



**ADDENDUM #1  
Public Works – Building Services  
Walden Crew Room and Office Concrete  
BID # 7150-20**

June 5, 2020

The attached addendum supersedes the original Information and Specifications regarding BID # 7150-20 where it adds to, deletes from, clarifies or otherwise modifies. All other conditions and any previous addendums shall remain unchanged.

**Please see the attached drawings and specifications that were not included in the bid documents. All inquiries regarding this BID submitted before 2:00 p.m. June 12, 2020 will be answered as scheduled on June 15, 2020.**

**Please note: Due to COVID-19, BIDS will only be accepted electronically by emailing [purchasing@bouldercounty.org](mailto:purchasing@bouldercounty.org).**

**Submittal Instructions:**

Submittals are due at the email box only, listed below, for time and date recording on or before **2:00 p.m. Mountain Time on June 22, 2020.**

**Please note that email responses are limited to a maximum of 50MB capacity. NO ZIP FILES ALLOWED. Electronic Submittals must be received in the email box listed below. Submittals sent to any other box will NOT be forwarded or accepted. This email box is only accessed on the due date of your questions or proposals. Please use the Delivery Receipt option to verify receipt of your email. It is the sole responsibility of the proposer to ensure their documents are received before the deadline specified above. Boulder County does not accept responsibility under any circumstance for delayed or failed email or mailed submittals.**

**Email**        [purchasing@bouldercounty.org](mailto:purchasing@bouldercounty.org); identified as **BID # 7150-20** in the subject line.

All proposals must be received and time and date recorded at the purchasing email by the above due date and time. Sole responsibility rests with the Offeror to see that their bid is received on time at the stated location(s). Any bid received after due date and time will be returned to the bidder. No exceptions will be made.

The Board of County Commissioners reserve the right to reject any and all bids, to waive any informalities or irregularities therein, and to accept the bid that, in the opinion of the Board, is in the best interest of the Board and of the County of Boulder, State of Colorado.



**RECEIPT OF LETTER  
ACKNOWLEDGMENT**

June 5, 2020

Dear Vendor:

This is an acknowledgment of receipt of Addendum #2 for BID #7150-20, Walden Crew Room and Office Concrete.

In an effort to keep you informed, we would appreciate your acknowledgment of receipt of the preceding addendum. Please sign this acknowledgment and email it back to [purchasing@bouldercounty.org](mailto:purchasing@bouldercounty.org) as soon as possible. If you have any questions, or problems with transmittal, please call us at 303-441-3525. This is also an acknowledgement that the vendor understands that **due to COVID-19, BIDS will only be accepted electronically by emailing [purchasing@bouldercounty.org](mailto:purchasing@bouldercounty.org).**

Thank you for your cooperation in this matter. This information is time and date sensitive; an immediate response is requested.

Sincerely,

Boulder County Purchasing

**Signed by:** \_\_\_\_\_ **Date:** \_\_\_\_\_

**Name of Company** \_\_\_\_\_

End of Document

**BOULDER COUNTY  
WALDEN TRANSPORTATION CREW ROOM  
AND OFFICE REMODEL**

**3897 N. 75<sup>TH</sup> Street  
Boulder, CO 80301**



**ARCHITECTURAL, STRUCTURAL, PLUMBING,  
MECHANICAL, ELECTRICAL, CIVIL  
SPECIFICATIONS**

**April 26, 2019**

**Boulder County Administrative Services  
Building Services Division  
2020 13<sup>th</sup> Street  
Boulder, CO 80302**

PROJECT MANUAL  
**BOULDER COUNTY TRANSPORTATION CREW ROOM AND OFFICE  
 REMODEL**  
 ARCHITECTURAL, STRUCTURAL, PLUMBING, MECHANICAL, ELECTRICAL, CIVIL  
 SPECIFICATIONS

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**SECTION 011000 - SUMMARY**

PART 1 - GENERAL

1.1 SUMMARY OF WORK

- A. Project: Walden Transportation Crew Room and Office Remodel, 3897 N. 75<sup>th</sup> St. Boulder, CO 80301
- B. Owner: Boulder County P.O. Box 471 Boulder, CO 80306
- C. Architect: Boulder County Building Services, Mackenzie Schoofs (mschoofs@bouldercounty.org)
- D. Contractor: TBD
- E. The Work consists of Demolition of existing Boulder County Crew Room and Office of Transportation Building at Walden Site. Construction of new, exterior load-bearing and interior non-loadbearing walls, new mechanical, additional plumbing, and new finishes. Also includes flood-proofing floor and flood walls.
- F. Owner-Furnished Items: The following products will be furnished by Owner and shall be installed by Contractor as part of the Work:
  - 1. Lockers
  - 2. Kitchen and Bathroom Accessories
  - 3. Toilet Partitions
  - 4. Grab Bars and blocking
  - 5. Mirrors
  - 6. Herman Miller
- G. Work Under Other Contracts:
  - 1. n/a

1.2 WORK RESTRICTIONS

- A. Contractor's Use of Premises: During construction, Contractor will have limited use of site and building indicated. Contractor's use of premises is limited only by Owner's right to perform work or employ other contractors on portions of Project and as follows:
  - 1. Owner will occupy premises during construction. Perform construction only during normal working hours (8 AM to 5 PM Monday thru Friday, other than holidays), unless

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otherwise agreed to in advance by Owner. Clean up work areas and return to a useable condition at the end of each work period.

2. Access to County premises will be at the discretion of the Boulder County Sheriff Office. After a thorough background check is conducted on each contractor, sub-contractor and employee who requests access, the condition of approval of access will be by the BCSO.

END OF SECTION 011000

**SECTION 013000 - ADMINISTRATIVE REQUIREMENTS**

PART 1 - GENERAL

1.1 PROJECT MANAGEMENT AND COORDINATION

- A. Verify layout information shown on Drawings, in relation to property survey and existing benchmarks, before laying out the Work.
- B. Progress meetings will be held at Project site every at intervals to be determined. Facilities Manager, Owners Rep, Project Manager, Architect, Contractor, and each subcontractor or other entity concerned with current progress or involved with planning or coordination of future activities, shall attend.
  - 1. Minutes of each meeting will be prepared by Contractor and distributed to all parties present.

1.2 SUBMITTAL PROCEDURES

- A. Coordinate submittal preparation with construction schedule, fabrication lead-times, other submittals, and other activities that require sequential operations.
  - 1. No extension of Contract Time will be authorized due to failure to transmit submittals in time to permit processing sufficiently in advance of when materials are required in the Work.
  - 2. Project Manager/Architect will not accept submittals from sources other than Contractor.
- B. Prepare submittals by placing a permanent label on each for identification. Provide space on the label or beside title block to record review and approval markings and action taken. Include the following information on the label:
  - 1. Project name.
  - 2. Date.
  - 3. Name and address of Contractor.
  - 4. Name and address of subcontractor or supplier.
  - 5. Number and title of appropriate Specification Section.
  - 6. Contractor's certification that materials comply with specified requirements.
- C. Product Data: Mark each copy to show applicable choices and options. Include the following:
  - 1. Data indicating compliance with specified standards and requirements.
  - 2. Notation of coordination requirements.
  - 3. For equipment data, include rated capacities, dimensions, weights, required clearances, and furnished specialties and accessories.
- D. Shop Drawings: Submit newly prepared information drawn to scale. Indicate deviations from Contract Documents. Do not reproduce Contract Documents or copy standard information. Submit 1 reproducible print and 1 blue- or black-line print on sheets at least 8-1/2 by 11 inches,

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

but no larger than 30 by 42 inches. Project Manager/Architect will return the reproducible print. Include the following:

1. Dimensions, profiles, methods of attachment, coordination with adjoining work, large scale details, and other information, as appropriate for the Work.
  2. Identification of products and materials.
  3. Notation of coordination requirements.
  4. Notation of dimensions established by field measurement.
- E. Samples: Submit Samples finished as specified and identical with the material proposed. Where variations are inherent in the material, submit at least 3 units that show limits of the variations. Include product name or name of the manufacturer.
- F. Project Manager/Architect will review each submittal with Facilities Manager, mark as appropriate to indicate action taken, and return copies less those retained. Compliance with specified requirements remains Contractor's responsibility.
- G. Before the work begins, subcontractors shall provide MSDA sheets for all materials to be utilized on this project.

END OF SECTION 013000

**SECTION 014000 - QUALITY REQUIREMENTS**

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Testing and inspecting 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. Testing and inspecting services are specified in other Sections of these Specifications or are required by authorities having jurisdiction and shall be performed by independent testing agencies.
  - 2. Where quality-control services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these services.
  - 3. Contractor is responsible for scheduling times for tests, inspections, and obtaining samples and notifying testing agency.
  - 4. Retesting and Reinspecting: Contractor shall pay for additional testing and inspecting required as a result of tests and inspections indicating noncompliance with requirements.
  
- B. Submittals: Testing agency shall submit a certified written report of each test and inspection to Contractor, Project Manager/Architect, and to authorities having jurisdiction when they so direct. Reports of each inspection, test, or similar service shall include the following:
  - 1. Name, address, and telephone number of testing agency.
  - 2. Project title and number.
  - 3. Date of issue.
  - 4. Dates and locations of samples and tests or inspections.
  - 5. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
  - 6. Names of individuals making tests and inspections.
  - 7. Description of the Work and test and inspection method.
  - 8. Complete test or inspection data, test and inspection results, an interpretation of test results, and comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
  - 9. Recommendations on retesting and reinspecting.
  - 10. Name and signature of laboratory inspector.
  
- C. Testing Agency Qualifications: An independent agency with the experience and capability to conduct testing and inspecting indicated; and where required by authorities having jurisdiction, that is acceptable to authorities.
  
- D. Testing Agency Responsibilities: Testing agency shall cooperate with Architect and Contractor in performing its duties and shall provide qualified personnel to perform inspections and tests.
  - 1. Agency shall promptly notify Architect and Contractor of irregularities or deficiencies in the Work observed during performance of its services.

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2. Agency shall not release, revoke, alter, or increase requirements of the Contract Documents nor approve or accept any portion of the Work.
  3. Agency shall not perform any duties of Contractor.
- E. Auxiliary Services: Cooperate with testing agencies and provide auxiliary services as requested, including the following:
1. Access to the Work.
  2. Incidental labor and facilities necessary to facilitate tests and inspections.
  3. Adequate quantities of materials for testing, and assistance in obtaining samples.
  4. Facilities for storage and field curing of test samples.
  5. Security and protection for samples and for testing and inspecting equipment.
- F. Special Tests and Inspections: Project Manager will engage a qualified agency/inspector to conduct special tests and inspections required by authorities having jurisdiction.
- G. Special Tests and Inspections: Conducted by a qualified agency/inspector as required by authorities having jurisdiction, as indicated in individual Specification Sections.
- H. 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.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 014000

**SECTION 016000 - PRODUCT REQUIREMENTS**

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Provide products of same kind from a single source.
- B. Deliver, store, and handle products according to manufacturer's written instructions, using means and methods that will prevent damage, deterioration, and loss, including theft.
  - 1. Schedule delivery to minimize long-term storage and to prevent overcrowding construction spaces.
  - 2. Deliver in manufacturer's original sealed packaging with labels and written instructions for handling, storing, protecting, and installing.
  - 3. Inspect to ensure compliance with the Contract Documents and to ensure items are undamaged and properly protected.
  - 4. Store heavy items in a manner that will not endanger supporting construction.
  - 5. Store items subject to damage above ground, under cover in a weathertight enclosure, with ventilation adequate to prevent condensation. Maintain temperature and humidity within range required.

PART 2 - PRODUCTS

2.1 PRODUCT OPTIONS

- A. Provide items that comply with the Contract Documents, are undamaged, and are new at the time of installation.
  - 1. Provide products and equipment complete with accessories, trim, finish, and other devices and components needed for a complete installation and the intended use and effect.
- B. Do not attach manufacturer's labels or trademarks, except for required nameplates, on surfaces exposed to view in occupied spaces or on the exterior.
- C. Select products as follows:
  - 1. Where these Specifications name only a single product or manufacturer, provide the item indicated. No substitutions will be permitted.
  - 2. Where these Specifications name 2 or more products or manufacturers, provide 1 of the items indicated. No substitutions will be permitted.
  - 3. Where products or manufacturers are specified by name, accompanied by the term "or equal," comply with provisions concerning "product substitutions" to obtain approval for use of an unnamed product or manufacturer.
  - 4. Where these Specifications describe a product and list characteristics required, with or without naming a brand or trademark, provide a product that complies with the characteristics and other requirements.
  - 5. Where these Specifications require compliance with performance requirements, provide



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products that comply and are recommended in writing by the manufacturer for the application.

6. Where these Specifications require compliance with codes, regulations, or reference standards, select a product that complies with the codes, regulations, or reference standards.

D. Unless otherwise indicated, Architect will select color, pattern, and texture of any product from manufacturer's full range of options.

### 2.2 PRODUCT SUBSTITUTIONS

A. Reasonable and timely requests for substitutions will be considered. Substitutions include changes proposed by the Contractor after award of the Contract, in products and methods of construction required by the Contract Documents.

1. Do not submit unapproved substitutions on Shop drawings.

B. Submit 2 copies of each request for product substitution. Identify product to be replaced, provide complete documentation showing compliance of proposed substitution with all specified requirements, and include the following:

1. A full comparison with the specified product.

2. A list of changes to other Work required to accommodate the substitution.

3. Any proposed changes in the Contract Sum or Contract Time should the substitution be accepted.

C. Architect will review the proposed substitution and notify Contractor of its acceptance or rejection.

END OF SECTION 016000

**SECTION 017000 - EXECUTION AND CLOSEOUT REQUIREMENTS**

PART 1 - GENERAL

1.1 CLOSEOUT SUBMITTALS

- A. Record Drawings: Maintain a set of prints of the Contract Drawings as Record Drawings. Mark to show actual installation where installation varies from that shown originally. At the end of job, these “red-lined” drawings will be scanned as PDF’s and delivered to Architect.
- B. Record Specifications: Maintain one copy of the Project Manual, including addenda, as Record Specifications. Mark to show variations in Work performed in comparison with the text of the Specifications and modifications.
- C. Operation and Maintenance Data: Organize data into 3-ring binders, with pocket folders for folded sheet information. Mark identification on front and spine of each binder. Include the following:
  - 1. Emergency instructions.
  - 2. Spare parts list.
  - 3. Wiring diagrams.
  - 4. Copies of warranties.
  - 5. Shop Drawings and Product Data

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION AND PREPARATION

- A. Examine substrates and conditions for compliance with manufacturer's written requirements including, but not limited to, surfaces that are sound, level, plumb, smooth, clean, and free of deleterious substances; substrates within installation tolerances; and application conditions within environmental limits. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to property survey and existing benchmarks.
- C. Take field measurements as required to fit the Work properly. Where fabricated products are to be fitted to other construction, verify dimensions by field measurement before fabrication and, when possible, allow for fitting and trimming during installation.

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### 3.2 CUTTING AND PATCHING

- A. **Do not cut structural members** without prior written approval of Project Manager/Architect.
- B. For patching, provide materials whose installed performance will equal or surpass that of existing materials. For exposed surfaces, provide or finish materials to visually match existing adjacent surfaces to the fullest extent possible.
- C. Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before **cutting to minimize interruption to occupied areas**.

### 3.3 INSTALLATION

- A. Comply with manufacturer's written instructions for installation. Anchor each product securely in place, accurately located and aligned. Clean exposed surfaces and protect from damage. If applicable, prepare surfaces to field finishing.
- B. Comply with NFPA 70 for installation for electrically operated equipment and electrical components and materials.
- C. Clean Project site and work areas daily, including common areas.

### 3.4 FINAL CLEANING

- A. Complete the following cleaning operations before requesting inspection from Boulder County custodian manager, Brent Bradford 303-441-4977, for certification of Substantial Completion:
  - 1. Remove labels that are not permanent.
  - 2. Clean transparent materials, including mirrors. Remove excess glazing compounds. Replace chipped or broken glass.
  - 3. Clean exposed finishes to a dust-free condition, free of stains, films, and foreign substances. Leave concrete floors broom clean.
  - 4. Vacuum carpeted surfaces and wax resilient flooring.
  - 5. Wipe surfaces of mechanical and electrical equipment. Remove excess lubrication. Clean plumbing fixtures. Clean light fixtures and lamps.
  - 6. Clean the site. Sweep paved areas; remove stains, spills and foreign deposits. Rake grounds to a smooth, even-textured surface.

### 3.5 CLOSEOUT PROCEDURES

- A. Request Substantial Completion inspection once the following are complete:
  - 1. Advise Owner of pending insurance changeover requirements.
  - 2. Submit Record Drawings and Specifications, maintenance manuals, warranties, and similar record information.
  - 3. Deliver spare parts, extra stock, and similar items.
  - 4. Change over locks and transmit keys to Project Manager/Construction Supervisor.

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5. Complete startup testing of systems and instruction of operation and maintenance personnel.
  6. Remove temporary facilities and controls.
  7. Complete final cleanup.
  8. Touch up, repair, and restore marred, exposed finishes.
  9. Obtain final inspections from authorities having jurisdiction.
- B. Upon receipt of a request for inspection, Project Manager/Architect/Facilities Manager will proceed with inspection or advise Contractor of unfilled requirements. Project manager will prepare the Certificate of Substantial Completion after inspection or advise Contractor of items that must be completed or corrected before the certificate will be issued.
- C. Arrange for each installed of equipment that requires operation and maintenance to provide instruction to Owner's personnel. Include a detailed review of the following:
1. Startup and shutdown
  2. Emergency operations and safety procedures.
  3. Noise and vibration adjustments.
  4. Maintenance manuals.
  5. Spare parts, tools, and materials.
  6. Lubricants and fuels.
  7. Identification systems.
  8. Control sequences
  9. Hazards.
  10. Warranties and bonds.
- D. Request inspection for certification of final acceptance and final payment, once the following are complete:
1. Submit final payment request with releases of liens and supporting documentation. Include insurance certificates.
  2. Submit a copy of the Substantial Completion inspection list stating that each item has been complete or otherwise resolved for acceptance.
  3. Submit final meter readings for utilities, a record of stored fuel, and similar data as of the date of Substantial Completion.
  4. Submit consent of surety to final payment.
- E. Architect will re-inspect the Work on receipt of notice that the Work has been completed.
1. On completion of re-inspection, Project Manager/Architect/Facilities Manager will prepare a certificate of final acceptance. If the Work is incomplete, Project Manager/Architect will advise Contractor of the Work that is incomplete or obligations that have not yet been fulfilled.

END OF SECTION 017000

**SECTION 018113 – SUSTAINABLE DESIGN REQUIREMENTS**

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Recycled Content:  
Indicate separate percentages, by weight, of pre-consumer and post-consumer recycled content per unit of product. Also include material costs, excluding cost of installation.
- B. Local/Regional Materials:  
Indicate location of manufacturing facility including name, address and distance between manufacturing facility and the project site. Provide manufacturer's documentation indicating location where the base materials were extracted, mined, quarried, harvested, etc and the distance between this location and the project site. Also include material costs, excluding cost of installation.
- C. VOC Content:  
Product data and material safety data sheets (MSDS) for adhesives, sealants, paints, coatings and carpet products used on the interior of the building indicating chemical composition and VOC content of each product used.
- D. Composite Wood and Agrifiber:  
Product data indicating the type of resin binder used, and confirming the product does not contain urea-formaldehyde resin binders.
- E. Certified Wood:  
Documentation from the manufacturer certifying that wood based product is made from wood obtained from forests certified by an FSC accredited certification body to comply with the Forest Stewardship Councils "Principles and Criteria." Include cost of material and chain-of-custody certification number obtained from manufacturer.

1.2 MATERIAL REQUIREMENTS

- A. Recycled Content:  
Materials/products shall contain the maximum amount of recycled content allowed that retains material integrity.
- B. Local/Regional Materials:  
Preference shall be given to manufacturer's whose facilities are within a 500 mile radius of the project site. Preference shall also be given to materials that are harvested, extracted, mined, quarried, etc. within a 500 mile radius of the project site.
- C. VOC Content:  
Adhesives, sealants, paints, coatings and carpet products used on the interior of the building shall comply with VOC limits as follows:

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1. For interior (i.e within the vapor barrier of the building) applications use adhesives and sealants that comply with the South Coast Air Quality Management District (SCAQMD) Rule #1168 and for sealants and sealant primers, the Bay Area Air Quality Management District Regulation 8, Rule 51, summarized by the limits defined for VOC content when calculated according to 40 CFR 59, Subpart D (EPA method 24).
  2. For interior applications use paints and coatings that comply with Green Seal's Standard GS-11, summarized by the limits defined for VOC content when calculated according to 40 CFR 59, Subpart D (EPA method 24) and the associated chemical restrictions.
  3. Carpet and carpet padding must not exceed the Carpet and Rug Institute's Green Label Indoor Air Quality Test Program, summarized by the associated VOC limits.
- D. Composite Wood and Agrifiber:  
All composite wood and agrifiber products shall be free of urea-formaldehyde resin binders.
- E. Certified Wood:  
Wood based products shall be made from wood obtained from forests certified by an FSC accredited certification body to comply with the Forest Stewardship Councils "Principles and Criteria."
- F. Construction Waste Management & Recycling:  
Construction Waste shall be managed in accordance with provisions of Section 017419 Construction Waste Management & Recycling. Documentation shall be submitted to satisfy the requirements of that section.

END OF SECTION 018113

**SECTION 033000 - CAST-IN-PLACE CONCRETE**

**PART 1 - GENERAL**

**SCHEDULE 0 - SUMMARY**

PRODUCT DATA SHEET 0 - This Section specifies cast-in place concrete, including formwork, reinforcement, concrete materials, mix design, placement procedures, and finishes.

PRODUCT DATA SHEET 1 - The Work includes:

1. Slabs on grade
2. Foundation walls/grade beams
3. Embedded items as needed.

**1.2 DEFINITIONS**

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume.

**1.3 SUBMITTALS**

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

PRODUCT DATA SHEET 2 - Design Mixes: For each concrete mix. Include alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.

PRODUCT DATA SHEET 3 - Steel Reinforcement Shop Drawings: Details of fabrication, bending, and placement, prepared according to ACI 315, "Details and Detailing of Concrete Reinforcement." Include material, grade, bar schedules, stirrup spacing, bent bar diagrams, arrangement, and supports of concrete reinforcement. Include special reinforcement required for openings through concrete structures.

PRODUCT DATA SHEET 4 - Welding Certificates: Copies of certificates for welding procedures and personnel.

PRODUCT DATA SHEET 5 - Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of current materials.

PRODUCT DATA SHEET 6 - Material Certificates: Signed by manufacturers certifying that each of the following items complies with requirements:

1. Cementitious materials and aggregates.
2. Form materials and form-release agents.
3. Steel reinforcement and reinforcement accessories.
4. Admixtures.
5. Curing materials.
6. Floor and slab treatments.

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7. Bonding agents.
8. Adhesives.
9. Vapor retarders.
10. Epoxy joint filler.
11. Joint-filler strips.
12. Repair materials.

### 1.4 QUALITY ASSURANCE

- A. **Installer Qualifications:** An experienced installer who has completed concrete Work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- B. **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 formwork and shoring and reshoring installations that are similar to those indicated for this Project in material, design, and extent.
- C. **Manufacturer Qualifications:** A firm experienced in manufacturing ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.
  1. Manufacturer must be certified according to the National Ready Mixed Concrete Association's Certification of Ready Mixed Concrete Production Facilities.

**PRODUCT DATA SHEET 7 - Testing Agency Qualifications:** An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
- A. **Source Limitations:** Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, each aggregate from one source, and each admixture from the same manufacturer.
  - B. **Welding:** Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code--Reinforcing Steel."
  - C. **ACI Publications:** Comply with the following, unless more stringent provisions are indicated:
    1. ACI 301, "Specification for Structural Concrete."
    2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
    3. Conform to ACI 318 "Building Code Requirements for Reinforced Concrete".
  - D. **Pre-installation Conference:** Conduct conference at Project site.
    1. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
      - a. Contractor's superintendent.
      - b. Independent testing agency responsible for concrete design mixes.
      - c. Ready-mix concrete producer.
      - d. Concrete subcontractor.



1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, and handle steel reinforcement to prevent bending and damage.

**PART 2 - PRODUCTS**

2.1 VAPOR BARRIER

PRODUCT DATA SHEET 1 - Vapor Retarder at slab on grade: 15 mil thick polyolefin-based.

2.1 FORM-FACING MATERIALS

- A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. (Surfaces will be exposed, as painted, finished ceilings). Furnish in largest practicable sizes to minimize number of joints.
  - 1. Plywood, metal, or other approved panel materials.
  - 2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
    - a. High-density overlay, Class 1, or better.
    - b. Medium-density overlay, Class 1, or better, mill-release agent treated and edge sealed.
    - c. Structural 1, B-B, or better, mill oiled and edge sealed.
    - d. B-B (Concrete Form), Class 1, or better, mill oiled and edge sealed.
- B. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.
- C. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
  - 1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- D. For Insulated Concrete Forms, see Section 03130.

2.2 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
- B. Provide Grade 40 bars for ties and stirrups, and for dowels which will be subject to bending after placement.
- C. Plain-Steel Wire: ASTM A 82, as shown on structural drawings.

2.3 REINFORCEMENT ACCESSORIES

- A. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete or fiber-reinforced concrete of greater compressive strength than concrete, and as follows:

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1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected or CRSI Class 2 stainless-steel bar supports.
- B. Joint Dowel Bars: Plain-steel bars, ASTM A 615/A 615M, Grade 60. Cut bars true to length with ends square and free of burrs.

### 2.4 CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150, Type I/II.
- B. Fly Ash: ASTM C 618, Class C or F.
1. No Fly Ash required for concrete slabs.
- C. Normal-Weight Aggregate: ASTM C 33, uniformly graded, and as follows:
1. Class: Severe weathering region, but not less than 3S.
  2. Nominal Maximum Aggregate Size: 3/4 inch.
  3. Combined Aggregate Gradation: Well graded from coarsest to finest with not more than 18 percent and not less than 8 percent retained on an individual sieve, except that less than 8 percent may be retained on coarsest sieve and on No. 50 sieve, and less than 8 percent may be retained on sieves finer than No. 50.
- D. Water: Potable and complying with ASTM C 94.

### 2.5 ADMIXTURES

- A. General: Admixtures certified by manufacturer to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material and to be compatible with other admixtures and cementitious materials. Do not use admixtures containing calcium chloride.
- B. Air-Entraining Admixture: ASTM C 260.
- C. Water-Reducing Admixture: ASTM C 494, Type A.
- D. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.
- E. Water-Reducing and Accelerating Admixture: ASTM C 494, Type E.
- F. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.
- G. Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Catexol 1000CL; Axim Concrete Technologies.
    - b. MCI 2000 or MCI 2005; Cortec Corporation.
    - c. DCI or DCI-S; W. R. Grace & Co., Construction Products Div.
    - d. Rheocrete 222+; Master Builders, Inc.
    - e. FerroGard-901; Sika Corporation.

