Connections: Male threaded or grooved.
   d. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.

C. Install shutoff valve immediately upstream of each dielectric fitting.

D. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

G. Install piping adjacent to equipment and specialties to allow service and maintenance.

H. Install piping to permit valve servicing.

I. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.

J. Install piping free of sags and bends.

K. Install fittings for changes in direction and branch connections.
L. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

M. Install sleeves for piping penetrations of walls, ceilings, and floors.

N. Install sleeve seals for piping penetrations of concrete walls and slabs.

O. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.2 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.

E. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Pressure-Sealed Joints: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.

G. Copper-Tubing Grooved Joints: Roll groove end of tube. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for roll-grooved joints.

H. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

I. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.3 VALVE INSTALLATION

A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for valve installations.
B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball valves for piping NPS 2 1/2 inch and smaller.

3.4 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

3.5 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or nipples.

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Division 23 Section "Hangers and Supports for HVAC and Plumbing Piping and Equipment" for pipe hanger and support products and installation.

1. Vertical Piping: MSS Type 8 or 42, clamps.
2. Individual, Straight, Horizontal Piping Runs:
   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
   c. Longer Than 100 Feet If Indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support vertical piping and tubing at base and at each floor.

C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.

E. Install supports for vertical copper tubing every 10 feet.

F. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
2. NPS 1-1/2: 108 inches with 3/8-inch rod.
3. NPS 2: 10 feet with 3/8-inch rod.

G. Install supports for vertical steel piping every 15 feet.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment and machines to allow service and maintenance.

1. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 22 plumbing fixture Sections for connection sizes.
2. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.8 IDENTIFICATION

A. Identify system components. Comply with requirements in Division 23 Section "Identification for HVAC and Plumbing Piping and Equipment" for identification materials and installation.

B. Label pressure piping with system operating pressure.

3.9 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Piping Inspections:

1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
   a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
   b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

C. Piping Tests:
1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
6. Prepare reports for tests and for corrective action required.

D. Domestic water piping will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.10 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
   a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
   b. Adjust calibrated balancing valves to flows indicated.
5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.11 CLEANING

A. Clean and disinfect potable and non-potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Fill and isolate system according to either of the following:
   1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
   2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

B. Clean non-potable domestic water piping as follows:
   1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
   2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
      a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
      b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.12 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

D. Under-building-slab, domestic water, NPS 2 and smaller, shall be the following:
   1. Soft copper tube, ASTM B 88, Type K; wrought-copper solder-joint fittings; and brazed joints.

E. Aboveground domestic water piping, NPS 2 and smaller, shall be one of the following:
   1. Hard copper tube, ASTM B 88, Type L; cast- or wrought- copper solder-joint fittings; and soldered joints.
   2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.
F. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L, ASTM B 88, Type M; cast- or wrought- copper solder-joint fittings; and soldered joints.
2. Hard copper tube, ASTM B 88, Type L or ASTM B 88, Type M; copper pressure-seal-joint fittings; and pressure-sealed joints.
3. Hard copper tube, ASTM B 88, Type L or ASTM B 88, Type M; grooved-joint copper-tube appurtenances; and grooved joints.

3.13 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:


3.14 CONSTRUCTION WASTE MANAGEMENT

A. Comply with the Waste Management Plan specified in Section 01 74 19 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL for additional requirements.

END OF SECTION 221116
SECTION 221119

DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

  A. Section Includes:

     1. Vacuum breakers.
     2. Backflow preventers.
     3. Strainers.
     4. Hose bibbs.
     5. Drain valves.
     7. Trap-seal primer device

1.3 SUBMITTALS

  A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

  A. Potable-water piping and components shall comply with NSF 61.

2.2 PERFORMANCE REQUIREMENTS

  A. Minimum Working Pressure for Domestic Water Piping Specialties: 150 psig unless otherwise
     indicated.

2.3 VACUUM BREAKERS

  A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

2. Size: NPS 1/4 to NPS 3, as required to match connected piping.
4. Inlet and Outlet Connections: Threaded.

B. Hose-Connection Vacuum Breakers:
2. Body: Bronze, nonremovable, with manual drain.

2.4 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:
1. Pressure Rating: 125 psig minimum unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations unless otherwise indicated.
5. Perforation Size:
   a. Strainers NPS 2 and Smaller: 0.020 inch.
   b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.

2.5 HOSE BIBBS

A. Hose Bibbs:
4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
7. Vacuum Breaker: Integral or field-installation, nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Operating key.
14. Include operating key with each operating-key hose bibb.
15. Include wall flange with each chrome- or nickel-plated hose bibb.

2.6 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

2. Pressure Rating: 400-psig minimum CWP.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
8. Inlet: Threaded or solder joint.

2.7 WATER-HAMMER ARRESTORS

A. Water-Hammer Arrestors:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. MIFAB, Inc.
   b. Precision Plumbing Products, Inc.
   c. Sioux Chief Manufacturing Company, Inc.
3. Type: Copper tube with piston.
4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.8 TRAP-SEAL PRIMER DEVICE

A. Supply-Type, Trap Seal Primer Device:

1. Sioux Chief, PPP, Inc. or Zurn.
4. Body: Bronze
5. Inlet and Outlet Connections: NPS ½ threaded, union, or solder joint.
6. Gravity Drain Outlet Connection: NPS ½ threaded or solder joint.
7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.
3.1 INSTALLATION

A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1. Locate backflow preventers in same room as connected equipment or system.
2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
3. Do not install bypass piping around backflow preventers.

B. Install balancing valves in locations where they can easily be adjusted.

C. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.

D. Install Y-pattern strainers for water on supply side of each pump.

E. Install water-hammer arresters in water piping according to PDI-WH 201 and as indicated on the contract drawings.

F. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

3.2 CONNECTIONS

A. Comply with requirements for ground equipment in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Fire-retardant-treated-wood blocking is specified in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical connections.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test each pressure vacuum breaker, reduced-pressure-principle backflow preventer and double-check, backflow-prevention assembly according to authorities having jurisdiction and the device's reference standard.

B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.
3.4 ADJUSTING

A. Set field-adjustable flow set points of balancing valves.

B. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

END OF SECTION 221119
SECTION 221123
DOMESTIC WATER PUMPS

PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section Includes:
      1. In-line, sealless centrifugal pumps.
      2. Close-coupled, end-suction centrifugal pumps.

1.3 DEFINITIONS
   A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or
      for remote-control, signaling power-limited circuits.

1.4 SUBMITTALS
   A. Product Data: For each type of product indicated. Include materials of construction, rated
      capacities, certified performance curves with operating points plotted on curves, operating
      characteristics, electrical characteristics, and furnished specialties and accessories.
   B. Operation and Maintenance Data: For domestic water pumps to include in operation and
      maintenance manuals.

1.5 QUALITY ASSURANCE
   A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by
      a qualified testing agency, and marked for intended location and application.
   B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.6 DELIVERY, STORAGE, AND HANDLING
   A. Retain shipping flange protective covers and protective coatings during storage.
   B. Protect bearings and couplings against damage.
C. Comply with pump manufacturer's written rigging instructions for handling.

1.7 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 IN-LINE, SEALLESS CENTRIFUGAL PUMPS

A. Description: Factory-assembled and -tested, in-line, close-coupled, canned-motor, sealless, overhung-impeller centrifugal pumps.

B. Pump Construction:

1. Pump and Motor Assembly: Hermetically sealed, replaceable-cartridge type with motor and impeller on common shaft and designed for installation with pump and motor shaft horizontal.
2. Casing: Bronze, with threaded or companion-flange connections.
4. Motor: Single speed, unless otherwise indicated.

2.2 CLOSE-COUPLED, END-SUCTION CENTRIFUGAL PUMPS

A. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally.

B. Pump Construction:

1. Casing: Vertically split, cast iron, with replaceable bronze wear rings, drain plug at bottom and air vent at top of volute, threaded gage tappings at inlet and outlet, and ASME B16.1, Class 125 flanges.
2. Impeller: Stainless steel; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.
6. Motor: Single speed, premium efficiency type, secured to mounting frame with adjustable alignment. Select motor that will not overload through full range of pump performance curve.
8. 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.
9. Unless noted otherwise, comply with NEMA MG1 designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC and Plumbing Equipment."
10. Enclosure: Open, dripproof.

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 220513 "Common Motor Requirements for Plumbing 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.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
C. Examine foundations for suitable conditions where pumps and pump systems are to be installed.
D. Proceed with installation only after unsatisfactory conditions have been corrected.
E. The pumps shall be installed in accordance with the manufacturers published instructions and as indicated in this Section.

3.2 PUMP INSTALLATION

A. Comply with HI 1.4 and HI2.4.
B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.
C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
D. Install in-line, sealless centrifugal pumps with shaft horizontal unless otherwise indicated.
E. Install continuous-thread hanger rods and spring hangers of size required to support in-line pump weight.
1. Comply with requirements for vibration isolation devices specified in Section 230548 "Vibration and Seismic Controls for HVAC and Plumbing Equipment." Fabricate brackets or supports as required.
2. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC and Plumbing Piping and Equipment."

F. Equipment Mounting:

1. Install base-mounted pumps on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation devices specified in Section 230548 "Vibration and Seismic Controls for HVAC and Plumbing."

G. Install thermostats in cold-water and hot-water return piping.

H. Install time-delay relays in piping between water heaters and hot-water storage tanks.

3.3 ALIGNMENT

A. Engage a factory-authorized service representative to perform alignment service.

B. Comply with requirements in Hydronics Institute standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.

C. Comply with pump and coupling manufacturers' written instructions.

D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.4 CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to pumps to allow service and maintenance.

C. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles, but no smaller than pipe sizes indicated on Contract Drawings.

1. Install flexible connectors adjacent to pumps in suction and discharge piping of pumps. Comply with requirements for flexible connectors specified in Section 221116 "Domestic Water Piping."

D. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping. Comply with requirements for valves specified in Section 230523 "General-Duty Valves for
HVAC and Plumbing Piping," and comply with requirements for strainers specified in Section 221119 "Domestic Water Piping Specialties."

1. Install pressure gage and snubber at suction of each pump and pressure gage and snubber at discharge of each pump. Install at integral pressure-gage tappings where provided or install pressure-gage connectors in suction and discharge piping around pumps. Comply with requirements for pressure gages and snubbers specified in Section 230519 "Meters and Gages for HVAC and Plumbing Piping."

E. Interlock hot-water recirculation pumps between water heater and hot-water storage tank with water heater burner and time-delay relay.

3.5 IDENTIFICATION

A. Comply with requirements for identification specified in Section 230553 "Identification for HVAC and Plumbing Piping and Equipment" for identification of pumps.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping.
4. Perform the following startup checks for each pump before starting:
   a. Verify bearing lubrication.
   b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
   c. Verify that pump is rotating in the correct direction.
5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
7. Open discharge valve slowly.
8. Adjust temperature settings on thermostats.

3.7 ADJUSTING

A. Adjust domestic water pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust initial temperature set points.

C. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
3.8 TESTING, ADJUSTING AND BALANCING

A. Meet with the TAB contractor prior to beginning TAB and review the TAB plan to determine the capabilities of the system toward completing TAB. Provide the TAB any needed unique instruments for setting valves and instruct TAB in their use.

B. Operate the systems and assist the TAB contractor in performing TAB, or provide sufficient training for TAB to operate the system without assistance.

C. TAB’s shall be performed for the chilled water and heating water pumps. The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform calibration and testing of the system with Testing, Adjusting, and Balancing for HVAC Contractor. All instrumentation and controls shall be calibrated and the specified accuracy shall be verified using test equipment with calibration traceable to NIST standards. Mechanical control devices shall be adjusted to operate as specified. Control parameters and logic (virtual) points including control loop setpoints, gain constants, and integral constraints, shall be adjusted before the system is placed on line. Written notification of any planned calibration and testing of the systems shall be given to the Owner at least 14 calendar days in advance.

3.9 INSTRUCTIONS AND DEMONSTRATION

A. Furnish the services of competent instructors to give full instruction to the designated the Owner personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the domestic water pumps. Instructors shall be thoroughly familiar with all parts of the installation and shall be instructed in operating theory as well as practical operation and maintenance work. Submit a lesson plan for the instruction course for approval. The lesson plan and instruction course shall be based on the approved operation and maintenance data and maintenance manuals.

B. Conduct a training course for the operating staff and maintenance staff selected by the Owner. Give the instruction during the first regular work week after the equipment or system has been accepted and turned over to Owner for regular operation. The number of man-days (8 hours per day) of instruction furnished shall be 1 man-day. Use approximately half of the time for classroom instruction and the other time for instruction at the location of equipment or system.

3.10 CONSTRUCTION WASTE MANAGEMENT

A. Comply with the Waste Management Plan specified in Section 017419 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL for additional requirements.

END OF SECTION 221123
SECTION 221316
SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Pipe, tube, and fittings.
   2. Specialty pipe fittings.
   3. Encasement for underground metal piping.

1.3 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

1.4 SUBMITTALS

A. Product Data: For all piping, fittings and couplings.

B. Field quality-control reports.

C. Shop Drawings include waste and vent piping, accessories and components and coordinated with all trades with elevations.

1.5 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
1. Notify Construction Manager and Owner no fewer than seven days in advance of proposed interruption of sanitary waste service.
2. Do not proceed with interruption of sanitary waste service without Construction Manager's and Owner's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS
A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS
A. Pipe and Fittings: ASTM A 74, Service class(es).
B. Gaskets: ASTM C 564, rubber.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS
A. Pipe and Fittings: ASTM A 888 or CISPI 301.
B. CISPI, Hubless-Piping Couplings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ANACO-Husky.
      c. Fernco Inc.
      d. Mission Rubber Company; a division of MCP Industries, Inc.
      e. Tyler Pipe.
   3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.4 COPPER TUBE AND FITTINGS
A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.
B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
C. Hard Copper Tube: ASTM B 88, Type L, water tube, drawn temper.
D. Copper Pressure Fittings:

2. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

E. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.5 PVC PIPE AND FITTINGS


B. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

D. Adhesive Primer: ASTM F 656.

E. Solvent Cement: ASTM D 2564.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at slopes per Florida Plumbing Codes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.
J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

K. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

L. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:
   1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent flow for piping NPS 4 and larger.
   2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
   3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
   1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.

N. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."

O. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

P. Install sleeves for piping penetrations of walls, ceilings, and floors.

Q. Install sleeve seals for piping penetrations of concrete walls and slabs.

R. Install escutcheons for piping penetrations of walls, ceilings, and floors.

S. Install aboveground PVC piping according to ASTM D 2665.

T. Install underground PVC piping according to ASTM D 2321.

3.2 JOINT CONSTRUCTION


B. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
C. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

D. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

E. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

F. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 appendixes.

3.3 VALVE INSTALLATION

A. General valve installation requirements are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Division 23 Section "Hangers and Supports for HVAC and Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
5. Vertical Piping: MSS Type 8 or Type 42, clamps.
6. Install individual, straight, horizontal piping runs:
   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
   c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
8. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

   1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
   2. NPS 3: 60 inches with 1/2-inch rod.
   3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.

F. Install supports for vertical cast-iron soil piping every 15 feet.

G. Install supports for vertical steel piping every 15 feet.

H. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

   1. NPS 1-1/4: 72 inches with 3/8-inch rod.
   2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
   3. NPS 2-1/2: 108 inches with 1/2-inch rod.
   4. NPS 4: 10 feet with 1/2-inch rod.

I. Install supports for vertical copper tubing every 10 feet.

J. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:

   1. NPS 1-1/2 and NPS 2: 48 inches with a 3/8-inch rod.
   2. NPS 3: 48 inches with 1/2-inch rod.
   3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
   4. NPS 6 and NPS 8: 48 inches with 3/4-inch rod.
   5. NPS 10 and NPS 12: 48 inches with 7/8-inch rod.

K. Install supports for vertical PVC piping every 48 inches.

L. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.5 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect drainage and vent piping to the following:

   1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
   2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
   3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
   4. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.
C. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

D. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.6 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Division 23 Section "Identification for HVAC and Plumbing Piping and Equipment."

3.7 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap
of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

6. Prepare reports for tests and required corrective action.

3.8 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.9 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil and waste piping NPS 4 and smaller shall be any of the following:

   1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
   2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
   3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

C. Aboveground, soil and waste piping NPS 6 and larger shall be any of the following:

   1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
   2. Hubless, cast-iron soil pipe and fittings CISPI, heavy-duty hubless-piping couplings; and coupled joints.
   3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

D. Aboveground, vent piping NPS 4 and smaller shall be any of the following:

   1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
   2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
   3. Copper DWV tube, copper drainage fittings, and soldered joints.
   4. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

E. Underground, soil, waste, and vent piping NPS 4 and smaller shall be any of the following:

   1. Service class, cast-iron soil piping; gaskets and gasketed joints.
   2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

END OF SECTION 221316
SECTION 221319
SANITARY, WASTE, AND VENT PIPING SPECIALTIES

PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section Includes:
      1. Floor drains.
      2. Hub drains.

1.3 SUBMITTALS
   A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for grease interceptors.

1.4 QUALITY ASSURANCE
   A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 FLOOR DRAINS
   A. Cast-Iron Floor Drains:
      4. Outlet: Bottom.
      5. Top of Body and Strainer Finish: Stainless steel.
      7. Trap Features: Trap-seal primer valve drain connection.
2.2 HUB DRAINS

A. Cast-Iron Hub Drains:

1. Pattern: drain.
2. Body Material: Cast iron.
3. Outlet: Bottom.
4. Top or Body and Strainer Finish: Stainless steel.
6. Funnel: As noted.

2.3 BACKWATER VALVES

A. Horizontal, Cast-Iron Backwater Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. MIFAB, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group; Specification Drainage Operation.
3. Size: Same as connected piping.
5. Cover: Cast iron with bolted or threaded access check valve.
6. End Connections: Hub and spigot or hubless.
7. Type Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang closed.
8. Extension: ASTM A 74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; or concrete pad replaces backwater valve cover.

2.4 MISCELLANEOUS DRAINAGE PIPING SPECIALTIES

A. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

B. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install backwater valves in drainage piping as indicated. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.

B. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
   1. Position floor drains for easy access and maintenance.
   2. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
   3. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

C. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

D. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

E. Assemble hub drain and install with top of hub a minimum of 1 inch above floor.

F. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
   1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
   2. Size: Same as floor drain inlet.

G. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

H. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

I. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 CONNECTIONS

A. Comply with requirements in Section 221316 "Sanitary, Waste, Vent, Condensate, and Storm Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.
3.3 FLASHING INSTALLATION

A. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

B. Secure flashing into sleeve and specialty clamping ring or device.

C. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Section 076200 "Sheet Metal Flashing and Trim."

D. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

3.4 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each grease interceptor.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 230553 "Identification for HVAC and Plumbing Piping and Equipment."

3.5 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221319
SECTION 223300

ELECTRIC, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
   1. Commercial, electric, storage, domestic-water heaters.

1.3 SUBMITTALS
A. Product Data: For each type and size of domestic-water heater indicated.
B. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.
C. Operation and maintenance data.

1.4 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.
C. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61, "Drinking Water System Components - Health Effects."

1.5 WARRANTY
A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric, domestic-water heaters that fail in materials or workmanship within specified warranty period.
1. Warranty Periods: From date of Substantial Completion.
   a. Commercial, Electric, Storage, Domestic-Water Heaters:
      1) Storage Tank: Five years.
      2) Controls and Other Components: Five years.
   b. Electric, Tankless, Domestic-Water Heaters: One year parts, 5 years leaks.
   c. Compression Tanks: Five years.

PART 2 - PRODUCTS

2.1 COMMERCIAL, ELECTRIC, DOMESTIC-WATER HEATERS

A. Commercial, Electric, Storage, Domestic-Water Heaters:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings.
      a. Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.
         1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
         2) NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.
   b. Pressure Rating: 150 psig.
   c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.

4. Factory-Installed Storage-Tank Appurtenances:
   a. Anode Rod: Replaceable magnesium.
   b. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
   c. Insulation: Comply with ASHRAE/IESNA 90.1.
   d. Jacket: Steel with enameled finish.
   e. Heating Elements: Electric, screw-in or bolt-on immersion type arranged in multiples of three.
   f. Temperature Control: Adjustable thermostat.
   g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
   h. Relief Valves: ASME rated and stamped for combination temperature-and-pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.
5. Special Requirements: NSF 5 construction.

2.2 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Compression Tanks:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings.
2. Description: Steel pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
3. Construction:
   a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
   b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
   c. Air-Charging Valve: Factory installed.

B. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC 3. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 with ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.

C. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1 or ASHRAE 90.2.

D. Heat-Trap Fittings: ASHRAE 90.2.

E. Combination Temperature-and-Pressure Relief Valves: ASME rated and stamped. Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.

F. Pressure Relief Valves: ASME rated and stamped. Include pressure setting less than domestic-water heater working-pressure rating.


H. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

2.3 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect domestic-water heaters specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test commercial domestic-water heaters to minimum of one and one-half times pressure rating before shipment.
C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

A. Commercial, Electric, Domestic-Water Heater Mounting:

1. Maintain manufacturer's recommended clearances.
2. Arrange units so controls and devices that require servicing are accessible.
3. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
4. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
5. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
6. Install anchor bolts to elevations required for proper attachment to supported equipment.
7. Anchor domestic-water heaters to substrate.

B. Install electric, domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 220523 "General-Duty Valves and Plumbing Piping."

C. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

D. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for electric, domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 221119 "Domestic Water Piping Specialties."

E. Install piping-type heat traps on inlet and outlet piping of electric, domestic-water heater storage tanks without integral or fitting-type heat traps.

F. Fill electric, domestic-water heaters with water.

G. Charge domestic-water compression tanks with air.
3.2 CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 230553 "Identification for HVAC and Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.

C. Prepare test and inspection reports.

3.5 COMMISSIONING

A. Provide the services of a supervisory level technician, in responsible charge of the work in this section, and factory authorized start-up and service technicians; for each major component or system in this section, to participate in the work specified in Division 01 Commissioning Requirements.

END OF SECTION 223300
SECTION 224300
PLUMBING FIXTURES

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section includes the following plumbing fixtures and specialties:
   1. Water closets.
   2. Lavatories.
   3. Electric water coolers.
   4. Sinks.

1.3 SUBMITTALS
A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 PLUMBING FIXTURES
A. Provide plumbing fixtures as indicated on the Contract Drawings.

2.2 GROUT
B. Characteristics: Nonshrink; recommended for interior and exterior applications.
C. Design Mix: 5000-psi, 28-day compressive strength.
D. Packaging: Premixed and factory packaged.
3.1 INSTALLATION

A. Install plumbing fixtures level and plumb according to roughing-in drawings.

B. Install supports, affixed to building substrate, for wall-mounted fixtures.
   1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
   2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
   3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

C. Install counter-mounted fixtures in and attached to casework.

D. Install water-supply piping with stop on each supply to each fixture to be connected to water-distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
   1. Exception: Use ball valve if supply stops are not specified with fixture. Comply with valve requirements specified in Section 230523 "General-Duty Valves for HVAC and Plumbing Piping."

E. Install flushometer valves on water closets.

F. Install flushometer valves for accessible water closets, with lever handle mounted on wide side of compartment.

G. Install toilet seats on water closets.

H. Install traps on fixture outlets.
   1. Exception: Omit trap on fixtures with integral traps.

I. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 230719 "HVAC and Plumbing Piping Insulation."

J. Seal joints between plumbing fixtures, counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

K. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings.

L. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

M. Comply with requirements for water piping specified in Section 221116 "Domestic Water Piping."
N. Comply with requirements for soil and waste drainage piping and vent piping specified in Section 221316 "Sanitary, Waste, and Vent Piping."

O. Comply with requirements for atmospheric vent piping specified in Section 221316 "Sanitary, Waste, and Vent Piping."

P. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 230719 "HVAC and Plumbing Piping Insulation."

3.2 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning plumbing fixtures, fittings, and controls.

3.3 CLEANING AND PROTECTION

A. After installing plumbing fixtures, inspect and repair damaged finishes.

B. Clean plumbing fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed fixtures and fittings.

D. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224300
SECTION 230513
COMMON MOTOR REQUIREMENTS FOR HVAC AND PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose,
   horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to
   600 V and installed at equipment manufacturer's factory or shipped separately by equipment
   manufacturer for field installation.

1.3 COORDINATION

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

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

B. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above
   sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads
   at designated speeds, at installed altitude and environment, with indicated operating sequence,
   and without exceeding nameplate ratings or considering service factor.
C. Compatibility: Motors indicated for use with variable frequency drive motor starters shall be rated for inverter duty and meet the requirements for the variable frequency drive manufacturer proposed.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Unless noted otherwise, efficiency: Energy efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.
   1. For motors with 2:1 speed ratio, consequent pole, single winding.
   2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Multispeed Motors: Separate winding for each speed.

F. Rotor: Random-wound, squirrel cage.

G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

H. Temperature Rise: Match insulation rating.

I. Insulation: Class F.

J. Code Letter Designation:
   1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
   2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T. For motors installed exterior to building, provide totally enclosed fan cooler motor housings configured for weather resistant applications.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
   1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
   2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
   3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
   1. Permanent-split capacitor.
   2. Split phase.
   3. Capacitor start, inductor run.
   4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT

A. Comply with the Waste Management Plan specified in Section 017419 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL for additional requirements.

END OF SECTION 230513
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Sleeves.
2. Stack-sleeve fittings.
3. Sleeve-seal systems.
4. Sleeve-seal fittings.
5. Grout.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

D. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.2 STACK-SLEEVE FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.
B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. Metraflex Company (The).
4. Pipeline Seal and Insulator, Inc.
5. Proco Products, Inc.

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Carbon steel and/or stainless steel.
3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, and/or stainless steel of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Presealed Systems.

B. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT


B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.
PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
   1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
   1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
   2. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
   3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.
   1. Cut sleeves to length for mounting flush with both surfaces.
   2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
   3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07 Section "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.
   1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
   2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Division 07 Section "Sheet Metal Flashing and Trim."
   3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
   4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Using grout, seal the space around outside of stack-sleeve fittings.

B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade:

2. Concrete Slabs-on-Grade:

   1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs above Grade:

4. Interior Partitions:


END OF SECTION 230517
SECTION 230518
ESCUTCHEONS FOR HVAC AND PLUMBING PIPING

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
1. Escutcheons.
2. Floor plates.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS
A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
D. One-Piece, 304 stainless steel type.

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

PART 3 - EXECUTION

3.1 INSTALLATION
A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. Escutcheons for New Piping:
   a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
   b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
   c. Insulated Piping: One-piece, stamped-steel type.
   d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
   e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
   f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
   g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type.

2. Escutcheons for Exterior Piping:
   a. 304 Stainless Steel.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One-piece, floor-plate type.
2. Existing Piping: Split-casting, floor-plate type.

3.2 FIELD QUALITY CONTROL

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

END OF SECTION 230518
SECTION 23 05 19

METERS AND GAGES FOR HVAC AND PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Liquid-in-glass thermometers.
   2. Thermowells.
   3. Dial-type pressure gages.
   4. Gage attachments.
   5. Test plugs.

B. This Section includes general requirements for meters and gages for use in HVAC and Plumbing systems and equipment installation. Where meters and gages are indicated in Division 22 and 23 Sections and where indicated on Contract Drawings, unless noted otherwise, provide products which comply with the requirements of this Section.

1.3 SUBMITTALS

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

B. Product Certificates: For each type of meter and gage, from manufacturer.

C. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals. Provide data from each type of meter and gage utilized on product.

1.6 Quality Assurance

A. Source Limitations: Obtain each meter and gage product from a single manufacturer.

PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Linear rectangular frame, Liquid-in-Glass Thermometers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal:
   a. Trerice, H.O. Co.
   b. Weiss Instruments.
   c. Ashcroft.
   d. Marsh Instruments.

3. Case: Cast aluminum; 9-inch nominal size unless otherwise indicated.
4. Case Form: Adjustable angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue or red organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
7. Window: Glass.
8. Stem: Aluminum and of length to suit installation.
   b. Design for Thermowell Installation: Bare stem.

10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.2 THERMOWELLS

A. Thermowells:

1. Manufacturers: Subject to compliance with requirements, provide thermowells of one of the following, or approved equal:
   a. Trerice, H.O. Co.
   b. Weiss Instruments.
   c. Ashcroft.
   d. Marsh Instruments.

3. Description: Pressure-tight, socket-type fitting made for insertion into piping.
4. Material for Use with Copper Tubing: Copper.
6. Type: To suit control instrument; stepped shank unless straight or tapered shank is required.
7. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
8. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
9. Bore: Diameter required to match thermometer bulb or stem.
10. Insertion Length: Length required to match control instrument.
11. Lagging Extension: Exposed top of thermowell shall extend immediately beyond or flush with surface insulation. Include on thermowells for insulated piping and tubing.
12. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
2.3 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, provide pressure gages of one of the following, or approved equal:
   a. Trerice, H.O. Co.
   b. Weiss Instruments.
   c. Ashcroft.
   d. Marsh Instruments.

2. Standard: ASME B40.100; as modified by the Section.
3. Case: Liquid-filled Sealed type; cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi and kPa.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.4 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and surge-dampening device. Include extension for use on insulated piping.

B. Siphons: Loop-shaped section of stainless-steel pipe with NPS 1/4 or NPS 1/2 pipe threads.

C. Valves: Brass ball, with NPS ¼, 3/8 or NPS 1/2, ASME B1.20.1 pipe threads.

2.5 TEST PLUGS

A. Subject to compliance with requirements, provide pressure and temperature test fittings (test plugs) by one of the following, or approved equal:
   a. Flow Design Inc.
   b. Petersen Products Co.
   c. Watts.

B. Description: Test-station fitting made for insertion into piping tee fitting.

C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
D. Thread Size: Minimum NPS 1/2, ASME B1.20.1 pipe thread.

E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

F. Core Inserts: EPDM or Viton self-sealing rubber.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending one-third of pipe diameter and in vertical position.

B. Install thermowells of sizes required to match thermometer and sensor connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium if recommended by thermometer and sensor manufacturer to enable accurate reading.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Provide thermowells in piping systems and tanks for each thermometer and additionally at temperature sensing device furnished as part of section 23 09 00, “Instrumentation and Control for HVAC”.

G. Install direct-mounted pressure gages located on pipe at the most readable position.

H. Install valve and snubber or syphon in piping for each pressure gage for steam and fluids.

I. Install test plugs where indicated on contract drawings.

J. Install thermometers where indicated.

K. Install pressure gages where indicated:
   1. Inlet and discharge of each pressure-reducing valve.
   2. Elsewhere as specified and where indicated on Contract Drawings.

3.2 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment in a manner to allow service and maintenance of meters, gages, machines, and equipment.

3.3 ADJUSTING

A. Adjust faces of meters and gages to proper angle for best visibility.
3.4 CONSTRUCTION WASTE MANAGEMENT

A. Comply with the Waste Management Plan specified in Section 01 74 19 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL for additional requirements.

END OF SECTION 23 05 19
SECTION 230523

GENERAL-DUTY VALVES FOR HVAC AND PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes general requirements for valves in HVAC and plumbing systems. Where valves are indicated in Division 22 and 23 Sections and where indicated on Contract Drawings, unless noted otherwise, provide valves and valve accessories which comply with this Section.

1.3 DEFINITIONS

A. CWP: Cold working pressure.
B. EPDM: Ethylene propylene copolymer rubber.
C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
D. NRS: Non-rising stem.
E. OS&Y: Outside screw and yoke.
F. RS: Rising stem.

1.4 SUBMITTALS

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

1.5 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from a single source and single manufacturer.
B. In addition to the requirements of this Section, valves in domestic and potable water systems shall be certified “lead-free” and comply with NSF 61 and NSF 372.
C. Minimum ASME Compliance:
1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

D. Multiple-duty or Triple duty valves are not acceptable.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, grooves, and weld ends.
   3. Set angle, gate, and globe valves closed to prevent rattling.
   4. Set ball and plug valves open to minimize exposure of functional surfaces.
   5. Set butterfly valves closed or slightly open.
   6. Block check valves in either closed or open position.

B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground on dunnage in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Unless otherwise indicated, refer to HVAC valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as piping system unless otherwise indicated.

D. Valve Actuator Types:
   1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
   2. Handwheel: For valves other than quarter-turn types.
   3. Handlever: For quarter-turn valves NPS 6 and smaller.
   4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

E. Valves in Insulated Piping: Equip with stem extensions to match insulation thicknesses and the following features:
1. Gate Valves: With rising stem for HVAC applications. Non-rising stem valves are acceptable in Domestic/potable water applications unless noted otherwise.
2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

F. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Solder Joint: With sockets according to ASME B16.18.
3. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRASS BALL VALVES

A. Two-Piece, Full-Port, Brass Ball Valves with Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Crane Co.; Crane Valve Group; Jenkins Valves.
   c. Flow-Tek, Inc.; a subsidiary of Bray International, Inc.
   d. Hammond Valve.
   e. Milwaukee Valve Company.
   f. Nibco.
   g. Apollo Valve.

2. Description:
   b. SWP Rating: 150 psig.
   c. CWP Rating: 600 psig.
   d. Body Design: Two piece.
   e. Body Material: Forged brass.
   f. Ends: Threaded.
   g. Seats: PTFE or TFE.
   h. Stem: Stainless steel.
   i. Ball: Stainless steel, vented.
   j. Port: Full.

2.3 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal:
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Hammond Valve.
d. Milwaukee Valve Company.
e. Nibco.
f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Full.

2.4 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Stainless-Steel Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Keystone Valves; a division of Tyco Valves and Controls
b. Bray International, Inc.

2. Description:

b. CWP Rating: 200 psig, minimum.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
e. Seat: EPDM.
f. Stem: Type 304 or 316 one- or two-piece stainless steel.
g. Disc: Type 304 or 316 stainless steel. Disc shall not have any contact with the seat in the open position.
h. Bearings: Type 304 or 316 stainless steel.
i. Retainer Ring: Fastened (bolted) to body. Seat orientation shall be set independent of flanging force; disc can be in any position during installation. Fasteners must be isolated from the media and shall not intrude further than 50% into the gasket area, fasteners shall not be in the center of the retainer ring.
j. Sealing Capable of sealing without line/media pressure.
k. Manual Actuation: Locking lever handle for line sizes up to and including 6 inch, worm-gear operator and hand wheel for sizes 8 inch and larger.
l. Motor Actuated Valves: Direct connect valve stem to motor actuator; split couplings are not acceptable. Provide actuators indicated in Section 230900, “Instrumentation and Control for HVAC”.

2.5 BRONZE LIFT CHECK VALVES

A. Class 125, Lift Check Valves with Nonmetallic Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal:
   a. Hammond Valve.
   b. Milwaukee Valve Company.
   c. Nibco.
   d. Mueller Steam Specialty; a division of SPX Corporation.
   e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
   a. Standard: MSS SP-80, Type 2.
   b. CWP Rating: 200 psig.
   e. Ends: Threaded.
   f. Disc: NBR, PTFE, or TFE.

2.6 BRONZE SWING CHECK VALVES

A. Class 150, Bronze Swing Check Valves with Nonmetallic Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Crane Co.; Crane Valve Group; Jenkins Valves.
   c. Hammond Valve.
   d. Milwaukee Valve Company.
   e. Nibco.
   f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
   a. Standard: MSS SP-80, Type 4.
   b. CWP Rating: 300 psig.
   c. Body Design: Horizontal flow.
   e. Ends: Threaded.
   f. Disc: PTFE or TFE.
2.7 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Metal Seats:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal:

   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Crane Co.; Crane Valve Group; Jenkins Valves.
   c. Crane Co.; Crane Valve Group; Stockham Division.
   d. Hammond Valve.
   e. Milwaukee Valve Company.
   f. Nibco.
   g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

   a. Standard: MSS SP-71, Type I.
   b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
   c. NPS 14 to NPS 24, CWP Rating: 150 psig.
   d. Body Design: Clear or full waterway.
   e. Body Material: ASTM A 126, gray iron with bolted bonnet.
   f. Ends: Flanged.
   g. Trim: Bronze.
   h. Gasket: Asbestos free.

2.8 IRON, CENTER-GUIDED CHECK VALVES

A. Class 250, Iron, Globe, Center-Guided Check Valves with Metal Seat:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:

   a. DeZurik.
   b. Keckley.
   c. Metraflex, Inc.
   d. Mueller Steam Specialty; a division of SPX Corporation.
   e. Val-Matic Valve and Manufacturing Corp.

2. Description:

   b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
   c. NPS 14 to NPS 24, CWP Rating: 300 psig.
   d. Body Material: ASTM A 126, gray iron.
   e. Style: Globe, spring loaded.
   f. Ends: Flanged.
   g. Stem and spring: Type 304 or 316 stainless steel.
   h. Seat and bushings: Bronze.
   i. Seat Seal: EPDM or Viton.
2.9 BRONZE GATE VALVES

A. Class 150, NRS Bronze Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal:
   
a. Hammond Valve.
b. Milwaukee Valve Company.
c. Nibco.
d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
   
a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 300 psig.
d. Ends: Threaded.
e. Stem: Bronze.
f. Disc: Solid wedge; bronze.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron.

2.10 IRON GATE VALVES

A. Class 125, OS&Y, Iron Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   
a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Hammond Valve.
e. Milwaukee Valve Company.
f. Nibco.
g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
   
a. Standard: MSS SP-70, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. NPS 14 to NPS 24, CWP Rating: 150 psig.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged.
f. Trim: Bronze.
g. Disc: Solid wedge.
h. Packing and Gasket: Asbestos free.
i. Bypass and drain connections: Where indicated.
2.11 BALANCING VALVES

A. Class 125, Manual Balancing Valves; Sizes 1/2 to 2 Inch:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal:
   a. Armstrong.
   b. Tour and Anderson.
   c. Bell & Gossett.

2. Description:
   a. CWP Rating: 200 psig.
   c. Ends: Threaded.
   d. Stem and Disc: Brass alloy B16.
   e. Packing: EPDM O-rings.
   f. Metering Ports: Two with EPDM check and gasket caps.
   g. Handwheel: Composite nylon and metal with hidden memory feature to program the valve with precision tamperproof balancing setting.

B. Class 125, Manual Balancing Valves; Sizes 3 to 12 Inches:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong.
   b. Tour and Anderson.

2. Description:
   a. CWP Rating: 200 psig.
   b. Body Material: Globe style, Cast Iron ASTM A48 Class 30B.
   c. Ends: Flanged.
   d. Disc: Bronze.
   e. Stem: Brass ASTM B-16.
   f. Spring: Stainless Steel ASTM A313 Type 302.
   g. Packing: O-rings BUNA and EPDM.
   h. Metering Ports: Two with EPDM check and gasket caps.
   i. Drain Ports: Two 1/4 inch NPT with brass plugs.
   j. Handwheel: Composite nylon and metal. Include with hidden memory feature to program the valve with precision tamperproof balancing setting.

C. Class 150, Manual Balancing Valves 14 inches and Larger:

1. Manufacturer: Subject to compliance with requirements, provide products by the following:
   a. DeZurik Inc., PEC Eccentric Plug Valve Series
2. Description:

a. Rating 150 psig.
c. Ends: Flanged; ANSI B16.5.
d. Body Bearing: 316 Sintered Stainless Steel; sizes 14 through 18 inches, and 316L ASTM A743, Grade CF-8M.
e. Plug: 316 Stainless steel with EPDM coating.
f. Thrust Bearing: PTFE.
h. Bonnet Bearing: 316 Sintered Stainless Steel; sizes 14 through 18 inches, and 316L ASTM A743, Grade CF-8M.
i. Bonnet Screws: Carbon Steel.
j. Packing: PTFE.
m. Nut: Stainless steel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support to building structure where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.
E. Install chainwheels on operators for butterfly and gate valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor. Provide each with chain bucket.

F. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.
2. Center-Guided Check Valves: In horizontal or vertical position, between flanges.
3. Lift Check Valves: With stem upright and plumb.

G. Coordinate types of balancing valves required with annotations on Contract Drawings.

H. Combination valves such as triple-duty valves are not acceptable.

I. At manual balancing valves 14 inches and larger, provide test plugs on piping up and downstream of valves.

3.3 ADJUSTING

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

3.4 CONSTRUCTION WASTE MANAGEMENT

A. Comply with the Waste Management Plan specified in Section 017419 Construction Waste Management and Disposal, for additional requirements.

END OF SECTION 230523
SECTION 230529

HANGERS AND SUPPORTS FOR HVAC AND PLUMBING 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 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Pipe stands.
7. Equipment supports.

B. Related Sections:

1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Division 23 Section "Vibration Controls for HVAC Piping and Equipment" for vibration isolation devices.
3. Division 23 Section(s) "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 QUALITY ASSURANCE

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

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel and 304 Stainless Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
   3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
   4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

B. Copper Pipe Hangers:
   1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components. Maintain dielectric isolation on copper pipe systems.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Allied Tube & Conduit.
      b. Cooper B-Line, Inc.
      c. Flex-Strut Inc.
      d. GS Metals Corp.
      e. Thomas & Betts Corporation.
      f. Unistrut Corporation; Tyco International, Ltd.
   2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
   4. Channels: Continuous slotted steel channel with inturned lips.
   5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
   7. Metallic Coating: Hot-dipped galvanized and copper clad.
2.4 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

3. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
4. Rilco Manufacturing Co., Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

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

2.6 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.7 EQUIPMENT SUPPORTS

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

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

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure. Maintain dielectric isolation between ferrous and non-ferrous materials. Equipment hanger rod attachments with nylon washers and insulating bushings at hanger rods for copper clad hangers.

   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
   2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems. Attach piping with u-bolts MSS SP-58 Type 24. Maintain dielectric isolation between ferrous and non-ferrous materials.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:
   1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
   2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Pipe Stand Installation:
1. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Division 07 Section "Roof Accessories" for curbs.

G. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.


I. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement, and to facilitate action of expansion loops, expansion bends, and similar units.

J. Install lateral bracing with pipe hangers and supports to prevent swaying.

K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

L. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

N. Insulated Piping:

1. Attach clamps and spacers to piping.
   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:
   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
b. NPS 4: 12 inches long and 0.06 inch thick.
c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.

5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.

6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 EXTERIOR SUPPORTS AND FASTENERS (EQUIPMENT AND PIPING)

A. Provide 304 stainless steel materials for all exterior applications including but not limited to equipment supports, pipe supports, anchors and fasteners.

3.5 ADJUSTING

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

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.
3.6 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.7 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports and metal framing systems and attachments for general service applications.

F. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.

G. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal-hanger shield inserts for insulated piping and tubing.

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For.
3. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
4. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
5. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.

6. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.

7. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.

2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

2. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.

3. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.

2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.

3. 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. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.

8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.

9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.

10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.

11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.

12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

   a. Light (MSS Type 31): 750 lb.
b. Medium (MSS Type 32): 1500 lb.
c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.

P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

R. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 230529
SECTION 23 05 48

VIBRATION CONTROLS FOR HVAC AND PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Isolation pads.
2. Spring isolators.
3. Spring hangers.
4. Concrete filled inertia bases.

B. This Section includes general requirements for vibration control products for use in HVAC and Plumbing systems and equipment installation. Where vibration control products are indicated in Division 22 and 23 Sections and where indicated on Contract Drawings, unless noted otherwise, provide products which comply with the requirements of this Section.

1.3 DEFINITIONS

B. FBC: Florida Building Code.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Product data for each type of isolation pads, spring isolators and spring hangers. Include rated load, rated deflection, and overload capacity for each vibration isolation device.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2.1 VIBRATION ISOLATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal:

1. Amber/Booth Company, Inc.
3. Mason Industries.
4. Vibration Isolation.

B. Isolation Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.

1. Resilient Material: Oil- and water-resistant neoprene.

C. Spring Isolators: Freestanding, laterally stable, floor mounted open and enclosed spring isolators.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

D. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

E. Concrete Filled Inertia Bases: Concrete inertia base frames shall be constructed of mill-rolled structural steel; all welded connections. Equip with welded structural steel outrigger members to accommodate supporting spring vibration isolators. Structural steel frame shall be fabricated with No. 4 reinforcing bars 8 inches on center each way near the bottom of the block, welded to
the frame. Equip outrigger-isolator mounting provisions for isolator and inertia base anchorages. Inertia base frames shall be field-filled with 3,000 psi cured-strength concrete.

1. Configuration of inertia bases must be rectangular to accommodate equipment supported and shall be of dimensions to exceed related equipment by a minimum of 6 inches on all sides.
2. Minimum thickness of inertia base, in addition to providing suitable mass, must be sufficient to provide stiffness to maintain equipment manufacturer's recommended alignment and duty efficiency of power-transmission components. Minimum thickness must be sufficient to result in base deflection at midpoint of unsupported span of not more than 1/1,440th of the span between isolators. Minimum thickness, the preceding requirements notwithstanding, must be 8 percent of the longest base dimension.
3. Concrete inertia bases shall be equipped with a minimum of four spring isolators.
4. Concrete inertia bases shall be installed in 4 inch high reinforced concrete housekeeping pad of dimensions which exceed the concrete inertia base.
5. Minimum dimension from the top of the housekeeping pad to the underside of the inertia base frame shall be not less than one inch.

F. Piping Vibration Isolators: Refer to Section 23 21 13, “Hydronic Piping”, and 22 11 19, “Domestic Water Piping Specialties.”

2.2 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.
2. All hardware shall be galvanized. Hot-dip galvanized steel components for all exterior units.
3. Baked enamel or powder coat for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation and thrust-restraint isolators to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 APPLICATIONS

A. Provide vibration isolation devices as indicated on Contract Drawings. Where specific types are not indicated, provide devices recommended by the vibration isolator manufacturer. Provide vibration isolation devices for each fan, air handling unit and additional equipment indicated.

B. Vibration control devices which are part of factory assembled equipment shall comply with the requirements of this section.

3.3 VIBRATION-CONTROL DEVICE INSTALLATION

A. Comply with requirements in Section 23 05 24, “Hangers and Supports for HVAC Piping and Plumbing Equipment” for installation of vibration control devices applied to hangers and supports.

B. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

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

3.4 FIELD QUALITY CONTROL

A. Engage vibration isolation product manufacturer to provide technical supervision of installations of vibration control products.

B. Perform inspections; verify isolations are providing isolation as designated by the manufacturer.

C. Remove and replace malfunctioning units and retest as specified above.
3.5 ADJUSTING

A. Adjust isolators after piping system is at operating weight. Isolators observed to be compression to the point of non-isolation contact shall be replaced with isolators which enable travel without contact.

B. Adjust active height of spring isolators and spring hangers.

3.6 CONSTRUCTION WASTE MANAGEMENT

A. Comply with the Waste Management Plan specified in Section 01 74 19 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL for additional requirements.

END OF SECTION 23 05 48
SECTION 23 05 53
IDENTIFICATION FOR HVAC AND PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Equipment labels.
   2. Warning signs and labels.
   3. Pipe labels.
   4. Duct labels.
   5. Valve tags.
   6. Warning tags.
   7. Ceiling grid tags.

B. This Section includes general requirements for identification products for use in HVAC and Plumbing systems and equipment installation. Where identification products are indicated in Division 22 and 23 Sections and where indicated on Contract Drawings, unless noted otherwise, provide products which comply with the requirements of this Section.

1.3 SUBMITTALS

A. Product Data: For each type of identification product and application indicated.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 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 acoustical ceilings and similar concealment.

1.5 QUALITY ASSURANCE

A. Equipment labels, pipe labels, duct labels, valve tags and ceiling grid tags shall be factory fabricated products. Subject to compliance with requirements, provide products manufactured by the following or approved equal:

1. Seton Nameplate.
2. Brady.

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.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F surface temperature.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2 by 4 inch for control devices, dampers and valves; and 4-1/2 inch x 6 inch for equipment.
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 self-tapping screws or brass grommets and wire fasteners.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated and areas served.

C. Equipment Label Schedule: For each item of equipment to be labeled, on three hole punched 8-1/2-by-11-inch bond paper laminated in clear plastic. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

1. Equipment schedule shall be included in operation and maintenance data binder.
2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black.

C. Background Color: Yellow.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F surface temperature.

E. Minimum Label Size: Length and width vary for required label content, but not less than 4-1/2 inches x 6 inches.

F. 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.

G. Fasteners: Stainless-steel self-tapping screws or brass grommets and wire fasteners.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Factory-printed, color-coded, with lettering indicating service designation, and showing flow direction. Comply with ANSI A13.1-2015 unless colors or nomenclature is indicated to be otherwise.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: A minimum of 1-1/2 inches high.

2.4 DUCT LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

C. Background Color: Red.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F surface temperature.

E. Minimum Label Size: Length and width vary for required label content, but not less than 4-1/2 inches by 6 inches.

F. 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.

G. Fasteners: Stainless-steel self-tapping screws or brass grommets and wire fasteners.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, for areas served, and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.
   2. Lettering Size: At least 1-1/2 inches high.

2.5 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
   1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Fasteners: Brass wire-link or beaded chain; or S-hook.

B. Valve Schedules: For each valve to be labeled, on three hole punched 8-1/2-by-11-inch bond paper laminated in clear plastic, tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
   1. Valve-tag schedule shall be included in operation and maintenance data binder.

2.6 CEILING GRID TAGS

A. Self-adhesive labels; printed plastic contact-type permanent-adhesive backing. Label shall be color coded to differentiate between items concealed above suspended ceilings. Include concealed device identifier; air terminal unit number, F/SD, FD, main and sub-main shutoff valve service (CHW, HW, Domestic water, etc.).
2.7 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: 3 by 5-1/4 inches minimum.
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping, ductwork, ceiling grid and equipment surfaces 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 item of mechanical equipment scheduled on the Contract Drawings. Provide equipment label for each air handling unit, exhaust fan, pump, chiller, boiler, DDC control panel, motor starter, VFD, heat exchanger, air terminal unit, fan coil unit and similar equipment.

B. Locate equipment labels where accessible and visible. Include designation indicated on Contract Drawing for each.

C. It is the work of this Section to ensure that factory furnished/installed manufacturer nameplates remain uncovered by insulation, paint and other construction substrates. Identify this requirement to the work of all other trades; painting and insulation for example. If it is necessary as part of insulation to conceal factory furnished/installed nameplates, provide a supplemental equipment label in a visible location which replicates the concealed factory furnished/installed nameplate.

3.3 PIPE LABEL INSTALLATION

A. Piping Color-Coding: Painting of piping is specified in Division 09 Section "Interior Painting."

B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Adjacent to each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Adjacent to equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 25 feet along each run.

C. Pipe Label Color Tables:

### TABLE I. COLOR CODES FOR MARKING PIPE

<table>
<thead>
<tr>
<th>System</th>
<th>Background</th>
<th>Letters</th>
<th>Legend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chilled water supply</td>
<td>Green</td>
<td>White</td>
<td>CHWS</td>
</tr>
<tr>
<td>Chilled water return</td>
<td>Green</td>
<td>White</td>
<td>CHWR</td>
</tr>
<tr>
<td>Heating water supply</td>
<td>Yellow</td>
<td>Black</td>
<td>HWS</td>
</tr>
<tr>
<td>Heating water return</td>
<td>Yellow</td>
<td>Black</td>
<td>HWR</td>
</tr>
<tr>
<td>Drain</td>
<td>Green</td>
<td>White</td>
<td>Drain</td>
</tr>
<tr>
<td>Vent</td>
<td>Green</td>
<td>White</td>
<td>Vent</td>
</tr>
<tr>
<td>Domestic Hot Water</td>
<td>Green</td>
<td>White</td>
<td>DHW</td>
</tr>
</tbody>
</table>

### TABLE II. COLOR CODE MARKING SIZES

<table>
<thead>
<tr>
<th>Outside Diameter of Pipe Covering (in)</th>
<th>Width of Color Band (in)</th>
<th>Arrow Length X Width (in) x (in)</th>
<th>Size of Legend Letters and Numerals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 1-1/2</td>
<td>8</td>
<td>8 x 2</td>
<td>½</td>
</tr>
<tr>
<td>1-1/2 to 2</td>
<td>8</td>
<td>8 x 2</td>
<td>¾</td>
</tr>
<tr>
<td>2 to 6</td>
<td>12</td>
<td>8 x 2</td>
<td>1-1/4</td>
</tr>
<tr>
<td>8 to 10</td>
<td>24</td>
<td>12 x 3</td>
<td>2-1/2</td>
</tr>
<tr>
<td>Over 10</td>
<td>32</td>
<td>12 x 3</td>
<td>3</td>
</tr>
</tbody>
</table>

3.4 DUCT LABEL INSTALLATION

A. Install factory fabricated self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:

2. ANSI A13.1 Colors and Designs: For kitchen cooking hood exhaust.

B. Install factory fabricated self-adhesive duct labels with associated directional flow arrows on main supply, and return duct systems at points where ducts enter into shafts, chases, spaces above suspended ceilings and otherwise at maximum intervals of 50 feet along the entire main duct run.

1. Red with White Letters: Each system indicated.
3.5 VALVE-TAG INSTALLATION

A. Provide tags on each valve in piping systems including shutoff valves, balancing valves, pressure regulating valves, pressure relief valves and motor actuated valves. Tags are not required for check valves. List tagged valves in a valve schedule. Provide valve tags; 1 1/2 inches, round or square with black background and white lettering.

3.6 CEILING GRID TAGS

A. Install tags on ceiling grid below the following devices: Air terminal units, fire dampers, duct smoke detectors, main and sub-main shutoff valves.

3.7 WARNING LABEL AND WARNING TAG INSTALLATION

A. Identify emergency boiler shutoff switch and natural gas shutoff switch. Locate at device.

3.8 CONSTRUCTION WASTE MANAGEMENT

A. Comply with the Waste Management Plan specified in Section 01 74 19 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL for additional requirements.

END OF SECTION 23 05 53
SECTION 23 05 93
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 other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Test, adjust, and balance the following mechanical and plumbing systems:
   1. Hydronic Balancing Valves.
   2. DDC System Verification.
   3. Air Handling Units.
   5. Fan Powered Boxes.
   6. Air Inlets and Outlets.

B. This Section does not include:
   1. Specifications for materials for patching mechanical systems;
   2. Specifications for materials and installation of adjusting and balancing devices. If devices must be added to achieve proper adjusting and balancing, refer to the respective system sections for materials and installation requirements.
   3. Requirements and procedures for piping systems leakage tests.

C. Inspections: Testing, adjusting and balancing subcontractor shall make necessary preparations and have the required people, tools, and reports available, and be in attendance at all interim and final and other inspections. This is a part of the work.

D. Compliance: All Testing, Adjusting and Balancing Systems work shall comply with requirements of the Florida Building Code, ASHRAE, one of the nationally recognized standards (NEBB, AABC or TABB) and the requirements of this Section.

E. DALT: Observe and confirm Duct Air Leakage Testing at site.

1.3 DEFINITIONS


C. TAB: Testing, adjusting, and balancing.
D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An entity engaged to perform TAB Work.

F. Systems Testing Adjusting and balancing is the process of checking and adjusting all the building environmental systems to produce the design objectives. It includes:

1. The balance of water distribution;
2. Adjustment of total system to provide design quantities;
3. Electrical measurement;
4. Verification of performance of all equipment and automatic controls;
5. The balance of air systems.

G. Test: To determine quantitative performance of equipment.

H. Adjust: To regulate the specified fluid flow rate at the equipment (e.g., reduce flow, throttling).

I. Balance: To proportion flows within the distribution system (submains, branches, and terminals) according to specified design quantities.

J. Procedure: Standardized approach and execution of sequence of work operations to yield reproducible results.

K. Report forms: Test data sheets arranged for collecting test data in logical order for submission and review. These data should also form the permanent record to be used as the basis for required future testing, adjusting, and balancing.

L. Terminal: The point where the controlled fluid enters or leaves the distribution system. These are supply inlets on water terminals, supply outlets on air terminals, return outlets on water terminals, and exhaust or return inlets on air terminals such as registers, grilles, diffusers, louvers, and hoods.

M. Main: Duct or pipe containing the system's major or entire fluid flow.

N. Submain: Duct or pipe containing part of the systems' capacity and serving two or more branch mains.

O. Branch main: Duct or pipe serving two or more terminals.

P. Branch: Duct or pipe serving a single terminal.

Q. TAB: Testing, adjusting and balancing.

R. TABd: Tested, adjusted and balanced.

1.4 SUBMITTALS

A. Agency Data:

1. Submit proof that the proposed testing, adjusting, and balancing agency meets the qualifications specified below.
B. Engineer and Technicians Data:
   1. Submit proof that the Test and Balance Engineer assigned to supervise the procedures, and the technicians proposed to perform the procedures meet the qualifications specified below.

C. Procedures and Agenda: Submit a synopsis of the testing, adjusting, and balancing procedures and agenda proposed to be used for this project.

D. Maintenance Data: Submit maintenance and operating data that include how to test, adjust, and balance the building systems.

E. Sample Forms: Submit sample forms, if other than the AABC standard forms indicated are proposed.

F. Design Review Report:
   1. Prepare and submit a "Design Review Report" describing balance capability of systems; valves, dampers, access spaces, and any condition in the HVAC system's design that would preclude the TAB team from accomplishing the work in conformance with the requirements of this Section. Provide a complete explanation including supporting documentation detailing the design deficiency. State that no such deficiencies are evident if this is the case.

G. Pre-field Engineering Report:
   1. Submit pre-field engineering report containing the following information:
      a. Strategy: Describe the method of approach to the TAB field work from start to finish. Include in this description a complete methodology for accomplishing each seasonal TAB field work session.
      b. Procedural Steps: Delineate fully the intended procedural steps to be taken by the TAB field team to accomplish the required TAB work of each water distribution system. Include intended procedural steps for TAB work for subsystems and system components.
      c. Pre-field Data: The approved TAB data report forms with the following pre-field information filled in:
      d. TAB report sheet for each item of equipment and system to be balanced with design data obtained from system drawings.
      e. Notations detailing additional data to be obtained from the contract site by the TAB field team.
      f. All calculations that can be performed prior to start of actual TAB field work. Include air density corrections for non-standard air temperatures and non-sea level site elevations.
      g. Designate the actual data to be measured in the TAB field work.
      h. Provide a list of the types of instruments, and the measuring range of each, which are anticipated to be used for measuring in the TAB field work. By means of a keying scheme, specify on each TAB data report form submitted, which instruments will be used for measuring each item of TAB data. If the selection of which instrument to use, is to be made in the field, specify from which instruments
the choice will be made. The instrument key number shall be placed in the blank space where the measured data would be entered.

i. Prerequisite HVAC Work Checklist: A list of inspections and work items which are to be completed by the Contractor prior to the TAB team coming to the contract site.

H. Advance Notice:


I. Certified TAB Report

1. Submit final test and balance report in typewritten text to the Architect at a minimum of 48 hours prior to each inspection. Submit Certified TAB Report in the specified format including the following data:

2. Report Format: Submit the completed pre-field data forms approved in the pre-field engineering report; and submit data forms completed by TAB field team, reviewed and certified by the TAB supervisor.

3. Temperatures: On each TAB report form reporting TAB work accomplished on HVAC thermal energy transfer equipment, include the indoor and outdoor dry bulb temperature range and indoor and outdoor wet bulb temperature range within which the TAB data was recorded.

4. Instruments: List the types of instruments actually used to measure the tab data. Include in the listing each instrument's unique identification number, calibration date, and calibration expiration date.

5. Certification: Include the typed name of the TAB supervisor and the dated signature of the TAB supervisor.

J. Checkout List:

1. Submit "Prerequisite HVAC Work Checkout List" of the work items and certify in writing that each item has been checked and is operating as designed.

K. Sample TAB Report Forms

1. Forms: Submit an index of all AABC or NEBB TAB report forms, by form number to be used in the project's TAB data reporting.

L. Certified Reports: Submit testing, adjusting, and balancing reports bearing the seal and signature of the Test and Balance Engineer. The reports shall be certified proof that the systems have been tested, adjusted, and balanced in accordance with the referenced standards; are an accurate representation of how the systems have been installed; are a true representation of how the systems are operating at the completion of the testing, adjusting, and balancing procedures; and are an accurate record of all final quantities measured, to establish normal operating values of the systems. Follow the procedures and format specified below:

1. Draft reports: Upon completion of testing, adjusting, and balancing procedures, prepare draft reports on the approved forms. Draft reports may be hand written, but must be complete, factual, accurate, and legible. Organize and format draft reports in the same manner specified for the final reports. Submit 2 complete sets of draft reports. Only 1 complete set of draft reports will be returned.
2. Final Report: Upon verification and approval of draft reports, prepare final reports, type written, and organized and formatted as specified below. Submit 2 complete sets of final reports. Note that TABs of partial completed equipment and systems will not be acceptable.

3. Report Format: Report forms shall be those standard forms prepared by the referenced standard for each respective item and system to be tested, adjusted, and balanced. Bind report forms complete with schematic systems diagrams and other data in reinforced, vinyl, three-ring binders. Provide binding edge labels with the project identification and a title descriptive of the contents. Divide the contents of the binder into the below listed divisions, separated by divider tabs:

   a. General Information and Summary
   b. Airside Systems
   c. Waterside Systems
   d. Temperature Control Systems

4. Report Contents: Provide the following minimum information, forms and data:

   a. General Information and Summary: Inside cover sheet to identify testing, adjusting, and balancing agency, Contractor, Owner, Architect, Engineer, and Project. Include addresses, and contact names and telephone numbers. Also include a certification sheet containing the seal and name address, telephone number, and signature of the Certified Test and Balance Engineer. Include in this division a listing of the instrumentations used for the procedures along with the proof of calibration.

   b. The remainder of the report shall contain the appropriate forms containing as a minimum, the information indicated on the standard report forms for each respective item and system. Prepare a schematic diagram for each item of equipment and system to accompany each respective report form.

M. Calibration Reports: Submit proof that all required instrumentation has been calibrated to tolerances specified in the referenced standards, within a period of six months prior to starting the project.

N. TAB Schedule: Submit proposed schedule of TABs to enable constructed occupancy when scheduled by Construction manager to be completed for occupancy.

1.5 QUALITY ASSURANCE

A. General Qualifications: Subcontractors for the testing, adjusting and balancing HVAC systems work shall have successfully completed at least five similar projects that have had Daytona State College inspections within the past four years. The assigned on-site foreman or superintendent must also meet this requirement. Submit substantiating data if requested.

B. Test and Balance Engineer's Qualifications: A Professional Engineer (either on the installer's staff or an Independent Consultant), currently registered in the State of Florida, and having at least 10-years of successful testing, adjusting, and balancing experience on projects with testing and balancing requirements similar to those required for this project.

C. Agency Qualifications:
1. Employ the services of an independent testing, adjusting, and balancing agency meeting the qualifications specified below, to be the single source of responsibility to test, adjust, and balance the building systems identified, to produce the design objectives. Services shall include checking installations for conformity to design, measurement and establishment of the fluid quantities of the systems as required to meet design specifications, and recording and reporting the results.

2. An independent testing, adjusting, and balancing agency certified by Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB) in those testing and balancing disciplines required for this project, and having at least one Professional Engineer registered in the State in which the services are to be performed, certified by AABC as a Test and Balance Engineer.

D. Modifications of References:

1. Accomplish work in accordance with referenced publications of AABC except as modified by this specification section. In the references referred to herein, consider the advisory or recommended provisions to be mandatory, as though the word "shall" had been substituted for the words "should" or "could" or "may" wherever they appear. Interpret reference to the "authority having jurisdiction," the "Administrative Authority," the "Owner," or the "Design Engineer" to mean the "Architect."

E. Responsibilities:

1. The TAB Contractor is ultimately responsible for ensuring compliance with the requirements of this section. However, the following delineation of specific work responsibilities is specified to facilitate execution of the various work efforts by personnel from separate organizations. Additionally, this breakdown of specific duties is specified to facilitate adherence to the schedule listed in Appendix A, "Testing, Adjusting, and Balancing Submittal and Work Schedule" included at the end of this section.

F. TAB Team Supervisor:

1. Overall Management: Supervise and manage the overall TAB team work effort, including preliminary and technical TAB procedures and TAB team field work.

G. Pre-TAB Meeting: Attend meeting with Contractor.

1. Design Review Report: Review design review report, project specifications and accompanying drawings to verify that the air systems and water systems are designed in such a way that the TAB engineer can accomplish the work in conformance with the requirements of this Section. Verify the presence and location of permanently installed test ports and other devices needed, including gage cocks, thermometer wells, flow control devices, flow meters, and balancing valves.

2. Support Required: Specify what technical support personnel are required from the Contractor other than the TAB agency, in other words, factory representatives for temperature controls or for equipment. Inform the Contractor in writing of the support requirements, in other words; what support personnel are needed and when they are needed. Furnish the notice as soon as the need is anticipated, either at the plan review report, or the pre-field engineering report, or during the TAB field work.
H. Pre-field Engineering Report: Utilize the following HVAC-related documentation: Contract Drawings and Specifications, approved installer submittal data for equipment, up-to-date Contract Document revisions and change orders; prepare this report.

I. Prerequisite HVAC Work Checklist: Identify through construction observation, any items which inhibit the TABs Agency from conducting their work. Ensure the Contractor gets a copy of this checklist at the same time as the pre-field engineering report is submitted.

J. Technical Assistance:
   1. Provide immediate technical assistance to TAB field team.
   2. Field Visit: After systems installation has commenced, visit the contract work site to inspect the installation and the progress of the TAB field work. Conduct these site visits weekly. Submit field report indicating any deficiencies, or sign-off on the construction to date. This includes HVAC control system components.
   3. Field Visit: Thirty days prior to the start of TAB work, visit the contract work site to inspect the installation. Inspect the system installation and report to Contractor and Architect the condition of the system and equipment.
   4. Field Visit: Near the end of the TAB field work effort, visit the contract work site to inspect the progress of the TAB field work. Review the TAB final report data and certify the final TAB report.

K. System Deficiencies: Submit in writing within one calendar week of each site visit to the Contractor and Architect, each system deficiency reported by the TAB field team. Provide in this submittal, a complete explanation including supporting documentation detailing the deficiency. Corrective work required for systems balance ability detected during balancing work shall be reported to the Architect with recommended corrective action.

L. Certified Report: Certify the TAB report. This certification includes the following work:
   1. Review: Review the TAB field data report. From this field report, prepare the certified TAB report.
   2. Verification: Verify adherence, by the TAB field team, to the TAB plan prescribed by the pre-field engineering report and verify adherence to the procedures specified in this section.

M. TAB Team Field Leader:
   1. Field Manager: Manage, in the field, the accomplishment of the work specified in Part 3 of this section.
   2. Full Time: Be present at the contract site when TAB field work is being performed by the TAB team; ensure day-to-day TAB team work accomplishments are in compliance with this section.
   3. Prerequisite Work: Do not bring the TAB team to the project site until a copy of the prerequisite checklist has been returned to the TAB Agency with Contractor certification that the items on the list are resolved/working as designed.

N. Codes and Standards:
   1. AABC: "National Standards for Total System Balance".
2. NEBB: Procedural Standard for Testing, Adjusting and Balancing of Environmental Systems."

O. Pre-Balancing Conference: Prior to beginning of the testing, adjusting, and balancing procedures, schedule and conduct a conference with the Architect and Contractor. The objective of the conference is final coordination and verification of system operation and readiness for testing, adjusting, and balancing.

1.6 PROJECT CONDITIONS
A. Full Owner Occupancy: Owner may occupy portions of the site and building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Systems and equipment shall be fully operational prior to TAB work.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION
3.1 EXAMINATION
A. Examine the Contract Documents, Contractor Product Submittals and Contractor Shop Drawings to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

B. Examine systems for installed system accessories, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, manual and motor actuated dampers. Verify that locations of these balancing devices are accessible.

C. Examine the approved submittals for systems and equipment.

D. Examine design data including system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about system and equipment controls.

E. Examine equipment performance data including fan curves, pump curves, and performance data of all heat generating devices such as chillers, boilers, and water heaters.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

2. Calculate system-effect factors to reduce performance ratings of airside equipment when installed under conditions different from the conditions used to rate equipment performance. Utilize AMCA 201 “Fans and Systems”.
F. Examine system and equipment installations and verify that field quality-control testing, manufacturer start up testing, cleaning, and adjusting specified in individual Sections have been performed.

G. Examine test reports specified in individual system and equipment Sections.

H. Examine HVAC and Plumbing equipment, filters and pipeline strainers and verify that bearings are greased, systems are free of fouling, and equipment with functioning controls is ready for operation.

I. Examine pipeline strainers and filters. Verify that startup screens are replaced by permanent screens with indicated perforations and that clean media is installed at filters.

J. Examine operation of motor actuated valves and dampers.

K. Examine system pumps to ensure absence of entrained air in the suction piping.

L. Examine heat transfer coils, boilers.

M. Examine operating safety interlocks and controls on equipment.

N. Examine operating safety interlocks and HVAC controls.

O. Examine air terminal units; verify accessibility, calibration and controls.

P. Examine air handling units including condition of coils and that the indicated filters are installed.

Q. Examine exhaust fans.

R. Examine motor rotation.

S. 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 TAB PROCEDURES

A. Test, adjust, and balance the listed systems to the state of operation indicated on and specified in the contract design documents. Provide instruments and consumables required to accomplish the TAB work. Conduct TAB work, on the listed systems in conformance with the AABC NSTSB, except as modified by this section:

1. Maintenance and Calibration of Instruments.
2. Accuracy of Measurements.

B. Testing, adjusting and balancing of the systems shall be coordinated with the control system installation. All control components shall be verified to be properly installed and operating as specified before proceeding with testing, adjusting and balancing.
C. Preliminary Procedures: Use the approved pre-field engineering report as instructions and procedures for accomplishing TAB field work. Plan TAB field procedures, including selecting locations for TAB test ports and accesses, and record preliminary field data.

1. Water Distribution Systems TAB Work:
   a. Heating water systems including boilers, filters, pumps, balance valves regulating valves and flow measurement devices.
   b. Domestic chilled and hot water recirc balancing valves and pumps.

2. Airside Systems TAB Work
   a. Supply, return and exhaust systems including fans and ductwork dampers.
   b. Air handling unit fans, coils AHU dampers and ductwork dampers.
   c. Air terminal units.
   d. Air outlets and inlets.

D. Adjustment of Equipment-General:

1. Equipment shipped to site may be set at factory to provide ideal performance based on information in schedules on contract drawings. It is this contractor's responsibility to test, adjust and balance each component and accessory of mechanical construction to acquire performance noted on drawings under actual installed conditions. Where adjustment is required to belt-driven equipment, provide the determination of replacement sheave sizes; replace sheaves and belts to acquire correct performance.

E. TAB Work on Performance Tests:

1. Performance Tests: In addition to the TAB proportionate balancing work on the water distribution systems, accomplish TAB work on the systems which directly transfer thermal energy. TAB the operational performance of the cooling systems.

2. Ambient Temperatures: On each tab report form used for recording data, record the outdoor and indoor ambient dry bulb temperature range and the outdoor and indoor ambient wet bulb temperature range within which the report form's data was recorded. That is, record these temperatures at beginning and at the end of data taking.

F. Workmanship: Conduct TAB work on specified systems until measured parameters are within plus or minus 5 percent of the design values, that is, the values specified or indicated on the contract documents.

G. Deficiencies: Strive to meet the intent of this section to maximize the performance of the equipment as designed and installed. However, if deficiencies in equipment design or installation prevent TAB work from being accomplished within the range of design values specified in the paragraph titled, "Workmanship," provide written notice as soon as possible to the Contractor and Architect describing the deficiency and recommended correction. Responsibility for correction of installation deficiencies is the installing Contractor's. If a deficiency is in equipment design, call the TAB team supervisor for technical assistance. Responsibility for reporting design deficiencies to Architect is the TAB team supervisor's. After deficiencies have been corrected by installing contractor, re-conduct TAB work until performance is achieved as specified under "workmanship."
H. When averaging values, take a sufficient quantity of readings which will result in a repeatability error of less than 5 percent. When measuring a single point, repeat readings until 2 consecutive identical values are obtained.

I. Take all reading with the eye at the level of the indicated value to prevent parallax.

J. Use pulsation dampeners where necessary to eliminate error involved in estimating average of rapidly fluctuation readings.

K. Take measurements in the system where best suited to the task.

3.3 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system-readiness checks and prepare reports. Verify the following:

1. Permanent electrical-power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Potable water systems are filled.
4. Automatic temperature-control systems are operational.
5. Equipment and duct access doors are securely closed.
6. Balance, smoke, and fire dampers are open.
7. Isolating and balancing valves are open and control valves are operational.
8. Ceilings are installed.
9. Windows and doors can be closed so indicated conditions for system operations can be met.
10. Access is available to equipment, valves and dampers.
11. Heat generating, prime movers and heat transfer equipment is capable of operation.

3.4 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance", or NEBB Procedural Standard for testing adjusting and balancing of environmental systems, and the requirements of this section.

1. Comply with requirements in ASHRAE 62.1-2010, Section 7.2.2, "Air Balancing."

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts plastic compression plugs.
2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC and Plumbing Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.5 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts using Contractor prepared Shop Drawings specified in Division 23 Sections.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

L. Verify that air duct system is sealed as specified in Division 23 Section "Metal Ducts."

3.6 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.
   a. Provide averaging pitot measurements at each main supply, return, and exhaust and outdoor air duct.
   b. Provide airflow summary of each air terminal unit, through diffuser and register summary.
   c. Provide air flow summary by register quality of each return and exhaust air system.
   d. Provide exhaust and supply air summary for each kitchen and dishwasher hood.

2. Measure fan static pressures as follows to determine actual static pressure:
a. Measure outlet static pressure as far downstream from the fan as practical 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 the 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.

3. Measure static pressure across each component that makes up air-handling unit equipment, and make-up air equipment, provide static pressure profile of each air handling unit and make-up air unit.
   a. Report the cleanliness status of filters and the time static pressures are measured.

4. Measure static pressures entering and leaving other devices, such as filters under final balanced conditions.
5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
6. Obtain approval from Architect and Construction Manager for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Division 23 Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
7. Do not make fan-speed adjustments that result in operation above the motor service factor. 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, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
   1. Measure airflow of submain and branch ducts.
      a. 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. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
   3. Re-measure 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 air outlets and inlets without making adjustments.
   1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust air outlets and inlets dampers for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers.
1. Adjust each outlet in the same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.7 GENERAL PROCEDURES FOR HYDRONIC AND POTABLE WATER SYSTEMS

A. Prepare test reports with pertinent design data.

B. Prepare schematic diagrams of systems' "as-built" piping layouts using Contractor prepared Shop Drawings specified in Division 22 and 23 Sections.

C. Prepare hydronic and potable water systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
   1. Open all manual valves for maximum flow.
   2. Check makeup water pressure gage for adequate pressure for highest vent.
   3. Check motor actuated valves for specified sequence of operation, and set at indicated flow.
   4. Set system controls so motor actuated valves are wide open according to sequence of operation.
   5. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.8 PROCEDURES FOR CONSTANT-FLOW HYDRONIC AND POTABLE WATER SYSTEMS

A. Use the following procedures:
   1. Report flow rates that are not within plus 5 percent of design.

B. Measure flow at all balancing valves to verify that valves are functioning as designed.

C. Set manual balancing valves, if installed, at calculated presettings.

D. Record flow at all flow meters.

E. Measure flow at main balancing valves and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

F. Adjust balancing valves to within specified tolerances of indicated flow rate as follows:
   1. Determine the balancing station with the highest percentage over indicated flow.
   2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
   3. Record settings and mark balancing devices.

G. Measure the differential-pressure-transmitter settings existing at the conclusion of balancing.

H. Check settings and operation of each safety valve.
3.9 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
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 of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.10 TOLERANCES

A. Set system's air flow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Design value or plus 5 percent.
2. Air Outlets and Inlets: Design value or plus 5 percent.
3. Heating-Water Flow Rate: Design value or plus 5 percent.
4. Cooling-Water Flow Rate: Design value or plus 5 percent.
5. Potable-Water Flow Rate: Design value or plus 5 percent, plus a maximum 15 second time delay after each faucet is open to acquire potable hot water of the design temperature at fixtures.

3.11 AIR BALANCING - ROOM PRESSURIZATION VERIFICATION:

A. Perform room pressurization verification at all doors and openings into rooms which are indicated to be negative in relation to the adjacent space. Test systems in each operational mode and verify that correct air flow direction at doorways and correct CFM offset between terminal units is maintained in any mode. Indicate if the room “passed” in the air balance report. Verify that all architectural door sealing treatments have been installed and patching of penetrations in room general construction has been completed. Conduct final testing and balancing with all doors closed.

3.12 DUCT AIR LEAKAGE TESTING (DALT)

A. Meet with the Contractor to develop a mutual understanding relative to the details of the DALT work. Ensure that the TAB supervisor is present at this meeting. Requirements to be discussed include required submittals, work schedule, and field quality control. Coordinate required DALT schedule with Section 23 31 13, “Metal Ducts” installers.
B. DALT Procedures: Provide instruments, consumables and personnel required to observe and validate the DALT field work. Follow the same basic procedure specified below for TAB Field Work including maintenance and calibration of instruments, accuracy of measurements, preliminary procedures, field work, workmanship and treatment of deficiencies. Verify that DALT equipment is calibrated in accordance with manufacturer's written procedures.

3.13 PERFORMING TESTING, ADJUSTING, AND BALANCING

A. Perform testing and balancing procedures on each system identified, in accordance with the requirements of this Section and as augmented by detailed procedures outlined in the referenced standards.

B. Cut ductwork for installation of test probes to the minimum extent necessary to allow adequate performance of procedures.

C. Seal any insulation disturbed during TABS to re-establish integrity of the vapor barrier.

D. Mark equipment settings, including valve indicators, fan speed control levers, and similar controls and devices, to show final settings. Mark with paint or other suitable, permanent identification materials.

E. Retest, adjust, and balance systems subsequent to significant system modifications, and resubmit test results.

3.14 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 systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: Prepare biweekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.15 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.

2. Include a list of instruments used for procedures, along with proof of calibration.

B. Final Report Contents: In addition to certified field-report data, include the following:
1. Fan curves.
2. Pump curves.
3. Manufacturers’ start-up test checkout lists for chillers, boilers, water heaters, pumps and air handling units.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB contractor.
3. Project name.
4. Project location.
5. Architect’s name and address.
6. Engineer’s name and address.
7. Contractor’s name and address.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:
   a. Indicated versus final performance.
   b. Notable characteristics of systems.
   c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:
   a. Settings for outdoor-, return-, and exhaust-air dampers.
   b. Condition of filters.
   c. Cooling coil, wet- and dry-bulb entering and leaving conditions at maximum summer seasonal load.
   d. Fan drive settings including settings and percentage of maximum pitch diameter.
   e. Variable frequency drive settings for variable-air-volume and variable-water-volume systems.
   f. Settings for supply-air, static-pressure controllers.
   g. Settings for waterside differential pressure transmitters.
   h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
7. Position of balancing valves and dampers.

E. Air-Handling-Unit Test Reports: For air-handling units and make-up air units, include the following:

1. Unit Data:
   a. Unit identification.
   b. Location.
   c. Make and type.
   d. Model number and unit size.
   e. Manufacturer's serial number.
   f. Unit arrangement and class.
   g. Discharge arrangement.
   h. Sheave make, size in inches, and bore.
   i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
   j. Number, make, and size of belts.
   k. Number, type, and size of filters.

2. Motor Data:
   a. Motor make, and frame type and size.
   b. Horsepower and rpm.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Operating amperage.
   f. Sheave make, size in inches, and bore.
   g. Center-to-center dimensions of sheave, and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):
   a. Total air flow rate in cfm.
   b. Total system static pressure in inches wg.
   c. Fan rpm.
   d. Discharge static pressure in inches wg.
   e. Filter static-pressure differential in inches wg.
   f. Preheat-coil static-pressure differential in inches wg.
   g. Cooling-coil static-pressure differential in inches wg.
   h. Heating-coil static-pressure differential in inches wg.
   i. Outdoor airflow in cfm.
   j. Return airflow in cfm.
   k. Outdoor-air damper position.
   l. Return-air damper position.

F. Fan Test Reports: For supply, make-up, and exhaust fans, include the following:

1. Fan Data:
   a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches, and bore.
h. Center-to-center dimensions of sheave, and amount of adjustments in inches.

2. Motor Data:
   a. Motor make, and frame type and size.
   b. Horsepower and rpm.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Operating amperage.
   f. Sheave make, size in inches, and bore.
   g. Center-to-center dimensions of sheave, and amount of adjustments in inches.
   h. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm.
   b. Total system static pressure in inches wg.
   c. Fan rpm.
   d. Discharge static pressure in inches wg.
   e. Suction static pressure in inches wg.

G. Round and Rectangular Duct Traverse Reports: Provide a traverse of each main supply, return, make-up air and exhaust duct. Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:
   a. System and air-handling-unit number.
   b. Location and zone.
   c. Traverse air temperature in deg F.
   d. Duct static pressure in inches wg.
   e. Duct size in inches.
   f. Duct area in sq. ft.
   g. Indicated air flow rate in cfm.
   h. Indicated velocity in fpm.
   i. Actual air flow rate in cfm.
   j. Actual average velocity in fpm.
   k. Barometric pressure in psig.

H. Air-Terminal-Unit Reports:

1. Unit Data:
   a. System and air-handling unit identification.
   b. Location and zone.
c. Apparatus used for test.
d. Area served.
e. Make.
f. Number from system diagram.
g. Type and model number.
h. Inlet Size.
i. Effective area in sq. ft.

2. Test Data (Indicated and Actual Values):

a. Air flow rate in cfm.
b. Air velocity in fpm.
c. Preliminary air flow rate as needed in cfm.
d. Preliminary velocity as needed in fpm.
e. Final air flow rate in cfm.
f. Final velocity in fpm.
g. Space temperature in deg F.

I. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:

a. System and air-handling-unit identification.
b. Location and zone.
c. Room or riser served.
d. Coil make and size.
e. Flowmeter type.

2. Test Data (Indicated and Actual Values):

a. Air flow rate in cfm.
b. Entering-water temperature in deg F.
c. Leaving-water temperature in deg F.
d. Water pressure drop in feet of H2O.
e. Entering-air temperature in deg F.
f. Leaving-air temperature in deg F.

J. Pump, Boiler, Test Reports: Include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. For pumps note actual impeller size.
g. Natural gas and propane input for each boiler and water heater.

2. Pump Motor Data:
a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Operating amperage.

3. Test Data (Indicated and Actual Values):
   a. Total air flow rate in gpm.
   b. Suction pressure for pumps in feet of H2O.
   c. Discharge pressure for pumps in feet of H2O.
   d. Inlet and outlet temperatures of each chiller and boiler.
   e. Differential pressure of each chiller and boiler at system full flow.

K. Instrument Calibration Reports:
   1. Report Data:
      a. Instrument type and make.
      b. Serial number.
      c. Application.
      d. Dates of use.
      e. Dates of calibration.

3.16 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. Check the following for each system with locations identified by Architect:
      a. Measure airflow of at least 10 percent of air outlets and percent of air inlets.
      b. Measure water flow of at least 5 percent of Air Terminal Units.
      c. Measure room temperature and humidity at each thermostat/temperature sensor. Compare the reading to the set point.
      d. Verify that balancing devices are marked with final balance position.
      e. Note deviations from the Contract Documents in the final report.

B. Final Inspection:
   1. After initial inspection is complete and documentation 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 Architect, Owner and Commissioning Authority.
   2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Architect and Owner.
   3. Architect and Owner shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total
measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

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.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.

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

D. Prepare test and inspection reports.

E. Final report shall be reviewed and approved by engineer of record, with approved copies available at final inspection.

3.17 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

3.18 ADDITIONAL REQUIREMENTS AND INSTRUCTIONS

A. The Test and Balance Subcontractor must review and report any deficiencies or sign off on the contract documents and shop drawings before the HVAC subcontractors start any on site construction work. Test and Balance Report to be provided for project manager, architect and engineering.

B. The Test and Balance Subcontractor must inspect the HVAC work installation every two weeks as it proceeds and report any deficiencies and sign off on the work to date. This includes the control system.

C. The Test and Balance contractor shall witness all DALT and verify the requirements are met for construction; sealing and leakage.

D. Thirty (30) days before starting the Test and Balance work, the T & B subcontractor must inspect the HVAC system and report to the A/E the condition of the system and equipment.
E. Test and Balance contractor shall attend all final inspections.

F. Corrective work required for systems balance ability, if detected during balancing work, shall be reported in writing to the A/E with recommended corrective action.

G. The Test and Balance contractor shall schedule his work so as to complete it and provide a typed report that will meet all Florida Building Code, ASHRAE, and one of the nationally recognized standards (NEBB, AABC or TABB) requirements, to the owner 48 hours prior to the inspection.

H. Provide the services of a TAB engineer or technician in responsible charge of the work in this section to participate in the work specified in Section 23 08 00 COMMISSIONING OF HVAC SYSTEMS. Coordinate work and the time required to assist in commissioning with the requirements of Section 23 08 00, “COMMISSIONING OF HVAC”.

3.19 CONSTRUCTION WASTE MANAGEMENT

A. Comply with the Waste Management Plan specified in Section 01 74 19 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL for additional requirements.
APPENDIX A

TAB SUBMITTAL AND WORK SCHEDULE

NOTE: Compliance with the following schedule is the Contractor's responsibility.

1. Qualify TAB Personnel: Within 45 calendar days after date of contract award, submit TAB agency and personnel qualifications.

2. Design Review Report: Within 60 calendar days after the date of the TAB agency personnel qualifications approval, submit design review report.

3. Pre-Field TAB Engineering Report: Within 60 calendar days after approval of the TAB Agency Personnel Qualifications, submit the Pre-Field TAB Engineering Report.

4. Checklist and Notice of TAB Work: At a minimum of 90 calendar days prior to substantial completion date, submit prerequisite HVAC work checklist certified as complete, and submit advance notice of commencement of TAB field work.

5. TAB Field Work: At a minimum of 30 calendar days prior to substantial completion date and when the ambient temperature is within Season 1 limits, accomplish TAB field work.

6. Submit TAB Report: No longer than 15 calendar days after completion of TAB field work, but prior to final inspection, submit certified TAB report.

7. TAB Field Check: 30 calendar days after certified TAB report is approved by the Architect, conduct field data check.

END OF SECTION 23 05 93
PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section includes insulation for mechanical and plumbing piping, ductwork and equipment.

1.3 SUBMITTALS
   A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor
      permeance thickness, and jackets (both factory and field applied if any). Submit an
      insulation schedule indicating manufacturer product number, thickness, density, jacket, sealant,
      and accessories for insulation products proposed for each pipe system, duct system and
      equipment specified to be insulated.

   B. Remaining paragraphs are defined in Division 01 Section "Submittal Procedures" as
      "informational submittals."

   C. Qualification Data: For qualified Installer.

   D. Material Test Reports: From a qualified testing agency acceptable to authorities having
      jurisdiction indicating, interpreting, and certifying test results for compliance of insulation
      materials, sealers, attachments, cements, and jackets, with requirements indicated. Include
      dates of tests and test methods employed.

1.4 QUALITY ASSURANCE
   A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship
      program or another craft training program certified by the Department of Labor, Bureau of
      Apprenticeship and Training.

   B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing
      identical products according to ASTM E 84, by a testing and inspecting agency acceptable to
      authorities having jurisdiction. Factory label insulation and jacket materials and adhesive,
      mastic, tapes, and cement material containers, with appropriate markings of applicable testing
      agency.
1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature. Store materials indoors where unaffected by weather.

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 23 05 29 "Hangers and Supports for HVAC and Plumbing Piping and Equipment."
B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with insulation schedules in Part 3 of this section for insulating materials.
B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Products: Subject to compliance with requirements, provide the following:
   a. Pittsburgh Corning Corporation; Foamglas.

2. Block Insulation: ASTM C 552, Type I.
3. Special-Shaped Insulation: ASTM C 552, Type III.
4. Board Insulation: ASTM C 552, Type IV.
5. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Aeroflex USA, Inc.; Aerocel.
   b. Armacell LLC; AP Armaflex.
   c. K-Flex USA; Insul-Sheet and K-FLEX LS.

H. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type I with factory applied FSK jacket. Factory-applied jacket requirements are specified in “Factory-Applied Jackets” Article.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. CertainTeed Corp.; SoftTouch Duct Wrap.
   b. Johns Manville; Microlite.
   c. Knauf Insulation; Friendly Feel Duct Wrap.
   d. Ownes Corning; SOFTR All-Service Duct Wrap.

I. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. Provide insulation with or without factory-applied jacket as indicated. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. CertainTeed Corp.; CertaPro Commercial Board.
   b. Fibrex Insulations Inc.; FBX.
   c. Johns Manville; 800 Series Spin-Glas.
   d. Knauf Insulation; Insulation Board.
   e. Manson Insulation Inc.; AK Board.
   f. Owens Corning; Fiberglas 700 Series.

J. Mineral-Fiber, Preformed Pipe Insulation:
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Fibrex Insulations Inc.; Coreplus 1200.
   b. Johns Manville; Micro-Lok.
   c. Knauf Insulation; 1000-Degree Pipe Insulation.
   d. Manson Insulation Inc.; Alley-K.
   e. Owens Corning; Fiberglas Pipe Insulation.
2. Type I, 850 Deg F (454 Deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with or without factory-applied jacket as indicated. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

3. Type II, 1200 Deg F (649 Deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, with or without factory-applied jacket as indicated. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

4. Type I, 850 deg F (454 Deg C) Mineral fiber with Integral Wicking Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547 including factory-applied jacket with manufacturer furnished jacket perforation panels.

K. Mineral-Fiber Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ jacket complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. (40 kg/cu. m) or more. Thermal conductivity (k-value) at 100 deg F (55 deg C) is 0.29 Btu x in./h x sq. ft. x deg F (0.042 W/m x K) or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. CertainTeed Corp.; CrimpWrap.
   b. Johns Manville; MicroFlex.
   c. Knauf Insulation; Pipe and Tank Insulation.
   d. Manson Insulation Inc.; AK Flex.
   e. Owens Corning; Fiberglas Pipe and Tank Insulation.

2.2 ADHESIVES

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

B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F (minus 73 to plus 93 deg C).

1. Products: Subject to compliance with requirements, provide the following:
   a. Foster, Brand, Construction Products; 81-84.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Use adhesive that complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.

C. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide one of the following:
a. Aeroflex USA, Inc.; Aeroseal.
b. Armacell LLC; Armaflex 520 Adhesive.
c. Foster, H. B. Fuller Construction Products; 85-75.
d. K-Flex USA; R-373 Contact Adhesive.
e. Childers, H.B. Fuller Construction Products, CP-82.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Use adhesive that complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.

D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide one of the following:
   b. Eagle Bridges – marathon Industries; 225.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Use adhesive that complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.


1. Products: Subject to compliance with requirements, provide one of the following:
   b. Eagle Bridges – marathon Industries; 225.

2. For indoor applications, use adhesive that has VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Use adhesive that complies with the testing and product requirements of the California Department of Health Services’ “Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers,” including 2004 Addenda.
2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II, and ASTM D 5590 as noted.

1. For indoor applications, use mastic that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Foster, H. B. Fuller Construction Products; 30-80/30-90AF.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.

3. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).

4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.


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

1. Products: Subject to compliance with requirements, provide one of the following:
   c. Eagle Bridges – Marathon Industries; 550.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms on 0.0625-inch dry film thickness.

3. Service Temperature Range: Minus 20 to plus 180 deg F.

4. Solids Content: 60 percent by volume and 66 percent by weight.


2.4 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A and ASTM D 5590 as noted. Materials shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers, H. B. Fuller Construction Products; CP-50 AHV2CP137 AF.
   b. Foster, H. B. Fuller Construction Products; 30-36 AF.

3. Mold resistant, fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.

4. Service Temperature Range: 0 to plus 180 deg F (Minus 18 to plus 82 deg C).

2.5 SEALANTS

A. Joint Sealants:
   1. Joint Sealants for Cellular-Glass Products: Subject to compliance with requirements, provide one of the following:
      a. Childers, H. B. Fuller Construction Products; CP-76.
      b. Eagle Bridges - Marathon Industries; 405.
      c. Foster, H. B. Fuller Construction Products; 30-45, 95-50.
      d. Mon-Eco Industries, Inc.; 44-05.
      e. Pittsburgh Corning Corporation; Pittseal 444.
   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Permanently flexible, elastomeric sealant.
   4. Service Temperature Range: Minus 100 to plus 300 deg F (Minus 73 to plus 149 deg C).
   5. Color: White, gray or tan.
   6. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   7. Use sealants that comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.

B. FSK and Metal Jacket Flashing Sealants:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers, H. B. Fuller Construction Products; CP-76.
      b. Eagle Bridges - Marathon Industries; 405.
      c. Foster, H. B. Fuller Construction Products; 95-44.
      d. Mon-Eco Industries, Inc.; 44-05.
   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Fire- and water-resistant, flexible, elastomeric sealant.
   4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
   5. Color: Aluminum, or gray.
   6. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   7. Use sealants that comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.

C. ASJ Flashing Sealants:
   1. Products: Subject to compliance with requirements, provide one of the following:
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
5. Color: White, or aluminum to match substrate.
6. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Use sealants that comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.7 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric: Approximately 2 oz./sq. yd. (68 g/sq. m) with a thread count of 10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm) for covering pipe and pipe fittings.

1. Products: Subject to compliance with requirements, provide the following:
   a. Childers, H. B. Fuller Construction Products; Chil-Glas Number 10.

B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. (34 g/sq. m) with a thread count of 10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm), in a Leno weave, for pipe.

1. Products: Subject to compliance with requirements, provide one of the following:
   b. Vimasco Corporation; Elastafab 894.