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### 2.6 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.
- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- D. Water: Potable.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.
- F. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.
- G. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Evaporation Retarder:
    - a. Cimfilm; Axim Concrete Technologies.
    - b. Finishing Aid Concentrate; Burke Group, LLC (The).
    - c. Spray-Film; ChemMasters.
    - d. Aquafilm; Conspec Marketing & Manufacturing Co., Inc.
    - e. Sure Film; Dayton Superior Corporation.
    - f. Eucobar; Euclid Chemical Co.
    - g. Vapor Aid; Kaufman Products, Inc.
    - h. Lambco Skin; Lambert Corporation.
    - i. E-Con; L&M Construction Chemicals, Inc.
    - j. Confilm; Master Builders, Inc.
    - k. Waterhold; Metalcrete Industries.
    - l. Rich Film; Richmond Screw Anchor Co.
    - m. SikaFilm; Sika Corporation.
    - n. Finishing Aid; Symons Corporation.
    - o. Certi-Vex EnvioAssist; Vexcon Chemicals, Inc.
  - 2. Clear, Waterborne, Membrane-Forming Curing Compound:
    - a. AH Clear Cure WB; Anti-Hydro International, Inc.
    - b. Klear Kote WB II Regular; Burke Chemicals.
    - c. Safe-Cure & Seal 20; ChemMasters.
    - d. High Seal; Conspec Marketing & Manufacturing Co., Inc.
    - e. Safe Cure and Seal; Dayton Superior Corporation.
    - f. Aqua Cure VOX; Euclid Chemical Co.
    - g. Cure & Seal 309 Emulsion; Kaufman Products Inc.
    - h. Glazecote Sealer-20; Lambert Corporation.
    - i. Dress & Seal WB; L&M Construction Chemicals, Inc.
    - j. Vocomp-20; W. R. Meadows, Inc.
    - k. Metcure; Metalcrete Industries.
    - l. Cure & Seal 150E; Nox-Crete Products Group, Kinsman Corporation.
    - m. Rich Seal 14 percent E; Richmond Screw Anchor Co.

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- n. Kure-N-Seal WB; Sonneborn, Div. of ChemRex, Inc.
- o. Florseal W.B.; Sternson Group.
- p. Cure & Seal 14 percent E; Symons Corporation.
- q. Seal Cure WB 150; Tamms Industries Co., Div. of LaPorte Construction Chemicals of North America, Inc.
- r. Hydro Seal; Unitex.
- s. Starseal 309; Vexcon Chemicals, Inc.

### 3. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound:

- a. Klear-Kote Cure-Sealer-Hardener, 30 percent solids; Burke Group, LLC (The).
- b. Polyseal WB; ChemMasters.
- c. UV Safe Seal; Lambert Corporation.
- d. Lumiseal WB Plus; L&M Construction Chemicals, Inc.
- e. Vocomp-30; W. R. Meadows, Inc.
- f. Metcure 30; Metalcrete Industries.
- g. Vexcon Starseal 1315; Vexcon Chemicals, Inc.

## 2.7 RELATED MATERIALS

- A. Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber, or ASTM D 1752, cork or self-expanding cork.
- B. Epoxy Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Shore A hardness of 80 per ASTM D 2240.
- C. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- D. Epoxy-Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class and grade to suit requirements, and as follows:
  - 1. Type II, non-load bearing, for bonding freshly mixed concrete to hardened concrete.
  - 2. Types I and II, non-load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
  - 3. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

## 2.8 REPAIR MATERIALS

- A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
  - 1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
  - 2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
  - 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.
  - 4. Compressive Strength: Not less than 4100 psi at 28 days when tested according to ASTM C 109/C 109M.

2.9 CONCRETE MIXES

- A. Prepare design mixes for each type and strength of concrete determined by either laboratory trial mix or field test data bases, as follows:
  - 1. Proportion normal-weight concrete according to ACI 211.1 and ACI 301.
- B. Use a qualified independent testing agency for preparing and reporting proposed mix designs for the laboratory trial mix basis.
- C. Slab-on-Grade: Proportion normal-weight concrete mix as follows:  
See Structural General Notes.
- D. Drilled Piers: Proportion normal-weight concrete mix as follows:  
See Structural General Notes
- E. Grade Beams: Proportion normal-weight concrete mix as follows:  
See Structural General Notes
- F. Cementitious Materials: For concrete exposed to deicers, limit percentage, by weight, of cementitious materials other than Portland cement according to ACI 301 requirements.
- G. Maximum Water-Cementitious Materials Ratio: 0.45 for concrete exposed to deicers or subject to freezing and thawing while moist.
- H. Do not air entrain concrete to trowel-finished interior floors and suspended slabs. Do not allow entrapped air content to exceed 3 percent.
- I. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
- J. Admixtures: Use admixtures according to manufacturer's written instructions.
  - 1. Use water-reducing admixture or high-range water-reducing admixture (superplasticizer) in concrete, as required, for placement and workability.
  - 2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
  - 3. Use water-reducing admixture in pumped concrete, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
  - 4. Use corrosion-inhibiting admixture in concrete mixes where indicated.

2.10 FABRICATING REINFORCEMENT

- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.11 CONCRETE MIXING

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

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1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

### **PART 3 - EXECUTION**

#### 3.1 FORMWORK

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until concrete structure can support such loads.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
- C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
  1. Class B, 1/4 inch.
- D. Construct forms tight enough to prevent loss of concrete mortar.
- E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Kerf wood inserts for forming keyways, reglets, recesses, and the like, for easy removal.
  1. Do not use rust-stained steel form-facing material.
- F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- G. Chamfer exterior corners and edges of permanently exposed concrete.
- H. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- I. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- J. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- K. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

#### 3.2 EMBEDDED ITEMS

- 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.

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1. Install anchor bolts, accurately located, to elevations required.

### 3.3 REMOVING AND REUSING FORMS

- A. General: Formwork that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete, provided concrete is hard enough to not be damaged by form-removal operations and provided curing and protection operations are maintained.
- B. Leave formwork for slabs and other structural elements that supports weight of concrete, in place until concrete has achieved the following:
  1. At least 70 percent of 28-day design compressive strength.
  2. Determine compressive strength of in-place concrete by testing representative field- or laboratory-cured test specimens according to ACI 301.
  3. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- C. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
- D. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Project Manager/Architect.

### 3.4 SHORES AND RESHORES

- A. Comply with ACI 318, ACI 301, and recommendations in ACI 347R for design, installation, and removal of shoring and reshoring.
- B. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.
- C. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

### 3.5 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
  1. Shop- or field-weld reinforcement according to AWS D1.4, where indicated.
- D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

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- E. Install welded wire fabric in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

### 3.6 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as foundation walls, grade beams, and other locations, as required.
  - 1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.
  - 2. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.
- C. Control Joints in Slab-on-Grade: Construct contraction joints in slabs-on-grade to form panels of patterns as shown. Use saw cuts 1/8 inch wide by 1/4 slab depth or inserts 1/4 inch wide by 1/4 of slab depth, unless otherwise indicated.
  - 1. Form contraction joints by inserting premolded plastic, hardboard, or fiberboard strip into fresh concrete until top surface of strip is flush with slab surface. Tool slab edges round on each side of insert. After concrete has cured, remove inserts and clean groove of loose debris.
  - 2. Contraction joints in unexposed floor slabs may be formed by saw cuts as soon as possible after slab finishing as may be safely done without dislodging aggregate.
  - 3. If joint pattern not shown, provide joints not exceeding 14 feet in either direction and located to conform to bay spacing wherever possible (at column centerlines, half bays, third bays).
  - 4. Joint sealant material is specified in Division 7 sections of these specifications.

### 3.7 CONCRETE PLACEMENT

- A. For slabs on grade, place vapor retarder on prepared subgrade, with joints lapped min. 6 inches (150 mm) and sealed.
- B. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete, and that required inspections have been performed.
- C. Slope concrete slabs on grade to drains, as shown on Project Manager/Architectural plans.
- D. Deposit concrete continuously or in layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as specified. Deposit concrete to avoid segregation.
- E. Deposit concrete in forms in horizontal layers no deeper than 24 inches and in a manner to avoid inclined construction joints. Place each layer while preceding layer is still plastic, to avoid cold joints.
  - 1. Consolidate placed concrete with mechanical vibrating equipment. Use equipment and procedures for consolidating concrete recommended by ACI 309R.



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2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the vibrator. Place vibrators to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mix constituents to segregate.
- F. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
  2. Maintain reinforcement in position on chairs during concrete placement.
  3. Screed slab surfaces with a straightedge, and strike off to correct elevations.
  4. Slope surfaces uniformly to drains where required.
  5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, free of humps or hollows, before excess moisture or bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.
- G. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
  2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
  3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators, unless otherwise specified and approved in mix designs.
- H. Hot-Weather Placement: Place concrete according to recommendations in ACI 305R and as follows, when hot-weather conditions exist:
1. Cool ingredients before mixing, to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
  2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
  3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots or dry areas.

### 3.8 FINISHING FLOORS AND SLABS

- A. General: Comply with recommendations in ACI 302.1R for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes.
1. Apply scratch finish to surfaces indicated and to surfaces to receive mortar setting beds for ceramic tile or bonded cementitious floor finishes.

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- C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.
1. Apply float finish to surfaces indicated, to surfaces to receive trowel finish, and to floor and slab surfaces to be covered with fluid-applied waterproofing.
- D. Trowel Finish: After applying float finish, apply first trowel finish and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
1. Apply a trowel finish to surfaces indicated and to floor and slab surfaces exposed to view, or to be covered with resilient flooring, ceramic tile, paint, or other thin film-finish coating system.
  2. Finish surfaces to the following tolerances, measured within 24 hours according to ASTM E 1155/E 1155M for a randomly trafficked floor surface:
    - a. Specified overall values of flatness, F(F) 35; and levelness, F(L) 25; with minimum local values of flatness, F(F) 24; and levelness, F(L) 17; for slabs-on-grade.
    - b. Specified overall values of flatness, F(F) 30; with minimum local values of flatness, F(F) 24; for suspended slabs.
  3. Finish and measure surface so gap at any point between concrete surface and an unlevelled freestanding 10-foot-long straightedge, resting on two high spots and placed anywhere on the surface, does not exceed the following:
    - a. 3/16 inch.
- E. Trowel and Fine-Broom Finish: Apply a partial trowel finish, stopping after second troweling, to surfaces indicated and to surfaces where ceramic tile is to be installed by either thickset or thin-set method. Immediately after second troweling, and when concrete is still plastic, slightly scarify surface with a fine broom.
- F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.
- G. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Project Manager/Architect before application.
- H. 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 defective areas. Remove fins and other projections exceeding 1/8 inch in height.
1. Apply to concrete surfaces exposed to public view (underside of formed concrete slabs) or to be covered with a coating or covering material applied directly to concrete, such as waterproofing, damp proofing or painting.

### 3.9 MISCELLANEOUS CONCRETE ITEMS

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- A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete Work.

### 3.10 CONCRETE PROTECTION 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 recommendations in ACI 305R for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Formed Surfaces: Cure formed concrete surfaces, including supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing by one or a combination of the following methods:
- D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces, by one or a combination of the following methods:
  - 1. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
    - a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings or penetrating liquid floor treatments.
    - b. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer recommends for use with floor coverings.
  - 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.
  - 3. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a 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. Repeat process 24 hours later, and apply a second coat. Maintain continuity of coating, and repair damage during curing period.

### 3.11 JOINT FILLING

- A. Remove dirt, debris, saw cuttings, curing compounds and sealers from joints; leave contact faces of joint clean and dry.
- B. Install semi rigid epoxy joint filler full depth in saw-cut joints. Overfill joint and trim joint filler flush with top of joint after hardening.

### 3.12 CONCRETE SURFACE REPAIRS

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- A. Defective Concrete: Repair and patch defective areas when approved by Project Manager/Architect/Facilities Manager. Remove and replace concrete that cannot be repaired and patched to Project Manager/Architect/Facilities Manager approval.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.
- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
  - 1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension in solid concrete, but not less than 1 inch in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
  - 2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
  - 3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Project Manager/Architect.
- D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish, and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
  - 1. Repair finished surfaces containing defects. Surface defects include spalls, pop-outs, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
  - 2. After concrete has cured at least 14 days, correct high areas by grinding.
  - 3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
  - 4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
  - 5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
  - 6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least 3/4 inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mix as original concrete, except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
  - 7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before

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bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

- E. Perform structural repairs of concrete, subject to Project Manager/Architect/Facilities Manager approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to Project Manager/Architect's approval.

### 3.13 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to sample materials, perform tests, and submit test reports during concrete placement. Sampling and testing for quality control may include those specified in this Article.
- B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
  - 1. Testing Frequency: Obtain at least one composite sample for each 50 cu. yd. or fraction thereof of each concrete mix placed each day. Test first truck of each day.
    - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mix, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
  - 2. Slump: ASTM C 143; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mix. Perform additional tests when concrete consistency appears to change.
  - 3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; ASTM C 173, volumetric method, for structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.
  - 4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
  - 5. Unit Weight: ASTM C 567, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.
  - 6. Compressive-Strength Tests: ASTM C 39; four specimens per test, one tested at 7 days, two tested at 28 days and two reserved for later testing if required.
    - a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at age indicated.
- C. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
- D. Strength of each concrete mix will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
- E. Test results shall be reported in writing to Project Manager/Architect, structural engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall

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contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

- F. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Project Manager/Architect but will not be used as sole basis for approval or rejection of concrete.
- G. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Project Manager/Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42 or by other methods as directed by Project Manager/Architect.

END OF SECTION 033000

**SECTION 051200 - STRUCTURAL STEEL**

**PART 1 - GENERAL**

1.1 SUMMARY

- A. This Section includes structural steel.

1.2 PERFORMANCE REQUIREMENTS

- A. Engineering Responsibility: Engage a fabricator who utilizes a qualified professional engineer to prepare calculations, Shop Drawings, and other structural data for structural steel connections.

1.3 SUBMITTALS

- A. Product Data for each type of product specified.
- B. Shop Drawings detailing fabrication of structural steel components.
  - 1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
  - 2. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
  - 3. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify high-strength bolted slip-critical, direct-tension, or tensioned shear/bearing connections.
- C. Mill test reports signed by manufacturers certifying that their products, including the following, comply with requirements.
  - 1. Structural steel, including chemical and physical properties.
  - 2. Bolts, nuts, and washers, including mechanical properties and chemical analysis.
  - 3. Shop primers.
  - 4. Non-shrink grout.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced Installer who has completed structural steel work similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
- B. Fabricator Qualifications: Engage a firm experienced in fabricating structural steel similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to fabricate structural steel without delaying the Work.
  - 1. Steel fabricator does not have to be AISC certified. However, steel subcontractor, fabricator and erector shall have been in business for a minimum of 5 years and shall have

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satisfactorily completed at least 3 projects of similar scope and complexity with letters of reference upon request.

- C. Comply with applicable provisions of the following specifications and documents:
  - 1. AISC's "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design."
  - 2. AISC's "Specification for Allowable Stress Design of Single-Angle Members."
  - 3. AISC's "Seismic Provisions for Structural Steel Buildings."
  - 4. ASTM A 6 "Specification for General Requirements for Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use."
  - 5. Research Council on Structural Connections' (RCSC) "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- D. Welding Standards: Comply with applicable provisions of AWS D1.1 "Structural Welding Code-Steel."
- E. Conduct a Pre-installation Conference at Project site.

### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver structural steel to Project site in such quantities and at such times to ensure continuity of installation.
- B. Store materials to permit easy access for inspection and identification. Keep steel members off ground by using pallets, platforms, or other supports. Protect steel members and packaged materials from erosion and deterioration.
  - 1. Store fasteners in a protected place. Clean and relubricate bolts and nuts that become dry or rusty before use.
  - 2. Do not store materials on structure in a manner that might cause distortion or damage to members or supporting structures. Repair or replace damaged materials or structures as directed.

### 1.6 SEQUENCING

- A. Supply anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, templates, instructions, and directions, as required, for installation.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Structural Steel Rolled Shapes:



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- B. Structural Steel Shapes, Plates, and Bars: As follows:
  - 1. Wide Flange Shapes: ASTM A992.
  - 2. Carbon Steel: ASTM A36.
- C. Cold-Formed Structural Steel Tubing: ASTM A 500, Grade B.
- D. Hot-Formed Structural Steel Tubing: ASTM A 501.
- E. Steel Pipe: ASTM A 53, Type E or S, Grade B.
  - 1. Weight Class: As indicated.
  - 2. Finish: Black, except where indicated to be galvanized.
- F. Carbon-Steel Castings: ASTM A 27, Grade 65-35, medium-strength carbon steel.
- G. High-Strength Steel Castings: ASTM A 148, Grade 80-50.
- H. Anchor Rods, Bolts, Nuts, and Washers: As follows:
  - 1. Anchor Rods: ASTM F1554, Grade 50 weldable.
  - 2. Washers: ASTM A 36.
  - 3. Finish: Plain, uncoated.
- I. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy hex steel structural bolts, heavy hex carbon-steel nuts, and hardened carbon-steel washers.
  - 1. Finish: Plain, uncoated.
- J. Welding Electrodes: Comply with AWS requirements.

### 2.2 PRIMER

- A. Primer: Primer is required for this job.

### 2.3 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: Premixed, nonmetallic, noncorrosive, non-staining grout containing selected silica sands, portland cement, shrinkage compensating agents, plasticizing and water-reducing agents, complying with ASTM C 1107, of consistency suitable for application, and a 30-minute working time. **General Contractor shall grout all base plates.**

### 2.4 FABRICATION

- A. Fabricate and assemble structural steel in shop to greatest extent possible. Fabricate structural steel according to AISC specifications referenced in this Section and in Shop Drawings.
  - 1. Camber structural steel members where indicated.

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2. Mark and match-mark materials for field assembly.
3. Fabricate for delivery a sequence that will expedite erection and minimize field handling of structural steel.
4. Complete structural steel assemblies, including welding of units, before starting shop-priming operations.
5. Comply with fabrication tolerance limits of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for structural steel.

B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.

1. Plane thermally cut edges to be welded.

C. Holes: Provide holes required for securing other work to structural steel framing and for passage of other work through steel framing members.

1. Cut, drill, or punch holes perpendicular to metal surfaces. Do not flame-cut holes or enlarge holes by burning. Drill holes in bearing plates.
2. Weld threaded nuts to framing and other specialty items as indicated to receive other work.

### 2.5 SHOP CONNECTIONS

A. Shop install and tighten nonhigh-strength bolts, except where high-strength bolts are indicated.

B. Shop install and tighten high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

C. Weld Connections: Comply with AWS D1.1 for procedures, appearance and quality of welds, and methods used in correcting welding work.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Before erection proceeds, verify elevations of concrete and masonry bearing surfaces and locations of anchorages for compliance with requirements.

B. Do not proceed with erection until unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place, unless otherwise indicated.

### 3.3 ERECTION

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- A. Set structural steel accurately in locations and to elevations indicated and according to AISC specifications.
- B. Base and Bearing Plates: Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen surfaces prior to setting base and bearing plates. Clean bottom surface of base and bearing plates.
  - 1. Set base and bearing plates for structural members on wedges, shims, or setting nuts as required.
  - 2. Tighten anchor bolts after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of base or bearing plate prior to packing with grout.
  - 3. Pack grout solidly between bearing surfaces and plates so no voids remain. Finish exposed surfaces, protect installed materials, and allow to cure. General Contractor shall grout all base plates.
    - a. Comply with manufacturer's instructions for proprietary grout materials.
- C. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."
- D. Align and adjust various members forming part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
  - 1. Level and plumb individual members of structure.
  - 2. Establish required leveling and plumbing measurements on mean operating temperature of structure. Make allowances for difference between temperature at time of erection and mean temperature at which structure will be when completed and in service.
- E. Splice members only where indicated.
- F. Remove erection bolts on welded, Project Manager/Architecturally exposed structural steel; fill holes with plug welds; and grind smooth at exposed surfaces.
- G. Do not use thermal cutting during erection.
- H. Do not enlarge unfair holes in members by burning or by using drift pins. Ream holes that must be enlarged to admit bolts.

### 3.4 FIELD CONNECTIONS

- A. Install and tighten nonhigh-strength bolts, except where high-strength bolts are indicated.
- B. Install and tighten high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
  - 1. Bolts: ASTM A 325 high-strength bolts, unless otherwise indicated.

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2. Connection Type: Snug tightened, unless indicated as slip-critical, direct-tension, or tensioned shear/bearing connections.
- C. Weld Connections: Comply with AWS D1.1 for procedures, appearance and quality of welds, and methods used in correcting welding work.
1. Comply with AISC specifications referenced in this Section for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.
  2. Assemble and weld built-up sections by methods that will maintain true alignment of axes without warp.

### 3.5 FIELD QUALITY CONTROL

- A. Owner will engage an independent testing and inspecting agency to perform field inspections and tests and to prepare test reports.
1. Testing agency will conduct and interpret tests and state in each report whether tested Work complies with or deviates from requirements.
- B. Correct deficiencies in or remove and replace structural steel that inspections and test reports indicate do not comply with specified requirements.
- C. Additional testing, at Contractor's expense, will be performed to determine compliance of corrected Work with specified requirements.
- D. Field-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- E. In addition to visual inspection, field-welded connections will be inspected and tested according to AWS D1.1.

END OF SECTION 051200

**SECTION 052100 – STEEL JOIST FRAMING**

**PART 1 GENERAL**

1.1 SUMMARY

- A. Section Includes:
  - 1. Open web steel joists and joist trusses.
  - 2. Bridging and attached seats.
- B. Related Sections:
  - 1. Division 01: Administrative, procedural, and temporary work requirements.

1.2 REFERENCES

- A. American Welding Society (AWS) D1.1 - Structural Welding Code - Steel.
- B. ASTM International (ASTM):
  - 1. A36/A36M - Standard Specification for Carbon Structural Steel.
- C. Society for Protective Coatings (SSPC) - Painting Manual.
- D. Steel Joist Institute (SJI) - Standard Specifications and Load Tables for Steel Joists and Joist Girders.

1.3 SUBMITTALS

- A. Submittals for Review:
  - 1. Shop Drawings:
    - a. Include joist identification numbers, types, locations spacings; bridging; and attachments.
    - b. Joists for which standard load tables are not applicable: Bear seal of structural engineer licensed in State in which project is located.

1.4 QUALITY ASSURANCE

- A. Fabricator and Erector Qualifications: Minimum 5 years [documented] experience in work of this Section.
- B. Welder Qualifications: AWS D1.1.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Store joists off ground; prevent contact with adjacent joists.
- B. Prevent damage to painted surfaces.

## **PART 2 PRODUCTS**

### 2.1 MANUFACTURERS

- A. Acceptable Manufacturers:
  - 1. Canam Steel. ([www.canamsteel.com](http://www.canamsteel.com))
  - 2. SMI Joist Co. ([www.smijoist.com](http://www.smijoist.com))
  - 3. Socar, Inc. ([www.socarinc.com](http://www.socarinc.com))
  - 4. Vulcraft Div., Nucor Corp. ([www.vulcraft.com](http://www.vulcraft.com))
- B. Substitutions: [Under provisions of Division 01.]

### 2.2 MATERIALS

- A. Steel Shapes:
  - 1. ASTM A992 or A36

### 2.3 ACCESSORIES

- A. Bolts, Nuts, and Washers: ASTM A307.
- B. Primer Paint: SSPC Paint 15, Type 1, red oxide.
- C. Welding Materials: AWS D1.1; type required for materials being welded.

### 2.4 FABRICATION

- A. Fabricate joists to SJI Series K.
- B. Provide end extensions where indicated.
- C. Frame special sized openings in joist chord framing as indicated.
- D. Provide bracing, bridging, anchors, connectors, and other accessories.
- E. Shop Painting:
  - 1. Shop prime steel surfaces except:
    - a. Surfaces to be welded.
    - b. Surfaces to receive direct-applied fireproofing.
  - 2. Surface preparation: SSPC SP2 - Hand Tool Cleaning or SP3 - Power Tool Cleaning.
  - 3. Application: One coat; follow coating manufacturer's instructions.
  - 4. Minimum dry film thickness: 1.5mils.

## **PART 3 EXECUTION**

### 3.1 ERECTION

- A. Erect joists and accessories in accordance with SJI Specifications.

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- B. Provide for distribution of concentrated loads incurred during erection.
- C. Complete bridging and permanently fasten joists in place before applying loads except as necessary for erection.
- D. Welding to conform to AWS D1.1.
- E. Erect joists to elevations, lines, and spacings indicated.
- F. Coordinate placement of anchors in other construction for securing bearing plates and wall attachments.
- G. Frame openings greater than 18 inches with supplementary framing.
- H. Position and field weld joist chord extensions and wall attachments.

### 3.2 FIELD QUALITY CONTROL

- A. Testing and Inspection Services:
  - 1. Inspect joists for conformance to specified requirements:
    - a. Verify placement including location, alignment, and bearing.
    - b. Inspect joist-to-seat and seat-to-support welds in accordance with AWS D1.1.

### 3.3 ADJUSTING

- A. Touch Up: Clean welds and abrasions after erection; touch up with same primer as originally applied.

END OF SECTION 052100

**SECTION 053100 - STEEL DECKING**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
  - 1. Roof deck.
  - 2. Non-composite form deck.
- B. Related Sections include the following:
  - 1. Division 3 Section "Cast-in-Place Concrete" for concrete fill and reinforcing steel.
  - 2. Division 5 Section "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.

1.3 SUBMITTALS

- A. Product Data: For each type of deck, accessory, and product indicated.
- B. Shop Drawings: Show layout and types of deck panels, anchorage details, reinforcing channels, pans, deck openings, special jointing, accessories, and attachments to other construction.
- C. Product Certificates: Signed by steel deck manufacturers certifying that products furnished comply with requirements.
- D. Welding Certificates: Copies of certificates for welding procedures and personnel.
- E. Research/Evaluation Reports: Evidence of steel deck's compliance with building code in effect for Project, from a model code organization acceptable to authorities having jurisdiction.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed steel deck similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- B. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.



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- C. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel," and AWS D1.3, "Structural Welding Code--Sheet Steel."
- D. Fire-Test-Response Characteristics: Where indicated, provide steel deck units identical to those steel deck units tested for fire resistance per ASTM E 119 by a testing and inspection agency acceptable to authorities having jurisdiction.
  - 1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another testing and inspecting agency.
  - 2. Steel deck units shall be identified with appropriate markings of applicable testing and inspecting agency.
- E. AISI Specifications: Calculate structural characteristics of steel deck according to AISI's "Specification for the Design of Cold-Formed Steel Structural Members."

### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.
- B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Steel Deck:
    - a. BHP Steel Building Products USA Inc.
    - b. Consolidated Systems, Inc.
    - c. Nucor Corp.; Vulcraft Div.
    - d. Roof Deck, Inc.
    - e. United Steel Deck, Inc.
    - f. Verco Manufacturing Co.
    - g. Wheeling Corrugating Co.; Div. of Wheeling-Pittsburgh Steel Corp.

### 2.2 ROOF DECK

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- A. Steel Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 29, and the following:
1. Prime-Painted Steel Sheet: ASTM A 611, Grades C, D or E (minimum  $F_y = 33$  KSI) shop primed with gray or white baked-on, lead- and chromate-free rust-inhibitive primer complying with performance requirements of FS TT-P-664.
  2. Deck Profile: Type WR, wide rib.
  3. Profile Depth: 1-1/2 inches and 3 inches
  4. Design Uncoated-Steel Thickness: Per Structural Drawings
  5. Span Condition: Triple span or more.
  6. Side Laps: Overlapped.

### 2.3 NON-COMPOSITE STEEL FORM DECK

- A. Non-Composite Steel Form Deck: Fabricate ribbed steel sheet non-composite form-deck panels to comply with "SDI Specifications and Commentary for Non-composite Steel Form Deck," in SDI Publication No. 29, the minimum section properties indicated, and the following:
1. Prime-Painted Steel Sheet: ASTM A 611, Grades C, D or E with top surface phosphatized and unpainted and bottom surface shop primed with gray or white baked-on, lead- and chromate-free rust-inhibitive primer complying with performance requirements of FS TT-P-664.
  2. Galvanized and Shop-Primed Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33, G60 inc coating; with unpainted top and bottom surface cleaned, pretreated, and primed with manufacturer's baked-on, lead- and chromate-free rust-inhibitive primer complying with performance requirements of FS TT-P-664.
  3. Profile Depth: As indicated.
  4. Design Uncoated-Steel Thickness: Per Structural Drawings
  5. Span Condition: Triple span or more.

### 2.4 ACCESSORIES

- A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.
- B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.
- C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.
- D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.
- E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

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- F. Steel Sheet Accessories: Steel sheet, of same material, finish, and thickness as deck, unless otherwise indicated.
- G. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi, of same material and finish as deck, and of thickness and profile recommended by SDI Publication No. 29 for overhang and slab depth unless otherwise indicated.
- H. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck, unless otherwise indicated.
- I. Piercing Hanger Tabs: Piercing steel sheet hanger attachment devices for use with floor deck.
- J. Shear Connectors: ASTM A 108, Grades 1010 through 1020 headed stud type, cold-finished carbon steel, AWS D1.1, Type B, with arc shields.
- K. Repair Paint: Lead- and chromate-free rust-inhibitive primer complying with performance requirements of FS TT-P-664.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

#### 3.2 INSTALLATION, GENERAL

- A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 29, manufacturer's written instructions, and requirements in this Section.
- B. Install temporary shoring before placing deck panels, if required to meet deflection limitations.
- C. Locate decking bundles to prevent overloading of supporting members.
- D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.
- E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.
- F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to decking.
- G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of decking, and support of other work.
- H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

3.3 ROOF DECK INSTALLATION

- A. Fasten roof deck panels to steel supporting members at supports as indicated on structural drawings.
- B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports as indicated on structural drawings.
- C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches, with end joints as follows:
  - 1. End Joints: Lapped 2 inches minimum or butted at Contractor's option.
- D. Miscellaneous Roof Deck Accessories: Install ridge and valley plates, finish strips, cover plates, end closures, and reinforcing channels according to deck manufacturer's written instructions. Attach to substrate to provide a complete deck installation.
- E. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive according to manufacturer's written instructions to ensure complete closure.

3.4 FLOOR DECK INSTALLATION

- A. Fasten floor deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated and as follows:
  - 1. Weld Diameter: 5/8 inch, nominal.
  - 2. Weld Spacing: Weld edge ribs of panels at each support per structural drawings.
- B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the structural drawings:
- C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 2 inches, with end joints as follows:
  - 1. End Joints: Lapped or butted at Contractor's option.
- D. Shear Connectors: Weld shear connectors through deck to supporting frame according to AWS D1.1 and manufacturer's written instructions. Butt end joints of deck panels; do not overlap. Remove and discard arc shields after welding shear connectors.
- E. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations, unless otherwise indicated.
- F. Floor Deck Closures: Weld steel sheet column closures, cell closures, and Z-closures to deck, according to SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of decking. Weld cover plates at changes in direction of floor deck panels, unless otherwise indicated.
- G. Install piercing hanger tabs not more than 14 inches apart in both directions, within 9 inches of walls at ends, and not more than 12 inches from walls at sides, unless otherwise indicated.

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### 3.5 FIELD QUALITY CONTROL

- A. Testing: Owner will engage a qualified independent testing agency to perform field quality-control testing.
- B. Field welds will be subject to inspection.
- C. Testing agency will report test results promptly and in writing to Contractor and Architect.
- D. Remove and replace work that does not comply with specified requirements.
- E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

### 3.6 REPAIRS AND PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
- B. Repair Painting: Wire brush and clean rust spots, welds, and abraded areas on both surfaces of prime-painted deck immediately after installation, and apply repair paint.
  - 1. Apply repair paint, of same color as adjacent shop-primed deck, to bottom surfaces of deck exposed to view.
- C. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.

END OF SECTION 053100

**SECTION 054000 - COLD-FORMED METAL FRAMING**

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Structural Performance: Provide cold-formed metal framing capable of withstanding design loads without deflections greater than the following:
- B. Submittals: Product Data, Shop Drawings, material certificates, and structural analysis data signed and sealed by a qualified professional engineer registered in the state where Project is located.
- C. Engage a qualified professional engineer to prepare design calculations.
- D. Comply with AISI's "Specification for the Design of Cold-Formed Steel Structural Members" for calculating structural characteristics of cold-formed metal framing.
- E. Comply with AWS D1.1, "Structural Welding Code--Steel," and AWS D1.3, "Structural Welding Code--Sheet Steel."
- F. Protect cold-formed metal framing from corrosion, deformation, and other damage during delivery, storage, and handling.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Galvanized Steel Sheet: ASTM A 653/A 653M, G60 (Z180) zinc coated; structural steel; as required by structural performance.
- B. Steel Studs: C-shaped, with flange width of not less than 1-5/8 inches (41 mm), and of depths and thickness indicated.
- C. Steel Track: U-shaped, minimum uncoated metal thickness same as studs used with track, with flange widths of 1-1/4 inches (32 mm) for studs, of web depths indicated.

2.2 ACCESSORIES

- A. Accessories: Fabricate from the same material and finish used for framing members, of manufacturer's standard thickness and configuration, unless otherwise indicated.
- B. Steel Shapes and Clips: ASTM A 36/A 36M, hot-dip galvanized according to ASTM A 153/A 153M.

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- C. Cast-in-Place Anchor Bolts: ASTM F 1554, Grade 36, threaded carbon-steel hex-headed bolts and carbon-steel nuts; and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A 153/A 153M, Class C.
- D. Mechanical Fasteners: Corrosion-resistant coated, self-drilling, self-threading steel drill screws.
- E. Insulation: ASTM C 665, Type I, unfaced mineral-fiber blankets.
- F. Galvanizing Repair Paint: SSPC-Paint 20 or DOD-P-21035.

### PART 3 - EXECUTION

#### 3.1 FRAMING

- A. Install framing and accessories level, plumb, square, and true to line, and securely fastened, according to ASTM C 1007. Temporarily brace framing until entire integrated supporting structure has been completed and permanent connections are secured.
  - 1. Cut framing members by sawing or shearing; do not torch cut.
  - 2. Fasten framing members by welding or screw fastening.
  - 3. Install insulation in built-up exterior framing members.
  - 4. Fasten reinforcement plates over web penetrations larger than standard punched openings.
- B. Erection Tolerances: Install cold-formed metal framing with a maximum variation of 1/8 inch in 10 feet (1:960) and with individual framing members no more than plus or minus 1/8 inch (3 mm) from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
- C. Studs: Install continuous top and bottom tracks securely anchored at corners and ends. Squarely seat studs against webs of top and bottom tracks. Space studs as indicated, set plumb, align, and fasten both flanges of studs to top and bottom tracks.
  - 1. Install and fasten horizontal bridging in stud system, spaced in rows not more than 48 inches (1219 mm) apart.
  - 2. Install miscellaneous framing and connections to provide a complete and stable wall-framing system.

END OF SECTION 054000

**SECTION 055000 – METAL FABRICATIONS**

**PART 1 - GENERAL**

1.1 SECTION REQUIREMENTS

- A. Supply and install:
  - 1. Railings as shown on the architectural drawings.
  - 2. Steel floor grates.
  - 3. Misc. steel shapes and fasteners, as needed.
- B. Design, engineer, fabricate and install metal fabrications to withstand specified structural loads, without exceeding the allowable design working stress of the material. Include anchors and connections.
  - 1. Stairs: Uniform load of 100 lbs per.sq.ft., or a concentrated rated load of 300 lbs on an area of 4 sq. inches in the center of the tread, whichever produces the greatest stress.
  - 2. Railings and guardrails: Per IBC Section 1607.7 and ASCE –7, Chapter 4.
- C. Submit shop drawings and calculations stamped by a licensed engineer, showing details of fabrication and installation.

**PART 2 - PRODUCTS**

2.1 METALS

- A. Steel Plates, Bars and angles: ASTM A 36 (ASTM A 36M).
- B. Steel Shapes: ASTM A 992.
- C. Rolled Steel Floor Plates: ASTM A 786 (ASTM A 786M).
- D. Steel Pipe: ASTM A 53, standard weight (Schedule 40), black finish.
- E. Gray-Iron Castings: ASTM A 48, class 30.

2.2. GROUT

- A. Non-shrink, Nonmetallic Grout: ASTM C 1107.

2.3. FABRICATION

- A. Fabricate all metal per drawings and all applicable codes and regulations.



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### 2.4. STEEL AND IRON FINISHES

- A. Prepare uncoated ferrous metal surfaces to comply with SSPC-SP 3, "Power Tool Cleaning", and paint with a rust-inhibitive primer complying with performance requirements of FS TT-P-664.

## **Part 3 - EXECUTION**

### 3.1 INSTALLATION

- A. Perform cutting, drilling and fitting required for installing miscellaneous metal fabrications. Set metal fabrication accurately in location, alignment and elevation, securely anchored, with edges and surfaces level, plumb, true and free of rack. Set posts of guardrail in pipe sleeves and grout.
- B. Fastenings shall be concealed as much as possible.
- C. Fit exposed connections accurately together to form hairline joints.
- D. Aluminum surfaces to be placed in contact with steel, masonry or concrete, or steel surfaces to be placed in contact with aluminum, shall each be coated with paint as specified in the Aluminum Construction Manual, latest edition, published by The Aluminum Association.

END OF SECTION 055000

**SECTION 055200 - METAL RAILINGS**

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Structural Performance: Provide railings capable of withstanding structural loads required by ASCE 7.
- B. Submittals: Product Data, Shop Drawings and manufacturer's color charts showing the full range of colors available for factory-applied finishes.

PART 2 - PRODUCTS

2.1 METALS

- A. Aluminum, Extruded Bars and Tubing: ASTM B 221 (ASTM B 221M), Alloy 6063-T5/T52.
- B. Aluminum Castings: ASTM B 26/B 26M, Alloy A356.0-T6.
- C. Bronze, Extruded Shapes: ASTM B 455, alloy UNS No. C38500 (architectural bronze).
- D. Bronze, Seamless Tubing: ASTM B 135 (ASTM B 135M), alloy UNS No. C23000 (red brass, 85 percent copper).
- E. Stainless-Steel Tubing: ASTM A 554, Grade MT 304.
- F. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- G. Steel Pipe: ASTM A 53, Schedule 40.
- H. Steel Tubing: ASTM A 500 (cold formed) or ASTM A 513, Type 5 (mandrel drawn).
- I. Iron Castings: ASTM A 47, Grade 32510 (ASTM A 47M, Grade 22010) or ASTM A 48, Class 30 (ASTM A 48M, Class 200).
- J. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails, unless otherwise indicated.

2.2 RAILING SYSTEMS (NOT USED)

2.3 FABRICATION

- A. Assemble railing systems in shop to the greatest extent possible. Use connections that maintain structural value of joined pieces.

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- B. Form changes in direction of railing members by mitering at elbow bends.
- C. Fabricate railing systems and handrails for connecting members by welding.
- D. Provide manufacturer's standard wall brackets, flanges, miscellaneous fittings, and anchors to connect handrail and railing members to other construction.
- E. Provide wall returns at ends of wall-mounted handrails.

### 2.4 FINISHES

- A. Steel Railings: Cleaned and shop primed.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Fit exposed connections accurately together to form tight, hairline joints.
- B. Set railings accurately in location, alignment, and elevation and free of rack.
- C. Coat concealed surfaces of aluminum that will be in contact with cementitious materials or dissimilar metals, with a heavy coat of bituminous paint.
- D. Anchor posts in concrete by forming or core-drilling holes 5 inches (125 mm) deep and 3/4 inch (20 mm) greater than OD of post. Fill annular space between post and concrete with nonshrink, nonmetallic grout.
- E. Attach handrails to wall with wall brackets.

END OF SECTION 055200

**SECTION 061053 - MISCELLANEOUS ROUGH CARPENTRY**

**PART 1 - GENERAL**

1.1 SUMMARY

A. This Section includes the following:

1. Framing with dimension lumber.
2. Rooftop equipment bases and support curbs.
3. Wood blocking, cants, and nailers.
4. Wood furring and grounds.
5. Wood sleepers.
6. Plywood backing panels.

1.2 SUBMITTALS

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

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

B. Research/Evaluation Reports: For the following, showing compliance with building code in effect for Project:

1. Preservative-treated wood.
2. Fire-retardant-treated wood.
3. Power-driven fasteners.

1.3 QUALITY ASSURANCE

A. Forest Certification: For the following wood products, provide materials produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC 1.2, "Principles and Criteria":

1. Dimension lumber framing.
2. Miscellaneous lumber.
3. Exterior wood trim.

**PART 2 - PRODUCTS**

2.1 WOOD PRODUCTS, GENERAL

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- A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
1. Factory mark each piece of lumber with grade stamp of grading agency.
  2. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece.
  3. Provide dressed lumber, S4S, unless otherwise indicated.
  4. Plywood, exterior grade

### 2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

- A. Preservative Treatment by Pressure Process: AWPA C2, except that lumber that is not in contact with the ground and is continuously protected from liquid water may be treated according to AWPA C31 with inorganic boron (SBX).
1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or 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 the following items.
1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
  2. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.
  3. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
  4. Wood framing members that are less than 18 inches above the ground in crawl spaces or unexcavated areas.
  5. Wood floor plates that are installed over concrete slabs-on-grade.

### 2.3 FIRE-RETARDANT-TREATED MATERIALS

- A. General: Comply with performance requirements in AWPA C20 (lumber) and AWPA C27 (plywood).
1. Use Exterior type for exterior locations and where indicated.
  2. Use Interior Type A, unless otherwise indicated.
- B. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.

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C. Application: Treat all wood on the project, with the exception of the items listed in paragraph above for preservative treatment.

1. Framing for raised platforms.
2. Concealed blocking.
3. Roof construction.
4. Plywood backing panels.

### 2.4 DIMENSION LUMBER FRAMING

A. Maximum Moisture Content: 19 percent.

B. Non-Load-Bearing Interior Partitions: Construction or No. 2 grade of any listed species.

C. Other Framing: No. 2 grade and any of the following species:

1. Douglas fir-larch; WCLIB or WWPA.
2. Douglas fir-south; WWPA.
3. Hem-fir; WCLIB or WWPA.

D. Schedule of materials:

1. Wood studs: Douglas fir-Larch, stud grade
2. Wood joints: Douglas fir-Larch, No. 1 grade
3. Wood beams, stringers and posts: Douglas fir-Larch, select structural grade
4. Plywood sheathing: APA rated sheathing, Exposure 1
5. Communication backboards: APA A-C Group 1, Exterior, 3/4" thickness

### 2.5 MISCELLANEOUS LUMBER

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

1. Blocking.
2. Nailers.
3. Rooftop equipment bases and support curbs.
4. Cants.
5. Furring.
6. Grounds.
7. Utility shelving.

B. For items of dimension lumber size, provide Construction or No. 2 grade lumber with 19 percent maximum moisture content of any species.

C. For exposed boards, provide lumber with 15 percent maximum moisture content of Premium or 2 Common (Sterling) grade; WCLIB, or WWPA.

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

1. Western woods, Construction or No. 2 Common grade; WCLIB or WWPA.

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### 2.6 PLYWOOD BACKING PANELS

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

### 2.7 FASTENERS

- A. General: Where carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners of Type 304 stainless steel.
- B. Power-Driven Fasteners: NES NER-272.
- C. Screws for Fastening to Cold-Formed Metal Framing: ASTM C 954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.
- D. Machine bolts: ASTM A307
- E. Lag Bolts: Federal Specifications FF-B-561
- F. Nails: common; use galvanized at exterior or wet locations
- G. Gage metal framing connectors: Simpson Strong Tie with ICBO Certification.
- H. Metal Plate connected wood trusses: designed per Truss Plate Institute. (TPI)

## PART 3 - EXECUTION

### 3.1 INSTALLATION, GENERAL

- A. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry to other construction; scribe and cope as needed for accurate fit. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.
- B. Framing Standard: Comply with AF&PA's "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- C. Do not splice structural members between supports, unless otherwise indicated.
- D. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
- E. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
  - 1. NES NER-272 for power-driven fasteners.
  - 2. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
- F. Exterior Wood Trim Installation: Install with minimum number of joints practical, using full-length pieces from maximum lengths of lumber available. Cope at returns and miter at corners to produce

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tight-fitting joints with full-surface contact throughout length of joint. Use scarf joints for end-to-end joints.

1. Match color and grain pattern across joints.
2. Install to tolerance of 1/8 inch in 96 inches for level and plumb. Install adjoining finish carpentry with 1/32-inch maximum offset for flush installation and 1/16-inch maximum offset for reveal installation.
3. Glue all floor sheathing with minimum continuous bead of carpenter adhesive. Use two continuous beads at abutting panels.

### 3.2 PROTECTION

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

END OF SECTION 061053



**SECTION 061643 - EXTERIOR SHEATHING**

**PART 1 - GENERAL**

1.01 SUMMARY

- A. Section Includes: Fiberglass-mat faced, moisture and mold resistant gypsum sheathing.
- B. Related Sections:
  - 1. Section 054000 Structural Metal Stud Framing.
  - 2. Section 061053 Rough Carpentry.
  - 3. Section 072400 Exterior Insulation and Finish System (EIFS).

1.02 REFERENCES

- A. ASTM International (ASTM):
  - 1. ASTM C473 Standard Test Methods for Physical Testing of Gypsum Panel Products.
  - 2. ASTM C518 Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
  - 3. ASTM C1002 Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
  - 4. ASTM C1177 Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing.
  - 5. ASTM C1280 Standard Specification for Application of Gypsum Sheathing.
  - 6. ASTM D3273 Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.
  - 7. ASTM D6329 Standard Guide for Developing Methodology for Evaluating the Ability of Indoor Materials to Support Microbial Growth Using Static Environmental Chambers.
  - 8. ASTM E72 Standard Test Methods of Conducting Strength Tests of Panels for Building Construction.
  - 9. ASTM E96 Standard Test Methods for Water Vapor Transmission of Materials.
- B. Gypsum Association (GA): GA-253 Application of Gypsum Sheathing.

1.03 SUBMITTALS

- A. Product Data: Manufacturer's specifications and installation instructions for each product specified.

1.04 WARRANTY

- A. Provide products that offer twelve months of coverage against in-place exposure damage (delamination, deterioration and decay).
- B. Manufacturer's Warranty:
  - 1. Five years against manufacturing defects.
  - 2. Ten years against manufacturing defects when used as a substrate in architecturally specified EIFS.

## PART 2 - PRODUCTS

### 2.01 MANUFACTURERS

- A. Georgia-Pacific Gypsum LLC:
  - 1. Fiberglass-Mat Faced Gypsum Sheathing: DensGlass Sheathing.
  - 2. Fiberglass-Mat Faced Gypsum Sheathing, Type X for Fire Rated Designs: DensGlass Fireguard Sheathing.
- B. Approved equivalent.

### 2.02 MATERIALS

- A. Fiberglass-Mat Faced Gypsum Sheathing: ASTM C1177:
  - 1. Thickness: 1/2 inch.
  - 2. Width: 4 feet.
  - 3. Length: 8 feet, 9 feet or 10 feet as required to minimize seams and waste.
  - 4. Weight: 1.9 lb/sq. ft.
  - 5. Edges: Square.
  - 6. Surfacing: Fiberglass mat on face, back, and long edges.
  - 7. Racking Strength (Ultimate, not design value) (ASTM E72): Not less than 540 pounds per square foot, dry.
  - 8. Flexural Strength, Parallel (ASTM C473): 80 lbf, parallel.
  - 9. Humidified Deflection (ASTM C1177): Not more than 2/8 inch.
  - 10. Permeance (ASTM E96): 23 perms.
  - 11. R-Value (ASTM C518): 0.56.
  - 12. Mold Resistance (ASTM D3273): 10, in a test as manufactured.
  - 13. Microbial Resistance (ASTM D6329, GREENGUARD 3-week protocol): Will not support microbial growth.
  - 14. Acceptable Products:
    - a. 1/2 inch DensGlass Sheathing, Georgia-Pacific Gypsum or approved equivalent.
- B. Fire-Rated Fiberglass-Mat Faced Gypsum Sheathing: ASTM C1177, Type X (if required by code):
  - 1. Thickness: 5/8 inch.
  - 2. Width: 4 feet.
  - 3. Length: [8 feet] [9 feet] [10 feet].
  - 4. Weight: 2.5 lb/sq. ft.
  - 5. Edges: Square.
  - 6. Surfacing: Fiberglass mat on face, back, and long edges.
  - 7. Racking Strength (Ultimate, not design value) (ASTM E72): Not less than 654 pounds per square foot, dry.
  - 8. Flexural Strength, Parallel (ASTM C1177): 100 lbf, parallel.
  - 9. Humidified Deflection (ASTM C1177): Not more than 1/8 inch.
  - 10. Permeance (ASTM E96): Not more than 17 perms.
  - 11. R-Value (ASTM C518): 0.67.
  - 12. Mold Resistance (ASTM D3273): 10, in a test as manufactured.
  - 13. Microbial Resistance (ASTM D6329, GREENGUARD 3-week protocol): Will not support microbial growth.

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14. Acceptable Products:

- a. 5/8 inch DensGlass Fireguard Sheathing, Georgia-Pacific Gypsum or approved equivalent.

2.03 ACCESSORIES

- A. Screws: ASTM C1002, corrosion resistant treated.

**PART 3 EXECUTION**

3.01 EXAMINATION

A. Verification of Conditions:

- 1. Inspection: Verify that project conditions and substrates are acceptable, to the installer, to begin installation of work of this section.

3.02 INSTALLATION

- A. General: In accordance with GA-253, ASTM C1280 and the manufacturer's recommendations.

- 1. Manufacturer's Recommendations:

- a. Current "Product Catalog", Georgia-Pacific Gypsum.

3.03 PROTECTION

- A. Protect gypsum board installations from damage and deterioration until date of Substantial Completion.

END OF SECTION 061643

**SECTION 062023 - INTERIOR FINISH CARPENTRY**

**PART 1 - GENERAL**

1.1 SUMMARY

A. This Section includes the following:

1. Interior standing and running trim.
2. Shelving and clothes rods.

B. See Division 06 Section "Interior Architectural Woodwork" for interior woodwork not specified in this Section.

1.2 SUBMITTALS

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

B. Samples: For each type of paneling indicated.

C. Submittals:

1. Manufacturers' product data for adhesives and glues, including printed statement of VOC content.
2. Composite wood manufacturer's product data for each composite wood product used indicating that the bonding agent contains no urea formaldehyde.

**PART 2 - PRODUCTS**

2.1 MATERIALS, GENERAL

A. Lumber: DOC PS 20 and applicable grading rules of inspection agencies certified by ALSC's Board of Review.

B. Softwood Plywood: DOC PS 1.

C. Hardboard: AHA A135.4.

D. MDF: ANSI A208.2, Grade 130, made with binder containing no urea-formaldehyde resin.

E. Particleboard: ANSI A208.1, Grade M-2, made with binder containing no urea-formaldehyde resin.

F. Melamine-Faced Particleboard: Particleboard complying with ANSI A208.1, Grade M-2, finished on both faces with thermally fused, melamine-impregnated decorative paper complying with LMA SAT-1.

2.2 FIRE-RETARDANT-TREATED MATERIALS

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

- A. Lumber: Comply with performance requirements in AWWA C20, Interior Type A. Kiln dry after treatment to a maximum moisture content of 19 percent.
- B. Plywood: Comply with performance requirements in AWWA C27, Interior Type A. Kiln dry after treatment to a maximum moisture content of 15 percent.
- C. Application: All interior lumber and plywood.

### 2.3 STANDING AND RUNNING TRIM

- A. Softwood Lumber Trim:
  - 1. Species and Grade: Douglas fir-larch or Douglas fir south, Superior or C & Btr finish; NLGA, WCLIB, or WWPA.
  - 2. Maximum Moisture Content: 15 percent.
- B. Hardwood Moldings for Transparent Finish (Stain or Clear Finish): WMMPA HWM 2, N-grade wood moldings made to patterns included in WMMPA WM 12.
  - 1. Species: White maple.
  - 2. Maximum Moisture Content: 9 percent.
- C. Moldings for painted trim:
  - 1. Hardwood moldings as above
  - 2. Optional Material: Primed MDF.

### 2.4 SHELVING AND CLOTHES RODS

- A. Shelving: Made from one of the following materials, 3/4 inch thick. Do not use particleboard or MDF that contains urea formaldehyde.
  - 1. Particleboard with solid-wood front edge.
  - 2. MDF with solid-wood front edge.
  - 3. Melamine-faced particleboard with applied PVC front edge.
  - 4. Softwood Boards: Douglas fir-larch, Douglas fir south, or hem-fir; Superior or C & Btr finish; NLGA, WCLIB, or WWPA; or southern pine, C finish; SPIB; kiln dried.
- B. Shelf Cleats: 3/4-by-5-1/2-inch boards with hole and notch to receive clothes rods, as specified above for shelving.
- C. Shelf Brackets with Rod Support: BHMA A156.16, B04051; prime-painted formed steel.
- D. Shelf Brackets without Rod Support: BHMA A156.16, B04041; prime-painted formed steel.

### 2.5 MISCELLANEOUS MATERIALS

- A. Glue: Aliphatic-resin, polyurethane, or resorcinol wood glue.

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

1. Use wood glue that has a VOC content of 30 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

### **PART 3 - EXECUTION**

#### 3.1 PREPARATION

- A. Before installing interior finish carpentry, condition materials to average prevailing humidity in installation areas for a minimum of 24 hours.

#### 3.2 INSTALLATION, GENERAL

- A. 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.
  2. Countersink fasteners, fill surface flush, and sand where face fastening is unavoidable.
  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.
  4. Install stairs with no more than 3/16-inch variation between adjacent treads and risers and with no more than 3/8-inch variation between largest and smallest treads and risers within each flight.

#### 3.3 STANDING AND RUNNING TRIM INSTALLATION

- A. Install with minimum number of joints practical, using full-length pieces from maximum lengths of lumber available. Cope at returns and miter at corners to produce tight-fitting joints. Use scarf joints for end-to-end joints.

#### 3.4 SHELVING INSTALLATION

- A. Cut shelf cleats at ends of shelves about 1/2 inch less than width of shelves and sand exposed ends smooth.
- B. Install shelf cleats by fastening to framing or backing with finish nails or trim screws, set below face and filled. Space fasteners not more than 16 inches o.c.
- C. Install shelf brackets according to manufacturer's written instructions, spaced not more than 36 inches o.c. Fasten to framing members, blocking, or metal backing, or use toggle bolts or hollow wall anchors.
- D. Cut shelves to neatly fit openings with only enough gap to allow shelves to be removed and reinstalled. Install shelves, fully seated on cleats, brackets, and supports.

END OF SECTION 062023

**SECTION 064023 - INTERIOR ARCHITECTURAL WOODWORK**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. This Section includes the following:
  - 1. Interior frames and jambs.
  - 2. Wood veneered cabinets
  - 3. Plastic-laminate cabinets.
  - 4. Plastic-laminate countertops.
  - 5. Solid-surfacing-material countertops.
  - 6. Shop finishing of woodwork.
  
- B. Interior Architectural woodwork includes wood furring, blocking, shims, and hanging strips unless concealed within other construction before woodwork installation.
  