2.8 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. Metal Jacket:
1. Products: Subject to compliance with requirements, provide one of the following:
   a. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
   b. RPR Products, Inc.; Insul-Mate.

   a. Sheet and roll stock ready for shop or field sizing and factory cut and rolled to size.
   b. Provide minimum 0.023 inch thick material.
   c. Moisture Barrier for Indoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper.
   d. Factory-Fabricated Fitting Covers:
      1) Same material, finish, and thickness as jacket.
      2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      3) Tee covers.
      4) Flange and union covers.
      5) End caps.
      6) Beveled collars.
      7) Valve covers.
      8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

3. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M. Provide smooth outer finish without corrugations and/or surface stippling.
   a. Sheet and roll stock ready for shop or field sizing and factory cut and rolled to size.
   b. Provide minimum 0.023 inch thickness material.
   c. Moisture Barrier for Indoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper.
   d. Factory-Fabricated Fitting Covers:
      1) Same material, finish, and thickness as jacket.
      2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      3) Tee covers.
      4) Flange and union covers.
      5) End caps.
      6) Beveled collars.
      7) Valve covers.
      8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.9 FIELD APPLIED CORNER ANGLES

A. Shop fabricated Type G90 galvanized steel. Minimum one inch by one inch angle stock of minimum 26 gage sheet metal.
2.10 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. ABI, Ideal Tape Division; 428 AWF ASJ.
      b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
      c. Compac Corporation; 104 and 105.
      d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
   2. Width: 3 inches (75 mm).
   3. Thickness: 11.5 mils (0.29 mm).
   4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
   7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. ABI, Ideal Tape Division; 491 AWF FSK.
      b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
      c. Compac Corporation; 110 and 111.
      d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
   2. Width: 3 inches (75 mm).
   3. Thickness: 6.5 mils (0.16 mm).
   4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
   7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

2.11 SECUREMENTS

A. Bands:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. ITW Insulation Systems; Gerrard Strapping and Seals.
      b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
   2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch (0.38 mm) thick, 3/4 inch (19 mm) wide with closed seal.
   3. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.023 inch thick, 3/4 inch (19 mm) wide with closed seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.

C. Wire: 0.062-inch (1.6-mm) soft-annealed, stainless steel.
1. Manufacturers: Subject to compliance with requirements, provide the following:

D. Insulation Pins and Hangers:
1. Capacitor-Discharge-Weld Pins: Copper or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch diameter shank, length to suit depth of insulation indicated.
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) AGM Industries, Inc.; CWP-1.
      2) GEMCO; CD.
      3) Midwest Fasteners, Inc.; CD.
      4) Nelson Stud Welding; TPA, TPC, and TPS.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) AGM Industries, Inc.; CHP-1.
      2) GEMCO; Cupped Head Weld Pin.
      3) Midwest Fasteners, Inc.; Cupped Head.
      4) Nelson Stud Welding; CHP.

2.12 INSULATION TYPES

A. Piping Insulation: Material and thicknesses shall conform to Insulation Schedule. Insulation composite/facing shall have a flame spread not greater than 25 and a smoke developed rating not exceeding 50 when tested in accordance with ASTM E 84, UL 723, and NFPA 255. Moisture vapor transmission of all service jacket shall be not greater than 0.02 perms when tested in conformance with ASTM E 96, method A.

1. Pipe Insulation - Type P1: Mineral fiber-preformed. Sections shall have a single seam that opens to receive the pipe and snaps closed after it is in place. Pipe insulation shall be complete with factory applied all service jacket. The all service jacket (ASJ) shall be reinforced with fiberglass scrim, and include a longitudinal lap, complete with pressure sensitive self sealing lap closure system (SSL).
2. Pipe Insulation - Type P2: Cellular Glass Insulation. Provide with a factory applied or field applied all service jacket (ASJ).


4. Pipe Insulation - Type P4: Flexible elastomeric cellular insulation. Type II shall have vapor retarder skin on both sides of the insulation, preformed, un-slit, to match diameter of piping system.

5. Pipe Insulation - Type P5: Wicking Type Mineral fiber-preformed. Sections shall have a single seam that opens to receive the pipe and snaps closed after it is in place. Pipe insulation shall be complete with factory applied all service jacket which includes factory applied perforation panels. The all service jacket (ASJ) shall be reinforced with fiberglass scrim, and include a longitudinal lap, complete with pressure sensitive self-sealing lap closure system (SSL).

B. Equipment Insulation: Material and thickness shall conform with Insulation Schedule. Increase the specified insulation thickness for equipment only where necessary to equal the thickness of angles or other structural members to make a smooth, exterior surface. Additional insulation is not required for factory-insulated equipment.

1. Equipment Insulation - Type E1: Mineral fiber board insulation. Rigid insulation board composed of glass fibers bonded together with a thermosetting binder and faced with an all service jacket (ASJ) facing. ASJ shall be fabricated of white kraft and aluminum foil laminate, with the white kraft facing out, reinforced with fiberglass scrim.

2. Equipment Insulation - Type E2: Mineral fiber tank insulation.

3. Equipment Insulation - Type E3: Cellular Glass Insulation

4. Equipment Insulation - Type E4: Flexible elastomeric insulation. Type II shall have vapor retarder skin on both sides of the insulation. Pre-formed sheet stock.

C. Ductwork Insulation: Material and thickness shall conform to Part 3 of this section. Increase the specified insulation thickness where necessary to equal the dimension of angles and other structural members.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 PREPARATION

A. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F (0 and 149 deg C) with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

B. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond all longitudinal and butt seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches (50 mm) o.c.
      a. Apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:
   1. Vibration-control devices.
   2. Testing agency labels and stamps.
   3. Nameplates and data plates.
   5. Handholes.
   6. Cleanouts.

3.4 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
   1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
   2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly
against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation. Note that PVC fitting covers with insulation fill are not an acceptable substitute.

3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive. Note that PVC fitting covers with insulation fill are not an acceptable substitute.

4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of preformed pipe insulation sized to the flange radius. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with adhesive sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) over
adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Finish all exposed piping insulation surfaces with a metal jacket.

3.5 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches (150 mm) o.c.
4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.
5. Provide vapor barrier and field applied ASJ.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Provide vapor barrier seal and field applied ASJ.

E. Pump Insulation: Insulate by forming a two-section box around the pump housing constructed of reinforced aluminum sheet materials. The box shall be removable, configured with an easily removable top. The box shall be fully lined with 2 inch thick cellular glass material. All joints
and contact surfaces to the metal box shall be fully covered with insulation adhesive to form a vapor tight seal. Joints between top cover and sides shall fit tightly forming a female shiplap joint on the side pieces and a male joint on the top cover, thus making the top cover removable, including separate jacketing on the removable section.

1. Upon completion a parting line shall be provided between the box and the removable sections allowing the removable sections to be removed without disturbing the insulation. Provide penetrations for the miscellaneous pump drain and control pipe tappings. Caulking shall be applied to parting line, between equipment and removable section insulation, and at all penetrations. Pipe unions shall be installed in the miscellaneous piping to enable the removal of the insulation box.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC PIPING INSULATION

A. The use of flexible elastomeric insulation for piping systems shall be limited to HVAC air conditioning condensate piping and control instrument tubing.

B. Seal longitudinal seams and end joints with manufacturer recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
3. Secure insulation to flanges and seal seams with manufacturer recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 EQUIPMENT INSULATION SYSTEMS INSTALLATION

A. Unless noted otherwise, install equipment insulation systems in accordance with the approved MICA Insulation Stds plates as supplemented by the manufacturer's published installation instructions.

B. General: Removable insulation sections shall be provided to cover parts of equipment that must be opened periodically for maintenance including vessel covers, fasteners, flanges and accessories. Equipment insulation shall be omitted on the following:

2. Boiler and tank manholes.
3. Cleanouts.
4. ASME stamps.
5. Manufacturer's nameplates.

C. Insulation for Cold Equipment: Cold equipment below 60 degrees F: Insulation shall be furnished on equipment handling media below 60 degrees F including the following:
1. Floor drain and hub drain bodies (serving AHU and fan coil unit condensate).

D. Insulation for Hot Equipment: Insulation shall be furnished on equipment handling media above 60 degrees F., including the following:

1. Hydronic hot water pumps.
2. Hydronic expansion tanks.

E. Pump Insulation: Insulate by forming a two-section box around the pump housing constructed of reinforced aluminum sheet materials. The box shall be removable, configured with an easily removable top. The box shall be fully lined with 2 inch thick rigid fiberglass material. Joints between top cover and sides shall fit tightly forming a female shiplap joint on the side pieces and a male joint on the top cover, thus making the top cover removable, including separate jacketing on the removable section.

1. Upon completion a parting line shall be provided between the box and the removable sections allowing the removable sections to be removed without disturbing the insulation. Provide penetrations in the box for the miscellaneous pump drain and control pipe tappings; caulk each. Caulking shall be applied to parting line, between equipment and removable section insulation, and at all penetrations. Pipe unions shall be installed in the miscellaneous piping to enable the removal of the insulation box.

F. Hot Equipment Installation (except pumps):

1. Insulation shall be formed or fabricated to fit the equipment. To ensure a tight fit on round equipment, edges shall be beveled and joints shall be tightly butted and staggered. For tanks, mineral-fiber tank insulation shall be lagged uniform, to fit the radius of the tank and end shells; boxing or flat-end insulation of tank elliptical end shells is not acceptable.
2. Insulation shall be secured in place with bands or wires at intervals as recommended by the manufacturer but not more than 12 inch centers. Where bands or wires are used, the outer visible insulation surface shall be a field applied ASJ. Insulation corners shall be protected under wires and bands with metal corner angles.
3. Insulation on mechanically accessible flanged openings on equipment shall be removable. Removable section joints shall be fabricated using a male-female shiplap type joint of mineral-fiber board insulation. The entire surface of the removable section shall be finished by applying two coats of vapor retarder coating with a layer of glass cloth embedded between the coats. The total dry thickness of the finish shall be 1/16 inch.
4. Exposed insulation corners shall be protected with corner angles.
5. Insulation on equipment with ribs shall be applied over 6 by 6 inches by 12 gauge welded wire fabric which has been cinched in place, or if approved by the Architect, spot welded to the equipment over the ribs. Insulation shall be secured to the fabric with J-hooks and 2 by 2 inches washers or shall be securely banded or wired in place on 12 inch centers. Where welded wire fabric is used, the outer visible insulation surface shall be a field applied ASJ. Insulation corners shall be protected under wires and bands with metal corner angles.
6. Mineral fiber insulation joints below the ASJ shall be filled with finishing cement.
7. For equipment handling media above 600 degrees F, insulation shall be applied in two or more equal thickness layers with joints staggered.
8. Upon completion of installation of insulation, penetrations shall be caulked. Two coats of adhesive shall be applied over insulation, including removable sections, with a layer of glass cloth embedded between the coats. The total dry thickness of the finish shall be 1/16 inch. Caulking shall be applied to parting line between equipment and removable section insulation.

3.8 DUCT INSULATION SYSTEMS INSTALLATION AND SCHEDULE

A. Provide insulation on ductwork, ductwork system components and accessories including sheet metal plenums at exterior louvers.

B. Install duct insulation systems in accordance with the approved MICA Insulation Stds plates as supplemented by the manufacturer's published installation instructions and as indicated in this Section.

C. Corner angles shall be installed on external corners of insulation on ductwork which is not concealed above ceilings, before covering with jacket, except ducts indicated to receive metal jacketing.

D. Duct insulation thickness shall be in accordance with the following Table. Ductwork accessory items such as side-access filter sections shall be insulated with material thickness indicated for each respective service. Insulation and vapor retarder/vapor barrier shall be provided for the following cold air ducts and associated equipment.

Minimum Duct Insulation (inches) Table

Supply and Return Air Ducts  2.0 inches thick material

E. Insulation for rectangular ducts shall be ASTM C 553, Type 1 with factory applied FSK jacket; Mineral Fiber Blanket Type, 0.75 lbs. per cuft. density where concealed above suspended ceilings and ASTM C 612, Type 1A with factory applied ASJ jacket; Mineral Fiber Board Type, minimum 3 lbs cuft. density where exposed in mechanical spaces. Board insulation for exposed round/oval ducts shall be scored and shaped to the radius, formed or fabricated to a tight fit, edges beveled and joints tightly butted and staggered. Except for ductwork indicated to be equipped with metal jacketing, insulation for all exposed ducts shall be provided with either a white, paint-able, factory-applied Type I jacket or a field applied vapor retarder/vapor barrier jacket with coating finish as specified, the total field applied dry film thickness shall be approximately 1/16 inch. Insulation on all concealed duct shall be provided with a factory-applied Type I or II vapor retarder/vapor barrier jacket. Duct insulation shall be continuous through sleeves and prepared openings except firewall and smoke barrier penetrations. Duct insulation terminating at fire dampers shall be continuous over the damper collar and retaining angle of dampers which are exposed to unconditioned air and which may be prone to condensate formation. Vapor retarder/vapor barrier materials shall be applied to form a complete unbroken vapor seal over the insulation. Note that glass cloth and mastic jacket sealing of each insulation joint and penetration is required without exception. Tape sealing products without glass cloth and mastic top-coating are not acceptable. Ductwork located above ceilings is considered to be concealed. All other ductwork locations are considered to be exposed. Duct insulation shall not be compressed to a thickness less than that specified at corners, seams and duct reinforcement.
F. Installation on Concealed Duct: For rectangular, oval or round ducts, Mineral Fiber Blanket insulation shall be attached by applying adhesive around the entire perimeter of the duct in 6 inch wide strips on 12 inch centers. For rectangular and oval ducts, 24 inches and larger insulation shall be additionally secured to bottom of ducts by the use of mechanical fasteners. Fasteners shall be spaced on 16 inch centers and not more than 16 inches from duct corners. For rectangular, oval and round ducts, mechanical fasteners shall be provided on sides of duct risers for all duct sizes. Fasteners shall be spaced on 16 inch centers and not more than 16 inches from duct corners. Insulation shall be impaled on the mechanical fasteners (self stick pins) where used and shall be pressed thoroughly into the adhesive. Care shall be taken to ensure vapor retarder/vapor barrier jacket joints overlap 2 inches. The insulation shall not be compressed to a thickness less than that specified. Insulation shall be carried over standing seams and trapeze-type duct hangers. Where mechanical fasteners are used, self-locking washers shall be installed and the pin trimmed and bent over. Jacket overlaps shall be secured with staples and glass cloth to ensure a secure seal. Staples, glass cloth and seams shall be coated with a brush coat of vapor retarder coating. Breaks in the jacket material shall be covered with patches of the same material as the vapor retarder jacket. The patches shall extend not less than 2 inches beyond the break or penetration in all directions and shall be secured with glass cloth and staples. Staples and glass cloth joints shall be sealed with a brush coat of vapor retarder coating. At jacket penetrations such as hangers, thermometers, and damper operating rods, voids in the insulation shall be filled and the penetration sealed with a brush coat of vapor retarder coating. Insulation terminations and pin punctures shall be sealed and flashed with a reinforced vapor retarder coating finish or glass cloth with a brush coat of vapor retarder coating. The coating shall overlap the adjoining insulation and un-insulated surface 2 inches. Pin puncture coatings shall extend 2 inches from the puncture in all directions. Where insulation standoff brackets occur, insulation shall be extended under the bracket and the jacket terminated at the bracket.

G. Installation on Exposed Duct Work: For rectangular and round ducts, Mineral Fiber Board insulation shall be secured to the duct by mechanical fasteners on all sides of the duct, spaced not more than 12 inches apart and not more than 3 inches from the edges of the insulation joints. A minimum of two rows of fasteners shall be provided for each side of duct 12 inches and larger. One row shall be provided for each side of duct less than 12 inches. Mechanical fasteners shall be as corrosion resistant as G-90 coated galvanized steel, and shall indefinitely sustain a 50 lb tensile dead load test perpendicular to the duct wall. Equip all longitudinal seams with shop fabricated galvanized steel metal corner angles; overlay a minimum of two inches at each joint. Duct insulation shall be formed with a minimum of jacket seams. For round ducts, rigid insulation shall be scored and shaped to fit duct radius. Each piece of rigid insulation shall be fastened to the duct using mechanical fasteners. When the height of projections is less than the insulation thickness, insulation shall be brought up to standing seams, reinforcing, and other vertical projections and shall not be carried over. Vapor retarder/barrier jacket shall be continuous across seams, reinforcing, and projections. When height of projections is greater than the insulation thickness, insulation and jacket shall be carried over. Apply insulation with joints tightly butted. Neatly bevel insulation around name plates and access plates and doors. Insulation shall be impaled on the fasteners; self-locking washers shall be installed and the pin trimmed and bent over. Joints in the insulation jacket shall be sealed with a 4 inch wide strip of glass cloth. Glass cloth seams shall be sealed with an embedded coat of vapor retarder mastic; brushed smooth. Breaks and ribs or standing seam penetrations in the jacket material shall be covered with a patch of the same material as the jacket. Patches shall extend not less than 2 inches beyond the break or penetration and shall be secured with glass cloth and mastic. Staples and joints shall be sealed with a brush coat of vapor retarder coating. At jacket penetrations such as hangers, thermometers, and damper
operating rods, the voids in the insulation shall be filled and the penetrations sealed with a brush coat of vapor retarder coating. Insulation terminations and pin punctures shall be sealed and flashed with a reinforced vapor retarder coating finish. The coating shall overlap the adjoining insulation and un-insulated surface 2 inches. Pin puncture coatings shall extend 2 inches from the puncture in all directions.

H. Duct Test Holes: After duct systems have been tested, adjusted, and balanced, breaks in the insulation and jacket shall be repaired in accordance with the applicable section of this specification for the type of duct insulation to be repaired.

3.9 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
   1. Draw jacket smooth and tight to surface with 2-inch (50-mm) overlap at seams and joints.
   2. Embed glass cloth between two 0.062-inch- (1.6-mm-) thick coats of lagging adhesive.
   3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:
   1. Draw jacket material smooth and tight.
   2. Install lap or joint strips with same material as jacket.
   3. Secure jacket to insulation with manufacturer's recommended adhesive.
   4. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
   5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches (300 mm) o.c. and at end joints.

3.10 FINISHES

A. Do not field paint aluminum or stainless-steel jackets.

3.11 PIPING AND EQUIPMENT INSULATION SCHEDULE

A. Type P1 - Pipe Insulation:
   1. Heating hot water (supply and return) piping systems including valves and pipeline accessories: 1-1/2 inches thick for 2 inch pipe size and smaller, 2 inches thick for 2-1/2 inch pipe size and larger.
   2. Domestic hot water and hot water recirculating: 1 inch thick up to and including 3 inch pipe size, 1 ½ inches thick for 4 inch pipe sizes and larger.
B. Type P2 - Pipe Insulation:
   1. Chilled water (Supply and Return) piping systems including valves and pipeline accessories, piping systems including valves and pipeline accessories, indoor applications; 1-1/2 inches thick up to 3 inch pipe size, 2 inches thick for 4 through 12 inch pipe size, 2-1/2 inch thick for pipe size exceeding 12 inch for chilled water (supply and return), outdoor locations, increase insulation thickness above by one inch.

C. Type P4 - Pipe Insulation:
   1. Air conditioning condensate drains; ¾ inch thick.
   2. Chilled Water System control instrument tubing; ¾ inch thick.

D. Type P6 - Pipe Insulation:
   1. Domestic cold water (supply and recirc) piping systems downstream of potable cold water heat exchanger including valves and pipeline accessories: 1 inch thick for 2 inch pipe size and smaller, 1-1/2 inches thick for 2-1/2 inch pipe size and larger.

E. Type E1 - Equipment Insulation:
   1. Hydronic Heating Water pumps, 2 inches thick (with aluminum enclosure).

F. Type E2 - Equipment Insulation:
   1. Hydronic Hot Water Filter; 2 inches thick (with aluminum jacketing). Jacketing shall be lapped to shed water.
   2. Hydronic Expansion Tanks; 1-1/2 inches thick (with aluminum jacketing). Jacketing shall be lapped to shed water.

3.12 CONSTRUCTION WASTE MANAGEMENT

A. Comply with the Waste Management Plan specified in Section 017419 Construction Waste Management and Disposal, for additional requirements.

END OF SECTION 23 07 19
SECTION 230900
INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

B. The “MI” numbered series portion of the Contract Documents indicate graphic layouts of components, input/output device point lists, sequences of operation and additional operating parameters for each system. The work of this Section includes the development and definition of the proposed installation to a state that this Section’s installer work effort is fully engineered; system operation determined and defined prior to installer mobilization of the site. Unless noted otherwise, provide the following:

1. This Section’s installer solutions shall be fully composed utilizing the equipment and accessory products proposed/submitted for installation under this Contract. The submittals under this Section shall reflect the actual heating Ventilating and Air Conditioning equipment purchased for the project.

2. The submittals under this Section shall include lists of materials proposed for each system indicated on the Contract Drawings; each input and output device identified by a model number which correlates to the submitted product data.

3. Indicate control range and set point for each input and output device on the Shop Drawing submittal in this Section.

4. Submit the Product Data and Shop Drawings simultaneously so that correlated review of the both may be conducted.

5. The sequences of operation indicated on the Contract Drawings form an empirical basis for system operation. The work of this Section includes the further definition of operational sequences including the development and incorporation of PID loops, validating HVAC component and equipment interlocks, validating interlocks with systems exclusive of this Section such as the Fire Alarm system, and additional control functions necessary for successful system operation.

6. Direct replication of the Contract Drawing graphics, point lists and/or sequences of operation as part of the Shop Drawing submittal will not be an acceptable substitute for installer engineering and pre-installation planning.
1.3 DEFINITIONS

A. DDC: Direct digital control.

B. I/O: Input/output.


D. ARCNET: ANSI/ATA 878.1 - Attached Resource Computer Network. ARCNET is a deterministic LAN technology; meaning it's possible to determine the maximum delay before a device is able to transmit a message.

E. BACnet: Building Automation and Control Network; the common name for the communication standard ASHRAE 135. The standard defines methods and protocol for cooperating building automation devices to communicate over a variety of LAN technologies.

F. BACnet/IP: An extension of BACnet, Annex J, defines this mechanism using a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnetworks that share the same BACnet network number. See also "BACnet Broadcast Management Device".

G. BACnet Internetwork: Two or more BACnet networks, possibly using different LAN technologies, connected with routers. In a BACnet internetwork, there exists only one message path between devices.

H. BACnet Network: One or more BACnet segments that have the same network address and are interconnected by bridges at the physical and data link layers.

I. BACnet Segment: One or more physical segments of BACnet devices on a BACnet network, connected at the physical layer by repeaters.

J. BBMD: BACnet Broadcast Management Device (BBMD). A communications device, typically combined with a BACnet router. A BBMD forwards BACnet broadcast messages to BACnet/IP devices and other BBMDs connected to the same BACnet/IP network. Every IP subnetwork that is part of a BACnet/IP network must have only one BBMD. See also "BACnet/IP".

K. BAS: Building Automation Systems, including DDC (Direct Digital Controls) used for facility automation and energy management.

L. BAS Manufacturer: The regional or local user responsible for managing all aspects of the BAS operation, including: network connections, workstation management, submittal review, technical support, control parameters, and daily operation.

M. BIBBs: BACnet Interoperability Building Blocks. A collection of BACnet services used to describe supported tasks. BIBBs are often described in terms of "A" (client) and "B" (server) devices. The “A” device uses data provided by the "B" device, or requests an action from the “B” device.
N. BI: BACnet International, formerly two organizations: the BACnet Manufacturers Association (BMA) and the BACnet Interest Group - North America (BIG-NA).

O. BI/BTL: BACnet International/BACnet Testing Laboratories (Formerly BMA/BTL). The organization responsible for testing products for compliance with the BACnet standard, operated under the direction of BACnet International.

P. Bridge: Network hardware that connects two or more network (or BACnet internetwork) segments at the physical and data link layers. A bridge may also filter messages.

Q. Broadcast: A message sent to all devices on a network segment.

R. Device: Any control system component, usually a digital controller that contains a BACnet Device Object and uses BACnet to communicate with other devices. See also "Digital Controller".

S. Device Object: Every BACnet device requires one Device Object, whose properties represent the network visible properties of that device. Every Device Object requires a unique Object Identifier number on the BACnet internetwork. This number is often referred to as the device instance.

T. Device Profile: A collection of BIBBs determining minimum BACnet capabilities of a device, defined in ASHRAE Standard 135-2004, Annex L. Standard device profiles include BACnet Operator Workstations (B-OWS), BACnet Building Controllers (B-BC), BACnet Advanced Application Controllers (B-AAC), BACnet Application Specific Controllers (B-ASC), BACnet Smart Actuator (B-SA), and BACnet Smart Sensor (B-SS). Each device used in new construction is required to have a PICS statement listing BIBBs supported.

U. Digital Controller: An electronic controller, usually with internal programming logic and digital and analog input/output capability, which performs control functions. In most cases, this is synonymous with a BACnet device described in this specification. See also "Device".

V. Direct Digital Control (DDC): Digital controllers performing control logic. Usually the controller directly senses physical values, makes control decisions with internal programs, and outputs control signals to directly operate switches, valves, dampers, and motor controllers.

W. DDC System: A network of digital controllers, communication architecture, and user interfaces. A DDC system may include programming, sensors, actuators, switches, relays, factory controls, operator workstations, and various other devices, components, and attributes.

X. Ethernet: A family of local-area-network technologies providing high-speed networking features over various media.

Y. Firmware: Software programmed into read only memory (ROM), flash memory, electrically erasable programmable read only memory (EEPROM), or erasable programmable read only memory (EPROM) chips.

Z. Gateway: Communication hardware connecting two or more different protocols, similar to human language translators. The Gateway translates one protocol into equivalent concepts for the other protocol. In BACnet applications, a gateway has BACnet on one side and non-BACnet (usually proprietary) protocols on the other side.
AA. Half Router: A device that participates as one partner in a BACnet point-to-point (PTP) connection. Two half-routers in an active PTP connection combine to form a single router.

BB. Hub: A common connection point for devices on a network.

CC. Internet Protocol (IP, TCP/IP, UDP/IP): A communication method, the most common use is the World Wide Web. At the lowest level, it is based on Internet Protocol (IP), a method for conveying and routing packets of information over various LAN media. Two common protocols using IP are User Datagram Protocol (UDP) and Transmission Control Protocol (TCP). UDP conveys information to well-known "sockets" without confirmation of receipt. TCP establishes "sessions", which have end-to-end confirmation and guaranteed sequence of delivery.

DD. Input/Output (I/O): Physical inputs and outputs to and from a device. The term also describes binary, analog or digital software, or "virtual" I/O. See also "Points".

EE. I/O Expansion Unit: An I/O expansion unit provides additional point capacity to a digital controller.

FF. IP subnet: Internet protocol (IP) identifies individual devices with a 32-bit number divided into four groups from 0 to 255. Devices are often grouped and share some portion of this number. For example, one device has IP address 209.185.47.68 and another device has IP address 209.185.47.82. These two devices share Class C subnet 209.185.47.00.

GG. Local-Area Network (LAN): A communication network that spans a limited geographic area and uses the same basic communication technology throughout.

HH. LonTalk: ANSI/EIA 709. A communication protocol developed by Echelon Corp. LonTalk is an optional physical and data link layer for BACnet.

II. MAC Address: Media Access Control address. The physical node address that identifies a device on a Local Area Network.

JJ. Master-Slave/Token-Passing (MS/TP): ISO/IEC 8802 (Part 3). One of the LAN options for BACnet. MSTP uses twisted-pair wiring for relatively low speed and low cost communication (up to 4,000 ft at 76.8K bps).

KK. Native BACnet Device: A device that uses BACnet as its primary, if not only, method of communication with other BACnet devices without intermediary gateways. A system that uses native BACnet devices at all levels is a native BACnet system.

LL. Network: Communication technology for data communications. BACnet approved network types are BACnet over Internet Protocol (IP), Point to Point (PTP) Ethernet, ARCNET, MS/TP, and LonTalk®.

MM. Network Engine: A device which provides management and system-wide control over one or more networks of digital controllers.

NN. Network Number: A site-specific number assigned to each network segment to identify for routing. This network number must be unique throughout the BACnet internetwork.
OO. Object: The concept of organizing BACnet information into standard components with various associated properties. Examples include analog input objects and binary output objects.

PP. Object Identifier: An object property used to identify the object, including object type and instance. Object Identifiers must be unique within a device.

QQ. Object Properties: Attributes of an object. Examples include present value and high limit properties of an analog input object. Properties are defined in ASHRAE 135; some are optional and some are required. Objects are controlled by reading from and writing to object properties.

RR. Peer-to-Peer: Peer-to-peer refers to devices where any device can initiate and respond to communication with other devices.

SS. Performance Verification Test (PVT): The procedure for determining if the installed BAS meets design criteria prior to final acceptance. The PVT is performed after installation, testing, and balancing of mechanical systems. Typically the PVT is performed by the Contractor in the presence of the Architect (A/E).

TT. PID: Proportional, integral, and derivative control; three parameters used to control modulating equipment to maintain a setpoint. Derivative control is often not required for HVAC systems (leaving "PI" control).

UU. PICS: Protocol Implementation Conformance Statement (PICS), describing the BACnet capabilities of a device. See BACnet, Annex A for the standard format and content of a PICS statement.

VV. Points: Physical and virtual inputs and outputs. See also "Input/Output".

WW. PTP: Point-to-Point protocol connects individual BACnet devices or networks using serial connections like modem-to-modem links.

XX. Repeater: A network component that connects two or more physical segments at the physical layer.

YY. Router: A BACnet router is a component that joins together two or more networks using different LAN technologies. Examples include joining a BACnet Ethernet LAN to a BACnet MS/TP LAN.

ZZ. Stand-Alone Control: Refers to devices performing equipment-specific and small system control without communication to other devices or computers for physical I/O, excluding outside air and other common shared conditions. Devices are located near controlled equipment, with physical input and output points limited to 64 or less per device, except for complex individual equipment or systems. Failure of any single device will not cause other network devices to fail. BACnet "Smart" actuators (B-SA profile) and sensors (B-SS profile) communicating on a network with a parent device are exempt from stand-alone requirements.

1.4 SUBMITTALS

A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for
materials, and installation and startup instructions for each type of product indicated. Each product shall be cross referenced to define its application and/or location within the control system.

1. **DDC System Hardware:** Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for each input device, controller, output device and system accessory.
2. **Control System Software:** Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
3. **Direct Digital Controllers:** Include BACnet PICS for each controller/device type, including smart sensors (B-SS) and smart actuators (B-SA).
4. **Sensors and Input Hardware.**
5. **Output Hardware.**
6. **Surge and transient protection.**
7. **Workstation computer.**
8. **System file server.**
9. **Uninterruptible power supply.**

**B. Shop Drawings:** Detail equipment assemblies and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.

1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
2. Schematic diagrams showing fans, coils, dampers, valves, and control devices.
3. **Wiring Diagrams:** Power, signal, and control wiring; point to point.
4. Details of control panel faces, including controls, instruments, and labeling.
5. Written description of sequence of operation.
6. Schedule of dampers including size, leakage, and flow characteristics.
7. Schedule of valves including flow characteristics.
8. **DDC System Hardware:**
   a. Wiring diagrams for control units with termination numbers.
   b. Schematic diagrams and floor plans for field sensors and control hardware.
   c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
9. **Control System Drawings Title Sheet:** Provide a title sheet for the control system drawing set. Include the project title, project location, contract number, the controls contractor preparing the drawings, an index of the control drawings in the set, and a legend of the symbols and abbreviations used throughout the control system drawings.
10. **DDC Points List:** Also known as a Point Schedule, provide for each input and output point physically connected to a digital controller: point name, point description, point type (Analog Output (AO), Analog Input (AI), Binary Output (BO), Binary Input (BI)), point sensor range, point actuator range, point address, BACnet object, associated BIBBS (where applicable), and point connection terminal number. Provide an individual points list for each digital controller. Provide an individual points list for each item of central station equipment such as air handling units. Typical schedules are acceptable for terminal equipment such as air terminal valves, fan coil units etc., except where the terminal valves are providing control beyond a typical application.
11. **Control System Components List:** Provide a complete list of control system components proposed for installation on this project. Include for each controller and device: control
system schematic name, control system schematic designation, device description, manufacturer, and manufacturer part number. For sensors, include point name, sensor range, and operating limits. For valves, include body style, Cv, design flow rate, pressure drop, valve characteristic (linear or equal percentage), and pipe connection size. For actuators, include point name, spring or non-spring return, modulating or two-position action, normal (power fail) position, nominal control signal operating range (0-10 volts DC or 4-20 milliamps), and operating limits.

12. Control System Schematics: Provide control schematics for each control system. Typical schematics for multiple terminal equipment are permitted providing that any terminal equipment with unique interlocks on characteristics are individually identified unless otherwise requested in design or contract criteria. Include the following:

a. Location of each input and output device.
b. Flow diagram for each piece of HVAC equipment.
c. Name or symbol for each control system component, such as V-1 for a valve.
d. Setpoints, with differential or proportional band values.
e. Written sequence of operation for the HVAC equipment.
f. Valve and Damper Schedules, with normal (power fail) position.


14. Provide control diagrams showing as-built fire alarm, and exhaust fan interlocks. Diagram shall be laminated with clear plastic and attached to indoor AHU housings so that they shall be visible to maintenance staff. For exterior roof units, diagrams shall be mounted in the VFD cabinets so that they shall be visible to maintenance staff.

15. Component Wiring Diagrams: Provide a wiring diagram for each type of input device and output device. Indicate how each device is wired and powered; showing typical connections at the digital controller and power supply. Show for all field connected devices such as control relays, motor starters, actuators, sensors, and transmitters.

16. Terminal Strip Diagrams: Provide a diagram of each terminal strip. Indicate the terminal strip location, termination numbers, and associated point names.

17. BACnet Communication Architecture Schematic: Provide a schematic showing the project's entire BACnet communication network, including addressing used for LANs, LAN devices including routers and bridges, gateways, controllers, workstations, and field interface devices. Indicate connection to existing networks and control devices.

C. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with BACnet.

D. Qualification Data: For Installer.

E. Field quality-control test reports.

2. Pre-performance Verification Testing Checklists.
3. Performance Verification Test Procedures, in booklet form and indexed, 60 days before the Contractor’s scheduled test dates. The performance verification test procedures shall refer to the devices by their unique identifiers as shown, shall explain, step-by-step, the actions and expected results that will demonstrate that the HVAC control system performs in accordance with the sequences of operation, and other contract documents. An HVAC control system performance verification test equipment list shall be included...
that lists the equipment to be used during performance verification testing. The list shall include manufacturer name, model number, equipment function, the date of the latest calibration, and the results of the latest calibration.

F. Operation and Maintenance Data: For HVAC instrumentation and control system to include in operation, and maintenance manuals. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:

1. As-built interconnection wiring diagrams with identified and numbered system components and devices.
2. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
3. Calibration records and list of set points.
4. Product data as indicated hereinbefore under “Submittals”.
5. Shop drawings as indicated hereinbefore under “Submittals”.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project. Installers and programmers shall be in the direct employ of the control manufacturer.

B. The subcontractor of this Section shall be a primary equipment manufacturer-owned branch office that is regularly engaged in the engineering, programming, installation and service of total integrated BAS of similar size, scope and complexity to the system indicated in this Contract. Distributors, manufacturer's representatives and wholesalers will not be acceptable.

C. Single Source Responsibility of Subcontractor: The controls subcontractor shall be responsible for the complete design, installation, and participating in the commissioning of the system. The controls subcontractor shall be in the business of design, installation and service of such building automation control systems similar in size and complexity.

D. Equipment and Materials: Equipment and materials shall be cataloged products of manufacturers regularly engaged in production and installation of HVAC control systems. Products shall be manufacturer's latest standard design and have been tested and proven in actual use.

E. Previous Experience: The controls subcontractor shall provide a list of no less than five similar projects which have building control systems as specified in this Section. These projects must be on-line and successfully functional such that the Owner could observe the control systems in full operation. The controls subcontractor personnel for this project shall have (minimum of three years) experience in design and installation of building automation systems similar in performance to those specified in this Section. Provide evidence of experience by submitting resumes of the project manager, the local branch manager, project engineer, the application engineering staff, and the electronic technicians who would be involved with the supervision, the engineering, and the installation of the control systems. Training and experience of these personnel shall not be less than three years. Failure to disclose this information will be a ground for disqualification of the supplier.
F. Local Representation: The controls subcontractor shall have in-place facility within 50 miles with technical staff, spare parts inventory, and necessary test and diagnostic equipment to support the control systems for this project.

G. Project Manager: Provide a competent and experienced Project Manager employed by the Controls Contractor. The Project Manager shall be supported as necessary by other Contractor employees in order to provide professional engineering, technical and management service for the work. The Project Manager shall attend scheduled Project Meetings as required and shall be empowered to make technical, scheduling and related decisions on behalf of the subcontractor.

H. 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.

I. Provide the services of the manufacturer representatives in responsible charge of the physical system installation and software installation, in order to be present during the calibration and testing of the system; at intervals necessary to enable fully automatic system operation, and at each inspection.

J. Standard Products: Provide material and equipment that are standard manufacturer's products currently in production and supported by a local service organization.

K. Finish of New Equipment: New equipment finishing shall be factory provided. Manufacturer's standard factory finishing shall be proven to withstand 125 hours in a salt-spray fog test. Equipment located outdoors shall be proven to withstand 500 hours in a salt-spray fog test. Salt-spray fog test shall be according to ASTM B 117, with acceptance criteria as follows: immediately after completion of the test, the finish shall show no signs of degradation or loss of adhesion beyond 0.125 inch on either side of the scratch mark.

L. Verification of Dimensions: The contractor shall verify all dimensions in the field, and advise the Architect of any discrepancy before performing work.

M. Modification of References: The advisory provisions in ASME B31.1 and NFPA 70 are mandatory. Substitute "shall" for "should" wherever it appears and interpret all references to the "authority having jurisdiction" and "owner" to mean the Architect.

N. Project Sequence: The control system work for this project shall proceed in the following order:

1. Submit and receive approval on the Shop Drawings, Product Data, and Certificates specified under the paragraph entitled "SUBMITTALS."
2. Perform the control system installation work, including all field check-outs and tuning.
3. Provide support to TAB personnel as specified under the paragraph "TEST AND BALANCE SUPPORT."
4. Submit and receive approval of the Controls System Operators Manual specified under the paragraph "CONTROLS SYSTEM OPERATORS MANUALS."
5. Submit and receive approval of the Performance Verification Testing Plan and Procedures and the Pre-PVT Checklist specified under the paragraph "PERFORMANCE VERIFICATION TESTING."
6. Perform the Performance Verification Testing.
7. Submit and receive approval on the PVT Report.
8. Submit and receive approval on the Training Documentation specified under the paragraph "INSTRUCTION TO OWNERS PERSONNEL". Submit at least 30 days before training.
9. Deliver the final Controls System Operators Manuals.
10. Conduct Training.
11. Submit and receive approval of Closeout Submittals.

O. All products shall be rated for continuous operation under the following conditions:

1. Pressure: Pressure conditions normally encountered in the installed location.
2. Vibration: Vibration conditions normally encountered in the installed location.
3. Temperature:
   a. Products installed indoors: Ambient temperatures in the range of 32 to 112 degrees F and temperature conditions outside this range normally encountered at the installed location.
   b. Products installed outdoors or in unconditioned indoor spaces: Ambient temperatures in the range of -35 to plus 151 degrees F and temperature conditions outside this range normally encountered at the installed location.
4. Humidity: 10 to 95 percent relative humidity, noncondensing and humidity conditions outside this range normally encountered at the installed location.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer at time frames coincident with factory fabricators.

B. Delivery, Storage, and Handling: Handle, store, and protect equipment and materials to prevent damage before and during installation according to manufacturer's recommendations, and as approved by the Architect. Replace damaged or defective items.

C. Operating Environment: Protect components from humidity and temperature variation, dust, and contaminants. If components are stored before installation, keep them within the manufacturer's limits.

D. Products shall be stored with protection from the weather, humidity, and temperature variations, dirt and dust, and other contaminants, within the storage condition limits published by the equipment manufacturer.

1.7 SYSTEM DESCRIPTION

A. Provide new BACnet DDC systems including associated equipment and accessories. All new devices are accessible using a Web browser interface and communicate using ASHRAE 135 BACnet communications without the use of gateways, unless gateways are shown on the design drawings and specifically requested by the Owner. Manufacturer's products, including design, materials, fabrication, assembly, inspection, and testing shall be in accordance with ASHRAE 135, ASME B31.1, and NFPA 70, except where indicated otherwise. The following items are
required to be submitted as part of the “Shop Drawings” submittal; refer to paragraph “Submittals” for additional information. Subject to compliance with requirements provide control system and installation by Johnson Controls.

1.8 SURGE PROTECTION

A. Power-Line Surge Protection: Equipment connected to ac circuits shall be protected against or withstand power-line surges. Equipment protection shall meet the requirements of IEEE C62.41. Provide surge protection at each digital controller, gateway, and router. Fuses shall not be used for surge protection.

B. Surge Protection for Transmitter and Control Wiring: DDC hardware shall be protected against or withstand surges induced on control and transmitter wiring installed outdoors and as shown. The equipment protection shall be protected against the following two waveforms:

1. A waveform with a 10-microsecond rise time, a 1,000-microsecond decay time and a peak current of 60 amps.
2. A waveform with an 8-microsecond rise time, a 20-microsecond decay time and a peak current of 500 amperes.

1.9 INPUT MEASUREMENT ACCURACY

A. Sensors, transmitters and DDC Hardware shall be selected, installed and configured such that the maximum error of the measured value at the SNVT output of the DDC hardware is less than 150% of the maximum allowable error specified for the sensor or instrumentation.

1.10 MAINTENANCE

A. The HVAC control System Operation and Maintenance (O&M) Instructions shall include:

1. Emergency, operation and maintenance manuals for each piece of control equipment.
2. HVAC control system sequences of operation formatted as submitted; corrected to field installed conditions.
3. Procedures for the HVAC system start-up, operation and shut-down including the manufacturer supplied procedures for each piece of equipment, and procedures for the overall HVAC system.
4. As-built HVAC control system detail drawings formatted as specified.
5. Printouts of configuration settings for all devices.
6. Routine maintenance checklist. The routine maintenance checklist shall be arranged in a columnar format. The first column shall list all installed devices, the second column shall state the maintenance activity or state no maintenance required, the third column shall state the frequency of the maintenance activity, and the fourth column for additional comments or reference.
7. Qualified service organization list.
B. Maintenance Service: Provide services, materials and equipment as necessary to maintain the entire system in an operational state as specified for a period of one year after successful completion and acceptance of the Performance Verification Test. Minimize impacts on facility operations.

1. Description of Work: The adjustment and repair of the system shall include the manufacturer's required sensor and actuator (including transducer) calibration, span and range adjustment.

2. Personnel: Use qualified service personnel to accomplish work promptly and satisfactorily. Advise the Owner in writing of the name of the designated service representative, and of any changes in personnel.

3. Scheduled Inspections: Perform two inspections at six-month intervals and all work required shall be performed. Inspections shall be scheduled in July and January. These inspections shall include:
   
a. Visual checks and operational tests of equipment.
b. Air handling units, including all control system equipment.
c. Clean control system equipment including interior and exterior surfaces.
d. Check and calibrate each field device. Check and calibrate 50 percent of the total analog inputs and outputs during the first inspection. Check and calibrate the remaining 50 percent of the analog inputs and outputs during the second major inspection. Certify analog test instrumentation accuracy to be twice the specified accuracy of the device being calibrated. Randomly check at least 25 percent of all digital inputs and outputs for proper operation during the first inspection. Randomly check at least 25 percent of the remaining digital inputs and outputs during the second inspection.
e. Run system software diagnostics and correct diagnosed problems.
f. Resolve any previous outstanding problems.

4. Scheduled Work: This work shall be performed during regular working hours, Monday through Friday, excluding Federal holidays.

5. Emergency Service: The Owner will initiate service calls when the system is not functioning properly. Qualified personnel in the direct employ of the control system manufacturer shall be available to provide service to the system. A telephone number where the service supervisor can be reached at all times shall be provided. Service personnel shall be at the site within 24 hours after receiving a request for service.

6. Operation: Scheduled adjustments and repairs shall include verification of the control system operation as demonstrated by the applicable tests of the performance verification test.

7. Records and Logs: Keep dated records and logs of each task, with cumulative records for each major component, and for the complete system chronologically. A continuous log shall be maintained for all devices. The log shall contain initial analog span and zero calibration values and digital points. Complete logs shall be kept and shall be available for inspection onsite, demonstrating that planned and systematic adjustments and repairs have been accomplished for the control system.

8. Work Requests: Record each service call request as received and include its location, date and time the call was received, nature of trouble, names of the service personnel assigned to the task, instructions describing what has to be done, the amount and nature of the materials to be used, the time and date work started, and the time and date of completion. Submit a record of the work performed within 5 days after work is accomplished.
PART 2 - PRODUCTS

2.1 DDC SYSTEM

A. Provide a networked DDC system for stand-alone control in compliance with the latest revision of the ASHRAE 135 BACnet standard. Include all programming, objects, and services required to meet the sequence of control. Provide BACnet communications between the DDC system and native BACnet devices furnished with HVAC equipment including variable frequency drives.

B. Direct digital controllers shall be UL 916 rated.

1. I/O Point Limitation: The total number of I/O hardware points used by a single stand-alone digital controller, including I/O expansion units, shall not exceed 64, except for complex individual equipment or systems. Install/O expansion units in the same cabinet as the digital controller.

2. Environmental Limits: Controllers shall be suitable for, or placed in protective enclosures suitable for the environment (temperature, humidity, dust, and vibration) where they are located.


4. Internal Clock: Provide internal clocks for all BACnet Building Controllers (B-BC) and BACnet Advanced Application Controllers (B-AAC) using BACnet time synchronization services. Automatically synchronize system clocks daily from an operator-designated controller. The system shall automatically adjust for daylight saving time.

5. Memory: Provide sufficient memory for each controller to support the required control, communication, trends, alarms, and messages. Protect programs residing in memory with EEPROM, flash memory, and by an uninterruptible power source (battery or uninterruptible power supply). The backup power source shall have capacity to maintain the memory during a 72-hour continuous power outage. Rechargeable power sources shall be constantly charged while the controller is operating under normal line power. Batteries shall be replaceable without soldering. Trend and alarm history collected during normal operation shall not be lost during power outages less than 72 hours long.

6. Immunity to Power Fluctuations: Controllers shall operate at 90 percent to 110 percent nominal voltage rating.

7. Transformer: The controller power supply shall be fused or current limiting and rated at 125 percent power consumption of the entire connected load.

8. Wiring Terminations: Use screw terminal wiring terminations for all field-installed controllers. Provide field-removable modular terminal strip or a termination card connected by a ribbon cable for all controllers other than terminal units.

9. Input and Output Interface: Provide hard-wired input and output interface for all controllers as follows:

   a. Protection: Shorting an input or output point to itself, to another point, or to ground shall cause no controller damage. Input or output point contact with sources up to 24 volts AC or DC for any duration shall cause no controller damage.

   b. Binary Inputs: Binary inputs shall have a toggle switch and monitor on and off contacts from a "dry" remote device without external power, and external 5-24 VDC voltage inputs.
c. Pulse Accumulation Inputs: Pulse accumulation inputs shall conform to binary input requirements and accumulate pulses at a resolution suitable to the application.

d. Analog Inputs: Analog inputs shall monitor low-voltage (0-10 VDC), current (4-20 mA), or resistance (thermistor or RTD) signals.

e. Binary Outputs: Binary outputs shall have a toggle switch and send a pulsed 24 VDC low-voltage signal for modulation control, or provide a maintained open-closed position for on-off control. For HVAC equipment and plant controllers, provide for manual overrides, either with three-position (on-off-auto) override switches and status lights, or with an adjacent operator display and interface. Where appropriate, provide a method to select normally open or normally closed operation.

f. Analog Outputs: Analog outputs shall send modulating 0-10 VDC or 4-20 mA signals to control output devices.

g. Tri-State Outputs: Tri-State outputs shall provide three-point floating control of terminal unit electronic actuators.

C. Digital Controller BACnet Internetwork: Provide a BACnet internetwork with control products, multiple peer buss network cables as indicated, communication media, connectors, repeaters, hubs, and routers. Provide intermediate gateways, only when requested by the Owner and shown on the contract drawings. Controller and operator interface communication shall conform to ASHRAE 135, BACnet. If a controller becomes non-responsive, the remaining controllers shall continue operating and not be affected by the failed controller. All network cables and control system wiring shall be provided as work of this Section. The use of the facility communication cables in lieu of network cables dedicated to the work of this Section is prohibited.

D. Communications Ports:

1. Direct-Connect Interface Ports: Provide at least one extra communication port at each local BACnet network for direct connecting a notebook computer or BACnet hand-held terminal so all network BACnet objects and properties may be viewed and edited by the operator.

2. Telecommunications Interface Port: Provide one telecommunication port per building, permitting remote communication via point-to-point (PTP) protocol over telephone lines.

E. Modems: Provide v.92 or DSL modems where required for communication between the BACnet Operator Workstation (B-OWS) and the DDC system.

F. Digital Controller Cabinet: Provide each digital controller in a factory fabricated metallic cabinet enclosure. Cabinets located indoors shall protect against dust and have a minimum NEMA 1 rating, except where indicated otherwise. Cabinets located outdoors or in damp environments shall protect against all outdoor conditions and have a minimum NEMA 4 rating. Outdoor control panels and controllers must be able to withstand extreme ambient conditions, without malfunction or failure, whether or not the controlled equipment is running. If necessary, provide a thermostatically controlled internal ventilating fan in locations exposed to direct sunlight. Cabinets shall have a hinged lockable door and an offset removable metal back plate. Provide like-keyed locks for all hinged panels provided and a set of two keys at each panel, with one key inserted in the lock. Each enclosure shall be sized to accommodate the number of controllers; I/O functions required for each enclosure, including installed spares, plus 10% expansion for each type of I/O function provided, control voltage transformers, fuses,
terminal strips, relays, contactors, control enclosure incoming power disconnect switch, receptacle, wiring troughs, and system accessories. Controller wiring terminals shall clearly be divided into analog input and output groups and digital input and output groups. The controllers and terminal strips shall be equipped with double sided screw type terminals. One side of the terminal strip shall be used for termination of field wiring from instrumentation and controls. The other side shall be used to connect the controller and system accessories to the network. Terminal strips shall have individual terminal identification numbers.

G. Main Power Switch and Receptacle and Auxiliary Transformers: Provide each control cabinet with a main external power on/off switch located inside the cabinet. Also provide each cabinet with a separate 120 VAC duplex receptacle. Provide control voltage transformer(s) interior to cabinet to enable power to associated controllers, input and output devices.

H. BACnet Gateways: Provide BACnet communication ports, whenever available as a plant equipment OEM standard option, for DDC integration via a single communication cable. Typical BACnet controlled plant equipment includes, but is not limited to, chillers, and variable frequency motor drives. Provide gateways to connect BACnet to legacy systems, existing non-BACnet devices, and existing non-BACnet DDC controlled plant equipment, only when specifically requested and approved by the Architect and shown on the submitted and approved BACnet Communication Architecture Schematic. Provide with each gateway an interoperability schedule, showing each point or event on the legacy side that the BACnet "client" will read, and each parameter that the BACnet network will write to. Describe this interoperability in terms of BACnet services, or Interoperability Building Blocks (BIBBS), defined in ASHRAE 135 Annex K. Provide two-year minimum warranty for each gateway, including parts and labor. The following minimum capabilities are required:

1. Gateways shall be able to read and view all readable object properties listed in the interoperability schedule on the non-BACnet network to the BACnet network and vice versa where applicable.
2. Gateways shall be able to write to all writeable object properties listed in the interoperability schedule on the non-BACnet network from the BACnet network and vice versa where applicable.
3. Gateways shall provide single-pass (only one protocol to BACnet without intermediary protocols) translation from the non-BACnet protocol to BACnet and vice versa.
4. Gateways shall meet the requirements of Data Sharing Read Property (DS-RP-B), Data Sharing Write Property (DS-WP-B), Device Management Dynamic Device Binding-B (DM-DDB-B), and Device Management Communication Control (DM-DCC-B) BIBBS, in accordance with ASHRAE 135.
5. Gateways shall include all hardware, software, software licenses, and configuration tools for operator-to-gateway communications. Provide backup programming and parameters on CD media and the ability to modify, download, backup, and restore gateway configuration.

2.2 DDC Software

A. Provide software to execute the sequence of operation.

B. Programming: Provide programming to execute the sequence of operation. Provide all programming and tools to configure and program all controllers. Provide programming routines
in simple, easy-to-follow logic with detailed text comments describing what the logic does and how it corresponds to the project's written sequence of operation.

1. Graphic-based programming shall use a library of function blocks made from pre-programmed code designed for DDC system control. Function blocks shall be assembled with interconnecting lines, depicting the control sequence in a flowchart. If providing a computer with device programming tools as part of the project, graphic programs shall be viewable in real time showing present values and logical results from each function block.

2. Menu-based programming shall be done by entering parameters, definitions, conditions, requirements, and constraints.

3. For line-by-line and text-based programming, declare variable types (local, global, real, integer, etc.) at the beginning of the program. Use descriptive comments frequently to describe the programming.

4. Provide a means for detecting program errors and testing software strategies with a simulation tool. Simulation may be inherent within the programming software suite, or provided by physical controllers mounted in a NEMA 1 test enclosure. The test enclosure shall contain one dedicated controller of each type provided under this contract, complete with power supply and relevant accessories.

C. Parameter Modification: All writeable object properties, and all other programming parameters needed to comply with the project specification shall be adjustable for devices at any network level, including those accessible with web-browser communication, and regardless of programming methods used to create the applications.

D. Short Cycling Prevention: Provide setpoint differentials and minimum on/off times to prevent equipment short cycling.

E. Equipment Status Delay: Provide an adjustable delay from when equipment is commanded on or off and when the control program looks to the status input for confirmation.

F. Run Time Accumulation: Use the Elapsed Time Property to provide re-settable run time accumulation for each Binary Output Object connected to mechanical loads greater than 1 HP, electrical loads greater than 10 KW, or wherever else specified.

G. Timed Local Override: Provide an adjustable override time for each push of a timed local override button.

H. Time Synchronization: Provide time synchronization, including adjustments for leap years, daylight saving time, and operator time adjustments.

I. Scheduling: Provide operating schedules as indicated, with equipment assigned to groups. Changing the schedule of a group shall change the operating schedule of all equipment in the group. Groups shall be capable of operator creation, modification, and deletion. Provide capability to view and modify schedules in a seven-day week format. Provide capability to enter holiday and override schedules one full year at a time.

J. Object Property Override: Allow writeable object property values to accept overrides to any valid value. Where specified or required for the sequence of control, the Out-Of-Service property of Objects shall be modifiable using BACnet's write property service. When
documented, exceptions to these requirements are allowed for life, machine, and process safety.

K. Alarms and Events: Alarms and events shall be capable of having programmed time delays and high-low limits. When a computer workstation or web server is connected to the BACnet internetwork, alarms/events shall report to the computer, printer, alphanumeric pager, e-mail, or cell phone, as defined by an authorized operator. Otherwise alarms/events shall be stored within a device on the BACnet network until connected to a user interface device and retrieved. Provide alarms/events in agreement with the point schedule, sequence of operation, and the BAS Owner. At a minimum, provide programming to initiate alarms/events any time a piece of equipment fails to operate, a control point is outside normal range or condition shown on schedules, communication to a device is lost, a device has failed, or a controller has lost its memory.

L. Trending: Provide BACnet trend services capable of trending all object present values set points, and other parameters indicated for trending on project schedules. Trends may be associated into groups, and a trend report may be set up for each group. Trends are stored within a device on the BACnet network, with operator selectable trend intervals from 10 seconds up to 60 minutes. The minimum number of consecutive trend values stored at one time shall be 100 per variable. When trend memory is full, the most recent data shall overwrite the oldest data. The operator workstation shall upload trends automatically upon reaching 3/4 of the device buffer limit (via Notification_Threshold property), by operator request, or by time schedule for archiving. Archived and real-time trend data shall be available for viewing numerically and graphically at the workstation and connected notebook computers.

M. Device Diagnostics: Each controller shall have diagnostic LEDs for power, communication, and device fault condition. The DDC system shall recognize and report a non-responsive controller.

N. Power Loss: Upon restoration of power, the DDC system shall perform an orderly restart and restoration of control.

O. Energy Data Recording: Provide a resettable signal accumulation for each flow meter and electric meter. Program monthly usage reports for the following:

1. Record electrical energy in KWH and electrical demand in KW.
2. Calculate hot water thermal energy in MBTUH using hot water supply temperature and flow and hot water return temperature signals.
3. Calculate chilled water thermal energy in MBTUH using chilled water supply temperature and flow and chilled water return temperature signals.
4. Record make-up water for each system; usage in K gallons.
5. Record potable water; usage in K gallons.
6. Record natural gas; usage in ft^3 and therms.

2.3 OPERATOR WORKSTATION

A. Provide a new operator workstation and file server capable of accessing all DDC system devices, storing trend data and enabling system interrogation using the BACnet protocol. The workstation shall be equipped with dual 27 inch color monitors which are capable of displaying,
modifying, creating, archiving, and deleting (as applicable): all points, objects, object properties, programming, alarms, trends, messages, schedules, and reports.

1. At a minimum the workstation hardware shall include: A desktop personal computer with Microsoft Windows 10 operating system or equal, sixth generation Intel Core i7 processor, 32 GB system memory, DVD/CD burner, 256 GB solid state hard drive, 2 TB hard drive, video graphics card with 8 GB GDDR5X on board memory, 10 Gbps memory speed, digital resolution of 7680x4320. Include built in media reader with memory stick support; Memory stick, MultiMediaCard Plus, SDHC and SXDC memory card formats. Include 6 USB 3.0 ports (backward compatible with USB 2.0 formats), 4 USB 2.0 ports, Bluetooth 4.0 interface and two 27 inch flat panel LED HD monitors with stands; 2560x1440 resolution, internal V.92 modem, sound card with speakers, 101 character keyboard, optical mouse, USB Hub with four USB 2.0 ports and connecting cable, 120-volt 800 VA uninterruptible power supply with automatic voltage regulation and 4 minimum battery back-up outlets and 2 surge protected outlets, Microsoft Office bundled software, Adobe Acrobat Writer, Anti-virus software, and Symantec Ghost disk imaging software or equal. Provide all original licenses, installation media, documentation, and recovery CDs capable of restoring the original configuration. Provide a manufacturer's 3-year next business day on-site warranty.

B. Password Protection: Provide at least five levels of password protection for operator interfaces. The lowest level shall only allow viewing graphics. The second level allows viewing graphics and changing space temperature setpoints. The third level allows the previous level's capability, plus changing operating schedules. The fourth level allows access to all functions except passwords. The highest level provides all administrator rights and allows full access to all programming, including setting new passwords and access levels. Provide the BAS Owner with the highest level password access. Provide automatic log out if no keyboard or mouse activity is detected after a user-defined time delay.

C. BACnet Operator Workstation DDC Software: Provide the latest version of software for the existing workstation computer including the manufacturer's installation CDs and licenses. Configure the software according to the DDC system manufacturer's specifications and in agreement with BACnet Operator Workstation (B-OWS) device standards found in ASHRAE 135, Annex L. The workstation software shall permit complete monitoring, modification, and troubleshooting interface with the DDC system. The operator interface with the software shall be menu-driven with appropriate displays and menu commands to manipulate the DDC system's objects, point data, operating schedules, control routines, system configuration, trends, alarms, messages, graphics, and reports. Trends shall be capable of graphic display in real time, with variables plotted as functions of time. Each alarmed point shall be capable of displaying its alarm history, showing when it went into alarm, if and when it was acknowledged, and when it went out of alarm. The modification of DDC system parameters and object properties shall be accomplished with "fill in the blank" and/or "point and drag" methods. Modifications shall download to the appropriate controllers at the operator's request.

D. Graphics Software: Provide web-based system graphics specifically designed for this project and viewable on browsers compatible with MS Internet Explorer 6.X or greater using an industry-standard file format such as HTML, BMP, JPEG, or GIF. Graphics shall replicate the indicated HVAC system design and include building plans with equipment locations, and schematic plans of each item of mechanical equipment, with all control variables clearly identified and capable of real-time display. Graphic displays shall have full-screen resolution when viewed on the workstation and notebook computers. Dynamic data on graphics pages
shall refresh within 10 seconds using an Internet connection, or 30 seconds using a dial-up modem connection. Graphics viewing shall not require additional "plug-in" software like Java, Shockwave and Flash applications unless the software is readily available for free over the Internet. The graphics shall show the present value and object name for each of the project's I/O points on at least one graphic page. Arrange point values and names on the graphic displays in their appropriate physical locations with respect to the floor plan or equipment graphic displayed. Graphics shall allow the operator to monitor current status, view zone and equipment summaries, use point-and-click navigation between graphic pages, and edit setpoints and parameters directly from the screens. Items in alarm shall be displayed using a different color or other obvious visual indicator. Provide graphics with the following:

1. Graphic Types: Provide at least one graphic display for each piece of HVAC equipment, building floor, and controlled zone. Indicate dynamic point values, operating statuses, alarm conditions, and control setpoints on each display. Provide summary pages where appropriate.

   a. Building Elevation: For buildings more than one story, provide an elevation view of the building with links to each of the building's floor plans. Simulate the building's architecture and include the building number and floor numbers. If possible, use an actual photograph of the building.

   b. Building Floor Plans: Provide a floor plan graphic for each of the building's floors with dynamic display of space temperature and other important data. If used, indicate and provide links to sub-plan areas. If possible, use the project's electronic drawing files for the graphic backgrounds. Provide clear names for important areas, such as "Main Conference Room." Include room names and numbers where applicable. Include features such as stairwells, elevators, and main entrances. Where applicable, include the mechanical room, HVAC equipment, and control component locations, with corresponding links to the equipment graphics.

   c. Sub-plan Areas: Where a building's floor plan is too large to adequately display on the screen, sub-divide the plan into distinct areas, and provide a separate graphic display for each area. Provide same level of detail requested in building floor plan section above.

   d. HVAC Equipment: Provide a graphic display for the new equipment accessory items. Equipment shall be represented by a two or three-dimensional drawing. Indicate the equipment, piping, ductwork, dampers, and control valves in the installed location. Include labels for equipment, piping, ductwork, dampers, and control valves. Show the direction of air and water flow. Include dynamic display of applicable object data with clear names in appropriate locations.

   e. Sequence of Operation: Provide a graphic screen displaying the written out full sequence of operation; submitted by the installer, based on the sequences of operation indicated on Contract Drawings for each piece of HVAC equipment. Provide a link to the sequence of operation displays on their respective equipment graphics. Include dynamic real-time data within the text for setpoints and variables.

2. Graphic Title: Provide a prominent, descriptive title on each graphic page.

3. Dynamic Update: When the workstation is on-line, all graphic I/O object values shall update with change-of-value services, or by operator selected discrete intervals.

4. Graphic Linking: Provide forward and backward linking between floor plans, sub-plans, and equipment.
5. **Graphic Editing:** Provide installed software to create, modify, and delete the DDC graphics. Include the ability to store graphic symbols in a symbol directory and import these symbols into the graphics.

6. **Dynamic Point Editing:** Provide full editing capability for deleting, adding, and modifying dynamic points on the graphics.

### 2.4 SENSORS AND INPUT HARDWARE

**A. Field-Installed Sensors:** Where feasible, provide the same sensor type throughout the project. Coordinate sensor types with the DDC system Owner to keep them consistent with existing installations.

1. **Resistance Temperature Detectors (RTDs):** Provide RTD temperature sensors with platinum elements compatible with the digital controllers. Encapsulate sensors in epoxy, series 300 stainless steel, anodized aluminum, or copper. Temperature sensor accuracy shall be 0.1 percent (1 ohm) of expected ohms (1000 ohms) at 32 degrees F. Temperature sensor stability error over five years shall not exceed 0.25 degrees F cumulative. Direct connection of RTDs to digital controllers without transmitters is preferred. When RTDs are connected directly, lead resistance error shall be less than 0.25 degrees F. The total error for a RTD circuit shall not exceed 0.5 degrees F.

2. **Temperature Sensor Details:**
   - **Room Type:** Provide the sensing element components within a decorative protective cover suitable for surrounding decor. Provide room temperature sensors with integral relative humidity sensor, timed override button where indicated, temperature setpoint adjustment, digital temperature and humidity display. Provide a communication port or 802.11x wireless support for a portable operator interface like a notebook computer or PDA.
   - **Duct Probe Type:** Ensure the probe is long enough to properly sense the air stream temperature.
   - **Duct Averaging Type:** Continuous averaging sensors shall be one foot in length for each 4 square feet of duct cross-sectional area, and a minimum length of 6 feet.
   - **Pipe Immersion Type:** Provide minimum three-inch long immersion sensing element. Provide each sensor with a corresponding pipe-mounted sensor well, unless indicated otherwise. Sensor wells shall be stainless steel when used in steel piping, and brass when used in copper piping. Provide the sensor well with a heat-sensitive transfer agent between the sensor and the well interior.
   - **Outside Air Type:** Provide a master outdoor air temperature and humidity sensing element on the building's north side with a protective weather shade that positions the sensor approximately 3 inches off the wall surface, does not inhibit free airflow across the sensing element, and protects the sensor from snow, ice, and rain.

3. **Sensor Ranges and Accuracy:** Temperature sensors may be provided without transmitters. Temperature sensors, including transmitter if used, shall have minimum operating ranges, minimum accuracy and maximum drift as specified below for the application:
   - **Conditioned Space Temperature:**
     1) Operating Range: 50 to 86 degrees F.
2) Accuracy: +/- 1 degree F over the operating range.
3) Drift: Maximum 1 degree F per year.

b. Unconditioned Space Temperature:

1) Operating Range: 20 to 150 degrees F.
2) Accuracy: +/- 1 degree F over the range of 30 to 131 degrees F and +/- 4 degrees F over the rest of the operating range.
3) Drift: Maximum 1 degree F per year.

c. Duct Temperature:

1) Operating Range: 40 to 140 degrees F.
2) Accuracy: +/- 2 degrees F.
3) Drift: Maximum 2 degrees F per year.

d. Outside Air Temperature:

1) Operating Range: -30 to +130 degrees F.
2) Accuracy: +/- 1 degree F over the range of 30 to 100 degrees F.
3) Drift: Maximum 1 degree F per year.

e. Chilled Water and Potable Cold Water:

1) Operating Range: 30 to 100 degrees F.
2) Accuracy: +/- 0.8 degrees F over the range of 35 to 65 degrees F and +/- 2 degrees F over the rest of the operating range.
3) Drift: Maximum 0.8 degrees F per year.

f. Heating Hot Water and Potable Hot Water:

1) Operating Range: 50 to 250 degrees F.
2) Accuracy: +/- 2 degrees F.
3) Drift: Maximum 2 degrees F per year.

B. Transmitters: Provide transmitters with 4 to 20 mA or 0 to 10 VDC linear output scaled to the sensed input. Transmitters shall be matched to the respective sensor, factory calibrated, and sealed. Size transmitters for an output near 50 percent of its full-scale range at normal operating conditions. The total transmitter error shall not exceed 0.1 percent at any point across the measured span. Supply voltage shall be 12 to 24 volts AC or DC. Transmitters shall have non-interactive offset and span adjustments. For temperature sensing, transmitter drift shall not exceed 0.03 degrees F a year.

1. Relative Humidity Transmitters: Provide transmitters with an accuracy equal to plus or minus 2 percent from 0 to 90 percent scale, and less than one percent drift per year. Sensing elements shall be the polymer type.
2. Pressure Transmitters: Unless noted otherwise, provide transmitters integral with the pressure transducer.

C. Electronic Air Flow Measurement Stations: Air flow measurement stations shall have an array of velocity sensing elements or fan vortex array design as indicated. The velocity sensing
elements shall be the RTD, traversing the ducted air in at least two directions. The air flow pressure drop across the station shall not exceed 0.08 inch water gage at a velocity of 2,000 fpm. The station shall be suitable for air flows up to 5,000 fpm, and a temperature range of 40 to 120 degrees F. The station's measurement accuracy over the range of 125 to 2,500 fpm shall be plus or minus 3 percent of the measured velocity. Station transmitters shall provide a linear, temperature-compensated 4 to 20 mA or 0 to 10 VDC output. The output shall be capable of being accurately converted to a corresponding air flow rate in cubic feet per minute. Transmitters shall be a 2-wire, loop powered device. The output error of the transmitter shall not exceed 0.5 percent of the measurement. Subject to compliance with requirements, provide Ebtron Gold Series or approved equal.

D. Current Transducers: Current transducers shall accept an AC current input and shall have an accuracy of +/- 0.5 percent of full scale. An integral power supply shall be provided if required for the analog output signal. The device shall have a means for calibration.

E. Current Sensing Relays (CSRs): Current sensing relays (CSRs) shall provide a normally-open contact with a voltage and amperage rating greater than its connected load. Current sensing relays shall be of split-core design. The CSR shall be rated for operation at 200 percent of the connected load. Voltage isolation shall be a minimum of 600 volts. The CSR shall auto-calibrate to the connected load.

F. Damper and Valve End Switches: Each end switch shall be a hermetically sealed switch with a trip lever and over-travel mechanism. The switch enclosure shall be suitable for mounting on the duct or valve exterior and shall permit setting the position of the trip lever that actuates the switch. The trip lever shall be aligned with the actuator linkage. End switches factory packaged to valve and damper actuators are not acceptable.

G. Electric Meters: Provide contacts for kilowatt (kw) pulse accumulation. Integrate electric meter signal into DDC system; meter signal output must be compatible with DDC input. DDC shall measure both instantaneous and accumulated electrical usage.

H. Chilled Water and Heating Water Flow Sensors: Provide magnetic mass principle insertion type flow meters. Wiring installed by the contractor between the control system and the meters shall be Belden 9320, two wire, shielded twisted cable, and shall not be included in conduit containing AC circuit wiring. Subject to compliance with requirements, provide F-3500 series manufactured by Onicon or approved equal.

1. Each meter shall have dual electrode design, each with its own sensing system, and an averaging circuit to reduce measurement errors due to swirl in undeveloped flow locations caused by short straight pipe runs. Sensing shall be accomplished electromagnetically; not through mechanical or photoelectric means. Paddle type rotors will not be acceptable.

2. Range and Accuracy: Provide unit with a maximum operating pressure of 400 PSI, maximum operating temperature of 250 deg F and a pressure drop of less than 0.1 PSI at 12 feet per second flow velocity. Flow sensor shall provide stable readings over a 200:1 turndown ratio. Accuracy shall be within +/-1.0% of actual reading at a liquid velocity of 2 to 20 feet/second.

3. Factory Calibration: Each sensor shall be individually wet-calibrated in a flow laboratory against a primary volumetric standard accurate to within 0.1% and directly traceable to the U.S. National Institute of Standards and Technology (NIST). Provide certificate of calibration with each flow meter.
4. Sensor Outputs: The sensor shall have integral analog outputs of 0-10 VDC and 4-20 mA linear to within +0.1% of calibrated span for connection to the control system. The sensor shall also include three internal frequency outputs, (top sensor, bottom sensor, average frequency) for commissioning and diagnostic purposes. All outputs shall be linear with flow rate.

5. Meter Construction: Provide type 316 stainless steel for all wetted parts, electronics enclosure shall be NEMA 4 aluminum. The sensor head shall be constructed of polypropylene. The unit shall be installed with hot tap installation, in order to be both insertable and removable through a ball valve when the pipe is under pressure.

6. Electrical: Operating power shall be nominal 120 VDC. Local instantaneous flow indicator shall be LED type in NEMA 4 enclosure with 3-1/2 inch digit display for wall or panel mounting. Provide 4-20 ma analog output signal for use by the facility DDC system. Furnish with flow meter manufacturer temperature sensors where indicated on Contract Drawings.

I. Water Flow Meter (Make-up Water): Sensor shall be a vane displacement device rated for liquid service as shown. A counter shall be mounted on top of the meter, and shall consist of a non-resettable mechanical totalizer for local reading, and a pulse transmitter for remote reading. The totalizer shall have a six-digit register to indicate the volume passed through the meter in gallons, and a sweep-hand dial to indicate down to 1 liter 0.25 gallons. Output signal shall be pulse type. Body shall be Class 125, bronze or carbon steel, threaded or flanged connections. Accuracy shall be +/- 2% of the flow range. Maximum pressure drop at full flow: 1 psig. Subject to compliance with requirements, provide Istec series 1800 meters or approved equal.

J. Carbon Monoxide Sensor: Carbon monoxide sensor and alarm shall consist of an infrared light source in a steel enclosure for room mounting. System shall enable the detection of non-combusted natural gas and liquified petroleum gas (propane) compounds within the boiler rooms. An optical detector/analyzer in a similar enclosure, suitable for indoor mounting shall be provided. Both assemblies shall include internal blower systems to keep optical windows free of dust at all times. The third component of the analyzer shall be the electronics cabinet. Automatic flue gas temperature compensation and manual/automatic zeroing devices shall be provided. Repeatability shall be +/- 2 percent of full scale with an accuracy of +/- 3 percent of full scale. Furnish with integral dry type contacts for alarm output connection to facility DDC system.

K. Provide photo-acoustic type CO2 sensors with integral transducers and linear output. The devices shall read CO2 concentrations between 0 and 2000 ppm with full scale accuracy of at least plus or minus 100 ppm.

L. Pipe Mount Temperature Limit Switch (Aquastat): Pipe mount temperature limit switches (aquastats) shall have a field adjustable setpoint between 60 and 90 degrees F, an accuracy of +/- 3.6 degrees F and a 10 degrees F fixed deadband. The switch shall have two sets of contacts, and each contact shall have a rating greater than its connected load. Contacts shall open or close upon change of temperature above or below setpoint as shown.

2.5 OUTPUT DEVICES

A. Control Dampers: Provide factory manufactured dampers. Control dampers shall comply with SMACNA 1966 except as modified or supplemented by this specification. Published damper
leakage rates and respective pressure drops shall have been verified by tests in compliance with AMCA 500-D requirements. Outside air dampers shall be provided where shown. Opposed blade dampers shall include an airfoil blade design. Blades shall have neoprene rubber compressible seals at points of contact. Subject to compliance with requirements. Provide TAMCO Series 1000 dampers or approved equal.

1. Frame Construction: Damper frame shall be not less than .080 inch thick and be fabricated of extruded aluminum (6063-T5). Damper frame shall be minimum 4 inches deep x 1 inch with mounting flanges on both side of frame. Frame shall be clear anodized to a minimum thickness of 0.7 mil deep and be assembled using stainless steel screws.

2. Blade Construction: Blades shall be airfoil design, constructed of extruded aluminum (6063-T5) with a minimum wall thickness of .06 inches. Blades shall be clear anodized to a minimum thickness of 0.7 mil deep. Blade seals shall be extruded silicone, secured in an integral slot within the aluminum blade extrusions and shall be mechanically fastened to prevent shrinkage and movement.

3. Seals: Frame seals shall be of extruded silicone and be secured in an integral slot within the aluminum extrusions.

4. Bearings: Bearings shall be maintenance free, composed of a Celcon inner bearing fixed to a 7/16" aluminum hexagon blade pin, rotating within a polycarbonate outer bearing inserted in the frame.

5. Linkage: Linkage hardware shall be installed in the frame side, out of the air stream and accessible after fabrication. All non-aluminum damper assembly and linkage hardware parts shall be constructed of type 304 stainless steel. Cup-point trunion screws shall be used to anchor bearings to linkage rod. Provide an adjustable hexagon drive rod, U-bolt fastener and retaining nuts. Motor actuators for the dampers shall be field provided by the controls installer.

6. Rating: Leakage shall not exceed 2 percent of air quantity at 2000-fpm face velocity through damper and 4-inch wg differential pressure. Dampers shall be designed to operate in air temperatures between -40°F and 210°F.

B. Control Valves: Valve bodies shall be designed for 125 psig minimum working pressure or 150 percent of the operating pressure, whichever is greater. Valve stems shall be Type 316 stainless steel. Valve leakage ratings shall be 0.01 percent of rated Cv value. Class 125 copper alloy valve bodies and Class 150 steel or stainless steel valves shall meet the requirements of ASME B16.5. Cast iron valve components shall meet the requirements of ASTM A 126 Class B or C.

1. Butterfly Valves: Butterfly valves shall be the threaded lug type suitable for dead-end service and for modulation to the fully-closed position, with stainless steel shafts supported by bearings, stainless steel or vinyl coated discs geometrically interlocked with or bolted to the shaft (no pins), and EPDM seats suitable for temperatures from minus 20 degrees F to plus 250 degrees F. Valves shall have a means of manual operation independent of the actuator.

2. Two-Way Valves: Two-way modulating valves shall have an equal percentage characteristic.

3. Three-Way Valves: Three-way valves shall have an equal percentage characteristic.

4. Valves for Chilled Water:

   a. Bodies for valves 1-1/2 inches and smaller shall be brass or bronze globe body, with threaded or union ends. Bodies for valves from 2 inches to 3 inches inclusive shall be globe body of brass, bronze, or iron. Bodies for 2 inch valves shall have
threaded connections. Bodies for valves from 2-1/2 to 3 inches shall have flanged connections.

b. Internal valve trim shall be brass or bronze, except that valve stems shall be stainless steel.

c. Unless indicated otherwise, provide modulating valves sized for 2 psi minimum and 4 psi maximum differential across the valve at the design flow rate.

d. Valves 4 inches and larger may be butterfly valves, unless indicated otherwise.

C. Plant Heating Water System Valve Actuators: Provide industrial duty valve actuators for motor actuated valves at water chillers, boilers, heat exchangers and bypass piping. Actuators shall each be mounted on a bracket which is coupled to the valve shaft. The actuator shall have a split phase capacitor AC reversing motor with 75%-100% duty. The actuator shall require 120 VAC, 1 Ph, 60 Hz power. The gearing on actuators shall have a torque rating of 1440-2400 in-lbs and shall have a permanently lubricated self-locking gear train with two stage planetary gear. The actuators shall each be equipped with a mechanical brake. Actuators shall be housed in a NEMA 4 corrosion resistant enclosure with a baked epoxy coating. Actuators shall have a thermal motor overload protector with automatic reset. Actuators shall be equipped with two single pole double throw internally mounted adjustable cam operated limit switches and manual override capability. Actuators shall be controlled by a solid-state electronic positioner board internally mounted, which will accept an isolated 4-20 mA DC control signal. Actuators shall be listed UL, ETL, and/or CSA; rated for continuous duty. Subject to compliance with requirements, provide actuators manufactured by EMI/Emerson or approved equal. Note that commercial grade actuators for these applications will not be acceptable.

D. General Actuators: Provide direct-drive electric actuators for all control applications, except where indicated otherwise. Each actuator shall deliver the torque required for continuous uniform motion and shall have internal switches to limit the travel, or be capable of withstanding continuous stalling without damage. Actuators shall function properly within 85 to 110 percent of rated line voltage. Provide actuators with hardened steel running shafts and gears of steel or copper alloy. Fiber or reinforced nylon gears may be used for torques less than 16 inch-pounds. Provide two-position actuators of single direction, spring return type. Provide modulating actuators capable of stopping at any point in the cycle, and starting in either direction from any point. Actuators shall be equipped with an end switch for reversing direction, and a button to disengage the clutch to allow manual adjustments. Provide the actuator with a hand crank for manual adjustments. Each actuator shall have distinct markings indicating the full-open and full-closed position, and the points in-between.

E. Output Switches: Field installed and DDC panel relays shall be double pole, double throw, UL listed, with contacts rated for the intended application, indicator light, and dust proof enclosure. The indicator light shall be lit when the coil is energized and off when coil is not energized. Relays shall be the socket type, plug into a fixed base, and replaceable without tools or removing wiring. Encapsulated "PAM" type relays may be used for terminal control applications.

2.6 ELECTRICAL POWER AND DISTRIBUTION

A. Transformers: Step down transformers shall be utilized where control equipment operates at lower than line circuit voltage. Transformers, other than transformers in bridge circuits, shall have primaries wound for the voltage available and secondaries wound for the correct control circuit voltage. Transformer shall be sized so that the connected load is 80 percent of the rated
capacity or less. Transformers shall conform to UL 508 and NEMA ST 1 and be UL Class 2 listed. Provide transformers at DDC controller cabinets of capacity to accommodate power required by lower level DDC controllers and associated devices. Where auxiliary transformers are required remote from DDC controller cabinets, they shall be installed above ceilings; where accessible in NEMA 1 enclosures similar to controller cabinets. If auxiliary transformers are provided, the electrical supply to the transformers shall be provided as work of this Section.

B. Surge and Transient Protection: Provide each digital controller with surge and transient power protection. Surge and transient protection shall consist of the following devices, installed externally to the controllers.

C. Power Line Surge Protection: Provide surge suppressors on the incoming power at each controller or grouped terminal controllers. Surge suppressors shall be rated in accordance with UL 1449, have a fault indicating light, and conform to the following:

1. The device shall be a transient voltage surge suppressor, hard-wire type individual equipment protector for 120 VAC/1 phase/2 wire plus ground.
2. The device shall react within 5 nanoseconds and automatically reset.
3. The voltage protection threshold, line to neutral, shall be no more than 211 volts.
4. The device shall have an independent secondary stage equal to or greater than the primary stage joule rating.
5. The primary suppression system components shall be pure silicon avalanche diodes.
6. The secondary suppression system components shall be silicon avalanche diodes or metal oxide varistors.
7. The device shall have an indication light to indicate the protection components are functioning.
8. All system functions of the transient suppression system shall be individually fused and not short circuit the AC power line at any time.
9. The device shall have an EMI/RFI noise filter with a minimum attenuation of 13 dB at 10 kHz to 300 MHz.
10. The device shall comply with IEEE C62.41.1 and IEEE C62.41.2, Class "B" requirements and be tested according to IEEE C62.45.
11. The device shall be capable of operating between minus 20 degrees F and plus 122 degrees F.

D. Communication Line Surge Protection: Provide surge and transient protection for DDC controllers and DDC network related devices connected to network communication lines, in accordance with the following:

1. The device shall provide continuous, non-interrupting protection, and shall automatically reset after safely eliminating transient surges.
2. The protection shall react within 5 nanoseconds using only solid-state silicon avalanche technology.
3. The device shall be installed at the distance recommended by its manufacturer.

E. Controller Input/Output Protection: Provide controller inputs and outputs with surge protection via optical isolation, metal oxide varistors (MOV), or silicon avalanche devices. Fuses are not permitted for surge protection.

F. Wiring: Provide complete electrical wiring for the DDC System, including wiring to transformer primaries. For all Central Energy Plant mechanical rooms, electrical rooms and
communication rooms, provide all wiring in electric metallic tubing. Control circuit wiring shall not run in the same conduit as power wiring over 100 volts. Run all circuits in metallic tubing or covered metal raceways with the exception that wiring located in concealed spaces such as above suspended ceilings and wiring to room sensors on stud walls may be installed without EMT raceways. At raceway end terminations to sensor pigtails, ends of raceway shall be equipped with sealing type grommets to prevent the entry of debris, moisture and insects. At penetrations into air system equipment such as air handling units and duct systems, seal interior of raceways with duct-seal compound to eliminate the passage of air within raceways. All conduit/raceways used as work of this Section shall be furnished factory coated with light blue exterior color.

1. Power Wiring: The following requirements are for field-installed wiring:
   a. Wiring for 24 V circuits shall be insulated copper 18 AWG minimum and rated for 300 VAC service.
   b. Wiring for 120 V circuits shall be insulated copper 14 AWG minimum and rated for 600 VAC service.

2. Analog Signal Wiring: Field-installed analog signal wiring shall be 18 AWG single or multiple twisted pair. Each cable shall be 100 percent shielded and have a 20 AWG drain wire. Each wire shall have insulation rated for 300 VAC service. Cables shall have an overall aluminum-polyester or tinned-copper cable-shield tape.

PART 3 - EXECUTION

3.1 CONTROL SYSTEM INSTALLATION

A. HVAC Control System Installation: The HVAC control system shall be completely installed, tested and capable of operation as intended by the Contract Drawing design. Perform the installation through competent technicians in the direct employ of the DDC System manufacturer. System wiring however, may be installed through a sub-contract from the work in this Section. All final connections and circuit verification shall be conducted by the DDC System installer. Dielectric isolation shall be provided where dissimilar metals are used for connection and support. Penetrations through and mounting holes in the building exterior shall be made watertight.

B. BACnet Naming and Addressing: Coordinate with the BAS Owner and provide unique naming and addressing for BACnet networks and devices.

1. MAC Address: Every BACnet device shall have an assigned and documented MAC Address unique to its network. For Ethernet networks, document the MAC Address assigned at its creation. For ARCNET or MS/TP, assign from 00 to 64.

2. Network Numbering: Assign unique numbers to each new network installed on the BACnet internetwork. Provide ability for changing the network number; either by device switches, network computer, or field operator interface. The BACnet internetwork (all possible connected networks) can contain up to 65,534 possible unique networks.

3. Device Object Identifier Property Number: Assign unique Device "Object Identifier" property numbers or device instances for each device on the BACnet internetwork. Provide for future modification of the device instance number; either by device switches,
network computer, or field interface. BACnet allows up to 4,194,302 possible unique devices per internetwork.

4. Device Object Name Property Text: The Device Object Name property field shall support 32 minimum printable characters. Assign unique Device "Object_Name" property names with plain-English descriptive names for each device. For example, the Device Object Name that for the device controlling the chiller plant at Building 3408 would be:
   a. Device Object_Name = CW System B3408
   b. Device Object Name for a VAV box controller might be:
   c. Device Object_Name = VAV BOX25

5. Object Name Property Text (Other than Device Objects): The Object Name property field shall support 32 minimum printable characters. Assign Object Name properties with plain-English names descriptive of the application. Examples include "Zone 1 Temperature" and "Fan Start/Stop".

6. Object Identifier Property Number (Other than Device Objects): Assign Object Identifier property numbers according to design drawings or tables if provided. If not provided, Object Identifier property numbers may be assigned at the Contractor's discretion but must be approved by the Owner. In this case they must be documented and unique for like object types within the device.

C. Minimum BACnet Object Requirements:

1. Use of Standard BACnet Objects: For the following points and parameters, use standard BACnet objects, where all relevant object properties can be read using BACnet's Read Property Service, and all relevant object properties can be modified using BACnet's Write Property Service: all device physical inputs and outputs, all set points, all PID tuning parameters, all calculated pressures, flow rates, and consumption values, all alarms, all trends, all schedules, and all equipment and lighting circuit operating status.

2. BACnet Object Description Property: The Object Description property shall support 32 minimum printable characters. For each object, complete the description property field using a brief, narrative, plain English description specific to the object and project application. For example: "HW Pump 1 Proof." Document compliance, length restrictions, and whether the description is writeable in the device PICS.

3. Analog Input, Output, and Value Objects: Support and provide Description and/or Device-Type text strings matching signal type and engineering units shown on the points list.

4. Binary Input, Output, and Value Objects: Support and provide Inactive-Text and Active-Text property descriptions matching conditions shown on the points list.

5. Calendar Object: For devices with scheduling capability, provide at least one Calendar Object with ten-entry capacity. All operators may view Calendar Objects; authorized operators may make modifications from a workstation. Enable the writeable Date List property and support all calendar entry data types.

6. Schedule Object: Use Schedule Objects for all building system scheduling. All operators may view schedule entries; authorized operators may modify schedules from any workstation computer.

7. Loop Object or Equal: Use Loop Objects or equivalent BACnet objects in each applicable field device for PID control. Regardless of program method or object used, allow authorized operators to adjust the Update Interval, Setpoint, Proportional Constant, Integral Constant, and Derivative Constant using BACnet read/write services.
D. Minimum BACnet Service Requirements:

1. Command Priorities: Use commandable BACnet objects to control machinery and systems, providing the priority levels listed below. If the sequence of operation requires a different priority, obtain approval from the Architect.

2. Priority Level Application:
   b. Automatic-Life Safety
   c. (User Defined)
   d. (User Defined)
   e. Critical Equipment Control
   f. Minimum On/Off
   g. (User Defined)
   h. Manual Operator
   i. (User Defined)
   j. (User Defined)

3. Alarming:
   a. Alarm Priorities - Coordinate alarm and event notification with the BAS Owner.
   b. Notification Class - Enable writeable Priority, Ack Required, and Recipient List properties of Notification Class objects.
   c. Event Notification Message Texts - Use condition specific narrative text and numerical references for alarm and event notification.

4. Updating Displayed Property Values: Allow workstations to display property values at discrete polled intervals, or based on receipt of confirmed and unconfirmed Change of Value notifications. The COV increment shall be adjustable by an operator using BACnet services, and polled intervals shall be adjustable at the operator workstation.

E. Local Area Networks: Obtain Architect approval before connecting new networks with existing networks exterior to Plant facility. Network numbers and device instance numbers shall remain unique when conjoining networks. Do not change existing network addressing without Architect approval. See also "BACnet Naming and Addressing".

F. BACnet Routers, Bridges, and Switches: Provide the quantity of BACnet routers, bridges, and switches necessary for communications implied by the DDC Architecture schematic. Provide BACnet routers with BACnet Broadcast Message Device (BBMD) capability on each BACnet internetwork communicating across an IP network. Configure each BACnet device and bridge, router, or switch to communicate on its network segment.

G. Wiring Criteria:

1. Run circuits in metallic tubing or enclosed in metallic raceways.
2. Do not run binary control circuit wiring in the same conduit as power wiring over 100 volts. Where analog signal wiring requires conduit, do not run in the same conduit with AC power circuits or control circuits operating at more than 100 volts.
3. Provide circuit and wiring protection required by NFPA 70.
4. Do not bury aluminum conduit in concrete.
5. Input/output identification: Permanently label each field-installed wire, cable, and pneumatic tube at each end with descriptive text using a commercial wire marking system that fully encircles the wire, cable, or tube. Locate the markers within 2 inches of each termination. Match the names and I/O number to the project's point list. Similarly label all power wiring serving control devices, including the word "power" in the label. Label all terminal blocks with alpha/numeric labels. All wiring and the wiring methods shall be in accordance with UL 508A.

6. For controller power, provide new 120 VAC circuits, with ground. Provide each circuit with a dedicated breaker, and run wiring in its own conduit, separate from any control wiring. Connect the controller's ground wire to the electrical panel ground; conduit grounds are not acceptable. For control panels and workstation computers indicated to be equipped with uninterruptible power supply systems provide control panel and workstation computer power wiring configured for use with the UPS.

7. Surge Protection: Install surge protection according to manufacturer's instructions. Multiple controllers fed from a common power supply may be protected by a common surge protector, properly sized for the total connected devices.

8. Grounding: Ground controllers and cabinets to a good earth ground as specified in Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS. Conduit grounding is not acceptable; all grounding shall have a direct path to the building earth ground. Ground sensor drain wire shields at the controller end.

9. The Contractor shall be responsible for correcting all associated ground loop problems.

10. Run wiring in panel enclosures in covered wire track/wireway.

H. Wiring Interlocks: Provide wiring interlocks and DDC communication points as indicated and necessary to accomplish sequences of operation. It is the work of this Section to coordinate the interface type; gateway, direct low-voltage interlock wiring, terminal connections and communication platform with the additional sub-control systems furnished under this Contract such as but not limited to the water chillers, variable-primary pumping systems, fuel oil systems, standby electrical power system, and medical gas systems.

I. Accessibility: Install all equipment so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install digital controllers, data ports, and concealed actuators, valves, dampers, and like equipment in locations freely accessible through access doors.

J. Digital Controllers:

1. Install as stand-alone control devices (see definitions).
2. Locate control cabinets at the locations shown on the drawings. If not shown on the drawings, install in the most accessible space, close to the controlled equipment.
3. Network Interface Jack: A standard network interface jack shall be provided for each controller on the control network. For terminal unit controllers with hardwired sensors this network interface jack shall be located at the sensor or within 10 feet of the controller. Locating the interface jack at the sensor is preferred. For all other nodes the network interface jack shall be located within 10 feet of the node. If the network interface jack is other than a 1/8 inch phone jack, provide an interface cable with a standard 1/8 inch phone jack on one end and a connector suitable for mating with installed network interface jack on the other. No more than one type of interface cable shall be required to access all network interface jacks. Furnish two interface cable(s).
K. Hand-Off-Auto Switches: Wire safety controls such as smoke detectors and freeze protection thermostats to protect the equipment during both hand and auto operation. Coordinate the wiring of H-O-A switches at air handling systems to enable shutdown of interlocked fans and dampers as indicated in the sequence of operation.

L. Temperature/Humidity Sensors: Install temperature/humidity sensors in locations that are accessible and provide a dynamic representation of sensed media. Installations in dead spaces are not acceptable. Calibrate sensors according to manufacturer's instructions. Do not use sensors designed for one application in a different application.

M. Room Temperature Sensors: Mount the sensors on interior walls to sense the average room temperature at the locations indicated. Avoid locations near heat sources such as copy machines or locations by supply air outlet drafts. Mount the center of the sensor approximately 4 feet above the finished floor. Refer to additional annotations on Contract Drawings.

N. Duct Temperature Sensors:
   1. Probe Type: Provide a gasket between the sensor housing and the duct wall. Seal the duct penetration air tight. Seal the duct insulation penetration vapor tight.
   2. Averaging Type (and coil freeze protection thermostats): Weave the capillary tube sensing element in a serpentine fashion perpendicular to the flow, across the duct or air handler cross-section, using durable non-metal supports. Prevent contact between the capillary and the duct or air handler internals. Provide a duct access door at the sensor location. The access door shall be hinged on the side, factory insulated, have cam type locks, and be as large as the duct will permit, maximum 18 by 18 inches. For sensors inside air handlers, the sensors shall be fully accessible through the air handler's access doors without removing any of the air handler's internals.