- C. Rough carriages for stairs are a part of interior Architectural woodwork. Platform framing, headers, partition framing, and other rough framing associated with stairwork are specified in Division 06 Section "Rough Carpentry."

**1.2 SUBMITTALS**

- A. Product Data: For cabinet hardware and accessories and finishing materials and processes.
  
- B. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.
  
- C. Samples:
  - 1. Lumber and panel products for transparent finish, for each species and cut, finished on one side and one edge.
  - 2. Lumber and panel products with shop-applied opaque finish, for each finish system and color, with exposed surface finished.
  - 3. Plastic-laminates, for each type, color, pattern, and surface finish.
  - 4. Thermoset decorative panels, for each type, color, pattern, and surface finish.
  - 5. Solid-surfacing materials.
  
- D. Sustainability Submittals:
  - 1. Product data:
    - a. Composite wood manufacturer's product data for each composite wood product used indicating that the bonding agent contains no urea formaldehyde.
    - b. Adhesive manufacturer's product data for each adhesive used indicating that the adhesive contains no urea formaldehyde.
  
- E. Woodwork Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.

### 1.3 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of woodwork.
- B. Quality Standard: Unless otherwise indicated, comply with AWI's "Architectural Woodwork Quality Standards."
  - 1. Provide AWI Quality Certification Program labels and certificates for woodwork, including installation.
- C. Forest Certification: Provide interior Architectural woodwork produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC 1.2, "Principles and Criteria."

### 1.4 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install woodwork until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

## **PART 2 - PRODUCTS**

### 2.1 WOODWORK FABRICATORS

- A. Fabricators: Subject to compliance with requirements, provide interior Architectural woodwork by one of the following:

### 2.2 MATERIALS

- A. Wood Species and Cut for Transparent Finish: maple, plain sawn
- B. Wood Species for Opaque Finish: Any closed-grain hardwood.
- C. Wood Products:
  - 1. Hardboard: AHA A135.4.
  - 2. Medium-Density Fiberboard: ANSI A208.2, Grade MD, made with binder containing no urea formaldehyde.
  - 3. Particleboard: ANSI A208.1, Grade M-2.
  - 4. Softwood Plywood: DOC PS 1, Medium Density Overlay.
  - 5. Veneer-Faced Panel Products (Hardwood Plywood): HPVA HP-1, made with adhesive containing no urea formaldehyde.
- D. Thermoset Decorative Panels: Particleboard or medium-density fiberboard finished with thermally fused, melamine-impregnated decorative paper complying with LMA SAT-1.



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- E. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or, if not indicated, as required by woodwork quality standard.
- F. Solid-Surfacing Material: Homogeneous solid sheets of filled plastic resin complying with ISSFA-2.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Avonite, Inc.
    - b. Formica Corporation.
    - c. Meganite Inc.; a division of the Pyrochem Group.
    - d. Nevamar Company, LLC; Decorative Products Div.
    - e. Swan Corporation (The).
    - f. Transolid, Inc.
    - g. Wilsonart International; Div. of Premark International, Inc.
    - h. Dovae by Chemchor Industries, Inc.
    - i. Or approved equal
- G. Tempered Float Glass for Cabinet Doors: ASTM C 1048, Kind FT, Condition A, Type I, Class 1 (clear), Quality-Q3, with exposed edges seamed before tempering, 6 mm thick, unless otherwise indicated.

### 2.3 FIRE-RETARDANT-TREATED MATERIALS

- A. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Comply with performance requirements of AWPA C20 (lumber) and AWPA C27 (plywood). Use Exterior Type or Interior Type A. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Kiln-dry material after treatment.
- B. Fire-Retardant Particleboard: Panels made from softwood particles and fire-retardant chemicals mixed together at time of panel manufacture with flame-spread index of 25 or less and smoke-developed index of 25 or less per ASTM E 84.
- C. Fire-Retardant Fiberboard: ANSI A208.2 medium-density fiberboard panels made from softwood fibers, synthetic resins, and fire-retardant chemicals mixed together at time of panel manufacture with flame-spread index of 25 or less and smoke-developed index of 200 or less per ASTM E 84.

### 2.4 CABINET HARDWARE AND ACCESSORIES

- A. General: Provide cabinet hardware and accessory materials associated with Architectural woodwork, except for items specified in Division 08 Section "Door Hardware (Scheduled by Describing Products)."
- B. Butt Hinges: 2-3/4-inch, 5-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, 125 degrees of opening, self-closing.

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

E. Wire Pulls: Back mounted, solid metal, 4 inches long, 5/16 inch in diameter.

F. Catches: Magnetic catches, BHMA A156.9, B03141.

G. Drawer Slides: BHMA A156.9, B05091.

1. Standard Duty (Grade 1, Grade 2, and Grade 3): Side mounted and extending under bottom edge of drawer; full-extension type; 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 1; for drawers not more than 6 inches high and 24 inches wide.
4. File Drawer Slides: Grade 1HD-200; for drawers more than 6 inches high or 24 inches wide.
5. Pencil Drawer Slides: Grade 2; for drawers not more than 3 inches high and 24 inches wide.

H. Aluminum Slides for Sliding Glass Doors: BHMA A156.9, B07063.

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

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

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

1. Bright Chromium Plated: BHMA 625 for brass or bronze base; BHMA 651 for steel base.
2. Satin Stainless Steel: BHMA 630.

### 2.5 MISCELLANEOUS MATERIALS

A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, fire-retardant-treated, kiln-dried to less than 15 percent moisture content.

B. Adhesives, General: Do not use adhesives that contain urea formaldehyde.

### 2.6 FABRICATION

A. General: Complete fabrication to maximum extent possible before shipment to Project site. Where necessary for fitting at site, provide allowance for scribing, trimming, and fitting.

1. Interior Woodwork Grade: Custom.
2. Shop cut openings to maximum extent possible. Sand edges of cutouts to remove splinters and burrs. Seal edges of openings in countertops with a coat of varnish.
3. Install glass to comply with applicable requirements in Division 08 Section "Glazing" and in GANA's "Glazing Manual." For glass in wood frames, secure glass with removable stops.

B. Interior Standing and Running Trim:

1. For transparent-finished trim items wider than available lumber, use veneered construction. Do not glue for width.

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2. Backout or groove backs of flat trim members and kerf backs of other wide, flat members, except for members with ends exposed in finished work.
3. Assemble casings in plant except where limitations of access to place of installation require field assembly.

C. Fire-Rated Interior Frames and Jambs: Products fabricated from fire-retardant particleboard or fire-retardant medium-density fiberboard with veneered, exposed surfaces and 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.

1. Fire Rating: 20 minutes.

D. Flush Wood Paneling and Wainscots:

1. Lumber Trim and Edges: At fabricator's option, trim and edges indicated as solid wood (except moldings) may be either lumber or veneered construction compatible with grain and color of veneered panels.
2. Matching of Adjacent Veneer Leaves: Book match.
3. Veneer Matching within Panel Face: Balance match.
4. Panel-Matching Method: In each separate area, use sequence-matched, uniform-size sets.
5. Fire-Retardant-Treated Paneling: Provide panels consisting of wood veneer and fire-retardant particleboard or fire-retardant medium-density fiberboard. Panels shall have flame-spread index of 75 or less and smoke-developed index of 450 or less per ASTM E 84.

E. Wood Cabinets for Transparent Finish:

1. AWI Type of Cabinet Construction: Flush overlay or as indicated.
2. Reveal Dimension: 1/2 inch.
3. Grain Direction: Vertically for drawer fronts, doors, and fixed panels.
4. Matching of Veneer Leaves: Book match.
5. Veneer Matching within Panel Face: Balance match.
6. Semiexposed Surfaces Other Than Drawer Bodies: Thermoset decorative panels.
7. Drawer Sides and Backs: Solid-hardwood lumber, stained to match species indicated for exposed surfaces.
8. Drawer Bottoms: Hardwood plywood.
9. Provide dust panels of 1/4-inch plywood or tempered hardboard above compartments and drawers, unless located directly under tops.

F. Plastic-Laminate Cabinets:

1. AWI Type of Cabinet Construction: Flush overlay.
  - a. Reveal Dimension: 1/2 inch.
2. Laminate Cladding for Exposed Surfaces: High-pressure decorative laminate as follows:
  - a. Horizontal Surfaces Other Than Tops: Grade HGS.
  - b. Postformed Surfaces: Grade HGP.
  - c. Vertical Surfaces: Grade HGS.
  - d. Edges: PVC Edge banding. .012 inch thick, matching laminate in color, pattern and finish.
3. Materials for Semiexposed Surfaces Other Than Drawer Bodies: Thermoset decorative panels.

4. Drawer Sides and Backs: Thermoset decorative panels.
5. Drawer Bottoms: Thermoset decorative panels.
6. Colors, Patterns, and Finishes: As selected by Owner from laminate manufacturer's full range of solid colors and wood grains, matte finish.
7. Provide dust panels of 1/4-inch plywood or tempered hardboard above compartments and drawers, unless located directly under tops.

G. Plastic-Laminate Countertops:

1. High-Pressure Decorative Laminate Grade: HGS.
2. Colors, Patterns, and Finishes: As indicated by manufacturer's designations.
3. Colors, Patterns, and Finishes: As selected by Owner from laminate manufacturer's full range of solid colors and wood grains, matte finish.
4. Edge Treatment: Same as laminate cladding on horizontal surfaces.
5. Core Material at Sinks: Exterior-grade plywood.

H. Solid-Surfacing-Material Countertops:

1. Solid-Surfacing-Material Thickness: 1/2 inch.
2. Colors, Patterns, and Finishes: As indicated by manufacturer's designations.
3. Fabricate tops in one piece with shop-applied backsplashes. Comply with solid-surfacing-material manufacturer's written recommendations for adhesives, sealers, fabrication, and finishing.
4. Install integral sink bowls in countertops in shop.

## 2.7 SHOP FINISHING

- A. Finish Architectural woodwork at fabrication shop. Defer only final touchup, cleaning, and polishing until after installation.
- B. Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of woodwork. Apply two coats to back of paneling.
- C. Transparent Finish:
  1. Grade: Premium.
  2. AWI Finish System: Catalyzed polyurethane..
  3. Staining: Match approved sample for color.
  4. Wash Coat for Stained Finish: Apply a wash-coat sealer to woodwork made from closed-grain wood before staining and finishing.
  5. Open-Grain Woods: After staining (if any), apply paste wood filler to open-grain woods and wipe off excess. Tint filler to match stained wood.
  6. Sheen: Satin, 31-45 gloss units measured on 60-degree gloss meter per ASTM D 523.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

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- A. Before installation, condition woodwork to average prevailing humidity conditions in installation areas. Examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming.
- B. Grade: Install woodwork to comply with requirements for the same grade specified in Part 2 for fabrication of type of woodwork involved.
- C. Install woodwork level, plumb, true, and straight to a tolerance of 1/8 inch in 96 inches. Shim as required with concealed shims.
- D. Scribe and cut woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
- E. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing as required for complete installation. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork and matching final finish if transparent finish is indicated.
- F. Standing and Running Trim: Install with minimum number of joints possible, using full-length pieces (from maximum length of lumber available) to greatest extent possible. Scarf running joints and stagger in adjacent and related members. Fill gaps, if any, between top of base and wall with plastic wood filler, sand smooth, and finish same as wood base if finished.
- G. Paneling: Anchor paneling to supporting substrate with concealed panel-hanger clips. Do not use face fastening, unless covered by trim.
- H. Stairs: Securely anchor carriages to supporting substrates. Install stairs with treads and risers no more than 1/8 inch from indicated position.
- I. Railings: Install rails with no more than 1/8 inch in 96-inch variation from a straight line.
  - 1. Stair Rails: Glue and dowel or pin balusters to treads and railings, and railings to newel posts.
  - 2. Wall Rails: Support rails on indicated metal brackets securely fastened to wall framing.
- J. Cabinets: Install without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation.
  - 1. Fasten wall cabinets through back, near top and bottom, at ends and not more than 16 inches o.c. with No. 10 wafer-head screws sized for 1-inch penetration into wood framing, blocking, or hanging strips or No. 10 wafer-head sheet metal screws through metal backing or metal framing behind wall finish
- K. Countertops: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop. Calk space between backsplash and wall with sealant specified in Division 07 Section "Joint Sealants."

END OF SECTION 064023

**SECTION 071326 - SELF-ADHERING SHEET WATERPROOFING**

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data
- B. Installer Qualifications: Authorized, approved, or licensed by waterproofing manufacturer.

PART 2 - PRODUCTS

2.1 WATERPROOFING MATERIALS

- A. Rubberized-Asphalt Sheet: 60-mil- (1.5-mm-) thick, self-adhering sheet consisting of 56 mils (1.4 mm) of rubberized asphalt laminated to a 4-mil- (0.10-mm-) thick, polyethylene film with release liner on adhesive side and formulated for application with primer or surface conditioner that complies with VOC limits of authorities having jurisdiction.
- B. Auxiliary Materials: Primer, surface conditioner, liquid membrane, substrate patching membrane, sheet strips, mastic, adhesives, tape, and metal termination bars recommended by waterproofing manufacturer.
  - 1. Primer: Liquid waterborne primer recommended for substrate.
  - 2. Surface Conditioner: Liquid, waterborne surface conditioner recommended for substrate.
- C. Protection Course: ASTM C 578, Type I, molded-polystyrene insulation board, 1 inch (25 mm) thick.
- D. Molded-Sheet Drainage Panel: Comply with Division 33 Section "Subdrainage."
- E. Molded-Sheet Drainage Panels: Permeable geotextile laminated to a three-dimensional, molded-plastic-sheet drainage core.
- F. Wall Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type IV or Type VI, fabricated with shiplap or channel edges and with one side having grooved drainage channels.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Clean, prepare, and treat substrates. Provide clean, dust-free, and dry substrates for waterproofing application.

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

- B. Remove oil, form-release agents, curing compounds, and other contaminants or coatings.
- C. Remove projections and fill honeycomb, aggregate pockets, holes, and other voids.
- D. Prepare, fill, prime, and treat joints and cracks in substrates. Remove dust and dirt from joints and cracks.
- E. Apply primer to substrates at required rate and allow it to dry.
- F. Install self-adhering sheet waterproofing according to manufacturer's written instructions and recommendations in ASTM D 6135.
- G. Apply and firmly adhere sheets. Accurately align sheets and maintain uniform 2-1/2-inch- (64-mm-) minimum lap widths and end laps. Overlap and seal seams and stagger end laps.
- H. Bridge and cover isolation joints, expansion joints, and discontinuous deck-to-wall and deck-to-deck joints with overlapping sheet strips. Invert and loosely lay first sheet strip over center of joint. Firmly adhere second sheet strip to first and overlap to substrate.
- I. Prepare, prime, and treat inside and outside corners according to ASTM D 6135.
- J. Prepare, treat, and seal surfaces at terminations, penetrations, drains, and protrusions according to ASTM D 6135.
- K. Repair tears, voids, and lapped seams not complying with requirements. Slit and flatten fishmouths and blisters. Patch with sheets extending 6 inches (150 mm) beyond repaired areas in all directions.
- L. Install protection course over waterproofing membrane immediately. Use adhesive or tape applied according to manufacturer's written instructions. Do not penetrate waterproofing.
  - 1. Lap edges and ends of geotextile to maintain continuity.

END OF SECTION 071326

**SECTION 072100 - BUILDING INSULATION**

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.
- B. Surface-Burning Characteristics: ASTM E 84, and as follows:
  - 1. Flame-Spread Index: 25 or less where exposed; otherwise, as indicated in Part 2 "Insulation Products" Article.
  - 2. Smoked-Developed Index: 450 or less.

PART 2 - PRODUCTS

2.1 INSULATION PRODUCTS

- A. Rigid expanded polystyrene (EPS) foam board insulation for continuous wall insulation, as an integral component of the EIFS.
- B. Mineral-Fiber-Blanket Insulation: ASTM C 665, Type I, unfaced with fibers manufactured from glass, with flame-spread index of 25 or less, for wall and parapet cavity insulation.
- C. Rigid extruded polystyrene (XPS) foam board (i.e. blue board, pink board or green board, with an insulation value of R-5 per inch) for underslab insulation.

2.2 ACCESSORIES

- A. Vapor Retarder where required for walls: Polyethylene, 4 mil. thick, rated at 1.0 perm or less, on warm side of exterior walls.

2.3 MANUFACTURERS

- A. Acceptable Manufacturers:
  - 1. Atlas
  - 2. Firestone
  - 3. GAF
  - 4. GenFlex
  - 5. Johns Manville
  - 6. Dow
  - 7. Owens Corning



8. GreenGuard

C. Substitutions: Under provisions of Division 01.

D. Provide each insulation type from a single manufacturer.

2.4 MATERIALS

A. Expanded polystyrene (EPS), mineral-fiber blanket insulation, and extruded polystyrene insulation: Provide products that comply with all applicable codes.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install insulation in areas and in thicknesses indicated or required to produce R-values indicated. Cut and fit tightly around obstructions and fill voids with insulation. Where more than one layer of rigid insulation is used, stagger all joints.
- B. Extend vapor retarder to extremities of areas to be protected from vapor transmission. Secure in place with adhesives or other anchorage. Locate seams at framing members, overlap, and seal with tape.
- C. Attach rigid insulation to substrate per manufacturer's recommendations. Confirm compatibility of insulation board with all substrates, including but not limited to any below-grade waterproofing membranes or coatings.

3.2 CLEANING / PROTECTION

- A. Remove trash and construction debris from insulation surface prior to application.
- B. Do not leave installed insulation exposed to weather. Cover with sheathing system immediately after installation.
  - 1. Temporarily seal exposed insulation edges at the end of each day.
  - 2. Remove and replace installed insulation that has become wet or damaged with new insulation.

END OF SECTION 072100

**SECTION 072216 – ROOF BOARD INSULATION**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. HCFC FREE Polyisocyanurate Rigid board type roof insulation(s) for thermal protection as part of roofing assemblies.
- B. Recover board Polyisocyanurate roof insulation.
- C. Roofing crickets.

1.2 RELATED SECTIONS

- A. Section 05 30 00 - Metal Decking.
- B. Section 06 10 00 - Rough Carpentry: Roof blocking and nailers.

1.3 REFERENCES

- A. ASTM C 1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Insulation Board.
- B. ASTM D 312 - Standard Specification for Asphalt Used in Roofing.
- C. ASTM E 108 - Standard Test Methods for Fire Tests of Roof Coverings.
- D. ASTM E 119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
- E. FM 4450 - Approval Standard - Class I Insulated Steel Roof Decks.
- F. FM 4470 - Approval Standard - Class I Roof Covers.
- G. LTTR – Long Term Thermal Resistance predicted by CAN/ULC-S770-03.
- H. UL 263 - Fire Tests of Building Construction and Materials.
- I. UL 790 - Standard Test Methods for Fire Tests of Roof Coverings.
- J. UL 1256 - Fire Test of Roof Deck Constructions.

K. ASTM E 2114-01 – Standard Terminology for Sustainability Relative to the Performance of Buildings

L. ASTM E 2129 –01 – Standard Practice for Data Collection for Sustainability Assessment of Building Products.

#### 1.4 DEFINITIONS

A. LTTR (Long Term Thermal Resistance) is defined as using techniques from ASTM C1303 or CAN/ULC-S770, the predicted R-Value that has been shown to be equivalent to the average performance of a permeably faced foam insulation product over 15 years. LTTR applies to ALL foam insulation products with blowing agents other than air, such as polyiso, extruded polystyrene and polyurethane. The new method is based on consensus standards in the US and Canada.

#### 1.5 SUBMITTALS

A. Submit under provisions of Section 013000 and 016000.

B. Product Data:

1. Manufacturer's specifications
2. Installation instructions for insulation board and fasteners
3. Product Data as per ASTM 2129 – 01 Standard for Data Collection for Sustainability Assessment of Building Products

C. Samples:

1. Submit 6 by 6 inch (152 by 152 mm) samples of each board type required.
2. Submit samples of each fastener type required.

D. Shop Drawings: Roof plan showing layout of boards and fastening patterns.

E. Certificates: System Manufacturer's or insulation manufacturer's certification that the insulation meets Zero ODP (Ozone Depletion Potential) and Zero GWP (Global Warming Potential) specification requirements.

F. Thermal Warranty: Submit sample warranty indicating conditions and limitations.

#### 1.6 QUALITY ASSURANCE

A. Regulatory Requirements:

1. American Society for Testing and Materials (ASTM).

2. Factory Mutual (FM).
3. Underwriters Laboratories Inc. (UL) Classification.
4. Metro-Dade County, Florida Product Control.
5. California State Insulation Quality Standards and Title 25 Foam Flammability Criteria.
6. IBC, BOCA, ICBO and SBCCI Sections on Foam Plastic Insulation.

#### 1.7 DELIVERY, STORAGE AND HANDLING

- A. Comply with general requirements specified in Section 016000.
- B. Deliver insulation in packages labeled with material name, thermal value and product code.
- C. When stored outdoors, stack insulation on pallets above ground or roof deck and cover with tarpaulin or other suitable waterproof coverings. Slit or remove manufacturer's packaging before covering with waterproof covering.

#### 1.8 PROJECT CONDITIONS

- A. Comply with insurance underwriter's requirements applicable for products of this Section.
- B. Do not install insulation on roof deck when water of any type is present. Do not apply roofing materials when substrate is damp or wet.

### PART 2 PRODUCTS

#### 2.1 MANUFACTURERS

- A. Acceptable Manufacturers:
  1. Atlas Roofing Corporation
  2. Firestone
  3. GAF
  4. GenFlex
  5. Johns Manville
  6. Dow
- C. Substitutions: Under provisions of Division 01.
- D. Provide polyiso roof board insulation from a single manufacturer.

## 2.2 MATERIALS

A. Polyiso Roof Board Insulation: Provide products that comply with the following:

1. ASTM standards specified.
2. Factory Mutual (FM) approvals specified.
3. Underwriters Laboratories Inc. (UL) classifications specified.
4. Metro-Dade County, Florida Product Control.
5. California State Insulation Quality Standards and Title 25 Foam Flammability Criteria.
6. BOCA National Building Code Section on Foam Plastic Insulation
7. ICBO Uniform Building Code Section on Foam Plastic Insulation.
8. SBCCI Standard Building Code Section on Foam Plastic Insulation.

B. Specification is based upon Atlas Roofing Corp. "ACFoam-II": Closed-cell HCFC FREE "Green" polyisocyanurate foam core manufactured using ACUltra Hydrocarbon blowing agent and integrally laminated to heavy non- asphaltic fiber-reinforced felt facers; FM 1-90 wind uplift classification; compressive strength - 25 psi.

- Federal Specification HH-I-1972/GEN and HH-I-1972/2, Class 1 have been cancelled.
- ASTM C 1289, Type II, Class 1
- Miami-Dade County, Florida Product Control No. 00-0208.04
- NYC MEA #107-01-M
- California State Insulation Quality Standards and Title 25 Foam Flammability Criteria (License #TC 1231)
- IBC, NBC, UBC and SBC Sections on Foam Insulation (Chapter 26)
- CCMC No. 12464-L
- CAN/CGSB-51.26-M86
- CAN/ULC-S704
- FM Standard 4450/4470 Approval
- ACFoam-II, -III, and -IV are approved for Class 1 insulated steel, wood, concrete and gypsum roof deck construction for 1-60 and 1-90 Windstorm Classifications. Refer to FM Approval Guide for details on specific systems.
- UL Standard 1256 Classification  
Insulated metal deck construction assemblies - Construction #120 and #123.
- UL Standard 790 (ASTM E 108) Classification  
Class A with most roof membrane systems. See UL Roofing Materials & Systems Directory.
- UL Standard 263 Fire Resistance Classification (ASTM E 119)  
Some classifications for fire resistance are P225, P230, P259, P508, P510, P514, P519, P701, P710, P713, P717, P718, P719, P720, P722, P723, P724, P725, P727, P728, P729, P730, P732, P801, P814, P815, P818, P819, and P828. See UL Fire Resistance Directory for updated listings.
- UL Standard 1897 Uplift Resistance  
120 psf, 150 psf, 165 psf, 245 psf.

- UL Certified for Canada
- UL of Canada  
Insulated Roof Deck Assemblies - Construction #C34.  
CAN/ULC-S126-M86, CAN/ULC-S101-M89, CAN/ULC-S107-M87

C. LTTR – Total Roof Insulation "R" Value: **R-30 min. (5" total thickness)**. Long-term thermal resistance values of the foam were determined in accordance with CAN/ULC-S770. All test samples were third-party selected and tested by an accredited materials testing laboratory.

D. Related Materials:

1. Fasteners: Factory Mutual approved.
2. Bearing Plates: As recommended by roofing manufacturer.
3. Base Ply: As recommended by membrane manufacturer.
4. Fasteners: For Nail Base and Vented-R: Atlas Nail Base Fasteners.
5. Asphalt Bitumen: Comply with ASTM D 312, Type III (steep) or Type IV. **USE ONLY ON APPROVED BOARD INSULATION TYPES.**
  - a. Provide with labels indicating flash point, softening point, finished blowing temperature, and equiviscous temperature.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine roof deck for suitability to receive insulation. Verify that substrate is dry, clean and free of foreign material that will damage insulation or impede installation.
- B. Verify that roof drains, scuppers, roof curbs, nailers, equipment supports, vents and other roof accessories are secured properly and installed in conformance with Contract Drawings and submittals.
- C. Verify that deck is structurally sound to support installers, materials and equipment without damaging or deforming work.
  1. Start of installation indicates installer accepts conditions of existing deck surfaces.

### 3.2 APPLICATION / INSTALLATION

- A. Install specified insulation using approved mechanical fasteners and bearing plates in accordance with manufacturer's latest written instructions and as required by governing codes and Owner's insurance carrier.
- B. Install with end joints staggered to avoid having insulation joints coinciding with joints in deck. In multi-layer installations, stagger joints in top and bottom layers.

### 3.3 CLEANING / PROTECTION

A. Remove trash and construction debris from insulation surface prior to application of roofing membrane.

B. Do not leave installed insulation exposed to weather. Cover and waterproof with completed roof system immediately after installation.

1. Temporarily seal exposed insulation edges at the end of each day.
2. Remove and replace installed insulation that has become wet or damaged with new insulation.

C. Protect installed insulation and roof cover from traffic by use of protective covering materials during and after installation

END OF SECTION 072216

**SECTION 072400 – EXTERIOR INSULATION AND FINISH SYSTEM (EIFS)**

**PART 1 GENERAL**

**1.01 SUMMARY**

- A. Provide EIFS with Drainage, with Air and Moisture Barrier for vertical above grade exterior wall substrate surfaces.
- B. RELATED SECTIONS:
  - 1. Section 061643: Sheathing
  - 2. Section 076200: Sheet Metal Flashing and Trim
  - 3. Section 079200: Joint Sealants
  - 4. Section 081113: Hollow Metal Doors and Frames
  - 5. Section 085200: Aluminum Windows

**1.02 SUBMITTALS**

- A. Manufacturer's specifications, details, installation instructions and product data.
- B. Manufacturer's code compliance report.
- C. Manufacturer's standard warranty.
- D. Applicator's certificate of instruction.
- E. Samples for approval as directed by architect or owner.
- F. EPS board manufacturer's certificate of compliance with ASTM E 2430
- G. Sealant manufacturer's certificate of compliance with ASTM C 1382.
- H. Prepare and submit project-specific details (when required by contract documents).

**1.03 REFERENCES**

- A. ASTM Standards:
  - 1. B 117 Test Method for Salt Spray (Fog) Testing
  - 2. C 578 Specification for Preformed, Cellular Polystyrene Thermal Insulation
  - 3. C 1177 Specification for Glass Mat Gypsum for Use as Sheathing
  - 4. C 1382 Test Method for Determining Tensile Adhesion Properties of Sealants When Used in Exterior Insulation and Finish Systems (EIFS) Joints
  - 5. D 522 Test Methods for Mandrel Bend Test of Attached Organic Coatings
  - 6. D 882 Standard Test Methods for Tensile Properties of Thin Plastic Sheeting
  - 7. D 968 Test Method for Abrasion Resistance of Organic Coatings by Falling Abrasive



8. D 1784 Specification for Rigid Poly (Vinyl Chloride) (PVC) and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
  9. D 2247 Practice for Testing Water Resistance of Coatings in 100% Relative Humidity
  10. D 3273 Test for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber
  11. E 84 Test Method for Surface Burning Characteristics of Building Materials
  12. E 96 Test Methods for Water Vapor Transmission of Materials
  13. E 119 Method for Fire Tests of Building Construction and Materials
  14. E 283 Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors under Specified Pressure Differences Across the Specimen
  15. E 330 Test Method for Structural Performance of Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference
  16. E 331 Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference
  17. E 1233 Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls and Doors by Cyclic Static Air Pressure Difference
  18. E 2098 Test Method for Determining Tensile Breaking Strength of Glass Fiber Reinforcing Mesh for Use in Class PB Exterior Insulation and Finish System after Exposure to a Sodium Hydroxide Solution
  19. E 2134 Test Method for Evaluating the Tensile-Adhesion Performance of an Exterior Insulation and Finish System (EIFS)
  20. E 2273 Test Method for Determining the Drainage Efficiency of Exterior Insulation and Finish System (EIFS) Clad Wall Assemblies
  21. E 2430 Specification for Expanded Polystyrene (EPS) Thermal Insulation Boards for use in Exterior Insulation and Finish Systems (EIFS)
  22. E 2485 Standard Test Method for Freeze/Thaw Resistance of Exterior Insulation and Finish Systems (EIFS) and Water Resistive Barrier Coatings
  23. E 2486 Standard Test Method for Impact Resistance of Class PB and PI Exterior Insulation and Finish Systems (EIFS)
  24. E 2570 Test Method for Water-Resistive (WRB) Coatings used Under Exterior Insulation and Finish Systems (EIFS) or EIFS with Drainage
  25. G 153 Recommended Practice for Operating Light-and Water-Exposure Apparatus (Carbon-Arc Type) for Exposure of Nonmetallic Materials
  26. G 154 Recommended Practice for Operating Light-and Water-Exposure Apparatus (Fluorescent UV-Condensation Type) for Exposure of Nonmetallic Materials
- B. Building Code Standards
1. AC235 Acceptance Criteria for EIFS Clad Drainage Wall Assemblies (April, 2008)
- C. National Fire Protection Association (NFPA) Standards
1. NFPA 268, "Standard Test Method for Determining Ignitability of Exterior Wall Assemblies Using a Radiant Heat Energy Source"
  2. NFPA 285, "Standard Method of Test for the Evaluation of Flammability Characteristics of Exterior Non-Load-Bearing Wall Assemblies containing Combustible Components Using the Intermediate-Scale, Multistory Test Apparatus"
- D. Other Referenced Documents

1. American Association of Textile Chemists and Colorists AATCC-127 Water Resistance: Hydrostatic Pressure Test
2. GA-600 Fire Resistance Design Manual
3. APA Engineered Wood Association E 30, Engineered Wood Construction Guide
4. ICC-ES ESR-1748, Evaluation Report for StoTherm NExT EIFS.
5. ICC-ES ESR-1233, Evaluation Report for StoGuard

#### 1.04 DESIGN REQUIREMENTS

##### A. Wind Load

1. Design for maximum allowable system deflection, normal to the plane of the wall, of L/240.
2. Design for wind load in conformance with code requirements.

##### B. Moisture Control

1. Prevent the accumulation of water behind the EIF system, either by condensation or leakage through the wall construction, in the design and detailing of the wall assembly.
  - a. Provide flashing to direct water to the exterior where it is likely to penetrate components in the wall assembly, including, above window and door heads, beneath window and door sills, at roof/wall intersections, decks, abutments of lower walls with higher walls, above projecting features, and at the base of the wall.
  - b. Air Leakage Prevention-- provide continuity of air barrier system at foundation, roof, windows, doors and other penetrations through the system with connecting and compatible air barrier components to minimize condensation and leakage caused by air movement.
  - c. Vapor Diffusion and Condensation-- eliminate the potential for accumulation of moisture in the wall assembly as a result of water vapor diffusion and condensation.

##### C. Impact Resistance

1. Provide ultra-high impact resistance to a minimum height of 6'-0" (1.8 m) above finished grade at all areas accessible to pedestrian traffic and other areas exposed to abnormal stress or impact. Areas with impact resistance other than "standard" are indicated on contract drawings.

##### D. Color Selection:

1. Select finish coat with a light reflectance value of 20 or greater. (The use of dark colors is not recommended with EIF Systems that incorporate expanded polystyrene [EPS]. EPS has a service temperature limitation of approximately 160° F [71°C]).

##### E. Joints

1. Design minimum 3/4 inch (19 mm) wide expansion joints in the EIFS where they exist in the substrate or supporting construction, where the EIFS adjoins dissimilar

construction or materials, at changes in building height, and at floor lines in multi-level wood frame construction.

2. Design minimum 1/2 inch (13 mm) wide perimeter sealant joints at all penetrations through the EIFS (windows, doors, etc.).
3. Specify compatible backer rod and sealant that has been evaluated in accordance with ASTM C 1382, "Test Method for Determining Tensile Adhesion Properties of Sealants When Used in Exterior Insulation and Finish System (EIFS) Joints," and that meets minimum 50% elongation after conditioning.
4. Design joints so that Air Barrier continuity is maintained across the joint and drain joints to the exterior.

#### F. Grade Condition

1. Do not specify EIFS below grade (unless designed for use below grade and permitted by code) or for use on surfaces subject to continuous or intermittent water immersion or hydrostatic pressure. Provide minimum 6 inch (152 mm) clearance above finished grade as required by code.

#### G. Trim, Projecting Architectural Features and Reveals

1. All trim and projecting architectural features must have a minimum 1:2 [27°] slope along their top surface. All horizontal reveals must have a minimum 1:2 [27°] slope along their bottom surface. Increase slope for northern climates to prevent accumulation of ice/snow and water on surface. Where trim/feature or bottom surface of reveal projects more than 2 inches (51 mm) from the face of the EIFS wall plane, protect the top surface with waterproof base coat. Periodic inspections and increased maintenance may be required to maintain surface integrity of EIFS on weather exposed sloped surfaces. Limit projecting features to easily accessible areas and limit total area to facilitate maintenance and minimize maintenance. Refer to Sto details 1.04a and 1.04b.
2. Do not use EIFS on weather exposed projecting ledges, sills, or other projecting features unless supported by framing or other structural support and protected with metal coping or flashing. Refer to Sto detail 10.61.

#### H. Insulation Thickness

1. Minimum EPS insulation thickness is 1 inch (25 mm).
2. Maximum EPS insulation thickness is 12 inches (305 mm) when installed in accordance with ESR-1748 (including architectural features).

#### I. Fire Protection

1. Do not use foam plastic in excess of 12 inches (305 mm) thick on noncombustible type construction unless approved by the code official.
2. Where a fire-resistance rating is required by code use EIFS over rated assembly (EIFS is considered to not add or detract from the fire-resistance of the rated assembly).
3. Refer to manufacturer's applicable code compliance report for other limitations that may apply.

## 1.05 PERFORMANCE REQUIREMENTS

Table 1—Air/Moisture Barrier Performance

TEST	METHOD	CRITERIA	RESULT
1. Water Penetration Resistance	AATCC 127 (Water Column)	Resist 21.6 in (55 cm) water for 5 hours before and after aging	Pass
2. Water Penetration Resistance after Cyclic Wind Loading	ASTM E 1233 / ASTM E 331	No water at exterior plane of sheathing after 10 cycles @ 80% design load and 75 minutes water spray at 6.24 psf (299 Pa) differential	No water penetration on Plywood, OSB, and Glass Mat Faced Gypsum sheathings
3. Water Resistance Testing	ASTM D 2247	Absence of deleterious effects after 14 day exposure	No deleterious effects
4. Water Vapor Transmission	ASTM E 96 Method B (Water Method)	Measure	Sto Gold Fill®*: 17.3 perms [994 ng/(Pa·s·m <sup>2</sup> )]
5. Air Leakage	ASTM E 283	<0.06 cfm/ft <sup>2</sup> (0.00030m <sup>3</sup> /s•m <sup>2</sup> )	<0.0044 cfm/ft <sup>2</sup> (0.000022 m <sup>3</sup> /s•m <sup>2</sup> )
6. Structural Integrity	ASTM E 330	2-inches (51 mm) H <sub>2</sub> O pressure (positive & negative) for 1 hour.	Pass
7. Dry Tensile Strength	ASTM D 882	20 lbs/in (3503 N/m), minimum before and after aging	Sto Gold Fill:* 159 lbs/in (27845 N/m) before aging 213 lbs/in (37302 N/m) after aging
8. Pliability	ASTM D 522	No Cracking or Delamination using 1/8" (3 mm) mandrel at 14°F (-10°C) before and after aging	Pass
9. Surface Burning	ASTM E 84	Flame Spread 0 – 25 for NFPA Class A, UBC Class I	Flame Spread: 5 Smoke Density: 10
10. Tensile Adhesion	ASTM C 297	>15 psi (103 kPa)	>30 psi (207 kPa) to Plywood, OSB, Glass Mat Faced Gypsum sheathings

\* Note: Sto Gold Fill testing with Sto Detail Mesh reinforcement

Table 2—EIFS Weather Resistance and Durability Performance

TEST	METHOD	CRITERIA	RESULTS
1. Accelerated Weathering	ASTM G 153 (Formerly ASTM G 23)	No deleterious effects* at 2000 hours when viewed under 5x magnification	Pass @ 2000
2. Accelerated Weathering	ASTM G 154 (Formerly ASTM G 53)	No deleterious effects* at 2000 hours when viewed under 5x magnification	Pass @ 4000 hours

BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

3. Freeze/Thaw Resistance	ASTM E 2485	No deleterious effects* at 10 cycles when viewed under 5x magnification	Pass @ 90 cycles
4. Water Penetration	ASTM E 331 (modified per ICC-ES AC 235)	No water penetration beyond the plane of the base coat/EPS board interface after 15 minutes at 6.24 psf (299 Pa) or 20% of design wind pressure, whichever is greater	Pass at 12.0 psf (575 Pa) after 30 minutes
5. Drainage Efficiency	ASTM E 2273	90% minimum	> 99%
6. Tensile Adhesion	ASTM E 2134	Minimum 15 psi (103kPa) tensile strength	Pass
7. Water Resistance	ASTM D 2247	No deleterious effects* at 14 day exposure	Pass @ 28 days
8. Salt Spray	ASTM B 117	No deleterious effects* at 300 hours	Pass @ 500 hrs
9. Abrasion Resistance	ASTM D 968	No cracking or loss of film integrity at 528 quarts (500 L) of sand	Pass @ 1057 quarts (1000 L)*
10. Mildew Resistance	ASTM D 3273	No growth supported during 28 day exposure period	Pass @ 42 days
11. Impact Resistance	ASTM E 2486	Level 1: 25-49 in-lbs (2.83-5.54J)  Level 2: 50-89 in-lbs (5.65-10.1J)  Level 3: 90-150 in-lbs (10.2-17J)  Level 4: >150 in-lbs (>17J)	Pass with one layer Sto Mesh  Pass with two layers Sto Mesh  Pass with one layer Sto Intermediate Mesh  Pass with one layer Sto Armor Mat and one layer Sto Mesh

\*No deleterious effects: no cracking, checking, crazing, erosion, rusting, blistering, peeling or delamination

Table 3—EIFS and Air/Moisture Barrier Fire Performance

TEST	METHOD	CRITERIA	RESULT
1. Fire Endurance	ASTM E 119	Maintain fire resistance of existing rated assembly	Pass*

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2. Intermediate Scale Multi-Story Fire Test	NFPA 285 (UBC Standard 26-9)	1. Resistance to vertical spread of flame within the core of the panel from one story to the next 2. Resistance to flame propagation over the exterior surface 3. Resistance to vertical spread of flame over the interior surface from one story to the next 4. Resistance to significant lateral spread of flame from the compartment of fire origin to adjacent spaces	Pass with 12 inches of EPS insulation *
3. Radiant Heat Ignition	NFPA 268	No ignition @ 20 minutes	Pass with 12 inches of EPS insulation
4. Surface Burning (individual components)	ASTM E 84	Individual components shall each have a flame spread of 25 or less, and smoke developed of 450 or less	Flame: 0 Smoke Developed: 5

Note: \* indicates results based on extrapolation of data from series testing. ASTM E119 testing performed on assembly with 4 inch (305 mm) thick EPS.

Table 4—EIFS Component Performance

TEST	METHOD	CRITERIA	RESULT
1. Alkali Resistance of Reinforcing Mesh	ASTM E 2098	Greater than 120 pli (21 dN/cm) retained tensile strength	Pass
2. Requirements for Rigid PVC Accessories	ASTM D 1784	Meets cell classification 13244C	Pass

1.06 QUALITY ASSURANCE

A. Manufacturer requirements

1. Member in good standing of the EIFS Industry Members Association (EIMA).
2. System manufacturer for a minimum of twenty-five (25) years.
3. Manufacturing facilities ISO 9001:2000 Certified Quality System.
4. Manufacturer's wall assembly listed in Gypsum Association Fire Resistance Design Manual.

B. Contractor requirements

1. Engaged in application of EIFS for a minimum of three (3) years.
2. Knowledgeable in the proper use and handling of Sto materials, possessing certificate of completion for Sto on-line applicator test.

3. Employ skilled mechanics who are experienced and knowledgeable in EIFS application, and familiar with the requirements of the specified work.
4. Successful completion of minimum of three (3) projects of similar size and complexity to the specified project.
5. Provide the proper equipment, manpower and supervision on the job site to install the system in compliance with Sto's published specifications and details and the project plans and specifications.

C. Insulation board manufacturer requirements

1. Recognized by Sto as capable of producing insulation board to meet system requirements, and hold a valid licensing agreement with Sto.
2. Listed by an approved agency.
3. Label insulation board with information required by Sto, the approved listing agency and the applicable building code.

D. Mock-up Testing

1. Construct full-scale mock-up of typical EIFS wall assembly with specified tools and materials and test air and water infiltration and structural performance in accordance with ASTM E 283, E 331 and E 330, respectively, through independent laboratory. Mock-up shall comply with requirements of project specifications. Where mock-up is tested at job site maintain approved mock-up at site as reference standard. If tested off-site accurately record construction detailing and sequencing of approved mock-up for replication during construction.

E. Inspections

1. Provide independent third party inspection where required by code or contract documents.
2. Conduct inspections in accordance with code requirements and contract documents.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Deliver all materials in their original sealed containers bearing manufacturer's name and identification of product.
- B. Protect coatings (pail products) from freezing and temperatures in excess of 90°F (32° C). Store away from direct sunlight.
- C. Protect Portland cement based materials (bag products) from moisture and humidity. Store under cover off the ground in a dry location.

1.08 PROJECT/SITE CONDITIONS

*(Weather conditions affect application and drying time. Hot or dry conditions limit working time and accelerate drying and may require adjustments in the scheduling of work to achieve desired results; cool or damp conditions extend working time and retard drying and may require added measures of protection against wind, dust, dirt, rain and freezing)*

- A. Maintain ambient and surface temperatures above 40°F (4°C) during application and drying period, minimum 24 hours after application of Air/Moisture barrier and EIFS.

- B. Provide supplementary heat for installation in temperatures less than 40°F (4°C).
- C. Provide protection of surrounding areas and adjacent surfaces from application of materials.

#### 1.09 COORDINATION/SCHEDULING

*(The work in this section requires close coordination with related sections and trades. Sequence work to provide protection of construction materials from weather deterioration)*

- A. Provide site grading such that EIFS terminates above finished grade a minimum of 6 inches (150 mm) or as required by code.
- B. Coordinate installation of foundation waterproofing, roofing membrane, windows, doors and other wall penetrations to provide a continuous air and moisture barrier.
- C. Provide protection of rough openings before installing windows, doors, and other penetrations through the wall.
- D. Coordinate installation of windows and doors so air barrier components are connected to them to provide a continuous air barrier.
- E. Install window and door head flashing immediately after windows and doors are installed.
- F. Install diverter flashings wherever water can enter the wall assembly to direct water to the exterior.
- G. Install copings and sealant immediately after installation of the EIF system and when EIFS coatings are dry.
- H. Attach penetrations through EIFS to structural support and provide water tight seal at penetrations.

#### 1.10 WARRANTY

- A. Provide manufacturer's standard warranty.

### PART 2 PRODUCTS

#### 2.01 MANUFACTURERS

- A. Provide Air/Moisture Barrier, EIF System and accessories from single source manufacturer or approved supplier. This specification based on StoTherm Classic NExT system by Sto Corp.
- B. The following are acceptable manufacturers:



1. Sto Corp.: Air/Moisture Barrier, EIF System with Drainage; StoTherm Classic NExT.
2. Dryvit Systems, Inc.: Outsulation Plus MD System with drainage.
3. Parex USA, Inc.: El Rey Stucco Insul-Flex VR Drainage.
4. Plastic Components, Inc.--Accessories

## 2.02 AIR/MOISTURE BARRIER

### A. StoGuard™

1. Joint Compound: Sto Gold Fill—ready mixed flexible joint compound for rough opening protection and joint treatment of wall sheathing (not required for concrete/masonry surfaces).
2. Waterproof Coating: Sto Gold Coat®—ready mixed waterproof coating for wall substrates and sheathings.

*(Note: StoGuard may be placed on pressure treated or fire retardant treated wood. The pressure treated or fire retardant treated wood shall be clean and dry.)*

## 2.03 ADHESIVE

### A. Cementitious Adhesives

1. Sto BTS® Plus—one-component, polymer-modified, cement based high build adhesive (for use over exterior glass mat faced gypsum sheathing (compliant with ASTM C 1177), exterior cementitious sheathing, concrete, masonry or cement plaster surfaces. Also used over exterior or Exposure I OSB and plywood sheathing when protected with StoGuard).

## 2.04 INSULATION BOARD

- A. Nominal 1.0 lb/ft<sup>3</sup> (16 kg/m<sup>3</sup>) Expanded Polystyrene (EPS) insulation board in compliance with ASTM E 2430 and ASTM C 578 Type I requirements *(Note: minimum required thickness is 1 inch [25 mm] and maximum allowable thickness is 12 inches [305 mm] when installed in accordance with ICC-ES ESR 1748.)*

## 2.05 BASE COAT

### A. Cementitious Base Coats (see 2.03 for product descriptions)

1. Sto BTS Plus

### B. Non-cementitious Base Coat

1. Sto RFP—one component ready mixed non-cementitious, fiber reinforced acrylic base coat.

### C. Waterproof Base Coat

1. Sto Flexyl—two component fiber reinforced acrylic based waterproof base coat mixed with portland cement (*for use as a waterproof base coat for foundations, parapets, splash areas, trim and other projecting architectural features*).

## 2.06 REINFORCING MESHES

### A. Standard Mesh (*for use above 6'-0" above finished floor elevation*):

1. Sto Mesh--nominal 4.5 oz./yd<sup>2</sup> (153 g/m<sup>2</sup>), symmetrical, interlaced open-weave glass fiber fabric made with alkaline resistant coating for compatibility with Sto materials (*achieves Standard Impact Classification*).

**BID ALTERNATE for upper portion of building:** High Impact Mesh in lieu of Standard Mesh for use above 6'-0" above finished floor elevation; lower portion to remain as Ultra-High Impact Mesh.

### B. High Impact Mesh:

1. Sto Intermediate Mesh--nominal 11.2 oz./yd<sup>2</sup> (380 g/m<sup>2</sup>), high impact, interwoven, open weave glass fiber fabric with alkaline resistant coating for compatibility with Sto materials (*achieves High Impact Classification*).

### C. Ultra-High Impact Mesh (*required to a minimum height of 6'-0" above finished floor elevation at all areas*):

1. Sto Armor Mat--nominal 15 oz./yd<sup>2</sup> (509 g/m<sup>2</sup>), ultra-high impact, double strand, interwoven, open-weave glass fiber fabric with alkaline resistant coating for compatibility with Sto materials. *Achieves Ultra-High Impact Classification when applied beneath Sto Mesh*).

### D. Specialty Meshes:

1. Sto Detail Mesh--nominal 4.2 oz/yd<sup>2</sup> (143 g/m<sup>2</sup>), flexible, symmetrical, interlaced glass fiber fabric, with alkaline resistant coating for compatibility with Sto materials (*used for standard EIFS backwrapping, aesthetic detailing, and reinforcement of sheathing joints and protection of rough openings with air/ moisture barrier*).

## 2.07 PRIMER (select one)

- A. Sto Primer Sand—acrylic based tintable primer with sand for roller application.
- B. Sto Primer Smooth – acrylic based tintable primer for spray application.

*(Note: the primer is an optional component)*

## 2.08 FINISH COAT

### A. Primary Finish:

Upper portion of building, above height of 6'-0" above finish floor elevation: Sto "Limestone" finish texture. Stolit<sup>®</sup>—acrylic based textured wall coating with graded marble aggregate.

Finish color by Architect, from manufacturer's standard color range.

- B. Secondary Finish:  
Lower portion of building, to height of 6'-0" above finish floor elevation: Sto "Medium" finish texture. Stolit<sup>®</sup>—acrylic based textured wall coating with graded marble aggregate. Finish color by Architect, from manufacturer's standard color range.

2.09 JOB MIXED INGREDIENTS

- A. Water--Clean and potable.
- B. Portland cement--Type I, Type II, or Type I-II in conformance with ASTM C 150.

2.10 ACCESSORIES

- A. Starter Track— Rigid PVC (polyvinyl chloride) plastic track Part No. STDE as furnished by Plastic Components, Inc., 9051 NW 97th Terrace, Miami, Florida 33178 (800 327-7077) or equivalent.

2.11 MIXING

- A. Sto Gold Fill--mix with a clean, rust-free high speed mixer to a uniform consistency.
- B. Sto Gold Coat--mix with a clean, rust-free high speed mixer to a uniform consistency.
- C. Sto BTS Plus--mix ratio with water: 5-6.5 quarts (4.7-6.2 L) of water per 47 pound (21.3 kg) bag of Sto BTS Plus. Pour water into a clean mixing pail. Add Sto BTS Plus, mix to a uniform consistency and allow to set for approximately 5 minutes. Adjust mix if necessary with additional Sto BTS Plus or water and remix to a uniform trowel consistency. Avoid re-tempering. Keep mix ratio consistent. Do not exceed maximum water amount in mix ratio.
- D. Sto BTS Silo--mix by machine with StoSilo spray equipment at a water flow rate setting of 450-600 L/hr.
- E. Sto BTS Xtra- Mix ratio with water: 4.75-5 quarts (4.5-4.7L) of water per 38 pound (17.2kg) bag of Sto BTS Xtra. Pour water into a clean mixing pail, add Sto BTS Xtra, mix to a uniform consistency and allow to set for approximately 5 minutes. Adjust mix if necessary with additional Sto BTS Xtra or water and remix to a uniform trowel consistency. Avoid re-tempering. Keep mix ratio consistent. Do not exceed maximum water amount in mix ratio.
- F. Sto RFP--mix with a clean, rust-free high speed mixer to a uniform consistency.
- G. Sto Flexyl--mix ratio with portland cement: 1:1 ratio by weight. Pour Sto Flexyl into a clean mixing pail. Add portland cement, mix to a uniform consistency and allow to set for approximately five minutes. Adjust mix if necessary with additional Sto Flexyl and remix to a uniform trowel consistency. Avoid re-tempering. Keep mix ratio consistent.
- H. Sto primer--mix with a clean, rust-free high speed mixer to a uniform consistency.

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- I. Stolit--mix with a clean, rust-free high speed mixer to a uniform consistency. A small amount of water may be added to adjust workability. Limit addition of water to amount needed to achieve the finish texture
- J. Mix only as much material as can readily be used.
- K. Do not use anti-freeze compounds or other additives.

### PART 3 EXECUTION

#### 3.01 ACCEPTABLE INSTALLERS

- A. Prequalify under Quality Assurance requirements of this specification (section 1.06 B).

#### 3.02 EXAMINATION

- A. Inspect surfaces for:
  - 1. Contamination—algae, chalkiness, dirt, dust, efflorescence, form oil, fungus, grease, laitance, mildew or other foreign substances.
  - 2. Surface absorption and chalkiness.
  - 3. Cracks—measure crack width and record location of cracks.
  - 4. Damage and deterioration.
  - 5. Moisture content and moisture damage—use a moisture meter to determine if the surface is dry enough to receive the EIFS and record any areas of moisture damage.
  - 6. Compliance with specification tolerances—record areas that are out of tolerance (greater than ¼ inch in 8-0 feet [6mm in 2438 mm] deviation in plane).
- B. Inspect sheathing application for compliance with applicable requirement:
  - 1. Glass Mat Faced gypsum sheathing compliant with ASTM C 1177.
  - 2. Exterior Grade and Exposure I wood based sheathing—APA Engineered Wood Association E 30
  - 3. Cementitious sheathing--Consult manufacturer's published recommendations
- C. Report deviations from the requirements of project specifications or other conditions that might adversely affect the Air/Moisture Barrier and EIFS installation to the General Contractor. Do not start work until deviations are corrected.

#### 3.03 SURFACE PREPARATION

- A. Remove surface contaminants on concrete and concrete masonry surfaces.
- B. Apply conditioner by sprayer or roller to chalking or excessively absorptive surfaces.
- C. Replace weather-damaged sheathing and repair damaged or cracked surfaces.
- D. Level surfaces to comply with required tolerances.
- E. Repair cracks, spalls or damage in concrete or concrete masonry surfaces.

## 3.04 INSTALLATION

*(Note: the air/moisture barrier described below is one component in the air barrier system and the moisture protection for the structure. Installation of the air/moisture barrier must be integrated with flashing and other air and moisture barrier components to ensure that where water is likely to penetrate the wall assembly, it will be drained to the exterior at the source of the leak. Proper air barrier connections and integration of the moisture barrier with flashing through sequencing of work and coordination of trades is necessary for a complete air barrier system and complete moisture protection.)*

## A. Air/Moisture Barrier

For installation over exterior or Exposure I Plywood, and Glass Mat Faced Gypsum Sheathing in compliance with ASTM C 1177:

1. Protect rough openings, joints and parapets: apply Sto Gold Fill joint compound by trowel over rough openings, sheathing joints, inside and outside corners, and tops of parapets. Immediately embed reinforcing mesh in the wet joint compound and trowel smooth. Embed minimum 4 inch (101 mm) wide mesh at sheathing joints and minimum 9 inch (152 mm) wide mesh at rough openings, inside and outside corners and tops of parapets (refer to Sto detail 10.23a for detailed information on proper protection of rough openings and sequencing of work at rough openings).
2. Spot fasteners with Sto Gold Fill joint compound.
3. Apply waterproof coating by roller over sheathing surface, including the dry joint compound, to a uniform wet mil thickness of 10 mils in one coat. Use ½ inch (13 mm) nap roller for plywood and gypsum sheathing. Use ¾ inch (19 mm) nap roller for glass mat faced gypsum sheathing. Protect from weather until dry.
4. Coordinate installation of connecting air barrier components with other trades to provide a continuous air tight membrane.
5. Coordinate installation of flashing and other moisture protection components with other trades to achieve complete moisture protection such that water is directed to the exterior, not into the wall assembly, and drained to the exterior at sources of leaks (windows, doors and similar penetrations through the wall assembly).