O. Immersion Temperature Sensors: Provide thermowells for sensors measuring piping, tank, or pressure vessel temperatures. Locate wells to sense continuous flow conditions. Do not install wells using extension couplings. Where piping diameters are smaller than the length of the wells, provide wells in piping at elbows to sense flow across entire area of well. Wells shall not restrict flow area to less than 70 percent of pipe area. Increase piping size as required to avoid restriction. Provide thermal conductivity material within the well to fully coat the inserted sensor. Coordinate installation of wells with piping installers and equipment manufacturers.

P. Outside Air Temperature Sensors: Provide outside air temperature sensors in weatherproof enclosures on the north side of the building, away from exhaust hoods and other areas that may affect the reading. Provide a shield to shade the sensor from direct sunlight.

Q. Energy Meters: Locate energy meters as indicated. Connect each meter output to the DDC system, to measure both instantaneous and accumulated energy usage.

R. Damper Actuators: Where possible, mount actuators outside the air stream in accessible areas.

S. Pressure Sensors: Locate pressure sensors as indicated.

T. Network Interface Jack: A standard network interface jack shall be provided for each controller on the control network. For terminal unit controllers with hardwired sensors this network interface jack shall be located at the sensor or within 10 feet of the controller. Locating the interface jack at the sensor is preferred. For all other nodes the network interface jack shall be
located within 10 feet of the node. If the network interface jack is other than a 1/8 inch phone jack, provide an interface cable with a standard 1/8 inch phone jack on one end and a connector suitable for mating with installed network interface jack on the other. No more than one type of interface cable shall be required to access all network interface jacks. Furnish two interface cable(s).

U. Duct Static Pressure Sensors: The duct static pressure sensing tap shall be located where indicated but not beyond 75 percent of the distance from the AHU outlet. If the transmitter is wired in a homerun configuration to an AHU controller, the transmitter shall be located in the same enclosure as the air handling unit (AHU) controller(s) for the AHU serving the air terminal valves.

V. Relative Humidity Sensors: Relative humidity sensors in supply air ducts shall be installed at least 10 feet downstream of humidity injection elements.

W. Flowmeters: The minimum straight unobstructed piping for the flowmeter installation shall be a minimum of 10 pipe diameters upstream and at least 5 pipe diameters downstream and in accordance with the manufacturer's installation instructions.

X. Dampers:
   1. Damper Actuators: Actuators shall not be mounted in the air stream. Multiple actuators shall not be connected to a common drive shaft. Actuators shall be installed so that their action shall seal the damper to the extent required to maintain leakage at or below the specified rate and shall move the blades smoothly. Coordinate and provide control and operation of damper and valve actuators which are factory supplied as an integral part of assembly such as internal face/bypass heating coils to enable sequence of operation.
   2. Damper Installation: Dampers shall be installed straight and true, level in all planes, and square in all dimensions. Dampers shall move freely without undue stress due to twisting, racking (parallelogramming), bowing, or other installation error. Blades shall close completely and leakage shall not exceed that specified at the rated static pressure. Provide structural support for multi-section dampers and multiple damper arrays. Acceptable methods include but are not limited to U-channel, angle iron, corner angles and bolts, bent galvanized steel stiffeners, sleeve attachments, braces, and building structure. Where multi-section dampers and multiple damper arrays are installed in ducts or sleeves, they shall not sag due to lack of support. Jackshafts shall not be used to link more than three damper sections. Blade to blade linkages shall not be used. Outside and return air dampers shall be installed such that their blades direct their respective air streams towards each other to provide for maximum mixing of air streams.

Y. Valves:
   1. Ball Valves: Where indicated through the sequence of operation two-position (open/closed) ball valves may be used on chilled water, or hot water. Modulating ball valves may only be used for chilled water applications (modulating ball valves shall not be used on steam or hot water applications). In modulating applications a characterizing equal-percentage bore shall be used.
   2. Butterfly Valves: In two-way modulating control applications, valve travel shall be limited to 70 percent (60 degrees) open position.
Z. Device Mounting Criteria: All devices shall be installed in accordance with manufacturer's recommendations and as specified and shown. Control devices to be installed in piping and ductwork shall be provided with required gaskets, flanges, thermal compounds, insulation, piping, fittings, and manual valves for shutoff, equalization, purging, and calibration. Strap-on temperature sensing elements shall not be used except as specified. Spare thermowells shall be installed adjacent to each thermowell containing a sensor and as shown. Devices located outdoors shall have a weather shield.

AA. Labels and Tags: Labels and tags shall be keyed to the unique identifiers shown on the As-Built drawings. All Enclosures and DDC Hardware shall be labeled. All sensors and actuators in mechanical rooms shall be tagged. Airflow measurement arrays shall be tagged to show flow rate range for signal output range, duct size, and AFMA flow coefficient. Duct static pressure taps shall be tagged at the location of the pressure tap. Tags shall be plastic or metal and shall be mechanically attached directly to each device or attached by a metal chain or wire. Labels exterior to protective enclosures shall be engraved plastic and mechanically attached to the enclosure or DDC Hardware. Labels inside protective enclosures may attached using adhesive, but shall not be hand written.

BB. DDC Controller Hardware shall be installed in an enclosure. Except for DDC Hardware used to control Terminal Units, where multiple pieces of DDC Hardware are used to execute one sequence all DDC Hardware executing that sequence shall be on a common local control bus and isolated from all other DDC Hardware via an EIA 709.1B Router or EIA 709.3 Repeater.

CC. Copper Tubing for sensing lines shall be hard-drawn in exposed areas and either hard-drawn or annealed in concealed areas. Only tool-made bends shall be used. Fittings for copper tubing shall be brass or copper solder joint type except at connections to apparatus, where fittings shall be brass compression type.

1. Tubing Lines to Sensors shall be purged of dirt, impurities and moisture before connecting to the control equipment.
2. Tubing for connection of sensing elements and transmitters to liquid shall be copper with brass compression fittings.

DD. Network Hardware: The Contractor shall install all network hardware in an enclosure or a telecommunication closet as defined by the project site. IP Network Hardware shall be powered through a UPS.

EE. IP Addresses: For equipment requiring IP addresses, the Contractor shall coordinate with the Florida Department of Veterans Affairs Chief Information Officer (CIO) to obtain IP addresses.

3.2 DRAWINGS

A. Provide DDC Contractor Design Drawings: Drawings shall be on A3 17 by 11 inches sheets in the form and arrangement shown. The drawings shall use the same abbreviations, symbols, nomenclature and identifiers shown. Each control system element on a drawing shall be assigned a unique identifier as shown. The DDC Contractor Design Drawings shall be delivered together as a complete submittal. Deviations shall be approved by the Architect. DDC Contractor Design Drawings shall include the following:
1. **Drawing Index and HVAC Design Drawing Legend:** The HVAC Control System Drawing Index shall show the name and number of the building, military site, State or other similar designation, and Country. The Drawing Index shall list all Contractor Design Drawings, including the drawing number, sheet number, drawing title, and computer filename when used. The Design Drawing Legend shall show and describe all symbols, abbreviations and acronyms used on the Design Drawings.

2. **Valve Schedule:** The valve schedule shall contain each valve's unique identifier, size, flow coefficient $K_v$ ($C_v$), pressure drop at specified flow rate, spring range, positive positioner range, actuator size, close-off pressure to torque data, dimensions, and access and clearance requirements data. The valve schedule shall contain actuator selection data supported by calculations of the force required to move and seal the valve, access and clearance requirements. A valve schedule shall be submitted for each HVAC system.

3. **Damper Schedule:** The damper schedule shall contain each damper's unique identifier, type, nominal and actual sizes, orientation of axis and frame, direction of blade rotation, actuator size and spring ranges, operation rate, positive positioner range, location of actuators and damper end switches, arrangement of sections in multi-section dampers, and methods of connecting dampers, actuators, and linkages. The Damper Schedule shall include the AMCA 500-D maximum leakage rate at the operating static-pressure differential. A damper schedule shall be submitted for each HVAC system.

4. **Thermostat and Sensor Schedule:** The thermostat and sensor schedule shall contain each thermostat's and room sensor's unique identifier, room identifier and control features and functions as shown. A thermostat and sensor schedule shall be submitted for each HVAC system.

5. **Critical Alarm Handling Schedule:** The critical alarm handling schedule shall contain the same fields as the critical alarm handling schedule Contract Drawing with Contractor updated information and any other project-specific information required to implement the alarm handling function. A critical alarm handling schedule shall be submitted for each HVAC system.

6. **Equipment Schedule:** The equipment schedule shall contain the unique identifier, manufacturer, model number, part number and descriptive name for each control device, hardware and component provided under this specification. An equipment schedule shall be submitted for each HVAC system.

7. **Points Schedule:** The Points Schedule drawing shall contain the same fields as the Points Schedule Contract Drawing with Contractor updated information. A Points Schedule shall be submitted for each HVAC system.

8. **Control System Schematics:** The control system schematics shall be in the same form as the control system schematic Contract Drawing with Contractor updated information. A control system schematic shall be submitted for each HVAC system.

9. **Sequences of Operation:** The HVAC control system sequence of operation shall be in the same format as the Contract Drawings and shall refer to the devices by their unique identifiers. No operational deviations from specified sequences will be permitted without prior written approval of the Government. Sequences of operation shall be submitted for each HVAC control system.

10. **Controller, Motor Starter and Relay Wiring Diagram:** The controller wiring diagrams shall be functional wiring diagrams which show the interconnection of conductors and cables to each controller and to the identified terminals of input and output devices, starters and package equipment. The wiring diagrams shall show necessary jumpers and ground connections. The wiring diagrams shall show the labels of all conductors. Sources of power required for control systems and for packaged equipment control systems shall be identified back to the panel board circuit breaker number, controller enclosures, magnetic starter, or packaged equipment control circuit. Each power supply
and transformer not integral to a controller, starter, or packaged equipment shall be shown. The connected volt-ampere load and the power supply volt-ampere rating shall be shown. Wiring diagrams shall be submitted for each HVAC control system.

B. Draft As-Built Drawings: The Contractor shall update the Contractor Design Drawings with all as-built data and submit as specified.

C. Final As-Built Drawings: The Contractor shall update the Draft As-Built Drawings with all final as-built data and submit as specified.

3.3 HVAC SYSTEMS SEQUENCES OF OPERATION

A. Refer to sequences of operation on Contract Drawings.

B. Alarm Handling: The Contractor shall install and configure DDC Hardware to provide alarm handling functionality for critical alarms as specified and shown, either in a piece of DDC Hardware dedicated to this function or in DDC Hardware performing other functions. The DDC Hardware providing alarm handling functionality shall provide the following capabilities as required:

1. Dial to a pager: Dial a paging service and leave a numeric message.
2. Dial to an e-mail server: Dial and connect to a remote server and send an e-mail via Simple Mail Transfer Protocol (SMTP).
3. Send e-mail over IP Network: Capable of connecting to an IP network.

3.4 IDENTIFICATION

A. Provide laminated plastic nameplate on each DDC control panel and additional items indicated on Contract Drawings. Comply with requirements in Division 23 Section "Identification for HVAC and Plumbing Piping and Equipment" for equipment labels.

3.5 TEST AND BALANCE SUPPORT

A. The controls contractor shall coordinate with and provide on-site support to the test and balance (TAB) personnel specified under Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC. This support shall include:

1. On-site operation and manipulation of control systems during the testing and balancing.
2. Control setpoint adjustments for balancing all relevant mechanical systems, including VAV boxes.
3. Tuning control loops with setpoints and adjustments determined by TAB personnel.

3.6 CONTROLS SYSTEM OPERATORS MANUALS

A. Provide two electronic and printed copies of a Controls System Operators Manual. The manual shall be specific to the project, written to actual project conditions, and provide a complete and concise depiction of the installed work. Provide information in detail to clearly explain all operation requirements for the control system.
B. Provide with each manual: CDs of the project's control system drawings, control programs, data bases, graphics, and all items listed below. Include gateway back-up data and configuration tools where applicable. Provide CDs in jewel case with printed and dated project-specific labels on both the CD and the case. For text and drawings, use Adobe Acrobat or MS Office file types. When approved by the Owner, AutoCAD and Visio files are allowed. Give files descriptive English names and organize in folders.

C. Provide printed manuals in sturdy 3-ring binders with a title sheet on the outside of each binder indicating the project title, project location, contract number, and the controls contractor name, address, and telephone number. Each binder shall include a table of contents and tabbed dividers, with all material neatly organized. Manuals shall include the following:

1. A copy of the as-built control system (shop) drawings set, with all items specified under the paragraph "Submittals." Indicate all field changes and modifications.
2. A copy of the project's mechanical design drawings, including any official modifications and revisions.
3. A copy of the project's approved Product Data submittals provided under the paragraph "Submittals."
5. A copy of the project's approved final TAB Report.
6. Printouts of all control system programs, including controller setup pages if used. Include plain-English narratives of application programs, flowcharts, and source code.
7. Printouts of all physical input and output object properties, including tuning values, alarm limits, calibration factors, and set points.
8. A table entitled "AC Power Table" listing the electrical power source for each controller. Include the building electrical panel number, panel location, and circuit breaker number.
9. The DDC manufacturer's hardware and software manuals in both print and CD format with printed project-specific labels. Include installation and technical manuals for all controller hardware, operator manuals for all controllers, programming manuals for all controllers, operator manuals for all workstation software, installation and technical manuals for the workstation and programming manuals for the workstation software.
10. A list of qualified control system service organizations for the work provided under this contract. Include their addresses and telephone numbers.
11. A written statement entitled "Technical Support" stating the control system manufacturer or authorized representative will provide toll-free telephone technical support at no additional cost to the Owner for a minimum of two years from project acceptance, will be furnished by experienced service technicians, and will be available during normal weekday working hours. Include the toll-free technical support telephone number.
12. A written statement entitled "Software Upgrades" stating software and firmware patches and updates will be provided upon request at no additional cost to the Government for a minimum of two years from contract acceptance. Include a table of all DDC system software and firmware provided under this contract, listing the original release dates, version numbers, part numbers, and serial numbers.

3.7 CONTROLLER TUNING

A. The Contractor shall tune each controller in a manner consistent with that described in the ASHRAE Fundamentals Handbook. Tuning shall consist of adjustment of the proportional, integral, and where applicable, the derivative (PID) settings to provide stable closed-loop control. Each loop shall be tuned while the system or plant is operating at a high gain (worst
case) condition, where high gain can generally be defined as a low-flow or low-load condition. Upon final adjustment of the PID settings, in response to a change in controller setpoint, the controlled variable shall settle out at the new setpoint with no more than two (2) oscillations above and below setpoint. Upon settling out at the new setpoint the controller output shall be steady. With the exception of naturally slow processes such as zone temperature control, the controller shall settle out at the new setpoint within five (5) minutes. The Contractor shall return the controller to its original setpoint and shall record and submit the final PID configuration settings with the O&M Instructions and on the associated Points Schedule.

3.8 START-UP AND START-UP TEST

A. The Contractor shall perform the following startup tests for each control system to ensure that the described control system components are installed and functioning per this specification.

1. General: The Contractor shall adjust, calibrate, measure, program, configure, set the time schedules, set alarms, and otherwise perform all necessary actions to ensure that the systems function as specified and shown in the sequence of operation and other contract documents.

2. Systems Check: An item-by-item check shall be performed for each HVAC system:

   a. Step 1 - System Inspection: With the system shut down, it shall be verified that power and main air are available where required and that all output devices are in their failsafe and normal positions. Each local display panel shall be inspected to verify that all displays indicate shutdown conditions.

   b. Step 2 - Calibration Accuracy Check: A two-point accuracy check of the calibration of each HVAC control system sensing element and transmitter shall be performed by comparing the SNVT output from the DDC Hardware the sensor is connected to the actual value of the variable measured at the sensing element. Digital indicating test instruments shall be used, such as digital thermometers, motor-driven psychrometers, and tachometers. The test instruments shall be at least twice as accurate as the specified sensor accuracy. The calibration of the test instruments shall be traceable to National Institute Of Standards And Technology standards. The first check point shall be with the HVAC system in the shutdown condition, and the second check point shall be with the HVAC system in an operational condition. Calibration checks shall verify that the sensing element-to-DDC system readout accuracies at two points are within the specified product accuracy tolerances. If not, the device shall be recalibrated or replaced and the calibration check repeated.

   c. Step 3 - Actuator Range Check: With the system running, a signal shall be applied to each actuator through the DDC Hardware controller. Proper operation of the actuators and positioners for all actuated devices shall be verified and the signal levels shall be recorded for the extreme positions of each device. The signal shall be varied from live zero to full range, and it shall be verified that the actuators travel from zero stroke to full stroke within the signal range. Where applicable, it shall be verified that all sequenced actuators move from zero stroke to full stroke in the proper direction, and move the connected device in the proper direction from one extreme position to the other.

3. Weather Dependent Test: Weather dependent test procedures that cannot be performed by simulation shall be performed in the appropriate climatic season. When simulation is used, the actual results shall be verified in the appropriate season.
4. Test Report: Upon completion of the Start-Up Test, the Contractor shall prepare and submit a Start-Up and Start-Up Testing Report documenting the results of the tests performed and certifying that the system is installed and functioning per this specification, and is ready for the Performance Verification Test (PVT).

3.9 PERFORMANCE VERIFICATION TESTING (PVT)

A. General: The PVT shall demonstrate compliance of the control system work with the contract requirements. The PVT shall be performed by the Contractor and witnessed and approved by the Architect. If the project is phased, provide separate testing for each phase. A Pre-PVT meeting to review the Pre-PVT Checklist is required to coordinate all aspects of the PVT and shall include the Contractor's QA representative, the Contractor's PVT administrator, the Architect's representative.

B. Performance Verification Testing Plan: Submit a detailed PVT Plan of the proposed testing for Government approval. Develop the PVT Plan specifically for the control system in this contract. The PVT Plan shall be a clear list of test items arranged in a logical sequence. Include the intended test procedure, the expected response, and the pass/fail criteria for every component tested.

1. The plan shall clearly describe how each item is tested, indicate where assisting personnel are required (like the mechanical contractor), and include what procedures are used to simulate conditions. Include a separate column for each checked item and extra space for comments. Where sequences of operations are checked, insert each corresponding routine from the project’s sequence of operation. For each test area, include signature and date lines for the Contractor's PVT administrator, the Contractor's QA representative, the Architect/Engineer’s representative to acknowledge successful completion.

C. PVT Sample Size: Test all central plant equipment and primary air handling unit controllers unless otherwise directed. Twenty percent sample testing is allowed for identical controllers typical of terminal control like VAV boxes and fan coil units. The commissioning agent shall test like controllers beyond a statistical sample if sample controllers require retesting or do not have consistent results.

D. PVT Observation: The Architect may witness all testing, or random samples of PVT items. When only random samples are witnessed, the Architect may choose which ones.

E. Pre-Performance Verification Testing Checklist: Submit the following as a list with items checked off once verified. Provide a detailed explanation for any items that are not completed or verified.

1. Verify all required mechanical installation work is successfully completed, and all HVAC equipment is working correctly (or will be by the time the PVT is conducted).
2. Verify HVAC motors operate below full-load amperage ratings.
3. Verify all required control system components, wiring, and accessories are installed.
4. Verify the installed control system architecture matches approved drawings.
5. Verify all control circuits operate at the proper voltage and are free from grounds or faults.
6. Verify all required surge protection is installed.
7. Verify the A/C Power Table specified in "CONTROLS SYSTEM OPERATORS MANUALS" is accurate.
8. Verify all DDC network communications function properly, including uploading and downloading programming changes.
9. Verify each digital controller’s programming is backed up.
10. Verify all wiring, components, and panels are properly labeled.
11. Verify all required points are programmed into devices.
12. Verify all TAB work affecting controls is complete.
13. Verify all valve and actuator zero and span adjustments are set properly.
14. Verify all sensor readings are accurate and calibrated.
15. Verify each control valve and actuator goes to normal position upon loss of power.
16. Verify all control loops are tuned for smooth and stable operation. View trend data where applicable.
17. Verify each controller works properly in stand-alone mode.
18. Verify all safety controls and devices function properly, including high static pressure cutouts and interfaces with building fire alarm system.
19. Verify all electrical interlocks work properly.
20. Verify workstation and maintenance personnel interface tools are delivered, all system and database software is installed, and graphic pages are created for each workstation and notebook.
21. Verify the as-built (shop) control drawings are completed.

F. Conducting Performance Verification Testing:

1. Conduct Architect/Owner-witnessed PVT after approval of the PVT Plan and the completed Pre-PVT Checklist. Notify the Architect of the planned PVT at least 15 days prior to testing. Provide an estimated time table required to perform the testing. Furnish personnel, equipment, instrumentation, and supplies necessary to perform all aspects of the PVT. Ensure that testing personnel are regularly employed in the testing and calibration of DDC systems. Using the project's as-built control system (shop) drawings, the project's mechanical design drawings, the approved Pre-PVT Checklist, and the approved PVT Plan, conduct the PVT.

2. During testing, identify any items that do not meet the contract requirements and if time permits, conduct immediate repairs and re-test. Otherwise, deficiencies shall be investigated, corrected, and re-tested later. Document each deficiency and corrective action taken.

3. If re-testing is required, follow the procedures for the initial PVT. The commissioning agent shall re-test any control system components affected by the original failed test.

G. Controller Capability and Labeling: Test the following for each controller:

1. Memory: Demonstrate that programmed data, parameters, and trend/ alarm history collected during normal operation is not lost during power failure.
2. Direct Connect Interface: Demonstrate the ability to connect directly to each type of digital controller with a temporary portable electronic device like a notebook computer or PDA. Show that maintenance personnel interface tools perform as specified in the manufacturer's technical literature.
3. Stand Alone Ability: Demonstrate controllers provide stable and reliable stand-alone operation using default values or other method for values normally read over the network.
4. Wiring and AC Power: Demonstrate the ability to disconnect any controller safely from its power source using the AC Power Table. Demonstrate the ability to match wiring...
labels easily with the control drawings. Demonstrate the ability to locate a controller's location using the BACnet Communication Architecture Schematic and floor plans.

5. Nameplates and Tags: Show the nameplates and tags are accurate and permanently attached to control panel doors, devices, sensors, and actuators.

H. Workstation and Software Operation: For user workstation provided:

1. Show points lists agree with naming conventions.
2. Show that graphics are complete.
3. Show the UPS operates as specified.

I. BACnet Communications and Interoperability Areas: Demonstrate proper interoperability of data sharing, alarm and event management, trending, scheduling, and device and network management. If available or required in this specification, use a BACnet protocol analyzer to assist with identifying devices, viewing network traffic, and verifying interoperability. These requirements must be met even if there is only one manufacturer of equipment installed. Testing includes the following:

1. Data Presentation: On each BACnet Operator Workstation, demonstrate graphic display capabilities.
2. Reading of Any Property: Demonstrate the ability to read and display any used readable object property of any device on the network.
3. Setpoint and Parameter Modifications: Show the ability to modify all setpoints and tuning parameters in the sequence of control or listed on project schedules. Modifications are made with BACnet messages and write services initiated by an operator using workstation graphics, or by completing a field in a menu with instructional text.
4. Peer-to-Peer Data Exchange: Show all BACnet devices are installed and configured to perform BACnet read/write services directly (without the need for operator or workstation intervention), to implement the project sequence of operation, and to share global data.
5. Alarm and Event Management: Show that alarms/events are installed and prioritized according to the BAS Owner. Demonstrate time delays and other logic is set up to avoid nuisance tripping, e.g., no status alarms during unoccupied times or high supply air during cold morning start-up. Show that operators with sufficient privilege can read and write alarm/event parameters for all standard BACnet event types. Show that operators with sufficient privilege can change routing (BACnet notification classes) for each alarm/event including the destination, priority, day of week, time of day, and the type of transition involved (TO-OFF NORMAL, TO-NORMAL, etc.).
6. Schedule Lists: Show that schedules are configured for start/stop, mode change, occupant overrides, and night setback as defined in the sequence of operations.
7. Schedule Display and Modification: Show the ability to display any schedule with start and stop times for the calendar year. Show that all calendar entries and schedules are modifiable from any connected workstation by an operator with sufficient privilege.
8. Archival Storage of Data: Show that data archiving is handled by the operator workstation/server, and local trend archiving and display is accomplished with BACnet Trend Log objects.
9. Modification of Trend Log Object Parameters: Show that an operator with sufficient privilege can change the logged data points, sampling rate, and trend duration.
10. Device and Network Management: Show the following capabilities:
a. Display of Device Status Information.
b. Display of BACnet Object Information.
c. Silencing Devices that are Transmitting Erroneous Data.
d. Time Synchronization.
e. Remote Device Re-initialization.
f. Backup and Restore Device Programming and Master Database(s).
g. Configuration Management of Half-Routers, Routers and BBMDs.

J. Execution of Sequence of Operation: Demonstrate that the HVAC system operates properly through the complete sequence of operation. Use read/write property services to globally read and modify parameters over the internetwork.

K. Control Loop Stability and Accuracy: For all control loops tested, give the Architect/Owner trend graphs of the control variable over time, demonstrating that the control loop responds to a 20 percent sudden change of the control variable set point without excessive overshoot and undershoot. If the process does not allow a 20 percent set point change, use the largest change possible. Show that once the new set point is reached, it is stable and maintained. Control loop trend data shall be in real-time with the time between data points 30 seconds or less.

L. Performance Verification Testing Report: Upon successful completion of the PVT, submit a PVT Report to the Architect/Owner and prior to the Owner taking use and possession of the facility. Do not submit the report until all problems are corrected and successfully re-tested. The report shall include the annotated PVT Plan used during the PVT. Where problems were identified, explain each problem and the corrective action taken. Include a written certification that the installation and testing of the control system is complete and meets all of the contract's requirements.

3.10 TRAINING

A. A training course shall be conducted for 6 operating staff members designated by Owner in the maintenance and operation of the system, including specified hardware and software. The training period, for a total of 8 hours of normal working time, shall be conducted within 30 days after successful completion of the performance verification test. The training course shall be conducted at the project site and Owner reserves the right to videotape the training sessions for later use. Audiovisual equipment and 6 sets of all other training materials and supplies shall be provided. A training day is defined as 8 hours of classroom instruction, including two 15 minute breaks and excluding lunchtime, Monday through Friday, during the daytime shift in effect at the training facility.

1. The Contractor shall prepare training documentation consisting of:

   a. Course Attendee List: A List of course attendees which shall be developed in coordination with Owner.
   b. Training Manuals: Training manuals shall include an agenda, defined objectives for each lesson, and a detailed description of the subject matter for each lesson. Where the Contractor presents portions of the course material by audiovisuals, copies of those audiovisuals shall be delivered to Owner as a part of the printed training manuals. Training manuals shall be delivered for each trainee with two additional copies delivered for archival at the project site.
2. Training Course Content: For guidance in planning the required instruction, the Contractor shall assume that attendees will have a high school education or equivalent, and are familiar with HVAC systems. The training course shall cover all of the material contained in the Operating and Maintenance Instructions, the layout and location of each controller enclosure, the layout of one of each type of equipment and the locations of each, the location of each control device external to the panels, preventive maintenance, troubleshooting, diagnostics, calibration, adjustment, commissioning, tuning, and repair procedures. Typical systems and similar systems may be treated as a group, with instruction on the physical layout of one such system. The results of the performance verification test and the Start-Up and Start-Up Testing Report shall be presented as benchmarks of HVAC control system performance by which to measure operation and maintenance effectiveness.

3.11 COMMISSIONING

A. Provide the services of a supervisory level technician, in responsible charge of the work in this section, and factory authorized start-up and service technicians; for each major component or system in this section, to participate in the work specified in Section 23 08 00 COMMISSIONING OF HVAC. Coordinate PVT work with the requirements of Section 23 08 00, COMMISSIONING OF HVAC. Where a test is indicated as part of functional performance testing in Section 23 08 00, it shall be provided as work of Section 23 08 00 or this section as deemed practicable by the Cx. For each of these items, the PVT report required by this section or the commissioning report required by Section 23 08 00 shall be annotated to indicate where the test results are recorded.

B. Attend each field commissioning meeting and field commissioning event as scheduled through the Construction Manager by the Commissioning Agent. Respond to comments and requests made by the Commissioning Agent including the execution of commissioning checklists. Obtain the Commissioning scope, meeting schedule and commissioning event schedule from the Construction Manager.

3.12 CONSTRUCTION WASTE MANAGEMENT

A. Comply with the Waste Management Plan specified in Section 017419 Construction Waste Management and Disposal, for additional requirements.

END OF SECTION 230900
SECTION 23 11 23

FACILITY FUEL-GAS PIPING

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. Section 23 05 53, Identification for HVAC and plumbing piping and equipment.

C. Section 23 05 17 Sleeves and Sleeve Seals for HVAC and Plumbing Piping.

D. Section 23 05 29 Hangers and Supports for HVAC and Plumbing Piping and Equipment.

E. Section 09 91 13 Exterior Painting and Section 09 91 23 Interior Painting.

1.2 SUMMARY

A. Section Includes:
   1. Pipes, tubes, and fittings.
   2. Piping specialties.
   3. Piping joining materials.
   4. Valves.
   5. Pressure regulators.

B. This Section applies to utility supplied natural gas piping systems.

1.3 DEFINITIONS

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

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

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

1.4 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:
1. **Piping and Valves**: 100 psig minimum unless otherwise indicated.
2. **Pressure Regulators**: 100 psig minimum unless otherwise indicated.

### 1.5 ACTION SUBMITTALS

**A. Product Data:** For each type of the following:

1. Piping specialties.
2. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
3. Pressure regulators. Indicate pressure ratings and capacities.

**B. Shop Drawings:** For facility gas piping layout. Include minimum 1/4 inch equals one foot floor plans, indicating piping layout and elevations, sections, and details for fabrication of pipe hangers, supports, dirt legs and attachments of the same to building structure.

1. **Shop Drawing Scale:** 1/4 inch per foot.
2. Detail mounting, supports, and valve arrangements for service meter assembly and pressure regulator assembly.

### 1.6 CLOSEOUT SUBMITTALS

**A. Operation and Maintenance Data:** For pressure regulators to include in emergency, operation, and maintenance manuals.

### 1.7 QUALITY ASSURANCE

**A. Steel Support Welding Qualifications:** Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

**B. Pipe Welding Qualifications:** Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

**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.

### 1.8 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 and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.**
1.9 PROJECT CONDITIONS
   A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

1.10 COORDINATION
   A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS
   A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
          4. Forged-Steel Flanges: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
             b. End Connections: Threaded or butt welding to match pipe.
             c. Lapped Face: Not permitted underground.
             e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.
          5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
             a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.
   B. PE Pipe: ASTM D 2513, SDR 11.
          1. PE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.
          2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
b. Casing: Steel pipe complying with ASTM A 53/A 53M, Schedule 40, black steel, Type E or S, Grade B with corrosion-protective coating covering. Vent casing aboveground.
c. Aboveground Portion: PE transition fitting.
d. Outlet shall be threaded or flanged or suitable for welded connection.
e. Tracer wire connection.
f. Ultraviolet shield.
g. Stake supports with factory finish to match steel pipe casing or carrier pipe.

   a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet connected to steel pipe complying with ASTM A 53/A 53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
   b. Outlet shall be threaded or flanged or suitable for welded connection.
   c. Bridging sleeve over mechanical coupling.
   d. Factory-connected anode.
   e. Tracer wire connection.
   f. Ultraviolet shield.
   g. Stake supports with factory finish to match steel pipe casing or carrier pipe.

5. Plastic Mechanical Couplings, NPS 1-1/2 and Smaller: Capable of joining PE pipe to PE pipe.
   a. PE body with molded-in, stainless-steel support ring.
   b. Buna-nitrile seals.
   c. Acetal collets.
   d. Electro-zinc-plated steel stiffener.

6. Plastic Mechanical Couplings, NPS 2 and Larger: Capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
   a. Fiber-reinforced plastic body.
   b. PE body tube.
   c. Buna-nitrile seals.
   d. Acetal collets.
   e. Stainless-steel bolts, nuts, and washers.

7. Steel Mechanical Couplings: Capable of joining plain-end PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
   a. Stainless-steel flanges and tube with epoxy finish.
   b. Buna-nitrile seals.
   c. Stainless-steel bolts, washers, and nuts.
   d. Factory-installed anode for steel-body couplings installed underground.

2.2 PIPING SPECIALTIES

A. Flexible Piping Joints:
   1. Approved for LPG service.
   2. Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
   3. Minimum working pressure of 250 psig and 250 deg F operating temperature.
4. Flanged- or threaded-end connections to match equipment connected and shall be capable of minimum 3/4-inch misalignment.
5. Maximum 36-inch length for liquid LPG lines.

B. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.

C. Facility Natural-Gas Flow Meters – Turbine-Type:

1. Type: Turbine type with volume totalizing digital readout that is continuously updated and corrected for the line pressure and temperature. Meter readouts shall be located on meter and in computer workstation. Meter shall be designed for natural gas at job site characteristics.

2. Performance: Maximum flow rate as scheduled. Pressure drop shall not exceed 5 inches wc. Accurate flow minimum turndown range shall be 20/1 with minimum accuracy one percent of flow rate over the entire range.

3. Construction:
   a. Meter: Design for 125 psi. Pipe connections flanged 125 or 150 psig ANSI. All bearings and gearing shall be in areas sealed from contaminants. Metering transducers operated through magnetic coupling. The measuring devices shall be contained within a module that can be removed from the meter body for service and calibration without breaking the main gas piping connections. Provide corrosion-resistant material of construction or coating.
   b. Indication Devices on Meter: Electronic type which provides a totalized continuous volume flow digital indication in cubic feet automatically continuously corrected to the local contract base temperature and pressure from actual varying line temperatures and pressures. Unit shall also display a totalized uncorrected volume flow indication. The display shall show actual line temperature and pressure at the meter and pressure-temperature correction factor. The smallest corrected flow indication shall be one thousand cubic feet, and indicator shall have at least six digits. Unit shall be watertight where drawings show an outdoor location.


5. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. American Meter, Sensus Metering Systems (formerly Equimeter and Rockwell)
b. Inflow Model ITMG50G

6. Accessories:
   a. Remote Digital Register: Provide a remote digital register system including pulse generator and all wiring and accessories for proper functioning. Remote register shall have a digital cubic feet volume readout corrected to the local contract base temperature and pressure from actual varying line conditions. Smallest indication shall be one thousand cubic feet, and indicator shall have at least six digits. Provide 120-volt power supply from panel. Main plant register shall be located on MICP; individual boiler registers shall be located on boiler control panels.

7. Coordinate meter DDC system interface with Section 23 09 00 “Instrumentation and Control for HVAC.”

D. Gas Service Meters: Coordinate provision of natural-gas meter assembly with local gas provider.

2.3 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for gas.


2.4 MANUAL GAS SHUTOFF VALVES

A. Aboveground Valves
   1. Lubricated plug valve with square head: wrench operated, 400 wog. Provide brass or bronze body and threaded ends for line sizes up to 2 inches, iron body and flanged ends for line sizes 2-1/2 inches and larger. Subject to compliance with requirements, provide valves manufactured by Homestead, Walworth, DeZurik or approved equal.

B. PE Ball Valves: Comply with ASME B16.40.
   1. Body: PE.
   2. Ball: PE.
   5. Ends: Plain or fusible to match piping.
   7. Operating Temperature: Minus 20 to plus 140 deg F.
   8. Operator: Nut or flat head for key operation.
   9. Include plastic valve extension.
   10. Include tamperproof locking feature for valves where indicated on Drawings.

C. Valve Boxes:
   1. Cast-iron, two-section box.
2. Top section with cover with "GAS" lettering.
3. Bottom section with base to fit over valve and barrel a minimum of 5 inches (125 mm) in diameter.
4. Adjustable cast-iron extensions of length required for depth of bury.
5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head and with stem of length required to operate valve.

2.5 MOTORIZED GAS VALVES

A. Automatic Gas Valves: Comply with UL 429.
1. Maxon Gas Electro-Mechanical Series
2. Body: Carbon-steel or stainless steel.
5. Normally closed.
7. Electrical operator for actuation by emergency shutoff device.

2.6 PRESSURE REGULATORS

A. General Requirements:
1. Single stage and suitable for gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Meter Company.
   b. Fisher Control Valves and Regulators; Division of Emerson Process Management.
   c. Richards Industries; Jordan Valve Div.
2. Body and Diaphragm Case: Forged steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 100 psig.

2.7 LABELING AND IDENTIFYING

A. Comply with Section 23 05 53 “Identification for HVAC and Plumbing Piping and Equipment.”

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for gas piping system to verify actual locations of piping connections before equipment installation.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Close equipment shutoff valves before turning off gas to premises or piping section.
B. Inspect natural-gas piping according to NFPA 54 and the Florida Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.
C. Comply with NFPA 54 and the Florida Gas Code requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

A. Comply with NFPA 54 and the Florida Gas Code for installation and purging of natural-gas piping.
B. Steel Piping with Protective Coating:
   1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
   2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
   3. Replace pipe having damaged PE coating with new pipe.
C. Install fittings for changes in direction and branch connections.
D. Install pressure gage cock upstream and downstream from each pressure regulator. Gage cocks are specified in Section 23 05 23, "General Duty Valves for HVAC and Plumbing Piping.”
3.4 INDOOR PIPING INSTALLATION

A. Comply with NFPA 54 and the Florida Gas Code for installation and purging of natural-gas piping.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

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

D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Locate valves for easy access.

H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps. Provide a sediment trap (dirt leg) at each boiler valve train, and elsewhere as indicated.

I. Install piping free of sags and bends.

J. Install factory fabricated fittings for changes in direction and branch connections.

K. Verify final equipment locations for roughing-in.

L. Comply with requirements in Sections specifying gas-fired equipment for roughing-in requirements.

M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches (75 mm) long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

O. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

P. Connect branch piping from top or side of horizontal piping.
Q. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.

R. Do not use gas piping as grounding electrode.

S. Install pressure cock upstream and downstream from each line regulator.

T. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 23 05 17 "Sleeves and Sleeve Seals for HVAC and Plumbing Piping."

U. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 23 05 17 "Sleeves and Sleeve Seals for HVAC and Plumbing Piping."

3.5 SERVICE-METER ASSEMBLY INSTALLATION

A. Install service-meter assemblies aboveground, on concrete bases.

B. Install metal shutoff valves upstream from service regulators. Shutoff valves are not required at second regulators if two regulators are installed in series.

C. Install strainer on inlet of service-pressure regulator and meter set.

D. Install service regulators mounted outside with vent outlet horizontal or facing down. Install screen in vent outlet if not integral with service regulator.

E. Install metal shutoff valves upstream from service meters.

F. Install service meters downstream from pressure regulators.

G. Install metal bollards to protect meter assemblies. Comply with requirements in Section 05 50 00 "Metal Fabrications" for pipe bollards.

3.6 VALVE INSTALLATION

A. Install manual gas shutoff valves where indicated and at each connection to a boiler or water heater.

B. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

3.7 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:

2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

3.8 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hangers and supports specified in Section 23 05 29 "Hangers and Supports for HVAC and Plumbing Piping and Equipment."

3.9 CONNECTIONS

A. Connect to utility's natural-gas main according to utility's procedures and requirements.

B. Install gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

C. Install piping adjacent to appliances to allow service and maintenance of appliances.

D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired boiler and water heater. Install union between valve and appliances or equipment.

E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each boiler and water heater.

3.10 LABELING AND IDENTIFYING

A. Comply with requirements in Section 23 05 53 "Identification for HVAC and Plumbing Piping and Equipment" for piping and valve identification.

B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.
3.11 PAINTING

A. Comply with requirements in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting" for painting interior and exterior gas piping.

B. Paint exposed, interior metal piping, valves, service regulators, service meters and piping specialties, except components, with factory-applied paint or protective coating.

1. Latex Over Alkyd Primer System: MPI INT 5.1Q.
   c. Topcoat: Interior latex (semigloss).
   d. Color: Yellow.

2. Alkyd System: MPI INT 5.1E.
   c. Topcoat: Interior alkyd (semigloss).
   d. Color: Yellow.

C. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.12 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Use 3000-psig, 28-day, compressive-strength concrete and reinforcement as specified in Section 03 30 00 "Cast-in-Place Concrete."

3.13 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Test, inspect, and purge gas according to NFPA 54, Florida Gas Code, and authorities having jurisdiction.

C. Gas piping will be considered defective if it does not pass tests and inspections.
D. Prepare test and inspection reports.

3.14 OUTDOOR PIPING SCHEDULE

A. Aboveground natural-gas piping shall be one of the following:
   1. Steel pipe with malleable-iron fittings and threaded joints; sizes up to 2 inch.
   2. Steel pipe with wrought-steel fittings and welded joints; sizes 2-1/2 inches and larger.

B. Underground natural-gas piping shall be:
   1. PE pipe and fittings joined by heat-fusion, or mechanical couplings; service-line risers with tracer wire terminated in an accessible location.
   2. Laser level below grade piping.

C. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

3.15 INDOOR PIPING SCHEDULE

A. Aboveground piping shall be the following:
   1. Steel pipe with malleable iron fittings and threaded joints; sizes up to 2 inch.
   2. Steel pipe with steel welding fittings and welded joints; sizes 2-1/2 inches and larger.

3.16 CONSTRUCTION WASTE MANAGEMENT

A. Comply with the Waste Management Plan specified in Section 017419 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL for additional requirements.

END OF SECTION 23 11 23
SECTION 23 21 13
HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following pipe and fitting materials, joining methods, special-duty valves, and specialties:

1. Chilled-water piping.
2. Heating hot water.
3. Air-vent piping.
4. General drain piping.
5. Chemical treatment piping.
6. HVAC condensate drain piping.
7. Make-up Water Piping.
8. Pressure regulating valves.
10. Strainers.
11. Flexible Connectors.

1.3 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:

1. Chilled-Water Piping: 150 psig at 200 deg F.
2. Heating-Water Piping: 150 psig at 250 deg F.
3. Drain Piping and Make-Up Water Piping: 200 deg F.
4. Chemical Treatment Piping: 150 psig at 200 deg F.

1.4 SUBMITTALS

A. Product Data: For each type of the following:

1. Pipe and fittings for each service indicated.
2. Air control devices.
3. Strainers.
4. Valves.
5. Dielectric Fittings.
6. Flexible Connectors.
7. Air Separators.

B. Prepare and submit fabrication shop drawings of mechanical piping and equipment. Drawings shall be prepared accurately to minimum scale specified. Hydronic systems and proposed equipment illustration shall be double line (actual dimensions). Drawings shall be prepared electronically using as a minimum AutoCAD 2015 or a similar product manufactured by Autodesk. Note that this Contract requirement is intended as an installer pre-construction planning and coordination means.

1. Submit dimensioned shop drawings indicating hydronic piping and equipment showing both the accurately scaled piping/equipment and its relationship to space enclosure. The drawings shall be based upon the building floor plans. Illustration shall be drawn to a minimum scale of 1/4 inch = 1 foot. Drawings shall indicate actual dimensions and elevations of ductwork above finished floor and/or grade. Provide illustrations including sections to clarify elevations of equipment, equipment connections, piping and system accessories. Coordinate piping and equipment with the work of additional building trades in the vicinity of the installation of work in this Section. Direct replication or copying of the Contract Drawing hydronic piping systems for this work effort will not be acceptable. Indicate the locations of all piping, equipment, valves, and auxiliaries, including clearances required for installation and maintenance of equipment. Generally, if drawing sections through areas of installation are indicated on the Contract Drawings, similar illustrations are expected through this submittal. Provide dimensioned distances from fixed general construction components; such as structural columns and surfaces of structural (bearing) walls. Horizontal piping shall generally provide a minimum of 7 feet 0 inches from floor, head clearance after insulation.

2. Shop drawings shall indicate equipment layouts which identify maintenance access spaces, and piping layouts which identify all valves, plenums, fittings, and access doors. Include plans and elevations which identify clearances required for maintenance and operation. Shop drawings shall indicate installation elevations of piping; coordinated with other trades, and be annotated with elevations indicating pipe centerline elevations above finished floor. Indicate locations and dimensions of concrete pads for floor mounted equipment with equipment anchorages clearly indicated. Provide pipe hanging and support details.

3. The shop drawings shall include as a minimum the following:

   a. Chilled and heating water piping.
   b. Valves.
   c. Elevation to centerline of piping.
   d. Pipeline specialties.
   e. Boilers.
   f. Pumps.
   g. Floor drains.
   h. Expansion tanks.
   i. Hydronic filters.
   j. Air handling units.
   k. Air terminal units.
   l. Pipe hanger details.
   m. Maintenance spaces.
4. Drawings shall be prepared in accordance with commercial accepted drafting procedures and practices.
5. Drawing sheet size shall match contract drawing size.
6. Leave blank space, approximately 2-1/2 inches wide x 3 inches high near title block (for submittal review stamp imprint).

C. Welding certificates.

D. Qualification Data: For Installer.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For air control devices, valves, and hydronic specialties valves to include in operation and maintenance manuals. Include product data for each as indicated hereinbefore under “Submittals.”

G. Submittals and Operation Manuals shall be assembled in a neat and orderly manner. Submittals and Operation Manuals shall be bound in booklet form and shall include a front and back cover and a title page with appropriate job name, location and equipment title.

1.5 QUALITY ASSURANCE

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

B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

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. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.

D. Verification of Dimensions: The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and advise the Architect of any discrepancy before performing any work.

E. Accessibility: Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible.

1.6 COORDINATION OF TRADES

A. Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor shall carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed
and shall arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions.

B. Contract Drawings indicate an engineering solution and design intent. Through the installer coordination effort, it may be required to re-position or shift piping or piping accessories to facilitate the installation of the hydronic piping system and adjacent trade materials. Provide piping offsets, fittings, and accessories as required to provide a complete installation and to eliminate interference with other construction. Coordinate pipe locations with space required for trades in the adjacent installation area.

C. Accessibility: Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible.

D. Conduct a pre-installation meeting and subsequent follow up meetings to coordinate the work of this Section with the metal stud installation for partitions indicated in Section 05 40 00, “Cold Formed Metal Framing”, masonry openings in Section “04 22 00, Concrete Unit Masonry”, truss chord coordination with Section 06 17 53, “Shop-Fabricated Wood Trusses” and firestopping at Section 07 84 00.50 “Firestopping”. Verify that openings are provided for piping penetrations through partitions constructed with metal studs, through roof truss work, and that masonry wall openings are provided for pipe penetrations. Verify firestopping requirements for all pipe penetrations.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Refer to Part 3 “Pipe Applications” article.

B. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

C. Wrought-Copper Fittings: ASME B16.22.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Anvil International, Inc.

b. S. P. Fittings; a division of Star Pipe Products.

2.2 STEEL PIPE AND FITTINGS

A. Refer to Part 3 “Pipe Applications” article.

B. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.


E. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

F. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
   2. End Connections: Butt welding.
   3. Facings: Raised face.

G. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.3 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

E. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

F. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.4 CHEMICAL TREATMENT PIPING

A. PVC Plastic Pipe: ASTM D 1785, with wall thickness as indicated in "Piping Applications" Article.
2.5 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric-Flange Insulating Kits:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Central Plastics Company.
   d. Pipeline Seal and Insulator, Inc.

2. Description:
   a. Nonconducting materials for field assembly of companion flanges.
   b. Pressure Rating: 150 psig.
   c. Gasket: Neoprene or phenolic.
   d. Bolt Sleeves: Phenolic or polyethylene.
   e. Washers: Phenolic with steel backing washers.

C. Dielectric Nipples:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Elster Perfection.
   b. Grinnell Mechanical Products.
   c. Matco-Norca, Inc.
   d. Precision Plumbing Products, Inc.

2. Description:
   a. Standard: IAPMO PS 66
   b. Electroplated steel nipple. complying with ASTM F 1545.
   c. Pressure Rating: 300 psig at 225 deg F.
   d. End Connections: Male threaded or grooved.
   e. Lining: Inert and noncorrosive, propylene.

2.6 VALVES

A. Comply with requirements specified in Section 23 05 23 "General-Duty Valves for HVAC and Plumbing Piping," and requirements of this Section.

B. Motor Actuated Valves, Actuators, and Sensors: Comply with requirements specified in Division 23 Section "Instrumentation and Control for HVAC." Provide all sensor wells and pipe taps for control instrumentation as work of this Section.

C. Pressure Regulating Valves: ASSE 1003 for water service, copper alloy body.
D. Water pressure relief valves: ANSI 221.22/CSA 4.4 and shall have bronze, copper alloy or cast-iron body with corrosion resistant internal working parts.

2.7 AIR CONTROL DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amtrol, Inc.
2. Armstrong Pumps, Inc.
3. Bell & Gossett Domestic Pump; a division of ITT Industries.
4. TACO.

B. Manual Air Vents:

1. ¼ inch ball valve in accordance with Section 23 05 23, “General Duty Valves for HVAC Piping”.

C. Automatic Air Vents:

1. Body: Bronze or cast iron.
2. Internal Parts: Nonferrous.
4. Inlet Connection: NPS 1/2.
7. Maximum Operating Temperature: 240 deg F.

D. Heating Water Air Separator:

1. Centrifugal tank-type design and include internal steel baffling and strainer element design, creating air separation.
2. Construction: Welded steel, constructed, tested and stamped in accordance with ASME BPVC SEC VIII D1 for a working pressure of 125 psi.
3. Capacity: Provide scheduled flow and pressure drop characteristics.
4. Efficiency: Designed to provide a minimum 97% efficient level with maximum velocity of 4 feet per second and a maximum pressure drop of one ft H2O.
5. Piping: Provide tangential inlet and outlet connections, threaded for 2 inches and smaller and flanged connections for sizes 2-1/2 inches and larger.
6. Auxiliary Connections: Equip with NPT piping vent and blowdown connections.
7. Note that tank products without internal baffling and strainer devices are not acceptable.

2.8 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.

B. Spherical, Rubber, Flexible Piping Connectors:
2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 deg F.

2.9 PIPE CLEANING

A. Pipe cleaning chemical: Provide surfactant / copolymer / phosphate compound in solution form. Furnish accessories to mix solution and charge into system.

B. Pipe cleaning accessories: Provide temporary piping loops, temporary circulating pump, caps and blind flanges to permit pipe cleaning. Temporary circulating pump shall be of a capacity to provide a minimum 8 feet/second velocity in all sections of piping to be cleaned.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Chilled water, heating water, vent and general drain piping, aboveground, NPS 2 and smaller, shall be the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered silver soldered joints.
2. Schedule 40 steel pipe; Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.

B. Chilled water and heating water piping, aboveground, NPS 2-1/2 to NPS 30 (DN 750) shall be the following:

1. Schedule 40 steel pipe for line sizes p to 12 inch, standard weight steel pipe for pipe sizes 14 inch and greater, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints. Fitting thickness shall match related piping system.

C. HVAC Condensate drain piping shall be the following:

1. DWV copper tubing, DWV fittings, and soldered joints.

D. Make-up Water shall be the following:

1. Type L copper tubing with wrought copper fittings and silver soldered joints.
3.2 VALVE APPLICATIONS

A. General-Duty Valve Applications: Unless otherwise indicated, use the following valve types:

1. Shutoff Duty: Unless noted otherwise, use ball valves up to 2 inch pipe size, use butterfly valves 2-1/2 inch pipe size and larger.
3. General Drain Valves: Use ¾ inch ball valve with schedule 80 nipples and threaded hose end and metallic cap with chain attachment.
5. Check valves at pump discharge locations: spring loaded lift-type check valves.

B. Install shutoff-duty valves at each branch connection to supply mains, at supply connections to each piece of equipment, and elsewhere as indicated.

C. Install throttling-duty valves at each branch connection to return mains, at return connections to each piece of equipment, and elsewhere as indicated.

D. Install general drain valves at low points in mains, risers, branch lines, and elsewhere as required for system drainage.

E. Install spring check valves on each pump discharge.

F. Install swing check valves for general check-flow applications.

3.3 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping to permit valve servicing.

E. Install piping free of sags and bends.

F. Install fittings for changes in direction and branch connections.

G. Install piping to allow application of insulation.

H. Select system components with pressure rating equal to or greater than system operating pressure.
I. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

J. Install piping at a uniform grade of 1-Inch per 40 feet in direction of pitch indicated.

K. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

L. Install branch connections to mains using tee fittings in main with takeoff out bottom of main, except for up-feed risers with takeoff out top of main line. Use factory fabricated threaded and buttwelding tees and elbows for all changes in direction and all branch connections. Forged branch fittings; weld-o-let and thread-o-let fittings are acceptable for branch piping connections when branch piping is two pipe sizes (or smaller) less than the main pipe size. Pipe saddles shall not be permitted.

1. Grooved pipe fitting products may be used only at final connections to water chiller.

2. Compression fit pipe joint products are not acceptable.

M. Install unions in pipes 2-inch NPS and smaller, adjacent to each valve, at final connections of each piece of equipment, and elsewhere as indicated. Install union on equipment side of valve. Unions are not required at flanged connections.

N. Install flanges on valves, apparatus, and equipment having 2-1/2-inch NPS and larger connections.

O. Install strainers as indicated. Install 3/4-inch NPS nipple and ball valve in blow-down connection of strainers 2-inch NPS and larger. Provide reducers as required to connect blowdown valve. Provide drain piping from strainer to nearest floor drain.

P. Provide dielectric isolation nipples and flange kits where connecting ferrous to non-ferrous piping system materials. Note that dielectric unions are not acceptable for dielectric isolations.

Q. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

R. Install valves according to Section 23 05 23 "General-Duty Valves for HVAC and Plumbing Piping," and requirements of this section.

S. Identify piping as specified in Section 23 05 53 "Identification for HVAC and Plumbing Piping and Equipment."

T. Install sleeves for piping penetrations of walls and slab-on-grade floors. Comply with requirements for sleeves specified in Section 23 05 17 "Sleeves and Sleeve Seals for HVAC and Plumbing Piping."

U. Install sleeve seals for piping penetrations of concrete walls and slab-on-grade floors. Comply with requirements for sleeve seals specified in Section 23 05 17 "Sleeves and Sleeve Seals for HVAC and Plumbing Piping."

V. Coordinate pipe penetrations through fire rated walls, fire/smoke rated walls and smoke tight walls with Section 078400.50 "Firestopping".
W. Install pipe wells and additional taps required for instrumentation at Section 230900, "Instrumentation and Control for HVAC".

3.4 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Section 23 05 29 "Hangers and Supports for HVAC and Plumbing Piping and Equipment." Unless noted otherwise, provide support of all piping specified in this section.

3.5 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.


F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.


H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.6 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, and elsewhere as required for system air venting.

B. Install automatic air vents at high points of system piping in mechanical equipment rooms only.
3.7 IDENTIFICATION

A. Provide pipe labels on each piping system, valve and item of equipment included in this Section. Comply with requirements in Division 23 Section "Identification for HVAC and Plumbing Piping and Equipment" for equipment labels and warning signs and labels.

B. Provide ceiling tag on ceiling below each main and sub-main shutoff valve.

3.8 ADJUSTING AND CLEANING

A. After completing system installation, including outlet fittings and devices, inspect finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.

B. Flush hydronic piping systems with clean water. Remove, clean, and replace strainer screens. After cleaning and flushing hydronic piping system, but before balancing, remove disposable fine-mesh strainers in pump suction diffusers.

C. Provide the following pipe cleaning procedure:

1. Close all shutoff valves to equipment coils. Fill system with potable water. Circulate water for minimum 24 hour period. Drain and flush system until solids are not present.
2. Fill system with potable water; vent air from system. Introduce cleaning chemical at solution volume recommended by chemical manufacturer. Circulate solution for 24 hours. Drain and flush system until drain water is clear.
3. Fill system with potable water; vent air from system. Introduce cleaning chemical at solution volume recommended by chemical manufacturer. Open all shutoff valves to heat transfer coils and equipment. Circulate solution for period recommended by chemical manufacturer. Drain and flush system until drain water is clear. Clean all permanent strainer baskets.
4. Fill system with potable water; vent air from system. Coordinate testing of water in system with chemical treatment program representative. Obtain written confirmation of acceptable water quality from chemical treatment representative. Submit confirmation; include in maintenance manual. Charges for chemical treatment representative services are borne by this section.

D. Mark calibrated nameplates of manual balancing valves after hydronic system balancing has been completed, to permanently indicate final balanced position.

E. Chemical Treatment: Coordinate chemical treatment with section 23 25 16, “Water Treatment for HVAC” supplier. Verify that chemical treatment has been successfully completed.

3.9 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:
   1. Use ambient temperature water as a testing medium.
   2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
   3. Determine that hydronic system is full of water.
   4. Subject piping system to hydrostatic test pressure that is not less than 150 psig. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
   5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
   6. Prepare written report of testing.

C. Perform the following before operating the system:
   1. Open manual valves fully.
   2. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
   3. Set temperature controls.
   4. Inspect and set operating temperatures of hydronic equipment, such as chillers, cooling towers, to specified values.
   5. Verify lubrication of motors and bearings.
   6. Coordinate testing, adjusting, and balancing, work of Section 23 05 93.

3.10 COMMISSIONING

A. Provide the services of the installer in responsible charge of the work in this Section to participate in the Owner provided Commissioning work. Attend field commissioning meetings and field commissioning events as scheduled through the Construction Manager by the Owners Commissioning Agent. Respond to comments and requests made by the Commissioning Agent including the execution of commissioning checklists. Obtain the Commissioning scope, meeting schedule and commissioning event schedule from the Construction Manager and Owner.

3.11 CONSTRUCTION WASTE MANAGEMENT

A. Comply with the Waste Management Plan specified in Section 01 74 19 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL for additional requirements.
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. In-Line Centrifugal Water Pumps.

1.3 DEFINITIONS

A. Buna-N: Nitrile rubber.

B. EPT: Ethylene propylene terpolymer.

C. CEP: Central Energy Plant.

D. DDC: Direct Digital Control System.

1.4 SUBMITTALS

A. Product Data: For each type of pump, include certified performance curves and rated capacities, operating characteristics, pump, motor and base dimensions, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.

B. Operation and Maintenance Manuals; include the following as a minimum:

1. System design information sheet.
2. Dimension and general arrangement drawing for PPS mounted pumps and field mounted pumps.
3. Piping schematic of packaged system components and specialties.
4. Electrical power wiring diagram.
5. Bill of material for each PPS and pump.
6. Pump and system operation and maintenance instructions.
7. Installation, operation and maintenance manuals.
8. Executed factory pre-start checklists and executed start-up checklists.
C. Submittals and Operation Manuals shall be assembled in a neat and orderly manner. Submittals and Operation Manuals shall be bound in booklet form and shall include a front and back cover and a title page with appropriate job name, location and equipment title.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain hydronic pumps through one source from a single manufacturer.

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. UL Compliance: Comply with UL 778 for motor-operated water pumps.

D. Provide submittal data specific to this project; generic product data is not acceptable.

E. Pump volute sizes scheduled on Contract Drawings are the acceptable minimum sizes.

F. General Design Criteria:
   1. Pumps design and manufacture shall conform to Hydraulic Institute Standards.
   2. Pump sizes, capacities, pressures, operating characteristics and efficiency shall be as scheduled.
   3. Head-capacity curves shall slope up to maximum head at shut-off. Select pumps near the midrange of the curve, so the design capacity falls to the left of the best efficiency point, to allow a cushion for the usual drift to the right in operation, without approaching the pump curve end point and possible cavitation and unstable operation. Select pumps for open systems so that required net positive suction head (NPSHR) does not exceed the net positive head available (NPSHA).
   4. Pump Driver: Furnish with pump. Size shall be non-overloading at any point on the head-capacity.
   5. Provide pump with motor, impeller, drive assemblies, bearings, coupling guard and other accessories specified. Statically and dynamically balance all rotating parts.
   6. Furnish pump and motor with a nameplate giving the manufacturers name, serial number of pump, capacity in GPM and head in feet at design condition, horsepower, voltage, frequency, speed and full load current and motor efficiency.
   7. Factory test pump before shipment. The manufacturer shall certify all pump ratings.
   8. Furnish one spare seal and casing gasket to Owner.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer’s Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

B. Retain protective covers for flanges and protective coatings during storage.
C. Equipment shall be delivered and stored with protective crating and weatherproof wrapping to provide protection from the weather, humidity, temperature variations, dirt and dust or other contaminants.

D. Provide rigging of pumps to the installation location. Rigging shall comply at a minimum with the manufacturer recommendations.

E. Proper protection and care of all material both before and during placement shall be the Contractor’s responsibility. Any materials found to be damaged shall be replaced at the Contractor’s expense.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Mechanical Seals: One mechanical seal(s) for each pump.
2. Casing Gaskets: One gasket for each pump.

PART 2 - PRODUCTS

2.1 CLOSED COUPLED, IN-LINE CENTRIFUGAL WATER PUMPS

A. Manufacturers: Subject to compliance with requirements, provide products by Pacific Pump Company (PACO), Bell and Gossett, or Taco.

B. Description: Factory-assembled and -tested, centrifugal, impeller-between-bearings, separately coupled, double-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for inline mounting, with pump and motor shafts vertical. Provide pumps factory assembled to packaged pump system.

C. Pump Construction:

1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and ASME B16.1, Class 125 flanges. Casing supports shall allow removal and replacement of impeller without disconnecting piping.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, and keyed to shaft. For pumps not frequency-drive controlled, trim impeller to match specified performance.
4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket.
5. Pump Bearings: Grease-lubricated ball bearings in cast-iron housing with grease fittings.
6. Coupling: Molded-rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor. EPDM coupling sleeve for variable-speed applications.
7. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.
9. Motor: Single speed, premium efficiency type, secured to mounting frame, with adjustable alignment.
10. 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.
11. Unless noted otherwise, comply with NEMA MG1 designation, temperature rating, service factor, and efficiency requirements.
14. Capacities and characteristics as scheduled.

D. Manufacturers: Subject to compliance with requirements, provide products by Pacific Pump Company (PACO), Bell and Gosset, or Taco.

E. Description: Factory-assembled and -tested, centrifugal, impeller-between-bearings, separately coupled, double-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal. Provide pumps factory assembled to packaged pump system.

F. Pump Construction:

1. Casing: Vertically split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and ASME B16.1, Class 125 flanges. Casing supports shall allow removal and replacement of impeller without disconnecting piping.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, and keyed to shaft. For pumps not frequency-drive controlled, trim impeller to match specified performance.
4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket.
5. Pump Bearings: Grease-lubricated ball bearings in cast-iron housing with grease fittings.
6. Coupling: Molded-rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor. EPDM coupling sleeve for variable-speed applications.
7. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.
9. Motor: Single speed, premium efficiency type, secured to mounting frame, with adjustable alignment.
10. 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.
11. Unless noted otherwise, comply with NEMA MG1 designation, temperature rating, service factor, and efficiency requirements.
14. Capacities and characteristics as scheduled.

2.2 MECHANICAL INSULATION

A. Provide in accordance with Section 23 07 16 “HVAC Equipment Insulation” and Section 23 07 19, “HVAC Piping Insulation”. Provide removable insulation box around each chilled water pump. Provide insulation of all chilled water piping, pipe fittings, valves and piping specialties.

2.3 MECHANICAL IDENTIFICATION

A. Provide in accordance with Section 23 0715 HVAC and Plumbing Insulation. Provide laminated plastic nameplate for each chilled water pump and pump VFD.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

C. Examine foundations for suitable conditions where pumps and pump systems are to be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

E. The pumps shall be installed in accordance with the manufacturers published instructions and as indicated in this Section.

3.2 PUMP ALIGNMENT

A. Engage a factory-authorized service representative to perform alignment service.

B. Comply with requirements in Hydronics Institute standards for alignment of pump and motor shaft. Add steel shims to the motor feet and bolt motor to base frame.

C. Comply with pump and coupling manufacturers' written instructions.

D. After alignment is correct, tighten bolts evenly.
3.3 CONNECTIONS

A. Coordinate pump and pump package installation with Drawings and with requirements specified in piping systems.

B. Comply with requirements for piping specified in Section 23 21 13 "Hydronic Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

C. Where installing piping or system accessories adjacent to pump, allow space for service and maintenance.

D. Provide blowdown drain lines from chilled water pump volute drain and check valve drain to the nearest floor drain. Provide blowdown drain line from pump check valve drain to grade.

E. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

F. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

G. Identify equipment in accordance with Section 23 05 53 “Identification for HVAC Piping and Equipment.”

H. Field insulate pumps in accordance with Section 23 07 15 “HVAC and Plumbing Insulation.”

I. Comply with Section 09 96 00, “High Performance Coatings.” Paint all new and existing concrete pads related to hydronic pumps.

J. Provide all interlock wiring between pump VFD’s, field installed devices and interlocks to facility direct digital control system.

3.4 MANUFACTURER’S SERVICES

A. Provide the services of a manufacturer’s representatives who are experienced in the installation, adjustment, and operation of the pumps. The representative shall supervise the installation, start-up adjustment, and testing of the equipment.

B. The pump manufacturer’s representative shall provide one on-site job visit for pre-start-up inspection of the installed pumps. Provide final checkout, adjustment, and start-up. The site visit shall occur only after all hook-ups, tie-ins, and terminations have been completed and signed-off on the system manufacturer's start-up request forms by the installer. At that time, all ancillary equipment (i.e. chillers, cooling towers, condenser water pumps, DDC systems etc.) shall be ready for automatic start-up.

C. The pump manufacturers shall provide on-site start-up service.

D. Provide the services of factory trained and authorized technicians to work with the TABs Contractor, DDC representatives, boiler and chiller manufacturer representatives to integrate the operation of the of this Section. Provide personnel at times and intervals necessary to calibrate all chilled water and heating water system set-points, troubleshoot (if necessary), issues resulting after startup, and make any additional software/hardware modifications to enable the
PPS to operate in accordance with the sequence of operation indicated on the Contract Drawings.

3.5 TESTING, ADJUSTING AND BALANCING

A. Meet with the TAB contractor prior to beginning TAB and review the TAB plan to determine the capabilities of the system toward completing TAB. Provide the TAB any needed unique instruments for setting valves and instruct TAB in their use.

B. Operate the systems and assist the TAB contractor in performing TAB, or provide sufficient training for TAB to operate the system without assistance.

C. TAB’s shall be performed for the chilled water and heating water pumps. The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform calibration and testing of the system with Testing, Adjusting, and Balancing for HVAC Contractor. All instrumentation and controls shall be calibrated and the specified accuracy shall be verified using test equipment with calibration traceable to NIST standards. Mechanical control devices shall be adjusted to operate as specified. Control parameters and logic (virtual) points including control loop setpoints, gain constants, and integral constraints, shall be adjusted before the system is placed on line. Written notification of any planned calibration and testing of the systems shall be given to the Owner at least 14 calendar days in advance.

3.6 INSTRUCTIONS AND DEMONSTRATION

A. Furnish the services of competent instructors to give full instruction to the designated the Owner personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the chilled and heating water systems and condenser water pump. Instructors shall be thoroughly familiar with all parts of the installation and shall be instructed in operating theory as well as practical operation and maintenance work. Submit a lesson plan for the instruction course for approval. The lesson plan and instruction course shall be based on the approved operation and maintenance data and maintenance manuals.

B. Conduct a training course for the operating staff and maintenance staff selected by the Owner. Give the instruction during the first regular work week after the equipment or system has been accepted and turned over to Owner for regular operation. The number of man-days (8 hours per day) of instruction furnished shall be 1 man-day. Use approximately half of the time for classroom instruction and the other time for instruction at the location of equipment or system.

3.1 CONSTRUCTION WASTE MANAGEMENT

A. Comply with the Waste Management Plan specified in Section 01 74 19 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL for additional requirements.

END OF SECTION 23 21 23
SECTION 23 31 13

METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Single-wall ducts and fittings.
   2. Sheet metal materials.
   3. Sealants and gaskets.
   4. Hangers and supports.
   5. Dampers.
   6. Fire dampers.
   7. Gravity Intake ventilators.

1.3 SUBMITTALS

A. Product Data: For each type of the following products:
   1. Sealants and gaskets.
   3. Fire dampers.

B. Prepare and submit fabrication shop drawings of mechanical ductwork and equipment. Drawings shall be prepared accurately to minimum scale specified. Metal ductwork systems and proposed equipment illustration shall be double line (actual dimensions). Drawings shall be prepared electronically using as a minimum AutoCAD 2015 or a similar product manufactured by Autodesk. Note that this Contract requirement is intended as an installer pre-construction planning and coordination means.

   1. Submit dimensioned shop drawings indicating ductwork and equipment showing both the accurately scaled ductwork/equipment and its relationship to space enclosure. The drawings shall be based upon the building floor plans. Illustration shall be drawn to a minimum scale of 1/4 inch = 1 foot. Drawings shall indicate actual dimensions and elevations of ductwork above finished floor and/or grade. Provide illustrations including sections to clarify elevations of equipment, equipment connections, ductwork and ductwork accessories. Coordinate ductwork and equipment with the work of additional
building trades in the vicinity of the installation of work in this Section. Direct replication or copying of the Contract Drawing ductwork systems for this work effort will not be acceptable. Indicate the locations of all ductwork, equipment, air outlets and inlets, and auxiliaries, including clearances required for installation and maintenance of equipment. Generally, if drawing sections through areas of installation are indicated on the Contract Drawings, similar illustrations are expected through this submittal. Provide dimensioned distances from fixed general construction components; such as structural columns and surfaces of structural (bearing) walls. Horizontal ductwork shall generally provide a minimum of 7 feet 0 inches from floor, head clearance after insulation.

2. Shop drawings shall indicate equipment layouts which identify maintenance access spaces, and ductwork layouts which identify all dampers, plenums, fittings, and access doors. Include plans and elevations which identify clearances required for maintenance and operation. Shop drawings shall indicate installation elevations of ductwork; coordinated with other trades, and be annotated with elevations indicating top and bottom elevations of ductwork above finished floor. Indicate locations and dimensions of concrete pads for floor mounted equipment with equipment anchorages clearly indicated. Provide ductwork hanging and support details.

3. The shop drawings shall include as a minimum the following:
   a. Supply, return and exhaust air ductwork systems.
   b. Flexible duct connectors.
   c. Duct materials and static-pressure classes.
   d. Elevation of top and bottom of ducts.
   e. Duct reinforcement details.
   f. Duct hanger details.
   g. Duct seam and joint details.
   h. Air handling units.
   i. Fire dampers.
   j. Hangers, Inserts, Supports and Bracing.
   k. Flexible duct connectors.
   l. Maintenance spaces.

4. Drawings shall be prepared in accordance with commercial accepted drafting procedures and practices.

5. Drawing sheet size shall match contract drawing size.

6. Leave blank space, approximately 2-1/2 inches wide x 3 inches high near title block (for submittal review stamp imprint).

7. Include name and phone numbers of both the installing Contractor and drawing preparer.

C. Welding certificates for welders.

D. Duct air leakage test reports.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For dampers, air control devices, and specialties to include in operation and maintenance manuals. Include product data for each as indicated hereinbefore under “Submittals.”
G. Submittals and Operation Manuals shall be assembled in a neat and orderly manner. Submittals and Operation Manuals shall be bound in booklet form and shall include a front and back cover and a title page with appropriate job name, location and equipment title.

1.4 QUALITY ASSURANCE

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

B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Verification of Dimensions: The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and advise the Architect of any discrepancy before performing any work.

D. Accessibility: Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible.

1.5 COORDINATION OF TRADES

A. Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor shall carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and shall arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions.

B. Contract Drawings indicate an engineering solution and design intent. Through the installer coordination effort, it may be required to re-position or shift ductwork and duct system accessories to facilitate the installation of the ductwork system and adjacent trade materials. Provide ductwork, offsets, fittings, and accessories as required to provide a complete installation and to eliminate interference with other construction. Coordinate duct locations with space required for trades in the adjacent installation area.

C. Accessibility: Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible.

D. Conduct a pre-installation meeting and subsequent follow up meetings to coordinate the work of this Section with the metal stud installation for partitions indicated in Section 05 40 00, “Cold Formed Metal Framing”, masonry openings in Section “04 22 00, Concrete Unit Masonry”, truss chord coordination with Section 06 17 53, “Shop-Fabricated Wood Trusses” and firestopping at Section 07 84 00.50 “Firestopping”. Verify that openings are provided for duct penetrations through partitions constructed with metal studs, through roof truss work, and that masonry wall openings are provided for duct penetrations. Verify firestopping requirements for all duct penetrations which are not indicated to receive fire.
PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA DCS based on indicated static-pressure class indicated on Contract Drawings unless otherwise indicated. Construct ducts of Type G90 galvanized steel or stainless steel as indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA DCS Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA DCS Longitudinal Seams: Select seam types and fabricate according to SMACNA DCS for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA DCS.

C. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA DCS for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA DCS.

2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA DCS based on indicated static-pressure class indicated on Contract Drawings unless otherwise indicated. All round ductwork shall be spiral lock seam type. Construct ducts of Type G90 galvanized steel or stainless steel as indicated.

B. Transverse Joints: Fabricate round ducts with spiral lockseam construction except where duct diameters exceed 72 inches and where ducts are indicated to be liquidtight welded. Fabricate ducts having diameters exceeding 72 inches with butt welded joints. Fabricate according to SMACNA DCS for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 RECTANGULAR AND SQUARE DUCT FABRICATION

A. Except as otherwise indicated, fabricate rectangular ducts with galvanized sheet steel or stainless steel as indicated, in accordance with SMACNA DCS including their associated details. Conform to the requirements in the referenced standard for metal thickness and reinforcing types.

1. Fabricate ductwork at scheduled static pressure class with reinforcing at 5'-0" center to center.
2. Provide materials that are free from visual imperfections such as pitting, seam marks, roller marks, stains, and discolorations.
3. Provide duct reinforcing through metal gage, joint type and external reinforcing methods. Internal duct tie-rod reinforcing of both straight duct runs and fittings is not acceptable.
B. Crossbreaking or Cross Beading: Crossbreak or bead duct sides that are 19 inches and larger and are 20 gage or less, with more than 10 sq. ft. of unbraced panel area, as indicated in SMACNA DCS unless they are lined or are externally insulated.

2.4 RECTANGULAR AND SQUARE DUCT FITTINGS

A. Fabricate elbows, transitions, offsets, branch connections, and other duct construction in accordance with SMACNA DCS and details on Contract Drawings.

1. Provide duct reinforcing through metal gage, joint type and external reinforcing methods. Internal duct tie-rod reinforcing is not acceptable.

2.5 ROUND DUCT FABRICATION

A. Fabricate round and flat oval ducts with spiral lockseam construction, except where flat-oval – equivalent diameters exceed 72 inches. Fabricate ducts having diameters greater than 72 inches with longitudinal butt-welded seams. Comply with SMACNA DCS for galvanized steel gages.

1. Provide duct reinforcing through metal gage, joint type and external reinforcing methods. Internal duct tie-rod reinforcing is not acceptable.

2.6 ROUND FITTINGS FABRICATION

A. 90-Degree Tees and Laterals and Conical Tees: Fabricate to conform to SMACNA DCS with metal thicknesses specified for longitudinal seam straight duct, unless indicated otherwise in this section.

B. Diverging-Flow Fittings: Fabricate with a reduced entrance to branch taps with no excess material projecting from the body onto branch tap entrance.

C. Elbows: Fabricate in die-formed, gored, pleated, or mitered construction. Fabricate the bend radius of die-formed, gored, and pleated elbows 1.5 times the elbow diameter. Provide duct reinforcing through metal gage, joint type and external reinforcing methods. Internal duct tie-rod reinforcing is not acceptable. Unless elbow construction type is indicated, provide elbows meeting the following requirements:

D. Mitered Elbows: Fabricate mitered elbows with welded construction in gages specified below.

1. Mitered Elbows Radius and Number of Pieces: Unless otherwise indicated, construct elbow to comply with SMACNA DCS.
2. Round Mitered Elbows: Solid welded and with metal thickness listed below for pressure classes from minus 2 inches to plus 2 inches:

   a. 3 to 26 inches: 24 gage.
   b. 27 to 36 inches: 22 gage.
   c. 37 to 50 inches: 20 gage.
   d. 52 to 60 inches: 18 gage.
   e. 62 to 84 inches: 16 gage.
3. Round Mitered Elbows: Solid welded and with metal thickness listed below for pressure classes from 2 inches to 10 inches:
   a. 3 to 14 inches: 24 gage.
   b. 15 to 26 inches: 22 gage.
   c. 27 to 50 inches: 20 gage.
   d. 52 to 60 inches: 18 gage.
   e. 62 to 84 inches: 16 gage.

E. Round Elbows - 8 Inches and Smaller: Die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend angle configurations or ½-inch-diameter (e.g. 3-1/2- and 4-1/2-inch) elbows with gored construction.

F. Round Elbows - 9 Through 14 Inches: Gored or pleated elbows for 30, 45, 60, and 90 degrees, except where space restrictions require a mitered elbow. Fabricate nonstandard bend angle configurations or ½-inch-diameter (e.g. 9-1/2- and 10-1/2-inch) elbows with gored construction.

G. Round Elbows - Greater than 14 Inches: Gored elbows, except where space restrictions require a mitered elbow.

H. Die-Formed Elbows for Sizes through 8 Inches and All Pressures: 20 gage with 2-piece welded construction.

I. Round Gored Elbows Gages: Same as for non-elbow fittings specified above.

2.7 JOINTS

A. Construct joints to meet the requirements of the leakage test scheduled. Duct components shall fit so that joints are not mismatched. Do not use duct sealant and tape to compensate for mismatched connections. Longitudinal locks or seams known as "button-punch snap-lock" will not be permitted. Apply fire-resistant sealing compound to exposed male part of fittings collars so that sealer will be on inside of joint and fully protected by the metal of the duct and fitting. Apply one brush coat of sealing compound over outside of joint to at least 2 inch band width covering screwheads and joint gap. Dents in the male portion of slip fitting collars will not be acceptable.

2.8 DUCT ACCESSORIES

A. Flexible Duct Equipment Connections: Provide a flexible duct connector at a minimum of 6 inches in length where sheet metal connections are made to air handling units, exhaust fans, ducted fan coil units and where ducts of dissimilar metals are connected. For round/oval ducts, secure the flexible material by stainless steel or zinc-coated, iron clinch-type draw bands. For rectangular ducts, install the flexible material locked to metal collars using normal duct construction methods. Provide a composite connector system that complies with UL 214 and is classified as "flame-retarded fabrics" in UL Bldg Mat Dir.
B. Flexible Duct Connectors at Air Inlets and Outlets: Provide duct that conforms to UL 181 and NFPA 90A with factory-applied insulation, vapor barrier, and end connections. Provide duct assembly that does not exceed 25 for flame spread and 50 for smoke developed. Provide ducts designed for working pressures of two inches water gauge positive and 1.5 inches water gauge positive. Provide flexible round duct length that does not exceed five feet. Secure connections by applying adhesive for two inches over rigid duct, apply flexible duct two inches over rigid duct, apply metal clamp, and provide minimum of three No. 8 sheet metal screws through clamp and rigid duct.

1. Inner duct core: Provide interlocking spiral or helically corrugated flexible core constructed of zinc-coated steel, aluminum, or stainless steel.

2. Insulation: Provide mineral fiber blanket type flexible insulation on connector exterior; minimum of one inch thick. Provide insulation covered on exterior with manufacturer's standard fire retardant vapor barrier jacket for flexible round duct.

3. Provide type 316 stainless steel flexible duct connectors at air inlets and outlets for duct systems indicated to be constructed of stainless steel, unless system is indicated to be liquidtight welded. Provide field installed duct wrap insulation continuous on stainless steel supply and return air flexible duct connectors which comply with Section 230715, “HVAC and Plumbing Insulation”.

C. Duct Access Doors: Provide hinged access doors conforming to SMACNA DCS in ductwork and plenums where indicated and at all air flow measuring stations, motor activated dampers, fire dampers coils, thermostats, sensors, and other apparatus requiring service and inspection in the duct system. Provide access doors upstream and downstream of air flow measuring stations and heating and cooling coils. Provide doors that are a minimum 15 by 18 inches, unless otherwise shown. Where duct size does not accommodate this size door, make the doors as large as practicable. Equip doors 24 by 24 inches or larger with fasteners operable from inside and outside the duct. Use insulated type doors in insulated ducts. Provide doors with continuous hinge on one side. Where hinged operation is impeded by work of other trades or adjacent ducts, provide cam-lock hardware with removable doors and metal chain secured to door frame and door. Access door in systems designed for pressures greater than 2 inches w.g. shall be two piece, double-wall insulated, oval configuration with spring compression twist-lock latching. Access doors shall be constructed of materials typical of the related duct system.

D. Fire Dampers: Use 1.5 hour rated fire dampers unless otherwise indicated. Provide fire dampers that conform to the requirements of NFPA 90A and UL 555. Perform the fire damper test as outlined in NFPA 90A. Provide automatic operating fire dampers with a dynamic rating suitable for the maximum air velocity and pressure differential to which it is subjected. Provide fire dampers approved for the specific application, and install according to their listing. Equip fire dampers with a steel sleeve or adequately sized frame installed in such a manner that disruption of the attached ductwork, if any, does not impair the operation of the damper. Equip sleeves or frames with perimeter mounting angles attached on both sides of the wall or floor opening. Provide curtain type fire dampers with damper blades out of the air stream. Install dampers that do not reduce the duct or the air transfer opening cross-sectional area. Install dampers so that the centerline of the damper depth or thickness is located in the centerline of the wall, partition or floor slab depth or thickness. Unless otherwise indicated, comply with the installation details given in SMACNA 1819 and in manufacturer's instructions for fire dampers. Perform acceptance testing of each fire damper according to paragraph Fire Damper Acceptance Test and NFPA 90A.
E. Manual Balancing Dampers: Furnish manual balancing dampers with accessible operating mechanisms. Use chromium plated operators (with all exposed edges rounded) in finished portions of the building. Provide manual volume control dampers that are operated by locking-type quadrant operators. Install dampers that are 2 gauges heavier than the duct in which installed. Provide access doors or panels for all concealed damper operators and locking setscrews. Provide stand-off mounting brackets, bases, or adapters not less than the thickness of the insulation when the locking-type quadrant operators for dampers are installed on ducts to be thermally insulated, to provide clearance between the duct surface and the operator. Stand-off mounting items shall be integral with the operator or standard accessory of the damper manufacturer.

1. Multiple Blade Type: Provide dampers with opposed blade configuration, multiple blades in a galvanized steel frame for interior duct mounting. Construct blades of 16 gauge galvanized steel. Provide heavy duty molded self-lubricating nylon bearings and 1/2 inch diameter steel axles. Construct frame of 5 inches x 1 inch steel channel. Furnish with locking linkage handle assembly to secure damper in required position.

2. Single Blade Type: Provide dampers with center pivot blade configuration. Construct blade of 18 gauge galvanized steel. Provide nylon end bearings and 1/4 inch diameter round steel axle. Construct frame of 16 gauge galvanized steel. Furnish with locking linkage handle assembly to secure damper in required position. Notch all damper rod ends. Maximum face size: 12 inches by 12 inches. Provide nylon or brass damper sealing type rod end bushings. Note that bushings configured to prevent air leakage are essential to successful duct leakage testing. Bearing systems which enable air leakage are not acceptable.


4. Remote operators: Where indicated, equip manual dampers with remote mechanical actuators. The actuator assembly shall include a concealed damper actuator; galvanized steel housing with internal wrench nut, cover plate with color and finish to match adjacent construction, secured with recessed stainless steel screws, configured for recessed ceiling mounting. The operator shall connect to the damper linkage through a remote cable; external helically wound galvanized steel with inner stainless steel wire. Furnish for actuator a worm gear control plate with integral cable clamp. Furnish for the damper axle a stand-off bracket with cable casing nuts and damper shaft hub with integral wire stop.

F. Turning Vanes and Branch Connections: Provide tuning vanes at all rectangular and square duct elbows, as well as at locations as indicated on the drawings or otherwise specified. Turning vanes shall be factory fabricated, consisting of curved turning vanes designed to provide uniform air distribution and change of direction with minimum turbulence or pressure loss.

1. Sub-main and branch takeoffs in square and rectangular duct systems shall be constructed with 45 degree boot connectors as indicated.

2. Sub-main and branch takeoffs in round and flat oval duct systems shall be constructed with 45 degree boot connectors as indicated.
G. Air Vents and Goosenecks: Fabricate air vents, and goosenecks from galvanized steel sheets with galvanized structural shapes. Provide sheet metal thickness, reinforcement, and fabrication that conform to SMACNA DCS. Accurately fit and secure louver blades to frames. Fold or bead edges of louver blades for rigidity and baffle these edges to exclude driving rain. Provide air vents, penthouses, and goosenecks with bird screen.

H. Bird Screens and Frames: Provide bird screens that conform to ASTM E 2016, No. 2 mesh, aluminum or stainless steel. Provide "medium-light" rated aluminum screens. Provide "light" rated stainless steel screens. Provide removable type frames fabricated from either stainless steel or extruded aluminum.

I. Miscellaneous Sheet Metal: Provide Type G-90 galvanized sheet steel and Type 316 stainless sheet steel; typical of indicated duct system materials, for louver plenums and interior of louver and damper blank-off plates.

1. Construct auxiliary drain pans below equipment of type G90 galvanized steel; all welded.

J. Gravity Intake ventilators.

1. Provide hooded type as indicated. Construct unit of minimum 14 gage aluminum sheet, welded and bolted with corrosion resistant fasteners. Ventilator shall be secured to a minimum 18 gage aluminum support structure with integral roof curb cap. Furnish hoods with bird screens and frames. Equip units with integral backdraft dampers in throat where indicated.

2.9 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA DCS for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections. Construct ductwork of materials indicated at schedule on Contract Drawings.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Stainless Steel: Comply with ASTM A 167.

1. Type 316.

D. Galvanized Duct Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; Type G90 galvanized.

E. Stainless Steel Duct Reinforcement Shapes and Plates: ASTM A 167, steel plates, shapes, and bars; Type 316 stainless steel.
2.10 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Water-Based Joint and Seam Sealant:
   1. Application Method: Brush on.
   2. Solids Content: Minimum 65 percent.
   5. Mold and mildew resistant.
   6. VOC: Maximum 75 g/L (less water).
   7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
   8. Service: Indoor or outdoor.
   9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

C. Flanged Joint Sealant: Comply with ASTM C 920.
   2. Type: S.
   3. Grade: NS.
   5. Use: O.
   6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   7. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

2.11 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Strap and Rod Sizes: Comply with SMACNA DCS, "Rectangular Duct Hangers Minimum Size," and "Minimum Hanger Sizes for Round Duct." Note that either galvanized steel strap hangers or trapeze supports with threaded rods are required for duct support. Cable support systems are not acceptable.

C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

D. Trapeze Supports:
   1. Supports for Galvanized-Steel Ducts: Galvanized-steel angles or channels and plates.
   2. Metal cable hanger systems are not acceptable.
2.12 DUCT AIR LEAKAGE TESTING

A. Provide instruments, consumables and personnel required to accomplish the DALT field work. Testing shall comply with SMACNA HVACADLTM requirements including calibration of instruments. Calibrate and maintain instruments in accordance with manufacturer's written procedures.

B. On completion of the installation of each duct system indicated to be DALT'd, notify the Construction Manager in writing prior to the scheduled testing.

C. Leak test the HVAC air ducts and sections of each system based on criteria scheduled on the Contract Drawings. Accomplish leak tests in accordance with SMACNA HVACADLTM, except as modified by this section. Use the duct class, seal class, leakage class and the leak test pressure data indicated, to comply with the procedures specified in SMACNA HVACADLTM. Provide testing fan, calibrated flow meter, instruments and consumables required to accomplish the DALT field work. DALT field work shall be monitored by the Construction Manager QC representative and the TAB team supervisor. If any of the duct sections exceed the leakage class during testing repairs shall be conducted. Provide retesting of ductwork until leakage rate is brought into compliance. Charges for retesting and observation of retesting shall be borne by the ductwork installer.

D. In spite of SMACNA 1972 CD to the contrary, DALT ductwork of construction class of 3-inch water gauge static pressure and below is required if scheduled on the Contract Drawings to be DALT'd. Separately conduct DALT work for large duct systems to enable the DALT work to be completed.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Provide duct sizes and configurations (rectangular, round) indicated on Contract Drawings. Conform to NFPA 90A, NFPA 96, SMACNA DCS and details on Contract Drawings. Provide mounting and supporting of ductwork and accessories including, but not limited to, structural supports, hangers, vibration isolators, stands, clamps and brackets, access doors, and dampers. Provide dielectric isolation between dissimilar metals. Dielectric isolation may be fluorinated elastomers or sponge-rubber gaskets. Install ductwork accessories as indicated and as recommended by manufacturer's printed instruction. Allow clearance for inspection, repair, replacement, and service. Seal all ductwork joints with topically applied mastic sealant; airtight. Factory injected duct sealant systems into duct seams are not acceptable.

B. Provide duct configurations, types and sizes indicated on Contract Drawings. The Contract Drawings indicate an engineered solution and design intent for each ductwork system. If through pre-installation or field coordination it is required to shift ductwork from the locations indicated to enable the installation of adjacent trades, the materials required to coordinate the final locations shall be provided as work of this Section. Any changes to the ductwork locations indicated on the Contract Drawings shall be clearly indicated in the "Shop Drawing" submittal. If reconfiguring duct aspect ratios are required as part of coordination, the maximum aspect ratio shall not exceed 4:1. The substitution of rectangular and/or square ductwork for round sizes indicated is prohibited.
C. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for fan sizing, maintain sound attenuation, and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings.

D. Install ducts according to SMACNA DCS unless otherwise indicated.

E. Install round ducts in maximum practical lengths.

F. Install ducts with fewest possible joints.

G. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

H. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

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. Route ducts to avoid passing through transformer vaults, electrical equipment rooms and communication rooms unless specifically indicated to be installed in these spaces.

L. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

M. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers.

N. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Seal ends of duct sections; in storage and post-installation, with plastic sheeting secured at perimeter of duct ends.

O. Stainless steel ductwork shall be welded liquidtight and pitched to inlet source such as kitchen cooking hoods and dishwash machines.

P. Kitchen cooling hood ductwork shall comply with NFPA 96. Provide access doors, hangers, supports identification and installation as prescribed in NFPA 96.

Q. Provide closure collars of a minimum 4 inches wide, unless otherwise indicated, for exposed ducts and items on each side of penetrated surface, except above suspended ceilings. Install collar tight against the surface and fit snugly around the duct or insulation. Grind sharp edges smooth to prevent damage to penetrating surface. Fabricate collars for square and rectangular ducts with a maximum side of 15 inches or less from 20 gauge galvanized steel. Install collars with fasteners a maximum of 6 inches on center. Attach to collars a minimum of 4 fasteners where the opening is 12 inches in diameter or less, and a minimum of 8 fasteners where the opening is 20 inches in diameter or less.
1. Fabricate collars for round ducts 15 inches in diameter or less from 20 gauge galvanized steel.
2. Fabricate collars for square and rectangular ducts, or round ducts with minimum dimension over 15 inches from 18 gauge galvanized steel.
3. Fabricate collars for square and rectangular ducts with a maximum side of 15 inches or less from 20 gauge galvanized steel.
4. For stainless steel duct systems, fabricate collars of Type 316 stainless steel, of gages related to sizes indicated for galvanized steel collars above.

3.2 DUCTWORK REINFORCEMENT
A. Conform to SMACNA DCS, details on Contract Drawings and the requirements of this Section. Air distribution systems shall operate with no chatter or vibration. Selection of ductwork joint methods shall assist in ductwork reinforcement. Provide supplemental galvanized steel angle framing at ductwork exterior. The use of duct-internal tie-rods is prohibited.

3.3 DUCTWORK TRANSITIONS
A. Duct transition sections shall be constructed to provide a gradual taper between 15 and 30 degrees. Transitions greater than 30 degrees may be used only when approved by the Architect. Provide both concentric and eccentric duct transition where indicated.

3.4 INSTALLATION OF EXPOSED DUCTWORK
A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
C. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
D. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.5 DUCT SEALING
A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA DCS. Refer to duct construction schedule on Contract Drawings.
   1. Seal all ductwork joints with topically applied mastic sealant; airtight. Factory injected duct sealant systems are not acceptable.
3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA DCS, "Hangers and Supports", and the hanger and supports requirements of this section. Note that cable duct support systems are not acceptable.

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
   1. Where practical, install concrete inserts before placing concrete.
   2. Do not use powder-actuated concrete fasteners.

C. Hanger Spacing: Comply with SMACNA DCS, "Rectangular Duct Hangers Minimum Size," and “Minimum Hanger Sizes for Round Duct,” for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.7 PENETRATIONS

A. Provide prepared openings for duct mains, branches, and other penetrating items, and install during the construction of the surface to be penetrated. Build framed, prepared openings for round duct larger than 15 inches and square, rectangular or oval ducts. Framed openings are also required where grilles, registers, and diffusers are installed at the openings. Provide 1/4 inch clearance between penetrating and penetrated surfaces except at grilles, registers, and diffusers. Seal spaces between opening and duct or duct insulation in accordance with Section 07 84 00.50, “Firestopping” and Section 07 92 00, “Joint Sealants”.

3.8 CONNECTIONS

A. Make connections to equipment with flexible connectors, unless duct system is indicated to be liquidtight welded.

3.9 IDENTIFICATION

A. Provide laminated plastic nameplate on each fire damper access door. Comply with requirements in Division 23 Section "Identification for HVAC and Plumbing Piping and Equipment" for equipment labels and warning signs and labels.

B. Provide ceiling tag on ceiling below each fire damper.

C. Provide identification of ductwork systems in accordance with Section "Identification for HVAC and Plumbing Piping and Equipment"
3.10 START UP

A. Air Balance: Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing."

3.11 CLEANING

A. Clean ductwork as installation progresses. Cap all open duct ends with 6 mil plastic sheeting and tape at end of each work day. Remove all debris and dirt from ducts and wipe clean. Before installing air outlets, vacuum the duct interior with a fine brush attachment to remove accumulated dust. Provide temporary air filters to protect ductwork which may be harmed by excessive dirt.

B. Thoroughly clean ducts and plenums of debris and blow free of small particles of rubbish and dust and then vacuum clean before installing outlet faces. Wipe surfaces clean, with no traces of oil, dust, dirt, or paint spots. Maintain system in this clean condition until final acceptance. Adjust dampers and other miscellaneous equipment requiring adjustment to setting indicated or directed. Maintain all equipment installed under the contract until close out documentation is received, the project is completed and the building has been documented as beneficially occupied.

1. Owner; including coils, prior to building occupancy, will be borne by this section.

3.12 COMMISSIONING

A. Provide the services of the installer in responsible charge of the work in this Section to participate in the Owner provided Commissioning work. Attend field commissioning meetings and field commissioning events as scheduled through the Construction Manager by the Owners Commissioning Agent. Respond to comments and requests made by the Commissioning Agent including the execution of commissioning checklists. Obtain the Commissioning scope, meeting schedule and commissioning event schedule from the Construction Manager and Owner.

3.13 CONSTRUCTION WASTE MANAGEMENT

A. Comply with the Waste Management Plan specified in Section 01 74 19 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL for additional requirements.

END OF SECTION 23 31 13
PART 1 - GENERAL

1.1 CERTIFICATION
A. Silencer ratings shall be certified by nationally known qualified independent testing laboratory. Testing shall be conducted in strict accordance with ASTM E477 method for testing prefabricated silencers for acoustical and airflow performance.

1.2 SUBMITTALS
A. Submit product data for review. Include in submittal:
   1. Dimensions and location of each silencer
B. Independent laboratory certified minimum dynamic insertion loss, self-generated noise, and pressure drop ratings for each silencer.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS
A. VibroAcoustics
B. Industrial Acoustics Company
C. Price

2.2 EQUIPMENT REQUIREMENTS
A. Construct duct silencers in accordance with SMACNA Standards for high pressure duct. Provide air-tight casing when tested to 8" water gauge pressure differential. Suitably stiffen casings to prevent permanent deformation when tested to 8" water gauge pressure differential.
B. Fabricate outer casings of rectangular silencers from minimum 22 gauge galvanized steel.
C. Fabricate outer casings of round silencers from galvanized steel as follows:
D. OUTSIDE DIAMETER MINIMUM METAL GAUGE
   1. 12"-26" 24
   2. 27"-36" 22
3. 37"-50" 20
4. 51"-60" 18

E. Fabricate interior casings from minimum 26 gauge galvanized perforated steel.

F. Filler material shall be inorganic mineral or glass fiber packed under minimum 5% compression. Filler material shall be vermin and moisture proof and inert. Fill material facing airstream shall be isolated from airstream by a cleanable mylar cover. Combustion rating of filler material shall be not less than the following when tested in accordance with NFPA 255, ASTM E84, or UL-723.

1. Flame Spread: 25
2. Smoke Development Rating: 50
3. Fuel Contribution: 20

G. See drawings for size, location, and acoustical and pressure drop performance required for each silencer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install silencers in accordance with manufacturer's published installation instructions. The duct silencer supplier or his qualified representative to be responsible for providing such supervision as may be required to assure correct and complete installation of the duct silencers.

B. Resiliently isolate silencers from the building construction at points of penetration of the building structure with minimum 1/2" thickness, 3 lb./cubic foot density glass fiber.

C. Seal multiple silencer units grouped together in parallel airtight with Ec-800 sealant as manufactured by 3M Company or approved equal.

3.2 TESTING

A. Demonstrate satisfactory performance to Architect. Be prepared to measure and/or evaluate compliance with laboratory certified ratings outlined above.

END OF SECTION
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. Section Includes:
   1. Series Fan Powered Air Terminal Units.

1.3 PERFORMANCE REQUIREMENTS
A. Structural Performance: Hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".

1.4 SUBMITTALS
A. Product Data: For each type of the following products, including rated capacities, furnished specialties, sound-power ratings, and accessories.
   1. Air terminal units.
   2. Insulation and adhesives.
   3. Sealants and gaskets.
B. Shop Drawings: For air terminal units. Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.
   3. Hangers and supports, including methods for duct and building attachment.
C. Field quality-control reports.
D. Operation and Maintenance Data: For air terminal units to include in 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. Air volume calibration charts.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

PART 2 - PRODUCTS

2.1 SERIES FAN POWERED AIR TERMINAL UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Environmental Technologies, Inc.
2. Price Industries.
3. Titus.
4. Trane.

B. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.

C. Casing: 0.034-inch (22 ga.) galvanized steel or 0.032-inch aluminum, double wall.

1. Insulation: Adhesive attached, 1-inch thick, 1-1/2 lbs per cubic/ft density glass fiber or polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
3. Air Outlet: S-slip and drive connections.
4. Access: Removable bottom, double-wall panels for access to air terminal unit interior; with airtight gasket.
5. Airstream Surfaces: Double wall galvanized steel casing with insulation between.

D. Airflow Measuring Station: PITOT Principle ring or cross configured inlet mounted type with flexible tubing to unit controller.

E. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: ARI 880 rated, 1 percent of nominal airflow at 4-inch wg inlet static pressure.
3. Blade shall not deflect at inlet pressures up to 6 inch wg.

F. Motor:
1. Comply with NEMA 1 designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
2. Type: Electronically commutated motor.
4. Enclosure Materials: Cast Aluminum
5. Efficiency: Premium efficient.

G. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.

H. Filters:
   1. Comply with ASHRAE 52.2.
   3. Thickness: Minimum 1 inch.

I. Direct Digital Controls: Single-package unitary controller and electric damper actuator specified in Division 23 Section "Instrumentation and Control for HVAC."

2.2 HANGERS AND SUPPORTS

   A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
   B. Air Terminal Unit Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
   C. Trapeze and Riser Supports: Galvanized steel shapes and plates for units with steel casings; aluminum for units with aluminum casings.

2.3 SOURCE QUALITY CONTROL

   A. Factory Tests: Test assembled air terminal units according to ARI 880.
   1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.

PART 3 - EXECUTION

3.1 INSTALLATION

   A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance. Maintain clearance at bottom access panel; verify field-applied duct installation does not impede access door.

C. Coordinate controls installation with Section 23 09 00, “Instrumentation and Control For HVAC” installer.

3.2 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports," and requirements of this section.

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.3 CONNECTIONS

A. Install piping adjacent to air terminal unit to allow service and maintenance to terminal unit and control panel as detailed on Contract Drawings.

B. Hot-Water Piping: In addition to requirements in Division 23 Section "Hydronic Piping," connect heating coils to supply with shutoff valve, strainer, motor actuated valve, and union or flange; and to return with balancing valve union or flange and shutoff valve.

C. Connect ducts to air terminal units according to Division 23 Section "Metal Ducts."

D. Connections to air terminal units with flexible connectors is prohibited. Maintain minimum length of straight duct at inlet connection as detailed on the Contract Drawings.

3.4 IDENTIFICATION

A. Provide laminated plastic nameplate on each air terminal unit indicating plan number, maximum and minimum factory-set airflows. Comply with requirements in Division 23 Section "Identification for HVAC and Plumbing Piping and Equipment" for equipment labels and warning signs and labels.

B. Provide label on ceiling below air terminal unit with plan number only.
3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Tests and Inspections:
   1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   2. Test and adjust controls and safety. Replace damaged and malfunctioning controls and equipment.

D. Air terminal unit will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.6 CLEANING

A. Cap all open ends of air terminal units with 6 mil plastic sheeting and tape at end of each work day. Remove all debris and dirt from ducts and wipe clean. Vacuum the air terminal unit interiors with a fine brush attachment to remove accumulated dust.

B. Thoroughly clean air terminal units of debris and blow free of small particles of rubbish and dust and then vacuum clean before installing outlet faces. Wipe surfaces clean, with no traces of oil, dust, dirt, or paint spots. Maintain system in this clean condition until final acceptance. Adjust dampers and other miscellaneous equipment requiring adjustment to setting indicated or directed. Maintain all equipment installed under the contract until close out documentation is received, the project is completed and the building has been documented as beneficially occupied.

3.7 STARTUP SERVICE

A. Perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
   3. Verify that controls and control enclosure are accessible.
   4. Verify that control connections are complete.
   5. Verify that nameplate and identification tag are visible.
   6. Verify that controls respond to inputs as specified.

3.8 TESTING ADJUSTING AND BALANCING

A. The requirements for testing, adjusting, and balancing are specified in Section 23 05 93, “Testing Adjusting and Balancing”. Begin testing, adjusting, and balancing only when the air supply and distribution, including controls, has been completed, with the exception of performance tests.
1. Meet with the TAB contractor prior to beginning TAB and review the TAB plan to determine the capabilities of the control system toward completing TAB. Provide the TAB any needed unique instruments for setting terminal unit boxes and instruct TAB in their use (handheld control system interface for use around the building during TAB, etc.).

2. Provide a qualified technician to assist the TAB contractor in performing TAB, or provide sufficient training for TAB to operate the system without assistance.

B. System Calibration and Adjustments: System calibration shall be performed for each air handling system. Provide all personnel, equipment, instrumentation, and supplies necessary to perform calibration and testing of the HVAC control system with Section 23 05 93, “Testing Adjusting and Balancing”. All instrumentation and controls shall be calibrated and the specified accuracy shall be verified using test equipment with calibration traceable to NIST standards.

C. Written notification of any planned calibration and testing of the systems shall be given to the Architect at least 14 calendar days in advance. Prepare a written plan indicating in a step-by-step manner, the procedures that will be followed to test, checkout and adjust the air handling systems prior to the commissioning work specified in Section 23 08 00, Commissioning of HVAC”, according to the process specified. At minimum, the plan shall include for type of equipment specified in this section:

1. System name.
2. List of devices.
3. Step-by-step procedures for testing each component after installation, including the process of verifying proper hardware and wiring installation, and the process of performing operational checks of each component.
4. A copy of the log and field checkout sheets that will document the process. This log must include a place for initial and clearly indicate when the equipment has "passed" and is operating within the contract parameters.
5. A description of the instrumentation required for testing.
6. Indicate what tests on what systems should be completed prior to TAB using the control system for TAB work. Coordinate with the TAB contractor for this determination.

3.9 COMMISSIONING

A. Provide the services of the installer in responsible charge of the work in this Section to participate in the Owner provided Commissioning work. Attend field commissioning meetings and field commissioning events as scheduled through the Construction Manager by the Owners Commissioning Agent. Respond to comments and requests made by the Commissioning Agent including the execution of commissioning checklists. Obtain the Commissioning scope, meeting schedule and commissioning event schedule from the Construction Manager and Owner.

3.10 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.
3.11 CONSTRUCTION WASTE MANAGEMENT

A. Comply with the Waste Management Plan specified in Section 01 74 19 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL for additional requirements.

END OF SECTION 233600
SECTION 233713
DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Perforated diffusers.
   2. Louver face diffusers.
   3. Eggcrate Grille.
   4. Adjustable bar registers and grilles.

B. Related Sections:
   1. Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volume-
      control dampers not integral to diffusers, registers, and grilles.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated, include the following:
   1. Data Sheet: Indicate materials of construction, finish, and mounting details; and
      performance data including throw and drop, static-pressure drop, and noise ratings.
   2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location,
      quantity, model number, size, and accessories furnished.

B. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items
   are shown and coordinated with each other, using input from Installers of the items involved:
   1. Ceiling suspension assembly members.
   2. Method of attaching hangers to building structure.
   3. Size and location of initial access modules for acoustical tile.
   4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers,
      access panels, and special moldings.

C. Source quality-control reports.
PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS

A. Perforated Diffuser:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. METALAIRE, Inc.
   b. Price Industries.
   c. Titus.

2. Devices shall be specifically designed for return and exhaust flows.
3. Material: Steel or aluminum backpan and pattern controllers, with aluminum face.
4. Finish: Baked enamel, white.
5. Face Size: 12 by 12 inches or 24 by 24 inches.
6. Duct Inlet: Round or Square and size as scheduled on the Contract Drawings.
7. Face Style: Flush.
8. Mounting: Surface or T-bar.
9. Pattern Controller: None.
10. Accessories:
    a. Equalizing grid.
    b. Plaster ring.
    c. Safety chain.

B. Louver Face Diffuser:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Anemostat Products; a Mestek company.
   b. METALAIRE, Inc.
   c. Price Industries.
   d. Titus.

2. Devices shall be specifically designed for variable-air-volume flows.
4. Finish: Baked enamel, white.
5. Face Size: 12 x 12 inches and 24 x 24 inches as indicated.
8. Dampers: None.
9. Accessories:
    a. Square to round neck adaptor.
    b. Throw reducing vanes.
    c. Equalizing grid.
    d. Plaster ring.
e. Safety chain.

C. Eggcrate Grille:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Anemostat Products; a Mestek company.
   b. METALAIRE, Inc.
   c. Price Industries.
   d. Titus.

2. Devices shall be specifically designed for return and transfer flows.
4. Finish: Baked enamel, white.
5. Face Size: 12 by 12 inches or 24 by 24 inches.
6. Grid: aluminum 1/2 x 1/2 x 1/2 grid (eggcrate core)
7. Face Style: Flush.
8. Mounting: Surface or T-bar.
9. Pattern Controller: None.
10. Accessories:
   a. Safety chain.

2.2 REGISTERS AND GRILLES

A. Adjustable Bar Register:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Anemostat Products; a Mestek company.
   b. METALAIRE, Inc.
   c. Price Industries.
   d. Titus.

3. Finish: Baked enamel, white.
4. Face Blade Arrangement: Horizontal spaced 1/2 inch apart.
7. Frame: 1 inch wide.
8. Mounting: Countersunk screw or Concealed.
9. Damper Type: Adjustable opposed blade.
10. Accessories:
   a. Front-blade gang operator.

B. Adjustable Bar Grille:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Anemostat Products; a Mestek company.
   b. METALAIRE, Inc.
   c. Price Industries.
   d. Titus.

3. Finish: Baked enamel, white.
4. Face Blade Arrangement: Horizontal spaced 1/2 inch apart.
7. Frame: 1 inch wide.
8. Mounting: Countersunk screw or Concealed.

2.3 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

D. Install low sidewall registers and grilles a minimum of 6 inches above finished floor.
3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

3.4 COMMISSIONING

A. Provide the services of a supervisory level technician, in responsible charge of the work in this section, and factory authorized start-up and service technicians; for each major component or system in this section, to participate in the work specified in Division 01 Commissioning Requirements.

END OF SECTION 233713
SECTION 235216
CONDENSING BOILERS

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section includes gas-fired, condensing boilers, trim, and accessories for generating hot water.

1.3 SUBMITTALS
A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for boiler.
   2. Include rated capacities, operating characteristics, and furnished specialties and accessories.
B. Shop Drawings: For boiler, boiler trim, and accessories.
   1. Include dimensioned plans, elevations, sections, and installation details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include diagrams for power, signal, and control wiring.
C. Source quality-control reports.
D. Field quality-control reports.
E. Sample Warranty: For special warranty.
F. Other Informational Submittals:
   1. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.
   2. CSA B51 pressure vessel Canadian Registration Number (CRN).
G. Operation and Maintenance Data: For boiler to include in emergency, operation, and maintenance manuals. Include product data for boiler as indicated herein before under “product data”.

1.4 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Boiler:
   a. Heat Exchanger Damaged by Thermal Shock: 10 years from date of Substantial Completion.

1.5 FACTORY TESTING

A. Factory Performance Tests:

1. Factory test boilers to validate capacities, burner operations and all safety devices.
2. Boilers shall comply with performance requirements indicated, as determined by performance tests. Adjust, modify, or replace equipment to comply.
3. Perform field performance tests to determine capacity and efficiency of boiler.
   a. Test for full capacity.
   b. Test for boiler efficiency at low fire 20, 40, 60, 80, 100, percent of full capacity. Determine efficiency at each test point.
4. Repeat tests until results comply with requirements indicated.
5. Provide analysis equipment required to determine performance.

PART 2 - PRODUCTS

2.1 BOILER

A. Manufacturers: Subject to compliance with requirements, provide boiler of one of the following:

1. Aerco.
2. Lochinvar.

B. Description: Boiler unit shall be furnished complete with the furnace, heat exchanger, natural gas burning equipment, boiler fittings and trim, automatic controls, induced draft fan assisted burner, electrical wiring, insulation, piping connections, and exterior jacket. The boiler shall be completely assembled and tested at the manufacturer's plant. Each boiler shall be of the condensing type and designed for water service as indicated. The boiler shall have a minimum output capacity in British thermal units per hour (Btuh) indicated, operational efficiency as indicated at the flow rate and inlet/outlet water temperatures indicated. Boiler and accessories
shall be designed and installed to permit ready accessibility for operation, maintenance, and service.

1. Electrical components, Devices and Accessories: Listed and Labeled as defined by NFPA 70, by a qualified testing agency and marked for the intended location and application.
2. Boilers shall be designed, constructed, and equipped in accordance with 2019 ASME BPVC.
3. The boiler capacity shall be based on the ratings certified by the American Boiler Manufacturers Association, or American Gas Association.
4. Unit shall meet or exceed ASHRAE 90.1 thermal efficiency standards.
5. Boiler shall conform to UL 795.
6. Test boiler for compliance with CSA B51.

C. Structure: The boiler shall be a self-contained packaged type, complete with accessories, mounted on a structural steel base or a steel base, integral to the boiler assembly. Construct boiler components into a reinforced steel frame. Components shall permit free thermal expansion without placing undue stress on any part of the boiler base or frame.

D. Boiler Jacket: Boiler shall be covered with a continuous furniture grade steel jacket with baked on enamel finish. Jacket shall be internally lined with fiberglass insulation.

E. Condensing Furnace/Heat Exchanger: The boiler shall be specifically designed for a low temperature condensing flue gas application. The heat exchanger and furnace shall be constructed to withstand the corrosive effects of condensate for each part which may be in contact with the condensate at all possible operating conditions. The boiler shall be provided with a separate combustion air intake, flue gas outlet, condensate drain and water inlet/outlet connections. The boiler shall be designed to withstand the water temperature differentials anticipated at the required operating conditions without experiencing any damage due to thermal shock. Wetted sections of the boiler shall be constructed of stainless steel; carbon steel with corrosion resistant linings or other steel alloys are not acceptable.

1. Equip unit with a condensate drain trap.
2. Equip unit with an inlet/outlet water drain shutoff valve and piping to a floor drain.
3. Equip furnace with a threaded condensate drain pipe tapping.
4. Provide the manufacturer recommended floor mounted acid neutralizing sump to accommodate drain effluent condensed through the combustion process.
5. Provide an air vent valve to vent entrapped air.
6. Equip unit with a pressure and temperature gage; minimum 3-1/2 inches diameter with normal operating point at 50% of gage scale.

F. Burner: Designed to burn natural gas. The natural gas burner shall be radial pattern, constructed of high corrosion resistant alloy stainless steel. Gas orifices shall be replaceable without total removal of the burner assembly. Burner shall be equipped with intermittent pilot operated electric ignition system.

G. Draft Fans: Boiler design shall include induced draft assisted combustion. Fans shall be centrifugal type with backward-curved blades. Each fan shall be sized for the manufacturer recommended output volume and static pressure rating to accommodate furnace pressure loss, boiler stack system pressure loss, excess air requirements at the burner, internal leakages, inlet and outlet temperatures, the air temperature of combustion. the air density corrections for
installed elevation and winter season minimum inlet air temperature condition, all throughout the full combustion range and additionally meeting the net-rated output at normal firing conditions, plus an overall excess air volume of 10 percent against an excess 20 percent static overpressure.

1. Fans shall conform to AMCA 801.
2. Noise levels for fans shall not exceed 85 decibels in any octave band.
3. Induced draft fan housings shall be provided with drain holes to accommodate the drainage of condensation.
4. Fan bearings shall be air-cooled.
5. Induced draft fan scroll sheets and rotor blades shall have protective liners.
6. Fans shall be driven by totally enclosed fan-cooled electric motors suitable for installation in a Class II, Division 1, Group F, hazardous location conforming to NFPA 70.
7. Motor starter shall be as recommended by the boiler manufacturer.

H. Draft Damper: Boiler outlet shall be equipped with a motor actuated shutoff damper. Damper actuator shall be industrial grade electric motor driven. Damper shall include factory installed open/closed end switches for use by the boiler control system.

I. Controls General: Provide boiler with a factory assembled and wired control panel including a PLC based combustion control system integral to the boiler. Accessory control system components for field mounting shall be installed in accordance with the manufacturer's recommendations and under the direct supervision of a representative of the control manufacturer. The controller shall process the signals for complete control and monitoring of the boiler including boiler status, starting and stopping all control functions, sequencing control functions and signaling alarm conditions.

1. Furnish the boiler with a master on-off switch.
2. Provide LCD display operating interface with graphic and text display to control modes and boiler operating parameters including status for ignition, pre-purge, fuel on, post purge, and failure status. Display shall indicate water inlet/outlet temperatures, percent firing rate, and indication of all alarm modes. Display shall indicate fuel valve status.
3. Control system shall enable modulating burner firing with a minimum of 10:1 turndown.
4. Boiler outlet water temperature shall be adjustable over a range of approximately 90 to 210 degrees F.
5. Control system shall be capable of boiler outlet water temperature reset based on outdoor air temperature.
6. Equip boiler furnace inlet and outlet with air temperature sensors.
7. Control system shall include boiler water operating high limits and include a manual reset high limit.
8. Equip boiler with a water safety relief valve.
9. Equip boiler with a factory water flow switch.
10. Furnish the boiler with water inlet and outlet temperature sensors for field pipe-socket mounting in piping systems.
11. Furnish each boiler with an outdoor air temperature sensor for field mounting.

K. Electrical Power: Unit shall factory wired to a single point electrical power connection housed in a NEMA 250 Type 1 enclosure. Provide factory wired branch circuit power to draft fan and boiler controls. Provide each motor with overcurrent protection.

L. Combustion Safety Controls and Equipment: Provide a UL listed, microprocessor-based distributed process controller with integral combustion safety features. The controls shall be factory tested to perform all operating and safety functions. The controls shall be capable of self-diagnostics and contain a message center to provide operator with status and failure mode information. Control systems and safety devices for automatically fired boiler shall conform to ASME CSD-1.

1. Electrical combustion and safety controls shall be rated at 120 volts, single phase, 60 Hz.
2. Provide dry-type contacts for use with a remote alarm bell to annunciate alarm conditions. The alarm circuit shall require manual reset. The following shutdown conditions shall require a manual reset before the boiler can automatically recycle:
   a. Flame failure.
   b. Failure to establish pilot flame.
   c. Failure to establish main flame.
   d. Low-water cutoff.
   e. High temperature cutoff.

3. Low-water Cutoff: Provide either a float actuated switch or electrically actuated probe type low-water cutoff factory installed to boiler. Chambers for float types shall be equipped with a blow-down valve and piping connection. Cutoff shall cause a safety shutdown and sound the alarm bell when the boiler water level drops below a safe minimum level. A safety shutdown due to low water shall require manual reset before operation can be resumed and shall prevent recycling of the burner. The cutoff shall strictly comply with the latest version of code, ASME CSD-1 Controls and Safety Devices for Automatically Fired Boiler.

4. Water Flow Switch: Hot water boiler limit controls shall be provided to include protection for low boiler water flow and high boiler water temperature. The limit controls shall be interlocked with the combustion control system to effect boiler alarm and shutdown. The controls shall not allow boiler startup unless boiler water flow is proven.

5. High Water Temperature Limit: Provide immersible aquastat type with a temperature setting above that of the combustion regulator and below that of the lowest relief valve setting. Aquastat shall function to cause a safety shutdown by closing fuel valves and shutting down burner equipment, activating an LCD screen indicator, and sounding the alarm in the event that boiler water temperature rises to the high temperature limit setting. Provide manual reset.

6. Water Relief Valve: factory installed to provide relieving capacity for the full output of boiler installed. Relief-valve piping shall conform to ASTM A 53/A 53M, schedule 40 steel pipe and be piped full-size to a floor drain.

M. Provide the additional field installed and wired safety equipment to annunciate boiler system alarms and provide boiler shutoff:

1. Provide a 4 inch diameter alarm bell for field mounting adjacent to the boiler system. Bell shall annunciate failure and safety modes. The alarm bell shall ring when the boiler is shut down by any safety control or interlock.
2. Furnish a boiler disconnect switch to be located on the wall outside boiler room entrance to enable rapid and complete shutdown of the boiler in the event of an emergency. Switch shall be red and furnished with a label indicating function of switch.

2.2 STACK, BREECHING AND SUPPORTS

A. For the heating hot water boiler and provide factory fabricated UL listed double wall steel stack, accessories and connectors for use with natural gas appliances at flue gas discharge outlet. Stack materials as a minimum shall comply with NFPA 211. Stack and components shall be constructed as a positive pressure assembly to convey flue gas from the boiler outlet to a wall or roof discharge outlet as indicated. Stack system shall be rated for an internal pressure of 60 inches w.g. All components shall be of a singular manufacturer, UL listed and tested as an assembly to a distance of 2 inches from combustible materials at the maximum boiler flue gas operating temperature.

1. Flue gas conveying components shall be double wall; minimum 1/4 inch thick air gap between with a superferritic stainless steel inner jacket designed for resistance to corrosive condensates and with outer jacket of type 316 stainless steel. Note that stack components constructed of plastic and galvanized steel are not acceptable.
2. Construct inner and outer walls separated by structural spacer clips.
3. Provide ¼ inch threaded taps with nipples and caps in stack vertical straight section to enable the use of a calorimeter.
4. Elbows shall be long radius type.
5. Tee fittings shall be equipped with 45 degree lateral connections.
6. Roof penetration fitting shall be UL listed ventilating sleeve type. Furnish adjustable mounting collar for roof penetration to enable compensation for roof pitch and slope.
7. Stack fittings and straight sections shall be mechanical compression joined and sealed with silicone caulk.
8. Provide weather resistant discharge cap with bird barrier.

B. For the heating hot water boiler, provide type G90 galvanized steel combustion air intake duct. Construct in accordance with Section 23 31 13, “Metal Ducts” based on a minimum of one inch w.g. static pressure class, seal class A.

1. Elbows shall be long radius type.
2. Provide 45 degree elbow down and galvanized steel bird screen at inlet termination.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting performance of the Work.

1. Boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
B. Examine mechanical spaces for suitable conditions where boiler will be installed.

C. Examine roughing-in for hydronic and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 BOILER INSTALLATION

A. Arrange installation of units to provide access space around air-handling units for service and maintenance.

B. Equipment Mounting:
   
   1. Install boiler on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

C. Install boiler level and plumb.

D. Install gas-fired boiler according to NFPA 54.

E. Assemble and install boiler trim, and all devices shipped loose for field mounting.

F. Install electrical devices furnished with boiler but not specified to be factory mounted.

G. Install control wiring to field-mounted electrical devices.

H. Stack, Breeching and Supports:

   1. Install boiler inlet and outlet stacks including straight sections, tee’s, elbows and drain sections. Terminate flue gas outlet above roof with rainproof cap.
   2. Connect full size to boiler connections.

I. Provide condensate piping from boiler manufacturer furnished acid neutralization sump; extend to nearest floor drain. Arrange piping to avoid tripping hazards. Provide cleanout caps at each change in direction of piping system.

### 3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to boiler to allow service and maintenance.

C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.

D. Connect piping to boiler, except safety relief valve connections, with flexible connectors of materials suitable for service.
E. Connect gas piping to boiler gas-train inlet with unions. Piping shall be at least full size of gas-train connection. Provide a reducer if required.

F. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.

G. Install piping from safety relief valves to nearest floor drain.

H. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

I. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 IDENTIFICATION

A. Provide laminated plastic nameplate on the boiler. Comply with requirements in Division 23 Section "Identification for HVAC and Plumbing Piping and Equipment" for equipment labels and warning signs and labels.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Perform installation and startup checks according to manufacturer's written instructions.
2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level, and water temperature.
   b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Boiler will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
3.6 START UP

A. Hydronic Water Balance: Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing."

3.7 CLEANING

A. Wipe surfaces clean, with no traces of oil, dust, dirt, or paint spots. Maintain system in this clean condition until final acceptance. Adjust valves, boiler control parameters and other associated equipment requiring adjustment to setting indicated or directed. Maintain all equipment installed under the contract until close out documentation is received, the project is completed and the building has been documented as beneficially occupied.

3.8 TESTING ADJUSTING AND BALANCING

A. The requirements for testing, adjusting, and balancing are specified in Section 23 05 93, “Testing Adjusting and Balancing”. Begin testing, adjusting, and balancing only when the hydronic hot water system, including controls, has been completed, with the exception of performance tests.

1. Meet with the TAB contractor prior to beginning TAB and review the TAB plan to determine the capabilities of the control system toward completing TAB.

2. Provide a qualified technician to assist the TAB contractor in performing TAB, or provide sufficient training for TAB to operate the system without assistance.

B. System Calibration and Adjustments: System calibration shall be performed for each boiler. Provide all personnel, equipment, instrumentation, and supplies necessary to perform calibration and testing of the HVAC control system with Section 23 05 93, “Testing Adjusting and Balancing”. All instrumentation and controls shall be calibrated and the specified accuracy shall be verified using test equipment with calibration traceable to NIST standards.

C. Written notification of any planned calibration and testing of the systems shall be given to the Architect at least 14 calendar days in advance. Prepare a written plan indicating in a step-by-step manner, the procedures that will be followed to test, checkout and adjust the boiler systems prior to the commissioning work specified in Section 23 08 00, Commissioning of HVAC”, according to the process specified. At minimum, the plan shall include for type of equipment specified in this section:

1. System name.
2. List of devices.
3. Step-by-step procedures for testing each component after installation, including the process of verifying proper hardware and wiring installation, and the process of performing operational checks of each component.
4. A copy of the log and field checkout sheets that will document the process. This log must include a place for initial and clearly indicate when the equipment has “passed” and is operating within the contract parameters.
5. A description of the instrumentation required for testing.
6. Indicate what tests on what systems should be completed prior to TAB using the control system for TAB work. Coordinate with the TAB contractor for this determination.
3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain boilers. Refer to Section 017900 "Demonstration and Training."

3.10 COMMISSIONING

A. Provide the services of the installer in responsible charge of the work in this Section to participate in the Owner provided Commissioning work. Attend field commissioning meetings and field commissioning events as scheduled through the Construction Manager by the Owners Commissioning Agent. Respond to comments and requests made by the Commissioning Agent including the execution of commissioning checklists. Obtain the Commissioning scope, meeting schedule and commissioning event schedule from the Construction Manager and Owner.

3.11 CONSTRUCTION WASTE MANAGEMENT

A. Comply with the Waste Management Plan specified in Section 017419 Construction Waste Management and Disposal, for additional requirements.

END OF SECTION 235216
SECTION 237413
CENTRAL-STATION AIR-HANDLING 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. Section Includes:
   1. Single-zone, draw-through air-handling units.

1.3 SUBMITTALS

A. Product Data: For each air-handling unit indicated.
   1. Unit dimensions and weight.
   2. Cabinet material, metal thickness, finishes, insulation, and accessories.
   3. Fans:
      a. Certified fan-performance curves with system operating conditions indicated.
      b. Certified fan-sound power ratings.
      c. Fan construction and accessories, including vibration isolation.
      d. Motor ratings, electrical characteristics, and motor accessories.
   4. Certified coil-performance ratings with system operating conditions indicated.
   5. Coil Description: Rows/Fins per inch/face velocity.
   6. Dampers including materials and characteristics.
   7. Filters with performance characteristics.
   8. Submittal may include software generated performance curves indicating an individual operating point but shall also include factory performance curves for each fan size indicating performance for all fan speeds (rpm), break horsepower and efficiency points available for the submitted fan.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to piping, controls and electrical.
   1. Detail equipment assemblies and indicate dimensions, weights, load distribution, required clearances, method of field assembly, components, and location and size of each field connection.
2. Rigging, installation, and startup procedures. Include operations and maintenance data for both the chiller and starter. Include location, size, and type of field piping and electrical connections.

3. Options and specialties, electrical requirements, point to point power and control wiring diagrams and connections. Indicate accessories, required for the complete system.

C. Certificates: For certification required in "Quality Assurance" Article.

D. Operation and Maintenance Data: For each air handing unit, include installation manuals, operation, and maintenance manuals. In addition to factory operation and maintenance data, include submittal product data, shop drawings, executed factory pre-start checklists and executed start-up checklists.

E. Warranty: Provide a complete unit parts and labor warranty for one year from startup and beneficial use by Owner.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components. All materials and adhesives shall conform to NFP 90A and NFPA 255 with 25/50 maximum flame/smoke spread ratings.

C. ARI Certification: Air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI. Coil capacities pressure drops and selection materials shall be certified in accordance with ARI Standard 410.

D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 – inch Systems and Equipment" and Section 7 - "Construction and Startup."

E. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."


1.5 DELIVERY, STORAGE AND HANDLING

A. Equipment shall be delivered with protective crating and weatherproof wrapping to provide protection from the weather, humidity, temperature variations, dirt and dust or other contaminants. Include an embedded desiccant to minimize/eliminate moisture within the equipment warping.

B. Deliver products to site on a factory-installed base rails.

C. Store indoors in clean dry place or furnish units with outdoor rated roofs. Handle carefully to avoid damage to components, enclosures, and finish.
D. Ship units in a single piece unless indicated to be equipped with demounts between sections.

1.6 EXTRA MATERIALS

A. Furnish extra materials that match installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One spare set for each air handling unit as indicated.
2. Gaskets: One set for each access door.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide one of the following:

1. Trane

2.2 AIR HANDLING UNITS

A. Single zone type, factory assembled air handling units with capacity characteristics, sound power levels, and static pressures, as indicated. Include intake and discharge plenum sections, filter sections, heating coil sections (where indicated), cooling coil sections, access sections, UVC emitters, and supply fan sections. Internal components such as filters, filter rack, coils, and fans must be completely removable from the unit without having to dismantle the unit or adjacent equipment; internal components shall not provide casing structural support. Provide units with component configurations indicated and dimensions not to exceed those indicated on contract drawings. Provide duct openings and access doors in unit at locations and of sizes indicated on contract drawings. Unit manufacturer shall provide certified ratings conforming to the latest edition of AMCA 210, 310, 500 and ARI 410. Units shall be UL or ETL listed

B. Units shall be completely factory assembled. Multiple sectioned units shall be assembled on a single structural steel base rail skid unless indicated to be, or manufacturer restricted to be constructed with multiple skid sections for field assembly. Units with manufacturer required demount seams or contract drawing indicated demount seams shall be furnished with sufficient gaskets between sections and bolts for reassembly in the field by the contractor.

C. Unit Base Rails/Internal Frame/Floor Panels: Units may be assembled using either a welded tube steel internal frame and insulated floor panels secured to structural steel skid base rails or be assembled using the insulated casing panels for unit structural support with panels secured to structural steel skid base rails. The air handling unit base rail system for each section shall be fabricated of galvanized steel structural C-channel framing shapes along the unit long axis and additional C-channel cross support members at multiple points along the short axis. Internal tube steel frames shall be fabricated of minimum 14-gauge carbon steel, welded to form a unitized assembly for support of all internal components including welding the frame to the base rail components. Base rails and internal steel frames shall be factory painted with primer
and a gray phenolic or epoxy corrosion inhibitive painting system. Base rails shall be fitted with lifting lugs, inter-section anchorage lugs and holes at each section to enable anchorage to the roof adapter curb. Provide integrated to the base rails and frame, a “double-wall” internally insulated floor panel system; for exterior mounted units, the floor roof panels shall be minimum 4 inch thick, R-24. For interior units, the floor panels shall be minimum 2 inch thick, R-13 consisting of minimum 20 gauge G-90 galvanized outer skin and minimum 10 gauge aluminum continuous tread-plate inner walking surface. The “double-wall” floor shall be thermally broken from the base rail and frame. All floor seams shall either be gasketed, caulked and sealed, or welded watertight and airtight. Insulation in base shall comply with paragraph “insulation” hereinafter. The unit base and floor shall be designed so that deflection is limited to no more than L/240 or span dimension at the casing design pressure indicated in the Section.

D. Exterior Panels: For exterior roof mounted units, the exterior wall and roof panels shall be minimum 4 inch thick R-24. For interior units, the exterior wall and roof panels shall be minimum 2 inch thick R-13. Provide units with exterior skin type G90 galvanized steel “double wall” internally insulated configuration fabricated of type G90 galvanized steel including a minimum 20 gage solid aluminum sheet interior skin and minimum 16 gauge galvanized steel outer skin. Panels shall include internal reinforcing. Each panel shall include thermally broken perimeter seams through gasketing or alternatively include an insulation thickness and fastener configuration, either system of which prevents exterior surface condensation at the conditions indicated. For units without internal tube steel frames, provide the minimum metal gages indicated, but not less than the gage and reinforcing necessary to limit casing deflection to 1/200 of the narrowest panel dimension. Side panel bottom and top surfaces shall be shaped to interlock to the floor and roof panels; all seams thermally broken and mechanically attached. Panel seams shall be gasketed and secured with hex head, zinc plated fasteners and neoprene washers. All panel seams shall be gasketed and sealed for an airtight unit at the static pressure indicated in this Section. Insulation in base shall comply with paragraph “insulation” hereinafter. Provide roof casing panels similar to the side panels except construct exterior skin crossbroken or pitched for drainage to an integral gutter system running along the unit long axis.

E. Exterior Panel Thermal Performance: Panels shall not be structurally dependent upon any of the air handling unit internal components such as filter racks, coil casings, or fan system components. Panel floor, walls and roof shall be “double-wall internally insulated”. Casing composition anchorages and attachments shall eliminate air handling unit exterior skin condensation from forming with coil supply air temperatures down to 48 degrees F and exterior ambient air at minimum 78 degrees F WB. The manufacturer shall certify that these conditions will be met under all circumstances.

F. Panel Insulation: Factory insulate air handling unit floors wall and roof panels with injected polyurethane foam. The insulation shall have a minimum effective R value of 16.6 and a noise reduction coefficient (NRC) of 0.70 / per inch thick (based on a type "A" mounting). Insulation shall be rated for a fire hazard classification of 25/50 (per ASTM-84 and UL 723 and CAN/ULC S102-M88). All insulation surfaces shall be encapsulated within the double wall casing panels.

G. Access Doors: The units shall each be equipped with double wall insulated, hinged access doors at locations shown on the plans. Fabricate doors of type G90 galvanized steel, minimum 16 gage exterior skin with minimum 20 gage solid aluminum sheet interior liner. Access doors shall fabricated using the same insulation and shall be of the same thickness as the casing. Provide extruded aluminum perimeter door frames with a built in thermal break barrier and full perimeter gasket. Where indicated, equip access doors with vision panels constructed of
reinforced glass in an extruded aluminum frame. Unless noted otherwise, access doors shall be minimum 18 inches wide except fan section access doors shall be minimum 24 inches wide and access door height shall be minimum 72 inches. Door hinge assemblies shall be die cast zinc or full piano style. Die cast hinges shall include a stainless steel pivot mechanism with field adjustable pitch. Provide a minimum of two heavy duty cast steel or high strength vinyl composite handles per door. All access doors shall open against air pressure. Provide ETL, UL 1995, and CAL-OSHA approved tool operated safety latch on all fan section access doors including electrical dead-man fan interlock. Access doors and frame assemblies shall eliminate air handling unit exterior skin condensation from forming with coil supply air temperatures down to 48 degrees F and exterior ambient air at minimum 78 degrees F WB. Equip each access door with an IP-4 test port similar to Dura Dyne or Ventlok #699.

H. Supply Fans: Plug type, minimum Class II. Fans shall deliver performance specified in the air handling unit schedule and shall be AMCA certified type. Fan wheels shall operate to pressurize a discharge plenum to provide uniform discharge velocity profiles and to allow even face velocities across and through the AHU casing. Unless noted otherwise, fans shall be direct drive.

1. Fan wheel diameters shall be in accordance with the standard sizes adopted by AMCA. Inlets shall be fully streamlined. Blades shall be welded to backplate and welded to wheel cone. Wheels shall be statically balanced prior to assembly and dynamically balanced as an assembly at the factory at design RPM prior to shipment. Fans shall be balanced at design RPM to a total displacement of less than 1 mil measured at each bearing pad prior to shipment.

2. Shafts shall be solid steel machined to standard diameters and tolerances for turned, ground and polished shafts. Center shall be provided at one end of shaft for tachometer reading. Fan shaft shall be designed to be a minimum of 29 percent below critical speed at design RPM. Fan wheels and drive sheaves shall be key-seated to fan shaft.

3. Fans shall be direct driven unless scheduled to be belt driven. Furnish TEFC, premium efficiency motor for each fan. Shaft and bearings shall be configured and sized to accommodate the fan impeller and drive style.

4. Each fan assembly, complete with motor, shall be mounted on a galvanized or welded steel base. Furnish fan base with a minimum of four open spring vibration isolators; minimum 2 inches reflection. Isolators shall each be capable of 30% over-travel before contact.

5. For fans scheduled as belt drive, fan bearings shall be spherical fallen type adjusted in self-aligning pillow blocks. Bearings shall be selected for a minimum L-50 life (400,000) hours at maximum horsepower and operating speed for the classification.

6. Solid steel shaft with center punch for tachometer.

7. Equip each fan with a steel tapered venturi inlet.

8. Equip each fan inlet with a reinforced neoprene coated canvas flexible connection. Where recommended by the manufacturer, provide spring compression thrust restraint vibration isolators, threaded rods and clip anchorages located at a minimum of two places; both sides of the fan.


11. Where indicated to be equipped with airflow measuring stations, equip each fan with an inlet side piezometer flow sensor array with transducer.

12. Equip each fan inlet side with an aluminum backdraft damper.

13. Equip fan section with a structural steel I-beam above motors to enable motor removal; extend beam to access door and include an extension to casing exterior.
14. Fans and fan bases not constructed of galvanized steel shall be factory painted with primer and gray phenolic or epoxy corrosion inhibitive paint system.

I. Water Coils:

1. All coil assemblies shall be leak tested under water at 300 PSIG and Performance is to be certified under ARI Standard 410. Coils exceeding the range of ARI standard rating conditions shall be noted.

2. Coils shall be constructed with stainless steel framing and permit coils to slide out individually from the unit. Water coils shall be constructed of seamless copper tubing mechanically expanded into fin collars. All fins shall be continuous within the coil casing to eliminate carryover inherent with a split fin design. Fins shall be die formed plate type; aluminum material. Enclose coil headers and return bends fully within casing, located over drain pans.

3. Headers shall be seamless copper with die formed tube holes.

4. Pipe connections to coil headers shall be male pipe thread (MPT) Schedule 40 Red Brass with 1/4 inch vent and ¾ inch drain provided for complete coil drainage. Coils shall be rated for minimum 250 PSIG working pressure. Intermediate tube supports shall be provided on coils which exceed 44 inches fin length with an additional support every 42 inches multiple thereafter.

5. Water coils shall have the following construction:

   a. 5/8 inch o.d. x .025 inch wall copper tube with .035 return bends.
   b. 0.010 inch thick aluminum fins.
   c. 16 gauge 304 stainless steel casing.
   d. Connection nipples extending minimum 5 inches from casing exterior.
   e. Vent and drain connections to casing exterior.
   f. Fin spacing shall not exceed 11 fins per inch width.

J. Condensate Drain Pans:

1. Construct drain pans from minimum 16 gauge type 304 stainless steel, welded seams with cross break and double sloping pitch to drain connection. Provide drain pans under each cooling coil. Coils shall be integrated to the floor panels above the base frame so that the condensate connection occurs above the base C-channel system.

2. Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.

3. Depth: A minimum of 2 inches deep.

4. Drain connection centerline shall not exceed a distance of 3 inches below the top of the base rail. Drain connections that protrude through the base rail are not acceptable.

5. Provide a minimum 1 inch NPS type 304 stainless steel nipple on one end of pan. Where drain connections are indicated to be on both sides of the unit, provide drain pans pitched at the center and sloped to each nipple.

6. Provide minimum 2 inch thickness of polyurethane foam insulation surrounding exterior surfaces of drain pan.

7. Units with stacked coils shall have intermediate drain pans below each coil with factory installed drain piping from the top to the bottom pan.

K. Interior Lighting: Provide marine type LED lights interior to casings with metal guard on each where indicated. Provide switches mounted on unit exterior for lighting control in each section independently; both sides of unit where indicated. Furnish unit with factory installed wiring to light switches, terminating at a single point power connection.
L. Leak and Sound Testing: For the air handling unit, assembled casing sections upstream of fan sections shall be tested at 10 inches W.G.; negative pressure. Assembled casing sections downstream of fan sections shall be tested at 10 inches W.G.; positive pressure. Exterior roof mounted unit leakage rates not to exceed one percent of that scheduled air flow. Interior unit leakage rates not to exceed five percent of that scheduled air flow. The unit shall also be equal to or less than the sound power levels indicated on the Contract Drawings.

M. Vibration Isolation: Entire fan and motor assembly for each fan shall be fabricated of galvanized steel members or carbon steel members with primer and gray phenolic or epoxy corrosion resisting paint system. The assembly base shall be equipped with a minimum of four housed spring compression vibration isolators with 1.5 inch nominal deflection mechanically bolted or welded reinforced portions of the floor panel system.

N. Filter Sections: Provide front loading or side loading non-angled filter sections in additional casing sections where indicated. Holding frames shall be fabricated of type 304 stainless steel. Side loading filter systems shall be equipped with a compression lever locking assembly. Front loading filters shall be equipped with compression filter restraint device at each filter. Provide visible identification on media frames showing filter model numbers required and the air-flow direction. Provide sealed galvanized steel baffle plates at each filter bank perimeter to prevent bypass of unfiltered air. Provide filter gage on each filter section; factory piped to filter section up and downstream. Gages shall be located accessible for viewing adjacent to unit.

O. Air Filtration: Unless noted otherwise, minimum filter arrestance shall comply with ASHRAE 52.1. Filter efficiencies, filter quantities and filter media area shall comply with schedules on Contract Drawings.

1. Filter section leakage at rated airflow, upstream to downstream of filter holding frame, and slide mechanism shall be less than 1% at 3 inch w.g. differential.

2. Leakage into housing frame ambient atmosphere at rated airflow shall be less than 0.5% at 3 inch w.g. negative.

3. Manufacturer shall certify filter frame leakage rates as part of the Product Data submittal.

4. Provide three sets of filters for each AHU; one set for use during construction, one clean set for use during testing, adjusting and balancing, and one spare set.

P. Access Sections and Plenum Sections: Access sections shall be provided where indicated and shall be equipped with access doors as shown. All supplemental unit sections shall be constructed in a manner identical to the remainder of the unit walls, floor and roof. At plenum sections, provide duct connections at locations and of sizes indicated on the Contract Drawings. Equip each roof mounted AHU with a supplemental access section to house the fan variable frequency drives and field-installed control system panels. The supplemental access sections shall be cooled through the passage of air from the supply plenum section.

Q. Electrical: Provide factory installed and wired electrical components interior to unit. Factory installed and field-installed components shall comply with NFPA 70 and the requirements of this Section. Provide wiring and raceway to all motors, disconnect switches, lighting, UVC light arrays, switches, and service receptacles. Furnish factory installed wiring in metallic raceways for all factory installed electrical components at AHU interior. Terminate power
wiring for AHU lighting/receptacles, UVC emitters, and fans (each separate) at junction boxes on AHU exterior.

R. Filter Gauges: Minimum 4 inch diameter dial type, diaphragm actuated draft and shall be provided for each filter section. Gauges shall have white dials with black figures, and shall be graduated in 0.01 inch of water and shall have a minimum range of 1 inch of water beyond the specified final resistance for the filter bank on which each gauge is applied. Each gauge shall incorporate a screw operated zero adjustment and shall be factory installed complete with two static pressure tips with integral compression fittings, two molded plastic vent valves, 1/4 inch diameter aluminum tubing, and mounting hardware.

S. Airflow Measuring Stations: Provide airflow measuring stations at each supply fan inlet and for exterior units, at each outdoor air intake assembly. Each station shall contain an array of velocity sensing elements equally spaced along multiple insertion probes for outdoor air units, or an array of velocity sensing elements designed in a frame for insertion to a fan vortex inlet for supply fan inlet types. The velocity sensing elements shall be of the RTD or thermistor type, with linearizing means. Pitot type air flow measuring stations will not be acceptable. The sensing elements shall be distributed across the duct or opening cross section in the quantity and pattern set forth for measurements and instruments of ASHRAE-03 and SMACNA-07 for the traversing of ducted air flows. Station construction shall be suitable for operation at airflows of up to 5000 feet per minute over a temperature range of -20 to 160 degrees F, and accuracy shall be plus or minus 3 percent over a range of 0 to 5000 feet per minute; scaled to volume. Equip airflow measurement stations with transmitters compatible with control system specified in Section 23 09 00, “Instrumentation and Control for HVAC”. Subject to compliance with requirements, provide Ebtron Gold series airflow measuring stations or approved equal.

T. Motor Actuated Dampers: Provide dampers where indicated in the return and outdoor air sections of the air handling unit casing. Subject to compliance with requirements, provide TAMCO Series 1000 dampers or approved equal.

1. Frame Construction: Damper frame shall be not less than .080 inch thick and be fabricated of extruded aluminum (6063-T5). Damper frame shall be minimum 4 inches deep x 1 inch with mounting flanges on both side of frame. Frame shall be clear anodized to a minimum thickness of 0.7 mil deep and be assembled using stainless steel screws.

2. Blade Construction: Blades shall be airfoil design, constructed of extruded aluminum (6063-T5) with a minimum wall thickness of .06 inches. Blades shall be clear anodized to a minimum thickness of 0.7 mil deep. Blade seals shall be extruded silicone, secured in an integral slot within the aluminum blade extrusions and shall be mechanically fastened to prevent shrinkage and movement.

3. Seals: Frame seals shall be of extruded silicone and be secured in an integral slot within the aluminum extrusions.

4. Bearings: Bearings shall be maintenance free, composed of a Celcon inner bearing fixed to a 7/16" aluminum hexagon blade pin, rotating within a polycarbonate outer bearing inserted in the frame.

5. Linkage: Linkage hardware shall be installed in the frame side, out of the air stream and accessible after fabrication. All non-aluminum damper assembly and linkage hardware parts shall be constructed of type 304 stainless steel. Cup-point trunnion screws shall be used to anchor bearings to linkage rod. Provide an adjustable hexagon drive rod, U-bolt fastener and retaining nuts. Motor actuators for the dampers shall be field provided by the controls installer.
6. Rating: Leakage shall not exceed 2 percent of air quantity at 2000-fpm face velocity through damper and 4-inch wg differential pressure. Dampers shall be designed to operate in air temperatures between -40°F and 210°F.

U. Motor Actuated Outdoor Air Damper/Airflow Measuring Station Assembly: For all units installed interior and exterior to building, provide combination motor actuated outdoor air damper and airflow measuring station integrated to a single assembly. The dampers and airflow measuring stations shall comply with the requirement of this Section except that for exterior units, the two devices shall be factory assembled in a common sleeve, integrated to the air handling unit outdoor air intake. For the indoor units, the two devices shall be installed in the outdoor air ductwork. Subject to compliance, provide AIR-IQ series damper/airflow measuring station assembly manufactured by Tamco/Ebtron or approved equal.

V. Exterior Unit Roof Curb: For each exterior unit, furnish a welded steel roof curb. Curb shall be configured with top surfaces to match the air handling unit base rails. Curb sides shall be thermally insulated with 2 inch thick minimum 3 lbs/cuft density fiberglass material. Provide curb height as indicated but not less the dimension required to enable the outdoor air intake to rest at a minimum of three feet above the finished roof, and enable the air handling unit condensate drain trap installation and condensate piping to slope to the indicated discharge point at pipe slope required by FBC.

W. UVC Emitters: Provide bank of UVC emitting lamps at the downstream side of each cooling coil face. Lamp banks shall be factory pre-wired to a single point connection; control panel with system pilot light, failure pilot light, and "lamp-out" relay and disconnect switch at unit exterior. All wiring internal to AHU shall be provided with rubber grommets where passing through metal junction boxes and control panels.

1. Irradiation - Emitters and fixtures are to be installed in sufficient quantity and in such an arrangement so as to provide an equal distribution of UVC energy on the coil and in the drain pan. To maintain energy efficiency, the UVC energy produced shall be of the lowest possible reflected and shadowed losses. Provide array with multiple rows of lamps; number defined by coil height. A single row of lamps will not be acceptable.

2. Intensity - The minimal UVC energy striking the leading edge of all coil fins shall not be less than 1500 mW/cm² at the closest point and through placement, not less than 70 percent of that value at the farthest point. This therefore sets the minimum quantity of fixtures to be installed and their placement. Additionally, equal amounts are to strike the drain, either directly or indirectly through reflection.

3. Installation - Emitters and fixtures shall be installed at right angles to the conforming lines of the coil fins, such that through incident angle reflection, UVC energy bathes all surfaces of the coil and drain pan as well as all of the line of sight airstream.

4. Units shall be high output, HVAC-type, germicidal UVC light sources, factory assembled and tested. Components shall include a housing, reflector, high efficiency electronic power source, Emitter sockets and Emitter tube, all constructed to withstand inner HVAC environments. Total output per inch arc length shall not be less than 10mw/cm2, at one meter, in a 400 fpm airstream at 50 degrees F.

5. Supports shall be type 304 stainless steel with wiring devices and raceways.

6. Reflectors shall be constructed of high spectral finished aluminum alloy with a minimum 85 percent reflectance of 254 nm UVC radiance.

7. UVC lamp banks shall operate at 115V nominal. They shall be UL class P2 type capable of igniting each Emitter at temperatures from 32-165 degrees F in airflow velocities to 1000 fpm. Their conversion efficiency shall not be less than 70% and they shall be
designed so as to enhance plasma vapor pressure for maximum photon production in cold airstreams. They shall be equipped with RF and line noise suppression.

8. Emitter tubes shall be of the high output, hot cathode, T5 (15mm) diameter, medium bipin type. They shall produce 95 percent of their energy at 254 nm and be capable of producing the specified output at airflow velocities to 1000 fpm at temperatures of 32-165 degrees F. They shall produce no ozone or other secondary contamination.

9. Provide each UVC array with a radiometric sensing and output device configured with 0-10 voc or 4-zone output for use by the facility DDC system. System shall enable interrogation of dynamic UVC light intensity.

2.3 FILTER MEDIA

A. List air filters according to requirements of UL 900, except list high efficiency particulate air filters of 99.97 percent efficiency by the DOP Test method under the Label Service to meet the requirements of UL 586. Provide physical size of filters and gross area of filter media as scheduled. Provide three sets of filters for each AHU; one set for use during construction, one set for use during TAB’s and one spare set. Provide filters as scheduled on Contract Drawings of materials as follows:

1. Panel-filters; 4 inch deep sectional, disposable type filters of the size indicated with a minimum MERV of 8 (return air) and 11 (outdoor ventilation air) when tested according to ASHRAE 52.2. Provide UL Class 2 filters, and nonwoven cotton and synthetic fiber mat media. Attach a wire support grid bonded to the media to a moisture resistant fiberboard frame. Bond all four edges of the filter media to the inside of the frame to prevent air bypass and increase rigidity.

2.4 SOURCE QUALITY CONTROL

A. Fan Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.

B. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating."

C. Water Coils: Factory tested to 300 psig according to ARI 410 and ASHRAE 33.

D. For units with demount seams, provide air leakage testing of air handling units after unit assembly at site. Testing constraints shall comply with the “Leak Testing” requirements indicated in this Section.
3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for hydronic and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Arrange installation of units to provide access space around air-handling units for service and maintenance.

B. Do not operate fan system until filters are in place. Install second set of filters during TABS.

C. Equipment Mounting:

1. Install AHU’s as indicated on the contract documents. Coordinate dimensions of concrete housekeeping pads with approved air handling units.

D. Interior Unit Support: Install unit level and plumb. Interior units shall be installed on reinforced concrete pad. Secure units to concrete pads with anchor bolts. Provide neoprene waffle pads between AHU base frame and concrete pads; spaced evenly, not to exceed 5’0” center. Locate pads to avoid anchorage points. Pads shall each be 6 inches x 6 inches x 1 inch thick.

E. Exterior Unit Support: Install unit level and plumb. Exterior units shall be installed on an insulated roof curb furnished by the air handling unit manufacturer. Both air handling unit and roof curb shall be anchored in accordance with the manufacturer NOA assembly certification.

F. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangements of ducts.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to air-handling unit to allow service and maintenance.

C. Connect piping to air-handling units.
D. Provide cooling coil condensate P-Trap at each drain pan connection and provide piping system; extend to nearest floor drain. Arrange piping to avoid tripping hazards. Provide cleanout caps at each change in direction of piping system.

E. Hydronic Water Piping: Comply with Section 232113 "Hydronic Piping." Install shutoff valve and union or flange at each coil supply and return connection. Install pipeline strainer and balancing valve where indicated. Install shutoff valve in main supply and return valve train connections to main piping. Provide supplemental pressure/temperature test fittings where indicated. Provide hose-end ball valve drain at each coil bottom and manual air vent at each coil top.

3.4 IDENTIFICATION

A. Provide laminated plastic nameplate on each air handling unit, associated variable frequency drive and air handling unit filter section. Comply with requirements in Division 23 Section "Identification for HVAC and Plumbing Piping and Equipment" for equipment labels and warning signs and labels.

3.5 START UP

A. Air Balance: Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing."

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.

E. Prepare test and inspection reports.
3.7 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system.
5. Verify that bearings and other moving parts are lubricated with factory-recommended lubricants.
6. Verify that outdoor-air dampers open and close, and maintain minimum outdoor-air setting.
7. Comb coil fins for parallel orientation.
8. Install new, clean filters.
9. Verify that motor actuated dampers, including fire and smoke dampers in connected duct systems are in fully open positions.

B. Starting procedures for air-handling units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm.
2. Measure and record motor electrical values for voltage and amperage.
3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.8 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

3.9 CLEANING

A. Thoroughly air handling units and plenums of debris and blow free of small particles of rubbish and dust and then vacuum clean before installing outlet faces. Wipe surfaces clean, with no traces of oil, dust, dirt, or paint spots. Maintain system in this clean condition until final acceptance. Adjust dampers and other miscellaneous equipment requiring adjustment to setting indicated or directed. Maintain all equipment installed under the contract until close out documentation is received, the project is completed and the building has been documented as beneficially occupied.
3.10 SYSTEM OPERATION DURING CONSTRUCTION

A. Air handling units and fans may be operated during building construction only when approved by the Architect. Exhaust fans are not permitted to be operated. If air handling units are operated to "dry-out" the facility during construction, they shall be used with the return air ductwork disconnected to avoid AHU and ductwork fouling from the building construction conditions. If it is elected and approved that the units may be used, provide the following:

1. Each air handling unit shall be equipped with the specified construction filters in the permanent AHU filter frames.
2. The AHU inlet connection shall be blanked off with sheet metal and sealed, the suction-side access door(s) shall be opened and configured with a temporary, galvanized steel framing rack, to enable the securing of low efficiency blanket type filter media to the rack. The rack dimensions and configuration shall allow the resulting blanket filter media coverage to not exceed a 500 feet per minute face velocity through the blanket filter media at the scheduled AHU air quantity; the media shall be sealed with temporary metal clips to prevent bypass air. The AHU's shall receive air to the suction side through the louvers to the space.
3. The AHU's shall not be operated when outdoor ambient temperature conditions are at 35 degrees F or less. If the AHU's in the temporary-use state are shut down at the end of the day, the louver shall be blanked off to create a barrier between the mechanical space and the facility exterior.
4. When conditions on the construction site are acceptable to the Architect, the temporary AHU access door filter rack may be removed and the permanent inlet-side AHU duct condition installed.
5. For the initial two weeks of AHU operation to the permanent duct systems; supply and return air, provide temporary low efficiency replaceable filter media over all return registers and continue to use low efficiency blanket filter media over the permanent AHU filter racks as described above. Secure in place with tape at filter perimeter; seal. Change each register filter when visibly soiled or at a minimum; weekly. The installer of this Section shall schedule observation of the temporary filter media with the Architect. The Owner expects to acquire clean AHU's and ductwork when the installation is completed. If ductwork and AHU is soiled with dust during construction, charges for cleaning the duct system and AHU, to the satisfaction of the Architect/Owner; including coils, prior to building occupancy, will be borne by this Section.

3.11 TESTING ADJUSTING AND BALANCING

A. The requirements for testing, adjusting, and balancing are specified in Section 23 05 93, “Testing Adjusting and Balancing”. Begin testing, adjusting, and balancing only when the air supply and distribution, including controls, has been completed, with the exception of performance tests.

1. Meet with the TAB contractor prior to beginning TAB and review the TAB plan to determine the capabilities of the control system toward completing TAB.
2. Provide a qualified technician to assist the TAB contractor in performing TAB, or provide sufficient training for TAB to operate the system without assistance.

B. System Calibration and Adjustments: System calibration shall be performed for each air handling system. Provide all personnel, equipment, instrumentation, and supplies necessary to
perform calibration and testing of the HVAC control system with Section 23 05 93, “Testing Adjusting and Balancing”. All instrumentation and controls shall be calibrated and the specified accuracy shall be verified using test equipment with calibration traceable to NIST standards.

C. Written notification of any planned calibration and testing of the systems shall be given to the Architect at least 14 calendar days in advance. Prepare a written plan indicating in a step-by-step manner, the procedures that will be followed to test, checkout and adjust the air handling systems prior to the commissioning work specified in Section 23 08 00, Commissioning of HVAC”, according to the process specified. At minimum, the plan shall include for type of equipment specified in this section:

1. System name.
2. List of devices.
3. Step-by-step procedures for testing each component after installation, including the process of verifying proper hardware and wiring installation, and the process of performing operational checks of each component.
4. A copy of the log and field checkout sheets that will document the process. This log must include a place for initial and clearly indicate when the equipment has "passed" and is operating within the contract parameters.
5. A description of the instrumentation required for testing.
6. Indicate what tests on what systems should be completed prior to TAB using the control system for TAB work. Coordinate with the TAB contractor for this determination.

3.12 DEMONSTRATION

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

3.13 COMMISSIONING

A. Provide the services of the installer in responsible charge of the work in this Section to participate in the Owner provided Commissioning work. Attend field commissioning meetings and field commissioning events as scheduled through the Construction Manager by the Owners Commissioning Agent. Respond to comments and requests made by the Commissioning Agent including the execution of commissioning checklists. Obtain the Commissioning scope, meeting schedule and commissioning event schedule from the Construction Manager and Owner.

3.14 CONSTRUCTION WASTE MANAGEMENT

A. Comply with the Waste Management Plan specified in Section 017419 Construction Waste Management and Disposal, for additional requirements.

END OF SECTION 237413
PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section Includes:
      1. Copper building wire rated 600 V or less.
      2. Aluminum building wire rated 600 V or less.
      3. Metal-clad cable, Type MC, rated 600 V or less.
      4. Fire-alarm wire and cable.
      5. Connectors, splices, and terminations rated 600 V and less.
   B. Related Requirements:
      1. Section 260523 "Control-Voltage Electrical Power Cables" for control systems
         communications cables and Classes 1, 2, and 3 control cables.

1.3 DEFINITIONS
   A. VFC: Variable-frequency controller.

1.4 ACTION SUBMITTALS
   A. Product Data: For each type of product.
   B. Product Schedule: Indicate type, use, location, and termination locations.

1.5 INFORMATIONAL SUBMITTALS
   A. Qualification Data: For testing agency.
   B. Field quality-control reports.
1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA.
   1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. Standards:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
   2. RoHS compliant.
   3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

C. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

D. Conductor Insulation:
   1. Type THHN and Type THWN-2: Comply with UL 83.

E. Shield:
   1. Type TC-ER: Cable designed for use with VFCs, with oversized crosslinked polyethylene insulation, spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire, and sunlight- and oil-resistant outer PVC jacket.

2.2 METAL-CLAD CABLE, TYPE MC

A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.

B. Standards:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
   2. Comply with UL 1569.
   3. RoHS compliant.
   4. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

C. Circuits:

D. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

E. Ground Conductor: Insulated.

F. Conductor Insulation:
   1. Type TFN/THHN/THWN-2: Comply with UL 83.

G. Armor: Steel, interlocked.

H. Jacket: PVC applied over armor.

2.3 FIRE-ALARM WIRE AND CABLE

A. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

B. Signaling Line Circuits: Twisted, shielded pair, No. 18 AWG.
   1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire-alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.

C. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.
   1. Low-Voltage Circuits: No. 16 AWG, minimum, in pathway.
   2. Line-Voltage Circuits: No. 12 AWG, minimum, in pathway.
   3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with red identifier stripe, NRTL listed for fire-alarm and cable tray installation, plenum rated.

2.4 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
B. VFC Output Circuits Cable: Extra-flexible stranded for all sizes.


3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Feeders Concealed in Ceilings, Walls, Partitions, and Crawls: Type THHN/THWN-2, single conductors in raceway.

B. VFC Output Circuits: Type XHHW-2 in metal conduit.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

3.4 INSTALLATION OF FIRE-ALARM WIRING

A. Comply with NECA 1 and NFPA 72.

B. Wiring Method: Install wiring in metal pathway according to Section 270528.29 "Hangers and Supports for Communications Systems."

1. Install plenum cable in environmental airspaces, including plenum ceilings.
2. Fire-alarm circuits and equipment control wiring associated with fire-alarm system shall be installed in a dedicated pathway system. This system shall not be used for any other wire or cable.

C. Wiring Method:

1. Cables and pathways used for fire-alarm circuits, and equipment control wiring associated with fire-alarm system, may not contain any other wire or cable.
2. Fire-Rated Cables: Use of two-hour, fire-rated fire-alarm cables, NFPA 70, Types MI and CI, is permitted.
3. Signaling Line Circuits: Power-limited fire-alarm cables shall not be installed in the same cable or pathway as signaling line circuits.
D. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with fire-alarm system to terminal blocks. Mark each terminal according to system’s wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

E. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes; cabinets; or equipment enclosures where circuit connections are made.

F. Color-Coding: Color-code fire-alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire-alarm system junction boxes and covers red.

3.5 CONNECTIONS

A. 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-486B.

B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

D. Comply with requirements in Section 283111 "Digital, Addressable Fire-Alarm System" for connecting, terminating, and identifying wires and cables.

3.6 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.7 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."
3.8 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections with the assistance of a factory-authorized service representative.

1. Perform each of the following visual and electrical tests:

   a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
   b. Test bolted connections for high resistance using one of the following:
      
      1) A low-resistance ohmmeter.
      2) Calibrated torque wrench.
      3) Thermographic survey.
   c. Inspect compression-applied connectors for correct cable match and indentation.
   d. Inspect for correct identification.
   e. Inspect cable jacket and condition.
   f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.
   g. Continuity test on each conductor and cable.

E. Cables will be considered defective if they do not pass tests and inspections.

END OF SECTION 260519
PART 1 - GENERAL

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

1.2 SUMMARY
A. Section includes grounding and bonding systems and equipment.
B. Section includes grounding and bonding systems and equipment, plus the following special applications:
   1. Underground distribution grounding.
   2. Ground bonding common with lightning protection system.
   3. Foundation steel electrodes.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS
A. Qualification Data: For testing agency and testing agency's field supervisor.
B. Field quality-control reports.

1.5 QUALITY ASSURANCE
A. Testing Agency Qualifications: Certified by NETA.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. Comply with UL 467 for grounding and bonding materials and equipment.

2.2 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:
   4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
   5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
   6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
   7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.3 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

C. Cable-to-Cable Connectors: Compression type, copper or copper alloy.

D. Conduit Hubs: Mechanical type, terminal with threaded hub.

E. Service Post Connectors: Mechanical type, bronze alloy terminal, in short- and long-stud

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 12 AWG and smaller, and stranded conductors for No. 10 AWG and larger unless otherwise indicated.

B. Conductor Terminations and Connections:
   1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
   2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
   3. Connections to Ground Rods at Test Wells: Bolted connectors.
C. Install insulated equipment grounding conductors with all feeders and branch circuits.

D. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Armored and metal-clad cable runs.
8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.

E. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

F. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

3.2 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
   1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

C. Grounding system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.
SECTION 260533

RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Metal conduits and fittings.
   2. Nonmetallic conduits and fittings.
   3. Metal wireways and auxiliary gutters.
   4. Surface raceways.
   5. Boxes, enclosures, and cabinets.

1.3 DEFINITIONS

A. ARC: Aluminum rigid conduit.
B. GRC: Galvanized rigid steel conduit.
C. IMC: Intermediate metal conduit.

1.4 ACTION SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. Metal Conduit:
   1. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. GRC: Comply with ANSI C80.1 and UL 6.
   3. ARC: Comply with ANSI C80.5 and UL 6A.
   4. IMC: Comply with ANSI C80.6 and UL 1242.
5. EMT: Comply with ANSI C80.3 and UL 797.
6. FMC: Comply with UL 1; zinc-coated steel [aluminum].
7. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

B. Metal Fittings:
1. Comply with NEMA FB 1 and UL 514B.
2. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Fittings, General: Listed and labeled for type of conduit, location, and use.
5. Fittings for EMT:
   a. Material: Steel.
   b. Type: compression.
6. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
7. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

C. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

A. Nonmetallic Conduit:
1. Listing and Labeling: Nonmetallic conduit shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Fiberglass:
   b. Comply with UL 2515 for aboveground raceways.
   c. Comply with UL 2420 for belowground raceways.
3. ENT: Comply with NEMA TC 13 and UL 1653.
4. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
5. LFNC: Comply with UL 1660.
6. Rigid HDPE: Comply with UL 651A.
7. Continuous HDPE: Comply with UL 651A.
8. Coilable HDPE: Preassembled with conductors or cables, and complying with ASTM D 3485.

B. Nonmetallic Fittings:
1. Fittings, General: Listed and labeled for type of conduit, location, and use.
2. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
   a. Fittings for LFNC: Comply with UL 514B.

3. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

   A. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
      1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

   B. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

   C. Wireway Covers: Screw-cover type unless otherwise indicated.

   D. Finish: Manufacturer's standard enamel finish.

2.4 BOXES, ENCLOSURES, AND CABINETS

   A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

   B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

   C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, [ferrous alloy] [aluminum], Type FD, with gasketed cover.

   D. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

   E. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.

   F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

   G. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

   H. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

   I. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.

   J. Gangable boxes are prohibited.
K. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

L. Cabinets:

1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Indoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed and Subject to Severe Physical Damage: GRC. Raceway locations include the following:
   a. Loading dock.
   b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
   c. Mechanical rooms.
3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
5. Damp or Wet Locations: GRC.
6. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

B. Minimum Raceway Size: 1/2-inch 3/4-inch trade size.

C. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

D. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

E. Install surface raceways only where indicated on Drawings.

3.2 INSTALLATION

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

B. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

C. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

D. Complete raceway installation before starting conductor installation.

E. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.

F. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.

G. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

H. Support conduit within 12 inches of enclosures to which attached.

I. Stub-Ups to Above Recessed Ceilings:
   1. Use EMT, IMC, or RMC for raceways.
   2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

J. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

K. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

L. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
M. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

N. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

O. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

P. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

Q. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

R. Surface Raceways:
   1. Install surface raceway with a minimum 2-inch radius control at bend points.
   2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

S. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

T. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
   1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
   2. Where an underground service raceway enters a building or structure.
   3. Conduit extending from interior to exterior of building.
   4. Conduit extending into pressurized duct and equipment.
   5. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
   6. Where otherwise required by NFPA 70.

U. Expansion-Joint Fittings:
   1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
   a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
   b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
   c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
   d. Attics: 135 deg F temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.

4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.

5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

V. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

   1. Use LFMC in damp or wet locations subject to severe physical damage.
   2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

W. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

X. Locate boxes so that cover or plate will not span different building finishes.

Y. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

Z. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

AA. Set metal floor boxes level and flush with finished floor surface.

BB. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.
SECTION 260553
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

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

1.2 SUMMARY
   A. This Section includes electrical identification materials and devices required to comply with
      ANSI C2, NFPA 70, OSHA standards, and authorities having jurisdiction.

1.3 SUBMITTALS
   A. Product Data: For each electrical identification product indicated.

1.4 QUALITY ASSURANCE
   A. Comply with ANSI A13.1.
   B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 POWER RACEWAY IDENTIFICATION MATERIALS
   A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of
      color field for each raceway size.
   B. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use
      with self-locking cable tie fastener.

2.2 CONDUCTOR IDENTIFICATION MATERIALS
   A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1
      to 2 inches wide.
2.3 WARNING LABELS AND SIGNS


B. Engraved Plastic Nameplates and Signs: Engraving stock, melamine plastic laminate, minimum 1/16 inch thick for signs up to 20 sq. in. and 1/8 inch thick for larger sizes.

C. Baked-Enamel Signs for Interior Use: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for the application. ¼ inch grommets in corners for mounting.

2.4 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon cable ties.
   2. Tensile Strength: 50 lb minimum.
   3. Temperature Range: Minus 40 to plus 185 deg F.

B. Paint: Formulated for the type of surface and intended use.
   1. Primer for Galvanized Metal: Single-component acrylic vehicle formulated for galvanized surfaces.
   2. Enamel: Silicone-alkyd or alkyd urethane as recommended by primer manufacturer.

2.5 EQUIPMENT IDENTIFICATION LABELS

A. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with colors as indicated on the drawings. Minimum letter height shall be as indicated on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Color Coding Raceways and Junction Boxes: Color code exposed and accessible raceways and all junction boxes of the systems listed below:
1. Apply two coats of paint to all junction box covers. Colors are as follows:


F. Caution Labels for Indoor Boxes and Enclosures for Power and Lighting: Install pressure-sensitive, self-adhesive labels identifying system voltage with black letters on orange background. Install on exterior of door or cover.

G. Circuit Identification Labels on Boxes: Install labels externally.

   1. Labeling Legend: Permanent, waterproof marker to identify panelboard name and circuit numbers that are within the box.

H. Apply Identification to Conductors as Follows:

   1. Multiple Power or Lighting Circuits in the Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color-coding to identify circuits’ voltage and phase.
   2. Multiple Control and Communication Circuits in the Same Enclosure: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color-coding, or cable marking tape.

I. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

A. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

   1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded feeder and branch-circuit conductors.

      a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG.
      b. Colors for 208/120-V Circuits:

         1) Phase A: Black.
         2) Phase B: Red.
         3) Phase C: Blue.
         4) Neutral: White with colored stripe to correspond to the associated phase conductor.
         5) Ground: Green.

      c. Colors for 480/277-V Circuits:

         1) Phase A: Brown.
         2) Phase B: Orange.
         3) Phase C: Yellow.
         4) Neutral: Grey with colored stripe to correspond to the associated phase conductor.
d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

B. Electrical and Communication Equipment Identification Labels: Engraved plastic laminate. Install on each unit of equipment. Refer to drawings for additional requirements.

C. Color Coding for Equipment Identification Labels: Engraved plastic laminated equipment identification labels. Refer to the drawings for color coding requirements.

D. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Baked-enamel warning signs.

2. Identify system voltage with white letters on a red background.
3. Apply to exterior of door, cover, or other access.

E. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

F. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch high letters for emergency instructions at equipment used for power transfer, load shedding.

G. Equipment Identification Labels: On each unit of equipment, install unique designation label as indicated on the drawings. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems.

1. Labeling Instructions:
   a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label.
   b. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
   c. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

2. Equipment to Be Labeled:
   a. Panelboards.
   b. Enclosures and electrical cabinets.
   c. Access doors and panels for concealed electrical items.
   d. Transformers.
   e. Enclosed switches.
   f. Enclosed circuit breakers.
   g. Enclosed controllers.
   h. Contactors.
i. Variable Frequency Drives.
j. Motor starters.
k. Switchboards.

3.3 CONSTRUCTION WASTE MANAGEMENT

A. Comply with the Waste Management Plan specified in Section 017419 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL for additional requirements.

END OF SECTION 260553
SECTION 260923
LIGHTING CONTROL DEVICES

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
   1. Toggle switches.
   2. Line voltage wall occupancy sensors with manual overrides.
   3. Digital local relay packs.
   4. Digital ceiling occupancy sensors.
   5. Digital wall switches.
   7. Commissioning remote control tool.
   8. Exterior photocell.

B. Related Requirements:
   1. Section 262726 "Wiring Devices" for snap switches.

1.3 SUBMITTALS
A. Product Data: For each type of product.
B. Shop Drawings: Show installation details for occupancy and light-level sensors.
   1. Interconnection diagrams showing field-installed wiring.
   2. Include diagrams for power, signal, and control wiring.
C. Field quality-control reports.
D. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation, and maintenance manuals.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: WattStopper

2.2 LINE VOLTAGE DEVICES

A. Toggle Switches

1. Comply with NEMA WD 1, UL 20, and FS W-S-896.
2. Quiet operating type switches, 120/277V, 20A.

B. Line Voltage, Wall Mounted, Occupancy Sensors

1. Wall switch sensors shall be capable of detection of occupancy at desktop level up to 300 square feet, and gross motion up to 1000 square feet.
2. Wall switch sensors shall accommodate loads from 0 to 800 watts at 120 volts; 0 to 1200 watts at 277 volts and shall have 180 degree coverage capability.
3. Wall switch sensors shall have no leakage current to load, in manual or in Auto/Off mode for safety purposes and shall have voltage drop protection.
4. Wall switch sensors shall provide a field selectable option to convert sensor operation from automatic-ON to manual-ON.
5. Dual technology sensors shall be wall mounted in such a way as to minimize coverage in unwanted areas.
6. Dual technology sensors shall consist of passive infrared and ultrasonic technologies for occupancy detection. Products that react to noise or ambient sound shall not be considered. Ultrasonic sensors shall utilize advanced signal processing to adjust the detection threshold dynamically to compensate for constantly changing levels of activity and air flow throughout controlled space.
7. Ultrasonic operating frequency shall be crystal controlled at 25 kHz within ± 0.005 percent tolerance, 32 kHz within ± 0.002 percent tolerance, or 40 kHz ± 0.002 percent tolerance to assure reliable performance and eliminate sensor cross-talk. Sensors using multiple frequencies are not acceptable.
8. All sensors shall be capable of operating normally with electronic ballasts and LED drivers.
9. Coverage of sensors shall remain constant after sensitivity control has been set. No automatic reduction shall occur in coverage due to the cycling of air conditioner or heating fans.
10. All sensors shall have readily accessible, user adjustable settings for time delay and sensitivity. Settings shall be located on the sensor (not the control unit) and shall be recessed to limit tampering.
11. In the event of failure, a bypass manual override shall be provided on each sensor. When bypass is utilized, lighting shall remain on constantly or control shall divert to a wall switch until sensor is replaced. This control shall be recessed to prevent tampering.
12. All sensors shall provide an LED as a visual means of indication at all times to verify that motion is being detected during both testing and normal operation.
13. Wall sensors shall be capable of 3-way operation as indicated on drawings.
14. All sensors shall have UL rated, 94V-0 plastic enclosures.
C. EXTERIOR PHOTOCELL
   1. Description: Solid state, with single-pole, double-throw dry contacts rated to operate connected relay or contactor coils or microprocessor input, and complying with UL 773A.
   2. Light-Level Monitoring Range: 0 to 3500 fc, with an adjustment for turn-on/turn-off levels.
   3. Time Delay: Prevents false operation.
   4. Weathertight housing, resistant to high temperatures and equipped with sun-glare shield.

2.3 DIGITAL LIGHTING CONTROL SYSTEM

A. The digital lighting and plug control system consists of local relay packs, occupancy sensors, interior daylight sensors, and wall switches. The local relay packs manage communication between digital system devices, control line voltage outputs to lighting and plug loads and provide low voltage power to all connected digital devices. The basis of design shall be Wattstopper Digital Lighting Management (DLM) system.

B. Digital Local Relay Pack

1. Relay packs shall be provided to match the room lighting and plug load and control requirements. The relay packs will not have, dip switches, potentiometers or require special configuration. The relay packs will include the following features:

   a. Automatic room configuration to the most energy-efficient sequence of operation based upon the devices in the room.
   b. Simple replacement - Using the default automatic configuration capabilities, a relay pack may be replaced with an off-the-shelf unit without requiring any configuration or setup.
   c. Device Status LEDs to indicate:

      1) Device has power.
      2) Status for setup mode.

   d. Plenum rated.
   e. Dual voltage (120/277 VAC, 60 Hz).
   f. 16A per lighting relay, 20A per plug load relay
   g. Zero cross circuitry for each load

C. Digital, Ceiling Mounted, Occupancy Sensors

1. Digital occupancy sensors shall have a white finish. Features include the following:

   a. Digital calibration and programming for the following variables:

      1) Sensitivity – occupancy and vacancy.
      2) Time delay – 30s, 2m, 5m, 10m, 15m, 30m).
      3) Test mode.
      4) Walk-through mode.

   b. Device Status LEDs including:
1) Ultrasonic detection.
2) PIR detection

c. Assignment of occupancy sensor to a specific load within the room without wiring or special tools.
d. Units shall not have any dip switches or potentiometers for field settings.
e. Manual override of controlled loads for wall units.

D. Interior Daylight Sensors

Daylight sensors shall work with relay pack or panel to provide automatic dimming daylight harvesting capabilities for any load type connected to the relay pack or panel. Sensors shall be interchangeable without the need for rewiring and shall include the following features:

1. The sensor’s internal photodiode shall only measure light waves within the visible spectrum.
2. Sensor light level range shall be from 1-6,000 foot candles (fc).
3. The capability of ON/OFF or dimming, for each controlled zone.
4. For dimming daylight harvesting, the photo sensor shall provide the option, when the daylight contribution is sufficient, of turning lights off or dimming lights to a field-selectable minimum level.
5. Photo sensors shall have a digital, independently configurable fade rate for both increasing and decreasing light level in units of percent per second.
6. Photo sensors shall provide adjustable cut-off time. Cut-off time is defined by the number of selected minutes the load is at the minimum output before the load turns off. Selectable range between 0-240 minutes including option to never cut-off.
7. Optional wall switch override shall allow occupants to reduce lighting level to increase energy savings or, if permitted by system administrator, raise lighting levels for a selectable period of time or cycle of occupancy.
8. Integral infrared (IR) transceiver for configuration and/or commissioning with a handheld configuration tool, to transmit detected light level to wireless configuration tool, and for communication with personal remote controls.
9. Configuration LED status light on device that blinks to indicate data transmission.
10. A choice of accessories to accommodate multiple mounting methods and building materials. The photo sensors may be mounted on a ceiling tile, skylight light well, suspended lighting fixture or back box.
11. Any load or group of loads in the room can be assigned to a daylighting zone.

E. Digital Wall Switches

1. Low voltage momentary pushbutton dimming switch. Wall switches shall include the following features:

   a. Two-way infrared (IR) transceiver for use with personal and configuration remote controls.
   b. Removable buttons for field replacement. Button replacement may be completed without removing the switch from the wall.
   c. Red configuration LED on each switch that blinks to indicate data transmission.
   d. LED bar graph to indicate light level of controlled load.
2. Two RJ-45 ports for connection to digital lighting network.
3. Multiple digital wall switches may be installed in a room by simply connecting them to the free topology digital lighting network. No additional configuration will be required to achieve multi-way switching.
4. The following switch attributes may be changed or selected using a wireless configuration tool:
   1) Individual button function may be configured to Toggle On/Off or dim.
   2) Switch buttons may be bound to any load on a room controller and are not load type dependent; each button may be bound to multiple loads.
5. Finish: Same as wiring devices, refer to section 26 27 26 “Wiring Devices” for requirements.

F. Configuration Remote Control Tool

1. Provide a minimum of two configuration tools to facilitate optional customization of digital lighting local networks. Wireless configuration tool feature infrared communications. Features and functionality of the wireless configuration tool shall include:
   a. Two-way infrared (IR) communication with IR-enabled devices within a range of approximately 30 feet.
   b. High visibility display, pushbutton user interface and menu-driven operation.
   c. Read, modify and send parameters for occupancy sensors, room controllers and buttons on digital wall switches.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Electrical installations shall conform to IEEE C2, NFPA 70, and to the requirements specified herein.

1. When using wire for connections other than the digital lighting network (Cat 6 with RJ-45 connectors), provide detailed point to point wiring diagrams for every termination. Provide wire specifications and wire colors to simplify contactor termination requirements.
2. Install the work of this Section in accordance with manufacturer's printed instructions unless otherwise indicated.
3. Provide quantity of sensor units indicated as a minimum. Provide additional units to give full coverage over controlled area. Full coverage shall provide hand and arm motion detection for office and administration type areas and walking motion for industrial areas, warehouses, storage rooms and hallways. Locate the sensor(s) as indicated and in accordance with the manufacturer's recommendations to maximize energy savings and to avoid nuisance activation and deactivation due to sudden temperature or airflow changes and usage.
4. Adjust sensor for the indicated light level at the typical work plane for that area.
5. Calibrate all sensor time delays and sensitivity to guarantee proper detection of occupants and energy savings.

6. Provide written or computer-generated documentation on the commissioning of the system including room by room description including:
   a. Sensor parameters, time delays, sensitivities, and daylighting setpoints.
   b. Sequence of operation, (e.g. manual ON, Auto OFF, etc.)
   c. Load Parameters (e.g. blink warning, etc.)


   a. Upon completion of the installation, the system shall be commissioned by the manufacturer's factory authorized representative who will verify a complete fully functional system.
   b. The electrical contractor shall provide both the manufacturer and the electrical engineer with ten working days written notice of the system startup and adjustment date.
   c. Upon completion of the system commissioning the factory-authorized technician shall provide the proper training to the owner's personnel on the adjustment and maintenance of the system.

3.2 FIELD QUALITY CONTROL

A. Upon completion of installation, verify that equipment is properly installed, connected, and adjusted. Conduct an operating test to show that equipment operates in accordance with requirements of this section.

1. Test digital and line voltage occupancy sensors for proper operation. Observe for light control over entire area being covered.

3.3 WIRING INSTALLATION

A. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

B. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

C. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."
1. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

3.5 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.

END OF SECTION 260923
SECTION 26 27 26
WIRING DEVICES

PART 1 - GENERAL

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

1.2 SUMMARY
   A. This Section includes the following:
      1. Receptacles, receptacles with integral GFCI, and associated device plates.
      2. Twist-locking receptacles.
      3. Snap switches and wall-box dimmers.

1.3 DEFINITIONS
   A. EMI: Electromagnetic interference.
   B. GFCI: Ground-fault circuit interrupter.
   C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
   D. RFI: Radio-frequency interference.
   E. TVSS: Transient voltage surge suppressor.
   F. UTP: Unshielded twisted pair.

1.4 SUBMITTALS
   A. Product Data: For each type of product indicated.
   B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

1.5 QUALITY ASSURANCE
   A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.
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. Comply with NFPA 70.

1.6 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles, heavy duty grade, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

   a. Cooper; 5351 (single), 5352 (duplex).
   b. Hubbell; HBL5351 (single), CR5352 (duplex).
   c. Leviton; 5891 (single), 5352 (duplex).
   d. Pass & Seymour; 5381 (single), 5352 (duplex).

2.3 GFCI RECEPTACLES

A. General Description: Straight blade, non-feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
2.4 SNAP SWITCHES
A. Comply with NEMA WD 1 and UL 20.
B. Switches, 120/277 V, 20 A:
   1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
      a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
      b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
      c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
      d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).

2.5 WALL PLATES
A. Single and combination types to match corresponding wiring devices.
   1. Plate-Securing Screws: Metal with head color to match plate finish.
   4. Material for Damp Locations: Cast aluminum with “In Use” spring-loaded lift cover, and listed and labeled for use in "wet locations."

2.6 FINISHES
A. Color: Wiring device catalog numbers in Section Text do not designate device color.
   1. Wiring Devices: Grey, unless otherwise indicated or required by NFPA 70 or device listing.

PART 3 - EXECUTION

3.1 INSTALLATION
A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.
B. All receptacles shall be heavy duty grade.
C. Coordination with Other Trades:
1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.

2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.

3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.

4. Install wiring devices after all wall preparation, including painting, is complete.

D. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.

2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.

3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.

4. Existing Conductors:
   a. Cut back and pigtail, or replace all damaged conductors.
   b. Straighten conductors that remain and remove corrosion and foreign matter.
   c. Pigtailing existing conductors is permitted provided the outlet box is large enough.

E. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.

2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.

3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.

4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.

5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.

6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.

7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtaills for device connections.

8. Tighten unused terminal screws on the device.

9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

F. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.

G. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
3.2 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."

1. Receptacles and Switch Plates: Identify panelboard and circuit number from which served. Use engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes. Provide engraved laminated plastic label for exterior devices with weather proof cover.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.
2. Test Instruments: Use instruments that comply with UL 1436.
3. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

3.4 CONSTRUCTION WASTE MANAGEMENT

A. Comply with the Waste Management Plan specified in Section 01 74 19 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL for additional requirements.

END OF SECTION 26 27 26
SECTION 262816
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
1. Molded-case circuit breakers (MCCBs).

1.3 DEFINITIONS
A. NC: Normally closed.
B. NO: Normally open.
C. SPDT: Single pole, double throw.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Include evidence of a nationally recognized testing laboratory (NRTL) listing for series rating of installed devices.
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

1.5 WARRANTY
A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.
1. Warranty Period: [One] <Insert number> year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

C. Comply with NFPA 70.

2.2 MOLDED-CASE CIRCUIT BREAKERS

A. Circuit breakers shall be constructed using glass-reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.

B. Circuit breakers shall have a toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. The circuit-breaker handle shall be over center, be trip free, and reside in a tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit-breaker tripping mechanism for maintenance and testing purposes.

C. The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker. Circuit breakers shall be series rated. Circuit breaker/circuit breaker combinations for series connected interrupting ratings shall be listed by UL as recognized component combinations. Any series rated combination used shall be marked on the end-use equipment along with the statement "Caution - Series Rated System. _____ Amps Available. Identical Replacement Component Required."

D. MCCBs shall be equipped with a device for locking in the isolated position.

E. Lugs shall be suitable for 140 deg F rated wire on 125-A circuit breakers and below.

F. Standard: Comply with UL 489 with interrupting capacity to comply with available fault currents.


H. Ground-Fault Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
I. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

3.2 PREPARATION

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

1. Notify Owner no fewer than seven days in advance of proposed interruption of electric service.
2. Indicate method of providing temporary electric service.
3. Do not proceed with interruption of electric service without Owner's written permission.
4. Comply with NFPA 70E.

3.3 INSTALLATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

C. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

D. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

E. Install fuses in fusible devices.

F. Comply with NFPA 70 and NECA 1.
3.4 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections.

E. Tests and Inspections for Molded Case Circuit Breakers:
   1. Visual and Mechanical Inspection:
      a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.
      b. Inspect physical and mechanical condition.
      c. Inspect anchorage, alignment, grounding, and clearances.
      d. Verify that the unit is clean.
      e. Operate the circuit breaker to ensure smooth operation.
      f. Inspect bolted electrical connections for high resistance using one of the two following methods:
         1) Use a low-resistance ohmmeter.
            a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
         2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
            a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
            g. Inspect operating mechanism, contacts, and chutes in unsealed units.
            h. Perform adjustments for final protective device settings in accordance with the coordination study.
   2. Electrical Tests:
a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.

c. Perform a contact/pole resistance test. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

d. Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values shall be no less than two megohms.

e. Determine the following by primary current injection:

1) Long-time pickup and delay. Pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.

2) Short-time pickup and delay. Short-time pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.

3) Ground-fault pickup and time delay. Ground-fault pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.

4) Instantaneous pickup. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances.

f. Test functionality of the trip unit by means of primary current injection. Pickup values and trip characteristics shall be as specified and within manufacturer's published tolerances.

g. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall be as indicated by manufacturer.

h. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset all trip logs and indicators. Investigate units that do not function as designed.

i. Verify operation of charging mechanism. Investigate units that do not function as designed.

3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

4. Perform the following infrared scan tests and inspections and prepare reports:
a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.

b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.

c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

F. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

1. Test procedures used.
2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
3. List deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 262816
SECTION 262923

VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes solid state separately enclosed, pre-assembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

1.3 DEFINITIONS

A. BAS: Building automation system.
B. IGBT: Insulated-gate bipolar transistor.
C. LAN: Local area network.
D. PID: Control action, proportional plus integral plus derivative.
E. PWM: Pulse-width modulated.
F. VFC: Variable-frequency motor controller.

1.4 SUBMITTALS

A. Product Data: For each type and rating of VFC indicated. Include features, performance, electrical ratings, operating characteristics, shipping and operating weights, and furnished specialties and accessories.

B. Shop Drawings: For each VFC indicated. Include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.

1. Show tabulations of installed devices, equipment features, and ratings. Include the following:
   
a. Each installed unit's type and details.
b. Factory-installed devices.
c. Enclosure types and details.
d. Nameplate legends.
e. Short-circuit current (withstand) rating of enclosed unit.
f. Features, characteristics, ratings, and factory settings of each VFC and installed devices.
g. Specified modifications.

2. Schematic and Connection Wiring Diagrams: For power, signal, and control wiring.

C. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around VFCs. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

D. Operation and Maintenance Data: For VFCs 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. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and MCP trip settings.
2. Manufacturer's written instructions for setting field-adjustable overload relays.
3. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
4. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.

E. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

F. Harmonic Analysis Study showing compliance with IEEE-519.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. 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.

C. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not store in space that is not permanently enclosed and air conditioned.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than 14 deg F and not exceeding 104 deg F.
2. Humidity: Less than 95 percent (noncondensing).
1.8   COORDINATION

A. Coordinate layout and installation of VFC’s with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate features, accessories, and functions of each VFC and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.9   WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within specified warranty period.

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

PART 2 - PRODUCTS

2.1   MANUFACTURED UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB.
2. Danfoss Inc.; Danfoss Drives Div.
3. Square D; a brand of Schneider Electric.
4. Yaskawa Electric America, Inc; Drives Division.

B. General Requirements for VFCs: Comply with NEMA ICS 7.1, NEMA ICS 61800-2, and UL 508C.

C. Application: Constant torque.

D. Variable Frequency Controllers: Description: NEMA ICS 2, IGBT, PWM, VFC; listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, 3 phase induction motor. The variable frequency drive assembly, including the bypass assembly shall have a UL listed short circuit rating of 65,000A in accordance with UL508C and NEMA ICS 7.1.

E. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

F. Output Rating: Three-phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.

G. Unit Operating Requirements:

1. Input AC voltage tolerance of 208 V, plus or minus 5 percent.
2. Input frequency tolerance of 60 Hz, full load.
3. Minimum Efficiency: 96 percent at 60 Hz, full load.
5. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
6. Starting Torque: 100 percent of rated torque or as indicated.
7. Speed Regulation: Plus or minus 1 percent.

H. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.
1. Electrical Signal: 4 to 20 mA at 24 V.
2. Pneumatic Signal: 3 to 15 psig (20 to 104 kPa).

I. Internal Adjustability Capabilities:
1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Acceleration: 2 to a minimum of 22 seconds.
4. Deceleration: 2 to a minimum of 22 seconds.
5. Current Limit: 50 to minimum of 110 percent of maximum rating.

J. Self-Protection and Reliability Features:
1. Input transient protection by means of surge suppressors to provide three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
4. Inverter overcurrent trips.
5. VFC and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved.
6. Critical frequency rejection, with three selectable, adjustable deadbands.
7. Instantaneous line-to-line and line-to-ground overcurrent trips.
10. Short-circuit protection.
11. Motor overtemperature fault.
12. Control interlock with disconnect switches on the output side of variable frequency motor controller. The “early break” auxiliary contact in the disconnect switch shall trigger a “freewheel” stop of the associated variable frequency controller before the disconnect contacts are opened. This shall allow the VFD to start the proper shutdown sequence, thus preventing damage to the internal electronic components and to the disconnect switch.

K. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.
L. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.

M. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

N. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

O. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

P. Line Reactor and Harmonic Filtering

1. The VFD shall be of the Clean Power type. The VFD input rectifier section shall include an input ac line reactor for added harmonic filtering. The input rectifier section components including the input ac line reactor shall be factory mounted and wired within the confines of the VFD enclosure.
2. In accordance with IEEE-519, individual or simultaneous operation of VFD’s shall not add more than 3% total harmonic voltage distortion while operating at full load and speed from the utility source or more than 5% while operating from a standby generator source.
3. In accordance with IEEE-519, the maximum allowable total harmonic current demand distortion limits for each VFD operating at full load and speed shall not exceed 5% as calculated and measured at the point of common coupling.

Q. Status Lights: Door-mounted LED indicators shall indicate the following conditions:

1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.


S. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:

1. Output frequency (Hz).

2.2 CONTROLS AND INDICATION

A. Status Lights: Door-mounted LED indicators displaying the following conditions:
1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.

B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.

1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.
   a. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.

C. Historical Logging Information and Displays:

1. Real-time clock with current time and date.
2. Running log of total power versus time.
3. Total run time.
4. Fault log, maintaining last four faults with time and date stamp for each.

D. Indicating Devices: Digital display and additional readout devices as required, mounted flush in VFC door and connected to display VFC parameters including, but not limited to:

1. Output frequency (Hz).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (V dc).
9. Set point frequency (Hz).
10. Motor output voltage (V ac).

E. Control Signal Interfaces:

1. Electric Input Signal Interface:
   a. A minimum of two programmable analog inputs: 0- to 10-V dc.
   b. A minimum of six multifunction programmable digital inputs.

2. Pneumatic Input Signal Interface: 3 to 15 psig.
3. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BAS or other control systems:
   
   a. 0- to 10-V dc.
   b. 4- to 20-mA dc.
   c. Potentiometer using up/down digital inputs.
   d. Fixed frequencies using digital inputs.

4. Output Signal Interface: A minimum of one programmable analog output signal(s) (4- to 20-mA dc, which can be configured for any of the following:

   a. Output frequency (Hz).
   b. Output current (load).
   c. DC-link voltage (V dc).
   d. Motor torque (percent).
   e. Motor speed (rpm).
   f. Set point frequency (Hz).

5. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:

   a. Motor running.
   b. Set point speed reached.
   c. Fault and warning indication (overtemperature or overcurrent).
   d. PID high- or low-speed limits reached.

F. PID Control Interface: Provides closed-loop set point, differential feedback control in response to dual feedback signals. Allows for closed-loop control of fans and pumps for pressure, flow, or temperature regulation.

1. Number of Loops: Two.

2.3 LINE CONDITIONING AND FILTERING

A. Input Line Conditioning: Based on the harmonic analysis study and report, provide input filtering, as required, to limit TDD and THD(V) at the defined PCC per IEEE 519.

B. EMI/RFI Filtering: CE marked; certify compliance with IEC 61800-3 for Category C2.

C. Any required input line conditioning shall be integral the variable frequency motor controller enclosure. If a separate enclosure is required for the filtering devices, then the variable frequency motor controller manufacturer shall be responsible for any interconnecting conduits, wiring and mounting of such enclosures.

2.4 BYPASS SYSTEMS

A. Scope: Bypass system is for heating hot water pumps only. Bypass system does not apply to air handling unit fans.
B. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.

C. Bypass Mode: Manual operation only; requires local operator selection at VFC. Transfer between power converter and bypass contactor and retransfer shall only be allowed with the motor at zero speed.

D. Bypass Controller: Two-contactor-style bypass allows motor operation via the power converter or the bypass controller; with input isolating switch arranged to isolate the power converter and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode.

2. Output Isolating Contactor: Non-load-break, NEMA-rated contactor.
3. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

E. Bypass Contactor Configuration:
1. Reduced voltage autotransformer type controllers shall be provided for motors 15 HP and larger.
2. Full voltage across the line type controller shall be provided for motors under 15HP.
3. NORMAL/BYPASS selector switch.
4. HAND/OFF/AUTO selector switch.
5. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFC while the motor is running in the bypass mode.
   a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
   b. Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.

7. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices.
   a. CPT Spare Capacity: 50 VA.

   a. Solid-State Overload Relays:
      1) Switch or dial selectable for motor-running overload protection.
      2) Sensors in each phase.
      3) Class 10/20 selectable tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
4) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
5) Analog communication module.

b. NC isolated overload alarm contact.
c. External overload reset push button.

2.5 ENCLOSURES

A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.
   1. Dry and Clean Indoor Locations: Type 1.
   2. Outdoor Locations: Type 3R.
   3. Other Wet or Damp Indoor Locations: Type 4.
   4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.

B. Plenum Rating: UL 1995; NRTL certification label on enclosure, clearly identifying VFC as "Plenum Rated."

2.6 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.


C. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

D. Control Relays: Auxiliary and adjustable time-delay relays.

E. Standard Displays:
   1. Output frequency (Hz).
   2. Set-point frequency (Hz).
   4. DC-link voltage (VDC).
   5. Motor torque (percent).
   7. Motor output voltage (V).

F. Historical Logging Information and Displays:
   1. Real-time clock with current time and date.
   2. Running log of total power versus time.
   3. Total run time.
   4. Fault log, maintaining last four faults with time and date stamp for each.

G. Current-Sensing, Phase-Failure Relays for Bypass Controller: Solid-state sensing circuit with isolated output contacts for hard-wired connection; arranged to operate on phase failure, phase
reversal, current unbalance of from 30 to 40 percent, or loss of supply voltage; with adjustable response delay.

2.7 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested VFCs before shipping.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordinate layout and installation of VFCs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Wall-Mounting Controllers: Install VFCs on walls with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

3.2 IDENTIFICATION

A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

1. Label each VFC with engraved nameplate.

3.3 CONTROL WIRING INSTALLATION

A. Bundle, train, and support wiring in enclosures.

B. Connect selector switches and other automatic control devices where applicable.

1. Connect selector switches to bypass only those manual- and automatic control devices that have no safety functions when switches are in manual-control position.

2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.4 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Inspect VFC, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.

2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.

3. Test continuity of each circuit.
4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Architect before starting the motor(s).
5. Test each motor for proper phase rotation.
7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
8. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:
   a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each VFC. Remove front panels so joints and connections are accessible to portable scanner.
   b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each VFC 11 months after date of Substantial Completion.
   c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

B. VFCs will be considered defective if they do not pass tests and inspections.
C. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.5 STARTUP SERVICE
A. Perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

3.6 ADJUSTING
A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.
B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium
Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Architect before increasing settings.

D. Set the taps on reduced-voltage autotransformer controllers.

E. Set field-adjustable circuit-breaker trip ranges.

F. Set field-adjustable pressure switches.

3.7 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.

B. Replace VFCs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.

3.9 CONSTRUCTION WASTE MANAGEMENT

A. Comply with the Waste Management Plan specified in Section 017419 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL for additional requirements.

END OF SECTION 262923
SECTION 265119
LED INTERIOR LIGHTING

PART 1 - PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
   1. Interior solid-state luminaires that use LED technology.
   2. Lighting fixture supports.

B. Related Requirements:
   1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.3 DEFINITIONS
A. CCT: Correlated color temperature.
B. CRI: Color Rendering Index.
C. Fixture: See "Luminaire."
D. IP: International Protection or Ingress Protection Rating.
E. LED: Light-emitting diode.
F. Lumen: Measured output of lamp and luminaire, or both.
G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 SUBMITTALS
A. Product Data: For each type of product.
   1. Arrange in order of luminaire designation.
   2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaires.
4. Include emergency lighting units, including batteries and chargers.
5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.

   a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
   b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

B. Shop Drawings: For nonstandard luminaires.

   1. Include plans, elevations, sections, and mounting and attachment details.
   2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include diagrams for power, signal, and control wiring.

C. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

   1. Lighting luminaires.
   2. Suspended ceiling components.
   3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches of the plane of the luminaires.
   4. Structural members to which luminaires will be attached.
   5. Items penetrating finished ceiling, including the following:

      a. Other luminaires.
      b. Air outlets and inlets.
      c. Sprinklers.
      d. Access panels.

D. Qualification Data: For testing laboratory providing photometric data for luminaires.

E. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

F. Product Certificates: For each type of luminaire.

G. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.

H. Sample warranty.

I. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
J. Calculations: Submit point-to-point lighting calculations for interior spaces. Interior calculations shall be at a 30 inch work plane.

1.5 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

B. Provide luminaires from a single manufacturer for each luminaire type.

C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.7 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

B. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LUMINAIRE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.

C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

D. Recessed Fixtures: Comply with NEMA LE 4.

E. Rated lamp life of 50,000 hours.

F. Dimmable from 100 percent to 0 percent of maximum light output.

G. Internal driver.

H. Nominal Operating Voltage: As indicated.
2.2 MATERIALS

A. Metal Parts:
   1. Free of burrs and sharp corners and edges.
   2. Sheet metal components shall be steel unless otherwise indicated.
   3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
   1. Label shall include the following lamp characteristics:
      a. "USE ONLY" and include specific lamp type.
      b. Lamp diameter, shape, size, wattage, and coating.
      c. CCT and CRI for all luminaires.

2.3 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.4 LUMINAIRE FIXTURE SUPPORT COMPONENTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.


D. Rod Hangers: 1/4-inch minimum diameter, cadmium-plated, threaded steel rod.

E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before fixture installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Install lamps in each luminaire.

D. Supports:
   1. Sized and rated for luminaire weight.
   2. Able to maintain luminaire position after cleaning and relamping.
   3. Provide support for luminaire without causing deflection of ceiling or wall.
   4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.

E. Flush-Mounted Luminaire Support:
   1. Secured to outlet box.
   2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
   3. Trim ring flush with finished surface.

F. Wall-Mounted Luminaire Support:
   1. Attached to structural members in walls.
   2. Do not attach luminaires directly to gypsum board.

G. Suspended Luminaire Support:
   1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
   3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of luminaire chassis, including one at each end.
   4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.
H. Ceiling-Grid-Mounted Luminaires:
   1. Secure to any required outlet box.
   2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
   3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

I. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.3 IDENTIFICATION
   A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL
   A. Perform the following tests and inspections:
      1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
      2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
   B. Luminaire will be considered defective if it does not pass operation tests and inspections.
   C. Prepare test and inspection reports.

3.5 STARTUP SERVICE
   A. Comply with requirements for startup specified in Section 260943.16 "Addressable-Fixture Lighting Controls."
   B. Comply with requirements for startup specified in Section 260943.23 "Relay-Based Lighting Controls."

3.6 ADJUSTING
   A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
      1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
      2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
      3. Adjust the aim of luminaires in the presence of the Architect.
3.7 CONSTRUCTION WASTE MANAGEMENT

A. Comply with the Waste Management Plan specified in Section 017419 Construction Waste Management and Disposal, for additional requirements.

END OF SECTION 265119
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Exterior solid-state luminaires that are designed for and exclusively use LED lamp technology.
   2. Luminaire supports.
   3. Luminaire-mounted photoelectric relays.

B. Related Requirements:
   1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color rendering index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of luminaire.
   1. Arrange in order of luminaire designation.
   2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaire.
4. Lamps, include life, output (lumens, CCT, and CRI), and energy-efficiency data.
5. Photometric data and adjustment factors based on laboratory tests, complying with IES LM-79 and IES LM-80.

   a. Manufacturer's Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.
   b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

6. Wiring diagrams for power, control, and signal wiring.
7. Photoelectric relays.
8. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.

B. Shop Drawings: For nonstandard luminaires.

   1. Include plans, elevations, sections, and mounting and attachment details.
   2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

   1. Luminaires.
   2. Structural members to which luminaires will be attached.
   3. Building features.
   4. Vertical and horizontal information.

B. Qualification Data: For testing laboratory providing photometric data for luminaires.

C. Product Certificates: For each type of the following:

   1. Luminaire.
   2. Photoelectric relay.

D. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.

E. Source quality-control reports.

F. Sample warranty.
1.6 CLOSEOUT SUBMITTALS
   A. Operation and Maintenance Data: For luminaires and photoelectric relays to include in
      operation and maintenance manuals.

1.7 QUALITY ASSURANCE
   A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturers' 
      laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
   B. Provide luminaires from a single manufacturer for each luminaire type.
   C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color 
      consistency among luminaires.
   D. Installer Qualifications: An authorized representative who is trained and approved by 
      manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING
   A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering 
      prior to shipping.

1.9 FIELD CONDITIONS
   A. Verify existing and proposed utility structures prior to the start of work associated with 
      luminaire installation.
   B. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire 
      installation.

1.10 WARRANTY
   A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that 
      fail in materials or workmanship within specified warranty period.
      1. Failures include, but are not limited to, the following:
         a. Structural failures, including luminaire support components.
         b. Faulty operation of luminaires and accessories.
         c. Deterioration of metals, metal finishes, and other materials beyond normal 
            weathering.
      2. Warranty Period: 2 year(s) from date of Substantial Completion.
PART 2 - PRODUCTS

2.1 LUMINAIRE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.

C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

D. UL Compliance: Comply with UL 1598 and listed for wet location.

E. L70 lamp life of 50,000 hours.

F. Lamps dimmable from 100 percent to 0 percent of maximum light output.

G. Internal driver.

H. Nominal Operating Voltage: As indicated.

I. Source Limitations: Obtain luminaires from single source from a single manufacturer.

J. Source Limitations: For luminaires, obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.

2.2 MATERIALS

A. Metal Parts: Free of burrs and sharp corners and edges.

B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses.

C. Diffusers and Globes:

1. Acrylic Diffusers: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

2. Glass: Annealed crystal glass unless otherwise indicated.

3. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

D. Lens and Refractor Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

E. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.

F. Housings:
1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.
2. Provide filter/breather for enclosed luminaires.

G. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
1. Label shall include the following lamp characteristics:
   a. "USE ONLY" and include specific lamp type.
   b. Lamp diameter, shape, size, wattage and coating.
   c. CCT and CRI for all luminaires.

2.3 FINISHES

A. Variations in Finishes: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

B. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

C. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.
3. Class I, Clear-Anodic Finish: AA-M32C22A41 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
4. Class I, Color-Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker), complying with AAMA 611.

D. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.

2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

2.4 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.

C. Examine walls for suitable conditions where luminaires will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Comply with NECA 1.

B. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Install lamps in each luminaire.

D. Fasten luminaire to structural support.

E. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Support luminaires without causing deflection of finished surface.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

F. Wall-Mounted Luminaire Support:
1. Attached to structural members in walls, provide additional backing and framing as required.


H. Install luminaires level, plumb, and square with finished floor unless otherwise indicated. Coordinate layout and installation of luminaires with other construction.

I. Adjust luminaires that require field adjustment or aiming.

J. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and 260533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

3.3 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch-thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

B. Perform the following tests and inspections:

   1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
   2. Verify operation of photoelectric controls.

C. Luminaire will be considered defective if it does not pass tests and inspections.

D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied
conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
3. Adjust the aim of luminaires in the presence of the Architect.

3.7 CONSTRUCTION WASTE MANAGEMENT

A. Comply with the Waste Management Plan specified in Section 017419 Construction Waste Management and Disposal, for additional requirements.

END OF SECTION 265619
SECTION 270526
GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
   1. Grounding conductors.
   2. Grounding connectors.
   3. Grounding busbars.
   4. Grounding labeling.

1.3 DEFINITIONS
A. BCT: Bonding conductor for telecommunications.
B. EMT: Electrical metallic tubing.
C. TGB: Telecommunications grounding busbar.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of product.
B. Shop Drawings: For communications equipment room signal reference grid. Include plans, elevations, sections, details, and attachments to other work.

1.5 INFORMATIONAL SUBMITTALS
A. As-Built Data: Plans showing as-built locations of grounding and bonding infrastructure, including the following:
   1. TGB, and routing of associated bonding conductors.
B. Qualification Data: For Installer, installation supervisor, and field inspector.
C. Field quality-control reports.
1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
   a. Result of the ground-resistance test, measured at the point of BCT connection.

PART 2 - PRODUCTS

2.1 SYSTEM COMPONENTS

A. Comply with J-STD-607-A.

B. Comply with UL 486A-486B.

C. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.

1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.

2.2 CONNECTORS

A. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.

B. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.

   1. Electroplated tinned copper, C and H shaped.

C. Busbar Connectors: Cast silicon bronze, solderless compression-type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch centers for a two-bolt connection to the busbar.

2.3 GROUNDING BUSBARS

A. TGB: Predrilled rectangular bars of hard-drawn solid copper, 1/4 by 2 inches in cross section, length as indicated on Drawings. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467, and shall comply with TIA-607-B.

   1. Predrilling shall be with holes for use with lugs specified in this Section.
   2. Mounting Hardware: Stand-off brackets that provide at least a 2-inch (50-mm) clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

2.4 LABELING

A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the ac grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of the electrical system.

B. Inspect the test results of the ac grounding system measured at the point of BCT connection.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with connection of the BCT only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with NECA 1.

B. Comply with J-STD-607-A.

3.3 APPLICATION

A. Conductors: Install stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Conductor Support:

1. Secure grounding and bonding conductors at intervals of not less than 36 inches.

C. Grounding and Bonding Conductors:

1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.

2. Install without splices.
3. Support at not more than 36-inch intervals.

3.4 GROUNDING BUSBARS

A. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers 2 inches minimum from wall, 18 inches above finished floor unless otherwise indicated.

3.5 CONNECTIONS

A. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6 AWG.

B. Interconnections: Interconnect TGB to the existing TMGB with the telecommunications backbone conductor.

C. Stacking of conductors under a single bolt is not permitted when connecting to busbars.

D. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:
   1. Use crimping tool and the die specific to the connector.
   2. Pretwist the conductor.
   3. Apply an antioxidant compound to all bolted and compression connections.

E. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system.

F. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.

G. Equipment Room Signal Reference Grid: Provide a low-impedance path between telecommunications cabinets, equipment racks, and the reference grid, using No. 6 AWG bonding conductors.
   1. Bond all conduits and piping entering the equipment room to the TMGB.

3.6 IDENTIFICATION

A. Labels shall be preprinted or computer-printed type.
   1. Label the backbone conductor at its attachment point: "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.
B. Tests and Inspections:

1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

2. Test the bonding connections of the system using an ac earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing a TMGB and using the process recommended by BICSI TDMM. Conduct tests with the facility in operation.
   
   a. Measure the resistance between the busbar and the nearest available grounding electrode. The maximum acceptable value of this bonding resistance is 100 milliohms.

3. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent.
   
   a. With the grounding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the TMGB. Maximum acceptable ac current level is 1 A.

C. Excessive Ground Resistance: If resistance to ground at the BCT exceeds 5 ohms, notify Architect promptly and include recommendations to reduce ground resistance.

D. Grounding system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.8 CONSTRUCTION WASTE MANAGEMENT

A. Comply with the Waste Management Plan specified in Section 017419 Construction Waste Management and Disposal, for additional requirements.
SECTION 270528
PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
   1. Metal conduits and fittings.
   2. Boxes, enclosures, and cabinets.

1.3 DEFINITIONS
A. GRC: Galvanized rigid conduit.
B. IMC: Intermediate metal conduit.
C. RTRC: Reinforced thermosetting resin conduit.

1.4 ACTION SUBMITTALS
A. Product data for the following:
   1. Boxes, enclosures, and cabinets.
B. Shop Drawings: For custom enclosures, cabinets and boxes. Include plans, elevations, sections, and attachment details.

1.5 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Pathway routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
   1. Structural members in paths of pathway groups with common supports.
   2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
2.1 METAL CONDUITS AND FITTINGS

A. Description: Metal raceway of circular cross section with manufacturer-fabricated fittings.

B. General Requirements for Metal Conduits and Fittings:
   1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
   2. Comply with TIA-569-C.

C. GRC: Comply with ANSI C80.1 and UL 6.

D. IMC: Comply with ANSI C80.6 and UL 1242.

E. EMT: Comply with ANSI C80.3 and UL 797.

F. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
   1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
   2. Fittings for EMT:
      a. Material: Steel.
      b. Type: Compression.
   3. Expansion Fittings: Steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.

G. Joint Compound for IMC and GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 BOXES, ENCLOSURES, AND CABINETS

A. Description: Enclosures for communications.

B. General Requirements for Boxes, Enclosures, and Cabinets:
   1. Comply with TIA-569-C.
   2. Boxes, enclosures, and cabinets installed in wet locations shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for use in wet locations.
   3. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
   4. Device Box Dimensions: 4 11/16 inches square by 2-1/8 inches deep unless noted otherwise.
   5. Gangable boxes are prohibited.
C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, aluminum, Type FD, with gasketed cover.

E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

F. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1, with continuous-hinge cover with flush latch unless otherwise indicated.
   1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
   2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

PART 3 - EXECUTION

3.1 PATHWAY APPLICATION

A. Outdoors: Apply pathway products as specified below unless otherwise indicated:
   1. Exposed Conduit: GRC.
   2. Concealed Conduit, Aboveground: GRC.
   3. Underground and Below Slab-on Grade Conduit: RNC, Type EPC-40-PVC for direct buried applications.
   4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply pathway products as specified below unless otherwise indicated:
   1. Exposed, Not Subject to Physical Damage: EMT.
   2. Exposed, Not Subject to Severe Physical Damage: EMT.
   3. Exposed and Subject to Severe Physical Damage: GRC.
   4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
   5. Damp or Wet Locations: GRC.

C. Pathway Fittings: Compatible with pathways and suitable for use and location.
   1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
   2. EMT: Use compression, steel fittings. Comply with NEMA FB 2.10.

3.2 INSTALLATION

A. Comply with the following standards for installation requirements except where requirements on Drawings or in this Section are stricter:
   1. NECA 1.
   2. NECA/BICSI 568.
   3. TIA-569-C.
4. NECA 101
5. NECA 102.
6. NECA 105.
7. NECA 111.

B. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.

C. Comply with requirements in Section 270529 "Hangers and Supports for Electrical Systems" for hangers and supports.

D. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.

E. Complete pathway installation before starting conductor installation.

F. Arrange stub-ups so curved portions of bends are not visible above finished slab.

G. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.

H. Conceal rigid conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

I. Support conduit within 12 inches of enclosures to which attached.

J. Pathways Embedded in Slabs: Do not embed raceways in slabs.

K. Stub-ups to Above Recessed Ceilings:
   1. Use EMT for pathways.
   2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

L. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.

M. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.

N. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus one additional quarter-turn.

O. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure, to assure a continuous ground path.

P. Cut conduit perpendicular to the length. For conduits of 2-inch trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.
Q. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Secure pull wire, so it cannot fall into conduit. Cap pathways designated as spare alongside pathways in use.

R. Install pathway-sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway-sealing fittings according to NFPA 70.

S. Install devices to seal pathway interiors at accessible locations. Locate seals, so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service pathway enters a building or structure.
3. Where otherwise required by NFPA 70.

T. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.

U. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet (7.6 m). Install in each run of aboveground RMC and EMT that is located where environmental temperature change may exceed 100 deg F, and that has straight-run length that exceeds 100 feet.

2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
   a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
   b. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
   c. Attics: 135 deg F temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal conduits.

4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.

5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

V. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
W. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

X. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.

Y. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

Z. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

3.3 PROTECTION

A. Protect coatings, finishes, and cabinets from damage or deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

END OF SECTION 270528
SECTION 283111
DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

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. Project includes modification of the existing Silent Knight 5808 alarm system. All new components shall be UL listed for use with the existing system and of the same manufacturer.
B. Section Includes but is not limited to the following:
   2. System smoke detectors.
   4. Addressable interface device.

1.3 DEFINITIONS
A. EMT: Electrical Metallic Tubing.
B. FACP: Fire Alarm Control Panel.
C. HLI: High Level Interface.

1.4 SUBMITTALS
A. Product Data: For each type of product, including furnished options and accessories.
   1. Include construction details, material descriptions, dimensions, profiles, and finishes.
   2. Include rated capacities, operating characteristics, and electrical characteristics.
B. Shop Drawings: For fire-alarm system.
   1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
   2. Include plans, elevations, sections, details, and attachments to other work.
   3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor
sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.

4. Detail assembly and support requirements.
5. Include voltage drop calculations for notification-appliance circuits.
6. Include battery-size calculations.
7. Include input/output matrix.
8. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.
9. Include performance parameters and installation details for each detector.
10. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
11. Provide program report showing that air-sampling detector pipe layout balances pneumatically within the airflow range of the air-sampling detector.
12. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale; coordinate location of duct smoke detectors and access to them.
   a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
   b. Show field wiring required for HVAC unit shutdown on alarm.
   c. Locate detectors according to manufacturer's written recommendations.
13. Include floor plans at 1/8” = 1’-0” scale to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.
14. Show interface with the existing system.

C. General Submittal Requirements:

1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
2. Shop Drawings shall be prepared by persons with the following qualifications:
   a. Trained and certified by manufacturer in fire-alarm system design.
   b. NICET-certified, fire-alarm technician; Level III minimum.
   c. Licensed or certified by authorities having jurisdiction.

D. Delegated-Design Submittal: For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Drawings showing the location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the device.
2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.
3. Indicate audible appliances required to produce square wave signal per NFPA 72.

E. Qualification Data: For Installer.

F. Field quality-control reports.
G. Letter of compliance demonstrating compliance with this specification as well as the UCF Design and Construction Standards, Division 28 “Electronic Safety and Security”, Fire Detection and Alarm section.

1.5 Sample Warranty: For special warranty.

A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following and deliver copies to authorities having jurisdiction:

a. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

b. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.

c. Complete wiring diagrams showing connections between all devices and equipment. Each conductor shall be numbered at every junction point with indication of origination and termination points.

d. Riser diagram.

e. Device addresses.

f. Air-sampling system sample port locations and modeling program report showing layout meets performance criteria.

g. Record copy of site-specific software.

h. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:

1) Equipment tested.

2) Frequency of testing of installed components.

3) Frequency of inspection of installed components.

4) Requirements and recommendations related to results of maintenance.

5) Manufacturer's user training manuals.

i. Manufacturer's required maintenance related to system warranty requirements.

j. Abbreviated operating instructions for mounting at fire-alarm control unit and each annunciator unit.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by Simplex Grinnell for installation of units required for this Project.

B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level III technician.

C. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.
D. The fire alarm system shall comply with this specification as well as the UCF Design and Construction Standards, Division 28 “Electronic Safety and Security”, Fire Detection and Alarm section. Submit compliance letter of compliance.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.

1. WarrantyExtent: All equipment and components not covered in the Maintenance Service Agreement.
2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Source Limitations for Fire-Alarm System and Components: Components shall be compatible with, and operate as an extension of the existing Simplex 4100 system. Provide system manufacturer's certification that all components provided have been tested as, and will operate as, a system.

B. Noncoded, UL-certified addressable system, with multiplexed signal transmission and horn/strobe evacuation.

C. All components provided shall be listed for use with the selected system.

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.

2.2 PROJECT SCOPE

A. General: Project scope is to modify the existing system to react to renovated spaces within the building.

1. Where connecting to existing fire alarm control panels, provide all required components within the existing panels to facilitate the installation and programming of all required circuits for a complete and operational fire alarm system.
2. Update the firmware for all existing network panels with the most recent firmware available at the onset of the project. If a newer release is available at project closeout, provide appropriate update prior to closeout.

B. Basic System Performance

1. Initiation Device Circuits (IDC) shall be wired Class A as part of an addressable device connected by the SLC Circuit.
2. Notification Appliance Circuits (NAC) for both visual and audible devices shall be wired Class A as part of an addressable device connected by the SLC Circuit.
3. On Class A configurations a signal ground fault or open circuit on the system Signaling Line Circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm.

2.3 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:
   2. Smoke detectors.
   3. Duct smoke detectors.
   4. Fire sprinkler water flow.

B. Fire-alarm signal shall initiate the following actions:
   1. Continuously operate alarm notification appliances.
   2. Identify alarm and specific initiating device at fire-alarm control unit, connected network control panels and off-premises network control panels.
   3. Transmit an alarm signal to the existing remote alarm receiving station.
   4. Shut-down heating, ventilating, and air-conditioning equipment.
   5. Record events in the system memory.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:
   1. User disabling of zones or individual devices.
   2. Loss of communication with any panel on the network.
   3. Activation of duct mounted smoke detector.

D. System trouble signal initiation shall be by one or more of the following devices and actions:
   1. Open circuits, shorts, and grounds in designated circuits.
   2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
   3. Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
   4. Loss of primary power at fire-alarm control unit.
   5. Ground or a single break in internal circuits of fire-alarm control unit.
   6. Abnormal ac voltage at fire-alarm control unit.
   7. Break in standby battery circuitry.
   8. Failure of battery charging.
   9. Abnormal position of any switch at fire-alarm control unit or annunciator.

E. System Supervisory Signal Actions:
   1. Identify specific device initiating the event at fire-alarm control unit.
   2. Record the event on system printer.
   3. Transmit a trouble or supervisory signal to the remote alarm receiving station.
2.4 MANUAL FIRE-ALARM BOXES

A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.

1. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
2. Station Reset: Key- or wrench-operated switch.

2.5 SYSTEM SMOKE DETECTORS

A. General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal.
2. Detectors shall be four-wire type.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
7. Remote Control: Unless otherwise indicated, detectors shall be digital-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.

B. Photoelectric Smoke Detectors:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
   a. Primary status.
   b. Device type.
   c. Present average value.
   d. Present sensitivity selected.
   e. Sensor range (normal, dirty, etc.).

C. Duct Smoke Detectors: Photoelectric type complying with UL 268A.

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
a. Primary status.
b. Device type.
c. Present average value.
d. Present sensitivity selected.
e. Sensor range (normal, dirty, etc.).

3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
4. Each sensor shall have multiple levels of detection sensitivity.
5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.

2.6 NOTIFICATION APPLIANCES

A. General Requirements for Notification Appliances: Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.

1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.

B. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch-high letters on the lens.

1. Rated Light Output:
   a. 15/30/75/110 cd, selectable in the field.

2. Mounting: Wall mounted unless otherwise indicated on the drawings.
3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
4. Flashing shall be in a temporal pattern, synchronized with other units.
5. Strobe Leads: Factory connected to screw terminals.

C. Voice/Tone Notification Appliances:

1. Comply with UL 1480.
2. Speakers for Voice Notification: Locate speakers for voice notification to provide the intelligibility requirements of the "Notification Appliances" and "Emergency Communications Systems" chapters in NFPA 72.
3. High-Range Units: Rated 2 to 15 W.
4. Low-Range Units: Rated 1/4 W.
5. Mounting: Ceiling mounted units shall be flush with white grille. Where indicated on plans provide wall or ceiling mounted combination audio/visual devices. Wall mounted devices shall be red in color and ceiling mounted devices shall be white in color.
6. Matching Transformers: Tap range matched to acoustical environment of speaker location.
2.7 ADDRESSABLE INTERFACE DEVICE

A. General:
   1. Include address-setting means on the module.
   2. Store an internal identifying code for control panel use to identify the module type.
   3. Listed for controlling HVAC fan motor controllers.

B. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts.

C. Control Module:
   1. Operate notification devices.

2.1 FIRE ALARM WIRE AND CABLE

A. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760. Cables as recommended by the fire alarm system manufacturer.

B. Signaling Line Circuits: Twisted, shielded pair, size as recommended by system manufacturer.
   1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.

C. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.
   1. Low-Voltage Circuits: No. 14 AWG, minimum, in pathway.
   2. Line-Voltage Circuits: No. 12 AWG, minimum, in pathway.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
   1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.

B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 EQUIPMENT INSTALLATION

A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."

1. Devices placed in service before all other trades have completed cleanup shall be replaced.
2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.

B. Install wall-mounted equipment, with tops of cabinets not more than 72 inches above the finished floor.

C. Manual Fire-Alarm Boxes:

1. Install manual fire-alarm box in the normal path of egress within 60 inches of the exit doorway.

D. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.

E. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches long shall be supported at both ends.

1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.

3.3 PATHWAYS

A. Pathways shall be installed in EMT.

B. EMT shall be painted red enamel.

3.1 WIRING INSTALLATION

A. Comply with NECA 1 and NFPA 72.

B. Wiring Method: Install wiring in EMT pathway.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated pathway system. This system shall not be used for any other wire or cable.

C. Wiring Method:
1. Cables and pathways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.
2. Signaling Line Circuits: Power-limited fire alarm cables shall not be installed in the same cable or pathway as signaling line circuits.

D. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

E. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

F. Color Coding: Color code fire alarm conductors differently from the normal building power wiring. Use one color code for alarm circuit wiring and another for supervisory circuits. Color code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

3.2 CONNECTIONS

A. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Install framed instructions in a location visible from fire-alarm control unit.

3.4 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

B. Ground shielded cables at the control panel location only. Insulate shield at device location.
3.5 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by the Engineer of Record and authorities having jurisdiction. The fire alarm system shall be successfully inspected, demonstrated and approved by the engineer of record prior to requesting inspection by the State Fire Marshall.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

D. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Visual Inspection: Conduct visual inspection prior to testing.
   a. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
   b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.


3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.

4. Test audible appliances for the private operating mode according to manufacturer's written instructions.

5. Test visible appliances for the public operating mode according to manufacturer's written instructions.

6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

E. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

F. Fire-alarm system will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

H. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

I. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.
3.6 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

1. Include visual inspections according to the "Visual Inspection Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.7 CONSTRUCTION WASTE MANAGEMENT

A. Comply with the Waste Management Plan specified in Section 017419 Construction Waste Management and Disposal, for additional requirements.

END OF SECTION 283111
Florida Energy Efficiency Code for Building Construction (FEEC)

Daytona State College
Lenholt Center - Building 130
Center for Women & Men Remodel Project
## Project Information

**Energy Code:**
2017 Florida Building Code, Energy Conservation  
**Project Title:**
Daytona State College Center for Women & Men Remodel  
**Project Type:**
Alteration

**Construction Site:**
Lenholt Center Building 130  
1200 W International Speedway Blvd  
Daytona Beach, FL 32114

**Owner/Agent:**
Daytona State College  
P.O. Box 2811  
Daytona Beach, FL 32114

**Designer/Contractor:**
RLF, Inc.  
4750 New Broad Street  
Orlando, FL 32814

## Allowed Interior Lighting Power

<table>
<thead>
<tr>
<th>A</th>
<th>B Floor Area (ft²)</th>
<th>C Allowed Watts / ft²</th>
<th>D Allowed Watts (B X C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-120 NORTH ENTRY (Common Space Types:Lobby - General)</td>
<td>280</td>
<td>0.90</td>
<td>252</td>
</tr>
<tr>
<td>2-122 CONFERENCE (Common Space Types:Conference/Meeting/Multipurpose)</td>
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<tr>
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<tr>
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<td>34-119 RECEPTION (Common Space Types:Office - Enclosed)</td>
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## Proposed Interior Lighting Power

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<tr>
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<tr>
<td>Fixture ID : Description / Lamp / Wattage Per Lamp / Ballast</td>
<td>Lamps/Fixture</td>
<td># of Fixtures</td>
<td>Fixture Watt.</td>
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<td>TYPE J1: LED Linear 8W</td>
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<tr>
<td>107 OFFICE (Common Space Types:Office - Enclosed 126 sq.ft.)</td>
<td>1</td>
<td>4</td>
<td>25</td>
<td>100</td>
</tr>
<tr>
<td>TYPE D1D: LED Panel 19W:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>108 OFFICE (Common Space Types:Office - Enclosed 120 sq.ft.)</td>
<td>1</td>
<td>2</td>
<td>25</td>
<td>50</td>
</tr>
<tr>
<td>TYPE D1D: LED Panel 19W:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>110 OFFICE (Common Space Types:Office - Enclosed 120 sq.ft.)</td>
<td>1</td>
<td>2</td>
<td>25</td>
<td>50</td>
</tr>
<tr>
<td>TYPE D1D: LED Panel 19W:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>111 OFFICE (Common Space Types:Office - Enclosed 129 sq.ft.)</td>
<td>1</td>
<td>2</td>
<td>25</td>
<td>50</td>
</tr>
<tr>
<td>TYPE D1D: LED Panel 19W:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>112 STORAGE (Common Space Types:Storage &gt;=50 - &lt;=1000 sq.ft. 101 sq.ft.)</td>
<td>1</td>
<td>1</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>TYPE D1D: LED Panel 19W:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>113 STAFF LOUNGE (Common Space Types:Lounge/Breakroom 248 sq.ft.)</td>
<td>1</td>
<td>2</td>
<td>25</td>
<td>50</td>
</tr>
<tr>
<td>TYPE D1D: LED Panel 19W:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>116 MULTI-PURPOSE (Common Space Types:Conference/Meeting/Multipurpose 219 sq.ft.)</td>
<td>1</td>
<td>4</td>
<td>25</td>
<td>100</td>
</tr>
<tr>
<td>TYPE D1D: LED Panel 19W:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>113A TOILET (Common Space Types:Restrooms 22 sq.ft.)</td>
<td>1</td>
<td>1</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>TYPE V1: LED Other Fixture Unit 25W:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>117 CONFERENCE (Common Space Types:Conference/Meeting/Multipurpose 434 sq.ft.)</td>
<td>1</td>
<td>6</td>
<td>25</td>
<td>150</td>
</tr>
<tr>
<td>TYPE D1D: LED Panel 19W:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>109 OFFICE (Common Space Types:Office - Enclosed 128 sq.ft.)</td>
<td>1</td>
<td>2</td>
<td>25</td>
<td>50</td>
</tr>
<tr>
<td>TYPE D1D: LED Panel 19W:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>119 RECEPTION (Common Space Types:Office - Enclosed 155 sq.ft.)</td>
<td>1</td>
<td>3</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td>TYPE D1D: LED Panel 19W:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total Proposed Watts = 3509

**Interior Lighting PASSES**

**Interior Lighting Compliance Statement**

Compliance Statement: The proposed interior lighting alteration project represented in this document is consistent with the building plans, specifications, and other calculations submitted with this permit application. The proposed interior lighting systems have been designed to meet the 2017 Florida Building Code, Energy Conservation requirements in COMcheck Version 4.1.1.0 and to comply with any applicable mandatory requirements listed in the Inspection Checklist.
COMcheck Software Version 4.1.1.0

Mechanical Compliance Certificate

Project Information

Project Title: Daytona State College Center for Women & Men Remodel
Location: Daytona Beach, Florida
Climate Zone: 2a
Project Type: Alteration

Construction Site: Lenholt Center Building 130
1200 W International Speedway Blvd
Daytona Beach, FL 32114

Owner/Agent: Daytona State College
P.O. Box 2811
Daytona Beach, FL 32114

Designer/Contractor: RLF, Inc.
4750 New Broad Street
Orlando, FL 32814

Mechanical Systems List

<table>
<thead>
<tr>
<th>Quantity</th>
<th>System Type &amp; Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AHU-7.1 (Single Zone):</td>
</tr>
<tr>
<td></td>
<td>Cooling: 1 each - Hydronic Coil, Capacity = 1191 kBtu/h, Air Economizer</td>
</tr>
<tr>
<td></td>
<td>No minimum efficiency requirement applies</td>
</tr>
<tr>
<td></td>
<td>Fan System: FAN SYSTEM 1 -- Compliance (Motor nameplate HP method): Passes</td>
</tr>
<tr>
<td></td>
<td>Fans:</td>
</tr>
<tr>
<td></td>
<td>SF/7.1.A Supply, Single-Zone VAV, 11125 CFM, 15.0 motor nameplate hp, 55.7 fan efficiency grade</td>
</tr>
<tr>
<td></td>
<td>SF/7.1.B Supply, Single-Zone VAV, 11125 CFM, 15.0 motor nameplate hp, 55.7 fan efficiency grade</td>
</tr>
</tbody>
</table>

Mechanical Compliance Statement

Compliance Statement: The proposed mechanical alteration project represented in this document is consistent with the building plans, specifications, and other calculations submitted with this permit application. The proposed mechanical systems have been designed to meet the 2017 Florida Building Code, Energy Conservation requirements in COMcheck Version 4.1.1.0 and to comply with any applicable mandatory requirements listed in the Inspection Checklist.

Name - Title ___________________________ Signature ___________________________ Date ___________________________
**COMcheck Software Version 4.1.1.0**

**Inspection Checklist**


Requirements: 100.0% were addressed directly in the COMcheck software

Text in the "Comments/Assumptions" column is provided by the user in the COMcheck Requirements screen. For each requirement, the user certifies that a code requirement will be met and how that is documented, or that an exception is being claimed. Where compliance is itemized in a separate table, a reference to that table is provided.

<table>
<thead>
<tr>
<th>Section # &amp; Req.ID</th>
<th>Plan Review</th>
<th>Complies?</th>
<th>Comments/Assumptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>C103.2 [PR2]</td>
<td>Plans, specifications, and/or calculations provide all information with which compliance can be determined for the mechanical systems and equipment and document where exceptions to the standard are claimed. Load calculations per acceptable engineering standards and handbooks.</td>
<td>☐Complies ☐Does Not ☐Not Observable ☐Not Applicable</td>
<td>Requirement will be met.</td>
</tr>
<tr>
<td>C405.6 [PR17]</td>
<td>Plans, specifications, and/or calculations provide all information with which compliance can be determined for the electrical systems and equipment and document where exceptions are claimed. Provisions are made for metering individual tenant units. Feeder connectors (for feeder and branch circuits) sized in accordance with approved plans with maximum drop of 5% voltage drop total.</td>
<td>☐Complies ☐Does Not ☐Not Observable ☐Not Applicable</td>
<td>Requirement will be met.</td>
</tr>
<tr>
<td>C103.2 [PR4]</td>
<td>Plans, specifications, and/or calculations provide all information with which compliance can be determined for the interior lighting and electrical systems and equipment and document where exceptions to the standard are claimed. Information provided should include interior lighting power calculations, wattage of bulbs and ballasts, transformers and control devices.</td>
<td>☐Complies ☐Does Not ☐Not Observable ☐Not Applicable</td>
<td>Requirement will be met.</td>
</tr>
</tbody>
</table>

**Additional Comments/Assumptions:**

Project Title: Daytona State College Center for Women & Men Remodel  
Data filename: G:\17123\Energy Compliance\DSC COMCheck.cck  
Report date: 08/09/19  
Page 5 of 15
<table>
<thead>
<tr>
<th>Section &amp; Req.ID</th>
<th>Footing / Foundation Inspection</th>
<th>Complies?</th>
<th>Comments/Assumptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>C403.2.4.5, C403.2.4.6 [FO9]</td>
<td>Snow/ice melting system sensors for future connection to controls. Freeze protection systems have automatic controls installed.</td>
<td>☐ Complies ☐ Does Not ☐ Not Observable ☐ Not Applicable</td>
<td>Exception: Requirement does not apply.</td>
</tr>
</tbody>
</table>

**Additional Comments/Assumptions:**
<table>
<thead>
<tr>
<th>Section # &amp; Req.ID</th>
<th>Plumbing Rough-In Inspection</th>
<th>Complies?</th>
<th>Comments/Assumptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>C404.5, C404.5.1, C404.5.2 [PL6]³</td>
<td>Heated water supply piping conforms to pipe length and volume requirements. Refer to section details.</td>
<td>☐ Complies ☐ Does Not ☐ Not Observable ☐ Not Applicable</td>
<td>Requirement will be met.</td>
</tr>
<tr>
<td>C404.6.3 [PL7]³</td>
<td>Pumps that circulate water between a heater and storage tank have controls that limit operation from startup to &lt;= 5 minutes after end of heating cycle.</td>
<td>☐ Complies ☐ Does Not ☐ Not Observable ☐ Not Applicable</td>
<td><strong>Exception:</strong> Requirement does not apply.</td>
</tr>
<tr>
<td>C404.7 [PL8]³</td>
<td>Water distribution system that pumps water from a heated-water supply pipe back to the heated-water source through a cold-water supply pipe is a demand recirculation water system. Pumps within this system have controls that start the pump upon receiving a signal from the action of a user of a fixture or appliance and limits the temperature of the water entering the cold-water piping to 104°F.</td>
<td>☐ Complies ☐ Does Not ☐ Not Observable ☐ Not Applicable</td>
<td><strong>Exception:</strong> Requirement does not apply.</td>
</tr>
</tbody>
</table>

**Additional Comments/Assumptions:**

1 High Impact (Tier 1)  
2 Medium Impact (Tier 2)  
3 Low Impact (Tier 3)
<table>
<thead>
<tr>
<th>Section # &amp; Req.ID</th>
<th>Mechanical Rough-In Inspection</th>
<th>Complies?</th>
<th>Comments/Assumptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>C402.2.6 [ME41](^3)</td>
<td>Thermally ineffective panel surfaces of sensible heating panels have insulation &gt;= R-3.5.</td>
<td>☐ Complies</td>
<td><strong>Exception:</strong> Requirement does not apply.</td>
</tr>
<tr>
<td>C403.2.12 .1 [ME65](^3)</td>
<td>HVAC fan systems at design conditions do not exceed allowable fan system motor nameplate hp or fan system bhp.</td>
<td>☐ Complies</td>
<td>Requirement will be met. See the Mechanical Systems list for values.</td>
</tr>
<tr>
<td>C403.2.12 .3 [ME117](^2)</td>
<td>Fans have efficiency grade (FEG) &gt;= 67. The total efficiency of the fan at the design point of operation &lt;= 15% of maximum total efficiency of the fan.</td>
<td>☐ Complies</td>
<td>Requirement will be met.</td>
</tr>
<tr>
<td>C403.2.9.1.1 [ME60](^2)</td>
<td>HVAC ducts and plenums insulated and sealed according to Florida Section C403.2.9, Table C403.2.9.1.</td>
<td>☐ Complies</td>
<td>Requirement will be met.</td>
</tr>
<tr>
<td>C403.2.9.2 [ME79](^2)</td>
<td>All ducts, air handlers, filter boxes, building cavities, mechanical closets and enclosed support platforms that form the primary air containment passageways for air distribution systems are constructed and erected in accordance with Table C403.2.9.2 and with Chapter 6 of the Florida Building Code, Mechanical. Ducts are be constructed, braced, reinforced and installed to provide structural strength and durability. All transverse joints, longitudinal seams and fitting connections are securely fastened in accordance with the applicable standards of this section.</td>
<td>☐ Complies</td>
<td>Requirement will be met.</td>
</tr>
<tr>
<td>C403.2.9.1.2 [ME80](^2)</td>
<td>Duct insulation is protected from damage but not limited to the following: 1. Insulation exposed to weather is suitable for outdoor service. Cellular foam insulation is protected or painted with a coating that is water retardant and provides shielding from solar radiation. 2. Insulation covering cooling ducts located outside the conditioned space is vapor retardant located outside the insulation, all penetrations and joints of which shall be sealed.</td>
<td>☐ Complies</td>
<td>Requirement will be met.</td>
</tr>
<tr>
<td>C403.2.9.1.3 [ME81](^2)</td>
<td>Additional insulation with vapor barrier is provided where the minimum duct insulation requirements of Section C403.2.9.1.1 are determined to be insufficient to prevent condensation.</td>
<td>☐ Complies</td>
<td><strong>Exception:</strong> Requirement does not apply.</td>
</tr>
<tr>
<td>C403.2.13 [ME71](^2)</td>
<td>Unenclosed spaces that are heated use only radiant heat.</td>
<td>☐ Complies</td>
<td><strong>Exception:</strong> Requirement does not apply.</td>
</tr>
<tr>
<td>C403.2.3 [ME55](^2)</td>
<td>HVAC equipment efficiency verified.</td>
<td>☐ Complies</td>
<td>See the Mechanical Systems list for values.</td>
</tr>
</tbody>
</table>

1 High Impact (Tier 1)  2 Medium Impact (Tier 2)  3 Low Impact (Tier 3)
<table>
<thead>
<tr>
<th>Section # &amp; Req.ID</th>
<th>Mechanical Rough-In Inspection</th>
<th>Complies?</th>
<th>Comments/Assumptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>C403.2.9.3 [ME10](^2)</td>
<td>Ducts, air handlers, filter boxes, building cavities, mechanical closets and enclosed support platforms that form the primary air containment passageways for air distribution systems are sealed in accordance with the applicable criteria of this section and Table C403.2.9.2.</td>
<td>☐ Complies</td>
<td>Requirement will be met.</td>
</tr>
<tr>
<td>C403.2.9.4 [ME78](^2)</td>
<td>Cavities in framed spaces are not used to deliver air from or return air to the conditioning system unless they contain an air duct insert which is insulated in accordance with Section C403.2.9.1 and constructed and sealed in accordance with the requirements of Section C403.2.9.2 appropriate for the duct materials used.</td>
<td>☐ Complies</td>
<td>Requirement will be met.</td>
</tr>
<tr>
<td>C403.2.9.5 [ME76](^2)</td>
<td>Air distribution systems are sized and designed in accordance with recognized engineering standards. Refer to section details.</td>
<td>☐ Complies</td>
<td>Requirement will be met.</td>
</tr>
<tr>
<td>C403.2.9.6 [ME77](^2)</td>
<td>Air-handling units not installed in attics of commercial buildings.</td>
<td>☐ Complies</td>
<td>Exception: Requirement does not apply.</td>
</tr>
<tr>
<td>C403.2.4.7 [ME113](^2)</td>
<td>Fault detection and diagnostics installed with air-cooled unitary DX units having economizers.</td>
<td>☐ Complies</td>
<td>Exception: Requirement does not apply.</td>
</tr>
<tr>
<td>C403.2.4.7 [ME113](^3)</td>
<td>Fault detection and diagnostics installed with air-cooled unitary DX units having economizers.</td>
<td>☐ Complies</td>
<td>Exception: Requirement does not apply.</td>
</tr>
<tr>
<td>C408.2.2.1 [ME53](^3)</td>
<td>Air system balancing accomplished in a manner to first minimize throttling losses, then for fans with fan system power greater than 1 hp, fan speeds shall be adjusted to meet design flow conditions. Balancing procedures shall be in accordance with NEBB Procedural Standards, the AABC, National Standards, or equivalent procedures.</td>
<td>☐ Complies</td>
<td>Requirement will be met.</td>
</tr>
<tr>
<td>C403.2.6.1 [ME59](^1)</td>
<td>Demand control ventilation provided for spaces &gt;500 ft(^2) and &gt;25 people/1000 ft(^2) occupant density and served by systems with air side economizer, auto modulating outside air damper control, or design airflow &gt;3,000 cfm.</td>
<td>☐ Complies</td>
<td>Exception: Requirement does not apply.</td>
</tr>
<tr>
<td>C403.2.6.2 [ME115](^3)</td>
<td>Enclosed parking garage ventilation has automatic contaminant detection and capacity to stage or modulate fans to 50% or less of design capacity.</td>
<td>☐ Complies</td>
<td>Exception: Requirement does not apply.</td>
</tr>
<tr>
<td>C403.2.7 [ME57](^1)</td>
<td>Exhaust air energy recovery on systems meeting Table C403.2.7(1) and C403.2.7(2).</td>
<td>☐ Complies</td>
<td>Exception: Requirement does not apply.</td>
</tr>
<tr>
<td>C403.2.8 [ME116](^3)</td>
<td>Kitchen exhaust systems comply with replacement air and conditioned supply air limitations, and satisfy hood rating requirements and maximum exhaust rate criteria.</td>
<td>☐ Complies</td>
<td>Exception: Requirement does not apply.</td>
</tr>
</tbody>
</table>

1. High Impact (Tier 1)  2. Medium Impact (Tier 2)  3. Low Impact (Tier 3)
<table>
<thead>
<tr>
<th>Section # &amp; Req.ID</th>
<th>Mechanical Rough-In Inspection</th>
<th>Complies?</th>
<th>Comments/Assumptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>C403.3 [ME62]1</td>
<td>Air economizers provided where required, meet the requirements for design capacity, control signal, ventilation controls, high-limit shut-off, integrated economizer control, and provide a means to relieve excess outside air during operation.</td>
<td>☐ Complies ☐ Does Not ☐ Not Observable ☐ Not Applicable</td>
<td>Requirement will be met.</td>
</tr>
<tr>
<td>C403.4.2.1 [ME50]2</td>
<td>Three-pipe hydronic systems using a common return for hot and chilled water are not used.</td>
<td>☐ Complies ☐ Does Not ☐ Not Observable ☐ Not Applicable</td>
<td>Requirement will be met.</td>
</tr>
<tr>
<td>C403.4.2.6 [ME26]3</td>
<td>Chilled water plants with multiple chillers have capability to reduce flow automatically through the chiller plant when a chiller is shut down. Boiler plants with multiple boilers have the capability to reduce flow automatically through the boiler plant when a boiler is shut down.</td>
<td>☐ Complies ☐ Does Not ☐ Not Observable ☐ Not Applicable</td>
<td>Requirement will be met.</td>
</tr>
<tr>
<td>C403.4.4.6 [ME110]3</td>
<td>Multiple zone VAV systems with DDC of individual zone boxes have static pressure setpoint reset controls.</td>
<td>☐ Complies ☐ Does Not ☐ Not Observable ☐ Not Applicable</td>
<td>Requirement will be met. See the Mechanical Systems list for values.</td>
</tr>
<tr>
<td>C403.4.5 [ME31]3</td>
<td>Condenser heat recovery system that can heat water to 85 ºF or provide 60% of peak heat rejection is installed for preheating of service hot water.</td>
<td>☐ Complies ☐ Does Not ☐ Not Observable ☐ Not Applicable</td>
<td>Requirement will be met.</td>
</tr>
<tr>
<td>C408.2.2.1 [ME53]3</td>
<td>Air outlets and zone terminal devices have means for air balancing.</td>
<td>☐ Complies ☐ Does Not ☐ Not Observable ☐ Not Applicable</td>
<td>Requirement will be met.</td>
</tr>
<tr>
<td>C408.2.2.2 [ME54]4</td>
<td>HVAC hydronic heating and cooling coils have means to balance and have pressure test connections.</td>
<td>☐ Complies ☐ Does Not ☐ Not Observable ☐ Not Applicable</td>
<td>Requirement will be met.</td>
</tr>
<tr>
<td>C409.5.1, C409.5.2 [ME123]3</td>
<td>Refrigerated display cases, walk-in coolers or walk-in freezers served by remote compressors and remote condensers not located in a condensing unit, have fan-powered condensers that comply with Sections C403.5.1 and refrigeration compressor systems that comply with C403.5.2.</td>
<td>☐ Complies ☐ Does Not ☐ Not Observable ☐ Not Applicable</td>
<td>Exception: Requirement does not apply.</td>
</tr>
</tbody>
</table>

Additional Comments/Assumptions:

Project Title: Daytona State College Center for Women & Men Remodel
Data filename: G:\17123\Energy Compliance\DSC COMCheck.cck
Report date: 08/09/19
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<table>
<thead>
<tr>
<th>Section # &amp; Req.ID</th>
<th>Rough-In Electrical Inspection</th>
<th>Complies?</th>
<th>Comments/Assumptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>C405.2.1[EL15]</td>
<td>Lighting controls installed to uniformly reduce the lighting load by at least 50%</td>
<td>Complies</td>
<td>Exception: Lighting that is related to means of egress in stairways, ramps, corridors, or emergency routes.</td>
</tr>
<tr>
<td>C405.2.1[EL18]</td>
<td>Occupancy sensors installed in required spaces.</td>
<td>Complies</td>
<td>Requirement will be met.</td>
</tr>
<tr>
<td>C405.2.1, C405.2.2, 3[EL23]</td>
<td>Independent lighting controls installed per approved lighting plans and all manual controls readily accessible and visible to occupants.</td>
<td>Complies</td>
<td>Requirement will be met.</td>
</tr>
<tr>
<td>C405.2.2.1[EL22]</td>
<td>Automatic controls to shut off all building lighting installed in all buildings.</td>
<td>Complies</td>
<td>Exception: Lighting that is related to means of egress in stairways, ramps, corridors, or emergency routes.</td>
</tr>
<tr>
<td>C405.2.3[EL16]</td>
<td>Daylight zones provided with individual controls that control the lights independent of general area lighting.</td>
<td>Complies</td>
<td>Requirement will be met.</td>
</tr>
<tr>
<td>C405.2.3, C405.2.3.1, C405.2.3.2[EL20]</td>
<td>Primary sidelighted areas are equipped with required lighting controls.</td>
<td>Complies</td>
<td>Requirement will be met.</td>
</tr>
<tr>
<td>C405.2.3, C405.2.3.1, C405.2.3.2, 3[EL21]</td>
<td>Enclosed spaces with daylight area under skylights and rooftop monitors are equipped with required lighting controls.</td>
<td>Complies</td>
<td>Exception: Requirement does not apply.</td>
</tr>
<tr>
<td>C405.2.4[EL4]</td>
<td>Separate lighting control devices for specific uses installed per approved lighting plans.</td>
<td>Complies</td>
<td>Requirement will be met.</td>
</tr>
<tr>
<td>C405.2.4[EL8]</td>
<td>Additional interior lighting power allowed for special functions per the approved lighting plans and is automatically controlled and separated from general lighting.</td>
<td>Complies</td>
<td>Requirement will be met.</td>
</tr>
<tr>
<td>C405.3[EL6]</td>
<td>Exit signs do not exceed 5 watts per face.</td>
<td>Complies</td>
<td>Requirement will be met.</td>
</tr>
</tbody>
</table>

Additional Comments/Assumptions:

1 High Impact (Tier 1)  2 Medium Impact (Tier 2)  3 Low Impact (Tier 3)
<table>
<thead>
<tr>
<th>Section # &amp; Req.ID</th>
<th>Final Inspection</th>
<th>Complies?</th>
<th>Comments/Assumptions</th>
</tr>
</thead>
</table>
| C303.3, C408.2.5. 2 [FI17]³ | Furnished O&M instructions for systems and equipment to the building owner or designated representative. | ☐ Complies  
☐ Does Not  
☐ Not Observable  
☐ Not Applicable | Requirement will be met. |
| C303.3, C408.2.5. 3 [FI8]³ | Furnished O&M manuals for HVAC systems within 90 days of system acceptance. | ☐ Complies  
☐ Does Not  
☐ Not Observable  
☐ Not Applicable | Requirement will be met. |
| C403.2.4. 2.4 [FI56]³ | Minimum one humidity control device per installed humidification/dehumidification system. Controls prevent simultaneous operation of humidification and dehumidification equipment. | ☐ Complies  
☐ Does Not  
☐ Not Observable  
☐ Not Applicable | Requirement will be met. |
| C403.2.1 [FI50]³ | HVAC systems and equipment design loads calculated in accordance with ANSI/ASHRAE/ACCA Standard 183 or ACCA Manual N or by an approved equivalent computational procedure. Design loads shall be attached to the code compliance form submitted to the building department when the building is permitted or, in the event the mechanical permit is obtained at a later time, the sizing calculation shall be submitted with the application for the mechanical permit. | ☐ Complies  
☐ Does Not  
☐ Not Observable  
☐ Not Applicable | Requirement will be met. |
| C403.2.2 [FI27]³ | HVAC systems and equipment capacity does not exceed calculated loads. | ☐ Complies  
☐ Does Not  
☐ Not Observable  
☐ Not Applicable | Requirement will be met. |
| C403.2.4. 1 [FI47]³ | Heating and cooling to each zone is controlled by a thermostat control. Minimum one humidity control device per installed humidification/dehumidification system. | ☐ Complies  
☐ Does Not  
☐ Not Observable  
☐ Not Applicable | Requirement will be met. |
| C403.2.4. 1.2 [FI38]³ | Thermostatic controls have a 5 °F deadband. | ☐ Complies  
☐ Does Not  
☐ Not Observable  
☐ Not Applicable | Requirement will be met. |
| C403.2.4. 1.3 [FI20]³ | Temperature controls have setpoint overlap restrictions. | ☐ Complies  
☐ Does Not  
☐ Not Observable  
☐ Not Applicable | Requirement will be met. |
| C403.2.4. 2 [FI39]³ | Each zone equipped with setback controls using automatic time clock or programmable control system. | ☐ Complies  
☐ Does Not  
☐ Not Observable  
☐ Not Applicable | Requirement will be met. |

<table>
<thead>
<tr>
<th>1 High Impact (Tier 1)</th>
<th>2 Medium Impact (Tier 2)</th>
<th>3 Low Impact (Tier 3)</th>
</tr>
</thead>
</table>

Project Title: Daytona State College Center for Women & Men Remodel  
Data filename: G:\17123\Energy Compliance\DSC COMCheck.cck  
Report date: 08/09/19  
Page 12 of 15
<table>
<thead>
<tr>
<th>Section # &amp; Req.ID</th>
<th>Final Inspection</th>
<th>Complies?</th>
<th>Comments/Assumptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>C408.2.2 [FI54]</td>
<td>Construction documents require that a written balance report be provided to the building owner or rep for HVAC systems serving zones with total condition area &gt; 5,000 sqft. Air distribution systems shall be tested, adjusted, and balanced by a licensed engineer or certified company.</td>
<td>☐ Complies</td>
<td>Requirement will be met.</td>
</tr>
<tr>
<td>C403.2.4.2.1, C403.2.4.2.2 [FI40]</td>
<td>Automatic Controls: Setback to 55°F (heat) and 85°F (cool); 7-day clock, 2-hour occupant override, 10-hour backup</td>
<td>☐ Complies</td>
<td>Requirement will be met.</td>
</tr>
<tr>
<td>C403.2.4.2.3 [FI41]</td>
<td>Systems include optimum start controls.</td>
<td>☐ Complies</td>
<td>Requirement will be met.</td>
</tr>
<tr>
<td>C405.4.1 [FI18]</td>
<td>Interior installed lamp and fixture lighting power is consistent with what is shown on the approved lighting plans, demonstrating proposed watts are less than or equal to allowed watts.</td>
<td>☐ Complies</td>
<td>See the Interior Lighting fixture schedule for values.</td>
</tr>
<tr>
<td>C408.2.1 [FI28]</td>
<td>Commissioning plan developed by registered design professional or approved agency.</td>
<td>☐ Complies</td>
<td>Requirement will be met.</td>
</tr>
<tr>
<td>C408.2.3.1 [FI31]</td>
<td>HVAC equipment has been tested to ensure proper operation.</td>
<td>☐ Complies</td>
<td>Requirement will be met.</td>
</tr>
<tr>
<td>C408.2.3.2 [FI10]</td>
<td>HVAC control systems have been tested to ensure proper operation, calibration and adjustment of controls.</td>
<td>☐ Complies</td>
<td>Requirement will be met.</td>
</tr>
<tr>
<td>C408.2.3.3 [FI32]</td>
<td>Economizers have been tested to ensure proper operation.</td>
<td>☐ Complies</td>
<td>Requirement will be met.</td>
</tr>
<tr>
<td>C408.2.4 [FI29]</td>
<td>Preliminary commissioning report completed and certified by registered design professional or approved agency.</td>
<td>☐ Complies</td>
<td>Requirement will be met.</td>
</tr>
<tr>
<td>C408.2.5.1 [FI7]</td>
<td>Furnished HVAC as-built drawings submitted within 90 days of system acceptance.</td>
<td>☐ Complies</td>
<td>Requirement will be met.</td>
</tr>
<tr>
<td>C408.2.5.1 [FI16]</td>
<td>Furnished as-built drawings for electric power systems within 90 days of system acceptance.</td>
<td>☐ Complies</td>
<td>Requirement will be met.</td>
</tr>
<tr>
<td>C408.2.5.3 [FI43]</td>
<td>An air and/or hydronic system balancing report is provided for HVAC systems.</td>
<td>☐ Complies</td>
<td>Requirement will be met.</td>
</tr>
<tr>
<td>Section # &amp; Req.ID</td>
<td>Final Inspection</td>
<td>Complies?</td>
<td>Comments/Assumptions</td>
</tr>
<tr>
<td>------------------</td>
<td>------------------</td>
<td>-----------</td>
<td>----------------------</td>
</tr>
<tr>
<td>C408.2.5.4 [FI30]¹</td>
<td>Final commissioning report due to building owner within 90 days of receipt of certificate of occupancy.</td>
<td>![Complies]</td>
<td>Requirement will be met.</td>
</tr>
<tr>
<td>C408.3 [FI33]¹</td>
<td>Lighting systems have been tested to ensure proper calibration, adjustment, programming, and operation.</td>
<td>![Complies]</td>
<td>Requirement will be met.</td>
</tr>
</tbody>
</table>

**Additional Comments/Assumptions:**
Engineering Calculations

Daytona State College
Lenholt Center - Building 130
Center for Women & Men Remodel Project
### Location
- Building owner
- Program user
- Company
- Comments

### By
- RLF

### Dataset name
- G:\17123\ME\Calculations\Load Calculations\TRACE\17123 - CALC.TRC

### Calculation time
- 12:10 PM on 12/14/2018

### TRACE® 700 version
- 6.3.4

### Location
- Orlando, Florida

### Latitude
- 28.0 deg

### Longitude
- 81.0 deg

### Time Zone
- 5

### Elevation
- 106 ft

### Barometric pressure
- 29.8 in. Hg

### Air density
- 0.0757 lb/cu ft

### Air specific heat
- 0.2444 Btu/lb·°F

### Density-specific heat product
- 1.1109 Btu/h·cfm·°F

### Latent heat factor
- 4,890.3 Btu·min/h·cu ft

### Enthalpy factor
- 4.5449 lb·min/hr·cu ft

### Summer design dry bulb
- 90.8 °F

### Summer design wet bulb
- 76.9 °F

### Winter design dry bulb
- 34.7 °F

### Summer clearness number
- 0.95

### Winter clearness number
- 0.95

### Summer ground reflectance
- 0.20

### Winter ground reflectance
- 0.20

### Carbon Dioxide Level
- 400 ppm

### Design simulation period
- January - December

### Cooling load methodology
- CLTD-CLF (ASHRAE TFM)

### Heating load methodology
- UATD
Design Cooling Load Summary
By RLF
17123 - Daytona State College

System - System - 001
Type - Bypass VAV with Reheat (30% Min Flow Default)

Coil Location - System
Coil Peak Calculation Time: August, hour 16
Ambient DB/WB/HR:  88 / 78 / 128

COOLING COIL LOAD INFORMATION

<table>
<thead>
<tr>
<th>Load Component</th>
<th>Sensible Btu/h</th>
<th>Latent Btu/h</th>
<th>Total Btu/h</th>
<th>Percent of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar Gain</td>
<td>38,798</td>
<td></td>
<td>38,798</td>
<td>4.8%</td>
</tr>
<tr>
<td>Glass Transmission</td>
<td>35,489</td>
<td>35,489</td>
<td>4.4%</td>
<td></td>
</tr>
<tr>
<td>Wall Transmission</td>
<td>15,889</td>
<td>15,889</td>
<td>2.0%</td>
<td></td>
</tr>
<tr>
<td>Roof Transmission</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td></td>
</tr>
<tr>
<td>Floor Transmission</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td></td>
</tr>
<tr>
<td>Adj Floor Transmission</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td></td>
</tr>
<tr>
<td>Partition Transmission</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td></td>
</tr>
<tr>
<td>Net Ceiling Load</td>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td></td>
</tr>
<tr>
<td>Lighting</td>
<td>86,450</td>
<td>86,450</td>
<td>10.8%</td>
<td></td>
</tr>
<tr>
<td>People</td>
<td>50,135</td>
<td>43,665</td>
<td>370,190</td>
<td>46.3%</td>
</tr>
<tr>
<td>Misc. Equipment Loads</td>
<td>54,608</td>
<td>54,608</td>
<td>6.8%</td>
<td></td>
</tr>
<tr>
<td>Cooling Infiltration</td>
<td>116,208</td>
<td>253,982</td>
<td>93,804</td>
<td>11.7%</td>
</tr>
<tr>
<td>**Sub-Total **</td>
<td><strong>397,577</strong></td>
<td><strong>297,847</strong></td>
<td><strong>695,224</strong></td>
<td><strong>86.9%</strong></td>
</tr>
</tbody>
</table>

COOLING COIL SELECTION

<table>
<thead>
<tr>
<th>Load Component</th>
<th>Sensible Btu/h</th>
<th>Latent Btu/h</th>
<th>Total Btu/h</th>
<th>Percent of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Cooling Load</td>
<td>473,818</td>
<td>326,218</td>
<td>800,037</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

COIL SELECTION PARAMETERS

- **Coil Entering Air (DB / WB)**: 76.5 / 65.5 °F
- **Coil Entering Humidity Ratio**: 76.86 gr/lb
- **Coil Leaving Air (DB / WB)**: 55.4 / 52.4 °F
- **Coil Leaving Humidity Ratio**: 54.19 gr/lb
- **Coil Sensible Load**: 473.82 MBh
- **Coil Total Load**: 800.04 MBh
- **Cooling Supply Air Temperature**: 55.41 °F
- **Total Cooling Airflow**: 20,304.29 cfm
- **Resulting Room Relative Humidity**: 62.09 %

General Engineering Checks

- **Total Cooling Load**: 66.7 ton
- **Total Floor Area**: 20,801 ft²
- **Cooling Airflow**: 0.98 cfm/ft²
- **Airflow / Load**: 304.55 cfm/ton
- **Percent Outdoor Air**: 0.0 %
- **Cooling Load Methodology**: CLTD-CLF (ASHRAE TFM)

TRACE® 700 v6.3.4 calculated at 12:10 PM on 12/14/2018

*Project Name: 17123 - Daytona State College*
*Dataset Name: 17123 - CALC.TRC*
Load / Airflow Summary
By RLF
Floor
System

Zone

Room **

Coil

Coil

Space

Cooling

Cooling

Design

Air

Minimum

VAV
VAV

Main Coil
Heating

Heating
Fan

Percent

Area

People

Sensible

Total

Max SA

Changes

SA

Minimum

Sensible

Max SA

ft²

#

Btu/h

Btu/h

cfm

ach/hr

cfm

%

Btu/h

cfm

OA
Clg

Htg

Alternative 1
101 - SOUTH ENTRY

Rm Peak

240

0.0

8,510

11,441

454

12.61

136

30

-16,527

318

0.0

0.0

102 - WEST ENTRY

Rm Peak

848

0.0

20,424

30,912

833

6.55

250

30

-25,951

583

0.0

0.0

103 - CORRIDOR

Rm Peak

359

0.0

4,632

9,015

188

3.49

56

30

-7,027

132

0.0

0.0

104 - CORRIDOR

Rm Peak

93

0.0

1,200

2,335

49

3.49

15

30

-1,820

34

0.0

0.0

105 - COPY/STORAGE

Rm Peak

107

0.0

2,063

3,370

87

5.45

26

30

-2,247

61

0.0

0.0

106 - OFFICE

Rm Peak

171

1.0

7,259

9,547

343

13.38

103

30

-8,805

240

0.0

0.0

107 - OFFICE

Rm Peak

126

1.0

3,932

5,690

156

8.25

47

30

-3,614

109

0.0

0.0

108 - OFFICE

Rm Peak

120

1.0

5,750

7,063

225

12.52

68

30

-6,565

158

0.0

0.0

110 - OFFICE

Rm Peak

120

1.0

2,993

4,658

129

7.18

39

30

-2,672

90

0.0

0.0

111 - OFFICE

Rm Peak

129

1.0

7,015

8,810

303

15.65

91

30

-6,634

212

0.0

0.0

112 - STORAGE

Rm Peak

101

0.0

2,467

3,716

91

5.98

27

30

-3,704

63

0.0

0.0

113 - STAFF LOUNGE

Rm Peak

248

4.0

4,200

8,228

176

4.73

53

30

-5,078

123

0.0

0.0

113A - TOILET

Rm Peak

22

0.0

284

552

12

3.49

3

30

-431

8

0.0

0.0

114 - WOMEN

Rm Peak

291

0.0

3,754

7,307

152

3.49

46

30

-5,696

107

0.0

0.0

115 - MEN

Rm Peak

249

0.0

3,213

6,253

130

3.49

39

30

-4,874

91

0.0

0.0

116 - MULTI-PURPOSE

Rm Peak

219

3.0

3,560

6,699

149

4.52

45

30

-4,451

104

0.0

0.0

117 - CONFERENCE

Rm Peak

434

8.0

14,727

21,334

620

9.53

186

30

-15,942

434

0.0

0.0

119 - DIRECTOR OFFICE

Rm Peak

289

3.0

17,781

21,063

749

17.27

225

30

-21,919

524

0.0

0.0

120 - NORTH ENTRY

Rm Peak

272

0.0

13,243

15,871

552

13.53

166

30

-21,202

387

0.0

0.0

121 - CHECK IN

Rm Peak

1,331

3.0

17,907

34,624

731

3.66

219

30

-26,219

512

0.0

0.0

122 - CONFERENCE

Rm Peak

475

8.0

25,033

32,073

1,091

15.31

327

30

-35,398

764

0.0

0.0

124 - RECEPT

Rm Peak

71

1.0

2,356

3,377

103

9.70

31

30

-1,711

72

0.0

0.0

124A - VETERANS SERVICES

Rm Peak

781

4.0

15,887

25,814

652

5.56

196

30

-20,972

456

0.0

0.0

124B - LOUNGE

Rm Peak

150

4.0

2,935

5,767

125

5.54

37

30

-3,160

87

0.0

0.0

124C - ELEC

Rm Peak

45

0.0

17,856

18,406

815

120.76

245

30

-5,131

571

0.0

0.0

124D - STOR

Rm Peak

42

0.0

698

1,211

27

4.36

8

30

-1,145

19

0.0

0.0

125A - BENEFITS

Rm Peak

163

1.0

4,065

6,170

167

6.82

50

30

-4,253

117

0.0

0.0

125B - COORDINATOR

Rm Peak

178

1.0

6,321

8,240

253

9.48

76

30

-7,855

177

0.0

0.0

126 - UNISEX

Rm Peak

45

0.0

581

1,130

24

3.49

7

30

-881

17

0.0

0.0

127 - UNISEX

Rm Peak

68

0.0

1,530

2,201

52

5.07

16

30

-2,096

36

0.0

0.0

130 - BREAK RM

Rm Peak

134

4.0

2,729

5,365

116

5.78

35

30

-2,846

81

0.0

0.0

131 - FOOD

Rm Peak

110

0.0

1,419

2,762

58

3.49

17

30

-2,153

40

0.0

0.0

132 - CUSTODIAL

Rm Peak

39

0.0

503

979

20

3.49

6

30

-763

14

0.0

0.0

133A - OFFICE

Rm Peak

154

1.0

3,431

5,512

147

6.37

44

30

-3,337

103

0.0

0.0

134 - SCULLERY

Rm Peak

166

2.0

2,642

5,169

110

4.42

33

30

-3,361

77

0.0

0.0

* This report does not display heating only systems.

Project Name:

17123 - Daytona State College

Dataset Name:

17123 - CALC.TRC

TRACE® 700 v6.3.4 calculated at 12:10 PM on 12/14/2018
Load/Airflow Summary Report Page 1 of 2


<table>
<thead>
<tr>
<th>System</th>
<th>Zone Room **</th>
<th>Sys Peak</th>
<th>Sys Block</th>
</tr>
</thead>
<tbody>
<tr>
<td>136 - OFFICE</td>
<td>Rm Peak</td>
<td>20,801</td>
<td>20,801</td>
</tr>
<tr>
<td>137 - PASSAGE</td>
<td>Rm Peak</td>
<td>324</td>
<td>1.0</td>
</tr>
<tr>
<td>138 - PASSAGE</td>
<td>Rm Peak</td>
<td>319</td>
<td>1.0</td>
</tr>
<tr>
<td>138A - CORRIDOR</td>
<td>Rm Peak</td>
<td>128</td>
<td>1.0</td>
</tr>
<tr>
<td>139 - LOADING DOCK</td>
<td>Rm Peak</td>
<td>71</td>
<td>1.0</td>
</tr>
<tr>
<td>140 - WALK-IN</td>
<td>Rm Peak</td>
<td>89</td>
<td>1.0</td>
</tr>
<tr>
<td>141 - WALK-IN</td>
<td>Rm Peak</td>
<td>121</td>
<td>1.0</td>
</tr>
<tr>
<td>142 - FOOD PREP</td>
<td>Rm Peak</td>
<td>967</td>
<td>5.0</td>
</tr>
<tr>
<td>143 - WALK-IN</td>
<td>Rm Peak</td>
<td>52</td>
<td>0.0</td>
</tr>
<tr>
<td>144 - MECHANICAL</td>
<td>Rm Peak</td>
<td>480</td>
<td>0.0</td>
</tr>
<tr>
<td>144A - ELEC</td>
<td>Rm Peak</td>
<td>24</td>
<td>1.0</td>
</tr>
<tr>
<td>145 - DRY STORAGE</td>
<td>Rm Peak</td>
<td>434</td>
<td>1.0</td>
</tr>
<tr>
<td>146 - SANDWICH PREP</td>
<td>Rm Peak</td>
<td>102</td>
<td>1.0</td>
</tr>
<tr>
<td>148 - SERVING</td>
<td>Rm Peak</td>
<td>1,397</td>
<td>30.0</td>
</tr>
<tr>
<td>148A - NEW MECHANICAL</td>
<td>Rm Peak</td>
<td>686</td>
<td>0.0</td>
</tr>
<tr>
<td>149 - STUDENT LOUNGE</td>
<td>Rm Peak</td>
<td>841</td>
<td>22.0</td>
</tr>
<tr>
<td>150 - STORAGE</td>
<td>Rm Peak</td>
<td>530</td>
<td>0.0</td>
</tr>
<tr>
<td>151 - APPAREL</td>
<td>Rm Peak</td>
<td>439</td>
<td>0.0</td>
</tr>
<tr>
<td>152 - UNISEX FITTING</td>
<td>Rm Peak</td>
<td>95</td>
<td>0.0</td>
</tr>
<tr>
<td>153 - OFFICE</td>
<td>Rm Peak</td>
<td>99</td>
<td>1.0</td>
</tr>
<tr>
<td>154 - CLASSROOM</td>
<td>Rm Peak</td>
<td>921</td>
<td>20.0</td>
</tr>
<tr>
<td>155 - SERVER</td>
<td>Rm Peak</td>
<td>63</td>
<td>0.0</td>
</tr>
<tr>
<td>156 - LIBRARY</td>
<td>Rm Peak</td>
<td>66</td>
<td>0.0</td>
</tr>
<tr>
<td>162 - CUSTODIAL</td>
<td>Rm Peak</td>
<td>67</td>
<td>0.0</td>
</tr>
<tr>
<td>163 - SPACE</td>
<td>Rm Peak</td>
<td>135</td>
<td>0.0</td>
</tr>
<tr>
<td>163 - TECH LAB</td>
<td>Rm Peak</td>
<td>2,448</td>
<td>50.0</td>
</tr>
<tr>
<td>163B - OFFICE</td>
<td>Rm Peak</td>
<td>154</td>
<td>1.0</td>
</tr>
<tr>
<td>163C - STORAGE</td>
<td>Rm Peak</td>
<td>58</td>
<td>0.0</td>
</tr>
<tr>
<td>164 - STUDY/LOUNGE</td>
<td>Rm Peak</td>
<td>887</td>
<td>15.0</td>
</tr>
<tr>
<td>164A - EAST ENTRY</td>
<td>Rm Peak</td>
<td>86</td>
<td>0.0</td>
</tr>
</tbody>
</table>

* This report does not display heating only systems.
### Room Checksums

**By RLF**

#### COOLING COIL PEAK

<table>
<thead>
<tr>
<th>Space Sens. + Lat. (%)</th>
<th>Plenum Sens. + Lat. (%)</th>
<th>Space Sens. Of Total (%)</th>
<th>Plenum Sens. Of Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Envelope Loads</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skylite Solar</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Skylite Cond</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Roof Cond</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Glass Solar</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Glass/Door Cond</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Wall Cond</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Partition/Door</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Floor</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Adjacent Floor</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Infiltration</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Sub Total</td>
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<td>889</td>
<td>10,358</td>
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#### CLG SPACE PEAK

<table>
<thead>
<tr>
<th>Space Sens. + Lat. (%)</th>
<th>Plenum Sens. + Lat. (%)</th>
<th>Space Sens. Of Total (%)</th>
<th>Plenum Sens. Of Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceiling Load</td>
<td>111</td>
<td>-111</td>
<td>-82</td>
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<tr>
<td>Ventilation Load</td>
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<td>0.0</td>
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<tr>
<td>Adj Air Trans Heat</td>
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<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Dehumid. Ov Sizing</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Ov/Undr Sizing</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Exhaust Heat</td>
<td>-146</td>
<td>-146</td>
<td>-1</td>
</tr>
<tr>
<td>Sup. Fan Heat</td>
<td>0.0</td>
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<td>0.0</td>
</tr>
<tr>
<td>Ret. Fan Heat</td>
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<tr>
<td>Duct Heat Pkup</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Underflr Sup Ht Pkup</td>
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<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Supply Air Leakage</td>
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<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Sub Total</td>
<td>983</td>
<td>246</td>
<td>1,229</td>
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</table>

#### HEATING COIL PEAK

<table>
<thead>
<tr>
<th>Space Sens. + Lat. (%)</th>
<th>Plenum Sens. + Lat. (%)</th>
<th>Space Sens. Of Total (%)</th>
<th>Plenum Sens. Of Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Envelope Loads</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skylite Solar</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Skylite Cond</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Roof Cond</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Glass Solar</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Glass/Door Cond</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Wall Cond</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Partition/Door</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Floor</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Adjacent Floor</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Infiltration</td>
<td>-3,529</td>
<td>-3,529</td>
<td>21.36</td>
</tr>
<tr>
<td>Sub Total</td>
<td>-13,763</td>
<td>-14,358</td>
<td>88.88</td>
</tr>
</tbody>
</table>

#### TEMPERATURES

- **Cooling**
  - SADB: 55.4
  - Ra Plenum: 76.5
  - Return: 76.5
  - Ret/OA: 76.5
- **Heating**
  - SADB: 164.6
  - Ra Plenum: 62.7
  - Return: 62.7
  - Ret/OA: 62.7

#### AIRFLOWS

- **Cooling**
  - Diffuser: 454
  - Terminal: 454
  - Min/Stop/Rh: 136
- **Heating**
  - Exhaust: 90
  - Rm Exh: 90
  - Auxiliary: 90

#### ENGINEERING CKS

- **% OA**
  - Cooling: 0.0
  - Heating: 0.0
- **cfm/ft²**
  - Cooling: 1.89
  - Heating: 1.89
- **cfm/ton**
  - Cooling: 476.18
  - Heating: 251.73

#### AREAS

- **Floor**
  - Gross Total: 240 ft²
  - Glass: 0.0 ft²
- **Main Htg**
  - -16.5 ft²
- **Preheat**
  - 0.0 ft²
- **Reheat**
  - -2.2 ft²
- **Humidif**
  - 0.0 ft²
- **Opt Vent**
  - 0.0 ft²
- **Total**
  - -16.5 ft²

#### COOLING COIL SELECTION

<table>
<thead>
<tr>
<th>Total Capacity ton</th>
<th>Sens Cap. MBh</th>
<th>Coil Airflow cfm</th>
<th>Enter DB/DB/HR °F</th>
<th>Leave DB/DB/HR °F</th>
<th>Underflr Sup Ht Pkup</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Clg</td>
<td>1.0</td>
<td>11.4</td>
<td>8.5</td>
<td>454</td>
<td>76.5 66.3</td>
</tr>
<tr>
<td>Aux Clg</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Opt Vent</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Total</td>
<td>1.0</td>
<td>11.4</td>
<td>8.5</td>
<td>454</td>
<td>76.5 66.3</td>
</tr>
</tbody>
</table>

#### HEATING COIL SELECTION

<table>
<thead>
<tr>
<th>Capacity Coil Airflow M Bh</th>
<th>Ent Lvg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Htg</td>
<td>-16.5</td>
</tr>
<tr>
<td>Aux Htg</td>
<td>0.0</td>
</tr>
<tr>
<td>Preheat</td>
<td>0.0</td>
</tr>
<tr>
<td>Reheat</td>
<td>-2.2</td>
</tr>
<tr>
<td>Humidif</td>
<td>0.0</td>
</tr>
<tr>
<td>Opt Vent</td>
<td>0.0</td>
</tr>
<tr>
<td>Total</td>
<td>-16.5</td>
</tr>
</tbody>
</table>

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**Project Name:** 17123 - Daytona State College  
**Dataset Name:** 17123 - CALC.TRC  
**TRACE® 700 v6.3.4 calculated at 12:10 PM on 12/14/2018**
### Room Checksums

**By RLF**

#### COOLING COIL PEAK

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Plenum Sens. + Lat.</th>
<th>Net Total</th>
<th>Percent of Total</th>
<th>Space Sensible</th>
<th>Percent of Total</th>
<th>Envelope Loads</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
<td></td>
<td>Btu/h</td>
<td>(%)</td>
<td>Skylite Solar</td>
</tr>
<tr>
<td>Skylite Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Skylite Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Roof Cond</td>
<td>0</td>
<td>2,051</td>
<td>2,051</td>
<td>7</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Glass Solar</td>
<td>6,275</td>
<td>6,275</td>
<td>6,140</td>
<td>34</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Glass/Door Cond</td>
<td>2,259</td>
<td>0</td>
<td>2,251</td>
<td>14</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Wall Cond</td>
<td>660</td>
<td>833</td>
<td>1,493</td>
<td>5</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Part/Door</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Floor</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Adjacent Floor</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0</td>
</tr>
<tr>
<td>Infiltration</td>
<td>14,836</td>
<td>14,836</td>
<td>4,875</td>
<td>27</td>
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<td>0</td>
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<tr>
<td><strong>Sub Total ==&gt;</strong></td>
<td>24,031</td>
<td>2,883</td>
<td>26,914</td>
<td>87</td>
<td>76.0</td>
<td>62.0</td>
</tr>
</tbody>
</table>

#### Internal Loads

| Ceiling Load       | 262                | -262      | 0                | 0              | 448              | 2              |
| Ventilation Load   | 0                  | 0         | 0                | 0              | 0                | 0              |
| Adj Air Trans Heat | 0                  | 0         | 0                | 0              | 0                | 0              |
| Dehumid. Ov Sizing| 0                  | 0         | 0                | 0              | 0                | 0              |
| Ov/Undr Sizing     | 0                  | 0         | 0                | 0              | 0                | 0              |
| Exhaust Heat       | -344               | -344      | -344             | -1             | 0                | 0              |
| Duct Heat Pkup     | 0                  | 0         | 0                | 0              | 0                | 0              |
| Supply Air Leakage | 0                  | 0         | 0                | 0              | 0                | 0              |
| **Sub Total ==>**  | 3,473              | 868       | 4,441            | 14             | 3,473            | 19             |

#### Ceiling Load

| Ceiling Load       | 262                | -262      | 0                | 0              | 448              | 2              |
| Ventilation Load   | 0                  | 0         | 0                | 0              | 0                | 0              |
| Adj Air Trans Heat | 0                  | 0         | 0                | 0              | 0                | 0              |
| Dehumid. Ov Sizing| 0                  | 0         | 0                | 0              | 0                | 0              |
| Ov/Undr Sizing     | 0                  | 0         | 0                | 0              | 0                | 0              |
| Exhaust Heat       | -344               | -344      | -344             | -1             | 0                | 0              |
| Duct Heat Pkup     | 0                  | 0         | 0                | 0              | 0                | 0              |
| Supply Air Leakage | 0                  | 0         | 0                | 0              | 0                | 0              |
| **Grand Total ==>**| 27,765             | 3,146     | 30,912           | 100.00         | 18,125           | 100.00         |

#### COOLING COIL SELECTION

<table>
<thead>
<tr>
<th>Total Capacity</th>
<th>Sens Cap</th>
<th>Coil Airflow</th>
<th>Enter DB/DB/HR</th>
<th>Leave DB/DB/HR</th>
<th>Cool Airflow</th>
</tr>
</thead>
<tbody>
<tr>
<td>ton</td>
<td>MBl/h</td>
<td>MBl/h</td>
<td>°F</td>
<td>°F</td>
<td>gr/lb</td>
</tr>
<tr>
<td>Main Clg</td>
<td>2.6</td>
<td>30.9</td>
<td>20.4</td>
<td>24.1</td>
<td>833</td>
</tr>
<tr>
<td>Aux Clg</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Opt Vent</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>2.6</td>
<td>30.9</td>
<td>20.4</td>
<td>24.1</td>
<td>833</td>
</tr>
</tbody>
</table>

#### AREAS

<table>
<thead>
<tr>
<th>Total Area</th>
<th>Gross Total</th>
<th>Glass ft² (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor</td>
<td>848</td>
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</tr>
<tr>
<td>Part</td>
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<td></td>
</tr>
<tr>
<td>Int Door</td>
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<td></td>
</tr>
<tr>
<td>ExFlr</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Roof</td>
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<td>0</td>
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<tr>
<td>Wall</td>
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<td>165</td>
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<tr>
<td>Ext Door</td>
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<tr>
<td><strong>Total</strong></td>
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<td>-25,951</td>
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#### HEATING COIL SELECTION

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Coil Airflow</th>
<th>Ent Lvg</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBl/h</td>
<td>°F</td>
<td>°F</td>
</tr>
<tr>
<td>Main Htg</td>
<td>-26.0</td>
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</tr>
<tr>
<td>Aux Htg</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Preheat</td>
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<td>0.0</td>
</tr>
<tr>
<td>Reheat</td>
<td>-4.1</td>
<td>250</td>
</tr>
<tr>
<td>Humidif</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Opt Vent</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>-26.0</td>
<td></td>
</tr>
</tbody>
</table>

#### TEMPERATURES

<table>
<thead>
<tr>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>SADB</td>
<td>55.4</td>
</tr>
<tr>
<td>Ra Plenum</td>
<td>76.0</td>
</tr>
<tr>
<td>Return</td>
<td>76.0</td>
</tr>
<tr>
<td>Ret/OA</td>
<td>76.0</td>
</tr>
<tr>
<td>Mfr TD</td>
<td>0.0</td>
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<tr>
<td>Bld TD</td>
<td>0.0</td>
</tr>
<tr>
<td>Fric</td>
<td>0.0</td>
</tr>
</tbody>
</table>

#### AIRFLOWS

| Diffuser  | 833 | 250 |
| Terminal  | 833 | 250 |
| Main Fan  | 833 | 250 |
| Sec Fan   | 0.0 | 0.0 |
| Nom Vent  | 0.0 | 0.0 |
| AHU Vent  | 0.0 | 0.0 |
| Infil     | 318 | 318 |
| Exhaust   | 318 | 318 |

#### ENGINEERING CKS

<table>
<thead>
<tr>
<th>% OA</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
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<td>0.0</td>
</tr>
<tr>
<td>0.98</td>
<td>0.98</td>
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</tr>
</tbody>
</table>

#### TRACE® 700 v6.3.4 calculated at 12:10 PM on 12/14/2018

**Project Name:** 17123 - Daytona State College  
**Dataset Name:** 17123 - CALC.TRC
### Room Checksums

**By RLF**

#### COOLING COIL PEAK

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Plenum Sens. + Lat.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
<tr>
<td>Envelope Loads</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skylite Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Skylite Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Roof Cond</td>
<td>0</td>
<td>1,006</td>
<td>1,006</td>
</tr>
<tr>
<td>Glass Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Glass/Door Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wall Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Partition/Door</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Floor</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Adjacent Floor</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Infiltration</td>
<td>6,389</td>
<td>6,389</td>
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</tr>
<tr>
<td><strong>Sub Total ==&gt;</strong></td>
<td>6,389</td>
<td>1,006</td>
<td>7,395</td>
</tr>
</tbody>
</table>

#### CLG SPACE PEAK

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>(%)</td>
</tr>
<tr>
<td>Envelope Loads</td>
<td></td>
</tr>
<tr>
<td>Skylite Solar</td>
<td>0</td>
</tr>
<tr>
<td>Skylite Cond</td>
<td>0</td>
</tr>
<tr>
<td>Roof Cond</td>
<td>0</td>
</tr>
<tr>
<td>Glass Solar</td>
<td>0</td>
</tr>
<tr>
<td>Glass/Door Cond</td>
<td>0</td>
</tr>
<tr>
<td>Wall Cond</td>
<td>0</td>
</tr>
<tr>
<td>Partition/Door</td>
<td>0</td>
</tr>
<tr>
<td>Floor</td>
<td>0</td>
</tr>
<tr>
<td>Adjacent Floor</td>
<td>0</td>
</tr>
<tr>
<td>Infiltration</td>
<td>-5,280</td>
</tr>
<tr>
<td><strong>Sub Total ==&gt;</strong></td>
<td>-5,280</td>
</tr>
</tbody>
</table>