For Installation over Exposure I OSB (Oriented Strand Board) sheathing:

1. Apply waterproof coating with a ¾ inch (19 mm) nap roller to sheathing surface to a uniform wet mil thickness of 10 mils. Protect from weather until dry. Then follow steps 1-5 above.

For Installation over Concrete or Concrete Masonry Unit (CMU) surfaces:

1. Repair cracks up to 1/8 inch (3 mm) wide with Sto Gold Fill. Rake the crack with a sharp tool to remove loose or friable material and blow clean with oil-free compressed air. Apply Sto Gold Fill by spray, trowel or putty knife over the crack and tool surface smooth. For cracks wider than 1/8 inch (3mm) up to ¼ inch (6mm) wide, use a paintable acrylic latex caulk to fill crack, tool flush, and allow to dry. *(Note: For moving cracks or cracks larger than ¼ inch (6mm), consult with a structural engineer for repair method).* Protect repair from weather until dry.
2. Liberally apply two coats of Sto Gold Coat to the surface with a ¾ inch nap roller or spray equipment to a minimum wet thickness of 10 mils each and up to a total maximum

of 30 mils depending on surface condition. Additional coats may be necessary to provide a void and pinhole free surface. Protect from weather until dry.

*Note: Sto Gold Coat functions as a waterproofing/air barrier on normal weight concrete/masonry unit wall construction with flush (struck flush with the surface of the CMU) or concave joints when a minimum of two liberal coats are applied. Additional coats may be necessary depending on the condition of the CMU wall surface, CMU porosity, joint profile, and other variables that may exist. For "rough" CMU wall surfaces, skim coat the entire surface with one of Sto's cementitious levelers (Sto Leveler, Sto BTS Plus, Sto BTS Silo, or Sto BTS Xtra) before application of Sto Gold Coat. A VOID AND PINHOLE FREE SURFACE must be achieved for Sto Gold Coat to properly function as a waterproofing/air barrier on CMU wall surfaces.*

3. Coordinate installation of connecting air barrier components with other trades to provide a continuous air tight membrane.
4. Coordinate installation of flashing and other moisture protection components with other trades to achieve complete moisture protection such that water is directed to the exterior, not into the wall assembly, and drained to the exterior at sources of leaks (windows, doors and similar penetrations through the wall assembly).

*(Note: windows and doors are typically installed immediately following installation of the air/moisture barrier and work should be sequenced accordingly. Consult with window manufacturer for installation requirements to maintain air barrier continuity and for head, jamb, sill flashing and perimeter sealant requirements).*

**B. Starter Track**

1. Strike a level line at the base of the wall to mark where the top of the starter track terminates.
2. Attach the starter track even with the line into the structure a maximum of 16 inches (406 mm) on center with the proper fastener: Type S-12 corrosion resistant screws for steel framing with minimum 3/8 inch (9 mm) penetration, and galvanized or zinc coated nails for wood framing with minimum 3/4 inch (19 mm) penetration. Attach between studs into blocking as needed to secure the track flat against the wall surface. For solid wood sheathing or concrete/masonry surfaces, attach directly at 12 inches (305 mm) on center maximum.
3. Butt sections of starter track together. Miter cut outside corners and abut. Snip front flange of one inside corner piece (to allow EPS Board to be seated inside of track) and abut.
4. Install Starter Track at other EIF System terminations as designated on detail drawings: above roof dormers or gable end walls, and beneath window sills with concealed flashing.

**C. Splice Strips for Starter Track and Flashing**

1. Starter Track, Window/Door Head Flashing and Side Wall Step Flashing: install 2 inch (51 mm) wide diagonal splice strips of detail mesh at ends of head flashings. Install minimum 4 inch (100 mm) wide splice strips of detail mesh between back flange of starter track, head flashings and roof/side wall step flashing. Center the mesh so it spans evenly between the back flange of the Starter Track or flashing and the sheathing. Embed the mesh in the wet joint compound and trowel smooth.
2. Apply waterproof coating over the splice strip when the joint compound is dry (refer to Sto Details 10.00 and 10.23b).

D. Backwrapping

1. Apply a strip of detail mesh to the dry air/moisture barrier at all system terminations (windows, doors, expansion joints, etc.) except where the Starter Track is installed. The mesh must be wide enough to adhere approximately 4 inches (100 mm) of mesh onto the wall, be able to wrap around the insulation board edge and cover a minimum of 2 ½ inches (64 mm) on the outside surface of the insulation board. Adhere mesh strips to the air/moisture barrier and allow them to dangle until the backwrap procedure is completed (paragraph I.1). Alternatively, pre-wrap terminating edges of insulation board.

E. Adhesive Application and Installation of Insulation Board (*for all adhesives except Sto BTS Silo*)

1. Rasp the interior lower face of insulation boards to provide a snug friction fit into the Starter Track. (*Note: rasping prevents an outward bow at the Starter Track*).
2. Apply adhesive to the back of the insulation board with the proper size stainless steel notched trowel. Apply uniform ribbons of adhesive parallel with the SHORT dimension of the board so that when boards are placed on the wall the ribbons will be VERTICAL. Apply adhesive uniformly so ribbons of adhesive do not converge.
3. Immediately place insulation boards in a running bond pattern on the wall with the long dimension horizontal. Start by inserting the lower edge of the boards inside the starter track at the base of the wall until they contact the bottom of the track. Apply firm pressure over the entire surface of the boards to ensure uniform contact of adhesive. Bridge sheathing joints by a minimum of 6 inches (152 mm). Interlock inside and outside corners.
4. Butt all board joints tightly together to eliminate any thermal breaks in the EIFS. Care must be taken to prevent any adhesive from getting between the joints of the boards.
5. Cut insulation board in an L-shaped pattern to fit around openings. Do not align board joints with corners of openings.
6. Remove individual boards periodically while the adhesive is still wet to check for satisfactory contact with the substrate and the back of the insulation board, and for spacing between ribbons of adhesive. An equal amount of adhesive must be on the substrate and the board when they are removed, as an indication of adequate adhesion. Do not use nails, screws, or any other type of non-thermal mechanical fastener.

G. Slivering and Rasping of Insulation Board Surface

*(Note: EPS insulation board exposed to sunlight will develop a powdery residue on the surface. This residue must be entirely removed by rasping the surface)*

1. After insulation boards are firmly adhered to the substrate, fill any open joints in the insulation board layer with slivers of insulation or spray foam. Use spray foam that is identified by the spray foam manufacturer as suitable for this use.
2. Rasp the insulation board surface to achieve a smooth, even surface and to remove any ultraviolet ray damage.

H. Trim, Reveals and Projecting Aesthetic Features

*(Note: Reveals/aesthetic grooves may be designed into the system to accommodate workability on multi-level buildings or lengthy wall sections)*

1. Attach features and trim where designated on drawings with adhesive to the insulation board or sheathing surface. Slope the top surface of all trim/features minimum 1:2 (27°) and the bottom of all horizontal reveals minimum 1:2 (27°).
2. Cut reveals/aesthetic grooves with a hot-knife, router or groove-tool in locations indicated on drawings.
3. Offset reveals/aesthetic grooves minimum 3 inches (75 mm) from insulation board joints.
4. Do not locate reveals/aesthetic grooves at high stress areas such as corners of windows, doors, etc.
5. A minimum  $\frac{3}{4}$  inch (19 mm) thickness of insulation board must remain at the bottom of the reveals/aesthetic grooves.

I. Completion of Backwrapping

1. Complete the backwrapping procedure by applying base coat to exposed edges of insulation board and approximately 4 inches (100 mm) onto the face of the insulation board. Pull mesh tight around the board and embed it in the base coat with a stainless steel trowel. Use a corner trowel for clean, straight lines. Smooth any wrinkles or gaps in the mesh.

J. Base Coat and Reinforcing Mesh Application

1. Apply minimum 9x12 inch (225x300 mm) diagonal strips of detail mesh at corners of windows, doors, and all penetrations through the system. Embed the strips in wet base coat and trowel from the center to the edges of the mesh to avoid wrinkles.
2. Apply detail mesh at trim, reveals and projecting architectural features. Embed the mesh in the wet base coat. Trowel from the base of reveals to the edges of the mesh.
3. Ultra-High impact mesh application (recommended to a minimum height of 6'-0" [1.8 m] above finished grade at all areas accessible to pedestrian traffic and other areas exposed to abnormal stress or impact, and where indicated on contract drawings): apply base coat over the insulation board with StoSilo spray equipment or a stainless steel trowel to a uniform thickness of approximately  $\frac{1}{8}$  inch (3 mm). Work horizontally or vertically in strips of 40 inches (1016 mm), and immediately embed the mesh into the wet base coat by troweling from the center to the edge of the mesh. Butt the mesh at seams. Allow the base coat to dry.
4. Standard mesh application: Apply base coat over the insulation board, including areas with Ultra-High impact mesh, with StoSilo spray equipment or a stainless steel trowel to a uniform thickness of approximately  $\frac{1}{8}$  inch (3 mm). Work horizontally or vertically in strips of 40 inches (1016mm), and immediately embed the mesh into the wet base coat by troweling from the center to the edge of the mesh. Overlap mesh not less than 2- $\frac{1}{2}$  inches (64 mm) at mesh seams and at overlaps of detail mesh. Feather seams and edges. Double wrap all inside and outside corners with minimum 2- $\frac{1}{2}$  inch (64 mm) overlap in each direction. Avoid wrinkles in the mesh. The mesh must be fully embedded so that no mesh color shows through the base coat when it is dry. Re-skim with additional base coat if mesh color is visible.
5. Sloped Surfaces: for trim, reveals, aesthetic bands, cornice profiles, sills or other architectural features that project beyond the vertical wall plane more than 2 inches (51 mm) apply waterproof base coat with a stainless steel trowel to the weather exposed sloped surface and minimum four inches (100 mm) above and below it.



Embed standard mesh or detail mesh in the waterproof base coat and overlap mesh seams a minimum of 2-½ inches (65 mm).

6. Allow base coat to thoroughly dry before applying primer or finish.

*Note: All trim and projecting architectural features must have a minimum 1:2 [27°] slope along their top surface. All horizontal reveals must have a minimum 1:2 [27°] slope along their bottom surface. Increase slope for northern climates to prevent accumulation of ice/snow and water on surface. Where trim/feature or bottom surface of reveal projects more than 2 inches (51 mm) from the face of the EIFS wall plane, protect the weather exposed sloped surface with waterproof base coat. Refer to Sto details 1.04a and 1.04b.*

*Do not use EIFS on weather exposed projecting ledges, sills, or other projecting features unless supported by framing or other structural support and protected with metal coping or flashing. Refer to Sto detail 10.61.*

K. Primer application

*(Note: the primer is an optional component)*

1. Apply primer evenly with brush, roller or proper spray equipment over the clean, dry base coat and allow to dry thoroughly before applying finish.

L. Finish Coat Application

1. Apply finish directly over the base coat or primed base coat when dry. Apply finish by spraying or troweling with a stainless steel trowel, depending on the finish specified. Follow these general rules for application of finish:
  - a. Avoid application in direct sunlight.
  - b. Apply finish in a continuous application, and work to an architectural break in the wall.
  - c. Weather conditions affect application and drying time. Hot or dry conditions limit working time and accelerate drying. Adjustments in the scheduling of work may be required to achieve desired results; cool or damp conditions extend working time and retard drying and may require added measures of protection against wind, dust, dirt, rain and freezing. Adjust work schedule and provide protection.
  - d. Do not install separate batches of finish side-by-side.
  - e. Do not apply finish into or over sealant joints. Apply finish to outside face of wall only.
  - f. Do not apply finish over irregular or unprepared surfaces, or surfaces not in compliance with the requirements of the project specifications.

3.05 PROTECTION

- A. Provide protection of installed materials from water infiltration into or behind them.
- B. Provide protection of installed materials from dust, dirt, precipitation, freezing and continuous high humidity until they are fully dry.

3.06 CLEANING, REPAIR AND MAINTENANCE

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- A. Clean and maintain the Exterior Insulation and Finish System (EIFS) for a fresh appearance and to prevent water entry into and behind the system. Repair cracks, impact damage, spalls or delamination promptly.
- B. Maintain adjacent components of construction such as sealants, windows, doors, and flashing, to prevent water entry into the wall assembly.
- C. Refer to Sto reStore Repair and Maintenance Guide ([reStore Program](#)) for detailed information on EIFS restoration - cleaning, repairs, recoating, resurfacing and refinishing, or re-cladding.

END OF SECTION 072400

**SECTION 072616 - UNDER-SLAB VAPOR RETARDERS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Surface preparation.
- B. Application of an underslab vapor retarder.

1.02 RELATED SECTIONS

- A. Section 033000 - Concrete.
- B. Section 071000 – Damp-proofing and Waterproofing.

1.03 REFERENCES

- A. ASTM D1709 - 09 Standard Test Methods for Impact Resistance of Plastic Film by the Free-Falling Dart Method.
- B. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.
- C. ASTM E154 - Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs.
- D. ASTM E1643 - Standard Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.
- E. ASTM E1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs.
- F. ASTM F1249-01 Standard Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor.

1.04 SUBMITTALS

- A. Comply with Section 01 33 00 - Submittal Procedures.
- B. Submit manufacturer's product data and application instructions.

1.05 QUALITY ASSURANCE

- A. Use an experienced installer and adequate number of skilled personnel who are

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thoroughly trained and experienced in the application of the vapor retarder.

- B. Obtain vapor retarder materials from a single manufacturer regularly engaged in manufacturing the product.
- C. Provide products which comply with all state and local regulations controlling use of volatile organic compounds (VOCs).

### 1.06 PRECONSTRUCTION MEETING

- A. Pre-Construction Meeting: Convene one week prior to installation of underslab vapor retarder. Attendees to be as follows: - Architect, Engineer, General Contractor, Vapor Retarder Installer, and Vapor Retarder Manufacturer to discuss the application in detail.

### 1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.
- B. Store materials in a clean, dry area in accordance with manufacturer's instructions.
- C. Protect materials during handling and application to prevent damage or contamination.
- D. Ensure membrane is stamped with manufacturer's name, product name, and membrane thickness at intervals of no more than 85" (220 cm).

### 1.08 ENVIRONMENTAL REQUIREMENTS

- A. Product not intended for uses subject to abuse or permanent exposure to the elements.
- B. Do not apply on frozen ground.

## PART 2 PRODUCTS

### 2.01 MANUFACTURER

- A. W. R. MEADOWS, INC., PO Box 338, Hampshire, Illinois 60140-0338. (800) 342-5976. (847) 683-4500. Fax (847) 683-4544. Web Site [www.wrmeadows.com](http://www.wrmeadows.com).

### 2.02 MATERIALS

- A. Plastic Vapor Retarder
  - 1. Performance-Based Specification: Vapor retarder membrane shall be manufactured from virgin polyolefin resins and shall meet or exceed all requirements of ASTM E1745, Class A.
    - a. Maximum Water Vapor Permeance (ASTM E154 Sections 7, 8, 11, 12, 13, by ASTM E96, Method B or ASTM F1249)
      - i. As received: 0.0183 perms.
      - ii. After Wetting and Drying: 0.0219 perms.
      - iii. Resistance to Plastic Flow and Temperature: 0.0197 perms.
      - iv. Effect Low Temperature and Flexibility: 0.0212 perms
      - v. Resistance to Deterioration from Organisms and Substances in

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- Contacting Soil: 0.0198 perms.
- b. Puncture Resistance (ASTM D1709): 4,394 grams.
- c. Tensile Strength ASTM E154, Section 9: 52 Lb. Force/Inch
- 2. Proprietary-Based Specification:
  - a. PERMINATOR 15 mil by W. R. MEADOWS.
  - b. Others as approved equal.

### 2.03 ACCESSORIES

- A. Seam Tape
  - 1. High Density Polyethylene Tape with pressure sensitive adhesive. Minimum width 4" (100 mm).
    - a. Perminator Tape by W.R. Meadows.
- B. Pipe Collars
  - 1. Construct pipe collars from vapor retarder material and pressure sensitive tape per manufacturer's instructions.

## PART 3 EXECUTION

### 3.01 SURFACE PREPARATION

- A. Prepare surfaces in accordance with manufacturer's instructions.
- B. Level, tamp, or roll earth or granular material beneath the slab base.

### 3.02 EXAMINATION

- A. Examine surfaces to receive membrane. Notify architect if surfaces are not acceptable. Do not begin surface preparation or application until unacceptable conditions have been corrected.

### 3.03 APPLICATION

- A. Install the vapor retarder membrane in accordance with manufacturer's instructions and ASTM E 1643-98.
- B. Unroll vapor retarder with the longest dimension parallel with the direction of the pour.
- C. Lap vapor retarder over footings and seal to foundation walls.
- D. Overlap joints 6" (152 mm) and seal with manufacturer's tape.
- E. Seal all penetrations (including pipes) with manufacturer's pipe boot.
- F. No penetration of the vapor retarder is allowed except for reinforcing steel and permanent utilities.
- G. Repair damaged areas by cutting patches of vapor barrier, overlapping damaged area 6" (152 mm) and taping all four sides with tape.

END OF SECTION 072616

**SECTION 074213 - METAL WALL PANELS**

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data, Shop Drawings, and color Samples.
- B. Steel sheet thickness specified is minimum thickness of base metal without metallic coatings.

PART 2 - PRODUCTS

2.1 METAL WALL PANELS

- A. Wall Panel Type: Concealed-fastener, lap-seam metal wall panels.
- B. Wall Panel Type: Factory-formed and -assembled.
- C. Metallic-Coated Steel Wall Panels: Fabricated from galvanized structural-steel sheet, ASTM A 653/A 653M, G90 (Z275), or aluminum-zinc alloy-coated structural-steel sheet, ASTM A 792/A 792M, Class AZ50 coating designation, Grade 40 (Class AZM150 coating designation, Grade 275).
  - 1. Nominal Metal Thickness: 0.022 inch (0.56 mm).
  - 2. Finish: Manufacturer's standard.
- D. Aluminum Wall Panels: Fabricated from aluminum sheet, ASTM B 209 (ASTM B 209M) for alclad Alloy 3003, 3004, or 3105.
  - 1. Metal Thickness: 0.032 inch (0.8 mm).
  - 2. Finish: Manufacturer's standard.
- E. Flush-Profile Metal Liner Panels: Solid panels formed with vertical panel edges and intermediate stiffening ribs symmetrically spaced between panel edges.
- F. Flashing and Trim: Formed from 0.025-inch (0.64-mm) nominal thickness, zinc-coated (galvanized) steel sheet or aluminum-zinc alloy-coated steel sheet. Provide flashing and trim as required to seal against weather and to provide finished appearance. Finish flashing and trim with same finish system as adjacent metal roof panels.
- G. Provide components required for a complete wall panel assembly including trim, copings, fasciae, mullions, sills, corner units, clips, seam covers, flashings, louvers, sealants, gaskets, fillers, closure strips, and similar items.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Anchor panels securely in place, with provisions for thermal and structural movement. Field cutting exterior panels by torch is not permitted. Install panels with concealed fasteners unless otherwise indicated. Where exposed, use fasteners finished to match wall panels.
  - 1. Steel Wall Panels: Use stainless-steel fasteners for surfaces exposed to the exterior and galvanized-steel fasteners for surfaces exposed to the interior.
  - 2. Aluminum Wall Panels: Use aluminum or stainless-steel fasteners for surfaces exposed to the exterior and aluminum or galvanized-steel fasteners for surfaces exposed to the interior.
- B. Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of wall panel assemblies. Provide types of gaskets, fillers, and sealants as indicated, or as recommended by panel manufacturer.
- C. Separate dissimilar metals and metal panels from contact with wood or cementitious materials, by painting each metal surface in area of contact with a bituminous coating or by other permanent separation.

END OF SECTION 074213

**SECTION 075303 – SINGLE PLY ROOFING: FULLY ADHERED TPO**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Install 1/4" per foot full tapered polyisocyanurate in manufacturer's approved insulation adhesive per I-120 wind uplift requirements.
- B. DensDeck Prime – 1/2 inch installed with manufacturer's approved adhesive per I-120 wind uplift requirements.
- C. Insulation – 1/2 inch per foot tapered insulation to be used for crickets.
- D. Membrane roofing and base flashings fully adhered to the 1/2 inch thick DensDeck Prime.
- E. Wind speed design 110 mph, 3 second gust.

1.2 RELATED SECTIONS

- A. Section 061053 - Rough Carpentry
- B. Section 076200 - Sheet Metal Flashing and Trim
- C. Section 079200 - Joint Sealants

1.3 REFERENCES

- A. ASTM C208 - Insulating Board
- B. ASTM 4637 - TPO Scrim Reinforced Fleeceback single ply membrane.
- C. NRCA (National Roofing Contractors Association) - Roofing and Waterproofing Manual.
- D. SPRI - Wind Design Guide for Fully Adhered Single Ply Roofing Systems.
- E. UL 790 - Fire Hazard Classifications.

1.4 SYSTEM DESCRIPTION

- A. TPO 60 mil Scrim Reinforced Fleeceback Membrane Conventional Roofing System:  
One ply membrane system with insulation, membrane finish, fully adhered with manufacturer's approved low rise adhesive.

1.5 SUBMITTALS FOR REVIEW

- A. Section 013000 - Submittals: Procedures for submittals.
- B. Product Data: Provide characteristics on membrane materials, flashing materials, and insulation. Provide manufacturer's recommended instructions for installation of materials.
- C. Manufacturer's certification that Contractor is an approved applicator to install the manufacturer's guaranteed roof system (labor and material).
- D. Shop Drawings: Indicate joint or termination detail conditions, conditions of interface with other materials, and tapered insulation cricket layout.
- E. Submit letter from membrane manufacturer that insulation to be supplied is an acceptable substrate for their guaranteed roof systems.
- F. Submit detail for proposed Night Seals.
- G. Samples: Not required.

1.6 SUBMITTALS FOR INFORMATION

- A. Section 013000 - Submittals: Procedures for submittals.



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- B. Manufacturer's Installation Instructions: Indicate special precautions required for heat welding the seams of the membrane.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

### 1.7 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacturing the products specified in this section with ten years' experience.
- B. Applicator: Company specializing in performing the work of this section with five years' experience and approved by system manufacturer.
- C. Perform Work in accordance with manufacturer's instructions.

### 1.8 REGULATORY REQUIREMENTS

- A. Conform to applicable code for roof assembly fire hazard requirements.
- B. UL 790: Class A Fire Hazard Classification.
- C. FM 6374: Roof Assembly Classification, of Class 1 Construction, wind uplift requirement: 110 mph, 3 second gust.

### 1.9 PRE-INSTALLATION MEETING

- A. Coordination and Meetings: Pre-installation meeting to take place one week before starting work of this section.

### 1.10 DELIVERY, STORAGE, AND PROTECTION

- A. Section 016000 - Material and Equipment: Transport, handle, store, and protect products.
- B. Store products in weather protected environment, clear of ground and moisture.
- C. The material stored on the roof surface shall be scattered over the roof deck to avoid damage to the structural roof system. Concentrated loads of high magnitude will not be permitted on the roof.
- D. The Contractor shall use extreme care in transporting materials across the existing roof surface. The Contractor may have to make repairs to damaged areas of the existing roof membrane, insulation and/or decking, where workmen have damaged the existing surface in transporting materials.
- E. The Contractor shall furnish all required storage enclosures and safeguards.

### 1.11 ENVIRONMENTAL REQUIREMENTS

- A. Section 016000 - Material and Equipment: Environmental conditions affecting products on site.
- B. Do not apply roofing membrane during inclement weather and follow manufacturer's written instruction on acceptable ambient temperature range suitable for installation of their product.
- C. Do not apply roofing membrane to damp or frozen deck surface.
- D. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed during same day.
- E. TPO membrane roofing, flashings, insulation, and adhesives shall not be applied when the surrounding air and surface temperature, relative humidity, or wind velocity is not within the range acceptable under the manufacturer's recommendations.
- F. Due to solvent flash off, condensation may form on freshly applied solvent based materials when ambient temperature is near the dew point. Due to possible surface curing, the application of solvent based material should be discontinued under these conditions. If condensation develops, discontinue the application of the solvent based materials and allow the surface to dry. When conditions allow for continuing the operation, apply a freshener coat of solvent based material to the previously coated materials.

G. Installation during Windy Conditions

1. Dynamic forces caused by winds of 20 mph or greater may disturb the installation of the TPO membrane during the adhesion of the membrane to the DensDeck Prime
  - A) Areas of greater impact during windy conditions are normally along the perimeter area of the building which is 0.4 times the building height or 0.1 times the lesser building dimension, whichever is smaller.

1.12 COORDINATION

- A. Coordinate the work with the installation of associated metal flashings, as the work of this section proceeds.

1.13 WARRANTY

- A. Section 017000 - Contract Closeout.
- B. At the owner's option, provide a 20-year labor and material warranty. Price for warranty is to be included in base bid but indicated separately on Bid Form.
- C. Correct defective Work within a two (2) year period after Substantial Completion for any work that fails to prevent penetration of water into the building or within a 2-year period under the manufacturer's 20-year warranty option. Provide warranty indicating such coverage.

PART 2 PRODUCTS

2.1 MANUFACTURERS - MEMBRANE MATERIAL

- A. TPO 60 mil scrim reinforced Fleeceback membrane.
- B. Section 01 60 00 - Materials and Equipment: As specified.

2.2 MEMBRANE AND ASSOCIATED MATERIALS

- A. Membrane: TPO 60 mil scrim reinforced Fleeceback single ply membrane.
- B. Accessories: Bonding adhesives, splice cements, lap caulk, primers, and water cut-off mastics are to be supplied by the membrane manufacturer and are to be compatible with materials to which they are to be applied.

2.3 INSULATION

- A. Full tapered 1/4" per foot tapered polyisocyanurate.
- B. Cover board insulation: 1/2 inch thick DensDeck Prime, shall be adhered to the polyisocyanurate insulation to meet I-20 wind uplift requirements. The DensDeck Prime shall be 1/2 inch thick by 4 ft X 4 ft.
- C. Adhered Insulation – for 1/2 inch thick DensDeck Prime. General approvals for the attachment of the insulation layer(s) using adhesives in adhered roofing system are restricted to non-steel deck projects.
  1. Adhesive shall be applied only to properly prepared and pre-approved substrates, free of any debris, dirt, grease, oil or moisture.
  2. The minimum product temperature at time of application shall be 70 degrees F.
  3. Adhesives are not recommended for applications when surface or ambient temperatures are below 40 degrees F. or above 110 degrees F.
  4. Insulation shall be fully bonded to the substrate with a maximum board size of 4 feet X 4 feet.
  5. Insulation shall be set into a continuous .5 inch bead of adhesive at a minimum rate of one linear foot of adhesive for every one square foot of insulation board per I-110

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wind uplift requirements. Install low rise adhesive at a rate of 4" on center, all layers of tapered insulation.