#### HEATING COIL PEAK

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>(%)</td>
</tr>
<tr>
<td>Envelope Loads</td>
<td></td>
</tr>
<tr>
<td>Skylite Solar</td>
<td>0</td>
</tr>
<tr>
<td>Skylite Cond</td>
<td>0</td>
</tr>
<tr>
<td>Roof Cond</td>
<td>0</td>
</tr>
<tr>
<td>Glass Solar</td>
<td>0</td>
</tr>
<tr>
<td>Glass/Door Cond</td>
<td>0</td>
</tr>
<tr>
<td>Wall Cond</td>
<td>0</td>
</tr>
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<td>Partition/Door</td>
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</tr>
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<td>Floor</td>
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<tr>
<td>Adjacent Floor</td>
<td>0</td>
</tr>
<tr>
<td>Infiltration</td>
<td>-5,280</td>
</tr>
<tr>
<td><strong>Sub Total ==&gt;</strong></td>
<td>-5,280</td>
</tr>
</tbody>
</table>

#### TEMPERATURES

<table>
<thead>
<tr>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>SADB</td>
<td>55.4</td>
</tr>
<tr>
<td>Ra Plenum</td>
<td>76.5</td>
</tr>
<tr>
<td>Return</td>
<td>76.5</td>
</tr>
<tr>
<td>Ret/OA</td>
<td>76.5</td>
</tr>
<tr>
<td>Fm Mtr/TD</td>
<td>0.0</td>
</tr>
<tr>
<td>Fm Bl/TD</td>
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</tr>
<tr>
<td>Fm FricT</td>
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#### AIRFLOWS

<table>
<thead>
<tr>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diffuser</td>
<td>188</td>
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<tr>
<td>Terminal</td>
<td>188</td>
</tr>
<tr>
<td>Main Fan</td>
<td>188</td>
</tr>
<tr>
<td>Sec Fan</td>
<td>0</td>
</tr>
<tr>
<td>Nom Vent</td>
<td>0</td>
</tr>
<tr>
<td>AHU Vent</td>
<td>0</td>
</tr>
<tr>
<td>Infi</td>
<td>135</td>
</tr>
<tr>
<td>MinStop/Rh</td>
<td>56</td>
</tr>
<tr>
<td>Exhaust</td>
<td>135</td>
</tr>
<tr>
<td>Rm Exh</td>
<td>0</td>
</tr>
<tr>
<td>Auxiliary</td>
<td>0</td>
</tr>
<tr>
<td>Leakage Dwn</td>
<td>0</td>
</tr>
<tr>
<td>Leakage Ups</td>
<td>0</td>
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</tbody>
</table>

#### ENGINEERING CKS

<table>
<thead>
<tr>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>% OA</td>
<td>0.0</td>
</tr>
<tr>
<td>cfm/ft²</td>
<td>0.52</td>
</tr>
<tr>
<td>cfm/ton</td>
<td>250.39</td>
</tr>
<tr>
<td>ft²/ton</td>
<td>477.87</td>
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<tr>
<td>Btu/hr/ft²</td>
<td>25.11</td>
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#### AREAS

<table>
<thead>
<tr>
<th>Gross Total</th>
<th>Glass ft² (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor</td>
<td>359</td>
</tr>
<tr>
<td>Part</td>
<td>0</td>
</tr>
<tr>
<td>Int Door</td>
<td>0</td>
</tr>
<tr>
<td>ExFlr</td>
<td>0</td>
</tr>
<tr>
<td>Roof</td>
<td>359</td>
</tr>
<tr>
<td>Wall</td>
<td>0</td>
</tr>
<tr>
<td>Ext Door</td>
<td>0</td>
</tr>
</tbody>
</table>

#### HEATING COIL SELECTION

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Coil Airflow</th>
<th>Ent</th>
<th>Lvg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Htg</td>
<td>-7.0</td>
<td>56</td>
<td>55.4</td>
</tr>
<tr>
<td>Aux Htg</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Preheat</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Reheat</td>
<td>-0.9</td>
<td>56</td>
<td>55.4</td>
</tr>
<tr>
<td>Humidif</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Opt Vent</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>-7.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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**Project Name:** 17123 - Daytona State College  
**Dataset Name:** 17123 - CALC.TRC

TRACE® 700 v6.3.4 calculated at 12:10 PM on 12/14/2018  
Alternative - 1 System Checksums Report Page 3 of 66
### Room Checksums

**By RLF**

**104 - CORRIDOR**

<table>
<thead>
<tr>
<th>COOLING COIL PEAK</th>
<th>CLG SPACE PEAK</th>
<th>HEATING COIL PEAK</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Heating Design Mo/Hr:</strong></td>
<td><strong>Cooling Mo/Hr:</strong></td>
<td><strong>Heating Design Mo/Hr:</strong></td>
</tr>
<tr>
<td>6 / 15</td>
<td>8 / 16</td>
<td>OADB: 35</td>
</tr>
<tr>
<td><strong>Outside Air:</strong></td>
<td><strong>Outside Air:</strong></td>
<td><strong>OADB:</strong></td>
</tr>
<tr>
<td>OADB/WB/HR: 88 / 78 / 128</td>
<td>OADB: 91</td>
<td><strong>OADB:</strong></td>
</tr>
<tr>
<td><strong>Heating Design</strong></td>
<td><strong>Cooling</strong></td>
<td><strong>Heating</strong></td>
</tr>
<tr>
<td><strong>Sensible</strong></td>
<td><strong>Total</strong></td>
<td><strong>Sensible</strong></td>
</tr>
<tr>
<td><strong>Net</strong></td>
<td><strong>Percent</strong></td>
<td><strong>Net</strong></td>
</tr>
<tr>
<td><strong>Of Total</strong></td>
<td>(%)</td>
<td><strong>Of Total</strong></td>
</tr>
<tr>
<td><strong>Space Sens. + Lat.</strong></td>
<td><strong>Plenum Sens. + Lat.</strong></td>
<td><strong>Space Sens. + Lat.</strong></td>
</tr>
<tr>
<td><strong>Btu/h</strong></td>
<td><strong>Btu/h</strong></td>
<td><strong>Btu/h</strong></td>
</tr>
</tbody>
</table>

**Internal Loads**

- **Lights:**
  - **Btu/h:** 381
  - **%:** 20
- **People:**
  - **Btu/h:** 0
  - **%:** 0
- **Misc:**
  - **Btu/h:** 0
  - **%:** 0
- **Sub Total ==>**
  - **Btu/h:** 381
  - **%:** 20

**Ceiling Load**

- **Btu/h:** 43
- **%:** 6

**Ventilation Load**

- **Btu/h:** 0
- **%:** 0

**Adj Air Trans Heat**

- **Btu/h:** 0
- **%:** 0

**Dehumid. Ov Sizing**

- **Btu/h:** 0
- **%:** 0

**Ov/Undr Sizing**

- **Btu/h:** 0
- **%:** 0

**Exhaust Heat**

- **Btu/h:** -56
- **%:** -2

**Sup. Fan Heat**

- **Btu/h:** 0
- **%:** 0

**Ret. Fan Heat**

- **Btu/h:** 0
- **%:** 0

**Duct Heat Pkup**

- **Btu/h:** 0
- **%:** 0

**Underflr Sup Ht Pkup**

- **Btu/h:** 0
- **%:** 0

**Supply Air Leakage**

- **Btu/h:** 0
- **%:** 0

**Grand Total ==>**

- **Btu/h:** 2,079
- **%:** 100

**AIRFLOWS**

- **Cooling:**
  - **Diffuser:** 49
- **Terminal:** 49
- **Main Fan:** 49
- **Sec Fan:** 0
- **Nom Vent:** 0
- **AHU Vent:** 0
- **Infil:** 35
- **MinStop/Rh:** 15
- **Exhaust:** 35
- **Auxiliary:** 0
- **Leakage Dwn:** 0
- **Leakage Ups:** 0

**TEMPERATURES**

- **Cooling**
  - **SADB:** 55.4
  - **Ra Plenum:** 76.5
  - **Return:** 76.5
  - **Ret/OA:** 76.5
  - **Fn MtrTD:** 0
  - **Fn BltdTD:** 0
  - **Fn Fric:** 0

- **Heating**
  - **SADB:** 167.5
  - **Ra Plenum:** 62.7
  - **Return:** 62.7
  - **Ret/OA:** 62.7
  - **Fn MtrTD:** 0
  - **Fn BltdTD:** 0
  - **Fn Fric:** 0

**ENGINEERING CKS**

- **% OA**
  - **Cooling:** 0.0
  - **Heating:** 0.0

**COOLING COIL SELECTION**

<table>
<thead>
<tr>
<th><strong>Total Capacity</strong></th>
<th><strong>Sens Cap.</strong></th>
<th><strong>Coil Airflow</strong></th>
<th><strong>Enter DB/WB/HR</strong></th>
<th><strong>Leave DB/WB/HR</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ton</strong></td>
<td><strong>MBh</strong></td>
<td><strong>MBh</strong></td>
<td><strong>cfm</strong></td>
<td><strong>°F</strong></td>
</tr>
<tr>
<td><strong>Main Clg</strong></td>
<td>0.2</td>
<td>2.3</td>
<td>1.2</td>
<td>49</td>
</tr>
<tr>
<td><strong>Aux Clg</strong></td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Opt Vent</strong></td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>0.2</td>
<td>2.3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**AREAS**

<table>
<thead>
<tr>
<th><strong>Class</strong></th>
<th><strong>Gross Total</strong></th>
<th><strong>Glass</strong></th>
<th><strong>ft² (%)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Floor</strong></td>
<td>93</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Part</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Int Door</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>ExFlr</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Roof</strong></td>
<td>93</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Wall</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Ext Door</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**HEATING COIL SELECTION**

<table>
<thead>
<tr>
<th><strong>Capacity</strong></th>
<th><strong>Coil Airflow</strong></th>
<th><strong>Ent</strong></th>
<th><strong>Lvg</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Btu/hr</strong></td>
<td><strong>cfm</strong></td>
<td><strong>°F</strong></td>
<td><strong>°F</strong></td>
</tr>
<tr>
<td><strong>Main Htg</strong></td>
<td>-1.8</td>
<td>15</td>
<td>55.4</td>
</tr>
<tr>
<td><strong>Aux Htg</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Preheat</strong></td>
<td>0.0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Reheat</strong></td>
<td>-0.2</td>
<td>15</td>
<td>55.4</td>
</tr>
<tr>
<td><strong>Humidif</strong></td>
<td>0.0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Opt Vent</strong></td>
<td>0.0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>-1.8</td>
<td>15</td>
<td>55.4</td>
</tr>
</tbody>
</table>

**TRACE® 700 v6.3.4 calculated at 12:10 PM on 12/14/2018**

**Dataset Name:** 17123 - CALC.TRC
Room Checksums
By RLF

105 - COPY/STORAGE

**COOLING COIL PEAK**
Peaked at Time: Mo/Hr: 8 / 16
Outside Air: OADB/WB/HR: 88 / 78 / 128

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Plenum Sens. + Lat.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
</tbody>
</table>

**CLG SPACE PEAK**
Mo/Hr: 6 / 15

**HEATING COIL PEAK**
Mo/Hr: Heating Design
OADB: 91

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Plenum Sens. + Lat.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
</tbody>
</table>

**Envelope Loads**

<table>
<thead>
<tr>
<th>Skylite Solar</th>
<th>Skylite Cond</th>
<th>Roof Cond</th>
<th>Glass Solar</th>
<th>Glass/Door Cond</th>
<th>Wall Cond</th>
<th>Partition/Door</th>
<th>Floor</th>
<th>Adjacent Floor</th>
<th>Infiltration</th>
<th>Sub Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1,904</td>
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**Internal Loads**

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<tr>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>438</td>
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<td>-1,574</td>
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**Grand Total**

<table>
<thead>
<tr>
<th>Total Capacity</th>
<th>Sens Cap.</th>
<th>Coil Airflow</th>
<th>Enter DB/DB/HR</th>
<th>Leave DB/DB/HR</th>
</tr>
</thead>
<tbody>
<tr>
<td>ton</td>
<td>MBh</td>
<td>MBh</td>
<td>°F</td>
<td>°F</td>
</tr>
<tr>
<td>M B</td>
<td>M B</td>
<td>cfm</td>
<td>gr/lb</td>
<td>gr/lb</td>
</tr>
</tbody>
</table>

**COOLING COIL SELECTION**

<table>
<thead>
<tr>
<th>Main Clg</th>
<th>Aux Clg</th>
<th>Opt Vent</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.3</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

**AREAS**

<table>
<thead>
<tr>
<th>Gross Total</th>
<th>Glass ft² (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor</td>
<td>107</td>
</tr>
<tr>
<td>Part</td>
<td>0</td>
</tr>
<tr>
<td>Int Door</td>
<td>0</td>
</tr>
<tr>
<td>ExFlr</td>
<td>0</td>
</tr>
<tr>
<td>Roof</td>
<td>0</td>
</tr>
<tr>
<td>Wall</td>
<td>0</td>
</tr>
<tr>
<td>Ext Door</td>
<td>0</td>
</tr>
</tbody>
</table>

**HEATING COIL SELECTION**

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Coil Airflow</th>
<th>Ent</th>
<th>Lvg</th>
</tr>
</thead>
<tbody>
<tr>
<td>M Bh</td>
<td>cfm</td>
<td>°F</td>
<td>°F</td>
</tr>
</tbody>
</table>

**TEMPERATURES**

<table>
<thead>
<tr>
<th>SADB</th>
<th>Ra Plenum</th>
<th>Ret/OA</th>
<th>Fn MtrTD</th>
<th>Fn BltTD</th>
<th>Fn Frict</th>
</tr>
</thead>
<tbody>
<tr>
<td>55.4</td>
<td>123.5</td>
<td>76.5</td>
<td>62.7</td>
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<td>0.0</td>
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</table>

**AIRFLOWS**

<table>
<thead>
<tr>
<th>Diffuser</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>87</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>Terminal</td>
<td>87</td>
<td>87</td>
</tr>
<tr>
<td>Main Fan</td>
<td>128</td>
<td>128</td>
</tr>
<tr>
<td>Sec Fan</td>
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<td>0</td>
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<tr>
<td>Nom Vent</td>
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<td>0</td>
</tr>
<tr>
<td>AHU Vent</td>
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<td>0</td>
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<td>Infl</td>
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<td>40</td>
</tr>
</tbody>
</table>

**ENGINEERING CKS**

<table>
<thead>
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<th>% OA</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>cfm/ft²</td>
<td>0.82</td>
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<tr>
<td>cfm/ton</td>
<td>311.38</td>
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<tr>
<td>ft³/ton</td>
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<td>381.06</td>
</tr>
<tr>
<td>Btu/hr/ft²</td>
<td>31.49</td>
<td>31.49</td>
</tr>
</tbody>
</table>

**No. People**

<table>
<thead>
<tr>
<th>0.0/1000 ft²</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0/1000 ft²</td>
</tr>
</tbody>
</table>

**Supply Air Leakage**

<table>
<thead>
<tr>
<th>Adjacent Floor</th>
<th>Ext Door</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

**Underflr Sup Ht Pkup**

<table>
<thead>
<tr>
<th>Adjacent Floor</th>
<th>Ext Door</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

**System Checksums Report Page 5 of 66**
### Room Checksums

**By RLF**

**Room Checksums**

### COOLING COIL PEAK

**Peaked at Time:**
- Mo/Hr: 8 / 16
- Mo/Hr: 11 / 15

**Outside Air:**
- OADB: 88 / 78 / 128
- OADB: 83

### CLG SPACE PEAK

**Mo/Hr:** Heating Design
- OADB: 35

### HEATING COIL PEAK

**Mo/Hr:** Heating Design
- OADB: 35

### TEMPERATURES

**Cooling**
- SADB: 55.4
- Ra Plenum: 76.5
- Return: 76.5
- Ret/OA: 76.5
- Fn MtrTD: 0.0
- Fn BldTD: 0.0
- Fn Frict: 0.0

**Heating**
- SADB: 132.4
- Ra Plenum: 62.7
- Return: 62.7
- Ret/OA: 62.7
- Fn MtrTD: 0.0
- Fn BldTD: 0.0
- Fn Frict: 0.0

### AIRFLOWS

**Cooling**
- Diffuser: 343
- Terminal: 103
- Main Fan: 343
- Sec Fan: 0
- Nom Vent: 0
- AHU Vent: 0
- Infil: 64
- MinStop/Rh: 103
- Exhaust: 64
- Auxiliary: 0
- Rm Exh: 0
- Leakage Dwn: 0
- Leakage Ups: 0

**Heating**
- Diffuser: 103
- Terminal: 103
- Main Fan: 343
- Sec Fan: 0
- Nom Vent: 0
- AHU Vent: 0
- Infil: 64
- MinStop/Rh: 103
- Exhaust: 64
- Auxiliary: 0
- Rm Exh: 0
- Leakage Dwn: 0
- Leakage Ups: 0

### ENGINEERING CKS

**% OA**
- Cooling: 0.0
- Heating: 0.0

**cfm/ft²**
- Cooling: 2.01
- Heating: 2.01

**cfm/ton**
- Cooling: 431.22
- Heating: 214.93

**ft²/ton**
- Cooling: 55.83
- Heating: 51.49

**No. People**
- Cooling: 1.0
- Heating: 5.8/1000 ft²

---

### AREAS

<table>
<thead>
<tr>
<th>Gross Total</th>
<th>Glass</th>
<th>ft² (%)</th>
</tr>
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<tbody>
<tr>
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<td>171</td>
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<tr>
<td>Part</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Int Door</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>ExFlr</td>
<td>29</td>
<td></td>
</tr>
<tr>
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<td>171</td>
<td>0</td>
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<tr>
<td>Wall</td>
<td>394</td>
<td>70</td>
</tr>
<tr>
<td>Ext Door</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### HEATING COIL SELECTION

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Coil Airflow</th>
<th>Ent Lvg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mbh</td>
<td>cfm</td>
<td>°F</td>
</tr>
<tr>
<td>Main Htg</td>
<td>8.8</td>
<td>103</td>
</tr>
<tr>
<td>Aux Htg</td>
<td>0.0</td>
<td>55.4</td>
</tr>
<tr>
<td>Preheat</td>
<td>0.0</td>
<td>132.4</td>
</tr>
<tr>
<td>Reheat</td>
<td>-1.7</td>
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</tr>
<tr>
<td>Humidif</td>
<td>0.0</td>
<td>70.0</td>
</tr>
<tr>
<td>Opt Vent</td>
<td>0.0</td>
<td>0.0</td>
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</tbody>
</table>

**Total**
- (-8.8, 103, 55.4, 132.4)

---

### COOLING COIL SELECTION

<table>
<thead>
<tr>
<th>Total Capacity</th>
<th>Sens Cap.</th>
<th>Coil Airflow</th>
<th>Enter DB/WB/HR</th>
<th>Leave DB/WB/HR</th>
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</thead>
<tbody>
<tr>
<td>ton</td>
<td>Mbh</td>
<td>cfm</td>
<td>°F</td>
<td>°F</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>gr/lb</td>
<td>gr/lb</td>
</tr>
<tr>
<td>Main Clg</td>
<td>0.8</td>
<td>9.6</td>
<td>7.3</td>
<td>343</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>76.5</td>
<td>66.3</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>81.2</td>
<td>55.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>55.4</td>
<td>65.8</td>
</tr>
<tr>
<td>Aux Clg</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Opt Vent</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

**Total**
- (0.8, 9.6)
### Room Checksums

By RLF

#### COOLING COIL PEAK

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td></td>
<td></td>
<td>Btu/h</td>
<td></td>
</tr>
<tr>
<td>Envelope Loads</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skylite Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Skylite Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Roof Cond</td>
<td>0</td>
<td>304</td>
<td>304</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Glass Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Glass/Door Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
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<td>Wall Cond</td>
<td>633</td>
<td>310</td>
<td>943</td>
<td>17</td>
<td>640</td>
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<tr>
<td>Partition/Door</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Floor</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Adjacent Floor</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
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<td>Infiltration</td>
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<td>2,204</td>
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<td>724</td>
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<td>2,837</td>
<td>614</td>
<td>3,451</td>
<td>1,364</td>
<td>40</td>
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</table>

#### Heating Design

- **Mo/Hr:**
  - Heating: 6 / 17
  - Cooling: 8 / 17
  - Mo/Hr: Peaked at Time:

#### TEMPERATURES

<table>
<thead>
<tr>
<th>SADB</th>
<th>Cooling</th>
<th>Heating</th>
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<tbody>
<tr>
<td>OADB: 89</td>
<td>55.4</td>
<td>125.0</td>
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<td>Ra Plenum</td>
<td>76.0</td>
<td>62.7</td>
</tr>
<tr>
<td>Return</td>
<td>76.0</td>
<td>62.7</td>
</tr>
<tr>
<td>Ret/OA</td>
<td>76.0</td>
<td>62.7</td>
</tr>
<tr>
<td>Fn Mtr/TD</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Fn Bld/TD</td>
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<td>0.0</td>
</tr>
<tr>
<td>Fn Frlct</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

#### AIRFLOWS

- **Diffuser:** 156 Btu/h
- **Terminal:** 156 Btu/h
- **Main Fan:** 156 Btu/h
- **Sec Fan:** 0 Btu/h
- **Nom Vent:** 0 Btu/h
- **AHU Vent:** 0 Btu/h
- **Infl:** 47 Btu/h
- **MinStop/Rh:** 47 Btu/h
- **Exhaust:** 203 Btu/h
- **Auxiliary:** 0 Btu/h
- **Rm Exh:** 0 Btu/h
- **Leakage Dwn:** 0 Btu/h
- **Leakage Ups:** 0 Btu/h

#### ENGINEERING CKS

- **% OA:** 0.0
- **cfm/ft²:** 1.24
- **cfm/ton:** 32.69
- **ft³/ton:** 265.74
- **Btu/hr/ft²:** 45.16

#### AREAS

- **Gross Total:** 126 ft²
- **Glass:** 0 ft²
- **%:** 0.0

#### HEATING COIL SELECTION

<table>
<thead>
<tr>
<th>Main Clg</th>
<th>Aux Clg</th>
<th>Opt Vent</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>0.0</td>
<td>0.0</td>
<td>0.5</td>
</tr>
<tr>
<td>5.7</td>
<td>3.9</td>
<td>0.0</td>
<td>5.7</td>
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</table>

#### HEATING COIL SELECTION

<table>
<thead>
<tr>
<th>Floor</th>
<th>Part</th>
<th>Int Door</th>
<th>Ext Door</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>126</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-3.6</td>
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<tr>
<td>55.4</td>
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<td>0</td>
<td>0</td>
<td>55.4</td>
</tr>
<tr>
<td>61.9</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>61.9</td>
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</table>

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**Project Name:** 17123 - Daytona State College
**Dataset Name:** 17123 - CALC.TRC
**TRACE® 700 v6.3.4 calculated at 12:10 PM on 12/14/2018**

**Alternative - 1 System Checksums Report Page 7 of 66**
### Room Checksums

By RLF

**Room:** 108 - OFFICE

---

#### HEATING COIL PEAK

**Mo/Hr:** Heating Design

**OADB:** 35

---

#### COOLING COIL PEAK

**Mo/Hr:** 6 / 17

**OADB/WB/HR:** 89 / 76 / 117

---

#### CLG SPACE PEAK

**Mo/Hr:** 6 / 17

**OADB:** 89

---

#### AIRFLOWS

<table>
<thead>
<tr>
<th>Type</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diffuser</td>
<td>225</td>
<td>68</td>
</tr>
<tr>
<td>Terminal</td>
<td>225</td>
<td>68</td>
</tr>
<tr>
<td>Main Fan</td>
<td>225</td>
<td>225</td>
</tr>
<tr>
<td>Sec Fan</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Nom Vent</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>AHU Vent</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Infl</td>
<td>45</td>
<td>45</td>
</tr>
<tr>
<td>MinStop/Rh</td>
<td>68</td>
<td>68</td>
</tr>
<tr>
<td>Exhaust</td>
<td>45</td>
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<tr>
<td>Rm Exh</td>
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<tr>
<td>Auxiliary</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Leakage Dwn</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Leakage Ups</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

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#### AREAS

**Gross Total**

**Glass**

<table>
<thead>
<tr>
<th>Area</th>
<th>Gross Total</th>
<th>Glass</th>
<th>(%)</th>
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</thead>
<tbody>
<tr>
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<td>120</td>
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<tr>
<td>Part</td>
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<td></td>
</tr>
<tr>
<td>Int Door</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ExFlr</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roof</td>
<td>120</td>
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<td>0</td>
</tr>
<tr>
<td>Wall</td>
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<td>Ext Door</td>
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</tr>
<tr>
<td>Total</td>
<td>-6.565</td>
<td>100.00</td>
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</tbody>
</table>

**Heating Load**

**Cooling Load**

**Leakage Ups**

**Leakage Dwn**

---

#### Temperatures

**Cooling**

**Heating**

---

#### Engineering CKS

**Total Capacity**

<table>
<thead>
<tr>
<th>Component</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Clg</td>
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<td>7.1</td>
</tr>
<tr>
<td>Aux Clg</td>
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<tr>
<td>Opt Vent</td>
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</tr>
<tr>
<td>Total</td>
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<td>7.1</td>
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</tbody>
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#### TRACE® 700 v6.3.4 calculated at 12:10 PM on 12/14/2018

**Project Name:** 17123 - Daytona State College

**Dataset Name:** 17123 - CALC.TRC

---

Alternative - 1  System Checksums Report Page 8 of 66
# Room Checksums

By RLF

### Thermodynamics

**COOLING Coil Peak**

- **Mo/Hr:** 8 / 16
- **Outside Air:** OADB/WB/HR: 88 / 78 / 128

**Heating Design**

- **Mo/Hr:** 6 / 15
- **OADB:** 91

**Heating Design**

- **Mo/Hr:** 8 / 16
- **Peaked at Time:**
- **OADB:** 35

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td></td>
<td></td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
<tr>
<td>Envelope Loads</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skylite Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Skylite Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Roof Cond</td>
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<td>336</td>
<td>336</td>
<td>7</td>
<td>2.15</td>
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<tr>
<td>Glass Solar</td>
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<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Glass/Door Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wall Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Partition/Door</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Floor</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Adjacent Floor</td>
<td>0.00</td>
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<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
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**Steel Floor**

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</thead>
<tbody>
<tr>
<td>2,136</td>
<td>2,136</td>
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</tbody>
</table>

**Internal Loads**

- **Lights:** 491
- **People:** 450
- **Misc:** 1,195

**Steel Floor**

<table>
<thead>
<tr>
<th>Btu/h</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2,136</td>
<td>2,136</td>
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</tbody>
</table>

**Ceiling Load**

- **Lights:** 491
- **People:** 450
- **Misc:** 1,195

<table>
<thead>
<tr>
<th>Btu/h</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>491</td>
<td>491</td>
</tr>
</tbody>
</table>

**Ventilation Load**

- **Adj Air Trans Heat:** 0
- **Dehumid. Ov Sizing:** 0
- **Ov/Undr Sizing:** 0
- **Exhaust Heat:** 0
- **Sup. Fan Heat:** 0
- **Ret. Fan Heat:** 0
- **Duct Heat Pkup:** 0
- **Underflr Sup Ht Pkup:** 0
- **Supply Air Leakage:** 0

**Ceiling Load**

- **Lights:** 491
- **People:** 450
- **Misc:** 1,195

<table>
<thead>
<tr>
<th>Btu/h</th>
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<tbody>
<tr>
<td>2,136</td>
<td>2,136</td>
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**Total**

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**Leaves**

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**Grand Total**

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<td>2,813</td>
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**return**

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**Grand Total**

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<tr>
<th>Btu/h</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>5,485</td>
<td>5,485</td>
</tr>
</tbody>
</table>

**Grand Total**

<table>
<thead>
<tr>
<th>Btu/h</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>5,485</td>
<td>5,485</td>
</tr>
</tbody>
</table>

**Computer Calculation**

**Trace® 700 v6.3.4 calculated at 12:10 PM on 12/14/2018**

**Project Name:** 17123 - Daytona State College

**Dataset Name:** 17123 - CALC.TRC

**Alternative - 1** System Checksums Report Page 9 of 66

---

### Engineering Calculations

**COOLING COIL SELECTION**

<table>
<thead>
<tr>
<th>Total Capacity</th>
<th>Sens Cap</th>
<th>Coil Airflow</th>
<th>Enter DB/WB/HR</th>
<th>Leave DB/WB/HR</th>
</tr>
</thead>
<tbody>
<tr>
<td>ton</td>
<td>MBh</td>
<td>cfm</td>
<td>°F</td>
<td>gr/lb</td>
</tr>
<tr>
<td>0.4</td>
<td>4.7</td>
<td>3.0</td>
<td>129</td>
<td>76.5</td>
</tr>
</tbody>
</table>

**AREAS**

<table>
<thead>
<tr>
<th>Gross Total</th>
<th>Glass ft² (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor</td>
<td>120</td>
</tr>
<tr>
<td>Part</td>
<td>0</td>
</tr>
<tr>
<td>Int Door</td>
<td>0</td>
</tr>
<tr>
<td>ExFlr</td>
<td>0</td>
</tr>
<tr>
<td>Roof</td>
<td>120</td>
</tr>
<tr>
<td>Wall</td>
<td>0</td>
</tr>
<tr>
<td>Ext Door</td>
<td>0</td>
</tr>
</tbody>
</table>

**Heating COIL SELECTION**

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Coil Airflow</th>
<th>Ent</th>
<th>Lvg</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBh</td>
<td>cfm</td>
<td>°F</td>
<td>°F</td>
</tr>
<tr>
<td>309.15</td>
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**Temperatures**

<table>
<thead>
<tr>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>SADB</td>
<td>55.4</td>
</tr>
<tr>
<td>Ra Plenum</td>
<td>76.5</td>
</tr>
<tr>
<td>Return</td>
<td>76.5</td>
</tr>
<tr>
<td>Ret/OA</td>
<td>76.5</td>
</tr>
</tbody>
</table>

**Fm Mtr/ID**

<table>
<thead>
<tr>
<th>Fm Bld/ID</th>
<th>Fm Fric</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

---

**Airflows**

- **Diffuser:** 129
- **Exhaust:** 45
- **Rm Exh:** 0
- **Auxiliary:** 0
- **Leakage Dwn:** 0
- **Leakage Ups:** 0

**Engineering CKS**

<table>
<thead>
<tr>
<th>% OA</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>1.02</td>
<td>0.00</td>
</tr>
<tr>
<td>0.0</td>
<td>39.02</td>
<td>0.00</td>
</tr>
</tbody>
</table>

---

**No. People**

| 1.0 | 8.3/1000 ft² |

---

**System Plenum Heat**

- **OADB:** 35
- **OADB:** 91
- **OADB:** 88 / 78 / 128
**Room Checksums**

By RLF

### 111 - OFFICE

#### COOLING COIL PEAK

- **Peaked at Time:** Mo/Hr: 8 / 17
- **Outside Air:** OADB/WB/HR: 87 / 78 / 128

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Plenum Sens. + Lat.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
</tbody>
</table>

- **Envelope Loads**
  - Skylite Solar: 0 Btu/h
  - Skylite Cond: 0 Btu/h
  - Roof Cond: 312 Btu/h
  - Glass Solar: 2,739 Btu/h
  - Glass/Door Cond: 986 Btu/h
  - Wall Cond: 28 Btu/h
  - Partition/Door: 0 Btu/h
  - Floor: 0 Btu/h
  - Adjacent Floor: 0.00 Btu/h
  - Infiltration: 2,257 Btu/h

- **Sub Total:** 6,010 Btu/h

#### CLG SPACE PEAK

- **Mo/Hr:** 6 / 17
- **OADB:** 89

<table>
<thead>
<tr>
<th>Space Sens.</th>
<th>Plenum Sens. + Lat.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
</tbody>
</table>

- **Envelope Loads**
  - Skylite Solar: 0 Btu/h
  - Skylite Cond: 0 Btu/h
  - Roof Cond: 0 Btu/h
  - Glass Solar: 0 Btu/h
  - Glass/Door Cond: 0 Btu/h
  - Wall Cond: 0 Btu/h
  - Partition/Door: 0 Btu/h
  - Floor: 0 Btu/h
  - Adjacent Floor: 0.00 Btu/h
  - Infiltration: 0 Btu/h

- **Sub Total:** 0 Btu/h

#### HEATING COIL PEAK

- **Mo/Hr:** Heating Design
- **OADB:** 35

<table>
<thead>
<tr>
<th>Space Sens.</th>
<th>Plenum Sens. + Lat.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
</tbody>
</table>

- **Envelope Loads**
  - Skylite Solar: 0 Btu/h
  - Skylite Cond: 0 Btu/h
  - Roof Cond: 0 Btu/h
  - Glass Solar: 0 Btu/h
  - Glass/Door Cond: 0 Btu/h
  - Wall Cond: 0 Btu/h
  - Partition/Door: 0 Btu/h
  - Floor: 0 Btu/h
  - Adjacent Floor: 0.00 Btu/h
  - Infiltration: 0 Btu/h

- **Sub Total:** 0 Btu/h

#### TEMPERATURES

- **Cooling**
- **Heating**

<table>
<thead>
<tr>
<th>SADB</th>
<th>Ra Plenum</th>
<th>Return</th>
<th>Ret/OA</th>
<th>Fn MtrTD</th>
<th>Fn BldT</th>
<th>Fn Frict</th>
</tr>
</thead>
<tbody>
<tr>
<td>55.4</td>
<td>76.0</td>
<td>76.0</td>
<td>62.7</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

#### AIRFLOWS

- **Diffuser**
- **Terminal**
- **Main Fan**

<table>
<thead>
<tr>
<th>Skylite Solar</th>
<th>Skylite Cond</th>
<th>Roof Cond</th>
<th>Glass Solar</th>
<th>Glass/Door Cond</th>
<th>Wall Cond</th>
<th>Partition/Door</th>
<th>Floor</th>
<th>Adjacent Floor</th>
<th>Infiltration</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 Btu/h</td>
<td>0 Btu/h</td>
<td>0 Btu/h</td>
<td>0 Btu/h</td>
<td>-2,741 Btu/h</td>
<td>-20 Btu/h</td>
<td>0 Btu/h</td>
<td>0.00</td>
<td>0.00 Btu/h</td>
<td>-1,897 Btu/h</td>
</tr>
</tbody>
</table>

#### ENGINEERING CKS

- **% OA**
- **Cooling**
- **Heating**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>40 Btu/h</td>
<td>0 Btu/h</td>
<td>0 Btu/h</td>
<td>0 Btu/h</td>
<td>0 Btu/h</td>
<td>394 Btu/h</td>
<td>0 Btu/h</td>
<td>0 Btu/h</td>
<td>-2,443 Btu/h</td>
<td>629 Btu/h</td>
<td>0 Btu/h</td>
<td>0 Btu/h</td>
</tr>
</tbody>
</table>

#### AREAS

- **Floor:** 129 ft²
- **Part:** 0 ft²
- **Int Door:** 0 ft²
- **ExFlr:** 0 ft²
- **Roof:** 129 ft²
- **Wall:** 115 ft²
- **Ext Door:** 0 ft²

- **Grand Total:** 8,223 ft²

#### COOLING COIL SELECTION

<table>
<thead>
<tr>
<th>Total Capacity</th>
<th>Sens Cap.</th>
<th>Coil Airflow</th>
<th>Enter DB/WB/HR°F</th>
<th>Leave DB/WB/HR°F</th>
<th>Underflr Sup Ht Pkup</th>
</tr>
</thead>
<tbody>
<tr>
<td>ton MDbh</td>
<td>MDbh</td>
<td>cfm</td>
<td>°F</td>
<td>°F</td>
<td></td>
</tr>
</tbody>
</table>

- **Main Clg:** 0.7 ton 8.8 MDbh
- **Aux Clg:** 0.0 ton 0.0 MDbh
- **Opt Vent:** 0.0 ton 0.0 MDbh

- **Total:** 0.7 ton 8.8 MDbh

#### HEATING COIL SELECTION

- **Capacity:** 17123 - Daytona State College
- **Dataset Name:** 17123 - CALC.TRC

- **Main Htg:** -6.6°F 91°F
- **Aux Htg:** 0.0°F 0.0°F
- **Preheat:** 0.0°F 0.0°F
- **Reheat:** -1.5°F 91°F
- **Humidif:** 0.0°F 0.0°F
- **Opt Vent:** 0.0°F 0.0°F

- **Total:** -6.6°F 91°F 75.4°F 121.1°F
Room Checksums
By RLF

### Temperatures

<table>
<thead>
<tr>
<th></th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>SADB</td>
<td>55.4</td>
<td>178.1</td>
</tr>
<tr>
<td>Ra Plenum</td>
<td>76.0</td>
<td>62.7</td>
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<tr>
<td>Return</td>
<td>76.0</td>
<td>62.7</td>
</tr>
<tr>
<td>Ret/OA</td>
<td>76.0</td>
<td>62.7</td>
</tr>
<tr>
<td>Fn Mtr/TD</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Fn Bld/TD</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Fn Fric</td>
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<td>0.0</td>
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</tbody>
</table>

### AIRFLOWS

<table>
<thead>
<tr>
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<th>Heating</th>
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<tbody>
<tr>
<td>Diffuser</td>
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<td>27.0</td>
</tr>
<tr>
<td>Terminal</td>
<td>91.0</td>
<td>27.0</td>
</tr>
<tr>
<td>Main Fan</td>
<td>91.0</td>
<td>91.0</td>
</tr>
<tr>
<td>Sec Fan</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Nom Vent</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>AHU Vent</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Infil</td>
<td>38.0</td>
<td>38.0</td>
</tr>
<tr>
<td>MinStop/Rh</td>
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<td>27.0</td>
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<tr>
<td>Return</td>
<td>128.0</td>
<td>128.0</td>
</tr>
<tr>
<td>Exhaust</td>
<td>38.0</td>
<td>38.0</td>
</tr>
<tr>
<td>Rm Exh</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Auxiliary</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Leakage Dwn</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Leakage Ups</td>
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### Engineering CKS

<table>
<thead>
<tr>
<th></th>
<th>Cooling</th>
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<tbody>
<tr>
<td>% OA</td>
<td>0.0</td>
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</tr>
<tr>
<td>cfm/ft²</td>
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</tr>
<tr>
<td>cfm/ton</td>
<td>292.48</td>
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</tr>
<tr>
<td>ft³/ton</td>
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<td>326.14</td>
</tr>
<tr>
<td>Btu/hr/ft²</td>
<td>36.79</td>
<td>36.79</td>
</tr>
</tbody>
</table>
| No. People | 0.0/1000 ft² |}

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### Areas

<table>
<thead>
<tr>
<th></th>
<th>Glass Gross Total</th>
<th>Glass ft² (%)</th>
</tr>
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<tbody>
<tr>
<td>Floor</td>
<td>101</td>
<td></td>
</tr>
<tr>
<td>Part</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Int Door</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>ExFlr</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>Roof</td>
<td>101</td>
<td></td>
</tr>
<tr>
<td>Wall</td>
<td>328</td>
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</tr>
<tr>
<td>Ext Door</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Total</td>
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</tr>
</tbody>
</table>

### Heating Coil Selection

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Coil Airflow</th>
<th>Ent Lvg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Htg</td>
<td>-3.7</td>
<td>27</td>
</tr>
<tr>
<td>Aux Htg</td>
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</tr>
<tr>
<td>Preheat</td>
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</tr>
<tr>
<td>Reheat</td>
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<tr>
<td>Humidif</td>
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<td>0.0</td>
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<tr>
<td>Opt Vent</td>
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<tr>
<td>Total</td>
<td>-3.7</td>
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</tr>
</tbody>
</table>

---

Project Name: 17123 - Daytona State College
Dataset Name: 17123 - CALC.TRCDataset Name: 17123 - CALC.TR
### Room Checksums

By RLF

#### 113 - STAFF LOUNGE

<table>
<thead>
<tr>
<th>COOLING COIL PEAK</th>
<th>CLG SPACE PEAK</th>
<th>HEATING COIL PEAK</th>
<th>TEMPERATURES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Peaked at Time:</strong></td>
<td><strong>Mo/Hr:</strong> 8 / 16</td>
<td><strong>Mo/Hr:</strong> 6 / 15</td>
<td><strong>SADB</strong></td>
</tr>
<tr>
<td>Outside Air:</td>
<td><strong>Mo/Hr:</strong> 88 / 78 / 128</td>
<td><strong>Mo/Hr:</strong> Heating Design</td>
<td><strong>Ra Plenum</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Return</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Ret/OA</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Fn Mtr/ID</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Fn Bld/ID</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Fn Frict</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Envelope Loads</td>
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<tr>
<td>Skylite Solar</td>
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</tr>
<tr>
<td>Glass Solar</td>
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<td>0</td>
<td>0</td>
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<tr>
<td>Glass/Door Cond</td>
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<td>0</td>
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<td>0</td>
<td>0</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Partition/Door</td>
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<td>0</td>
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<td>0</td>
<td>0</td>
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</tr>
<tr>
<td>Adjacent Floor</td>
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<td>0.00</td>
<td>0.00</td>
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<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
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</tr>
<tr>
<td>Infiltration</td>
<td>4,414</td>
<td>4,414</td>
<td>54</td>
<td>1,632</td>
<td>43</td>
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<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Sub Total ==&gt;&gt;</strong></td>
<td>4,414</td>
<td>695</td>
<td>5,109</td>
<td>62</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| **Internal Loads** | | | | | | | | | | | |
| Ceiling Load | -115 | 0 | 0 | 180 | 5 | | | | | | |
| Ventilation Load | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Adj Air Trans Heat | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dehumid. Ov Sizing | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ov/Undr Sizing | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Exhaust Heat | -151 | -151 | -2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Additional Heat | -1,419 | -1,419 | -27.94 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Duct Heat Pkup | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Underflr Sup Ht Pkup | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Supply Air Leakage | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Grand Total ==>>** | 7,544 | 684 | 8,228 | 100.00 | 3,828 | 100.00 | | | | | |

<table>
<thead>
<tr>
<th><strong>Areas</strong></th>
<th><strong>Gross Total</strong></th>
<th><strong>Glass</strong></th>
<th><strong>%</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor</td>
<td>248</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Part</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Int Door</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ExtFlr</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roof</td>
<td>248</td>
<td>0</td>
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</tr>
<tr>
<td>Wall</td>
<td>0</td>
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<tr>
<td>Ext Door</td>
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<table>
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<tr>
<th><strong>Heating Coils</strong></th>
<th><strong>Capacity</strong></th>
<th><strong>Airflow</strong></th>
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<td><strong>Aux Clg</strong></td>
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<td>0.0</td>
<td></td>
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</tr>
<tr>
<td><strong>Opt Vent</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>0.7</td>
<td>8.2</td>
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</tr>
</tbody>
</table>
Room Checksums
By RLF

### COOLING COIL PEAK

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
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<td>0.00</td>
</tr>
<tr>
<td>Glass/Door Cond</td>
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<tr>
<td>Wall Cond</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Partition/Door</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
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<tr>
<td>Floor</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Adjacent Floor</td>
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<td>Infiltration</td>
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<td>392.00</td>
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<tr>
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<td>62.00</td>
<td>453.00</td>
<td>145.00</td>
<td>58.00</td>
</tr>
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</table>

### Internal Loads

| Ceiling Load      | -10                  | 0         | 0                 | 0             | 16.00           |
| Ventilation Load  | 0                    | 0         | 0                 | 0             | 0              |
| Adj Air Trans Heat| 0                    | 0         | 0                 | 0             | 0              |
| Dehumid. Ov Sizing| 0                    | 0         | 0                 | 0             | 0              |
| Ov/Undr Sizing    | 0                    | 0         | 0                 | 0             | 0              |
| Exhaust Heat      | -13                  | -13       | -2               | 6.50          | 67.50           |
| Duct Heat Pkup    | 0                    | 0         | 0                 | 0             | 0              |
| Underflr Sup Ht Pkup | 0                   | 0         | 0                 | 0             | 0              |
| Supply Air Leakage| 0                    | 0         | 0                 | 0             | 0              |
| Grand Total ==>   | 492.00               | 61.00     | 552.00            | 251.00        | 100.00          |

### TEMPERATURES

<table>
<thead>
<tr>
<th>SADB</th>
<th>Ra Plenum</th>
<th>Return</th>
<th>Ret/OA</th>
<th>Fn MtrTD</th>
<th>Fn BldT</th>
<th>Fn Fric</th>
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### ENGINEERING CKS

<table>
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<tr>
<th>% OA</th>
<th>Cooling</th>
<th>Heating</th>
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<tbody>
<tr>
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<td>0.0</td>
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### AREAS

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<th>Gross Total</th>
<th>Glass ft² (%)</th>
<th>Floor</th>
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<tr>
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<td>0.0</td>
</tr>
<tr>
<td>Part</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Int Door</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>ExFlr</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Roof</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Wall</td>
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<tr>
<td>Ext Door</td>
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<tr>
<td>0.0</td>
<td>0.0</td>
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### HEATING COIL SELECTION

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Coil Airflow</th>
<th>Ent</th>
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<tr>
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<tr>
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<td>Humidif</td>
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<tr>
<td>Opt Vent</td>
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<td>0.0</td>
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### AIRFLOWS

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<tr>
<td>Exhaust</td>
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<tr>
<td>Auxiliary</td>
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</table>

### TRACE® 700 v6.3.4 calculated at 12:10 PM on 12/14/2018
Project Name: 17123 - Daytona State College
Dataset Name: Alternative - 1 System Checksums Report Page 13 of 66
### COOLING COIL PEAK

**Space Sens. + Lat.**
- Btu/h: 616
- Btu/h: 11

**Plenum Sens. + Lat.**
- Btu/h: 816
- Btu/h: 0

**Net Total**
- Btu/h: 1,915
- Btu/h: 58

**Percent Of Total**
- Btu/h: 76.5
- Btu/h: 62.7

### CLG SPACE PEAK

**Space Sens.**
- Btu/h: 5179

**Plenum Sens. + Lat.**
- Btu/h: 816
- Btu/h: 0

**Net Total**
- Btu/h: 5179
- Btu/h: 71

**Percent Of Total**
- Btu/h: 76.5
- Btu/h: 62.7

### HEATING COIL PEAK

**Space Sens.**
- Btu/h: 5179

**Plenum Sens. + Lat.**
- Btu/h: 816
- Btu/h: 0

**Net Total**
- Btu/h: 5179
- Btu/h: 71

**Percent Of Total**
- Btu/h: 76.5
- Btu/h: 62.7

---

### COOLING COIL SELECTION

**Total Capacity**
- ton: 0.6
- MBh: 7.3
- Sens Cap: 3.8
- Coil Airflow: 152
- Enter DB: 76.5
- WB: 66.3
- Airflg: 18.1
- Leave DB: 5.4
- WB: 50.4
- Airflg: 18.1
- cfm: 46.5

---

### AREAS

**Gross Total**
- ft²: 291

**Glass**
- Total: 4.955

---

### HEATING COIL SELECTION

**Capacity**
- MBh: 6.505
- cfm: 802
- ft²: 7,307

**Ent**
- °F: 100.0

**Lvg**
- °F: 100.0

---

### TEMPERATURES

**Cooling**
- SADB: 55.4
- Ra Plenum: 76.5
- Fm Mtr/TD: 0.0

**Heating**
- Heating: 152
- Return: 152
- Fm Bld/TD: 0.0

---

### AIRFLOWS

**Diffuser**
- Cooling: 152
- Heating: 46

**Main Fan**
- Cooling: 109
- Heating: 109

**Exhaust**
- Cooling: 109
- Heating: 109

---

### ENGINEERING CKS

**OA Preheat Diff.**
- cfm/ft²: 0.52
- cfm/ton: 250.39

**System Plenum Heat**
- ft²/ton: 477.87
- Btu/hr·ft²: 25.11

---

### Other

**No. People**
- Main Htg: 0
- Aux Htg: 0
- Preheat: 0
- Reheat: 0
- Humidid: 0
- Opt Vent: 0

---

**TRACE® 700 v6.3.4 calculated at 12:10 PM on 12/14/2018**

**Project Name:** 17123 - Daytona State College

**Dataset Name:** 17123 - CALC.TRC

---

**Room Checksums**

By RLF

---

**114 - WOMEN**
# Room Checksums

By RLF

## COOLING COIL PEAK

- **Peaked at Time:** Mo/Hr: 8 / 16
- **Outside Air:** OADB/WB/HR: 88 / 78 / 128

### Envelope Loads
- Skylite Solar
- Skylite Cond
- Roof Cond
- Glass Solar
- Glass/Door Cond
- Wall Cond
- Partition/Door
- Floor
- Adjacent Floor
- Infiltration

### Internal Loads
- Lights
- People
- Misc

### Total Envelope Loads
- 1,020

### Ceiling Load
- 115

### Ventilation Load
- 0

### Adj Air Trans Heat
- 0

### Dehumid. Ov Sizing
- 0

### Ov/Undr Sizing
- 0

### Exhaust Heat
- -151

### RA Preheat Diff.
- 0

### System Plenum Heat
- -498

### Underflr Sup Ht Pkup
- 0

### Supply Air Leakage
- 0

### Grand Total
- 5,566

## HEATING COIL PEAK

- **Mo/Hr:** Heating Design
- **OADB:** 35

### Envelope Loads
- Skylite Solar
- Skylite Cond
- Roof Cond
- Glass Solar
- Glass/Door Cond
- Wall Cond
- Partition/Door
- Floor
- Adjacent Floor
- Infiltration

### Internal Loads
- Lights
- People
- Misc

### Total Envelope Loads
- 1,020

### Ceiling Load
- -578

### Ventilation Load
- 0

### Adj Air Trans Heat
- 0

### Ov/Undr Sizing
- 0

### Exhaust Heat
- 760

### RA Preheat Diff.
- 0

### System Plenum Heat
- -498

### Underflr Sup Ht Pkup
- 0

### Supply Air Leakage
- 0

### Grand Total
- 4,240

## COOLING COIL SELECTION

- **Main Clg**
- **Aux Clg**
- **Opt Vent**

## AREAS

- **Gross Total**
- **Glass**

## HEATING COIL SELECTION

- **Capacity**
- **Coil Airflow**
- **Ent Lvl**

---

Project Name: 17123 - Daytona State College
Dataset Name: 17123 - CALC.TRC

---

**ENGINUERING CKS**

TRA® 700 v6.3.4 calculated at 12:10 PM on 12/14/2018
Project Name: 17123 - Daytona State College
Dataset Name: Alternative - 1 System Checksums Report Page 15 of 66
## Room Checksums

### 116 - MULTI-PURPOSE

### Heating Design

<table>
<thead>
<tr>
<th>Mo/Hr:</th>
<th>Heating Design</th>
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<tbody>
<tr>
<td>6/15</td>
<td>OADB: 91</td>
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</tbody>
</table>

### Cooling Design

<table>
<thead>
<tr>
<th>Mo/Hr:</th>
<th>Cooling Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>8/16</td>
<td>OADB: 88 / 78 / 128</td>
</tr>
</tbody>
</table>

### Room Checksums

#### Envelope Loads

- **Skylite Solar:** 0
- **Skylite Cond:** 0
- **Roof Cond:** 0
- **Glass Solar:** 0
- **Glass/Door Cond:** 0
- **Wall Cond:** 0
- **Partition/Door:** 0
- **Floor:** 0
- **Adjacent Floor:** 0
- **Infiltration:** 3,897

#### Internal Loads

- **Lights:** 897
- **People:** 1,200
- **Misc:** 0
- **Sub Total:*** 2,097

#### Ceiling Load

- **Adj Air Trans Heat:** 0
- **Dehum. Ov Sizing:** 0
- **Ov/Undr Sizing:** 0
- **Exhaust Heat:** -133
- **Duct Heat Pkup:** 0
- **Underflr Sup Ht Pkup:** 0
- **Supply Air Leakage:** 0

#### Grand Total:*** 6,096

### Cooling Coil Selection

#### Total Capacity

- **Main Clg:** 0.6 ton, 6.7 Mbh
- **Aux Clg:** 0.0
- **Opt Vent:** 0.0

#### Net Sensible

- **Main Clg:** 6.7
- **Aux Clg:** 0.0
- **Opt Vent:** 0.0

#### Cool Airflow

- **Main Clg:** 149 cfm
- **Aux Clg:** 0.0
- **Opt Vent:** 0.0

### Areas

- **Floor:** 219 ft²
- **Part:** 0 ft²
- **Int Door:** 0 ft²
- **ExFlr:** 0 ft²
- **Roof:** 219 ft²
- **Wall:** 0 ft²
- **Ext Door:** 0 ft²

### Heating Coil SELECTION

#### Gross Total

| Gross Total | Glass | (%)
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>219</td>
<td>0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

### Engineering Cks

- **% OA:** 0.0
- **cfm/ft²:** 0.68
- **cfm/ton:** 266.04
- **ft²/ton:** 392.27
- **Btu/hr/ft²:** 30.59

### Temperatures

#### Cooling

- **SADB:** 55.4
- **Ra Plenum:** 76.5
- **Ret/OA:** 76.5

#### Heating

- **SADB:** 145.3
- **Ra Plenum:** 62.7
- **Ret/OA:** 62.7

### Airflows

#### Diffuser

- **Cooling:** 149
- **Heating:** 45

#### Exhaust

- **Cooling:** 231
- **Heating:** 82

### Ceiling Load

- **Ceiling Load:** -508
- **Ventilation Load:** 0
- **Adj Air Trans Heat:** 0
- **Ov/Undr Sizing:** 0
- **Exhaust Heat:** -133
- **Ov/Undr Sizing:** 0
- **Adj Air Trans Heat:** 0
- **Ov/Undr Sizing:** 0
- **Exhaust Heat:** 669

### Fan MtrIT

- **Cooling:** 149
- **Heating:** 45

### Ceiling Load

- **ExFlr:** 0
- **Opt Vent:** 0

### Engineered Cks

- **% OA:** 0.0
- **cfm/ft²:** 0.68
- **cfm/ton:** 266.04
- **ft²/ton:** 392.27
- **Btu/hr/ft²:** 30.59

### Areas

- **Floor:** 219
- **Part:** 0
- **Int Door:** 0
- **ExFlr:** 0
- **Roof:** 219
- **Wall:** 0
- **Ext Door:** 0

### Heating Load

- **Grand Total:** -3,729
- **Net:** -101
- **Grand Total:** -4,451

### Engineering Cks

- **% OA:** 0.0
- **cfm/ft²:** 0.68
- **cfm/ton:** 266.04
- **ft²/ton:** 392.27
- **Btu/hr/ft²:** 30.59

### Areas

- **Floor:** 219
- **Part:** 0
- **Int Door:** 0
- **ExFlr:** 0
- **Roof:** 219
- **Wall:** 0
- **Ext Door:** 0

### Heating Load

- **Grand Total:** -3,729
- **Net:** -101
- **Grand Total:** -4,451

### Engineering Cks

- **% OA:** 0.0
- **cfm/ft²:** 0.68
- **cfm/ton:** 266.04
- **ft²/ton:** 392.27
- **Btu/hr/ft²:** 30.59

### Areas

- **Floor:** 219
- **Part:** 0
- **Int Door:** 0
- **ExFlr:** 0
- **Roof:** 219
- **Wall:** 0
- **Ext Door:** 0

### Heating Load

- **Grand Total:** -3,729
- **Net:** -101
- **Grand Total:** -4,451

### Engineering Cks

- **% OA:** 0.0
- **cfm/ft²:** 0.68
- **cfm/ton:** 266.04
- **ft²/ton:** 392.27
- **Btu/hr/ft²:** 30.59

### Areas

- **Floor:** 219
- **Part:** 0
- **Int Door:** 0
- **ExFlr:** 0
- **Roof:** 219
- **Wall:** 0
- **Ext Door:** 0

### Heating Load

- **Grand Total:** -3,729
- **Net:** -101
- **Grand Total:** -4,451
Room Checksums
By RLF

<table>
<thead>
<tr>
<th>COOLING COIL PEAK</th>
<th>CLG SPACE PEAK</th>
<th>HEATING COIL PEAK</th>
<th>TEMPERATURES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Peaked at Time:</strong> Mo/Hr: 8 / 17</td>
<td><strong>Mo/Hr:</strong> 6 / 17</td>
<td><strong>Mo/Hr:</strong> Heating Design</td>
<td><strong>SADB</strong> Cooling Heating</td>
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<tr>
<td><strong>Outside Air:</strong> OADB/WB/HR: 87 / 78 / 128</td>
<td><strong>OADB:</strong> 89</td>
<td><strong>OADB:</strong> 35</td>
<td>55.4 132.5 76.0 62.7</td>
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<table>
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<tr>
<th><strong>Space Sens. + Lat.</strong></th>
<th><strong>Plenum Sens. + Lat.</strong></th>
<th><strong>Net Total</strong></th>
<th><strong>Percent Of Total</strong></th>
<th><strong>Space Sensible</strong></th>
<th><strong>Percent Of Total</strong></th>
<th><strong>Space Sensible</strong></th>
<th><strong>Percent Of Total</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Envelope Loads</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skylite Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Skylite Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Roof Cond</td>
<td>0</td>
<td>1,050</td>
<td>1,050</td>
<td>5</td>
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<td>0</td>
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<tr>
<td>Glass Solar</td>
<td>4,926</td>
<td>0</td>
<td>4,926</td>
<td>23</td>
<td>4,820</td>
<td>36</td>
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<tr>
<td>Glass/Door Cond</td>
<td>1,773</td>
<td>0</td>
<td>1,773</td>
<td>8</td>
<td>1,979</td>
<td>15</td>
<td>0</td>
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<tr>
<td>Wall Cond</td>
<td>233</td>
<td>513</td>
<td>746</td>
<td>3</td>
<td>235</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Partition/Door</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Floor</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Adjacent Floor</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Infiltration</td>
<td>7,593</td>
<td>7,593</td>
<td>7,593</td>
<td>36</td>
<td>2,495</td>
<td>18</td>
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<tr>
<td><strong>Sub Total ==&gt;</strong></td>
<td>14,525</td>
<td>1,563</td>
<td>16,088</td>
<td>75</td>
<td>9,529</td>
<td>71</td>
<td>0</td>
</tr>
</tbody>
</table>

| **Internal Loads** | | | | | | | |
| Ceiling Load | 134 | -134 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ventilation Load | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Adj Air Trans Heat | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dehumid. Ov Sizing | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ov/Undr Sizing | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Exhaust Heat | -176 | -176 | -1 | 0 | 0 | 0 | 0 | 0 |
| Exhaust Heat | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Duct Heat Pkap | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Underflr Sup Ht Pkap | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Supply Air Leakage | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Grand Total ==>** | 19,636 | 1,698 | 21,334 | 100.00 | 13,496 | 100.00 | 0 | 0 |

| **COOLING COIL SELECTION** | | | | | | | |
| **Total Capacity** | **Sens Cap.** | **Coil Airflow** | **Enter DB/WB/HR** | **Leave DB/WB/HR** | | | |
| | ton | MBh | MBlh | cfm | °F | °F | gr/lb | °F | °F | gr/lb |
| Main Clg | 1.8 | 21.3 | 14.7 | 620 | 76.0 | 66.2 | 81.2 | 55.4 | 55.2 | 64.9 |
| Aux Clg | 0.0 | 0.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Opt Vent | 0.0 | 0.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total** | 1.8 | 21.3 | | | | | | |

| **AREAS** | **Gross Total** | **Glass ft² (%)** | | | | | |
| Floor | 434 | | | | | | |
| Part | 0 | | | | | | |
| Int Door | 0 | | | | | | |
| ExtFlr | 19 | | | | | | |
| Roof | 434 | 0 | 0 | | | | |
| Wall | 250 | 130 | 52 | | | | |
| Ext Door | 0 | 0 | 0 | | | | |
| **Total** | -15.9 | 186 | 55.4 | 132.5 | 76.0 | 62.7 | 0.0 | 0.0 |

| **HEATING COIL SELECTION** | **Capacity** | **Coil Airflow** | **Ent Lvg** | | | | |
| | MBh | cfm | °F | | | | |
| Main Htg | -15.9 | 186 | 55.4 | 132.5 | 76.0 | 62.7 | 0.0 | 0.0 |
| Aux Htg | 0.0 | 0.0 | 0.0 | | | | |
| Preheat | 0.0 | 0.0 | 0.0 | | | | |
| Reheat | 0.0 | 0.0 | 0.0 | | | | |
| Humidif | 0.0 | 0.0 | 0.0 | | | | |
| Opt Vent | 0.0 | 0.0 | 0.0 | | | | |
| **Total** | -15.9 | | | | | | |

| **AIRPLAYS** | **Cooling** | **Heating** | | | | | |
| Diffuser | 620 | 186 | | | | | |
| Terminal | 620 | 186 | | | | | |
| Main Fan | 620 | 620 | | | | | |
| Sec Fan | 0 | 0 | | | | | |
| Nom Vent | 0 | 0 | | | | | |
| AHU Vent | 0 | 0 | | | | | |
| Infil | 163 | 163 | | | | | |
| Min/Stop/Rh | 186 | 186 | | | | | |
| Exhaust | 783 | 783 | | | | | |
| Rm Exh | 163 | 163 | | | | | |
| Auxiliary | 0 | 0 | | | | | |
| Leakage Dw | 0 | 0 | | | | | |
| Leakage Us | 0 | 0 | | | | | |

| **ENGINEERING CKS** | **% OA** | **Cooling** | **Heating** | | | | |
| | | 0.0 | 0.0 | | | | |
| | | 1.43 | 1.43 | | | | |
| | | 348.85 | | | | | |
| | | 244.12 | | | | | |
| | | 49.16 | | | | | |
| | | -176 | | | | | |

| **TRACE® 700 v6.3.4 calculated at 12:10 PM on 12/14/2018** | | | | | | | |
| Project Name: 17123 - Daytona State College | | | | | | | |
| Dataset Name: 17123 - CALC.TRC | | | | | | | |
## Room Checksums

By RLF

### 119 - DIRECTOR OFFICE

### Room Information

- **Room Checksums**
- **By RLF**

### Heating Design

- **Mo/Hr:** 6 / 17
- **OADB:** 89

### Heating Coils

- **Mo/Hr:** Heating Design
- **OADB:** 35

### Temperatures

- **SADB:** 55.4
- **Ra Plenum:** 76.7
- **Return:** 76.7
- **Ret/OA:** 76.7
- **Fm Mtr/TD:** 0.0
- **Fm Blt/WD:** 0.0
- **Fm Frict:** 0.0

### Airflows

- **Diffuser:** 749
- **Terminal:** 749
- **Main Fan:** 749
- **Sec Fan:** 0
- **Nom Vent:** 0
- **AHU Vent:** 0
- **Infl:** 108
- **MinStop/Reh:** 225
- **Exhaust:** 108
- **Rm Exh:** 0
- **Auxiliary:** 0
- **Leakage Dwn:** 0
- **Leakage Ups:** 0

### Engineering CKS

- **% OA:** 0.0
- **cfm/ft²:** 2.59
- **cfm/ton:** 426.57
- **ft²/ton:** 164.85
- **Btu/hr·ft²:** 72.88
- **Btu/hr·ft²:** 72.88

### Envelope Loads

- **Skylite Solar:** 0.0
- **Skylite Cond:** 0.0
- **Roof Cond:** 0.0
- **Glass Solar:** 0.0
- **Glass/Door Cond:** 2.23
- **Wall Cond:** 0.0
- **Floor:** 0.0
- **Adjacent Floor:** 0.0
- **Infiltration:** 4.344
- **Sub Total:** 15.694

### Internal Loads

- **Lights:** 1.184
- **People:** 1.350
- **Misc:** 1.195
- **Sub Total:** 3.728
- **Ceiling Load:** 153
- **Ventilation Load:** 0
- **Adj Air Trans Heat:** 0
- **Dehumid. Ov Sizing:** 0
- **Ov/Undr Sizing:** 0
- **Exhaust Heat:** -201
- **Adj Air Trans Heat:** 0
- **Ov/Undr Sizing:** 0
- **Exhaust Heat:** 882
- **OA Preheat Diff.:** 0
- **RA Preheat Diff.:** 0
- **Additional Reheat:** -6,039
- **System Plenum Heat:** 2,033
- **Underftr Sup Ht Pkp:** 0
- **Supply Air Leakage:** 0
- **Grand Total:** 19,575

### Cooling Coils

<table>
<thead>
<tr>
<th>Type</th>
<th>Total Capacity</th>
<th>Sens Cap</th>
<th>Coil Airflow</th>
<th>Enter DB/WB/HR</th>
<th>Leave DB/WB/HR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Clg</td>
<td>1.8</td>
<td>21.1</td>
<td>17.8</td>
<td>749</td>
<td>76.7</td>
</tr>
<tr>
<td>Aux Clg</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Opt Vent</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Total</td>
<td>1.8</td>
<td>21.1</td>
<td>17.8</td>
<td>749</td>
<td>76.7</td>
</tr>
</tbody>
</table>

### Heating Coils

<table>
<thead>
<tr>
<th>Type</th>
<th>Total Capacity</th>
<th>Sens Cap</th>
<th>Coil Airflow</th>
<th>Enter DB/WB/HR</th>
<th>Leave DB/WB/HR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Clg</td>
<td>1.8</td>
<td>21.1</td>
<td>17.8</td>
<td>749</td>
<td>76.7</td>
</tr>
<tr>
<td>Aux Clg</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Opt Vent</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Total</td>
<td>1.8</td>
<td>21.1</td>
<td>17.8</td>
<td>749</td>
<td>76.7</td>
</tr>
</tbody>
</table>
## Room Checksums

By RLF

### COOLING COIL PEAK

- **Peaked at Time:** Mo/Hr: 6 / 15
- **Outside Air:** OADB/WB/HR: 91 / 77 / 118

### CLG SPACE PEAK

### HEATING COIL PEAK

- **Mo/Hr:** Heating Design
  - **OADB:** 35
- **OADB/WB/HR:** Outside Air: 77.3 62.7

### TEMPERATURES

<table>
<thead>
<tr>
<th>SADB</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>77.3</td>
<td>55.4</td>
<td>120.6</td>
</tr>
<tr>
<td>77.3</td>
<td>55.4</td>
<td>120.6</td>
</tr>
</tbody>
</table>

### AIRFLOWS

<table>
<thead>
<tr>
<th>Diffuser</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>552</td>
<td>166</td>
<td>166</td>
</tr>
</tbody>
</table>

### ENGINEERING CKS

- **% OA:** 0.0 / 1000 ft²
  - Cooling: 2.03
  - Heating: 2.03
- **cfm/ton:** 417.52
- **ft²/ton:** 205.66
- **Btu/hr·ft²:** 58.35

### AREAS

- **Gross Total**
  - **Floor:** 272
  - **Part:** 0
  - **Int Door:** 0
  - **ExFlr:** 45
  - **Roof:** 272
  - **Wall:** 644
  - **Ext Door:** 0

- **Glass (%)**
  - Main Htg: 55.4
  - Aux Htg: 55.4
  - Preheat: 0
  - Reheat: 55.4
  - Humidif: 0
  - Opt Vent: 0

### HEATING COIL SELECTION

- **Capacity**
  - **Main Clg:** 1.3
  - **Aux Clg:** 0.0
  - **Opt Vent:** 0.0

- **Sens Cap.**
  - Main Clg: 15.9
  - Aux Clg: 0.0
  - Opt Vent: 0.0

- **Coil Airflow**
  - Main Clg: 13.2
  - Aux Clg: 0.0
  - Opt Vent: 0.0

- **Enter DB/WB/HR**
  - Main Clg: 77.3
  - Aux Clg: 0.0
  - Opt Vent: 0.0

- **Leave DB/WB/HR**
  - Main Clg: 91
  - Aux Clg: 0.0
  - Opt Vent: 0.0

---

**Project Name:** 17123 - Daytona State College  
**Dataset Name:** 17123 - CALC.TRC
Room Checksums
By RLF

121 - CHECK IN

COOLING COIL PEAK
Peaked at Time: Mo/Hr: 8 / 16
Outside Air: OADB/WB/HR: 88 / 78 / 128

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Plenum Sens. + Lat.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td></td>
<td>(%)</td>
</tr>
<tr>
<td>Envelope Loads</td>
<td>Skylite Solar</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Skylite Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Roof Cond</td>
<td>0</td>
<td>3,730</td>
<td>11</td>
</tr>
<tr>
<td>Glass Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Glass/Door Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wall Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Partition/Door</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Floor</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Adjacent Floor</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Infiltration</td>
<td>23,687</td>
<td>23,687</td>
<td>68</td>
</tr>
<tr>
<td>Sub Total ==&gt;</td>
<td>23,687</td>
<td>3,730</td>
<td>79</td>
</tr>
</tbody>
</table>

Internal Loads

| Lights             | 5,451               | 1,363     | 20               |
| People             | 1,200               | 0         | 3                |
| Misc               | 0                   | 0         | 0                |
| Sub Total ==>      | 6,651               | 1,363     | 23               |

Ceiling Load

| 615                | -615                | 964       | 6                |

Ventilation Load

| 0                  | 0                   | 0         | 0                |

Adj Air Trans Heat

| 0                  | 0                   | 0         | 0                |

Dehumid. Ov Sizing

| 0                  | 0                   | 0         | 0                |

Ov/Undr Sizing

| 0                  | 0                   | 0         | 0                |

Exhaust Heat

| -808              | -808                | -2        |

Sup. Fan Heat

| 0                  | 0                   | 0         | 0                |

Ret. Fan Heat

| 0                  | 0                   | 0         | 0                |

Duct Heat Pkup

| 0                  | 0                   | 0         | 0                |

Underflr Sup Ht Pkup

| 0                  | 0                   | 0         | 0                |

Supply Air Leakage

| 0                  | 0                   | 0         | 0                |

Grand Total ==> 30,053 3,670 34,624 100.00 15,911 100.00

COOLING COIL SELECTION

<table>
<thead>
<tr>
<th>Total Capacity</th>
<th>Sens Cap.</th>
<th>Coil Airflow</th>
<th>Enter DB/ WB/ HR</th>
<th>Leave DB/ WB/ HR</th>
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</thead>
<tbody>
<tr>
<td>ton</td>
<td>MBh</td>
<td>cfm</td>
<td>°F</td>
<td>°F</td>
</tr>
<tr>
<td>Main Clg</td>
<td>2.9</td>
<td>34.6</td>
<td>17.9</td>
<td>731</td>
</tr>
<tr>
<td>Aux Clg</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Opt Vent</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Total</td>
<td>2.9</td>
<td>34.6</td>
<td>17.9</td>
<td>731</td>
</tr>
</tbody>
</table>

CLG SPACE PEAK
Mo/Hr: 6 / 15
OA DB: 91

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Plenum Sens. + Lat.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td></td>
<td>(%)</td>
</tr>
<tr>
<td>Envelope Loads</td>
<td>Skylite Solar</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Skylite Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Roof Cond</td>
<td>0</td>
<td>3,730</td>
<td>11</td>
</tr>
<tr>
<td>Glass Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Glass/Door Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wall Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Partition/Door</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Floor</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Adjacent Floor</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Infiltration</td>
<td>8,761</td>
<td>8,761</td>
<td>55</td>
</tr>
<tr>
<td>Sub Total ==&gt;</td>
<td>8,761</td>
<td>3,730</td>
<td>79</td>
</tr>
</tbody>
</table>

Internal Loads

| Lights             | 0                   | 0         | 0                |
| People             | 0                   | 0         | 0                |
| Misc               | 0                   | 0         | 0                |
| Sub Total ==>      | 0                   | 0         | 0                |

Ceiling Load

| -3,090             | 0                   | 0         | 0                |

Ventilation Load

| 0                  | 0                   | 0         | 0                |

Adj Air Trans Heat

| 0                  | 0                   | 0         | 0                |

Dehumid. Ov Sizing

| 0                  | 0                   | 0         | 0                |

Ov/Undr Sizing

| 0                  | 0                   | 0         | 0                |

Exhaust Heat

| -4,063             | -15.50              |

OA Preheat Diff.

| 0                  | 0.00                |

RA Preheat Diff.

| 0                  | 0.00                |

Additional Reheat

| -5,898             | 22.49               |

System Plenum Heat

| -2,554             | 9.74                |

Underflr Sup Ht Pkup

| 0                  | 0.00                |

Supply Air Leakage

| 0                  | 0.00                |

Grand Total ==> -22,664 -26,219 100.00

AREAS

<table>
<thead>
<tr>
<th>Gross Total</th>
<th>Glass</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor</td>
<td>1,331</td>
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</tr>
<tr>
<td>Part</td>
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</tr>
<tr>
<td>Int Door</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>ExFlr</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Roof</td>
<td>1,331</td>
<td></td>
</tr>
<tr>
<td>Wall</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Ext Door</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

HEATING COIL PEAK
Mo/Hr: Heating Design
OA DB: 35

<table>
<thead>
<tr>
<th>Net Sensible</th>
<th>Net Percent</th>
<th>Coil % Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
<tr>
<td>Envelope Loads</td>
<td>Skylite Solar</td>
<td>0</td>
</tr>
<tr>
<td>Skylite Cond</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Roof Cond</td>
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<td>0</td>
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<tr>
<td>Wall Cond</td>
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</tr>
<tr>
<td>Partition/Door</td>
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<tr>
<td>Floor</td>
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<tr>
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ENGINEERING CKS

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<tr>
<th>No. People</th>
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TEMPERATURES

<table>
<thead>
<tr>
<th>Cooling</th>
<th>Heating</th>
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<tr>
<td>SADB</td>
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</tr>
<tr>
<td>Ra Plenum</td>
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</tr>
<tr>
<td>Return</td>
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</tr>
<tr>
<td>Ret/OA</td>
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</tr>
<tr>
<td>Fn MtrTD</td>
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<tr>
<td>Fn BidTD</td>
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AIRFLOWS

<table>
<thead>
<tr>
<th>Cooling</th>
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</tr>
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<tbody>
<tr>
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<tr>
<td>Terminal</td>
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<tr>
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<tr>
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<td>Nom Vent</td>
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<tr>
<td>AHU Vent</td>
<td>0</td>
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<tr>
<td>Infli</td>
<td>499</td>
</tr>
<tr>
<td>MinStop/Rh</td>
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<tr>
<td>Return</td>
<td>1,230</td>
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<td>Exhaust</td>
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<td>Rm Exh</td>
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<tr>
<td>Auxiliary</td>
<td>0</td>
</tr>
<tr>
<td>Leakage Dwn</td>
<td>0</td>
</tr>
<tr>
<td>Leakage Ups</td>
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</tr>
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TRACE® 700 v6.3.4 calculated at 12:10 PM on 12/14/2018
Project Name: 17123 - Daytona State College
Dataset Name: Alternative - 1   System Checksums Report Page 20 of 66

Project Name: 17123 - Daytona State College
Dataset Name: Alternative - 1   System Checksums Report Page 20 of 66
### Room Checksums

**By RLF**

<table>
<thead>
<tr>
<th>Space Sens. + Lat. Btu/h</th>
<th>Envelope Loads</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skylite Solar 0</td>
<td>Skylite Solar 0</td>
</tr>
<tr>
<td>Skylite Cond 0</td>
<td>Skylite Cond 0</td>
</tr>
<tr>
<td>Roof Cond 0</td>
<td>Roof Cond 0-806</td>
</tr>
<tr>
<td>Glass Solar 8,058</td>
<td>Glass Solar 0-0</td>
</tr>
<tr>
<td>Glass/Door Cond 7,359</td>
<td>Glass/Door Cond -19,626</td>
</tr>
<tr>
<td>Wall Cond 481</td>
<td>Wall Cond -625</td>
</tr>
<tr>
<td>Partition/Door 0</td>
<td>Partition/Door 0</td>
</tr>
<tr>
<td>Floor 0</td>
<td>Floor -1,755</td>
</tr>
<tr>
<td>Adjacent Floor 0.00</td>
<td>Adjacent Floor 0.00</td>
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<tr>
<td>Infiltration 8,453</td>
<td>Infiltration -6,985</td>
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<tr>
<td>Sub Total 24,351</td>
<td>Sub Total -28,991</td>
</tr>
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</table>

**Envelop Loads**

- Skylite Solar 0 Btu/h
- Skylite Cond 0 Btu/h
- Roof Cond 0 Btu/h
- Glass Solar 8,058 Btu/h
- Glass/Door Cond 7,359 Btu/h
- Wall Cond 481 Btu/h
- Partition/Door 0 Btu/h
- Floor 0 Btu/h
- Adjacent Floor 0.00 Btu/h
- Infiltration 8,453 Btu/h
- Sub Total 24,351 Btu/h

**Heating Design**

- Mo/Hr: 6 / 16
- OADB: 90

<table>
<thead>
<tr>
<th>Space Sens. + Lat. Btu/h</th>
<th>Coil Peak</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skylite Solar 0</td>
<td>0 Btu/h</td>
</tr>
<tr>
<td>Skylite Cond 0</td>
<td>0 Btu/h</td>
</tr>
<tr>
<td>Roof Cond 0</td>
<td>0 Btu/h</td>
</tr>
<tr>
<td>Glass Solar 8,058</td>
<td>0 Btu/h</td>
</tr>
<tr>
<td>Glass/Door Cond 7,359</td>
<td>0 Btu/h</td>
</tr>
<tr>
<td>Wall Cond 481</td>
<td>0 Btu/h</td>
</tr>
<tr>
<td>Partition/Door 0</td>
<td>0 Btu/h</td>
</tr>
<tr>
<td>Floor 0</td>
<td>0 Btu/h</td>
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<tr>
<td>Adjacent Floor 0.00</td>
<td>0 Btu/h</td>
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<tr>
<td>Infiltration 8,453</td>
<td>0 Btu/h</td>
</tr>
<tr>
<td>Sub Total 24,351</td>
<td>0 Btu/h</td>
</tr>
</tbody>
</table>

**Cooling Design**

- Mo/Hr: 6 / 16
- OADB: 90

**Heating Coil Selection**

- Main Clg 2.7 Mton
- Aux Clg 0.0 Mton
- Opt Vent 0.0 Mton

**Cooling Coil Selection**

- Main Clg 2.7 Mton
- Aux Clg 0.0 Mton
- Opt Vent 0.0 Mton

**Areas**

- Gross Total 475 ft²
- Glass 515 ft²

**Heating Coil Selection**

- Main Htg -35.4 °F
- Aux Htg 0.0 °F
- Preheat 0.0 °F
- Reheat -5.3 °F
- Humidif 0.0 °F
- Opt Vent 0.0 °F

**Heating Coils**

- Total 2.7 Mton

**Cooling Coils**

- Total 2.7 Mton

---

Project Name: 17123 - Daytona State College

Dataset Name: 17123 - CALC.TRC

TRACE® 700 v6.3.4 calculated at 12:10 PM on 12/14/2018

Alternative - 1 System Checksums Report Page 21 of 66
### COOLING COIL PEAK

<table>
<thead>
<tr>
<th>Space Sens. + Lat</th>
<th>Net Total</th>
<th>百分比</th>
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</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h (%)</td>
<td>Btu/h</td>
</tr>
<tr>
<td>Skylite Solar</td>
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<td>0</td>
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<tr>
<td>Skylite Cond</td>
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<tr>
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<td>0</td>
</tr>
<tr>
<td>Wall Cond</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Partition/Door</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Floor</td>
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### CLG SPACE PEAK

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<tbody>
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<td>Wall Cond</td>
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<tr>
<td>Partition/Door</td>
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<td>0</td>
</tr>
<tr>
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### HEATING COIL PEAK

<table>
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<th>百分比</th>
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<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h (%)</td>
<td>Btu/h</td>
</tr>
<tr>
<td>Skylite Solar</td>
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<td>0</td>
</tr>
<tr>
<td>Skylite Cond</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Roof Cond</td>
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<td>0</td>
</tr>
<tr>
<td>Glass Solar</td>
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<td>0</td>
</tr>
<tr>
<td>Glass/Door Cond</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wall Cond</td>
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<tr>
<td>Partition/Door</td>
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<td>0</td>
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<tr>
<td>Floor</td>
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<td>0</td>
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<tr>
<td>Adjacent Floor</td>
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<tr>
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<tr>
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### THERMOMETERS

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<th>加热器</th>
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<tr>
<td>Fm Fric</td>
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### AIRFLOWS

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<td>0</td>
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<tr>
<td>Nom Vent</td>
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<td>0</td>
</tr>
<tr>
<td>AHU Vent</td>
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<td>0</td>
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<tr>
<td>Infil</td>
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<td>0</td>
</tr>
<tr>
<td>Leakege Dwn</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Leakege Ups</td>
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### ENGINEERING CKS

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<tr>
<td>ft³/ton</td>
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<tr>
<td>Btu/hr/ft²</td>
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### AREAS

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<th>总面积</th>
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<tr>
<td>墙面</td>
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<td>0</td>
</tr>
<tr>
<td>门</td>
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<td>0</td>
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<tr>
<td>窗口</td>
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<tr>
<td>总面积</td>
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### HEATING COIL SELECTION

<table>
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<th>冷凝器</th>
<th>加热器</th>
</tr>
</thead>
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<tr>
<td>ton</td>
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<tr>
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</tr>
<tr>
<td>Aux Clg</td>
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<td>0.0</td>
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<tr>
<td>Opt Vent</td>
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<td>0.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>0.3</td>
<td>3.4</td>
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### COOLING COIL SELECTION

<table>
<thead>
<tr>
<th>总容量</th>
<th>冷凝器</th>
<th>加热器</th>
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<tbody>
<tr>
<td>ton</td>
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<tr>
<td>Main Clg</td>
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<tr>
<td>Aux Clg</td>
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<tr>
<td>Opt Vent</td>
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<td>0.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
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<td>3.4</td>
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### Room Checksums

By RLF

**124A - VETERANS SERVICES**

<table>
<thead>
<tr>
<th><strong>Room Checksums</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>By RLF</strong></td>
</tr>
</tbody>
</table>

#### COOLING COIL PEAK

**Heating Design**

- Mo/Hr: 6 / 15
- Outside Air: OADB/WB/HR: 89 / 78 / 126

**Cooling Design**

- Mo/Hr: 8 / 15

#### CLG SPACE PEAK

**Heating Design**

- Mo/Hr: 6 / 15
- Outside Air: OADB: 91

**Cooling Design**

- Mo/Hr: 8 / 15

#### HEATING COIL PEAK

**Heating Design**

- Mo/Hr: 6 / 15
- Outside Air: OADB: 91

**Cooling Design**

- Mo/Hr: 8 / 15

#### TEMPERATURES

**Cooling**

- SADB: 55.4
- Ra Plenum: 76.5
- Return: 76.5
- Ret/OA: 76.5
- Fn Mtr/TD: 0.0
- Fn Bld/TD: 0.0
- Fn Frict: 0.0

**Heating**

- SADB: 152.0
- Ra Plenum: 62.7
- Return: 62.7
- Ret/OA: 62.7
- Fn Mtr/TD: 0.0
- Fn Bld/TD: 0.0
- Fn Frict: 0.0

#### AIRFLOWS

**Cooling**

- Diffuser: 652
- Terminal: 652
- Main Fan: 652

**Heating**

- Min/Stop/Rh: 196
- Exhaust: 293
- Rm Exh: 293
- Auxiliary: 0
- Leakage Dwn: 0
- Leakage Ups: 0

#### ENGINEERING CKS

**Cooling**

- % OA: 0.0
- cfm/ft²: 0.83
- cfm/ton: 303.01
- ft³/ton: 363.06
- Btu/hr·ft²: -33.05

**Heating**

- % OA: 0.0
- cfm/ft²: 0.0
- cfm/ton: 0.0
- ft³/ton: 0.0
- Btu/hr·ft²: 0.0

---

**Area Checksums**

**Heating**

- Main Htg: -21.0
- Aux Htg: 0.0
- Preheat: 0.0
- Reheat: -3.2
- Humidif: 0.0
- Opt Vent: 0.0

**Cooling**

- Main Htg: 196
- Aux Htg: 55.4
- Preheat: 76.5
- Reheat: 55.4
- Humidif: 55.4
- Opt Vent: 0.0

---

**COOLING COIL SELECTION**

<table>
<thead>
<tr>
<th><strong>Space Sens + Lat.</strong></th>
<th><strong>Plenum Sens + Lat.</strong></th>
<th><strong>Net Total</strong></th>
<th><strong>Per Tot (%)</strong></th>
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<tbody>
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<td><strong>Btu/h</strong></td>
<td><strong>Btu/h</strong></td>
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<tr>
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<td><strong>0</strong></td>
<td><strong>0</strong></td>
<td><strong>0</strong></td>
</tr>
<tr>
<td><strong>Adjacent Floor</strong></td>
<td><strong>0</strong></td>
<td><strong>0</strong></td>
<td><strong>0</strong></td>
</tr>
<tr>
<td><strong>Infiltration</strong></td>
<td><strong>13,653</strong></td>
<td><strong>13,653</strong></td>
<td><strong>53</strong></td>
</tr>
<tr>
<td><strong>Sub Total =&gt;</strong></td>
<td><strong>6,195</strong></td>
<td><strong>6,195</strong></td>
<td><strong>38</strong></td>
</tr>
</tbody>
</table>

**CEILING LOAD**

- **Lights**: 3,199
- **People**: 1,800
- **Misc**: 1,195
- **Sub Total =>**: 6,195

**VENTILATION LOAD**

- **Ceiling Load**: 380
- **Ventilation Load**: 0
- **Adj Air Trans Heat**: 0
- **Dehumid. Ov Sizing**: 0
- **Ov/Undr Sizing**: 0
- **Exhaust Heat**: -499
- **Ret. Fan Heat**: 0
- **Duct Heat Pkup**: 0
- **Underflr Sup Ht Pkup**: 0
- **Supply Air Leakage**: 0
- **Grand Total =>**: 23,088

**ENGINEERING CKS**

- **Total Capacity Sens Cap. Coil Airflow**: 258
- **Enter DB/ WB/HR**: 652
- **Leave DB/ WB/HR**: 652

- **Total**: 258
**Room Checksums**

By RLF

### 124B - LOUNGE

#### COOLING COIL PEAK

**Peaked at Time:** Mo/Hr: 8 / 16
**Outside Air:** OADB/WB/HR: 88 / 78 / 128

<table>
<thead>
<tr>
<th>Space</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
</table>
| Sens. + Lat. | Btu/h | Plenum Sens. + Lat. | Btu/h | (%)
| Skylite Solar | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Skylite Cond | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Roof Cond | 0 | 420 | 420 | 7 | 0 | 0 | 0 |
| Glass Solar | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Glass/Door Cond | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Wall Cond | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Partition/Door | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Floor | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Adjacent Floor | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Infiltration | 2.670 | 2.670 | 46 | 46 | 987 | 36 | 987 | 36 |
| **Sub Total ==>** | 2.670 | 420 | 3,090 | 54 | 987 | 36 | 987 | 36 |

#### CLG SPACE PEAK

**Mo/Hr:** OADB: 6 / 15

<table>
<thead>
<tr>
<th>Space</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
</table>
| Sens. + Lat. | Btu/h | Plenum Sens. + Lat. | Btu/h | (%)
| Skylite Solar | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Skylite Cond | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Roof Cond | 0 | 420 | 420 | 7 | 0 | 0 | 0 |
| Glass Solar | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Glass/Door Cond | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Wall Cond | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Partition/Door | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Floor | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Adjacent Floor | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Infiltration | 2.670 | 2.670 | 46 | 46 | 987 | 36 | 987 | 36 |
| Sub Total ==> | 2.670 | 420 | 3,090 | 54 | 987 | 36 | 987 | 36 |

#### HEATING COIL PEAK

**Mo/Hr:** Heating Design
**OADB:** 35

<table>
<thead>
<tr>
<th>Space</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
</table>
| Sens. + Lat. | Btu/h | Plenum Sens. + Lat. | Btu/h | (%)
| Skylite Solar | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Skylite Cond | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Roof Cond | 0 | 420 | 420 | 7 | 0 | 0 | 0 |
| Glass Solar | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Glass/Door Cond | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Wall Cond | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Partition/Door | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Floor | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Adjacent Floor | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Infiltration | -2.206 | -2.206 | 69.81 | 69.81 | -2.206 | -2.206 | 69.81 | 69.81 |
| **Sub Total ==>** | -2.206 | -2.206 | 69.81 | 69.81 | -2.206 | -2.206 | 69.81 | 69.81 |

#### TEMPERATURES

**SADB:** 55.4 / 131.5
**Ra Plenum:** 76.5 / 62.7
**Ret/OA:** 76.5 / 62.7
**Fm MtrTD:** 0.0 / 0.0
**Fm BldTD:** 0.0 / 0.0
**Fm Fric:** 0.0 / 0.0

#### AIRFLOWS

**Diffuser** 125 / 37
**Terminal** 125 / 37
**Main Fan** 125 / 37
**Sec Fan** 0 / 0
**Exhaust** 56 / 56
**Auxiliary** 0 / 0
**Leakage Dwn** 0 / 0
**Leakage Ups** 0 / 0

#### ENGINEERING CKS

**% OA** 0.0 / 0.0
**cfm/ft²** 0.83 / 0.83
**cfm/ton** 259.18
**ft³/ton** 312.13
**Btu/hr·ft²** 38.45 / -21.06
**No. People** 4.0 / 26.7/1000 ft²

---

**COOLING COIL SELECTION**

- **Main Clg** 0.5 / 5.8 / 58.2 / 6.63 / 48.8
- **Aux Clg** 0.0 / 0.0 / 0.0 / 0.0 / 0.0
- **Opt Vent** 0.0 / 0.0 / 0.0 / 0.0 / 0.0

**AREAS**

- **Floor** Gross Total: 150 ft², Glass: 50.0 (%)
- **Part** 0
- **Int Door** 0
- **ExFlr** 0
- **Roof** 150 / 0.0
- **Wall** 0 / 0.0
- **Ext Door** 0 / 0.0

**HEATING COIL SELECTION**

- **Main Htg** -3.2
- **Aux Htg** 0.0
- **Preheat** 0.0
- **Reheat** -0.6
- **Humidif** 0.0
- **Opt Vent** 0.0

**No. People** 4.0

---

Project Name: 17123 - Daytona State College
Dataset Name: 17123 - CALC.TRC

TRACE® 700 v6.3.4 calculated at 12:10 PM on 12/14/2018
Alternative - 1 System Checksums Report Page 24 of 66
### Room Checksums

By RLF

#### 124C - ELEC

**Heating Design**

- **Mo/Hr: 6/16**
- **OADB: 91**

**Cooling Design**

- **Mo/Hr: 8/16**
- **OADB: 88/78/128**

### Room Checksums Details

**Room Checksums**

**Heating Design**

- **Mo/Hr: 6/15**
- **OADB: 35**

#### Envelope Loads

- Skylite Solar: 176.0
- Outside Air: 55.4
- Ra Plenum: 76.5
- Ceiling: 62.7

#### Internal Loads

- **Lights:** 184.0
- **People:** 0.0
- **Misc:** 17,065.0

#### Ceiling Load

- **Clothing:** 21.0
- **Ventilation Load:** 0.0

#### Adj Air Trans Heat

- **Dehumid. Ov Sizing:** 0.0

#### Exhaust Heat

- **Exhaust Heat:** 0.0
- **OA Preheat Diff:** 0.0
- **RA Preheat Diff:** 0.0
- **Additional Reheat:** -6,575.0
- **System Plenum Heat:** 2,545.0
- **Underflr Sup Ht Pkp:** 0.0
- **Supply Air Leakage:** 0.0

#### Air Infiltration

- **801:** 296.0
- **4:** 1,138.0
- **946:** 456.3

#### Sub Total

- **Envelope Loads:** -1,168.0
- **Internal Loads:** 18,216.0
- **Grand Total:** 100.00

### Heating Coil Selection

#### Capacity

- **Total Capacity:** 1.5 ton
- **Sens Cap.:** 18.4 MBh
- **Cool Airflow:** 100.00 cfm
- **Enter DB/DB/HR:** 815 °F
- **Leave DB/DB/HR:** 81.2 °F

### Areas

- **Floor:** 45 ft²
- **Part:** 0 ft²
- **Int Door:** 0 ft²
- **ExFlr:** 6 ft²
- **Roof:** 45 ft²
- **Wall:** 85 ft²
- **Ext Door:** 0 ft²

### Heating Coil Selection

- **Main Clg:** 1.5 ton
- **Aux Clg:** 0.0 MBh
- **Opt Vent:** 0.0 MBh

### Engineering CKS

- **No. People:** 18,216
- **Total:** 1.5 ton

### Areas

- **Floor:** 45 ft²
- **Part:** 0 ft²
- **Int Door:** 0 ft²
- **ExFlr:** 6 ft²
- **Roof:** 45 ft²
- **Wall:** 85 ft²
- **Ext Door:** 0 ft²

### Heating Coil Selection

- **Total:** 1.5 ton

---

**Project Name:** 17123 - Daytona State College  
**Dataset Name:** 17123 - CALC.TRC  
**TRACE® 700 v6.3.4 calculated at 12:10 PM on 12/14/2018**
### Room Checksums

By RLF

#### COOLING COIL PEAK

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Plenum Sens. + Lat.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Envelope Loads**
  - Skylite Solar: 0 Btu/h
  - Skylite Cond: 0 Btu/h
  - Roof Cond: 0 Btu/h
  - Glass Solar: 0 Btu/h
  - Glass/Door Cond: 0 Btu/h
  - Wall Cond: 107 Btu/h
  - Partition/Door: 0 Btu/h
  - Floor: 0 Btu/h
  - Adjacent Floor: 0.00 Btu/h
  - Infiltration: 747 Btu/h

- **Sub Total ==>** 854 Btu/h

#### CLG SPACE PEAK

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Plenum Sens. + Lat.</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td></td>
</tr>
</tbody>
</table>