6. Place the boards onto the adhesive beads and walk on the boards, spreading the adhesive for maximum contact.

7. A second walking will be required after ten (10) minutes to ensure maximum contact and bond strength.

### 2.4 FLASHINGS

- A. Flexible Flashings: Same material as membrane; but unsupported FiberTite flashing material.
- B. Counter flashings: As specified in Section 076200.
- C. Sealants: As recommended by membrane manufacturer.
- D. Strip Reglet Devices: Galvanized steel; maximum possible lengths per location, with attachment flanges.
- E. Stack Boots: Flexible boot and collar with clamps for pipe stacks through membrane.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Verify that surfaces and site conditions are ready to receive work.
- B. Verify deck surfaces are dry and free of snow or ice. Confirm dry deck by moisture meter with 12 percent moisture maximum.
- C. Verify roof openings, curbs, pipes, sleeves, ducts, and vents through roof are solidly set.

### 3.2 INSULATION APPLICATION

- A. 1/4" per foot full tapered polyisocyanurate and 1/2" DensDeck Prime, set in manufacturer's approved insulation adhesive with 4" on-center .5 inch bead.
- B. Lay boards with edges in moderate contact without forcing. Cut insulation to fit neatly to perimeter blocking and around penetrations through roof.
- C. Apply no more insulation than can be covered with membrane in same day.

### 3.3 INSTALLATION OF TPO MEMBRANE

- A. TPO Scrim Reinforced Fleeceback 60 mil Roofing System
  - 1. TPO scrim reinforced Fleeceback 60 mil membrane
    - a. Position the TPO Membrane and fold the sheet to allow a workable exposure to the underside of the sheet.
    - b. Apply a 4" on center bead of low rise adhesive to the Dens-Deck Substrate.
    - c. Apply low rise adhesive 4" on center throughout the entire field of the roof.

### 3.4 TPO SCRIM REINFORCED FLEECEBACK 60 MIL MEMBRANE

- A. Apply flexible flashings or field fabricated flashings to seal membrane to vertical elements.
- B. Fully adhere membrane to penetration and use continuous pieces where feasible and practical.
- C. Overlap splices a minimum of 3 inches and extend flashing a minimum of 4 inches onto new roof surface. Heat weld all seams.
- D. Coordinate installation of through-wall scuppers and related flashings.
- E. Where sheet metal flashings are detailed, secure field membrane to wood nailers, set sheet metal flashing in a full bed of water cut-off mastic and nail in place. Strip in sheet metal flashing with membrane to be fully adhered using appropriate adhesives and cements. Provide sealant at base of sheet metal jack and around edge of membrane

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flashing seam to field membrane. Flashings are to be totally bonded and free of fishmouths or wrinkles (refer to diagram section).

### 3.5 NIGHT SEALS

- A. Temporary night seals are to be constructed at the end of each working day to protect the insulation, roofing and building components from damage due to wind and moisture.
- B. Temporary night seals are to be as detailed by the Contractor and approved by the manufacturer and Owner/Owner's representative.

### 3.6 FIELD QUALITY CONTROL

- A. Division 01- Quality Assurance: Field inspection and testing.
- B. Correct identified defects or irregularities.

### 3.7 MECHANICAL (if existing)

- A. Mechanical and HVAC equipment shall remain operational at all times unless shutdown is required, and then coordinated in advance with Owner/Owner's representative.
- B. When required, the contractor shall carefully disconnect, remove, re-install and re-connect exhaust units, vents and HVAC equipment, as necessary, for completion of the roof work. The roofing contractor shall note that all the mechanical equipment is in working order prior to disconnecting any units and will caution his workmen not to damage any of the existing equipment and service lines.
- C. Roofing work around HVAC equipment must proceed with extreme care to prevent damage to gas/refrigerant lines, electrical lines and condensate drain lines. Damage to the service lines or drain lines will be the sole responsibility of the roofing contractor and all repairs will be accomplished by appropriately trained personnel (plumbers, electricians, HVAC mechanics) at the roofing contractor's expense. Repairs will include system purging, system charging and system start up if required. All mechanical equipment shall be demonstrated to be in proper working order upon completion of the project.

### 3.8 ELECTRICAL

- A. All damage to electrical components shall be replaced by a licensed electrician at the roofing contractor's expense.
- B. All associated electrical work shall be performed by a licensed electrician and is the responsibility of the contractor.

### 3.9 CLEANING

- A. Section 017000 - Contract Closeout: Cleaning installed work.
- B. In areas where finished surfaces are soiled by Work of this section, consult manufacturer of surfaces for cleaning advice and conform to their instructions.
- C. Repair or replace defaced or disfigured finishes caused by Work of this section.

### 3.10 PROTECTION OF FINISHED WORK

- A. Section 017000 - Contract Closeout: Protecting installed work.
- B. Protect building surfaces against damage from roofing work.
- C. Where traffic must continue over finished roof membrane, protect surfaces.

END OF SECTION 075303

**SECTION 076200 - SHEET METAL FLASHING AND TRIM**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Counter-flashings at roof curb mounted equipment.
- B. Rain collars and caps.
- C. Penetration flashings.

1.2 RELATED SECTIONS

- A. Section 075303 - Single Ply Roofing.
- B. Section 079200 - Joint Sealers.

1.3 REFERENCES

- A. ASTM A525 - Steel Sheet, Zinc Coated, (Galvanized) by the Hot-Dip Process.
- B. ASTM B32 - Solder Metal.
- C. Water Cut-off Mastic - provided by membrane roofing manufacturer. (Section 07 53 03)
- D. FS O-F-506 - Flux, Soldering, Paste and Liquid.
- E. NRCA (National Roofing Contractors Association) - Roofing Manual.
- F. SMACNA - Architectural Sheet Metal Manual.

1.4 QUALITY ASSURANCE

- A. Perform work in accordance with SMACNA and NRCA standard details and requirements.
- B. Maintain one copy of the specifications and approved shop drawings on site.

1.5 QUALIFICATIONS

- A. Fabricator and Installer: Company specializing in sheet metal flashing work with 5 years documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Section 01 60 00.
- B. Stack preformed material to prevent twisting, bending, or abrasion, and to provide ventilation. Slope metal sheets to ensure drainage. Secure to prevent damage to metal and to roof during inclement weather.
- C. Prevent contact with materials which may cause discoloration or staining.

1.7 COORDINATION

- A. Coordinate work under provisions of Section 01 30 39.
- B. Coordinate with the work of Section 07 53 03 for installation of the new roof system and maintaining it weathertight on a daily basis.

PART 2 PRODUCTS

2.1 SHEET MATERIALS

- A. Galvanized Steel: ASTM A446, Grade A, G90 zinc coating; 24 gage core steel. To be used for roof top unit curb flashings, counter-flashings and pipe flashings.
- B. Pre-finished Galvanized Steel Sheet: ASTM A361/361M, ASTM A446/A446M, Grade A, G90 zinc coating, 24 gage steel, shop pre-coated with modified silicone or PUDF

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polyvinylidene fluoride coating. Color to be chosen by owner. To be used for the perimeter wall cap flashings.

### 2.2 ACCESSORIES

- A. Fasteners: Galvanized steel with soft neoprene washers.
- B. Primer: Zinc chromate type.
- C. Protective Backing Paint: Bituminous or approved equal.
- D. Sealant: Polyurethane type, specified in Section 07900.
- E. Plastic Cement: ASTM D4586, Type I.
- F. Solder: ASTM B32; 50/50 type.
- G. Flux: FS O-F-506.

### 2.3 FABRICATION

- A. Fabricate counter-flashings to allow toe to extend 3 inches over roofing base flashing.
- B. Counter-flashing shall be formed in not more than 10-foot lengths. Lap ends 3 inches and caulk all loose lock joints. Cut and miter all inside and outside corner joints.
- C. All sheet metal penetration flashings (i.e., roof jacks, pitch pans, etc.) and through wall scuppers to have all seams soldered weathertight.

### 2.4 FINISH

- A. Back paint concealed metal surfaces with protective backing paint to a minimum dry film thickness of 15 mil.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Verify roof openings, curbs, pipes, sleeves, ducts, or vents through roof are solidly set, reglets are in place, and nailing strips located.
- B. Verify roofing termination and base flashings are in place, sealed, and secure.
- C. Verify sheet membrane waterproofing has been installed at top of perimeter parapet wall prior to installation of sheet metal cap flashing.

### 3.2 INSTALLATION

- A. Conform to drawing details included in the specification manual and to conform to SMACNA and NRCA details.
- B. Secure flashings in place using concealed fasteners. [Use exposed fasteners only where permitted.]
- C. Apply a TPO recommended sealant compound between metal flashings and membrane flashings and between lap joints in perimeter edge flashings.
- D. Fit flashings tight in place. Make corners square, surfaces true and straight in planes, and lines accurate to profiles.
- E. Seal metal joints watertight.
- F. Finish all sheet metal weather tight.
- G. Where lap seams do not have a joint cover, lap according to pitch but in no case less than 3 inches.
- H. Make all lap seams in the direction of water flow.
- I. Provide suitable watertight expansion joint as required for proper installation.
- J. Caulking of sheet metal where required shall be neatly and thoroughly performed for a watertight seal.
- K. For all sheet metal penetration flashings (roof jacks, pitch pans, etc.) provide rain collars/hoods installed over top of these flashings.

3.3 FASTENING

- A. Secure metal as per detailed drawings.
- B. For fastening into concrete, use masonry/concrete anchors with neoprene washers with steel backing. Use all metal anchors only, no plastic anchors allowed.
- C. For exposed fastening into wood, use screws with neoprene washers.
- D. All fasteners to be corrosion resistant coated.

3.4 SOLDERING

- A. Thoroughly clean and tin all joint materials prior to soldering.
- B. Use heavy soldering copper of a blunt design, properly tinned for use.
- C. Perform all soldering slowly with well-heated soldering copper in order to heat seams thoroughly and to completely fill them in.
- D. Make all exposed soldering of finished surfaces neat, full-flowing, and smooth.
- E. After soldering, thoroughly wash and flux with a soda solution.

3.5 FIELD QUALITY CONTROL

- A. Field inspection will be performed under provisions of Section 01 40 00.
- B. Inspection will involve surveillance of work during installation to ascertain compliance with specified requirements.
- C. All roof surfaces to be adequately protected to prevent damage. Keep all scrap metal off roof surface at all times. If damage to roof does occur; visibly mark area and report immediately to roof contractor and/or Owner/Owner's representative.

END OF SECTION 076200

**SECTION 077100 - MANUFACTURED ROOF SPECIALTIES**

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data, Shop Drawings, and color Samples.
- B. Provide products that comply with applicable requirements in SMACNA's "Architectural Sheet Metal Manual," unless otherwise indicated.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), 6063-T5 alloy and temper, or as recommended by manufacturer for use intended and as required for proper application of finish indicated.
- B. Aluminum Sheet: ASTM B 209 (ASTM B 209M), 3003-H14 alloy and temper, or as recommended by manufacturer for use intended and as required for proper application of finish indicated, with a minimum thickness of 0.050 inch (1.2 mm).
- C. Aluminum Finish: High-performance coating, AAC12C42R1X, composed of inhibitive primer and color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight, with a total minimum dry film thickness of 0.9 mil (0.023 mm); complying with AAMA 2604.
- D. Coil-Coated Galvanized Steel Sheet: Galvanized steel sheet, ASTM A 653/A 653M, G90 (Z275), 0.028 inch (0.7 mm) thick; prepainted with 2-coat fluoropolymer according to ASTM A 755 (ASTM A 755M), composed of inhibitive primer and color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight, with a total minimum dry film thickness of 0.9 mil (0.023 mm).
- E. Copper Sheet: ASTM B 370; Temper H00, cold rolled, unless Temper 060 is required for forming; at least 16 oz./sq. ft. (0.55 mm thick), unless otherwise indicated.
- F. Stainless-Steel Sheet: ASTM A 666, Type 304, soft annealed, with No. 2D finish, unless harder temper is required for forming or performance; at least 0.0187 inch (0.5 mm) thick, unless otherwise indicated.

2.2 ROOF SPECIALTIES

- A. Coil-Coated Galvanized Steel Fasciae with finish to match color by architect:
- B. 24 ga. Coil-Coated Galvanized Steel Scuppers, Gutters, Headers and Downspouts with finish to match color by architect:



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## PART 3 - EXECUTION

### 3.1 FABRICATION

A. Form sections square, true, and accurate in size. Form gutter in maximum possible lengths and free from distortion or defects detrimental to appearance or performance. Allow for expansion at corners and joints.

B. Field measure conditions prior to fabricating work.

### 3.2 INSTALLATION

- A. Coordinate with installation of roof decks and other substrates to produce a watertight assembly capable of withstanding inward and outward loading pressures, and thermal and lateral loads.
- B. Coat back side of aluminum roof specialties with bituminous coating where they will contact wood, ferrous metal, or cementitious construction.
- C. Expansion Provisions: Install running lengths to allow controlled expansion for movement of metal components, to prevent water leakage, deformation, or damage.
- D. Install scuppers, gutters, downspouts, and accessories in accordance with manufacturer's instructions.
- E. Seal all joints watertight.

END OF SECTION 077100

**SECTION 077200 - ROOF ACCESSORIES**

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.
- B. Sheet Metal Standard: Comply with SMACNA's "Architectural Sheet Metal Manual."

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Metallic-Coated Steel Sheet: Galvanized steel, ASTM A 653/A 653M, G90 (Z275), or aluminum-zinc alloy-coated steel, ASTM A 792/A 792M, AZ50 (AZM150).
  - 1. Prepainted, Metallic-Coated Steel Sheet: Coil-coated with manufacturer's standard 2-coat, thermocured system consisting of inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight.
- B. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy and temper recommended by manufacturer for type of use and finish:
  - 1. Factory Prime Coating: Pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat; with a minimum dry film thickness of 0.2 mil (0.005 mm).
  - 2. Baked-Enamel Finish: Thermosetting, modified-acrylic enamel primer/topcoat system complying with AAMA 2603 except with a minimum dry film thickness of 1.5 mils (0.04 mm), medium gloss.
  - 3. High-Performance Organic Finish: Manufacturer's standard 2-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight.

2.2 ROOF ACCESSORIES

- A. Roof Curbs and Equipment Supports: Fabricate from 0.079-inch- (2.0-mm-) thick, metallic-coated steel with welded or sealed mechanical corner joints.
  - 1. Provide units with cant strips and base profile coordinated with roof insulation thickness and roof deck slope.
  - 2. Provide preservative-treated wood nailers at tops of curbs.
  - 3. Provide manufacturer's standard rigid or semirigid insulation.
  - 4. Finish: Prime painted.

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PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation: Unless otherwise indicated, install roof accessory items according to construction details of NRCA's "Roofing and Waterproofing Manual." Coordinate with installation of roof deck, vapor barriers, roof insulation, roofing, and flashing to ensure combined elements are secure, waterproof, and weathertight.

END OF SECTION 077200

**SECTION 079200 - JOINT SEALANTS**

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data and color Samples.
- B. Environmental Limitations: Do not proceed with installation of joint sealants when ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer or are below 40 deg. F.

PART 2 - PRODUCTS

2.1 JOINT SEALANTS

- A. Compatibility: Provide joint sealants, joint fillers, and other related materials that are compatible with one another and with joint substrates under service and application conditions.
- B. Sealant for Use in Building Expansion Joints:
  - 1. Single-component, neutral-curing silicone sealant, ASTM C 920, Type S; Grade NS; Class 25; Uses T, M, and O, with the additional capability to withstand 100 percent movement in extension and 50 percent movement in compression for a total of 150 percent movement.
- C. Sealant for General Exterior Use Where Another Type Is Not Specified:
  - 1. Single-component, non-sag urethane sealant, ASTM C 920, Type S; Grade NS; Class 25; and Uses NT, M, A, and O.
- D. Sealant for Exterior Traffic-Bearing Joints, Where Slope Precludes Use of Pourable Sealant:
  - 1. Single-component, non-sag urethane sealant, ASTM C 920, Type S; Grade NS; Class 25; Uses T, NT, M, G, A, and O.
- E. Sealant for Exterior Traffic-Bearing Joints, Where Slope Allows Use of Pourable Sealant:
  - 1. Single-component, pourable urethane sealant, ASTM C 920, Type S; Grade P; Class 25; Uses T, M, G, A, and O.
- F. Sealant for Use in Interior Joints in Ceramic Tile and Other Hard Surfaces in Kitchens and Toilet Rooms and Around Plumbing Fixtures:
  - 1. Single-component, mildew-resistant silicone sealant, ASTM C 920, Type S; Grade NS; Class 25; Uses NT, G, A, and O; formulated with fungicide.

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### G. Sealant for Interior Use at Perimeters of Door and Window Frames:

1. Latex sealant, single-component, non-sag, mildew-resistant, paintable, acrylic-emulsion sealant complying with ASTM C 834.

### 2.2 JOINT-SEALANT BACKING

- A. General: Provide sealant backings of material and type that are non-staining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer.
- B. Cylindrical Sealant Backings: ASTM C 1330, of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
- C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Comply with ASTM C 1193.
- B. Comply with ASTM C 919 for use of joint sealants in acoustical applications.

END OF SECTION 079200

**SECTION 081110 - STEEL DOOR AND WINDOW KNOCKDOWN FRAMES**

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Provide Interior steel door and window frames and trim, as shown on the drawings and schedules.
- B. Comply with ANSI/SDI 100.
- C. Comply with NFPA 80 for fire-rated door assemblies. Provide assemblies identical to those tested per ASTM E 152, and labeled and listed by UL, Warnock Hersey, or another testing and inspecting agency acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Steel frames for interior doors and windows:
  - 1 Preformed and prefinished steel frames as manufactured by "Timely". Timely TA-8 standard steel casing to match jamb section. Color: Alumaton (SC108).
  - 2 All frame profiles to be Timely #50 to accommodate 4-7/8" to 5" wall thickness, unless noted otherwise.
  - 3. Cold rolled steel, 20 ga commercial service S-series. Standard 2-3/4" adjustable strike, color Zincrome. For Sally Port door #39, 18 ga. Kerfed frame CK-series with 90 minute fire rating.
  - 4. Pre-mitered casing sections with aligning corner inserts.
  - 5. Hinge reinforcement plates: 14 ga , factory attached, to accommodate specified hinge sizes (3 ea. 4 1/2").
  - 6. Provide closer reinforcement as required.
  - 7. For interior window frames, furnish mullion attachment brackets as needed, and precut glass stops and glass stop screws.
  - 8. Note: Re: Door Schedule for doors to be prepped for Von Duprin electric strike (provided by others).
- B. Vision lights for doors:

Vision Light glass stops shall be wood stops to match door finish. Stops shall be designed to accept 1/4" glass. Stops for fire rated doors shall be steel. Glass shall be provided and installed by owner.
- C. Prepare doors and frames to receive mortised and concealed hardware according to SDI 107, and as shown on the door schedule and listed in the Hardware Schedules. Provide backing for door closers as required.
- D. Weatherstrip/Smoke Gasket: TA-46 (QDS500) 90 minute rated gasket for kerfed frames. All pieces factory mitered to assure perfect corner alignment.

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- E. Silencers: TA-5 vinyl, 2 per frame, clear stick-on type. Silencers not required on Kerfed frames or frames scheduled to receive stop mounted gasket or weatherstrip
- F. Prepare frames for ASA 4-7/8" strikes where required. Provide minimum 1/4" depth of threads in factory tapped screw holes
- G. Installation fasteners (Provided by others)
  - 1. Interior Frames: #6 Drywall type of length sufficient to penetrate studs or structure at least 1/2".

### 2.2 FABRICATION

- A. Openings for single swing, pair, borrowed light and sidelight frames to be pre-cut, notched and fabricated at the manufacturer's facility. For fire rated and exterior openings, provide kerf at stop for installation of smoke gasket or weatherstrip
- B. Provide minimum 14 gage hinge reinforcement plate tapped for machine screws supplied with hinges. Hinge plate to be mechanically attached to hinge emboss on frame
- C. Casing Clips: Fabricate frames with factory applied, heat treated clips to ensure no deflection in the clip upon application or removal of casing. Attachment clips may not be of same material as frame
- D. Provide notches, tabs and/or stops for positive alignment of frame parts at all corners
- E. Mullions to be notched as required to provide tight joints
- F. Provide manufacturer's standard mullion brackets for positive connection of frame and mullion parts
- G. For windows, provide manufacturer's standard steel glass stop pre-cut to exact length. Fire rated glazed openings to have hole for installation screw within 2" of each end of stop piece
- H. Provide insert channel full width of borrowed lights installed on finish floor. Provide full width head channel for ceiling height units.
- I. Provide adequate structural support (by others) for ceiling insert channel for ceiling height frames
- K. Attach approved mylar label to each fire-rated frame indicating fire rating details
- L. Factory install TA-46 smoke gasket on all pre-finished, CK series frames. Install with factory mitered corners to ensure adequate seal and pleasing appearance

### 2.3 FINISHING

- A. Frame Units: Pre-finished with factory applied impact resistant, polyester baked enamel finish or optional electrostatic applied water based paint system
- B. Frames for high humidity areas to be electro galvanized prior to pre-finishing.
- C. Casing Finishes

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

1. Steel: Prefinished with factory applied impact resistant, polyester baked enamel finish.
2. Aluminum: Prefinished with factory applied impact resistant, polyester baked enamel finish or Clear anodized for Alumaton (SC108) paint finished frames

### Part 3 – EXECUTION

#### 3.1 EXAMINATION

- A. Verify acceptability of existing conditions before starting work.
- B. Verify that opening sizes and wall thicknesses are within specified tolerances. Verify that all finished walls are in plane to ensure proper door alignment.

#### 3.2 INSTALLATION

- A. Install frames in accordance with manufacturer's requirements.
- B. Anchor frames with screws located at every casing clip or every 11" as shown on manufacturer's instructions. Field verify quantity and location of fasteners prior to installing casing.
- C. Install Pre-finished frames near end of the project after wall painting and wall coverings are applied.
- D. Install frames using qualified installers familiar with installation of pre-finished drywall frames.
- E. Coordinate installation of glass and glazing in glazed units.
- F. Coordinate installation of frames with installation of hardware specified in Section 087100 and doors in Section 082110.
- G. Touch-up blemishes on finished frames with factory prepared touch up paint.

END OF SECTION 081110



**SECTION 081113 – HOLLOW METAL DOORS AND FRAMES**

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. Custom hollow metal doors and frames.

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 08 Section "Glazing" for glass types in doors and frames.
- 4. Division 26 Sections for electrical connections including conduit and wiring for door controls and operators.

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.
- C. Custom Hollow Metal Work: Hollow metal work fabricated according to ANSI/NAAMM-HMMA 861.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, core descriptions, fire-resistance rating, temperature-rise ratings, and finishes.
- B. Shop Drawings: Include the following:
  - 1. Schedule: 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.
  - 2. Elevations of each door design.
  - 3. Details of doors, including vertical and horizontal edge details and metal thicknesses.
  - 4. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
  - 5. Locations of reinforcement and preparations for hardware.
  - 6. Details of each different wall opening condition.

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

7. Details of anchorages, joints, field splices, and connections.
8. Details of accessories.
9. Details of moldings, removable stops, and glazing.
10. Details of conduit and preparations for power, signal, and control systems.

- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each type of hollow metal door and frame assembly.

### 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 at positive pressure according to NFPA 252.
- C. Smoke-Control Door Assemblies: Comply with NFPA 105 or UL 1784.

### 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.
- 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 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Amweld Building Products, LLC.
  2. Benchmark; a division of Therma-Tru Corporation.
  3. Ceco Door Products; an Assa Abloy Group company.
  4. Curries Company; an Assa Abloy Group company.
  5. Deansteel Manufacturing Company, Inc.
  6. Firedoor Corporation.
  7. Fleming Door Products Ltd.; an Assa Abloy Group company.
  8. Habersham Metal Products Company.
  9. Mesker Door Inc.
  10. Pioneer Industries, Inc.
  11. Republic
  12. Security Metal Products Corp.
  13. Steelcraft; an Ingersoll-Rand company.
  14. Windsor Republic Doors.

2.2 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. 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.
- D. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.
- E. Grout: ASTM C 476, except with a maximum slump of 4 inches, as measured according to ASTM C 143/C 143M.
- F. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool with 6- to 12-lb/cu. ft. density; with maximum flame-spread and smoke-development indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.
- G. Glazing: Comply with requirements in Division 08 Section "Glazing."
- H. 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.

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

### 2.3 CUSTOM HOLLOW METAL DOORS

- A. General: Provide doors not less than 1-3/4 inches thick, of seamless hollow construction unless otherwise indicated. Construct doors with smooth surfaces without visible joints or seams on exposed faces. Comply with ANSI/NAAMM-HMMA 861.
- B. Exterior Door Face Sheets: Fabricated from metallic-coated steel sheet, minimum 0.053 inch (16 gage) thick.
- C. Interior Door Face Sheets: Fabricated from cold-rolled steel sheet, minimum 0.053 inch (16 gage) thick.
- D. Core Construction: Provide thermal-resistance-rated cores for exterior doors.
  - 1. Steel-Stiffened Core: 0.026-inch- thick, steel vertical stiffeners of same material as face sheets extending full-door height, with vertical webs spaced not more than 6 inches apart, spot welded to face sheets a maximum of 5 inches o.c. Spaces filled between stiffeners with glass- or mineral-fiber insulation.
    - 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.
- E. Vertical Edges for Single-Acting Doors: Beveled 1/8 inch in 2 inches.
- F. Vertical Edges for Double-Acting Doors: Round vertical edges with 2-1/8-inch radius.
- G. Top and Bottom Channels: Closed with continuous channels, minimum 0.053 inch thick, of same material as face sheets and spot welded to both face sheets.
- H. Hardware Reinforcement: Fabricate according to ANSI/NAAMM-HMMA 861 with reinforcing plates from same material as door face sheets.

### 2.4 CUSTOM HOLLOW METAL FRAMES (Fire-rated Door #39 only; all other interior frames to be "Timely" knock-down frames):

- A. General: Fabricate frames of construction indicated. Close contact edges of corner joints tight with faces mitered and stops butted or mitered. Continuously weld faces and soffits and finish faces smooth. Comply with ANSI/NAAMM-HMMA 861.
  - 1. Exterior Door Frames: 0.067-inch- thick.
  - 2. Interior Door Frames, thicknesses as follows:
    - a. Door Frames for Openings 48 Inches Wide or Less: Fabricated from 0.053-inch (16 gage) thick steel sheet.
    - b. Door Frames for Openings More Than 48 Inches Wide: Fabricated from 0.067-inch-thick steel sheet.

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3. Sidelight and Transom Frames: Fabricated from same thickness material as adjacent door frame.
  4. Interior Borrowed-Light Frames: Fabricated from 0.053-inch (16 gage) thick steel sheet.
- B. Exterior Frames: Formed from metallic-coated steel sheet.
- C. Interior Frames: Fabricated from cold-rolled steel sheet.
- D. Hardware Reinforcement: Fabricate according to ANSI/NAAMM-HMMA 861 with reinforcing plates from same material as frame. Minimum thickness of steel reinforcing plates for the following hardware:
1. Hinges and Pivots: One piece 0.167 inch thick plate 12 inches long by full width of the jamb at each hinge
  2. Closers: 0.123 inch channel section 12 inches long and full width of frame trim.
  3. Strikes, Flush Bolts, Surface-Mounted Hold-Open Arms, Panic Devices, and Other Surface Mounted Hardware: 0.093 inch thick.
  4. Reinforce frames in direct proportion to the size and weight of door.
  5. Spot weld reinforcement at the factory. Drill and tap for mortise template hardware
- E. Head Reinforcement: Provide minimum 0.093-inch- thick, steel channel or angle stiffener for opening widths more than 48 inches. Where installed in masonry, leave vertical mullions in frames open at top for grouting.