- **Internal Loads**
  - Lights: 172 43 Btu/h
  - People: 0 Btu/h
  - Misc: 0 Btu/h

- **Sub Total ==>** 172 Btu/h

#### HEATING COIL PEAK

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td></td>
</tr>
</tbody>
</table>

- **Envelope Loads**
  - Skylite Solar: 0 Btu/h
  - Skylite Cond: 0 Btu/h
  - Roof Cond: 0 Btu/h
  - Glass Solar: 0 Btu/h
  - Glass/Door Cond: 0 Btu/h
  - Wall Cond: -184 Btu/h
  - Partition/Door: 0 Btu/h
  - Floor: -112 Btu/h
  - Adjacent Floor: 0.00 Btu/h
  - Infiltration: -618 Btu/h

- **Sub Total ==>** -914 Btu/h

#### TEMPERATURES

- **Cooling**
  - SADB: 55.4°F
  - Ra Plenum: 67.5°F
  - Return: 67.5°F
  - Ret/OA: 67.5°F
  - Fn MtrTD: 0.0°F
  - Fn BldT: 0.0°F
  - Fn Frict: 0.0°F

- **Heating**
  - SADB: 180.6°F
  - Ra Plenum: 62.7°F
  - Return: 62.7°F
  - Ret/OA: 62.7°F

#### AIRFLOWS

- **Diffuser**
  - Cooling: 27 cfm
  - Heating: 8 cfm

- **Main Fan**
  - Cooling: 27 cfm
  - Heating: 27 cfm

- **Sec Fan**
  - Cooling: 0 cfm
  - Heating: 0 cfm

#### ENGINEERING CKS

- **% OA**
  - Cooling: 0.0%
  - Heating: 0.0%

- **cfm/ft²**
  - Cooling: 0.65
  - Heating: 0.65

- **cfm/ton**
  - Cooling: 272.03
  - Heating: 416.30

- **Btu/hr·ft²**
  - Cooling: 28.83
  - Heating: 27.26

- **No. People**
  - 0

- **Room Checksums Report Page 26 of 66**
### Room Checksums

**By RLF**

### COOLING COIL PEAK

- **Peaked at Time:**
  - Mo/Hr: 8 / 15
  - Outside Air: OADB/WB/HR: 89 / 78 / 126

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Plenum Sens. + Lat.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
</tbody>
</table>

### CLG SPACE PEAK

- **Mo/Hr:** 6 / 15
  - OADB: 91

### HEATING COIL PEAK

- **Mo/Hr:** Heating Design
  - OADB: 35

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Wall Cond</th>
<th>Floor</th>
<th>Adj Floor</th>
<th>Infiltration</th>
<th>Sub Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>308</td>
<td>0</td>
<td>0.00</td>
<td>2.849</td>
<td>3.158</td>
</tr>
</tbody>
</table>

### Envelope Loads

- Skylite Solar: 0
- Skylite Cond: 0
- Roof Cond: 0
- Glass Solar: 0
- Glass/Door Cond: 0
- Wall Cond: 0
- Return: 0
- Adjacent Floor: 0
- Infiltration: 2.849
- Sub Total: 3.158

### Internal Loads

- Ceiling Load: 79
- Ventilation Load: 0
- Adj Air Trans Heat: 0
- Dehumid. Ov Sizing: 0
- Ov/Undr Sizing: 0
- Exhaust Heat: -104
- Ret. Fan Heat: 0
- Duct Heat Pkup: 0
- Underflr Sup Ht Pkup: 0
- Supply Air Leakage: 0

### Total Capacity

<table>
<thead>
<tr>
<th>Total Capacity</th>
<th>Sens Cap.</th>
<th>Coil Airflow</th>
<th>Enter DB/WB/HR</th>
<th>Leave DB/WB/HR</th>
</tr>
</thead>
<tbody>
<tr>
<td>ton</td>
<td>MBh</td>
<td>cfm</td>
<td>°F</td>
<td>°F</td>
</tr>
<tr>
<td></td>
<td>Btu/h</td>
<td>gr/lb</td>
<td></td>
<td>gr/lb</td>
</tr>
</tbody>
</table>

### COOLING COIL SELECTION

- **Main Clg:** 0.5 / 6.2
- **Aux Clg:** 0.0 / 0.0
- **Opt Vent:** 0.0 / 0.0

### AREAS

- **Gross Total**
- **Glass (ft²)**
- **(%)**

<table>
<thead>
<tr>
<th>Area</th>
<th>163</th>
<th>61</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor</td>
<td>163</td>
<td>61</td>
</tr>
<tr>
<td>Part</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Int Door</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>ExFlr</td>
<td>11</td>
<td>0</td>
</tr>
<tr>
<td>Roof</td>
<td>163</td>
<td>0</td>
</tr>
<tr>
<td>Wall</td>
<td>142</td>
<td>0</td>
</tr>
<tr>
<td>Ext Door</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### HEATING COIL SELECTION

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Coil Airflow</th>
<th>Ent</th>
<th>Lvg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>cfm</td>
<td>°F</td>
<td>°F</td>
</tr>
</tbody>
</table>

### TEMPERATURES

- **Cooling**
  - SADB: 55.4
  - Ra Plenum: 76.5
  - Ret/OA: 76.5
  - Fn Mtr/TD: 0.0
  - Fn Bld/TD: 0.0
  - Fn Fric: 0.0

- **Heating**
  - SADB: 131.9
  - Ra Plenum: 62.7
  - Ret/OA: 62.7
  - Fn Mtr/TD: 0.0
  - Fn Bld/TD: 0.0
  - Fn Fric: 0.0

### AIRFLOWS

- **Diffuser**
  - Cooling: 167
  - Heating: 50
- **Terminal**
  - Cooling: 167
  - Heating: 50
- **Main Fan**
  - Cooling: 167
  - Heating: 50
- **Sec Fan**
  - Cooling: 0
  - Heating: 0
- **Nom Vent**
  - Cooling: 0
  - Heating: 0
- **AHU Vent**
  - Cooling: 0
  - Heating: 0
- **Infil**
  - Cooling: 50
  - Heating: 50
- **MinStop/Rh**
  - Cooling: 61
  - Heating: 61
- **Exhaust**
  - Cooling: 61
  - Heating: 61
- **Auxiliary**
  - Cooling: 0
  - Heating: 0
- **Leakage Dwn**
  - Cooling: 0
  - Heating: 0
- **Leakage Ups**
  - Cooling: 0
  - Heating: 0

### ENGINEERING CKS

<table>
<thead>
<tr>
<th>% OA</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>cfm/ft²</td>
<td>cfm/ton</td>
</tr>
<tr>
<td>0.0</td>
<td>1.02</td>
<td>324.48</td>
</tr>
<tr>
<td>0.0</td>
<td>37.85</td>
<td>317.02</td>
</tr>
<tr>
<td>0.0</td>
<td></td>
<td>37.85</td>
</tr>
</tbody>
</table>

### Grand Total

- **===>**
- **5,549**
- **621**
- **6,170**
- **100.00**
- **3,630**
- **100.00**

---

Project Name: 17123 - Daytona State College
Dataset Name: 17123 - CALC.TRC

TRACE® 700 v6.3.4 calculated at 12:10 PM on 12/14/2018
Alternative - 1 System Checksums Report Page 27 of 66
### Room Checksums

By RLF

#### Room Checksums

<table>
<thead>
<tr>
<th>COOLING COIL PEAK</th>
<th>CLG SPACE PEAK</th>
<th>HEATING COIL PEAK</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Space Sens. + Lat.</strong></td>
<td><strong>Plenum Sens. + Lat.</strong></td>
<td><strong>Net Total</strong></td>
</tr>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h (%)</td>
</tr>
<tr>
<td>Envelope Loads</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skylite Solar</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Skylite Cond</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Roof Cond</td>
<td>0</td>
<td>560</td>
</tr>
<tr>
<td>Glass Solar</td>
<td>560</td>
<td>0</td>
</tr>
<tr>
<td>Glass/Door Cond</td>
<td>835</td>
<td>0</td>
</tr>
<tr>
<td>Wall Cond</td>
<td>642</td>
<td>1,007</td>
</tr>
<tr>
<td>Partition/Door</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Floor</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Adjacent Floor</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Infiltration</td>
<td>2,891</td>
<td>2,891</td>
</tr>
<tr>
<td><strong>Sub Total ==&gt;</strong></td>
<td>4,928</td>
<td>926</td>
</tr>
</tbody>
</table>

#### Internal Loads

| Ceiling Load | 129 | 129 | 2 | 0 | 0 | 0 | 0 | 0 |
| Ventilation Load | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Adj Air Trans Heat | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dehumid. Ov Sizing | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ov/Undr Sizing | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Exhaust Heat | -169 | -169 | -2 | 0 | 0 | 0 | 0 | 0 |
| Ret. Fan Heat | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Duct Heat Pkup | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Supply Air Leakage | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Sub Total ==>** | 2,374 | 182 | 2,556 | 31 | 2,174 | 39 | 0 | 0 |

#### Ceiling Load

| Ceiling Load | 129 | 129 | 2 | 0 | 0 | 0 | 0 | 0 |
| Ventilation Load | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Adj Air Trans Heat | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dehumid. Ov Sizing | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ov/Undr Sizing | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Exhaust Heat | 543 | -9.62 | -9.62 | 0 | 0 | 0 | 0 | 0 |
| RA Preheat Diff. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Additional Reheat | -2,043 | 26.00 | 26.00 | 0 | 0 | 0 | 0 | 0 |
| System Plenum Heat | 606 | -7.71 | -7.71 | 0 | 0 | 0 | 0 | 0 |
| Underflr Sup Ht Pkup | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Supply Air Leakage | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Sub Total ==>** | 6,624 | -7,856 | -7,856 | 100.00 | 0 | 0 | 0 | 0 |

#### Total Capacity

<table>
<thead>
<tr>
<th><strong>Total Capacity</strong></th>
<th><strong>Sens Cap.</strong></th>
<th><strong>Coil Airflow</strong></th>
<th><strong>Enter DB/ WB/HR</strong></th>
<th><strong>Leave DB/ WB/HR</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>ton</td>
<td>MBh</td>
<td>Sens. of H</td>
<td>cfm</td>
<td>°F</td>
</tr>
<tr>
<td>Main Clg</td>
<td>0.7</td>
<td>8.2</td>
<td>6.3</td>
<td>253</td>
</tr>
<tr>
<td>Aux Clg</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td>Opt Vent</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>0.7</td>
<td>8.2</td>
<td>6.3</td>
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#### AREAS

<table>
<thead>
<tr>
<th>Areas</th>
<th>Gross Total</th>
<th>Glass ft² (%)</th>
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<tr>
<td>Floor</td>
<td>178</td>
<td>100.00</td>
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<tr>
<td>Part</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>Int Door</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>ExFlr</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>Roof</td>
<td>178</td>
<td>0.00</td>
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<tr>
<td>Wall</td>
<td>388</td>
<td>14.00</td>
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<tr>
<td>Ext Door</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>7.9</td>
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#### HEATING COIL SELECTION

<table>
<thead>
<tr>
<th><strong>Capacity</strong></th>
<th><strong>Coil Airflow</strong></th>
<th><strong>Ent</strong></th>
<th><strong>Lvg</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>MBh</td>
<td>cfm</td>
<td>°F</td>
<td>°F</td>
</tr>
<tr>
<td>Main Htg</td>
<td>-7.9</td>
<td>76</td>
<td>55.4</td>
</tr>
<tr>
<td>Aux Htg</td>
<td>0.0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Preheat</td>
<td>0.0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Reheat</td>
<td>-1.2</td>
<td>76</td>
<td>55.4</td>
</tr>
<tr>
<td>Humidif</td>
<td>0.0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Opt Vent</td>
<td>0.0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>-7.9</td>
<td>76</td>
<td>55.4</td>
</tr>
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</table>

#### ENVIRONMENT CKS

<table>
<thead>
<tr>
<th>% OA</th>
<th>Cooling</th>
<th>Heating</th>
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<tr>
<td></td>
<td>cfm/ft²</td>
<td>cfm/ton</td>
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<td>1.42</td>
<td>1.42</td>
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#### TEMPERATURES

<table>
<thead>
<tr>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>SADB</td>
<td>55.4</td>
</tr>
<tr>
<td>Ra Plenum</td>
<td>77.3</td>
</tr>
<tr>
<td>Return</td>
<td>77.3</td>
</tr>
<tr>
<td>Ret/OA</td>
<td>77.3</td>
</tr>
<tr>
<td>Fn Mtr/TD</td>
<td>0.0</td>
</tr>
<tr>
<td>Fn Bid/TD</td>
<td>0.0</td>
</tr>
<tr>
<td>Fn Frct</td>
<td>0.0</td>
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#### AIRFLOWS

<table>
<thead>
<tr>
<th>Diffuser</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
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<tbody>
<tr>
<td>253</td>
<td>76</td>
<td>76</td>
</tr>
<tr>
<td>Terminal</td>
<td>253</td>
<td>253</td>
</tr>
<tr>
<td>Main Fan</td>
<td>253</td>
<td>253</td>
</tr>
<tr>
<td>Sec Fan</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Nom Vent</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>AHU Vent</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Infli</td>
<td>67</td>
<td>67</td>
</tr>
<tr>
<td>Min/Stop/Rh</td>
<td>76</td>
<td>76</td>
</tr>
<tr>
<td>Exhaust</td>
<td>67</td>
<td>67</td>
</tr>
<tr>
<td>Rm Exh</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Auxiliary</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Leake Up Dwn</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Leake Up S</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

#### Supply Air Leakage

| Main Htg | 0.00 |
| Aux Htg | 0.00 |
| Preheat | 0.00 |
| Reheat | 0.00 |
| Humidif | 0.00 |
| Opt Vent | 0.00 |

#### TRACE® 700 v6.3.4 calculated at 12:10 PM on 12/14/2018

Project Name: 17123 - Daytona State College
Dataset Name: 17123 - CALC.TRC

Alternative - 1 System Checksums Report Page 28 of 66
### Room Checksums

**By RLF**

#### COOLING COIL PEAK

Peaked at Time:
- Mo/Hr: 8 / 16
- Outside Air: OADB/WB/HR: 88 / 78 / 128

<table>
<thead>
<tr>
<th>Envelope Loads</th>
<th>Btu/h</th>
<th>Btu/h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skylite Solar</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Skylite Cond</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Roof Cond</td>
<td>0</td>
<td>126</td>
</tr>
<tr>
<td>Glass Solar</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Glass/Door Cond</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wall Cond</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Partition/Door</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Floor</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Adjacent Floor</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Infiltration</td>
<td>801</td>
<td>801</td>
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<tr>
<td>Sub Total</td>
<td>801</td>
<td>126</td>
</tr>
</tbody>
</table>

#### CLG SPACE PEAK

Mo/Hr: 6 / 15

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Space Plenum Sens. + Lat.</th>
<th>Space Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Internal Loads</th>
<th>Btu/h</th>
<th>Btu/h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceiling Load</td>
<td>21</td>
<td>24</td>
</tr>
<tr>
<td>Ventilation Load</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Adj Air Trans Heat</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Dehumid. Ov Sizing</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Ov/Undr Sizing</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Exhaust Heat</td>
<td>-27</td>
<td>-27</td>
</tr>
<tr>
<td>Duct Heat Pkup</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Supply Air Leakage</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

#### HEATING COIL PEAK

Mo/Hr: Heating Design

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Space Plenum Sens. + Lat.</th>
<th>Space Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
</tbody>
</table>

#### TEMPERATURES

<table>
<thead>
<tr>
<th>SADB</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>55.4</td>
<td>167.5</td>
<td></td>
</tr>
</tbody>
</table>

#### AIRFLOWS

- **Diffuser**: 24 7
- **Terminal**: 24 7
- **Main Fan**: 24 24
- **Sec Fan**: 0 0
- **Exhaust**: 17 17
- **Auxiliary**: 0 0
- **Leakage Dwn**: 0 0
- **Leakage Ups**: 0 0

#### ENGINEERING CKS

<table>
<thead>
<tr>
<th>% OA</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
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<td>0.0</td>
<td>0.0</td>
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</tbody>
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#### AREAS

<table>
<thead>
<tr>
<th>Gross Total</th>
<th>Glass ft² (%)</th>
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<tr>
<td>45</td>
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#### HEATING COIL SELECTION

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Coil Airflow Ent Lvg</th>
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<tbody>
<tr>
<td>Mbh</td>
<td>cfm</td>
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</table>

Project Name: 17123 - Daytona State College
Dataset Name: 17123 - CALC.TRC
Room Checksums
By RLF

### Temperatures

<table>
<thead>
<tr>
<th></th>
<th>Cooling</th>
<th>Heating</th>
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<tbody>
<tr>
<td>SADB</td>
<td>55.4</td>
<td>177.1</td>
</tr>
<tr>
<td>Ra Plenum</td>
<td>75.4</td>
<td>62.7</td>
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<td>Return</td>
<td>75.4</td>
<td>62.7</td>
</tr>
<tr>
<td>Ret/OA</td>
<td>75.4</td>
<td>62.7</td>
</tr>
<tr>
<td>Fn Mtr/TD</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Fn Bld/TD</td>
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<tr>
<td>Fn Fric</td>
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### Airflows

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<td>16</td>
</tr>
<tr>
<td>Terminal</td>
<td>52</td>
<td>16</td>
</tr>
<tr>
<td>Main Fan</td>
<td>52</td>
<td>52</td>
</tr>
<tr>
<td>Sec Fan</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Nom Vent</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>AHU Vent</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Infl</td>
<td>26</td>
<td>26</td>
</tr>
<tr>
<td>MinStop/Rh</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Return</td>
<td>77</td>
<td>77</td>
</tr>
<tr>
<td>Exhaust</td>
<td>26</td>
<td>26</td>
</tr>
<tr>
<td>Rm Exh</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Auxiliary</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Leakage Dwn</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Leakage Ups</td>
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### Engineering CKS

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<tbody>
<tr>
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<td>cfm/ft²</td>
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<td>ft²/ton</td>
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<tr>
<td>Btu/hr/ft²</td>
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<tr>
<td>No. People</td>
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### Engineering CKS

#### Cool Airflow

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<th></th>
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<th>Aux Htg</th>
<th>Int Door</th>
<th>ExFlr</th>
<th>Roof</th>
<th>Wall</th>
<th>Ext Door</th>
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<tbody>
<tr>
<td></td>
<td>-2.1</td>
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<tr>
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<td>155.4</td>
<td>16</td>
<td>55.4</td>
<td>155.4</td>
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<tr>
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<td>155.4</td>
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<td>177.1</td>
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#### Electrical Considerations

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<th>cfm</th>
<th>MMB</th>
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<tbody>
<tr>
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<td>16</td>
<td>55.4</td>
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<tr>
<td>Aux Htg</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Int Door</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>ExFlr</td>
<td>-0.3</td>
<td>16</td>
<td>55.4</td>
</tr>
<tr>
<td>Roof</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wall</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Ext Door</td>
<td>0</td>
<td>0</td>
<td>0</td>
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</tbody>
</table>

### Cooling Coil Peak

<table>
<thead>
<tr>
<th></th>
<th>Mo/Hr: 7 / 13</th>
<th>OADB/WB/HR: 87 / 76 / 119</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>6 / 13</td>
<td>OADB: 89</td>
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</table>

### Heating Coil Peak

|                  | Mo/Hr: Heating Design | OADB: 35 |

### Areas

<table>
<thead>
<tr>
<th></th>
<th>Gross Total</th>
<th>Glass ft² (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor</td>
<td>68</td>
<td></td>
</tr>
<tr>
<td>Part</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Int Door</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>ExFlr</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Roof</td>
<td>68</td>
<td>0</td>
</tr>
<tr>
<td>Wall</td>
<td>146</td>
<td>0</td>
</tr>
<tr>
<td>Ext Door</td>
<td>0</td>
<td>0</td>
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#### Calculations

<table>
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<tr>
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<th>127 - UNISEX</th>
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</table>
**Room Checksums**

**By RLF**

---

### COOLING COIL PEAK

- **Peaked at Time:** Mo/Hr: 8 / 16
- **Outside Air:** OADB/WB/HR: 88 / 78 / 128

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Btu/h</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skyline Solar</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Skylite Cond</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Roof Cond</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Glass Solar</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Glass Door Cond</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wall Cond</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Partitions/Door</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Floor</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Adjacent Floor</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Infiltration</td>
<td>2,385</td>
<td>44</td>
</tr>
<tr>
<td><strong>Sub Total ==&gt;</strong></td>
<td>2,385</td>
<td>51</td>
</tr>
</tbody>
</table>

**Internal Loads**

- **Lights:** Btu/h
- **2,000**
- **People:** Btu/h
- **0.00**
- **Misc:** Btu/h
- **0.00**
- **Sub Total ==>:** Btu/h
- **2,549**

**Ceiling Load**

- **62**
- **-62**
- **0**
- **0.00**

**Ventilation Load**

- **0**
- **0**
- **0.00**

**Adj Air Trans Heat**

- **0**
- **0**
- **0.00**

**Dehumid. Ov Sizing**

- **0**
- **0**
- **0.00**

**Ov Undr Sizing**

- **0**
- **0**
- **0.00**

**Exhaust Heat**

- **-81**
- **-81**
- **-2**

**Sup Fan Heat**

- **0**
- **0**
- **0.00**

**Ret Fan Heat**

- **0**
- **0**
- **0.00**

**Duct Heat Pkup**

- **0**
- **0**
- **0.00**

**Underflr Sup Ht Pkup**

- **0**
- **0**
- **0.00**

**Supply Air Leakage**

- **0**
- **0**
- **0.00**

**Total Capacity**

- **4,995**
- **369**
- **5,365**

**Grand Total ==>**

- **2,528**
- **100.00**

---

### CLG SPACE PEAK

- **Mo/Hr:** 6 / 15
- **OADB:** 91

**Room Checksums**

**By RLF**

---

### HEATING COIL PEAK

- **Mo/Hr:** Heating Design
- **OADB:** 35

**Room Checksums**

**By RLF**

---

### TEMPERATURES

**Cooling**

- **55.4**
- **128.9**

**Heating**

- **76.5**
- **62.7**

**RA Plenum**

- **76.5**
- **62.7**

**Return**

- **76.5**
- **62.7**

---

### AIRFLOWS

**Heating**

- **116**
- **35**

**Cooling**

- **116**
- **35**

---

### ENGINEERING CKS

- **% OA**
- **0.0**
- **0.0**
- **0.0**
- **0.0**
- **0.0**
- **0.0**
- **0.0**
- **0.0**

---

### AREAS

**Gross Total**

- **134**
- **91**
- **50**
- **100**

**Glass**

- **ft²**
- **%**

**Floor**

- **134**
- **91**

**Part**

- **0**

**Int Door**

- **0**

**ExFlr**

- **0**

**Roof**

- **134**
- **91**

**Wall**

- **0**
- **0**

**Ext Door**

- **0**
- **0**

**Total**

- **29.9/1000 ft²**

---

### HEATING COIL SELECTION

**Total Capacity**

- **5.4**
- **100.00**

**Grand Total ==>**

- **2,846**
- **100.00**

---

### COOLING COIL SELECTION

- **Main Clg**
  - **0.5**
  - **5.4**
- **Aux Clg**
  - **0.0**
  - **0.0**
- **Opt Vent**
  - **0.0**
  - **0.0**

**Total**

- **0.5**
- **5.4**

---

**Ciras** 700 v6.3.4 calculated at 12:10 PM on 12/14/2018

---

Project Name: 17123 - Daytona State College

Dataset Name: 17123 - CALC.TRC
Room Checksums
By RLF

131 - FOOD

**COOLING COIL PEAK**

<table>
<thead>
<tr>
<th>Space Sens. + Lat</th>
<th>Plenum Sens. + Lat</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
<tr>
<td><strong>Envelope Loads</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skylite Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Skylite Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Roof Cond</td>
<td>0</td>
<td>308</td>
<td>11</td>
</tr>
<tr>
<td>Glass Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Glass/Door Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wall Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Partition/Door</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Floor</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Adjacent Floor</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>Sub Total ==&gt;</strong></td>
<td>1,958</td>
<td>308</td>
<td>2,266</td>
</tr>
<tr>
<td><strong>Internal Loads</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Lights</td>
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<td>563</td>
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<tr>
<td><strong>Ceiling Load</strong></td>
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</tr>
<tr>
<td><strong>Adj Air Trans Heat</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Dehumid. Ov Sizing</strong></td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Ov/Undr Sizing</strong></td>
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<td>0</td>
<td>0</td>
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<tr>
<td><strong>Exhaust Heat</strong></td>
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<tr>
<td><strong>Duct Heat Pkup</strong></td>
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<td>0</td>
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<tr>
<td><strong>Underflr Sup Ht Pkup</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Supply Air Leakage</strong></td>
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<tr>
<td><strong>Grand Total ==&gt;</strong></td>
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<td>2,762</td>
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</table>

**CLG SPACE PEAK**

<table>
<thead>
<tr>
<th>Space Sens. + Lat</th>
<th>Plenum Sens. + Lat</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
<tr>
<td><strong>Envelope Loads</strong></td>
<td></td>
<td></td>
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<tr>
<td>Skylite Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Skylite Cond</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Roof Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Glass Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Glass/Door Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wall Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Partition/Door</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Floor</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Adjacent Floor</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>Sub Total ==&gt;</strong></td>
<td>1,958</td>
<td>308</td>
<td>2,266</td>
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<tr>
<td><strong>Ceiling Load</strong></td>
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<tr>
<td><strong>Ventilation Load</strong></td>
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<td>0</td>
</tr>
<tr>
<td><strong>Adj Air Trans Heat</strong></td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Dehumid. Ov Sizing</strong></td>
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<tr>
<td><strong>Ov/Undr Sizing</strong></td>
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<td>0</td>
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<tr>
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<td>-2</td>
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<tr>
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<td>0</td>
</tr>
<tr>
<td><strong>Underflr Sup Ht Pkup</strong></td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Supply Air Leakage</strong></td>
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**HEATING COIL PEAK**

<table>
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<th>Space Sens. + Lat</th>
<th>Plenum Sens. + Lat</th>
<th>Net Total</th>
<th>Percent Of Total</th>
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</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
<tr>
<td><strong>Envelope Loads</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skylite Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Skylite Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Roof Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Glass Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Glass/Door Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wall Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Partition/Door</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Floor</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Adjacent Floor</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
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<tr>
<td><strong>Sub Total ==&gt;</strong></td>
<td>-1,618</td>
<td>-1,618</td>
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**AREAS**

<table>
<thead>
<tr>
<th>Gross Total</th>
<th>Glass ft² (%)</th>
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</thead>
<tbody>
<tr>
<td>Floor</td>
<td>110</td>
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<tr>
<td>Part</td>
<td>0</td>
</tr>
<tr>
<td>Int Door</td>
<td>0</td>
</tr>
<tr>
<td>ExFlr</td>
<td>0</td>
</tr>
<tr>
<td>Roof</td>
<td>110</td>
</tr>
<tr>
<td>Wall</td>
<td>0</td>
</tr>
<tr>
<td>Ext Door</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>-2.2</td>
</tr>
</tbody>
</table>

**HEATING COIL SELECTION**

| Main Clg    | 0.2 | 2.8 |
| Aux Clg     | 0.0 | 0.0 |
| Opt Vent    | 0.0 | 0.0 |
| **Total**   | 0.2 | 2.8 |

**TEMPERATURES**

| SADB      | 55.4 | 167.5 |
| Ra Plenum | 76.5 | 62.7 |
| Return    | 76.5 | 62.7 |
| Ret/OA    | 76.5 | 62.7 |

**ENGG CKS**

| % OA      | 0.0  | 0.0  |
| cfm/ft²   | 0.52 | 0.52 |
| cfm/ton   | 250.39 |       |

**AIRFLOWS**

| Diffuser | 58 | 17 |
| Terminal | 58 | 17 |
| Main Fan | 58 | 58 |
| Sec Fan  | 0  | 0  |
| Nom Vent | 0  | 0  |
| AHU Vent | 0  | 0  |
| Infil    | 41 | 41 |
| MinStop/Rh | 17 | 17 |
| Exhaust  | 99 | 99 |
| Rm Exh   | 0  | 0  |
| Auxiliary| 0  | 0  |
| Leakage Dwn | 0  | 0  |
| Leakage Ups | 0  | 0  |

**PROJECT**

TRACE® 700 v6.3.4 calculated at 12:10 PM on 12/14/2018
Project Name: 17123 - Daytona State College
Dataset Name: 17123 - CALC.TRC
Alternative - 1
System Checksums Report Page 32 of 66
Room Checksums
By RLF

### COOLING COIL PEAK
- Mo/Hr: 8 / 16
- Outside Air: OADB/WB/HR: 88 / 78 / 128
- Space Sens. + Lat. Btu/h
- Plenum Sens. + Lat. Btu/h
- Net Total Btu/h
- Percent Of Total (%)
- Space Sensible Btu/h
- Percent Of Total (%)

<table>
<thead>
<tr>
<th>Envelope Loads</th>
<th>Btu/h</th>
<th>Btu/h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skylite Solar</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Skylite Cond</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Roof Cond</td>
<td>0</td>
<td>109</td>
</tr>
<tr>
<td>Glass Solar</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Glass/Door Cond</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wall Cond</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Partition/Door</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Floor</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Adjacent Floor</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Infiltration</td>
<td>694</td>
<td>694</td>
</tr>
<tr>
<td>Sub Total ===</td>
<td>694</td>
<td>109</td>
</tr>
</tbody>
</table>

### CLG SPACE PEAK
- Mo/Hr: 8 / 16
- OADB: 91
- Space Sensible Btu/h
- Percent Of Total (%)

### HEATING COIL PEAK
- Mo/Hr: Heating Design
- OADB: 35
- Space Peak Btu/h
- Coil Peak Btu/h
- Percent Of Total (%)

### TEMPERATURES
- SADB: 55.4 / 167.5
- Ra Plenum: 76.5 / 62.7
- Return: 76.5 / 62.7
- Ret/OA: 76.5 / 62.7
- Fn Mtr/TD: 0.0 / 0.0
- Fn BldT/D: 0.0 / 0.0
- Fn Frict: 0.0 / 0.0

### AIRFLOWS
- Diffuser: Cooling 20 / Heating 6
- Terminal: Cooling 20 / Heating 20
- Main Fan: Cooling 20 / Heating 20
- Sec Fan: Cooling 0 / Heating 0
- Nom Vent: Cooling 0 / Heating 0
- AHU Vent: Cooling 0 / Heating 0
- Infil: Cooling 15 / Heating 15
- MinStop/Rh: Cooling 6 / Heating 6
- Exhaust: Cooling 35 / Heating 35
- Rm Exh: Cooling 0 / Heating 0
- Auxiliary: Cooling 0 / Heating 0
- Leakage Dwn: Cooling 0 / Heating 0
- Leakage Ups: Cooling 0 / Heating 0

### ENGINNEERING CKS
- % OA: Cooling 0.0 / Heating 0.0
- cfm/ft²: Cooling 0.52 / Heating 0.52
- cfm/ton: Cooling 250.39 / Heating 250.39
- ft²/ton: Cooling 477.86 / Heating 477.86
- Btu/hr/ft²: Cooling 25.11 / Heating 19.57
- No. People: Cooling 0.0 / Heating 0.0

---

### COOLING COIL SELECTION
- Total Capacity ton
- Sens Cap. MBh
- Airflow cfm
- Enter DB/ WB/ HR °F
- Leave DB/ WB/ HR °F
- Gross Total 100.00
- Grand Total 100.00

### AREAS
- Gross Total ft²
- Glass ft² (%)

<table>
<thead>
<tr>
<th>Areas</th>
<th>Gross Total</th>
<th>Glass ft²</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor</td>
<td>39</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Part</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Int Door</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ExFlr</td>
<td>0</td>
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<tr>
<td>Roof</td>
<td>39</td>
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<tr>
<td>Wall</td>
<td>0</td>
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<td>0.0</td>
</tr>
<tr>
<td>Ext Door</td>
<td>0</td>
<td>0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

### HEATING COIL SELECTION
- Capacity: 0.1
- Airflow: 1.0

---

Project Name: 17123 - Daytona State College
Dataset Name: 17123 - CALC.TRC

TRACE® 700 v6.3.4 calculated at 12:10 PM on 12/14/2018
Alternative - 1 System Checksums Report Page 33 of 66
Room Checksums
By RLF

133A - OFFICE

### COOLING COIL PEAK
Peaked at Time: Mo/Hr: 8 / 16
Outside Air: OADB/WB/HR: 88 / 78 / 128

<table>
<thead>
<tr>
<th>Envelope Loads</th>
<th>Space Sens. + Lat.</th>
<th>Plenum Sens. + Lat.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td></td>
<td>(%)</td>
</tr>
<tr>
<td>Skylite Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Skylite Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Roof Cond</td>
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<tr>
<td>Glass/Door Cond</td>
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<tr>
<td>Wall Cond</td>
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<td>0</td>
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<tr>
<td>Partition/Door</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Floor</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Adjacent Floor</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Infiltration</td>
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<td>58</td>
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### CLG SPACE PEAK
Mo/Hr: 6 / 15

<table>
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<th>Internal Loads</th>
<th>Space Sens. + Lat.</th>
<th>Plenum Sens. + Lat.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td></td>
<td>(%)</td>
</tr>
<tr>
<td>Ceiling Load</td>
<td>71</td>
<td>-71</td>
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<tr>
<td>Ventilation Load</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Adj Air Trans Heat</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Dehumid. Ov Sizing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Ov/Undr Sizing</td>
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<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Exhaust Heat</td>
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<td>-94</td>
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</tr>
<tr>
<td>Sup. Fan Heat</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Ret. Fan Heat</td>
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<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Duct Heat Pkup</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Underflr Sup Ht Pkup</td>
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<tr>
<td>Supply Air Leakage</td>
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<td>158</td>
<td>2,433</td>
<td>44</td>
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</table>

### HEATING COIL PEAK
Mo/Hr: Heating Design
OADB: 35

<table>
<thead>
<tr>
<th>Envelope Loads</th>
<th>Space Sens. + Lat.</th>
<th>Plenum Sens. + Lat.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td></td>
<td>(%)</td>
</tr>
<tr>
<td>Skylite Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Skylite Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Roof Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Glass Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Glass/Door Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wall Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Partition/Door</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Floor</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Adjacent Floor</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Infiltration</td>
<td>-2.265</td>
<td>-2.265</td>
<td>67.86</td>
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<tr>
<td>Sub Total ==&gt;</td>
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<td>-2.265</td>
<td>75.88</td>
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### TEMPERATURES

<table>
<thead>
<tr>
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<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>SADB</td>
<td>55.4</td>
<td>123.5</td>
</tr>
<tr>
<td>Ra Plenum</td>
<td>76.5</td>
<td>62.7</td>
</tr>
<tr>
<td>Return</td>
<td>76.5</td>
<td>62.7</td>
</tr>
<tr>
<td>Ret/OA</td>
<td>76.5</td>
<td>62.7</td>
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### AIRFLOWS

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<tr>
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<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diffuser</td>
<td>147</td>
<td>44</td>
</tr>
<tr>
<td>Terminal</td>
<td>147</td>
<td>147</td>
</tr>
<tr>
<td>Main Fan</td>
<td>147</td>
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<tr>
<td>Sec Fan</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Nom Vent</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>AHU Vent</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Infl</td>
<td>58</td>
<td>58</td>
</tr>
<tr>
<td>MinStop/Rh</td>
<td>44</td>
<td>44</td>
</tr>
<tr>
<td>Return</td>
<td>205</td>
<td>205</td>
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<tr>
<td>Exhaust</td>
<td>58</td>
<td>58</td>
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<tr>
<td>Auxiliary</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Leakage Dwn</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Leakage Ups</td>
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### ENGINEERING CKS

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<thead>
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<th>Cooling</th>
<th>Heating</th>
</tr>
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<tbody>
<tr>
<td>% OA</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>cfm/ft²</td>
<td>0.96</td>
<td>0.96</td>
</tr>
<tr>
<td>cfm/ton</td>
<td>320.21</td>
<td></td>
</tr>
<tr>
<td>ft²/ton</td>
<td>335.28</td>
<td></td>
</tr>
<tr>
<td>Btu/hr·ft²</td>
<td>37.59</td>
<td>-21.67</td>
</tr>
<tr>
<td>No. People</td>
<td>1.0</td>
<td>6.5/1000 ft²</td>
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</table>

### COOLING COIL SELECTION

<table>
<thead>
<tr>
<th>Options</th>
<th>Sens Cap. (MBh)</th>
<th>Coil Airflow (cfm)</th>
<th>Enter DB/DB/HR °F</th>
<th>Leave DB/DB/HR °F</th>
<th>Heats (Btu/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Clg</td>
<td>0.5</td>
<td>5.5</td>
<td>3.4</td>
<td>147</td>
<td>76.6</td>
</tr>
<tr>
<td>Aux Clg</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Opt Vent</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Total</td>
<td>0.5</td>
<td>5.5</td>
<td>3.4</td>
<td>147</td>
<td>76.6</td>
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</table>

### AREAS

<table>
<thead>
<tr>
<th>Gross Total</th>
<th>Glass</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor</td>
<td>154</td>
<td></td>
</tr>
<tr>
<td>Part</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Int Door</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>ExFlr</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Roof</td>
<td>154</td>
<td>0</td>
</tr>
<tr>
<td>Wall</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Ext Door</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>-3.3</td>
<td></td>
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</tbody>
</table>

### HEATING COIL SELECTION

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Coil Airflow (Mbh)</th>
<th>Ent (°F)</th>
<th>Lvg (°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Htg</td>
<td>-3.3</td>
<td>44</td>
<td>55.4</td>
</tr>
<tr>
<td>Aux Htg</td>
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<td>0.0</td>
<td>0.0</td>
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<tr>
<td>Preheat</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Reheat</td>
<td>-0.7</td>
<td>44</td>
<td>55.4</td>
</tr>
<tr>
<td>Humidif</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Opt Vent</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Total</td>
<td>-3.3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Room Checksums

**By RLF**

---

#### COOLING COIL PEAK

**Peaked at Time:**
- Mo/Hr: 8 / 16
- Outside Air: OADB/WB/HR: 88 / 78 / 128

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Plenum Sens. + Lat.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
<tr>
<td>Skylite Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Skylite Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Roof Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Glass Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Glass/Door Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wall Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Partition/Door</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Floor</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Adjacent Floor</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Infiltration</td>
<td>2.954</td>
<td>2.954</td>
<td>57.0</td>
</tr>
<tr>
<td>Sub Total ==&gt;</td>
<td>2.954</td>
<td>465</td>
<td>5.73</td>
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</tbody>
</table>

**Internal Loads**

- Ceiling Load: 77
- Ventilation Load: 0
- Adj Air Trans Heat: 0
- Dehumid. Ov Sizing: 0
- Ov/Undr Sizing: 0
- Exhaust Heat: -101
- Sup. Fan Heat: 0
- Ret. Fan Heat: 0
- Duct Heat Pkup: 0
- Underflr Sup Ht Pkup: 0
- Supply Air Leakage: 0

**Sub Total ==>**:
- Ceiling Load: -385
- Ventilation Load: 0
- Adj Air Trans Heat: 0
- Ov/Undr Sizing: 0
- Exhaust Heat: 14
- OA Preheat Diff.: 0
- RA Preheat Diff.: 0
- Additional Reheat: -130
- Underflr Sup Ht Pkup: 0
- Supply Air Leakage: 0

**Grand Total ==>**:
- Total Capacity: 4,711
- Internal Loads: 458
- Envelope Loads: 5,169

#### CLG SPACE PEAK

**Mo/Hr: 6 / 15**

**OADB: 91**

#### HEATING COIL PEAK

**Mo/Hr: Heating Design**

**OADB: 35**

<table>
<thead>
<tr>
<th>Space Sens.</th>
<th>Coil Peak</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
<tr>
<td>Skylite Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Skylite Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Roof Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Glass Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Glass/Door Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wall Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Partition/Door</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Floor</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Adjacent Floor</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Infiltration</td>
<td>-2.441</td>
<td>-2.441</td>
<td>72.63</td>
</tr>
<tr>
<td>Sub Total ==&gt;</td>
<td>-2.441</td>
<td>-2.441</td>
<td>72.63</td>
</tr>
</tbody>
</table>

**Internal Loads**

- Ceiling Load: -385
- Ventilation Load: 0
- Adj Air Trans Heat: 0
- Ov/Undr Sizing: 0
- Exhaust Heat: 14
- OA Preheat Diff.: 0
- RA Preheat Diff.: 0
- Additional Reheat: -130
- Underflr Sup Ht Pkup: 0
- Supply Air Leakage: 0

**Grand Total ==>**:
- Total Capacity: 2.393
- Internal Loads: 2.393
- Envelope Loads: 2.393

---

#### TEMPERATURES

<table>
<thead>
<tr>
<th>Cool Heating</th>
</tr>
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<tbody>
<tr>
<td>SADB 55.4</td>
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<tr>
<td>Ra Plenum 76.5</td>
</tr>
<tr>
<td>Return 76.5</td>
</tr>
<tr>
<td>Ret/OA 76.5</td>
</tr>
<tr>
<td>Fn Mtr/THD 0.0</td>
</tr>
<tr>
<td>Fn Bld/THD 0.0</td>
</tr>
<tr>
<td>Fn Fric 0.0</td>
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#### ENGINNERING CKS

<table>
<thead>
<tr>
<th>% OA</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
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<td>0.0</td>
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</tbody>
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<table>
<thead>
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<th>cfm/ft²</th>
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<th>Heating</th>
</tr>
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<tbody>
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<td>0.0</td>
<td>0.0</td>
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<table>
<thead>
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<th>cfm/ton</th>
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<th>Heating</th>
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<tbody>
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<td>255.29</td>
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<table>
<thead>
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<th>ft²/ton</th>
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<th>Heating</th>
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<table>
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<table>
<thead>
<tr>
<th>No. People</th>
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<th>1/2000 ft²</th>
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#### ENVRIONMENT CKS

- **Main Htg**: -3.4
- **Aux Htg**: 0.0
- **Preheat**: 0.0
- **Reheat**: -0.5
- **Humidif**: 0.0
- **Opt Vent**: 0.0

**Total**: -3.4

---

#### AIRFLOWS

<table>
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<tr>
<th>Diffuser</th>
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<td>0.0</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Nom Vent</th>
<th>AHU Vent</th>
</tr>
</thead>
<tbody>
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<td>0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Infil</th>
<th>Cooling</th>
<th>Heating</th>
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<tbody>
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<td>0.0</td>
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<table>
<thead>
<tr>
<th>MinStop/Rh</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
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<table>
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<th>Heating</th>
</tr>
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<table>
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<th>Cooling</th>
<th>Heating</th>
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<table>
<thead>
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<th>Heating</th>
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<table>
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<td>0.0</td>
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<table>
<thead>
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<th>Leakage Dwn</th>
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<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
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<table>
<thead>
<tr>
<th>Leakage Ups</th>
<th>Cooling</th>
<th>Heating</th>
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</thead>
<tbody>
<tr>
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<td>0.0</td>
<td>0.0</td>
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#### AREAS

<table>
<thead>
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<th>166</th>
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</thead>
<tbody>
<tr>
<td>Glass ft² (%)</td>
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<table>
<thead>
<tr>
<th>Floor</th>
<th>166</th>
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</thead>
<tbody>
<tr>
<td>Part</td>
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</tr>
<tr>
<td>Int Door</td>
<td>0.0</td>
</tr>
<tr>
<td>ExFlr</td>
<td>0.0</td>
</tr>
<tr>
<td>Roof</td>
<td>0.0</td>
</tr>
<tr>
<td>Wall</td>
<td>0.0</td>
</tr>
<tr>
<td>Ext Door</td>
<td>0.0</td>
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</tbody>
</table>

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#### HEATING COIL SELECTION

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Coil Airflow</th>
<th>Ent Lvg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>cfm/ft²</td>
<td>°F/F</td>
</tr>
<tr>
<td>Main Clg</td>
<td>4.5</td>
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</tr>
<tr>
<td>Aux Clg</td>
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<td>0.0</td>
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<tr>
<td>Opt Vent</td>
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<td>0.0</td>
</tr>
</tbody>
</table>

**Total**: 4.5

---

**Dataset Name**: 17123 - CALC.TRC
**Project Name**: 17123 - Daytona State College
### Room Checksums

**By RLF**

#### COOLING COIL PEAK

- **Peaked at Time:** Mo/Hr: 8 / 16
- **Outside Air:** OADB/WB/HR: 88 / 78 / 128

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Plenum Sens. + Lat.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
<th>Space Sensible</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Envelope Loads</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skylite Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Skylite Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Roof Cond</td>
<td>0</td>
<td>300</td>
<td>300</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Glass Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Glass/Door Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wall Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Partition/Door</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Floor</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Adjacent Floor</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Infiltration</td>
<td>1,904</td>
<td>1,904</td>
<td>44</td>
<td>704</td>
<td>26</td>
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<tr>
<td><strong>Sub Total ==&gt;&gt;</strong></td>
<td>1,904</td>
<td>300</td>
<td>2,204</td>
<td>51</td>
<td>704</td>
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</table>

| Internal Loads    |                     |           |                 |                |                 |
| Ceiling Load      | 49                  | -49       | 0               | 77             | 3               |
| Ventilation Load  | 0                   | 0         | 0               | 0              | 0               |
| Adj Air Trans Heat| 0                   | 0         | 0               | 0              | 0               |
| Dehumid. Ov Sizing| 0                   | 0         | 0               | 0              | 0               |
| Ov/Undr Sizing    | 0                   | 0         | 0               | 0              | 0               |
| Duct Heat Pkup    | 0                   | 0         | 0               | 0              | 0               |
| Supply Air Leakage| 0                   | 0         | 0               | 0              | 0               |
| **Grand Total ==>>**| 4,036               | 295       | 4,331           | 100.00         | 2,665           | 100.00 |

#### CLG SPACE PEAK

- **Mo/Hr:** 6 / 15
- **OADB:** 91

#### HEATING COIL PEAK

- **Mo/Hr:** Heating Design
- **OADB:** 35

<table>
<thead>
<tr>
<th>Space Sensible</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Envelope Loads</td>
<td></td>
</tr>
<tr>
<td>Skylite Solar</td>
<td>0</td>
</tr>
<tr>
<td>Skylite Cond</td>
<td>0</td>
</tr>
<tr>
<td>Roof Cond</td>
<td>0 -181</td>
</tr>
<tr>
<td>Glass Solar</td>
<td>0</td>
</tr>
<tr>
<td>Glass/Door Cond</td>
<td>0</td>
</tr>
<tr>
<td>Wall Cond</td>
<td>0</td>
</tr>
<tr>
<td>Partition/Door</td>
<td>0</td>
</tr>
<tr>
<td>Floor</td>
<td>0</td>
</tr>
<tr>
<td>Adjacent Floor</td>
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<tr>
<td>Infiltration</td>
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<tr>
<td><strong>Sub Total ==&gt;&gt;</strong></td>
<td>-1,574</td>
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</table>

#### ENVELOPE LOADS

| Skylite Solar | 55.4  |
| Skylite Cond | 114.6 |
| Glass Solar | 55.4  |
| Glass/Door Cond | 55.4 |
| Wall Cond | 55.4  |
| Partition/Door | 55.4 |
| Floor | 55.4  |
| Adjacent Floor | 55.4 |
| Infiltration | 55.4  |

#### AIRFLOWS

- **Diffuser:** Cooling 122 Heating 37
- **Terminal:** Cooling 122 Heating 37
- **Main Fan:** Cooling 122 Heating 37
- **Sec Fan:** Cooling 122 Heating 37
- **Exhaust:** Cooling 122 Heating 37
- **Auxiliary:** Cooling 122 Heating 37
- **Leakage Dwnt:** Cooling 122 Heating 37
- **Leakage Ups:** Cooling 122 Heating 37

#### ENGINEERING CKS

<table>
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<tr>
<th>% OA</th>
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<th>Heating</th>
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<td>1.4</td>
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#### AREAS

| Gross Total | Glass Total | (%)
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<tbody>
<tr>
<td>Floor</td>
<td>107</td>
<td></td>
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<tr>
<td>Part</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Int Door</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>ExFlr</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Roof</td>
<td>107</td>
<td></td>
</tr>
<tr>
<td>Wall</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Ext Door</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

#### HEATING COIL SELECTION

- **Total Capacity:**
  - Ton: 0.4
  - MBh: 4.3
  - Sens Cap: 2.8

- **Enter DB/DB/HR:**
  - °F: 76.5
  - °F: 66.3
  - °F: 81.2

- **Leave DB/DB/HR:**
  - °F: 55.4
  - °F: 55.0
  - °F: 64.3

- **Main Clg**
  - Ton: 0.4
  - MBh: 4.3
  - Sens Cap: 2.8

- **Aux Clg**
  - Ton: 0.0
  - MBh: 0.0

- **Opt Vent**
  - Ton: 0.0
  - MBh: 0.0

- **GRAND TOTAL**
  - Ton: 0.4
  - MBh: 4.3

---

**Dataset Name:** 17123 - CALC.TRC

---

**Project Name:** 17123 - Daytona State College

**Dataset Name:** 17123 - CALC.TRC

---

**Trace® 700 v6.3.4 calculated at 12:10 PM on 12/14/2018**

**Alternative - 1 System Checksums Report Page 36 of 66**
### Room Checksums

By RLF

#### COOLING COIL PEAK

<table>
<thead>
<tr>
<th>Space Sens. + Lat</th>
<th>Plenum Sens. + Lat</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
</tbody>
</table>

**Envelope Loads**
- Skylite Solar: 0 Btu/h
- Skylite Cond: 0 Btu/h
- Roof Cond: 0 Btu/h
- Glass Solar: 0 Btu/h
- Glass/Door Cond: 0 Btu/h
- Wall Cond: 0 Btu/h
- Partition/Door: 0 Btu/h
- Floor: 0 Btu/h
- Adjacent Floor: 0 Btu/h
- Infiltration: 5,766 Btu/h

**Sub Total ==>>** 5,766 Btu/h

#### CLG SPACE PEAK

#### HEATING COIL PEAK

<table>
<thead>
<tr>
<th>Space Sens. + Lat</th>
<th>Heated Airflow Ent. DB/DB/HR</th>
<th>Space Sens. + Lat</th>
<th>Heated Airflow Ent. DB/DB/HR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>°F</td>
<td>°F</td>
<td>gr/lb</td>
</tr>
</tbody>
</table>

**Envelope Loads**
- Skylite Solar: 0 Btu/h
- Skylite Cond: 0 Btu/h
- Roof Cond: 0 Btu/h
- Glass Solar: 0 Btu/h
- Glass/Door Cond: 0 Btu/h
- Wall Cond: 0 Btu/h
- Partition/Door: 0 Btu/h
- Floor: 0 Btu/h
- Adjacent Floor: 0 Btu/h
- Infiltration: -4,765 Btu/h

**Sub Total ==>>** -4,765 Btu/h

#### COOLING COIL SELECTION

<table>
<thead>
<tr>
<th>Total Capacity</th>
<th>Sens Cap.</th>
<th>Cool Airflow</th>
</tr>
</thead>
<tbody>
<tr>
<td>ton</td>
<td>MBh</td>
<td>cfm</td>
</tr>
</tbody>
</table>

**Main Clg**
- 0.7 ton, 8.1 MBh, 8.1 cfm

**Aux Clg**
- 0.0 MBh, 0.0 MBh, 0.0 cfm

**Opt Vent**
- 0.0 MBh, 0.0 MBh, 0.0 cfm

**Total**
- 0.7 ton, 8.1 MBh, 8.1 cfm

#### AREAS

<table>
<thead>
<tr>
<th>Gross Total</th>
<th>Glass ft² (%)</th>
</tr>
</thead>
</table>

**Floor**
- 324 ft²

**Part**
- 0 ft²

**Int Door**
- 0 ft²

**ExFlir**
- 0 ft²

**Roof**
- 324 ft²

**Wall**
- 0 ft²

**Ext Door**
- 0 ft²

**Total**
- 324 ft²

#### HEATING COIL SELECTION

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Cool Airflow</th>
<th>Ent °F</th>
<th>Lvg °F</th>
</tr>
</thead>
</table>

**Main Htg**
- 0.0 MBh, 0.0 MBh, 0.0 °F

**Aux Htg**
- 0.0 MBh, 0.0 MBh, 0.0 °F

**Preheat**
- 0.0 MBh, 0.0 MBh, 0.0 °F

**Reheat**
- 0.0 MBh, 0.0 MBh, 0.0 °F

**Humidif**
- 0.0 MBh, 0.0 MBh, 0.0 °F

**Opt Vent**
- 0.0 MBh, 0.0 MBh, 0.0 °F

**Total**
- 0.0 MBh, 0.0 MBh, 0.0 °F

---

Project Name: 17123 - Daytona State College
Dataset Name: 17123 - CALC.TRC

---

TRACE® 700 v6.3.4 calculated at 12:10 PM on 12/14/2018
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Room Checksums
By RLF

<table>
<thead>
<tr>
<th>COOLING COIL PEAK</th>
<th>CLG SPACE PEAK</th>
<th>HEATING COIL PEAK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peaked at Time:</td>
<td>Mo/Hr: 8 / 16</td>
<td>Mo/Hr: 6 / 15</td>
</tr>
<tr>
<td>Outside Air:</td>
<td>OADB/WB/HR: 88 / 78 / 128</td>
<td>OADB: 91</td>
</tr>
<tr>
<td>Space Sens. + Lat. Btu/h</td>
<td>Plenum Sens. + Lat. Btu/h</td>
<td>Net Total Btu/h</td>
</tr>
<tr>
<td>Skylite Solar</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Skylite Cond</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Roof Cond</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Glass Solar</td>
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<td>552</td>
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<td>Glass/Door Cond</td>
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<tr>
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<td>119</td>
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<tr>
<td>Partition/Door</td>
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<td>0</td>
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<tr>
<td>Floor</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Adjacent Floor</td>
<td>0.00</td>
<td>0.00</td>
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<tr>
<td>Infiltration</td>
<td>3,506</td>
<td>3,506</td>
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<tr>
<td>Sub Total ==&gt;</td>
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<td>Internal Loads</td>
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<tr>
<td>Lights</td>
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<td>People</td>
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<tr>
<td>Misc</td>
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<td>202</td>
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<tr>
<td>Ceiling Load</td>
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<td>-91</td>
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<tr>
<td>Ventilation Load</td>
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<tr>
<td>Adj Air Trans Heat</td>
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</tr>
<tr>
<td>Dehumid. Ov Sizing</td>
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<tr>
<td>Ov/Undr Sizing</td>
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<th>AREAS</th>
<th>HEATING COIL SELECTION</th>
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<tbody>
<tr>
<td>Total Capacity</td>
<td>Gross Total</td>
<td>Glass</td>
</tr>
<tr>
<td>ton</td>
<td>f²</td>
<td>(%)</td>
</tr>
<tr>
<td>Mbh</td>
<td>°F</td>
<td>°F</td>
</tr>
<tr>
<td>Main Clg</td>
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<td>6.0</td>
</tr>
<tr>
<td>Aux Clg</td>
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<td>°F</td>
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<td>gr/ft²</td>
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<td>Leakage Dwnt</td>
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<td>0</td>
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<tr>
<td>ENGINEERING CKS</td>
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<td></td>
</tr>
<tr>
<td>% OA</td>
<td>0.0/1000ft²</td>
<td>0.0/1000ft²</td>
</tr>
<tr>
<td>System Checksums Report Page 38 of 66</td>
<td></td>
<td></td>
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</table>
Room Checksums
By RLF

138A - CORRIDOR

<table>
<thead>
<tr>
<th>COOLING COIL PEAK</th>
<th>CLG SPACE PEAK</th>
<th>HEATING COIL PEAK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peaked at Time:</td>
<td>Mo/Hr: 6 / 15</td>
<td>Mo/Hr: Heating Design</td>
</tr>
<tr>
<td>Outside Air:</td>
<td>OADB: 91</td>
<td>OADB: 35</td>
</tr>
</tbody>
</table>

**HEAT/COOLING COIL SELECTION**

<table>
<thead>
<tr>
<th>Component</th>
<th>Sens Cap.</th>
<th>Coil Airflow</th>
<th>Enter DB/DB/HR</th>
<th>Leave DB/DB/HR</th>
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<tbody>
<tr>
<td>Main Clg</td>
<td>3.2</td>
<td>1.7</td>
<td>67 76.5 66.3</td>
<td>812 55.4 50.4 46.5</td>
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<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
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<tr>
<td>Opt Vent</td>
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<td><strong>Total</strong></td>
<td>3.2</td>
<td>1.7</td>
<td>67 76.5 66.3</td>
<td>812 55.4 50.4 46.5</td>
</tr>
</tbody>
</table>

**AREAS GROSS TOTAL**

<table>
<thead>
<tr>
<th>Area</th>
<th>Gross Total</th>
<th>Glass</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor</td>
<td>128</td>
<td>0.0/1000 ft²</td>
<td>100.0</td>
</tr>
<tr>
<td>Part</td>
<td>0</td>
<td>0.0/1000 ft²</td>
<td>100.0</td>
</tr>
<tr>
<td>Int Door</td>
<td>0</td>
<td>0.0/1000 ft²</td>
<td>100.0</td>
</tr>
<tr>
<td>ExFr</td>
<td>0</td>
<td>0.0/1000 ft²</td>
<td>100.0</td>
</tr>
<tr>
<td>Roof</td>
<td>128</td>
<td>0.0/1000 ft²</td>
<td>100.0</td>
</tr>
<tr>
<td>Wall</td>
<td>0</td>
<td>0.0/1000 ft²</td>
<td>100.0</td>
</tr>
<tr>
<td>Ext Door</td>
<td>0</td>
<td>0.0/1000 ft²</td>
<td>100.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>-2,180</td>
<td>-2,506</td>
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</table>

**HEATING COIL SELECTION**

<table>
<thead>
<tr>
<th>Component</th>
<th>Sens Cap.</th>
<th>Coil Airflow</th>
<th>Ent DB/DB/HR</th>
<th>Leave DB/DB/HR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Htg</td>
<td>-2.5</td>
<td>20 55.4 167.5</td>
<td>-2.5 20 55.4 167.5</td>
<td></td>
</tr>
<tr>
<td>Aux Htg</td>
<td>0.0</td>
<td>0.0 0.0 0.0</td>
<td>0.0 0.0 0.0</td>
<td></td>
</tr>
<tr>
<td>Preheat</td>
<td>0.0</td>
<td>0.0 0.0 0.0</td>
<td>0.0 0.0 0.0</td>
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<tr>
<td>Reheat</td>
<td>-0.3</td>
<td>20 55.4 70.0</td>
<td>-0.3 20 55.4 70.0</td>
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<tr>
<td>Humidif</td>
<td>0.0</td>
<td>0.0 0.0 0.0</td>
<td>0.0 0.0 0.0</td>
<td></td>
</tr>
<tr>
<td>Opt Vent</td>
<td>0.0</td>
<td>0.0 0.0 0.0</td>
<td>0.0 0.0 0.0</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>-2.5</td>
<td>20 55.4 167.5</td>
<td>-2.5 20 55.4 167.5</td>
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</table>

**ENGINEERING CKS**

<table>
<thead>
<tr>
<th>Component</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>% OA</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>cfm/ft²</td>
<td>0.52</td>
<td>0.52</td>
</tr>
<tr>
<td>cfm/ton</td>
<td>250.39</td>
<td>250.39</td>
</tr>
<tr>
<td>ft²/ton</td>
<td>477.86</td>
<td>477.86</td>
</tr>
<tr>
<td>Btu/hr/ft²</td>
<td>25.11</td>
<td>-19.57</td>
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</table>

**TEMPERATURES**

<table>
<thead>
<tr>
<th>Component</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>SADB</td>
<td>55.4</td>
<td>167.5</td>
</tr>
<tr>
<td>Ra Plenum</td>
<td>76.5</td>
<td>62.7</td>
</tr>
<tr>
<td>Return</td>
<td>76.5</td>
<td>62.7</td>
</tr>
<tr>
<td>Ret/ OA</td>
<td>76.5</td>
<td>62.7</td>
</tr>
<tr>
<td>Fn MtrTD</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Fn BlD TD</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Fn Frict</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

**AIRFLOWS**

<table>
<thead>
<tr>
<th>Component</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diffuser</td>
<td>67</td>
<td>20</td>
</tr>
<tr>
<td>Terminal</td>
<td>67</td>
<td>20</td>
</tr>
<tr>
<td>Main Fan</td>
<td>67</td>
<td>20</td>
</tr>
<tr>
<td>Sec Fan</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Nom Vent</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>AHU Vent</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Infil</td>
<td>48</td>
<td>48</td>
</tr>
<tr>
<td>MinStop/Rh</td>
<td>20</td>
<td>0.0</td>
</tr>
<tr>
<td>Exhaust</td>
<td>48</td>
<td>48</td>
</tr>
<tr>
<td>Rm Exh</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Auxiliary</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Leakage Dwn</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Leakage Ups</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

**TRACE® 700 6.3.4 calculated at 12:10 PM on 12/14/2018**
Project Name: 17123 - Daytona State College
Dataset Name: 17123 - CALC.TRC
### Room Checksums

**By RLF**

139 - LOADING DOCK

**Heating Design**

- Mo/Hr: 6 / 15
- OADB: 91

**Cooling Space Peak**

- Mo/Hr: 8 / 16
- OADB/WB/HR: 88 / 78 / 128

### Temperatures

- **SADB**: 55.4 / 67.5
- **Ra Plenum**: 76.5 / 62.7
- **Return**: 76.5 / 62.7
- **Ret/OA**: 76.5 / 62.7
- **Fn Mtr/TD**: 0.0 / 0.0
- **Fn Blt/TD**: 0.0 / 0.0
- **Fn Fric**: 0.0 / 0.0

### Airflows

- **Diffuser**
  - Cooling: 167 / 50
  - Heating: 167 / 50
- **Main Fan**
  - Cooling: 167 / 167
  - Heating: 167 / 167
- **Sec Fan**
  - Cooling: 0 / 0
  - Heating: 0 / 0
- **Nom Vent**
  - Cooling: 0 / 0
  - Heating: 0 / 0
- **AHU Vent**
  - Cooling: 0 / 0
  - Heating: 0 / 0
- **Infil**
  - Cooling: 120 / 120
  - Heating: 120 / 120
- **Exhaust**
  - Cooling: 287 / 287
  - Heating: 287 / 287
- **Rm Exh**
  - Cooling: 0 / 0
  - Heating: 0 / 0
- **Auxiliary**
  - Cooling: 0 / 0
  - Heating: 0 / 0
- **Leakage Dwn**
  - Cooling: 0 / 0
  - Heating: 0 / 0
- **Leakage Ups**
  - Cooling: 0 / 0
  - Heating: 0 / 0

### Engineering CKS

- **% OA**
  - Cooling: 0.0 / 0.0
  - Heating: 0.0 / 0.0
- **cfm/ft²**
  - Cooling: 0.52
  - Heating: 0.52
- **cfm/ton**
  - Cooling: 250.39
  - Heating: 477.87
- **Btu/hr·ft²**
  - Cooling: 25.11
  - Heating: -19.57

### Areas

- **Floor**: Gross Total = 319 ft² / (%)
- **Part**: 0 / 0
- **Int Door**: 0 / 0
- **ExFlr**: 0 / 0
- **Roof**: 319 / 0
- **Wall**: 0 / 0
- **Ext Door**: 0 / 0

### Engineering CKS

- **Main Htg**: -6.2 / 50
- **Aux Htg**: 0 / 0
- **Preheat**: 0 / 0
- **Reheat**: -0.8 / 50
- **Humid**: 0 / 0
- **Opt Vent**: 0 / 0

### Heating Coil Selection

- **Total**: 0.7 / 8.0

### Cooling Coil Selection

- **Total**: 0.7 / 8.0

---

Project Name: 17123 - Daytona State College  
Dataset Name: 17123 - CALC.TRC  
TRACE® 700 v6.3.4 calculated at 12:10 PM on 12/14/2018  
Alternative - 1 System Checksums Report Page 40 of 66
## Room Checksums

By RLF

### COOLING COIL PEAK

**Peaked at Time:**
- Mo/Hr: 8 / 15

**Outside Air:**
- OADB/WB/HR: 89 / 78 / 126

<table>
<thead>
<tr>
<th>Envelope Loads</th>
<th>Space Sens. + Lat</th>
<th>Plenum Sens. + Lat</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skylite Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Skylite Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Roof Cond</td>
<td>0</td>
<td>210</td>
<td>210</td>
<td>8</td>
</tr>
<tr>
<td>Glass Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Glass/Door Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wall Cond</td>
<td>651</td>
<td>308</td>
<td>959</td>
<td>35</td>
</tr>
<tr>
<td>Partition/Door</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Floor</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Adjacent Floor</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Infiltration</td>
<td>1.241</td>
<td>1.241</td>
<td>358</td>
<td>25</td>
</tr>
<tr>
<td><strong>Sub Total ==&gt;</strong></td>
<td>1.892</td>
<td>518</td>
<td>2,410</td>
<td>88</td>
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</tbody>
</table>

**Internal Loads**
- Lighting: 291, 73, 363, 13
- People: 0, 0, 0, 0
- Misc: 0, 0, 0, 0

**Sub Total ==>** 291, 73, 363, 13

**Ceiling Load**
- 35, -35, 0, 0
- Ventilation Load: 0, 0, 0, 0
- Adj Air Trans Heat: 0, 0, 0, 0
- Dehumid. Ov Sizing: 0, 0, 0, 0
- Ov/Undr Sizing: 0, 0, 0, 0
- Exhaust Heat: -45, -45, -2, -2
- Sup. Fan Heat: 0, 0, 0
- Ret. Fan Heat: 0, 0
- Duct Heat Pkup: 0, 0
- Underflr Sup Ht Pkup: 0, 0
- Supply Air Leakage: 0, 0

**Grand Total ==>** 2,218, 511, 2,729, 100.00

### CLG SPACE PEAK

**Mo/Hr:** 8 / 13

**OADB:** 87

### HEATING COIL PEAK

**Mo/Hr:** Heating Design

**OADB:** 35

### TEMPERATURES

- **Cooling:**
  - SADB: 55.4
  - Ra Plenum: 76.5
  - Return: 76.5
  - Ret/OA: 76.5
- **Heating:**
  - Fm Mtr/TA: 0.0
  - Fm BldTD: 0.0
  - Fm Frict: 0.0

### AIRFLOWS

- **Diffuser:**
  - Cooling: 66
  - Heating: 20
- **Terminal:**
  - Cooling: 66
  - Heating: 20
- **Main Fan:**
  - Cooling: 66
  - Heating: 66
- **Sec Fan:**
  - Cooling: 0
  - Heating: 0
- **Nom Vent:**
  - Cooling: 0
  - Heating: 0
- **AHU Vent:**
  - Cooling: 0
  - Heating: 0
- **Infl:**
  - Cooling: 27
  - Heating: 27
- **Min/Stop/Rh:**
  - Cooling: 20
  - Heating: 20
- **Exhaust:**
  - Cooling: 92
  - Heating: 92
- **Rm Exh:**
  - Cooling: 0
  - Heating: 0
- **Auxiliary:**
  - Cooling: 0
  - Heating: 0
- **Leakage Dwn:**
  - Cooling: 0
  - Heating: 0
- **Leakage Ups:**
  - Cooling: 0
  - Heating: 0

### ENGINEERING CKS

- **% OA:**
  - Cooling: 0.0
  - Heating: 0.0
  - cfm/ft²: 0.93
  - cfm/ton: 288.90
  - ft³/ton: 312.26
  - Btu/hr·ft²: -39.96

- **No. People:**
  - Cooling: 0.0
  - Heating: 0.0

### AREAS

**Gross Total:** 71

**ft² (%):**
- Floor: 0.0
- Part: 0.0
- Int Door: 0.0
- ExFlr: 0.0
- Roof: 0.0
- Wall: 0.0
- Ext Door: 0.0

**Total:** 2.8

### HEATING COIL SELECTION

**Capacity:**
- Cooling: 1.0
- Heating: 0.0

**Airflow:**
- Cooling: 0.0
- Heating: 0.0

**Ef:**
- Cooling: 55.4
- Heating: 185.0

**Lvg:**
- Cooling: 20
- Heating: 55.4
**Room Checksums**

By RLF

### COOLING COIL PEAK

- **Peaked at Time:** Mo/Hr: 8 / 15
- **Outside Air:** OADB/WB/HR: 89 / 78 / 126

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Plenum Sens. + Lat.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
</tbody>
</table>

#### Envelope Loads
- Skylite Solar 0 0 0 0 0 0 0
- Skylite Cond 0 0 0 0 0 0 0
- Roof Cond 0 268 268 10 0 0 0
- Glass Solar 0 0 0 0 0 0 0
- Glass/Door Cond 0 0 0 0 0 0 0
- Wall Cond 227 107 333 13 0 0 0
- Floor 0 0 0 0 0 0 0
- Adjacent Floor 0.00 0.00 0.00 0.00 0.00 0.00 0.00
- Infiltration 1,556 1,556 61 0 0 0 0

**Sub Total:** 1,782 375 2,157 84 0 0 0

#### Internal Loads
- Lights 365 91 456 18 0 0 0
- People 0 0 0 0 0 0 0
- Misc 0 0 0 0 0 0 0

**Sub Total:** 365 91 456 18 0 0 0

#### Ceiling Load
- 43 -43 0 0 64 5 0

#### Ventilation Load
- 0 0 0 0 0 0 0

#### Adj Air Trans Heat
- 0 0 0 0 0 0 0

#### Dehumid. Ov Sizing
- 0 0 0 0 0 0 0

#### Ov/Undr Sizing
- 0 0 0 0 0 0 0

**Grand Total:** 2,190 366 2,556 100.00 1,255 100.00

### CLG SPACE PEAK

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Plenum Sens. + Lat.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
</tbody>
</table>

#### Ceiling Load
- -207 0 0 0

#### Ventilation Load
- 0 0 0 0

#### Adj Air Trans Heat
- 0 0 0 0

#### Dehumid. Ov Sizing
- 0 0 0 0

**Grand Total:** -2,006 -2,286 100.00

### HEATING COIL PEAK

- **Mo/Hr:** Heating Design
- **OADB:** 35

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Plenum Sens. + Lat.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
</tbody>
</table>

#### Envelope Loads
- Skylite Solar 0 0 0 0 0 0 0
- Skylite Cond 0 0 0 0 0 0 0
- Roof Cond 0 151 151 6.60 0 0 0
- Glass Solar 0 0 0 0 0 0 0
- Glass/Door Cond 0 0 0 0 0 0 0
- Wall Cond -305 -426 18.63 0 0 0 0
- Partition/Door 0 0 0 0 0 0 0
- Floor -186 -186 8.12 0 0 0 0
- Adjacent Floor 0.00 0.00 0.00 0 0 0 0
- Infiltration -1,309 -1,309 57.24 0 0 0 0

**Sub Total:** -1,799 -2,071 90.58 0 0 0 0

### AREAS

<table>
<thead>
<tr>
<th>Gross Total</th>
<th>Glass ft² (%)</th>
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<tbody>
<tr>
<td>Floor</td>
<td>89</td>
</tr>
<tr>
<td>Part</td>
<td>0</td>
</tr>
<tr>
<td>Int Door</td>
<td>0</td>
</tr>
<tr>
<td>ExFlr</td>
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<tr>
<td>Roof</td>
<td>89</td>
</tr>
<tr>
<td>Wall</td>
<td>104</td>
</tr>
<tr>
<td>Ext Door</td>
<td>0</td>
</tr>
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</table>

**Total:** -2.3

### HEATING COIL SELECTION

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Coil Airflow</th>
<th>Ent</th>
<th>Lvg</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMBh</td>
<td>cfm/ft²</td>
<td>°F</td>
<td>°F</td>
</tr>
<tr>
<td>Main Htg</td>
<td>-2.3</td>
<td>55.4</td>
<td>17</td>
</tr>
<tr>
<td>Aux Htg</td>
<td>0</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Preheat</td>
<td>0</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Reheat</td>
<td>-0.3</td>
<td>55.4</td>
<td>17</td>
</tr>
<tr>
<td>Humidif</td>
<td>0</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Opt Vent</td>
<td>0</td>
<td>0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

**Total:** -2.3

---

**Temperatures**

<table>
<thead>
<tr>
<th></th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>SADB</td>
<td>55.4</td>
<td>174.3</td>
</tr>
<tr>
<td>Ra Plenum</td>
<td>76.5</td>
<td>62.7</td>
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<tr>
<td>Return</td>
<td>76.5</td>
<td>62.7</td>
</tr>
<tr>
<td>Ret/OA</td>
<td>76.5</td>
<td>62.7</td>
</tr>
<tr>
<td>Fm Mtr/TD</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Fm Bd/TD</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Fm Fric</td>
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<td>0.0</td>
</tr>
</tbody>
</table>

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**Airflows**

<table>
<thead>
<tr>
<th></th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diffuser</td>
<td>58</td>
<td>17</td>
</tr>
<tr>
<td>Terminal</td>
<td>58</td>
<td>17</td>
</tr>
<tr>
<td>Main Fan</td>
<td>58</td>
<td>58</td>
</tr>
<tr>
<td>Sec Fan</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Nom Vent</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>AHU Vent</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Infil</td>
<td>33</td>
<td>33</td>
</tr>
<tr>
<td>MinStop/Rh</td>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td>Return</td>
<td>91</td>
<td>91</td>
</tr>
<tr>
<td>Exhaust</td>
<td>33</td>
<td>33</td>
</tr>
<tr>
<td>Rm Exh</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Auxiliary</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Leakage Dw</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Leakage Ups</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

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**Engineering CKS**

<table>
<thead>
<tr>
<th></th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>% OA</td>
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</tr>
<tr>
<td>cfm/ft²</td>
<td>0.65</td>
<td>0.65</td>
</tr>
<tr>
<td>cfm/ton</td>
<td>270.83</td>
<td>270.83</td>
</tr>
<tr>
<td>ft³/ton</td>
<td>417.82</td>
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</tr>
<tr>
<td>Btu/hr/ft²</td>
<td>28.72</td>
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**Trace® 700 v6.3.4 Calculated at 12:10 PM on 12/14/2018**

**Project Name:** 17123 - Daytona State College
**Dataset Name:** 17123 - CALC.TRC
### Room Checksums

By RLF

**Room: 141 - WALK-IN**

#### COOLING COIL PEAK

- **Peaked at Time:** Mo/Hr: 8 / 16
- **Outside Air:** OADB/WEB/HR: 88 / 78 / 128

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Plenum Sens. + Lat.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
<tr>
<td>Skylite Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Skylite Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Roof Cond</td>
<td>0</td>
<td>339</td>
<td>339</td>
</tr>
<tr>
<td>Glass Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Glass/Door Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wall Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Partition/Door</td>
<td>0</td>
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</tr>
<tr>
<td>Floor</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Adjacent Floor</td>
<td>0.00</td>
<td>0.00</td>
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<tr>
<td>Infiltration</td>
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<td>Sub Total ==&gt;</td>
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<td>339</td>
<td>2,493</td>
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#### CLG SPACE PEAK

- **Mo/Hr:** 6 / 15
- **OADB:** 91

#### HEATING COIL PEAK

- **Mo/Hr:** Heating Design
- **OADB:** 35

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Percent Of Total</th>
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<tbody>
<tr>
<td>Btu/h</td>
<td>(%)</td>
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<tr>
<td>Skylite Solar</td>
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<tr>
<td>Skylite Cond</td>
<td>0</td>
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<tr>
<td>Roof Cond</td>
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<tr>
<td>Glass Solar</td>
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<tr>
<td>Glass/Door Cond</td>
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<tr>
<td>Wall Cond</td>
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<tr>
<td>Floor</td>
<td>0</td>
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<tr>
<td>Adjacent Floor</td>
<td>0.00</td>
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<tr>
<td>Infiltration</td>
<td>-1,779</td>
</tr>
<tr>
<td>Sub Total ==&gt;</td>
<td>-1,779</td>
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</table>

#### Envelope Loads

| Lights | 496 | 124 | 619 | 20 | 496 | 36 |
| People | 0 | 0 | 0 | 0 |
| Misc | 0 | 0 | 0 | 0 |
| Sub Total ==> | 496 | 124 | 619 | 20 | 496 | 36 |

#### Ceiling Load

- **Mo/Hr:** 56
- **Ventilation Load:** 0
- **Adj Air Trans Heat:** 0
- **Dehumid. Ov Sizing:** 0
- **Ov/Undr Sizing:** 0
- **Exhaust Heat:** -73
- **Sup. Fan Heat:** 0
- **Ret. Fan Heat:** 0
- **Duct Heat Pkup:** 0
- **Underflr Sup Ht Pkup:** 0
- **Supply Air Leakage:** 0

#### Internal Loads

| Ceiling Load | -281 | 0 | 0 |
| Ventilation Load | 0 | 0 | 0 |
| Adj Air Trans Heat | 0 | 0 | 0 |
| Ov/Undr Sizing | 0 | 0 | 0 |
| Exhaust Heat | 369 | -511 |
| OA Preheat Diff. | 0 | 0 |
| RA Preheat Diff. | 0 | 0 |
| Additional Reheat | -511 | 21.59 |
| System Plenum Heat | -242 | 10.22 |
| Underflr Sup Ht Pkup | 0 | 0 |
| Supply Air Leakage | 0 | 0 |

#### Grand Total

| 2,705 | 334 | 3,039 | 100.00 | 1,380 | 100.00 |

#### COOLING COIL SELECTION

<table>
<thead>
<tr>
<th>Total Capacity</th>
<th>Sens Cap.</th>
<th>Coil Airflow</th>
<th>Enter DB/WEB/HR</th>
<th>Leave DB/WEB/HR</th>
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</thead>
<tbody>
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<td>ton</td>
<td>MBh</td>
<td>cfm</td>
<td>°F</td>
<td>°F</td>
</tr>
<tr>
<td>Main Clg</td>
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<td>3.0</td>
<td>1.6</td>
<td>63</td>
</tr>
<tr>
<td>Aux Clg</td>
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<td>0.0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Opt Vent</td>
<td>0.0</td>
<td>0.0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
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<td>3.0</td>
<td>1.6</td>
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#### AREAS

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<th>Glass</th>
<th>ft²</th>
<th>(%)</th>
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</tr>
<tr>
<td>Int Door</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>ExFlr</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roof</td>
<td>121</td>
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<td>0</td>
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<tr>
<td>Wall</td>
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<td>0</td>
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</tr>
<tr>
<td>Ext Door</td>
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#### HEATING COIL SELECTION

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<td>°F</td>
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<tr>
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<tr>
<td>Preheat</td>
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<tr>
<td>Reheat</td>
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<tr>
<td>Humidif</td>
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<tr>
<td>Opt Vent</td>
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<td>0</td>
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<tr>
<td>Total</td>
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#### TEMPERATURES

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<th>Heating</th>
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<td>Return</td>
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<tr>
<td>Ret/OA</td>
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<tr>
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<tr>
<td>Fn BldT</td>
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<tr>
<td>Fn Frict</td>
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#### AIRFLOWS

| Diffuser | 63 | 19 |
| Terminal | 63 | 19 |
| Main Fan | 63 | 63 |
| Sec Fan | 0 | 0 |
| Nom Vent | 0 | 0 |
| AHU Vent | 0 | 0 |
| Infl | 45 | 45 |
| MinStop/Rh | 19 | 19 |
| Return | 109 | 109 |
| Exhaust | 45 | 45 |
| Rm Exh | 0 | 0 |
| Auxiliary | 0 | 0 |
| Leakage Dwn | 0 | 0 |
| Leakage Ups | 0 | 0 |

#### ENGINEERING CKS

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<table>
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<th>cfm/ton</th>
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<th>Heating</th>
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<table>
<thead>
<tr>
<th>ft²/ton</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
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<td>25.11</td>
<td>19.57</td>
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<table>
<thead>
<tr>
<th>No. People</th>
<th>0.0</th>
<th>0.0/1000 ft²</th>
</tr>
</thead>
</table>

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Project Name: 17123 - Daytona State College
Dataset Name: 17123 - CALC.TRC

TRACE® 700 v6.3.4 calculated at 12:10 PM on 12/14/2018

Alternative - 1
System Checksums Report Page 43 of 66
Room Checksums
By RLF

**COOLING COIL PEAK**

Peaked at Time: Mo/Hr: 8 / 16
Outside Air: OADB/WB/HR: 88 / 78 / 128

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Plenum Sens. + Lat.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
<tr>
<td>Envelope Loads</td>
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<td></td>
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<tr>
<td>Skylite Solar</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Skylite Cond</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Roof Cond</td>
<td>0</td>
<td>2,710</td>
<td>2,710</td>
</tr>
<tr>
<td>Glass Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Glass/Door Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wall Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Partition/Door</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Floor</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Adjacent Floor</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Infiltration</td>
<td>17,209</td>
<td>17,209</td>
<td>64</td>
</tr>
<tr>
<td><strong>Sub Total ==&gt;</strong></td>
<td>17,209</td>
<td>2,710</td>
<td>19,920</td>
</tr>
<tr>
<td>Ceiling Load</td>
<td>447</td>
<td>-447</td>
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</tr>
<tr>
<td>Ventilation Load</td>
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<td>0</td>
<td>0</td>
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<tr>
<td>Adj Air Trans Heat</td>
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<td>0</td>
</tr>
<tr>
<td>Dehumid. Ov Sizing</td>
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<tr>
<td>Ov/Undr Sizing</td>
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</tr>
<tr>
<td>Exhaust Heat</td>
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</tr>
<tr>
<td>Ret. Fan Heat</td>
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</tr>
<tr>
<td>Duct Heat Pkup</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Underflr Sup Ht Pkup</td>
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<td>0</td>
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<tr>
<td>Supply Air Leakage</td>
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<td>0</td>
</tr>
<tr>
<td><strong>Grand Total ==&gt;</strong></td>
<td>24,117</td>
<td>2,666</td>
<td>26,783</td>
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</table>

**COOLING COIL SELECTION**

<table>
<thead>
<tr>
<th>Total Capacity</th>
<th>Sens Cap.</th>
<th>Coil Airflow</th>
<th>Enter DB/WH/HR</th>
<th>Leave DB/WH/HR</th>
<th>% OA</th>
</tr>
</thead>
<tbody>
<tr>
<td>ton</td>
<td>MBh</td>
<td>MBh</td>
<td>cfm</td>
<td>°F</td>
<td>°F</td>
</tr>
<tr>
<td>Main C Ig</td>
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</tr>
<tr>
<td>Opt Vent</td>
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<td><strong>Total</strong></td>
<td>2.2</td>
<td>26.8</td>
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</table>

**CLG SPACE PEAK**

Mo/Hr: 6 / 15
OADB: 91

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Plenum Sens. + Lat.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
<tr>
<td>Skylite Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Skylite Cond</td>
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</tr>
<tr>
<td>Roof Cond</td>
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<td>2,710</td>
<td>2,710</td>
</tr>
<tr>
<td>Glass Solar</td>
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<td>Wall Cond</td>
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<td>Adjacent Floor</td>
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<tr>
<td>Infiltration</td>
<td>17,209</td>
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<td><strong>Sub Total ==&gt;</strong></td>
<td>17,209</td>
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<td>19,920</td>
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<td>Adj Air Trans Heat</td>
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<tr>
<td><strong>Grand Total ==&gt;</strong></td>
<td>24,117</td>
<td>2,666</td>
<td>26,783</td>
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**HEATING COIL PEAK**

Mo/Hr: Heating Design
OADB: 35

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Plenum Sens. + Lat.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
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<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
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<tr>
<td>Envelope Loads</td>
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<tr>
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<tr>
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<td>Exhaust Heat</td>
<td>2,952</td>
<td>-19.86</td>
<td>-19.86</td>
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<td><strong>Grand Total ==&gt;</strong></td>
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**AREAS**

<table>
<thead>
<tr>
<th>Gross Total</th>
<th>Glass</th>
</tr>
</thead>
<tbody>
<tr>
<td>ft²</td>
<td>(%)</td>
</tr>
<tr>
<td>Floor</td>
<td>967</td>
</tr>
<tr>
<td>Part</td>
<td>0</td>
</tr>
<tr>
<td>Int Door</td>
<td>0</td>
</tr>
<tr>
<td>ExFlr</td>
<td>0</td>
</tr>
<tr>
<td>Roof</td>
<td>967</td>
</tr>
<tr>
<td>Wall</td>
<td>0</td>
</tr>
<tr>
<td>Ext Door</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>-19.2</td>
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</table>

**HEATING COIL SELECTION**

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Coil Airflow</th>
<th>Ent</th>
<th>Lvg</th>
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<tbody>
<tr>
<td>Mbh</td>
<td>cfm</td>
<td>°F</td>
<td>°F</td>
</tr>
<tr>
<td>Main Htg</td>
<td>169</td>
<td>55.4</td>
<td>157.6</td>
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<tr>
<td>Aux Htg</td>
<td>0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Preheat</td>
<td>0</td>
<td>0.0</td>
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</tr>
<tr>
<td>Reheat</td>
<td>0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Humidif</td>
<td>0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Opt Vent</td>
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<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>-19.2</td>
<td></td>
<td></td>
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**TEMPERATURES**

<table>
<thead>
<tr>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>SADB</td>
<td>55.4</td>
</tr>
<tr>
<td>Ra Plenum</td>
<td>76.5</td>
</tr>
<tr>
<td>Return</td>
<td>76.5</td>
</tr>
<tr>
<td>Ret/OA</td>
<td>76.5</td>
</tr>
<tr>
<td>Fn MtrTD</td>
<td>0.0</td>
</tr>
<tr>
<td>Fn BlTD</td>
<td>0.0</td>
</tr>
<tr>
<td>Fn Fric</td>
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**ENGINNEERING CKS**

<table>
<thead>
<tr>
<th>% OA</th>
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**AIRFLOWS**

<table>
<thead>
<tr>
<th>Diffuser</th>
<th>Cooling</th>
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<tbody>
<tr>
<td>564</td>
<td>169</td>
<td>169</td>
</tr>
<tr>
<td>Terminal</td>
<td>564</td>
<td>564</td>
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</table>

**Grand Total ==>

| 100.0 | 12,276 |

**TRACE® 700 v6.3.4 calculated at 12:10 PM on 12/14/2018**

Project Name: 17123 - Daytona State College
Dataset Name: 17123 - CALC.TRC
### Room Checksums

**By RLF**

**143 - WALK-IN**

#### TEMPERATURES

<table>
<thead>
<tr>
<th></th>
<th>Cooling</th>
<th>Heating</th>
</tr>
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<tbody>
<tr>
<td>SADB</td>
<td>55.4</td>
<td>167.5</td>
</tr>
<tr>
<td>Ra Plenum</td>
<td>76.5</td>
<td>62.7</td>
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<tr>
<td>Return</td>
<td>76.5</td>
<td>62.7</td>
</tr>
<tr>
<td>Ret/OA</td>
<td>76.5</td>
<td>62.7</td>
</tr>
<tr>
<td>Fn Mtr/BD</td>
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<td>0.0</td>
</tr>
<tr>
<td>Fn Bld/BD</td>
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<tr>
<td>Fn Fric</td>
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#### AIRFLOWS

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<tbody>
<tr>
<td>Diffuser</td>
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<td>8</td>
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<tr>
<td>Terminal</td>
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<td>8</td>
</tr>
<tr>
<td>Main Fan</td>
<td>27</td>
<td>8</td>
</tr>
<tr>
<td>Sec Fan</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Nom Vent</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>AHU Vent</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Infli</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>MinStop/Rh</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Return</td>
<td>47</td>
<td>47</td>
</tr>
<tr>
<td>Exhaust</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Rm Exh</td>
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<td>0</td>
</tr>
<tr>
<td>Auxiliary</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Leakage Dw</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Leakage Ups</td>
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<td>0</td>
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#### ENGINEERING CKS

<table>
<thead>
<tr>
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<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>% OA</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>cfm/ft²</td>
<td>0.52</td>
<td>0.52</td>
</tr>
<tr>
<td>cfm/ton</td>
<td>250.39</td>
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<tr>
<td>ft³/ton</td>
<td>477.86</td>
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</tr>
<tr>
<td>Btu/hr/ft²</td>
<td>25.11</td>
<td>-19.57</td>
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#### Grand Total

|          | -885 | -1,018 | 100.00 |

### COOLING COIL SELECTION

<table>
<thead>
<tr>
<th></th>
<th>Cool Cap.</th>
<th>Coil Airflow</th>
<th>Enter DB/ WB/HR</th>
<th>Leave DB/ WB/HR</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Clg</td>
<td>0.1</td>
<td>1.3</td>
<td>0.7</td>
<td>27</td>
<td>0.1</td>
</tr>
<tr>
<td>Aux Clg</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Opt Vent</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Total</td>
<td>0.1</td>
<td>1.3</td>
<td>0.7</td>
<td>27</td>
<td>0.1</td>
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### AREAS

<table>
<thead>
<tr>
<th></th>
<th>Gross Total</th>
<th>Glass</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor</td>
<td>52</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Part</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Int Door</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ExFlr</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roof</td>
<td>52</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wall</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Ext Door</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### HEATING COIL SELECTION

<table>
<thead>
<tr>
<th></th>
<th>Capacity</th>
<th>Coil Airflow</th>
<th>Ent</th>
<th>Lvg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Htg</td>
<td>-1.0</td>
<td>8</td>
<td>55.4</td>
<td>167.5</td>
</tr>
<tr>
<td>Aux Htg</td>
<td>0.0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Preheat</td>
<td>0.0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Reheat</td>
<td>-0.1</td>
<td>8</td>
<td>55.4</td>
<td>70.0</td>
</tr>
<tr>
<td>Humidif</td>
<td>0.0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Opt Vent</td>
<td>0.0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>-1.0</td>
<td></td>
<td></td>
<td></td>
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</table>

**Project Name:** 17123 - Daytona State College  
**Dataset Name:** 17123 - CALC.TRC  
**TRACE® 700 v6.3.4 calculated at 12:10 PM on 12/14/2018**  
**Alternative - 1 System Checksums Report Page 45 of 66**
**Room Checksums**  
By RLF

<table>
<thead>
<tr>
<th>System</th>
<th>Capacity</th>
<th>Sens Cap.</th>
<th>Coil Airflow</th>
<th>Enter DB/WB/HR</th>
<th>Leave DB/WB/HR</th>
<th>Grand Total</th>
<th>Grand Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HEATING</strong></td>
<td>1.3</td>
<td>15.0</td>
<td>9.2</td>
<td>360</td>
<td>76.5 66.3</td>
<td>182</td>
<td>7.840</td>
</tr>
<tr>
<td><strong>COOLING</strong></td>
<td>1.3</td>
<td>15.0</td>
<td>9.2</td>
<td>360</td>
<td>76.5 66.3</td>
<td>182</td>
<td>7.840</td>
</tr>
</tbody>
</table>

**COOLING COIL SELECTION**

| Main Clg | 1.3 | 15.0 | 9.2 | 360 | 76.5 66.3 | 182 | 7.840 |
| Aux Clg | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Opt Vent | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

**AREAS**

<table>
<thead>
<tr>
<th>Gross Total</th>
<th>Glass</th>
<th>(ft²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor</td>
<td>480</td>
<td></td>
</tr>
<tr>
<td>Part</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Int Door</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>ExFlr</td>
<td>57</td>
<td></td>
</tr>
<tr>
<td>Roof</td>
<td>480</td>
<td>0</td>
</tr>
<tr>
<td>Wall</td>
<td>733</td>
<td>0</td>
</tr>
<tr>
<td>Ext Door</td>
<td>42</td>
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**HEATING COIL SELECTION**

<table>
<thead>
<tr>
<th>Sun. Plenum</th>
<th>Capacity</th>
<th>Coil Airflow</th>
<th>Ent. DB/WB/HR</th>
<th>Leave DB/WB/HR</th>
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<tbody>
<tr>
<td>Main Htg</td>
<td>-15.5</td>
<td>108</td>
<td>55.4 54.4</td>
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</tr>
<tr>
<td>Aux Htg</td>
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<td>0.0</td>
<td>0.0 0.0</td>
<td></td>
</tr>
<tr>
<td>Preheat</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0 0.0</td>
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</tr>
<tr>
<td>Reheat</td>
<td>-1.8</td>
<td>108</td>
<td>55.4 70.0</td>
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</tr>
<tr>
<td>Humidif</td>
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<td>0.0</td>
<td>0.0 0.0</td>
<td></td>
</tr>
<tr>
<td>Opt Vent</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0 0.0</td>
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</tr>
<tr>
<td>Total</td>
<td>-15.5</td>
<td>-15.5</td>
<td>-15.5</td>
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**TRACE® 700 v6.3.4 calculated at 12:10 PM on 12/14/2018**

Project Name: 17123 - Daytona State College  
Dataset Name: 17123 - CALC.TRC  
Alternative - 1 System Checksums Report Page 46 of 66
### Room Checksums

**By RLF**

#### COOLING COIL PEAK

**Heating Design Mo/Hr:** 6 / 15

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Plenum Sens. + Lat.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
<tr>
<td>Envelope Loads</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Skylite Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Skylite Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Roof Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Glass Solar</td>
<td>0</td>
<td>135</td>
<td>135</td>
</tr>
<tr>
<td>Glass/Door Cond</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wall Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Partition/Door</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Floor</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Adjacent Floor</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Infiltration</td>
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<td>854</td>
<td>5</td>
</tr>
<tr>
<td>Sub Total ==&gt;</td>
<td>18,138</td>
<td>132</td>
<td>18,270</td>
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</table>

#### CLG SPACE PEAK

**Mo/Hr:** 6 / 15

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Plenum Sens. + Lat.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
<tr>
<td>Envelope Loads</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Skylite Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Skylite Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Roof Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Glass Solar</td>
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<td>135</td>
<td>135</td>
</tr>
<tr>
<td>Glass/Door Cond</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wall Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Partition/Door</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Floor</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Adjacent Floor</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Infiltration</td>
<td>854</td>
<td>854</td>
<td>5</td>
</tr>
<tr>
<td>Sub Total ==&gt;</td>
<td>18,138</td>
<td>132</td>
<td>18,270</td>
</tr>
</tbody>
</table>

#### HEATING COIL PEAK

**Mo/Hr:** Heating Design

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Btu/h</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Envelope Loads</td>
<td>Skylite Solar</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Skylite Cond</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Roof Cond</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Glass Solar</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Glass/Door Cond</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Wall Cond</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Partition/Door</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Floor</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Adjacent Floor</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>Infiltration</td>
<td>-706</td>
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<tr>
<td></td>
<td>Sub Total ==&gt;</td>
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</table>

#### TEMPERATURES

** Cooling**

- SADB: 55.4
- Ra Plenum: 76.5
- Return: 76.5
- Ret/OA: 76.5

** Heating**

- SADB: 73.0
- Ra Plenum: 62.7
- Return: 62.7
- Ret/OA: 62.7

#### AIRFLOWS

- **Cooling**
  - Diffuser: 809
  - Terminal: 809
  - Main Fan: 809
  - Sec Fan: 0
  - Nom Vent: 0
  - AHU Vent: 0
  - Infil: 18
  - MinStop/Rh: 243
  - Return: 827

- **Heating**
  - Exhaust: 18
  - Auxiliary: 0
  - Rm Exh: 0
  - Leak Dwn: 0
  - Leakage Ups: 0

### ENGINEERING CKS

#### COOLING COIL SELECTION

<table>
<thead>
<tr>
<th>Total Capacity</th>
<th>Sens Cap.</th>
<th>Coil Airflow</th>
<th>Enter DB/DB/HR</th>
<th>Leave DB/DB/HR</th>
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</thead>
<tbody>
<tr>
<td>ton</td>
<td>MBh</td>
<td>cfm</td>
<td>°F</td>
<td>°F</td>
</tr>
<tr>
<td>Mbh</td>
<td></td>
<td>gr/lb</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Btu/h</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main Clg</td>
<td>1.5</td>
<td>18.3</td>
<td>17.7</td>
<td>809</td>
</tr>
<tr>
<td>Aux Clg</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Opt Vent</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Total</td>
<td>1.5</td>
<td>18.3</td>
<td>17.7</td>
<td>809</td>
</tr>
</tbody>
</table>

#### AREAS

<table>
<thead>
<tr>
<th>Gross Total</th>
<th>Glass ft² (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor</td>
<td>48</td>
</tr>
<tr>
<td>Part</td>
<td>0</td>
</tr>
<tr>
<td>Int Door</td>
<td>0</td>
</tr>
<tr>
<td>ExFlr</td>
<td>0</td>
</tr>
<tr>
<td>Roof</td>
<td>48</td>
</tr>
<tr>
<td>Wall</td>
<td>0</td>
</tr>
<tr>
<td>Ext Door</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>-4.8</td>
</tr>
</tbody>
</table>

#### HEATING COIL SELECTION

- **Capacity**
  - Main Htg: -4.8
  - Aux Htg: 0
  - Preheat: 0
  - Reheat: 3.9
  - Humidif: 0
  - Opt Vent: 0

- **Airflow**
  - Btu/hr: 380.63
  - Btu/h/ft²: -99.01

- **Leakage**
  - Up: 0
  - Dwn: 0

#### Other Details

- **Dataset Name:** Alternative - 1
- **Dataset Name:** System Checksums Report Page 47 of 66
**Room Checksums**

By RLF

### COOLING COIL PEAK

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Plenum Sens. + Lat.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
</tbody>
</table>

- Envelope Loads
  - Skylite Solar: 0
  - Skylite Cond: 0
  - Roof Cond: 0
  - Glass Solar: 1,413
  - Glass/Door Cond: 1,024
  - Wall Cond: 1,151
  - Partition/Door: 0
  - Floor: 0
  - Adjacent Floor: 0.00
  - Infiltration: 7,587
  - Sub Total: 11,175

- Internal Loads
  - Ceiling Load: 211
  - Ventilation Load: 0
  - Adj Air Trans Heat: 0
  - Dehumid. Ov Sizing: 0
  - Ov/Undr Sizing: 0
  - Exhaust Heat: -277
  - Duct Heat Pkup: 0
  - Underflr Sup Ht Pkup: 0
  - Supply Air Leakage: 0
  - Sub Total: 1,777

- Total Capacity
  - Main Clg: 1.3
  - Aux Clg: 0.0
  - Opt Vent: 0.0
  - Total: 1.3

### CLG SPACE PEAK

<table>
<thead>
<tr>
<th>Space Sens.</th>
<th>Plenum Sens.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
</tbody>
</table>

- Heating Components
  - Mo/Hr: 6 / 15
  - OADB: 89 / 78 / 126

- Outside Air: 55.4°F, 165.2°F

### HEATING COIL PEAK

<table>
<thead>
<tr>
<th>Space Sens.</th>
<th>Plenum Sens.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
</tbody>
</table>

- Envelope Loads
  - Skylite Solar: 0
  - Skylite Cond: 0
  - Roof Cond: 0
  - Glass Solar: 1,413
  - Glass/Door Cond: 1,024
  - Wall Cond: 1,151
  - Partition/Door: 0
  - Floor: 0
  - Adjacent Floor: 0.00
  - Infiltration: 7,587
  - Sub Total: 11,175

- Internal Loads
  - Ceiling Load: 211
  - Ventilation Load: 0
  - Adj Air Trans Heat: 0
  - Dehumid. Ov Sizing: 0
  - Ov/Undr Sizing: 0
  - Exhaust Heat: -277
  - Duct Heat Pkup: 0
  - Underflr Sup Ht Pkup: 0
  - Supply Air Leakage: 0
  - Sub Total: 1,777

- Total Capacity
  - Main Clg: 1.3
  - Aux Clg: 0.0
  - Opt Vent: 0.0
  - Total: 1.3

### AREAS

<table>
<thead>
<tr>
<th>Gross Total</th>
<th>Glass ft² (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Floor: 434
- Part: 0
- Int Door: 0
- ExFlr: 41
- Roof: 434
- Wall: 547
- Ext Door: 0

### TEMPERATURES

<table>
<thead>
<tr>
<th>Heating</th>
<th>Cooling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ra Plenum</td>
<td>76.5</td>
</tr>
<tr>
<td>Return</td>
<td>76.5</td>
</tr>
<tr>
<td>Ret/OA</td>
<td>76.5</td>
</tr>
<tr>
<td>Fm Mtr/TD</td>
<td>0.0</td>
</tr>
<tr>
<td>Fm Blt/TD</td>
<td>0.0</td>
</tr>
<tr>
<td>Fm Frict</td>
<td>0.0</td>
</tr>
</tbody>
</table>

### AIRFLOWS

- Diffuser: 391 CFM
- Terminal: 391 CFM
- Main Fan: 391 CFM
- Sec Fan: 0 CFM
- Nom Vent: 0 CFM
- AHU Vent: 0 CFM
- Infl: 163 CFM
- MinStop/Rh: 117 CFM
- Return: 553 CFM
- Exhaust: 163 CFM
- Rm Exh: 0 CFM
- Auxiliary: 0 CFM
- Leakage Dwn: 0 CFM
- Leakage Ups: 0 CFM

### ENGINEERING CKS

<table>
<thead>
<tr>
<th>% OA</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>cfm/ft²</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.90</td>
<td>0.90</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>cfm/ton</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>310.13</td>
<td>344.65</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ft²/ton</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,325</td>
<td>-6.27</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ft²/1000 ft²</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>34,82</td>
<td>-32.91</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No. People</th>
<th>163</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0/1000 ft²</td>
<td>0.0/1000 ft²</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Supply Air Leakage Ups</th>
<th>Supply Air Leakage Dwn</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

**TRACE® 700 v6.3.4 calculated at 12:10 PM on 12/14/2018**

Project Name: 17123 - Daytona State College

Dataset Name: 17123 - CALC.TRC

Alternative - 1 System Checksums Report Page 48 of 66
**Room Checksums**

By RLF

### COOLING COIL PEAK

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Plenum Sens. + Lat</th>
<th>Net Total</th>
<th>Space Sensible</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
<td></td>
</tr>
</tbody>
</table>

#### Envelope Loads
- Skylite Solar: 0
- Skylite Cond: 0
- Roof Cond: 0
- Glass Solar: 0
- Glass/Door Cond: 0
- Wall Cond: 848
- Partition/Door: 0
- Floor: 0
- Adjacent Floor: 0
- Infiltration: 1,785
- Sub Total: 2,632

#### Internal Loads
- Ceiling Load: 31
- Ventilation Load: 0
- Adj Air Trans Heat: 0
- Dehumid. Ov Sizing: 0
- Ov/Undr Sizing: 0
- Exhaust Heat: -41
- Ret. Fan Heat: 0
- Duct Heat Pkup: 0
- Underflr Sup Ht Pkup: 0
- Supply Air Leakage: 0

#### Grand Total
- 3,582

### CLG SPACE PEAK

The peak values for Heating and Cooling are as follows:

#### Heating Design
- Mo/Hr: 6 / 16
- OADB: 90

**Heating Design**
- Mo/Hr: 6 / 16
- OADB: 90

### HEATING COIL PEAK

The peak values for Heating and Cooling are as follows:

#### Heating Design
- Mo/Hr: 6 / 16
- OADB: 90

**Heating Design**
- Mo/Hr: 6 / 16
- OADB: 90

### TEMPERATURES

**Cooling**
- SADB: 55.4
- Ra Plenum: 76.0
- Return: 76.0
- Ret/OA: 76.0
- Fn MtrTD: 0.0
- Fn BlTD: 0.0
- Fn Fric: 0.0

**Heating**
- SADB: 162.7
- Ra Plenum: 62.7
- Return: 62.7
- Ret/OA: 62.7
- Fn MtrTD: 0.0
- Fn BlTD: 0.0
- Fn Fric: 0.0

### AIRFLOWS

**Diffuser**
- Cooling: 96
- Heating: 29

**Terminal**
- Cooling: 96
- Heating: 29

**Main Fan**
- Cooling: 96
- Heating: 96

**Sec Fan**
- Cooling: 0
- Heating: 0

**AHU Vent**
- Cooling: 0
- Heating: 0

**Infl**
- Cooling: 38
- Heating: 38

**Exhaust**
- Cooling: 38
- Heating: 38

### ENGINEERING CKS

**% OA**
- Cooling: 0.0
- Heating: 0.0

**cfm/ft²**
- Cooling: 0.94
- Heating: 0.94

**cfm/ton**
- Cooling: 270.68
- Heating: 286.67

**ft²/ton**
- Cooling: 43.57
- Heating: 56.36

**No. People**
- 3,582

### AREAS

**Gross Total**
- Floor: 102
- Part: 0
- Int Door: 0
- ExFlr: 20
- Roof: 102
- Wall: 263
- Ext Door: 0

**Glass ft² (%)**
- Main Htg: -3.4
- Aux Htg: 0
- Preheat: 0
- Reheat: -0.5
- Humidif: 0
- Opt Vent: 0

**Total**
- -3.4
# Room Checksums

By RLF

## COOLING COIL PEAK

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Plenum Sens. + Lat.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
</tbody>
</table>

### Envelope Loads
- **Skylite Solar**: 0
- **Skylite Cond**: 0
- **Roof Cond**: 0
- **Glass Solar**: 0
- **Glass/Door Cond**: 0
- **Wall Cond**: 523
- **Floor**: 0
- **Adjacent Floor**: 0
- **Infiltration**: 24,862

### Internal Loads
- **Ceiling Load**: 645
- **Ventilation Load**: 0
- **Adj Air Trans Heat**: 0
- **Dehumid. Ov Sizing**: 0
- **Ov/Undr Sizing**: 0
- **Exhaust Heat**: -848
- **Duct Heat Pkup**: 0
- **Supply Air Leakage**: 0

### Sub Total
- **Total**: 48,252

## CLG SPACE PEAK

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Plenum Sens. + Lat.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
</tbody>
</table>

### System Plenum Heat
- **Main Htg**: -30.2
- **Aux Htg**: 0
- **Sup. Fan Heat**: 0
- **Ret. Fan Heat**: 0
- **Duct Heat Pkup**: 0
- **Underflr Sup Ht Pkup**: 0
- **Supply Air Leakage**: 0

### Adj Air Trans Heat
- **Main Clg**: 1,397
- **Aux Clg**: 0
- **Opt Vent**: 0

### Grand Total
- **Total**: 4,427

## HEATING COIL PEAK

<table>
<thead>
<tr>
<th>Space Sens.</th>
<th>Coil Peak</th>
<th>Net Sens</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
</tbody>
</table>

### Envelope Loads
- **Skylite Solar**: 0
- **Skylite Cond**: 0
- **Roof Cond**: 0
- **Glass Solar**: 0
- **Glass/Door Cond**: 0
- **Wall Cond**: -549
- **Floor**: -334
- **Adjacent Floor**: 0
- **Infiltration**: -20,544

### Internal Loads
- **Ceiling Load**: -3,243
- **Ventilation Load**: 0
- **Adj Air Trans Heat**: 0
- **Ov/Undr Sizing**: 0
- **Exhaust Heat**: -848
- **OA Preheat Diff.**: 0
- **RA Preheat Diff.**: 0
- **Additional Reheat**: -9,109
- **System Plenum Heat**: -1,304
- **Underflr Sup Ht Pkup**: 0
- **Supply Air Leakage**: 0

### Grand Total
- **Total**: 1,653

## TEMPERATURES

### Cooling
- **SADB**: 55.4
- **Ra Plenum**: 76.5
- **Fn Mtr/TD**: 0.0
- **Fn Bld/TD**: 0.0
- **Fn Frc**: 0.0

### Heating
- **SADB**: 135.6
- **Ra Plenum**: 62.7
- **Ret/OA**: 62.7

## AIRFLOWS

### Diffuser
- **Cooling**: 1,129
- **Heating**: 339

### Envelope Loads
- **Skylite Solar**: 0
- **Skylite Cond**: 0
- **Roof Cond**: 0
- **Glass Solar**: 0
- **Glass/Door Cond**: 0
- **Wall Cond**: -549
- **Floor**: -334
- **Adjacent Floor**: 0
- **Infiltration**: -20,544

### Grand Total
- **Cooling**: 1,129
- **Heating**: 339

## ENGINEERING CKS

### % OA
- **Cooling**: 0.0
- **Heating**: 0.0

### Btu/hr (ft²)
- **Cooling**: 0.81
- **Heating**: 0.81

### Btu/hr (ton)
- **Cooling**: 258.84
- **Heating**: 320.21

### Btu/hr (ft²)
- **Cooling**: -37.48
- **Heating**: -21.59

### No. People
- **Cooling**: 3.0
- **Heating**: 21.5/1000 ft²
### Room Checksums

**By RLF**

#### COOLING COIL PEAK

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
</tbody>
</table>

**Peaked at Time:** Mo/Hr: 8 / 16

**Outside Air:** OADB/WB/HR: 88 / 78 / 128

- Skylite Solar: 0 Btu/h
- Skylite Cond: 0 Btu/h
- Roof Cond: 0 Btu/h
- Glass Solar: 0 Btu/h
- Glass/Door Cond: 0 Btu/h
- Wall Cond: 0 Btu/h
- Partition/Door: 0 Btu/h
- Floor: 0 Btu/h
- Adjacent Floor: 0.00 Btu/h
- Infiltration: 12.209 Btu/h

**Sub Total ==>** 12.209 Btu/h

- Ceiling Load: 317 Btu/h
- Ventilation Load: 0 Btu/h
- Adj Air Trans Heat: 0 Btu/h
- Dehumid. Ov Sizing: 0 Btu/h
- Ov/Undr Sizing: 0 Btu/h
- Exhaust Heat: -417 Btu/h
- Duct Heat Pkup: 0 Btu/h
- Supply Air Leakage: 0 Btu/h

**Grand Total ==>** 15,335 Btu/h

#### CLG SPACE PEAK

<table>
<thead>
<tr>
<th>Heating Design</th>
<th>Mo/Hr: 6 / 15</th>
<th>OADB: 91</th>
</tr>
</thead>
</table>

#### HEATING COIL PEAK

**Mo/Hr:** Heating Design

**OADB:** 35

- Skylite Solar: 0 Btu/h
- Skylite Cond: 0 Btu/h
- Roof Cond: 0 Btu/h
- Glass Solar: 0 Btu/h
- Glass/Door Cond: 0 Btu/h
- Wall Cond: 0 Btu/h
- Partition/Door: 0 Btu/h
- Floor: 0 Btu/h
- Adjacent Floor: 0.00 Btu/h
- Infiltration: -10,088 Btu/h

**Sub Total ==>** -10,088 Btu/h

- Ceiling Load: -1,593 Btu/h
- Ventilation Load: 0 Btu/h
- Adj Air Trans Heat: 0 Btu/h
- Ov/Undr Sizing: 0 Btu/h
- Exhaust Heat: 2,094 Btu/h
- Duct Heat Pkup: 0 Btu/h
- Supply Air Leakage: 0 Btu/h

**Grand Total ==>** -11,681 Btu/h

#### TEMPERATURES

<table>
<thead>
<tr>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>SADB</td>
<td>55.4</td>
</tr>
<tr>
<td>Ra Plenum</td>
<td>76.5</td>
</tr>
<tr>
<td>Ret/OA</td>
<td>76.5</td>
</tr>
<tr>
<td>Fm Mtr/TD</td>
<td>0.0</td>
</tr>
<tr>
<td>Fm BldT</td>
<td>0.0</td>
</tr>
<tr>
<td>Fm Fric</td>
<td>0.0</td>
</tr>
</tbody>
</table>

#### AIRFLOWS

- **Diffuser:** Cooling 359 Btu/hr, Heating 108 Btu/hr
- **Terminal:** Cooling 359 Btu/hr, Heating 108 Btu/hr
- **Main Fan:** Cooling 359 Btu/hr, Heating 359 Btu/hr
- **Sec Fan:** Cooling 0 Btu/hr, Heating 0 Btu/hr
- **Exhaust:** Cooling 257 Btu/hr, Heating 257 Btu/hr
- **Auxiliary:** Cooling 0 Btu/hr, Heating 0 Btu/hr
- **Leakage Dwnt:** Cooling 0 Btu/hr, Heating 0 Btu/hr
- **Leakage Ups:** Cooling 0 Btu/hr, Heating 0 Btu/hr

#### ENGINEERING CKS

- **% OA:** Cooling 0.0, Heating 0.0
- **cfm/ft²:** Cooling 0.52, Heating 0.52
- **cfm/ton:** Cooling 250.39, Heating 250.39
- **ft³/ton:** Cooling 477.87, Heating 477.87
- **Btu/hr/ft²:** Cooling 25.11, Heating 25.11
- **No. People:** Cooling 0, Heating 0

#### COOLING COIL SELECTION

<table>
<thead>
<tr>
<th>Total Capacity</th>
<th>Sens Cap</th>
<th>Coil airflow</th>
<th>Enter DB/WB/HR</th>
<th>Leave DB/WB/HR</th>
</tr>
</thead>
<tbody>
<tr>
<td>ton MBh</td>
<td>MBh</td>
<td>cfm</td>
<td>°F</td>
<td>°F</td>
</tr>
<tr>
<td>1.4</td>
<td>17.2</td>
<td>8.9</td>
<td>359</td>
<td>76.5</td>
</tr>
<tr>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Opt Vent</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

**Total:** 1.4 ton 17.2 MBh

#### AREAS

- **Floor:** Gross Total 1,927 Btu/h, Glass 1,050 Btu/h, (%) 33.6

#### HEATING COIL SELECTION

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Coil Airflow</th>
<th>Ent Lvg</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBh</td>
<td>cfm</td>
<td>°F</td>
</tr>
<tr>
<td>Main Htg</td>
<td>-13.4</td>
<td>108</td>
</tr>
<tr>
<td>Aux Htg</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Preheat</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Reheat</td>
<td>-1.8</td>
<td>108</td>
</tr>
<tr>
<td>Humidif</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Opt Vent</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

**Total:** -13.4 Btu/h

---

Project Name: 17123 - Daytona State College

Dataset Name: 17123 - CALC.TRC
### Room Checksums

**By RLF**

#### COOLING COIL PEAK

- **Peaked at Time:**
  - Mo/Hr: 8 / 16
- **Outside Air:**
  - OADB/WB/HR: 88 / 78 / 128

#### CLG SPACE PEAK

- **Mo/Hr:**
  - 6 / 15

#### HEATING COIL PEAK

- **Mo/Hr:**
  - Heating Design
  - OADB: 91

#### TEMPERATURES

<table>
<thead>
<tr>
<th>SADB</th>
<th>Ra Plenum</th>
<th>Ret/OA</th>
</tr>
</thead>
<tbody>
<tr>
<td>55.4</td>
<td>76.5</td>
<td>76.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fnr MtrTD</th>
<th>Fnr Bltd</th>
<th>Fnr Frict</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

#### AIRFLOWS

<table>
<thead>
<tr>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diffuser</td>
<td>693</td>
</tr>
<tr>
<td>Terminal</td>
<td>693</td>
</tr>
<tr>
<td>Main Fan</td>
<td>693</td>
</tr>
<tr>
<td>Sec Fan</td>
<td>0</td>
</tr>
<tr>
<td>Nom Vent</td>
<td>0</td>
</tr>
<tr>
<td>AHU Vent</td>
<td>0</td>
</tr>
<tr>
<td>Infiltration</td>
<td>315</td>
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<tr>
<td>Exfiltration</td>
<td>208</td>
</tr>
<tr>
<td>Exhaust</td>
<td>1,009</td>
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</table>

#### ENGINEERING CKS

<table>
<thead>
<tr>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>%OA</td>
<td>0.0</td>
</tr>
<tr>
<td>Cfm/ft²</td>
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</tr>
<tr>
<td>Cfm/ton</td>
<td>259.07</td>
</tr>
<tr>
<td>ft³/ton</td>
<td>314.21</td>
</tr>
<tr>
<td>Btu/hr·ft²</td>
<td>38.19</td>
</tr>
</tbody>
</table>

#### AREAS

- **Gross Total**
  - Floor: 841
  - Part: 0
  - Int Door: 0
  - ExFlr: 0
  - Roof: 841
  - Wall: 0
  - Ext Door: 0
- **Glass ft² (%)**
  - Main Htg: -17.7
  - Aux Htg: 0.0
  - Preheat: 0.0
  - Reheat: -3.4
  - Humidif: 0.0
  - Opt Vent: 0.0
  - Total: -17.7

#### COOLING COIL SELECTION

<table>
<thead>
<tr>
<th>Total Capacity</th>
<th>Sens Cap.</th>
<th>Coil Airflow</th>
<th>Enter DB/WB/HR</th>
<th>Leave DB/WB/HR</th>
</tr>
</thead>
<tbody>
<tr>
<td>ton</td>
<td>MBh</td>
<td>MBh</td>
<td>cfm</td>
<td>°F</td>
</tr>
<tr>
<td>Main Clg</td>
<td>2.7</td>
<td>32.1</td>
<td>16.4</td>
<td>693</td>
</tr>
<tr>
<td>Aux Clg</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Opt Vent</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Total</td>
<td>2.7</td>
<td>32.1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### HEATING COIL SELECTION

- **Capacity**
  - Mbh
- **Airflow**
  - Cfm
- **Ent Lvg**
  - °F

<table>
<thead>
<tr>
<th>Main Htg</th>
<th>Aux Htg</th>
<th>Preheat</th>
<th>Reheat</th>
<th>Humidif</th>
<th>Opt Vent</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>-17.7</td>
<td>208</td>
<td>55.4</td>
<td>132.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

---

**Project Name:** 17123 - Daytona State College  
**Dataset Name:** 17123 - CALC.TRC

---

**TRACE® 700 v6.3.4 calculated at 12:10 PM on 12/14/2018**  
**Alternative - 1 System Checksums Report Page 52 of 66**
Room Checksums
By RLF

**Room Checksums**

### COOLING COIL PEAK

- **Peaked at Time:**
  - Mo/Hr: 8 / 17
  - Outside Air: OADB/WB/HR: 87 / 78 / 128

- **Space Sens. + Lat.**
  - Btu/h
  - Plenum Sens. + Lat.
  - Btu/h
  - Net Total Sensible Btu/h
  - Percent of Total

- **Envelope Loads**
  - Skylite Solar: 0
  - Skylite Cond: 0
  - Roof Cond: 0
  - Glass Solar: 2,682
  - Glass/Door Cond: 982
  - Wall Cond: 1,942
  - Floor: 146
  - Adjacent Floor: 0
  - Infiltration: 9,273

- **Sub Total ==>**
  - 14,679

- **Ceiling Load**
  - 163

- **Ventilation Load**
  - 0

- **Adj Air Trans Heat**
  - 0

- **Dehumid. Ov Sizing**
  - 0

- **Ov/Undr Sizing**
  - 0

- **Exhaust Heat**
  - -215

- **Ret. Fan Heat**
  - 0

- **Duct Heat Pkp**
  - 0

- **Underflr Sup Ht Pkp**
  - 0

- **Supply Air Leakage**
  - 0

- **Grand Total ==>**
  - 17,213

### CLG SPACE PEAK

- **Mo/Hr:** 6 / 17
- **OADB:** 89

### HEATING COIL PEAK

- **Mo/Hr:** Heating Design
- **OADB:** 35

### TEMPERATURES

- **Cooling:**
  - SADB: 55.4
  - Ra Plenum: 76.0
  - Return: 76.0
  - Ret/OA: 76.0
  - Fn Mtr/TD: 0.0
  - Fn BldTd: 0.0
  - Fn Frict: 0.0

- **Heating:**
  - Ra Plenum: 62.7
  - Return: 62.7
  - Ret/OA: 62.7

### AIRFLOWS

- **Cooling:**
  - Diffuser: 503
  - Terminal: 503
  - Main Fan: 503

- **Heating:**
  - MinStop/Rh: 151
  - Exhaust: 199

### ENGNERING CKS

- **% OA Cooling:**
  - 0.0

### AREAS

- **Floor:**
  - Gross Total: 530

- **Glass (ft²):**
  - 0

- **% of Total:**
  - 0

### HEATING COIL SELECTION

- **Capacity:**
  - MMBh: 1.7
  - MMBh: 13.2
  - MMBh: 0
  - MMBh: 0

- **Coil Airflow:**
  - cfm: 503
  - cfm: 0
  - cfm: 0

- **Enter DB/ WB/ HR:**
  - °F: 76.0
  - °F: 66.2
  - °F: 0

- **Leave DB/ WB/ HR:**
  - °F: 81.2
  - °F: 55.4
  - °F: 0

- **Part:**
  - 0

- **Int Door:**
  - 0

- **ExFlr:**
  - 0

- **Roof:**
  - 530

- **Wall:**
  - 810

- **Ext Door:**
  - 0

- **Total:**
  - -17.7

---

**Project Name:** 17123 - Daytona State College

**Dataset Name:** 17123 - CALC.TRC
### Room Checksums

**By RLF**

#### COOLING COIL PEAK

**Peaked at Time:**
- Mo/Hr: 8 / 16

**Outside Air:**
- OADB/WB/HR: 88 / 78 / 128

<table>
<thead>
<tr>
<th>Component</th>
<th>Sens. + Lat.</th>
<th>Plenum + Lat.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
<tr>
<td>Envelope Loads</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skylite Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Skylite Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Roof Cond</td>
<td>0</td>
<td>1,230</td>
<td>1,230</td>
<td>9</td>
</tr>
<tr>
<td>Glass Solar</td>
<td>635</td>
<td>0</td>
<td>635</td>
<td>5</td>
</tr>
<tr>
<td>Glass/Door Cond</td>
<td>1,029</td>
<td>0</td>
<td>1,029</td>
<td>7</td>
</tr>
<tr>
<td>Wall Cond</td>
<td>786</td>
<td>508</td>
<td>1,295</td>
<td>9</td>
</tr>
<tr>
<td>Partition/Door</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Floor</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Adjacent Floor</td>
<td>0.0</td>
<td>0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Infiltration</td>
<td>7,813</td>
<td>7,813</td>
<td>7,813</td>
<td>56</td>
</tr>
<tr>
<td><strong>Sub Total =</strong></td>
<td>10,263</td>
<td>1,738</td>
<td>12,001</td>
<td>86</td>
</tr>
</tbody>
</table>

**Internal Loads**

- **Lights:** 1,798 Btu/h
- **People:** 0 Btu/h
- **Misc:** 0 Btu/h
- **Sub Total =** 1,798 Btu/h

**Ceiling Load**

- 203 Btu/h

**Ventilation Load**

- 0 Btu/h

**Adj Air Trans Heat**

- 0 Btu/h

**Dehumid. Ov Sizing**

- 0 Btu/h

**Ov/Undr Sizing**

- 0 Btu/h

**Exhaust Heat**

- -267 Btu/h

**Duct Heat Pkup**

- 0 Btu/h

**Underflr Sup Ht Pkup**

- 0 Btu/h

**Supply Air Leakage**

- 0 Btu/h

**Grand Total =** 12,264 Btu/h

#### CLG SPACE PEAK

**Mo/Hr:** 6 / 16

**OADB:** 90

### HEATING COIL PEAK

**Mo/Hr:** Heating Design

**OADB:** 35

<table>
<thead>
<tr>
<th>Component</th>
<th>Sens. + Lat.</th>
<th>Plenum + Lat.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
<tr>
<td>Envelope Loads</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skylite Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Skylite Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Roof Cond</td>
<td>0</td>
<td>1,230</td>
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<td>Glass Solar</td>
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<td>Glass/Door Cond</td>
<td>1,029</td>
<td>0</td>
<td>1,029</td>
<td>7</td>
</tr>
<tr>
<td>Wall Cond</td>
<td>786</td>
<td>508</td>
<td>1,295</td>
<td>9</td>
</tr>
<tr>
<td>Partition/Door</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Floor</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Adjacent Floor</td>
<td>0.0</td>
<td>0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Infiltration</td>
<td>7,813</td>
<td>7,813</td>
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<td>1,738</td>
<td>12,001</td>
<td>86</td>
</tr>
</tbody>
</table>

**Internal Loads**

- **Lights:** 1,798 Btu/h
- **People:** 0 Btu/h
- **Misc:** 0 Btu/h
- **Sub Total =** 1,798 Btu/h

**Ceiling Load**

- -1,019 Btu/h

**Ventilation Load**

- 0 Btu/h

**Adj Air Trans Heat**

- 0 Btu/h

**Dehumid. Ov Sizing**

- 0 Btu/h

**Ov/Undr Sizing**

- 0 Btu/h

**Exhaust Heat**

- -267 Btu/h

**Duct Heat Pkup**

- 0 Btu/h

**Underflr Sup Ht Pkup**

- 0 Btu/h

**Supply Air Leakage**

- 0 Btu/h

**Grand Total =** 12,264 Btu/h

### AREAS

<table>
<thead>
<tr>
<th>Area</th>
<th>Gross Total</th>
<th>Glass ft² (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor</td>
<td>439</td>
<td></td>
</tr>
<tr>
<td>Part</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Int Door</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>ExFlr</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Roof</td>
<td>439</td>
<td>0</td>
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<tr>
<td>Wall</td>
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<td>72</td>
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<tr>
<td>Ext Door</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Grand Total =** 12,816 ft²

### HEATING COIL SELECTION

<table>
<thead>
<tr>
<th>Component</th>
<th>Capacity</th>
<th>Coil Airflow</th>
<th>Ent</th>
<th>Lvg</th>
</tr>
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<tbody>
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<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Opt Vent</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1.2</td>
<td>14.0</td>
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</tr>
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</table>

### TEMPERATURES

<table>
<thead>
<tr>
<th>Component</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>SADB</td>
<td>55.4</td>
<td>164.7</td>
</tr>
<tr>
<td>Ra Plenum</td>
<td>76.5</td>
<td>62.7</td>
</tr>
<tr>
<td>Return</td>
<td>76.5</td>
<td>62.7</td>
</tr>
<tr>
<td>Ret/OA</td>
<td>76.5</td>
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<td>0.0</td>
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<tr>
<td>Fn FricL</td>
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<td>0.0</td>
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</tbody>
</table>

### ENGINEERING CKS

<table>
<thead>
<tr>
<th>Component</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>% OA</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>cfm/ft²</td>
<td>0.80</td>
<td>0.80</td>
</tr>
<tr>
<td>cfm/ton</td>
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</tr>
<tr>
<td>ft³/ton</td>
<td>376.77</td>
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</tr>
<tr>
<td>Btu/hr·ft²</td>
<td>31.85</td>
<td>-29.19</td>
</tr>
</tbody>
</table>

### AIRFLOWS

<table>
<thead>
<tr>
<th>Component</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infll</td>
<td>165</td>
<td>165</td>
</tr>
<tr>
<td>MinStop/Rh</td>
<td>106</td>
<td>106</td>
</tr>
<tr>
<td>Exhaust</td>
<td>165</td>
<td></td>
</tr>
<tr>
<td>Rn Exh</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Auxiliary</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Leag Dwn</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Leag Ups</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

### ENGINEERING CKS

- **% OA:** 0.0 / 0.0
- **cfm/ft²:** 0.80 / 0.80
- **cfm/ton:** 302.11
- **ft³/ton:** 376.77
- **Btu/hr·ft²:** 31.85 / -29.19

**Grand Total:** 100.00 / 100.00

---

**Project Name:** 17123 - Daytona State College

**Dataset Name:** 17123 - CALC.TRC

TRACE® 700 v6.3.4 calculated at 12:10 PM on 12/14/2018

Alternative - 1 System Checksums Report Page 54 of 66
## Room Checksums

**By RLF**

### COOLING COIL PEAK

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Plenum Sens. + Lat.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
</tbody>
</table>

**Envelope Loads**

- Skylite Solar: 0
- Skylite Cond: 0
- Roof Cond: 0
- Glass Solar: 0
- Glass/Door Cond: 0
- Wall Cond: 888
- Part/Wall: 433
- Return: 1,321

**Heating Design**

Mo/Hr: 6 / 17

**Mo/Hr: 8 / 17**

**Mo/Hr: Peaked at Time:**

**Cooling**

OADB/WB/HR: 35

**Heating**

OADB: 89

### CLG SPACE PEAK

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Plenum Sens. + Lat.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
</tbody>
</table>

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- Part/Wall: 433
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**Heating Design**

Mo/Hr: 6 / 17

**Mo/Hr: 8 / 17**

**Mo/Hr: Peaked at Time:**

**Cooling**

OADB/WB/HR: 35

**Heating**

OADB: 89

### HEATING COIL PEAK

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Btu/h</th>
</tr>
</thead>
</table>

**Envelope Loads**

- Skylite Solar: 0
- Skylite Cond: 0
- Roof Cond: 0
- Glass Solar: 0
- Glass/Door Cond: 0
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- Part/Wall: 433
- Return: 1,321

**Heating Design**

Mo/Hr: 6 / 17

**Mo/Hr: 8 / 17**

**Mo/Hr: Peaked at Time:**

**Cooling**

OADB/WB/HR: 35

**Heating**

OADB: 89

### TEMPERATURES

**Cooling**

OADB: 55.4

**Heating**

OADB: 155.6

### AIRFLOWS

**Diffuser**

Cooling: 84

Heating: 25

**Terminal**

Cooling: 84

Heating: 25

**Main Fan**

Cooling: 84

Heating: 84

**Sec Fan**

Cooling: 0

Heating: 0

**Nom Vent**

Cooling: 0

Heating: 0

**AHU Vent**

Cooling: 0

Heating: 0

**Infil**

Cooling: 36

Heating: 36

**Min/Stop/Rh**

Cooling: 25

Heating: 25

**Exhaust**

Cooling: 36

Heating: 36

**Rm Exh**

Cooling: 0

Heating: 0

**Auxiliary**

Cooling: 0

Heating: 0

**Leakage Dwon**

Cooling: 0

Heating: 0

**Leakage Ups**

Cooling: 0

Heating: 0

### ENGINEERING CKS

**% OA**

Cooling: 0.0

Heating: 0.0

**cfm/ft²**

Cooling: 0.88

Heating: 0.88

**cfm/ton**

Cooling: 274.04

Heating: 274.04

**ft³/ton**

Cooling: 311.89

Heating: 311.89

**Btu/hr·ft²**

Cooling: 38.50

Heating: 38.50

**Btu/hr·ft²**

Cooling: -29.36

Heating: -29.36

**No. People**

Cooling: 0.0

Heating: 0.0

### AREAS

**Gross Total**

- Floor: 95
- Part: 0
- Int Door: 0
- ExFlr: 0
- Roof: 95
- Wall: 262
- Ext Door: 0

**Glass**

- (ft²)

**%**

- (cooling)

- (heating)

### HEATING COIL SELECTION

**Capacity**

- Main Clg: 0.3
- Aux Clg: 0.0
- Opt Vent: 0.0

**Cool Airflow**

- Main Clg: 3.7
- Aux Clg: 0.0
- Opt Vent: 0.0

**Enter DB/ WB/ HR**

- Main Clg: 84.0
- Aux Clg: 0.0
- Opt Vent: 0.0

**Leave DB/ WB/ HR**

- Main Clg: 76.0 66.2 81.2
- Aux Clg: 0.0
- Opt Vent: 0.0

**Total**

- Main Clg: 0.3 3.7
- Aux Clg: 0.0 0.0
- Opt Vent: 0.0 0.0

---

**Project Name:** 17123 - Daytona State College

**Dataset Name:** 17123 - CALC.TRC

**TRACE® 700 v6.3.4 calculated at 12:10 PM on 12/14/2018**

**Alternative - 1 System Checksums Report Page 55 of 66**
### Room Checksums

By RLF

#### COOLING COIL PEAK

- Peak at Time: Mo/Hr: 8 / 17
- Outside Air: OADB: 87 / 78 / 128

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Plenum Sens. + Lat.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
<tr>
<td>Envelope Loads</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skylite Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Skylite Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Roof Cond</td>
<td>0</td>
<td>238</td>
<td>5</td>
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<tr>
<td>Glass Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Glass/Door Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wall Cond</td>
<td>587</td>
<td>288</td>
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<tr>
<td>Floor</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Adjacent Floor</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Infiltration</td>
<td>1.732</td>
<td>1.732</td>
<td>35</td>
</tr>
<tr>
<td><strong>Sub Total =&gt;</strong></td>
<td>2,319</td>
<td>526</td>
<td>57</td>
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</table>

#### CLG SPACE PEAK

- Mo/Hr: 6 / 17
- OADB: 89

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Plenum Sens. + Lat.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
<tr>
<td>Envelope Loads</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skylite Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Skylite Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Roof Cond</td>
<td>0</td>
<td>-168</td>
<td>6.03</td>
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<tr>
<td>Glass Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Glass/Door Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wall Cond</td>
<td>-410</td>
<td>-573</td>
<td>20.60</td>
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<td>Partition/Door</td>
<td>0</td>
<td>0</td>
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<td>Floor</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Adjacent Floor</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Infiltration</td>
<td>-1,456</td>
<td>-1,456</td>
<td>52.35</td>
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<tr>
<td><strong>Sub Total =&gt;</strong></td>
<td>-1,866</td>
<td>-2,197</td>
<td>78.99</td>
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</table>

#### HEATING COIL PEAK

- Mo/Hr: Heating Design
- OADB: 35

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Plenum Sens. + Lat.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
<tr>
<td>Envelope Loads</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skylite Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Skylite Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Roof Cond</td>
<td>0</td>
<td>-1,485</td>
<td>6.03</td>
</tr>
<tr>
<td>Glass Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Glass/Door Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wall Cond</td>
<td>-1,485</td>
<td>-1,485</td>
<td>52.35</td>
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<tr>
<td><strong>Sub Total =&gt;</strong></td>
<td>-2,970</td>
<td>-3,362</td>
<td>78.99</td>
</tr>
</tbody>
</table>

#### ENVELOPE LOADS

- Skylite Solar
- Skylite Cond
- Roof Cond
- Glass Solar
- Glass/Door Cond
- Wall Cond
- Floor
- Adjacent Floor
- Infiltration

#### AIRFLOWS

- Diffuser
- Terminal
- Main Fan
- Sec Fan
- Nom Vent
- AHU Vent
- Infi
- Auxiliary
- Leakage Dwn
- Leakage Ups

#### ENGINEERING CKS

- % OA
- cfm/ft²
- cfm/ton
- ft³/ton
- Btu/hr/ft²

#### AREAS

- Gross Total
- Glass ft² (%)
- Floor
- Part
- Int Door
- ExFlr
- Roof
- Wall
- Ext Door

#### HEATING COIL SELECTION

- Main Clg
- Aux Clg
- Opt Vent

#### TEMPERATURES

- Cooling SADB 55.4 114.7
- Heating Ra Plenum 76.0 62.7
- Return 76.0 62.7
- Ret/OA 76.0 62.7
- Fn MtrTD 0.0 0.0
- Fn BldTD 0.0 0.0
- Fn Fric 0.0 0.0

---

Project Name: 17123 - Daytona State College
Dataset Name: 17123 - CALC.TRC

TRACE® 700 v6.3.4 calculated at 12:10 PM on 12/14/2018
Alternative - 1 System Checksums Report Page 56 of 66
# Room Checksums

By RLF

## COOLING COIL PEAK

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Plenum Sens. + Lat.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
<th>Space Sensible</th>
<th>Percent Of Total</th>
<th>Btu/h</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Envelope Loads</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skylite Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Skylite Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Roof Cond</td>
<td>2,784</td>
<td>2,784</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Glass Solar</td>
<td>1,293</td>
<td>1,293</td>
<td>4</td>
<td>764</td>
<td>4</td>
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<tr>
<td>Glass/Door Cond</td>
<td>1,026</td>
<td>1,026</td>
<td>3</td>
<td>1,152</td>
<td>6</td>
<td>0</td>
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<tr>
<td>Wall Cond</td>
<td>8</td>
<td>151</td>
<td>0</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Partition/Door</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Floor</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Adjacent Floor</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Infiltration</td>
<td>16,100</td>
<td>16,100</td>
<td>45</td>
<td>6,062</td>
<td>32</td>
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</table>

**Sub Total ==>**

<table>
<thead>
<tr>
<th>Btu/h</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>18,427</td>
<td>59</td>
</tr>
</tbody>
</table>

## CLG SPACE PEAK

<table>
<thead>
<tr>
<th>Space Sensible</th>
<th>Percent Of Total</th>
<th>Btu/h</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceiling Load</td>
<td>448</td>
<td>4</td>
<td>667</td>
</tr>
<tr>
<td>Ventilation Load</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Adj Air Trans Heat</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Dehumid. Ov Sizing</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Ov/Undr Sizing</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Exhaust Heat</td>
<td>-589</td>
<td>-2</td>
<td>0</td>
</tr>
<tr>
<td>Duct Heat Pkup</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Supply Air Leakage</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Sub Total ==>**

<table>
<thead>
<tr>
<th>Btu/h</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>14,029</td>
<td>42</td>
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</table>

## HEATING COIL PEAK

<table>
<thead>
<tr>
<th>Space Sensible</th>
<th>Percent Of Total</th>
<th>Btu/h</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceiling Load</td>
<td>-2,138</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Ventilation Load</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Adj Air Trans Heat</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Ov/Undr Sizing</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Exhaust Heat</td>
<td>2,811</td>
<td>-12.44</td>
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</tr>
<tr>
<td>OA Preheat Diff.</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>RA Preheat Diff.</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Additional Reheat</td>
<td>-6,924</td>
<td>30.63</td>
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</tr>
<tr>
<td>System Plenum Heat</td>
<td>-510</td>
<td>2.25</td>
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<tr>
<td>Underflr Sup Ht Pkup</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Supply Air Leakage</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Sub Total ==>**

<table>
<thead>
<tr>
<th>Btu/h</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>18,681</td>
<td>59</td>
</tr>
</tbody>
</table>

## Internal Loads

<table>
<thead>
<tr>
<th>Btu/h</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3,156</td>
<td>100</td>
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</table>

**Grand Total ==>**

<table>
<thead>
<tr>
<th>Btu/h</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>36,060</td>
<td>100</td>
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</tbody>
</table>

## TEMPERATURES

<table>
<thead>
<tr>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>SADB</td>
<td>55.4</td>
</tr>
<tr>
<td>Ra Plenum</td>
<td>76.5</td>
</tr>
<tr>
<td>Return</td>
<td>76.5</td>
</tr>
<tr>
<td>Ret/OA</td>
<td>76.5</td>
</tr>
<tr>
<td>Fn Mtr/TD</td>
<td>0.0</td>
</tr>
<tr>
<td>Fn Bld/TD</td>
<td>0.0</td>
</tr>
<tr>
<td>Fn Frict</td>
<td>0.0</td>
</tr>
</tbody>
</table>

## AIRFLOWS

<table>
<thead>
<tr>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diffuser</td>
<td>858</td>
</tr>
<tr>
<td>Terminal</td>
<td>858</td>
</tr>
<tr>
<td>Main Fan</td>
<td>858</td>
</tr>
<tr>
<td>Exhaust</td>
<td>345</td>
</tr>
<tr>
<td>Rm Exh</td>
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<tr>
<td>Auxiliary</td>
<td>0</td>
</tr>
<tr>
<td>Leakeag Dwn</td>
<td>0</td>
</tr>
<tr>
<td>Leakeag Ups</td>
<td>0</td>
</tr>
</tbody>
</table>

## ENGINEERING CKS

<table>
<thead>
<tr>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>% OA</td>
<td>0.0</td>
</tr>
<tr>
<td>A/cf/t²</td>
<td>0.93</td>
</tr>
<tr>
<td>A/cf/ton</td>
<td>285.68</td>
</tr>
<tr>
<td>f³/t²</td>
<td>306.49</td>
</tr>
<tr>
<td>Btu/hr/ft³</td>
<td>39.15</td>
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## AREAS

<table>
<thead>
<tr>
<th>Gross Total</th>
<th>Glass</th>
<th>ft²</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor</td>
<td>921</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Part</td>
<td>0</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Int Door</td>
<td>0</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>ExFlr</td>
<td>0</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Roof</td>
<td>921</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Wall</td>
<td>111</td>
<td>72</td>
<td>65</td>
</tr>
<tr>
<td>Ext Door</td>
<td>0</td>
<td>0</td>
<td>0.0</td>
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</table>

**Total**

<table>
<thead>
<tr>
<th>Btu/h</th>
</tr>
</thead>
<tbody>
<tr>
<td>-22,606</td>
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## HEATING COIL SELECTION

<table>
<thead>
<tr>
<th>Total Capacity</th>
<th>Sens Cap.</th>
<th>Coil Airflow</th>
<th>Enter DB/WB/HR</th>
<th>Leave DB/WB/HR</th>
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</thead>
<tbody>
<tr>
<td>ton</td>
<td>MMBh</td>
<td>cfm</td>
<td>°F</td>
<td>°F</td>
</tr>
<tr>
<td>----------------</td>
<td>-----------</td>
<td>--------------</td>
<td>----------------</td>
<td>----------------</td>
</tr>
<tr>
<td>Main Clg</td>
<td>3.0</td>
<td>36.1</td>
<td>23.1</td>
<td>858</td>
</tr>
<tr>
<td>Aux Clg</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Opt Vent</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

**Total**

<table>
<thead>
<tr>
<th>Btu/h</th>
</tr>
</thead>
<tbody>
<tr>
<td>36.1</td>
</tr>
</tbody>
</table>

---

**Project Name:** 17123 - Daytona State College

**Dataset Name:** 17123 - CALC.TRC
### Room Checksums

By RLF

#### TEMPERATURES

<table>
<thead>
<tr>
<th>Room</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>SADB</td>
<td>55.4</td>
<td>88.5</td>
</tr>
<tr>
<td>Ra Plenum</td>
<td>76.5</td>
<td>62.7</td>
</tr>
<tr>
<td>Return</td>
<td>76.5</td>
<td>62.7</td>
</tr>
<tr>
<td>Ret/OA</td>
<td>76.5</td>
<td>62.7</td>
</tr>
<tr>
<td>Fm Mtr/ID</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Fm Bld/ID</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Fm Frict</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

#### AIRFLOWS

<table>
<thead>
<tr>
<th>Room</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
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<tr>
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<td>52</td>
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<tr>
<td>Main Fan</td>
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<tr>
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<td>MinStop/Rh</td>
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#### INTERNAL LOADS

<table>
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<tbody>
<tr>
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</tr>
<tr>
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<td>-1,033</td>
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#### INVENTORIES

<table>
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<tr>
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<td>0.0</td>
</tr>
<tr>
<td>People</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Misc</td>
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#### ENGINEERING CKS

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<thead>
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#### SUPPLEMENTARY LOADS

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<tr>
<td>Underflr Sup Ht Pkup</td>
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<tr>
<td>Adj Air Trans Heat</td>
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<td>0.0</td>
</tr>
<tr>
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</tr>
<tr>
<td>Exhaust Heat</td>
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<td>0.0</td>
</tr>
<tr>
<td>Ret. Fan Heat</td>
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<tr>
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<tr>
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<tr>
<td>Part</td>
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<td>0.0</td>
</tr>
<tr>
<td>Opt Vent</td>
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<tr>
<td>Ov/Undr Sizing</td>
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<tr>
<td>Exhaust Heat</td>
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<td>0.0</td>
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<tr>
<td>Ret. Fan Heat</td>
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<td>Duct Heat Pkup</td>
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<tr>
<td>Int Door</td>
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<tr>
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#### COOLING COIL SELECTION

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
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#### AREAS

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<td>Glass</td>
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#### HEATING COIL SELECTION

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<th>Heating</th>
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<td>Reheat</td>
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TRACE® 700 v6.3.4 calculated at 12:10 PM on 12/14/2018

Project Name: 17123 - Daytona State College

Dataset Name: 17123 - CALC.TRC
### Room Checksums
By RLF

#### COOLING COIL PEAK
**Peaked at Time:** Mo/Hr: 8 / 16  
**Outside Air:** OADB/WB/HR: 88 / 78 / 128  
**Mo/Hr: 6 / 15**  
**Mo/Hr: Peaked at Time:**

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Plenum Sens. + Lat.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
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<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Envelope Loads</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skylite Solar</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skylite Cond</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roof Cond</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glass Solar</td>
<td></td>
<td></td>
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<tr>
<td>Glass/Door Cond</td>
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<tr>
<td>Partition/Door</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Floor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjacent Floor</td>
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<tr>
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<td>1.175</td>
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<table>
<thead>
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<th>Internal Loads</th>
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<tbody>
<tr>
<td>Lights</td>
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<td>68</td>
<td>338</td>
</tr>
<tr>
<td>People</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Misc</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Sub Total ==&gt;</td>
<td>270</td>
<td>68</td>
<td>338</td>
</tr>
</tbody>
</table>

| Ceiling Load       | 30                  | -30       | 0                |
| Ventilation Load   | 0                   | 0         | 0                |
| Adj Air Trans Heat | 0                   | 0         | 0                |
| Dehumid. Ov Sizing | 0                   | 0         | 0                |
| Ov/Undr Sizing     | 0                   | 0         | 0                |
| Exhaust Heat       | -40                 | -40       | -2               |
| Sup. Fan Heat      | 0                   | 0         | 0                |
| Ret. Fan Heat      | 0                   | 0         | 0                |
| Duct Heat Pkup     | 0                   | 0         | 0                |
| Underflr Sup Ht Pkup | 0                 | 0         | 0                |
| Supply Air Leakage | 0                   | 0         | 0                |
| Grand Total ==>    | 1,475               | 182       | 1,657            |

#### CLG SPACE PEAK
**Mo/Hr: 6 / 15**  
**OADB: 91**  
**Mo/Hr: Heating Design**  
**OADB: 35**

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Plenum Sens. + Lat.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
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<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
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</tr>
<tr>
<td>Envelope Loads</td>
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<tr>
<td>Skylite Solar</td>
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<tr>
<td>Skylite Cond</td>
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<td></td>
<td></td>
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<tr>
<td>Glass Solar</td>
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<td></td>
<td></td>
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<tr>
<td>Glass/Door Cond</td>
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<tr>
<td>Wall Cond</td>
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<td>Floor</td>
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<tr>
<td>Adjacent Floor</td>
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<table>
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</tr>
<tr>
<td>People</td>
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<td>0</td>
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<tr>
<td>Misc</td>
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<tr>
<td>Sub Total ==&gt;</td>
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| Ceiling Load       | -153                | 0         | 0                |
| Ventilation Load   | 0                   | 0         | 0                |
| Adj Air Trans Heat | 0                   | 0         | 0                |
| Ov/Undr Sizing     | 0                   | 0         | 0                |
| Exhaust Heat       | 201                 | -15.59    |                  |
| OA Preheat Diff.   | 0                   | 0         | 0                |
| RA Preheat Diff.   | 0                   | 0         | 0                |
| Additional Reheat  | -279                | 21.59     |                  |
| System Plenum Heat | -132                | 10.22     |                  |
| Underflr Sup Ht Pkup | 0               | 0         | 0                |
| Supply Air Leakage | 0                   | 0         | 0                |
| Grand Total ==>    | -1,124              | -1,292    | 100.00           |

#### HEATING COIL PEAK
**Mo/Hr: Heating Design**  
**OADB: 35**

<table>
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<th>Plenum Sens. + Lat.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
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<tr>
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<td>Btu/h</td>
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<tr>
<td>Skylite Solar</td>
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<tr>
<td>Skylite Cond</td>
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<tr>
<td>Roof Cond</td>
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<tr>
<td>Glass Solar</td>
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<td>Floor</td>
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#### TEMPERATURES
**Cooling**  
**Heating**

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<th>SADB</th>
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<th>Ret/OA</th>
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<tr>
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<td>67.5</td>
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<table>
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<th>Fm Bld/TD</th>
<th>Fm Frict</th>
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</thead>
<tbody>
<tr>
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</tbody>
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#### AIRFLOWS
**Diffuser**  
**Terminal**  
**Main Fan**  
**Sec Fan**  
**Nom Vent**  
**AHU Vent**  
**Infi**  
**MinStop/Rh**  
**Exhaust**  
**Rm Exh**  
**Auxiliary**  
**Leakage Dwnt**  
**Leakage Ups**

#### ENGINEERING CKS
**% OA**  
**cfm/ft²**  
**cfm/ton**  
**ft²/ton**  
**Btu/hr/ft²**

<table>
<thead>
<tr>
<th>No. People</th>
<th>0.0</th>
<th>0.0/1000 ft²</th>
</tr>
</thead>
</table>

#### AREAS
**Gross Total**  
**Glass ft² (%)**

| Floor       | 66        | 0.0        |
| Part        | 0         | 0.0        |
| Int Door    | 0         | 0.0        |
| ExFlr       | 0         | 0.0        |
| Roof        | 66        | 0.0        |
| Wall        | 0         | 0.0        |
| Ext Door    | 0         | 0.0        |
| Total       | -1.3      | -1.95      |

#### HEATING COIL SELECTION
**Capacity**  
**Coil Airflow**  
**Ent Lvg °F**

| Main Htg  | -1.3      | 55.4    |
| Aux Htg   | 0.0       | 0.0     |
| Preheat   | 0.0       | 0.0     |
| Reheat    | -0.2      | 55.4    |
| Humidif   | 0.0       | 0.0     |
| Opt Vent  | 0.0       | 0.0     |
| Total     | -1.3      |         |
## Room Checksums

By RLF

### COOLING COIL PEAK

**Peaked at Time:** Mo/Hr: 8 / 16

**Outside Air:** OADB/WB/HR: 88 / 78 / 128

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Plenum Sens. + Lat.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
<th>Space Sensitive</th>
<th>Percent Of Total</th>
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<tr>
<td>Envelope Loads</td>
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<tr>
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<td>Glass/Door Cond</td>
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<tr>
<td>Wall Cond</td>
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<tr>
<td>Partition/Door</td>
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</tr>
<tr>
<td>Floor</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Adjacent Floor</td>
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<td>441</td>
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</tr>
</tbody>
</table>

**Sub Total ==>** 1.192 188 1380 82 441 58

**Internal Loads**

| Ceiling Load       | 31                | -31       | 0                | 49             | 6               |
| Ventilation Load   | 0                 | 0         | 0                | 0              | 0               |
| Adj Air Trans Heat | 0                 | 0         | 0                | 0              | 0               |
| Dehumid. Ov Sizing | 0                 | 0         | 0                | 0              | 0               |
| Ov/Undr Sizing     | 0                 | 0         | 0                | 0              | 0               |
| Exhaust Heat       | -41               | -41       | -2.1             | -1.56          | 0               |
| Sup. Fan Heat      | 0                 | 0         | 0                | 0              | 0               |
| Ret. Fan Heat      | 0                 | 0         | 0                | 0              | 0               |
| Duct Heat Pkup     | 0                 | 0         | 0                | 0              | 0               |
| Supply Air Leakage | 0                 | 0         | 0                | 0              | 0               |

**Grand Total ==>** 1,498 185 1,682 100.00 764 100.00

### CLG SPACE PEAK

**Mo/Hr:** 6 / 15

**OADB:** 91

### HEATING COIL PEAK

**Mo/Hr:** Heating Design

**OADB:** 35

<table>
<thead>
<tr>
<th>Space Sensitive</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Envelope Loads</td>
<td></td>
</tr>
<tr>
<td>Skylite Solar</td>
<td>0</td>
</tr>
<tr>
<td>Skylite Cond</td>
<td>0</td>
</tr>
<tr>
<td>Roof Cond</td>
<td>0</td>
</tr>
<tr>
<td>Glass Solar</td>
<td>0</td>
</tr>
<tr>
<td>Glass/Door Cond</td>
<td>0</td>
</tr>
<tr>
<td>Wall Cond</td>
<td>0</td>
</tr>
<tr>
<td>Partition/Door</td>
<td>0</td>
</tr>
<tr>
<td>Floor</td>
<td>0</td>
</tr>
<tr>
<td>Adjacent Floor</td>
<td>0.00</td>
</tr>
<tr>
<td>Infiltration</td>
<td>-985</td>
</tr>
</tbody>
</table>

**Sub Total ==>** -985 -1,099 83.79

**Internal Loads**

| Ceiling Load       | -156             | 0            | 0               |
| Ventilation Load   | 0                | 0            | 0               |
| Adj Air Trans Heat | 0                | 0            | 0               |
| Ov/Undr Sizing     | 0                | 0            | 0               |
| Exhaust Heat       | 205              | -15.59       |
| OA Preheat Diff.   | 0                | 0            |
| RA Preheat Diff.   | 0                | 0            |
| Additional Reheat  | -283             | 21.59        |
| System Plenum Heat | -134             | 10.22        |
| Underflr Sup Ht Pkup | 0            | 0            |
| Supply Air Leakage | 0                | 0            |

**Grand Total ==>** -1,141 -1,312 100.00

### TEMPERATURES

**Cooling**

<table>
<thead>
<tr>
<th>Space</th>
<th>Sens Cap.</th>
<th>Coil Airflow</th>
<th>Enter DB/ WB/HR</th>
<th>Leave DB/ WB/HR</th>
<th>Net DB/ WB/HR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Clg</td>
<td>0.1</td>
<td>1.7</td>
<td>0.9</td>
<td>35</td>
<td>76.5 66.3</td>
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<tr>
<td>Aux Clg</td>
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<td>0.0</td>
<td>0</td>
<td>0 0</td>
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<tr>
<td>Opt Vent</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0</td>
<td>0 0</td>
</tr>
</tbody>
</table>

**Total** 0.1 1.7

**Heating**

<table>
<thead>
<tr>
<th>Space</th>
<th>Sens Cap.</th>
<th>Coil Airflow</th>
<th>Enter DB/ WB/HR</th>
<th>Leave DB/ WB/HR</th>
<th>Net DB/ WB/HR</th>
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</thead>
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<tr>
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<td>11</td>
<td>55.4</td>
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<tr>
<td>Aux Htg</td>
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<td>0</td>
<td>0 0</td>
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<td></td>
</tr>
<tr>
<td>Preheat</td>
<td>0.0</td>
<td>0</td>
<td>0 0</td>
<td></td>
<td></td>
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<tr>
<td>Reheat</td>
<td>-0.2</td>
<td>11</td>
<td>55.4</td>
<td>70.0</td>
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<tr>
<td>Humidif</td>
<td>0.0</td>
<td>0</td>
<td>0 0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opt Vent</td>
<td>0.0</td>
<td>0</td>
<td>0 0</td>
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<td></td>
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</table>

**Total** -1.3

### AREAS

**Gross Total** 67

<table>
<thead>
<tr>
<th>Space</th>
<th>Gross Total</th>
<th>Glass ft² (%)</th>
</tr>
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<tr>
<td>Floor</td>
<td>67</td>
<td></td>
</tr>
<tr>
<td>Part</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Int Door</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>ExFlr</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Roof</td>
<td>67</td>
<td>0</td>
</tr>
<tr>
<td>Wall</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Ext Door</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Total** 67

### ENGINEERING CKS

<table>
<thead>
<tr>
<th>% OA</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

**cfm/ft²**

<table>
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<tr>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.52</td>
<td>0.52</td>
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</table>

**cfm/ton**

<table>
<thead>
<tr>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>250.39</td>
<td>477.86</td>
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</tbody>
</table>

**Btu/hr·ft²**

<table>
<thead>
<tr>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>21.51</td>
<td>19.57</td>
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</table>

**No. People**

<table>
<thead>
<tr>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0/1000 ft²</td>
<td>0.0/1000 ft²</td>
</tr>
</tbody>
</table>

---

Project Name: 17123 - Daytona State College

Dataset Name: 17123 - CALC.TRC
**Room Checksums**
By RLF

### COOLING COIL PEAK

**Peaked at Time:** Mo/Hr: 8 / 16

**Outside Air:** OADB/WB/HR: 88 / 78 / 128

<table>
<thead>
<tr>
<th>Space Sens. + Lat</th>
<th>Plenum Sens. + Lat</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
</tbody>
</table>

**Envelope Loads**
- Skylite Solar: 0
- Skylite Cond: 0
- Roof Cond: 0
- Glass Solar: 0
- Glass/Door Cond: 0
- Wall Cond: 0
- Partition/Door: 0
- Floor: 0
- Adjacent Floor: 0

**Sub Total ==>>** 2,403

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>62</td>
<td>-62</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-82</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Grand Total ==>>** 3,018

### CLG SPACE PEAK

**Mo/Hr:** 6 / 15

<table>
<thead>
<tr>
<th>Space Sens. + Lat</th>
<th>Plenum Sens. + Lat</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
</tbody>
</table>

### HEATING COIL PEAK

**Mo/Hr:** Heating Design

<table>
<thead>
<tr>
<th>Space Sens. + Lat</th>
<th>Plenum Sens. + Lat</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
</tbody>
</table>

**Envelope Loads**
- Skylite Solar: 0
- Skylite Cond: 0
- Roof Cond: 0
- Glass Solar: 0
- Glass/Door Cond: 0
- Wall Cond: 0
- Partition/Door: 0
- Floor: 0
- Adjacent Floor: 0

**Sub Total ==>>** -2,403

### TEMPERATURES

**Cooling**
- SADB: 55.4
- Ra Plenum: 76.5
- Return: 76.5
- Ret/OA: 76.5

**Heating**
- SADB: 167.5
- Ra Plenum: 62.7
- Return: 62.7
- Ret/OA: 62.7

### AIRFLOWS

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<thead>
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<th>Diffuser</th>
<th>Cooling</th>
<th>Heating</th>
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<td>21</td>
<td>21</td>
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<tr>
<td>Terminal</td>
<td>71</td>
<td>71</td>
</tr>
<tr>
<td>Main Fan</td>
<td>71</td>
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</tr>
<tr>
<td>Sec Fan</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Nom Vent</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>AHU Vent</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Infil</td>
<td>51</td>
<td>51</td>
</tr>
<tr>
<td>MinStop/Rh</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td>Exhaust</td>
<td>121</td>
<td>121</td>
</tr>
<tr>
<td>Rm Exh</td>
<td>51</td>
<td>51</td>
</tr>
<tr>
<td>Auxiliary</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Leakege Dwn</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Leakege Ups</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### ENGINEERING CKS

<table>
<thead>
<tr>
<th>% OA</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
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<td>0.0</td>
</tr>
</tbody>
</table>

**cfm/ft²**
- 0.52

**cfm/ton**
- 250.39

**ft²/ton**
- 777.86

<table>
<thead>
<tr>
<th>No. People</th>
<th>0.0/1000 ft²</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

### AREAS

**Gross Total**
- Floor: 135
- Part: 0
- Int Door: 0
- ExFlr: 0
- Roof: 135
- Wall: 0
- Ext Door: 0

<table>
<thead>
<tr>
<th>Gross Total</th>
<th>Glass ft² (%)</th>
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</thead>
<tbody>
<tr>
<td>135</td>
<td>135</td>
</tr>
</tbody>
</table>

### HEATING COIL SELECTION

**Capacity**
- Main Htg: -2.6
- Aux Htg: 21
- Preheat: 55.4
- Reheat: 70.0
- Humidif: 0.0
- Opt Vent: 0.0

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Coil Airflow</th>
<th>Ent</th>
<th>Lvg</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2.6</td>
<td>21</td>
<td>55.4</td>
<td>167.5</td>
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<tr>
<td>0.0</td>
<td>0.0</td>
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</tr>
<tr>
<td>0.0</td>
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<td>0.0</td>
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</tbody>
</table>

**TRACE® 700 v6.3.4 calculated at 12:10 PM on 12/14/2018**

Project Name: 17123 - Daytona State College
Dataset Name: 17123 - CALC.TRC
Room Checksums
By RLF

<table>
<thead>
<tr>
<th>COOLING COIL PEAK</th>
<th>CLG SPACE PEAK</th>
<th>HEATING COIL PEAK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peaked at Time:</td>
<td>Mo/Hr: 8 / 16</td>
<td>Mo/Hr: 6 / 15</td>
</tr>
<tr>
<td>Outside Air:</td>
<td>OADB/HR: 88 / 128</td>
<td>OADB: 91</td>
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<td>Skylite Solar</td>
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<td>0</td>
</tr>
<tr>
<td>Skylite Cond</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Roof Cond</td>
<td>0</td>
<td>6,861</td>
</tr>
<tr>
<td>Glass Solar</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Glass/Door Cond</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wall Cond</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Partition/Door</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Floor</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Adjacent Floor</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Infiltration</td>
<td>43.566</td>
<td>43.566</td>
</tr>
<tr>
<td>Sub Total ==&gt;</td>
<td>43.566</td>
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<tr>
<td>Internal Loads</td>
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<tr>
<td>Lights</td>
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<tr>
<td>People</td>
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<tr>
<td>Misc</td>
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<td>Adj Air Trans Heat</td>
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<tr>
<td>OA Preheat Diff.</td>
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<tr>
<td>RA Preheat Diff.</td>
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<tr>
<td>Additional Reheat</td>
<td>-14,979</td>
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<td>System Plenum Heat</td>
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<thead>
<tr>
<th>TEMPERATURES</th>
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<tbody>
<tr>
<td>SADB</td>
</tr>
<tr>
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<tr>
<td>Return</td>
</tr>
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<td>Ret/OA</td>
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<td>Fn Bld/TD</td>
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<td>Fn Frict</td>
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<table>
<thead>
<tr>
<th>AIRFLOWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diffusor</td>
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<tr>
<td>Terminal</td>
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<tr>
<td>Main Fan</td>
</tr>
<tr>
<td>Sec Fan</td>
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<tr>
<td>Nom Vent</td>
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<tr>
<td>AHU Vent</td>
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<tr>
<td>Infl</td>
</tr>
<tr>
<td>MinStop/Rh</td>
</tr>
<tr>
<td>Exhaust</td>
</tr>
<tr>
<td>Rm Exh</td>
</tr>
<tr>
<td>Auxiliary</td>
</tr>
<tr>
<td>Leakage Dwn</td>
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<tr>
<td>Leakage Ups</td>
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<table>
<thead>
<tr>
<th>ENGINEERING CKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>% OA</td>
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<td>ft³/ton</td>
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<tr>
<td>Btu/hr/ft²</td>
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<td>No. People</td>
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<table>
<thead>
<tr>
<th>AREAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross Total</td>
</tr>
<tr>
<td>Floor</td>
</tr>
<tr>
<td>Part</td>
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<tr>
<td>Int Door</td>
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<tr>
<td>ExFlr</td>
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<tr>
<td>Roof</td>
</tr>
<tr>
<td>Wall</td>
</tr>
<tr>
<td>Ext Door</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HEATING COIL SELECTION</th>
</tr>
</thead>
<tbody>
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<td>Capacity</td>
</tr>
<tr>
<td>----------</td>
</tr>
<tr>
<td>MBl</td>
</tr>
<tr>
<td>Main Htg</td>
</tr>
<tr>
<td>Aux Htg</td>
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<tr>
<td>Humidif</td>
</tr>
<tr>
<td>Opt Vent</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

Project Name: 17123 - Daytona State College
Dataset Name: 17123 - CALC.TRC
### Room Checksums

By RLF

---

**COOLING COIL PEAK**

Peak at Time: Mo/Hr: 8 / 16

Outside Air: OADB/WB/HR: 88 / 78 / 128

<table>
<thead>
<tr>
<th>Space Sens. + Lat</th>
<th>Plenum Sens. + Lat</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>SkyLite Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>SkyLite Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Roof Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Glass Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Glass/Door Cond</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wall Cond</td>
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<tr>
<td>Partition/Door</td>
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</tr>
<tr>
<td>Floor</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
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<td>0.00</td>
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**CLG SPACE PEAK**

Mo/Hr: 6 / 15

<table>
<thead>
<tr>
<th>Space Sens. + Lat</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>SkyLite Solar</td>
<td>0</td>
</tr>
<tr>
<td>SkyLite Cond</td>
<td>0</td>
</tr>
<tr>
<td>Roof Cond</td>
<td>0</td>
</tr>
<tr>
<td>Glass Solar</td>
<td>0</td>
</tr>
<tr>
<td>Glass/Door Cond</td>
<td>0</td>
</tr>
<tr>
<td>Wall Cond</td>
<td>0</td>
</tr>
<tr>
<td>Partition/Door</td>
<td>0</td>
</tr>
<tr>
<td>Floor</td>
<td>0</td>
</tr>
<tr>
<td>Adjacent Floor</td>
<td>0.00</td>
</tr>
<tr>
<td>Infiltration</td>
<td>-2.265</td>
</tr>
<tr>
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**HEATING COIL PEAK**

Mo/Hr: Heating Design

<table>
<thead>
<tr>
<th>Space Sens. + Lat</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>SkyLite Solar</td>
<td>0</td>
</tr>
<tr>
<td>SkyLite Cond</td>
<td>0</td>
</tr>
<tr>
<td>Roof Cond</td>
<td>0</td>
</tr>
<tr>
<td>Glass Solar</td>
<td>0</td>
</tr>
<tr>
<td>Glass/Door Cond</td>
<td>0</td>
</tr>
<tr>
<td>Wall Cond</td>
<td>0</td>
</tr>
<tr>
<td>Partition/Door</td>
<td>0</td>
</tr>
<tr>
<td>Floor</td>
<td>0</td>
</tr>
<tr>
<td>Adjacent Floor</td>
<td>0.00</td>
</tr>
<tr>
<td>Infiltration</td>
<td>-2.265</td>
</tr>
<tr>
<td>Sub Total ==&gt;</td>
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**TEMPERATURES**

<table>
<thead>
<tr>
<th>SADB</th>
<th>Cooling</th>
<th>Heating</th>
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</thead>
<tbody>
<tr>
<td>55.4</td>
<td>123.5</td>
<td>62.7</td>
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**AIRFLOWS**

<table>
<thead>
<tr>
<th>Diffuser</th>
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<tbody>
<tr>
<td>147</td>
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<td>44</td>
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**ENGINEERING CKS**

<table>
<thead>
<tr>
<th>% OA</th>
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<th>Heating</th>
</tr>
</thead>
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**COOLING COIL SELECTION**

**AREAS**

<table>
<thead>
<tr>
<th>Gross Total</th>
<th>Glass</th>
<th>(%)</th>
</tr>
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<tbody>
<tr>
<td>154 Floor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24 Part</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 Int Door</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 ExFlr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>154 Roof</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>0 Wall</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>0 Ext Door</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

**HEATING COIL SELECTION**

**Grand Total**: 100.00

---

**Room Checksums**

By RLF

---

**COOLING COIL SELECTION**

<table>
<thead>
<tr>
<th>Main Clg</th>
<th>0.5</th>
<th>5.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aux Clg</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Opt Vent</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

**AREAS**

**HEATING COIL SELECTION**

---

TRACE® 700 v6.3.4 calculated at 12:10 PM on 12/14/2018

Project Name: 17123 - Daytona State College

Dataset Name: 17123 - CALC.TRC
### Room Checksums

By RLF

#### COOLING COIL PEAK

Peaked at Time: Mo/Hr: 8 / 16
Outside Air: OADB/WB/HR: 88 / 78 / 128

<table>
<thead>
<tr>
<th>Space Sens. + Lat. Btu/h</th>
<th>Plenum Sens. + Lat. Btu/h</th>
<th>Net Total Btu/h</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Envelope Loads</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skylite Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Skylite Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Roof Cond</td>
<td>0</td>
<td>163</td>
<td>11</td>
</tr>
<tr>
<td>Glass Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Glass Door Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wall Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Partition/Door</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Floor</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Adjacent Floor</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Infiltration</td>
<td>1.032</td>
<td>1.032</td>
<td>71.0</td>
</tr>
<tr>
<td>Sub Total ==&gt;</td>
<td>1.032</td>
<td>1.032</td>
<td>71.0</td>
</tr>
</tbody>
</table>

| Internal Loads           |                            |                 |                  |
| Ceiling Load             | 27                         | -27             | 0                |
| Ventilation Load         | 0                          | 0               | 0                |
| Adj Air Trans Heat       | 0                          | 0               | 0                |
| Dehumid. Ov Sizing       | 0                          | 0               | 0                |
| Ov/Undr Sizing           | 0                          | 0               | 0                |
| Exhaust Heat             | -35                        | -35             | -2               |
| Sup. Fan Heat            | 0                          | 0               | 0                |
| Ret. Fan Heat            | 0                          | 0               | 0                |
| Duct Heat Pkup           | 0                          | 0               | 0                |
| Underflr Sup Ht Pkup     | 0                          | 0               | 0                |
| Supply Air Leakage       | 0                          | 0               | 0                |
| Grand Total ==>          | 1.297                      | 160             | 1,456            |

#### CLG SPACE PEAK

Mo/Hr: 6 / 15

<table>
<thead>
<tr>
<th>Space Sens. + Lat. Btu/h</th>
<th>Plenum Sens. + Lat. Btu/h</th>
<th>Net Total Btu/h</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skylite Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Roof Cond</td>
<td>0</td>
<td>163</td>
<td>11</td>
</tr>
<tr>
<td>Glass Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Glass Door Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wall Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Partition/Door</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Floor</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Adjacent Floor</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Infiltration</td>
<td>1.032</td>
<td>1.032</td>
<td>71.0</td>
</tr>
<tr>
<td>Sub Total ==&gt;</td>
<td>1.032</td>
<td>1.032</td>
<td>71.0</td>
</tr>
</tbody>
</table>

| Ceiling Load             | -135                       | 0               | 0                |
| Ventilation Load         | 0                          | 0               | 0                |
| Adj Air Trans Heat       | 0                          | 0               | 0                |
| Ov/Undr Sizing           | 0                          | 0               | 0                |
| Exhaust Heat             | 177                        | -15.59          |                 |
| OA Preheat Diff.         | 0                          | 0               | 0                |
| RA Preheat Diff.         | 0                          | 0               | 0                |
| Additional Reheat        | -245                       | 21.59           |                 |
| System Plenum Heat       | -116                       | 10.22           |                 |
| Underflr Sup Ht Pkup     | 0                          | 0               | 0                |
| Supply Air Leakage       | 0                          | 0               | 0                |
| Grand Total ==>          | -988                       | -1,135          | 100.00           |

#### HEATING COIL PEAK

Mo/Hr: Heating Design
OADB: 35

<table>
<thead>
<tr>
<th>Space Sens. Btu/h</th>
<th>Coil Peak Btu/h</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Envelope Loads</td>
<td>Skylite Solar</td>
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</tr>
<tr>
<td>Skylite Cond</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Roof Cond</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Glass Solar</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Glass Door Cond</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wall Cond</td>
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<td>0</td>
</tr>
<tr>
<td>Partition/Door</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Floor</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Adjacent Floor</td>
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<td>0.00</td>
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<td>-951</td>
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#### AREAS

**COOLING COIL SELECTION**

<table>
<thead>
<tr>
<th>Total Capacity ton</th>
<th>Sens Cap. MBh</th>
<th>Coil Airflow cfm</th>
<th>Enter DB/DB/HR °F</th>
<th>Leave DB/DB/HR °F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Clg</td>
<td>0.1</td>
<td>1.5</td>
<td>0.8</td>
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</tr>
<tr>
<td>Aux Clg</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Opt Vent</td>
<td>0.0</td>
<td>0.0</td>
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</tr>
<tr>
<td>Total</td>
<td>0.1</td>
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**HEATING COIL SELECTION**

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Coil Airflow gr/ft²</th>
<th>Ent Lvg °F</th>
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</thead>
<tbody>
<tr>
<td>Main Htg</td>
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<td>55.4 167.5</td>
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<td>Aux Htg</td>
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<tr>
<td>Preheat</td>
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</tr>
<tr>
<td>Reheat</td>
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<td>Humidif</td>
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<td>0.0 0.0</td>
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<tr>
<td>Opt Vent</td>
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<td>0.0 0.0</td>
</tr>
<tr>
<td>Total</td>
<td>-1.1</td>
<td>55.4 167.5</td>
</tr>
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#### TEMPERATURES

<table>
<thead>
<tr>
<th>SADB</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>55.4</td>
<td>167.5</td>
<td></td>
</tr>
</tbody>
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<table>
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<table>
<thead>
<tr>
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<tbody>
<tr>
<td>76.5</td>
<td>62.7</td>
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</table>

<table>
<thead>
<tr>
<th>Fn Mtr/TD</th>
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</tr>
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<table>
<thead>
<tr>
<th>Fn Bl TD</th>
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#### AIRFLOWS

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<tr>
<th>Diffuser</th>
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<tbody>
<tr>
<td>30</td>
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<table>
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<table>
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<table>
<thead>
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<th>Sec Fan</th>
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<th>Heating</th>
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</thead>
<tbody>
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</tbody>
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<table>
<thead>
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<th>Nom Vent</th>
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<th>Heating</th>
</tr>
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<table>
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<th>AHU Vent</th>
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<th>Heating</th>
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<table>
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<th>Infl</th>
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<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
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<table>
<thead>
<tr>
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<th>Heating</th>
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</thead>
<tbody>
<tr>
<td>0</td>
<td>9</td>
<td></td>
</tr>
</tbody>
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<table>
<thead>
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<th>Exhaust</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
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<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
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<th>Heating</th>
</tr>
</thead>
<tbody>
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<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Roof</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>58</td>
<td>9</td>
<td>30</td>
</tr>
</tbody>
</table>

#### ENGINEERING CKS

<table>
<thead>
<tr>
<th>No. People</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>0.0/1000 ft²</td>
<td></td>
</tr>
</tbody>
</table>

### TRACE® 700 v6.3.4 calculated at 12:10 PM on 12/14/2018

Project Name: 17123 - Daytona State College
Dataset Name: 17123 - CALC.TRC
Room Checksums

By RLF

COOLING COIL PEAK
Peaked at Time: Mo/Hr: 8 / 16
Outside Air: OADB/WB/HR: 88 / 78 / 128

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Plenum Sens. + Lat.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
<tr>
<td>Envelope Loads</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skylite Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Skylite Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Roof Cond</td>
<td>0</td>
<td>2,486</td>
<td>2,486</td>
</tr>
<tr>
<td>Glass Solar</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Glass/Door Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wall Cond</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Partition/Door</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Floor</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Adjacent Floor</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Infiltration</td>
<td>15,786</td>
<td>15,786</td>
<td>53</td>
</tr>
<tr>
<td>Sub Total ==&gt;</td>
<td>15,786</td>
<td>2,486</td>
<td>18,272</td>
</tr>
</tbody>
</table>

Internal Loads
Lights: 3,633 Btu/h
People: 7,500 Btu/h
Misc: 0 Btu/h
Sub Total ==> 11,133 Btu/h

Ceiling Load: 410 Btu/h
Ventilation Load: 0 Btu/h
Adj Air Trans Heat: 0 Btu/h
Dehumid. Ov Sizing: 0 Btu/h
Ov/Undr Sizing: 0 Btu/h
Exhaust Heat: -539 Btu/h
Sup. Fan Heat: 0 Btu/h
Ret. Fan Heat: 0 Btu/h
Duct HeatPkup: 0 Btu/h
Underflr Sup Ht Pkup: 0 Btu/h
Supply Air Leakage: 0 Btu/h

Grand Total ==> 27,328 Btu/h

CLG SPACE PEAK
Mo/Hr: 6 / 15
OADB: 91

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Plenum Sens. + Lat.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
</tbody>
</table>

Heating Design
Mo/Hr: Peaked at Time:

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Plenum Sens. + Lat.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
</tbody>
</table>

Envelope Loads
Skylite Solar: 0 Btu/h
Skylite Cond: 0 Btu/h
Roof Cond: 0 Btu/h
Glass Solar: 0 Btu/h
Glass/Door Cond: 0 Btu/h
Wall Cond: 0 Btu/h
Partition/Door: 0 Btu/h
Floor: 0 Btu/h
Adjacent Floor: 0 Btu/h
Infiltration: -13,044 Btu/h
Sub Total ==> -13,044 Btu/h

Ceiling Load: 2,059 Btu/h
Ventilation Load: 0 Btu/h
Adj Air Trans Heat: 0 Btu/h
Ov/Undr Sizing: 0 Btu/h
Exhaust Heat: 2,708 Btu/h
OA Preheat Diff.: 0 Btu/h
RA Preheat Diff.: 0 Btu/h
Additional Reheat: -5,139 Btu/h
System Plenum Heat: -1,222 Btu/h
Underflr Sup Ht Pkup: 0 Btu/h
Supply Air Leakage: 0 Btu/h

Grand Total ==> -15,104 Btu/h

HEATING COIL PEAK
Mo/Hr: Heating Design
OADB: 35

<table>
<thead>
<tr>
<th>Space Sens.</th>
<th>Plenum Sens.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/h</td>
<td>Btu/h</td>
<td>Btu/h</td>
<td>(%)</td>
</tr>
</tbody>
</table>

Envelope Loads
Skylite Solar: 0 Btu/h
Skylite Cond: 0 Btu/h
Roof Cond: 0 Btu/h
Glass Solar: 0 Btu/h
Glass/Door Cond: 0 Btu/h
Wall Cond: 0 Btu/h
Partition/Door: 0 Btu/h
Floor: 0 Btu/h
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Infiltration: -13,044 Btu/h
Sub Total ==> -13,044 Btu/h

Ceiling Load: 2,059 Btu/h
Ventilation Load: 0 Btu/h
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System Plenum Heat: -1,222 Btu/h
Underflr Sup Ht Pkup: 0 Btu/h
Supply Air Leakage: 0 Btu/h

Grand Total ==> -15,104 Btu/h

AREAS
Gross Total: 887 ft²
Glass: 0 ft²

Floor
Part
Int Door
ExFlr
Roof
Wall
Ext Door

Total

HEATING COIL SELECTION

<table>
<thead>
<tr>
<th>Total Capacity</th>
<th>Sens Cap.</th>
<th>Coil Airflow</th>
</tr>
</thead>
<tbody>
<tr>
<td>ton M Bh</td>
<td>MBh</td>
<td>cfm</td>
</tr>
<tr>
<td>----------------</td>
<td>-----------</td>
<td>--------------</td>
</tr>
<tr>
<td>Main Clg</td>
<td>2.5</td>
<td>29.8</td>
</tr>
<tr>
<td>Aux Clg</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Opt Vent</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Total</td>
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<td>29.8</td>
</tr>
</tbody>
</table>

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<th>Sens Cap.</th>
<th>Coil Airflow</th>
</tr>
</thead>
<tbody>
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<td>MBh</td>
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<tr>
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<td>29.8</td>
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<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Opt Vent</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Total</td>
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TEMPERATURES

<table>
<thead>
<tr>
<th>SADB</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>55.4</td>
<td>141.1</td>
<td>62.7</td>
</tr>
<tr>
<td>6.4</td>
<td>62.7</td>
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</tr>
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<td>62.7</td>
<td>62.7</td>
</tr>
<tr>
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<td>0.0</td>
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<td>0.0</td>
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<table>
<thead>
<tr>
<th>AIRFLOWS</th>
</tr>
</thead>
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<td>Cooling</td>
</tr>
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<tr>
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<tr>
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<table>
<thead>
<tr>
<th>ENGINEERING CKS</th>
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<tr>
<td>% OA</td>
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<tr>
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<tr>
<td>0.72</td>
</tr>
<tr>
<td>256.7</td>
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<tr>
<td>33.57</td>
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<tr>
<td>20.52</td>
</tr>
<tr>
<td>16.8/1000 ft²</td>
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<tr>
<td>16.8/1000 ft²</td>
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</table>

Project Name: 17123 - Daytona State College
Dataset Name: 17123 - CALC.TRCC

TRACE® 700 v6.3.4 calculated at 12:10 PM on 12/14/2018
Alternative - 1 System Checksums Report Page 65 of 66
### Room Checksums

**By RLF**

#### COOLING COIL PEAK

Peaked at Time: Mo/Hr: 8 / 11

Outside Air: OADB/WB/HR: 83 / 73 / 110

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Plenum Sens. + Lat.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Envelope Loads</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skylite Solar</td>
</tr>
<tr>
<td>Skylite Cond</td>
</tr>
<tr>
<td>Roof Cond</td>
</tr>
<tr>
<td>Glass Solar</td>
</tr>
<tr>
<td>Glass/Door Cond</td>
</tr>
<tr>
<td>Wall Cond</td>
</tr>
<tr>
<td>Partition/Door</td>
</tr>
<tr>
<td>Floor</td>
</tr>
<tr>
<td>Adjacent Floor</td>
</tr>
<tr>
<td>Infiltration</td>
</tr>
</tbody>
</table>
| Sub Total ====

4,513  427  4,940  91  3,906  92

#### CLG SPACE PEAK

Mo/Hr: 6 / 12

OADB: 86

<table>
<thead>
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<th>Space Sens. + Lat.</th>
<th>Plenum Sens. + Lat.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Envelope Loads</th>
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<tr>
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</tr>
<tr>
<td>Floor</td>
</tr>
<tr>
<td>Adjacent Floor</td>
</tr>
<tr>
<td>Infiltration</td>
</tr>
</tbody>
</table>
| Sub Total ====

#### HEATING COIL PEAK

Mo/Hr: Heating Design

OADB: 35

<table>
<thead>
<tr>
<th>Space Sens. + Lat.</th>
<th>Plenum Sens. + Lat.</th>
<th>Net Total</th>
<th>Percent Of Total</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Envelope Loads</th>
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</tr>
<tr>
<td>Floor</td>
</tr>
<tr>
<td>Adjacent Floor</td>
</tr>
<tr>
<td>Infiltration</td>
</tr>
</tbody>
</table>
| Sub Total ====

#### TEMPERATURES

- **Cooling**
  - SADB: 55.4
  - Ra Plenum: 73.6
  - Return: 73.6
  - Ret/OA: 73.6
  - Fn Mtr/ID: 0.0
  - Fn Bld/ID: 0.0
  - Fn Fric: 0.0

- **Heating**
  - SADB: 142.4
  - Ra Plenum: 62.7
  - Return: 62.7
  - Ret/OA: 62.7
  - Fn Mtr/ID: 0.0
  - Fn Bld/ID: 0.0
  - Fn Fric: 0.0

#### ENGINEERING CKS

<table>
<thead>
<tr>
<th>Total Capacity</th>
<th>Sens Cap.</th>
<th>Coil Airflow</th>
<th>Enter DB/DB/HR</th>
<th>Leave DB/DB/HR</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Main Clg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aux Clg</td>
</tr>
<tr>
<td>Opt Vent</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
</tbody>
</table>

#### AREAS

<table>
<thead>
<tr>
<th>Gross Total</th>
<th>Glass ft² (%)</th>
</tr>
</thead>
</table>

| Floor |
| Part |
| Int Door |
| ExFlr |
| Roof |
| Wall |
| Ext Door |
| **Total** |

#### HEATING COIL SELECTION

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Coil Airflow</th>
<th>Ent</th>
<th>Lvg</th>
</tr>
</thead>
</table>

- **Main Htg:** -5.7
- **Aux Htg:** 0.0
- **Preheat:** 0.0
- **Reheat:** -1.0
- **Humidif:** 0.0
- **Opt Vent:** 0.0

**Total:** -5.7

---

Project Name: 17123 - Daytona State College

Dataset Name: 17123 - CALC.TRC

TRACE® 700 v6.3.4 calculated at 12:10 PM on 12/14/2018

Alternative - 1 System Checksums Report Page 66 of 66
### System Checksums

By RLF

**Bypass VAV with Reheat (30% Min Flow Default)**

#### TEMPERATURES

<table>
<thead>
<tr>
<th>SADB</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>OADB: 35</td>
<td>55.4</td>
<td>141.5</td>
</tr>
<tr>
<td>Ra Plenum</td>
<td>76.5</td>
<td>62.7</td>
</tr>
<tr>
<td>Return</td>
<td>76.5</td>
<td>62.7</td>
</tr>
<tr>
<td>Ret/OA</td>
<td>76.5</td>
<td>62.7</td>
</tr>
<tr>
<td>Fn Mtr/TD</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Fn Bl/TS</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Fn Fric</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

#### AIRFLOWS

<table>
<thead>
<tr>
<th>Diffuser</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>20,304</td>
<td>6,091</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Terminal</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>20,304</td>
<td>6,091</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Main Fan</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
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<td>20,304</td>
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<th>Heating</th>
</tr>
</thead>
<tbody>
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</tbody>
</table>

<table>
<thead>
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<th>Rm Exh</th>
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<tr>
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<table>
<thead>
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<th>Auxiliary</th>
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<table>
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<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

<table>
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<th>Cooling</th>
<th>Heating</th>
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</thead>
<tbody>
<tr>
<td>0</td>
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</tbody>
</table>

#### ENGINEERING CKS

<table>
<thead>
<tr>
<th>% OA</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>cfm/ft²</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.98</td>
<td>0.98</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>cfm/ton</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>304.55</td>
<td>304.55</td>
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</table>

<table>
<thead>
<tr>
<th>ft³/ton</th>
<th>Cooling</th>
<th>Heating</th>
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<tbody>
<tr>
<td>312.00</td>
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<td></td>
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</table>

<table>
<thead>
<tr>
<th>Btu/hr·ft²</th>
<th>Cooling</th>
<th>Heating</th>
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</thead>
<tbody>
<tr>
<td>38.46</td>
<td>-28.00</td>
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<table>
<thead>
<tr>
<th>No. People</th>
<th>Cooling</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>198</td>
<td>198</td>
<td></td>
</tr>
</tbody>
</table>

### System - 001

#### COOLING COIL PEAK

<table>
<thead>
<tr>
<th>Peaked at Time:</th>
<th>Mo/Hr: 8 / 16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outside Air:</td>
<td>OADB/WB/HR: 88 / 78 / 128</td>
</tr>
</tbody>
</table>

#### CLG SPACE PEAK

<table>
<thead>
<tr>
<th>Net Sens. + Lat.</th>
<th>Net Plenum + Lat.</th>
<th>Net Percent of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Space Sens.</td>
<td>Btu/h</td>
<td>Btu/h</td>
</tr>
<tr>
<td>Plenum Sens.</td>
<td>Btu/h</td>
<td>Btu/h</td>
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#### HEATING COIL PEAK

<table>
<thead>
<tr>
<th>Heating Design</th>
<th>Mo/Hr: 6 / 15</th>
</tr>
</thead>
<tbody>
<tr>
<td>OADB:</td>
<td>91</td>
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#### TEMPERATURES

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<thead>
<tr>
<th>SADB</th>
<th>OADB: 35</th>
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<tbody>
<tr>
<td>Ra Plenum</td>
<td>76.5</td>
</tr>
<tr>
<td>Return</td>
<td>76.5</td>
</tr>
<tr>
<td>Ret/OA</td>
<td>76.5</td>
</tr>
<tr>
<td>Fn Mtr/TD</td>
<td>0.0</td>
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#### AIRFLOWS

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<thead>
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<tr>
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#### ENGINEERING CKS

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<td>198</td>
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### AREAS

<table>
<thead>
<tr>
<th>Gross Total</th>
<th>Glass</th>
<th>ft² (%)</th>
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</thead>
<tbody>
<tr>
<td>Floor</td>
<td>20,801</td>
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</tr>
<tr>
<td>Part</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Int Door</td>
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<td></td>
</tr>
<tr>
<td>ExFlr</td>
<td>674</td>
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</tr>
<tr>
<td>Roof</td>
<td>20,081</td>
<td>0</td>
</tr>
<tr>
<td>Wall</td>
<td>9,958</td>
<td>2,373</td>
</tr>
<tr>
<td>Ext Door</td>
<td>84</td>
<td>0</td>
</tr>
</tbody>
</table>

#### HEATING COIL SELECTION

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Operating Mgr</th>
<th>Ent Lvg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Htg</td>
<td>-582.4</td>
<td>6,091</td>
</tr>
<tr>
<td>Aux Htg</td>
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<td>55.4</td>
</tr>
<tr>
<td>Preheat</td>
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<td>0.0</td>
</tr>
<tr>
<td>Reheat</td>
<td>-98.7</td>
<td>6,091</td>
</tr>
<tr>
<td>Humidif</td>
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<td>0.0</td>
</tr>
<tr>
<td>Opt Vent</td>
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<td>0.0</td>
</tr>
</tbody>
</table>

**TRACE® 700 v6.3.4 calculated at 12:10 PM on 12/14/2018**

**Project Name:** 17123 - Daytona State College

**Dataset Name:** 17123 - CALC.TRC