### 2.5 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.

### 2.6 HOLLOW METAL PANELS

- A. Provide hollow metal panels of same materials, construction, and finish as specified for adjoining hollow metal work.

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### 2.7 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.
- D. Refer to Division 08 Section "Glazing" for glass types in doors and frames.
  - 1. Note: 1-inch thick insulating glass units for exterior doors. Provide manufacturer's standard overlapping steel trim and moldings for glass units over 1/4-inch thick.

### 2.8 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.

### 2.9 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 ANSI/NAAMM-HMMA 861.
- 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. Glazed Lites: Factory cut openings in doors.
- 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. Sidelight and Transom Bar 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.

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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/NAAMM-HMMA 861.
  2. Reinforce doors and frames to receive nontemplated, 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.

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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.

### 2.10 STEEL FINISHES

- A. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning"; remove dirt, oil, grease, or other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 3, "Power Tool Cleaning," or SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
- B. Factory Priming for Field-Painted Finish: Apply shop primer specified below immediately after surface preparation and pretreatment. Apply a smooth coat of even consistency to provide a uniform dry film thickness of not less than 0.7 mils (0.02 mm).
  1. Shop Primer: Manufacturer's or fabricator's standard, fast-curing, corrosion-inhibiting, lead- and chromate-free, universal primer complying with ANSI A224.1 acceptance criteria; compatible with substrate and field-applied finish paint system indicated; and providing a sound foundation for field-applied topcoats 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. If required by owner, 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:



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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 HMMA 840.
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.
  3. Metal-Stud Partitions: Solidly pack mineral-fiber insulation behind frames.
  4. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.
  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.
  6. 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.
  7. Installation Tolerances: Adjust hollow metal door frames for squareness, alignment, twist, and plumb to the following tolerances:

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

- 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.
    - d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 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.

END OF SECTION 081113

**SECTION 083116 - ACCESS PANELS AND FRAMES**

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Access panels and frames for walls and ceilings.
2. Accessories.

B. Related Requirements:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section
2. Section 013300 - Submittal Procedures: For administrative and procedural requirements for processing of submittals during the construction phase.
3. Section 017700 - Closeout Procedures: For administrative and procedural requirements for completion of the Work.
4. Section 08 31 13 - Access Doors and Frames: For doors and frames.  
Section 09 29 00 - Gypsum Board: For gypsum wallboard infill.
5. Section 09 91 00 - Painting: For field painting of access panels and frames.

1.02 REFERENCES

A. Reference Standards:

1. ASTM International (ASTM):
  - a. ASTM A36/A36M-12, Standard Specification for Carbon Structural Steel
  - b. ASTM A153/A153M-09, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
  - c. ASTM A653/A653M-11, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process
  - d. ASTM A666-10, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar]
  - e. ASTM A879/A879M-12, Standard Specification for Steel Sheet, Zinc Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface
  - f. ASTM A1008/A1008M-12a, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
  - g. ASTM B209-10, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
  - h. ASTM B221-12a, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
  - i. ASTM F2329-11, Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners
2. International Code Council (ICC):
  - a. International Building Code (IBC) – 2012 Edition.

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

3. Intertek Testing Services/Warnock-Hersey International (ITS/WHI)
4. National Fire Protection Association (NFPA):
  - a. NFPA 80-2013, Standard for Fire Doors and Other Opening Protectives
  - b. NFPA 252-2012, Standard Methods of Fire Tests of Door Assemblies
  - c. NFPA 288-2012, Standard Methods of Fire Tests of Horizontal Fire Door Assemblies Installed in Horizontal Fire Resistance-Rated Assemblies
5. Underwriters Laboratories, Inc. (UL)
  - a. UL 10B-2008, Fire Tests of Door Assemblies
  - b. Classified Building Materials Index

### 1.03 ACTION SUBMITTALS

- A. Submit in accordance with Section 013000:
  1. Product Data:
    - a. Materials description for access panels and frames including details showing mounting type, relationships to surrounding construction, panel and frame type, materials, and construction, and locking features.
    - b. Installation instructions for each product specified.
  2. Shop Drawings:
    - a. Include details of each frame type, elevation of panel, anchorage and accessory items.
    - b. Schedule showing each type of access panel and frame, locations, sizes, latching or locking provisions, and other data pertinent to installation
    - c. Indicate installation procedures and accessories required for a complete installation.

### 1.04 QUALITY ASSURANCE

- A. Comply with standards referenced in Article 1.03 REFERENCES.
- B. Provide access panels and frames produced by a single manufacturer.
- C. Wherever a fire-resistance classification is indicated, provide access assembly with panel, frame, hinge, and latch from manufacturer listed in Underwriters Laboratories, Inc.; "Classified Building Materials Index" for rating shown.
  1. Provide UL Label on each fire-rated access panel.

### 1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle access panels and frames using means and methods that will prevent damage, deterioration, or loss.
  1. Deliver units in manufacturer's original packaging, properly labeled for identification.

## PART 2 - PRODUCTS

### 2.01 ACCESS PANELS AND FRAMES MANUFACTURERS

- A. Acceptable Manufacturers (or approved equal):

J. L. Industries, Inc., a division of Activar Construction Products Group  
4450 West 78th St. Circle  
Bloomington, MN 55435-5416

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- B. Substitutions shall be allowed. Manufacturers seeking approval of their products are required to comply with the Owner's Instructions to Bidders, generally contained in the Project Manual.

### 2.02 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Access Panels and Frames: Units complying with NFPA 80 that are identical to access panel and frame assemblies tested for fire-test-response characteristics according to the following test method, and that are listed and labeled by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
  1. NFPA 252 or UL 10B for fire-rated access panel assemblies installed vertically.
  2. NFPA 288 for fire-rated access panel assemblies installed horizontally.

### 2.03 TM SERIES - INTERIOR FLUSH NONFIRE-RATED ACCESS PANELS AND FRAMES

- A. Style TM: Multi-purpose flush steel access panel.
  1. Model No. TM - \_\_\_\_ (size per plans).
  2. Frame: 16-gauge steel with 1-inch (25.40-mm) flange.
  3. Panel: 16-gauge steel mounted to frame with 90-degree continuous concealed hinge.
  4. Finish: Powder coat primer; gray.
  5. Standard Latch/Lock: Flush screwdriver-operated steel cam.
  6. General Use: Walls or Ceilings
  7. Style TM Options:
    - a. Color: White

### 2.04 FD SERIES - INTERIOR FIRE-RATED ACCESS PANELS AND FRAMES

- A. Style FD: Fire-rated and insulated flush access panel where required in rated wall assembly.
  1. Model No. FD - \_\_\_\_ (size per plans).
  2. Frame and Trim: 16-gauge steel with 1-inch (25.40-mm) flange, and welded-on masonry anchor.
  3. Panel: Insulated 20-gauge steel with continuous hinge; 2-inch (50.80-mm) thickness.
  4. Finish: Powder coat primer; gray.
  5. Standard Latch/Lock: Universal turn ring and key lock.
  6. General Use: Walls.
  7. Fire-Rating: 1-hour
  8. Style FD Options:
    - a. Color: White.

### 2.05 MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- B. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A879/A879M, with cold-rolled steel sheet substrate complying with ASTM A1008/A1008M, Commercial Steel (CS), exposed.
- C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.
- D. Aluminum Extrusions: ASTM B221, Alloy 6063-T6.
- E. Aluminum Sheet: ASTM B209, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than strength and durability properties of Alloy 5005-H15; with minimum sheet thickness according to ANSI H35.2.
- F. Frame Anchors: Same type as panel face.
- G. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A153/A153M or ASTM F2329.

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

- H. Furnish inserts and anchoring devices which must be built into other work for installation of access panels.

### 2.06 FABRICATION

- A. General: Furnish each access panel assembly manufactured as an integral unit, complete and ready for installation.
- B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- C. Panels and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access panel frames to types of supports indicated.
  - 1. For concealed flanges with drywall bead, provide edge trim for gypsum board securely attached to perimeter of frames.
  - 2. Provide mounting holes in frames for attachment of units to metal or wood framing.
- D. Recessed Access Panels: Form face of panel to provide recess for application of applied finish. Reinforce panel as required to prevent buckling.
- E. Latching Mechanisms: Furnish number required to hold panels in flush, smooth plane when closed.
  - 1. For cylinder locks, furnish 2 keys per lock and key all locks alike.
  - 2. For recessed panels, provide access sleeves for each locking device. Furnish plastic grommets and install in holes cut through finish.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
  - 1. Notify the Contractor in writing of conditions detrimental to proper and timely completion of the installation.
  - 2. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 INSTALLATION

- A. General: Comply with manufacturer's written instructions for installing access panels and frames.
- B. Install panels flush with adjacent finish surfaces or recessed to receive finish material.

### 3.03 ADJUSTING AND CLEANING

- A. Adjust access panels to operate easily without binding. Verify that integral locking/latching devices operate properly.
- B. Remove panels and frames that are warped, bowed, or otherwise damaged, and replace with new components.
- C. On completion of access panel installation, clean interior and exterior surfaces as recommended by manufacturer.

END OF SECTION 083116

**SECTION 083900 – STEEL PEDESTRIAN FLOOD DOORS**

Part 1. GENERAL

1.1 SECTION INCLUDES

- A. Steel Pedestrian Flood Door with frame and hardware

1.2 RELATED SECTIONS

- A. Section 033000 - Cast-In-Place Concrete.
- B. Section 051200 - Structural Steel.
- C. Section 054000 – Metal Framing

1.3 REFERENCES

- A. ASTM A 36 - Standard Specification for Carbon Structural Steel.
- B. ASTM A 167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
- C. ASTM A 276 - Standard Specification for Stainless Steel Bars and Shapes.
- D. ASTM B 26 - Standard Specification for Aluminum-Alloy Sand Castings.
- E. ASTM B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- F. ASTM B 211 - Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire.
- G. ASTM A 500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
- H. AISI CL 304 - American Iron and Steel Institute.
- I. Aluminum Association - Specification for Aluminum Structures, 7th Edition.
- J. ASME Structural Welding Code Section IX.
- K. FEMA #114 - Engineering Principles and Practices of Retrofitting Flood-Prone Residential Structures.
- L. FEMA Technical Bulletin 3-93 - Non-Residential Flood Proofing.
- M. SEI/ASCE 7-02 - Minimum Design Loads for Buildings and Other Structures.
- N. AWS D1.1 - Structural Welding Code - Steel.

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

- O. AWS D1.2 - Structural Welding Code - Aluminum.
- P. Aluminum Structures - A Guide to Their Specifications and Design.
- Q. U.S. Army Corps of Engineers, EP 1165-2-314 - Flood Proofing Regulations, 15 December 1995.

### 1.4 DESIGN / PERFORMANCE REQUIREMENTS

- A. Design watertight doors to perform under hydrostatic loads (and hydrodynamic or other loads as specified) to control short-term load pressures indicated. All water pressure loads and operating loads are transferred to the building structure.
- B. Standard loading: Standard Flood Doors are designed for hydrostatic loading, and have no additional allowances included for hydrodynamic loads, wave loads or debris impact loads.
- C. Special loading: Design Flood Doors for hydrodynamic loads, wave loads, debris impact loads, or other uniform loads as indicated.
- D. Design Safety Factor for all watertight door Flood Door Models of a minimum 2:1. Based on material ultimate yield strengths.
- E. Design Safety Factor for Anchors, minimum of 4:1 for cast-in-place concrete, or minimum of 6:1 for concrete masonry unit construction.

### 1.5 SUBMITTALS

- A. Submit under provisions of Section 013000.
- B. [ Product Data ]: Manufacturer's data sheets on each product to be used, including:
  - (1) Preparation instructions and recommendations.
  - (2) Storage and handling requirements and recommendations.
  - (3) Installation instructions.
- C. Shop Drawings: Provide shop drawings showing layout, profiles, and product components, including anchorage, hardware, and finishes. Include dimensional plans, applicable material specifications, elevations and sections detailing mounting and connections, and load diagrams.
- D. Calculations: Submit calculations approved by a qualified engineer, to verify the flood door's ability to withstand the design loading.
- E. Closeout Submittals: Provide Operation and Maintenance data to include methods for maintaining installed products, precautions against cleaning materials and methods detrimental to finishes and performance.
- F. Manufacturer's Certificates: Certify products meet or exceed specified requirements.

### 1.6 QUALITY ASSURANCE



## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

- A. **Manufacturer Qualifications:** Manufacturer must demonstrate a minimum of five years successful experience in design and manufacture of similar flood related closures. Upon request, provide supporting evidence including list of installations, descriptions, name and method of contact.
- B. **Welder Qualifications:** Welders Certified in accordance with American Welding Society Procedures: AWS-1-GMAW-S, WPS No. B2.004.90 for applicable material used in production of specified product.

### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging container with identification labels intact until ready for installation.
- B. Protect materials from exposure to moisture.
- C. Store materials in a dry, warm, ventilated weathertight location. If outdoor storage is required, block materials to store at an incline, to prevent pooling of any moisture and promote runoff. Tarp materials in a tent-like arrangement, elevated above the product with open sides to allow airflow. Store all other hardware in a dry controlled environment.
- D. Use caution when unloading and handling product to avoid bending, denting, crushing, or other damage to the product.
- E. When using forklifts, use forks of proper length to fully support product being moved. Consult shop drawings or consult with factory for proper lift points.

### 1.8 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

### 1.9 COORDINATION

- A. Coordinate Work with other operations and installation of adjacent materials to avoid damage.

## Part 2. PRODUCTS

### 2.1 MANUFACTURERS

- A. **Acceptable Manufacturer (or approved equal):** Assa Abloy Door Security Solutions of the Rockies, which is located at: 3650 Fraser Street, Unit D, Aurora, CO 80011; Tel: 303-371-3190; Fax: 303-265-9895; Email: [Jacob.Hauzen@assaabloy.com](mailto:Jacob.Hauzen@assaabloy.com)
- B. Requests for substitutions will be considered in accordance with provisions of Section 016000.

C. Obtain all watertight doors and flood doors assemblies from single manufacturer.

## 2.2 EQUIPMENT

A. Watertight Doors: Provide the following doors:

- (1) Hinged Pedestrian Flood Door: Assa Abloy Model FD36C  
ANSI and ADA compliant.

B. Products Details:

- (1) Sealing Requirements: Flood Door and gasket design shall provide an effective barrier against short-term high water situations, to the protection level indicated on Drawings.
- (2) Operation: Provide with latching operable from one side only (typical).
- (3) Mounting/Load Transfer: Anchor to existing structure. Flood Door designed for specified hydrostatic pressure (and other loads as specified) and will transfer loads to adjacent structure.
- (4) Frames to be anchored utilizing mechanical, chemical or other anchor types as designed. Manufacturer to include all anchors, water-stop, and sealants, as designed.
- (5) Loading Direction Selection:
  - a) Standard: Positive Pressure Loading: (Direction of loading against flood door so as to further compress gaskets against flood door frame-"seating").
- (6) Provide rectangular door opening with square corners to facilitate easy passage.
- (7) Provide compression gasket which requires no inflation.

## 2.3 MATERIALS

A. Flood Door:

- (1) Steel: Structural or formed steel shapes conforming to ASTM A 36; tubing conforming to ASTM A 500 Grade B, ASTM A 513; bars conforming to ASTM A 36, M1020; of appropriate size and strength with welded construction.
- (2) Stainless Steel: Stainless steel conforming to ASTM A 276.

B. Panel Sheeting: Flood Door to be sheeted with steel sheeting or plate, Commercial Quality Low-Carbon ASTM-A-569, ASTM-A-366, ASTM-A-36 of appropriate size and strength with welded construction.

C. Gaskets to be factory mounted to flood door assembly. Gaskets to be compressible rubber type, typically EPDM unless otherwise noted, and to be field replaceable.

D. Frame to include jamb, head, and sill members for field locating and installation on structure. Jamb members to be designed and fabricated with appropriate material as required for the loading.

- (1) Steel: Structural or formed steel shapes conforming to ASTM A 36 of appropriate size and strength with welded construction.

E. Threshold:

- (1) Aluminum: 6063T-5 alloy conforming to ASTM B 26.

F. Frame Mounting Hardware: Provide anchors, sealant, and water stop, as required.

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

- G. Operating Hardware: Provide hardware sized for the size and weight of the flood door and loads. Hardware to be factory located on jambs and door panels, as practical. All loads are transferred to building structure. Latching hardware to be as indicated on Drawings. Flood door panel to be factory prepared for applicable latching devices.  
FD36C Hardware: as indicated on drawings.
- H. Steel Shop Finish: Apply in accordance with manufacturer recommendations and instructions.
  - (1) Primer: One shop coat of manufacturer's standard shop primer (S-W Kemflash Primer E61-R-26).
  - (2) Finish: By others.
- I. Stainless Steel products to be mill finish, welds are ground smooth, not polished, and are factory acid washed, neutralized and rinsed.
- J. Labeling. Each watertight door and frame will be individually identified for matched installation.
- K. Instruction Placard: Provide pictorial and written operation instruction placards with flood door.

### 2.4 FABRICATION

- A. Fit and shop assemble items in largest practical sections, for delivery to site.
- B. Fabricate items with joints tightly fitted and secured.
- C. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

## Part 3. EXECUTION

### 3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

### 3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

### 3.3 INSTALLATION

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

- A. Install in accordance with manufacturer's installations instructions, approved shop drawings, shipping, handling, and storage instructions, and product carton instructions for installation.
- B. Frames shall be installed level, square, plumb, and rigid.
- C. Sealants, water-stop, and grouting to be applied per product application directions and in accordance with manufacturer's instructions.
- D. Field Grouting to be completed by appropriate personnel, and in accordance with product application directions and manufacturer's instructions.
- E. Tolerances: All dimensional requirements must be in accordance with manufacturer's installation instructions and shop drawings.
- F. Field Testing:
  - (1) Perform visual dry test for gasket alignment, continuity contact and pre-compression.
  - (2) Where feasible, construct temporary water barrier and test installed flood barrier.

### 3.4 FIELD QUALITY CONTROL

- A. Manufacturer's representative to verify that installation of assembly and that the perimeter conditions are in conformance to the manufacturer's recommendations.
- B. Products to be operated and field verified including the sealing surfaces to assure that they maintain contact at the correct sealing points.
- C. Verify that hinging and latching assemblies operate freely and correctly.
- D. Verify all anchorage is in accordance with manufacture's installation instructions and applicable data sheets.

### 3.5 CLEANING

- A. Repair or replace damaged installed products or components.
- B. Clean all sealing surfaces.
- C. Touch up damaged finish.

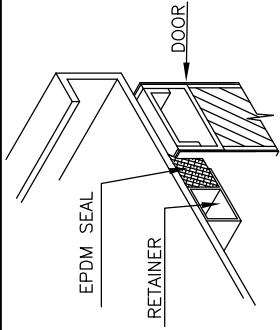
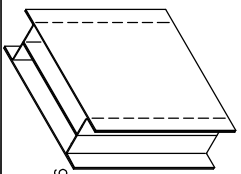
### 3.6 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

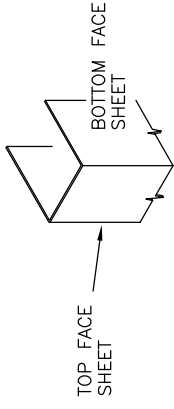
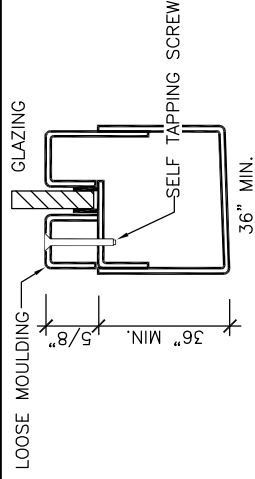
END OF SECTION 083900

STANDARD 22 GAGE STIFFENERS,  
OPTIONAL STIFFENERS: 20, 18, 16  
FIBERGLASS INSULATION PLACED  
BETWEEN STIFFENERS  
DENSITY: 0.5 LB/FT<sup>3</sup>

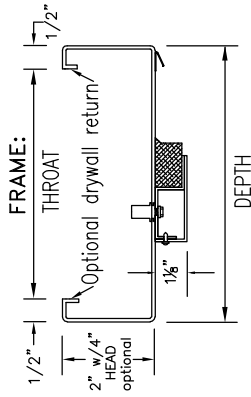
STEEL STIFFENED CORE  
WELDED STEEL STIFFENERS (WS) OR  
PERMANENTLY BONDED STEEL STIFFENERS (WSB)  
DOOR CONSTRUCTION



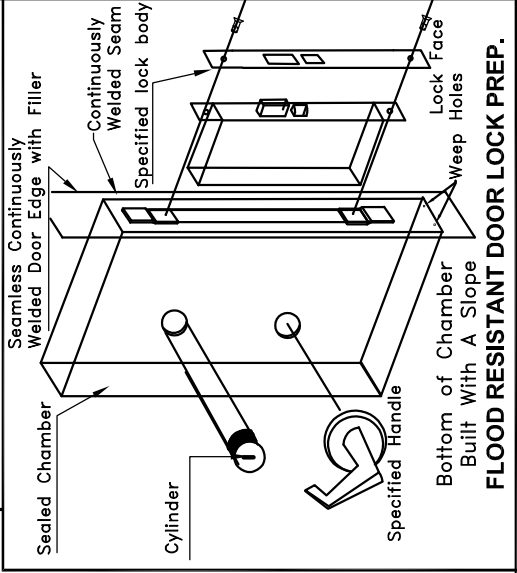
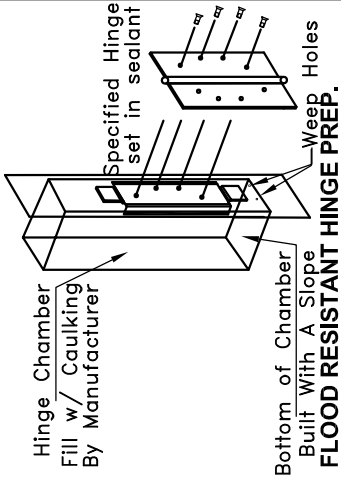
DOOR FRAME & SEAL (TOP & BOTTOM SIM.) DOOR FRAME & GLAZING DETAIL



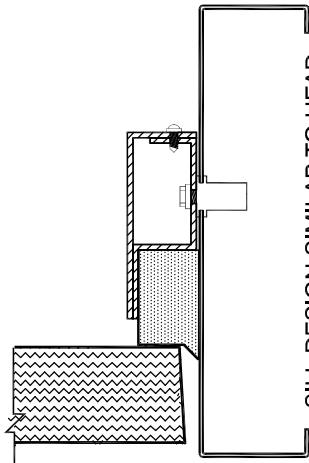
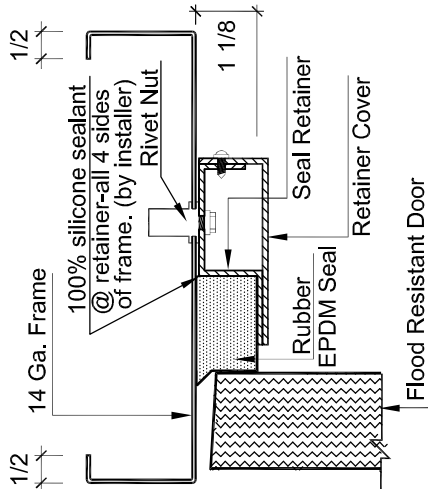
AVAILABLE IN 16 & 14 GAGE WITH OFFSET SEAM  
OPTIONAL 12 GAGE WELDED SEAMLESS  
CONSTRUCTED WITH CENTER SEAM  
**VERTICAL EDGES (SEAMLESS WELDED EDGE)**



**FRF FRAME PROFILE**  
CORNERS: CONTINUOUSLY WELDED  
AVAILABLE IN 12 & 14 GAGE



**MODEL FD36C UTILIZES "FRF" PROFILE FRAME**  
(SEAL SET FLDA FOR SINGLES (STANDARD FRAME NOT AVAILABLE))



VERTICAL SECTION  
**MODEL FD36C**  
Flood Compression seal system  
1 3/4" Flood Door System Tech Data

**SPECIFICATIONS**

- 1) All exposed surfaces of door and frame to receive one coat of rust inhibitive prime paint complying with ASTM A250.10.
- 2) Frame is required to be 4 sided, complete with EPDM compression seals.
- 3) Flood assembly should be installed in the seated position only. Meaning as the water rises, it applies pressure to the door, pressing it tighter against the seals.
- 4) Assembly is equipped with flood resistant door, frame, seals and created for shipment.
- 5) Door Thickness is 1 3/4". Door weight is 6.75 pounds per square foot. Be aware that the frame must be securely tied to the framing from the sub floor to the structure above and grouted solid.
- 6) Flood resistant doors are to be formed of no less than 16 Gauge steel face sheets continuously welded at the vertical edges and finished smooth. Capped top and bottom and sealed.
- 7) Frames are to be formed of no less than 14 Gauge sheet steel with corners mitered, continuously welded and ground smooth.
- 8) Doors and frames are formed from commercial quality zinc coated steel conforming to ASTM A653 & ASTM A924. Flood resistant core and internal construction are manufacturer's proprietary standards as tested in accordance with ASTM E90, E413, E1332, & E2235.
- 9) Frames must be fully grouted above the expected waterline.
- 10) Please be aware that industry standard construction tolerances for squareness of frame installation, plumbness of walls, flatness of floors, etc. may result in potential leakage.
- 11) The required core will be provided to achieve the rating needed. The appropriate flood resistant seal sets are provided with each assembly.

**ASSA ABLOY, the global leader**  
in door opening solutions

STANDARD PRIMER PAINT: TESTED IN CONFORMANCE WITH ANSI A250.10

TESTED AND IN COMPLIANCE WITH AMERICAN NATIONAL STANDARD FOR FLOOD ABATEMENT EQUIPMENT:  
ANSI / FM APPROVALS 2570-2014, SECTION 4.3, FOR WATER LEVELS UP TO 36". COMPLETE WITH PERIMETER  
SEALS AND BOTTOM SEALS.

FINISH  
FLOOD  
PERFORMANCE

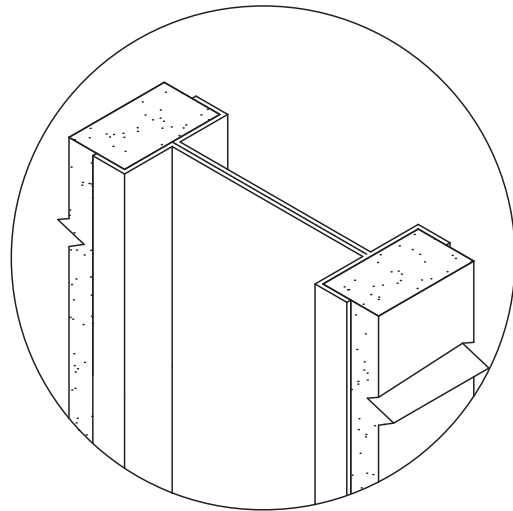
Flood Resistant Door Technical Data

July, 2017



TESTED TO THE AMERICAN NATIONAL STANDARD FOR FLOOD ABATEMENT EQUIPMENT FOR WATER DEPTHS UP TO AND INCLUDING 36" TO STANDARDS SET FORTH BY ANSI/FM APPROVALS 2510-2014 (SECTION 4.3) NOT EXCEEDING MAXIMUM ALLOWABLE WATER SEEPAGE.

- 10" BY 10" LITE IS ALLOWED AT THE TOP OF THE DOOR
- OPTIONAL STAINLESS STEEL AVAILABLE

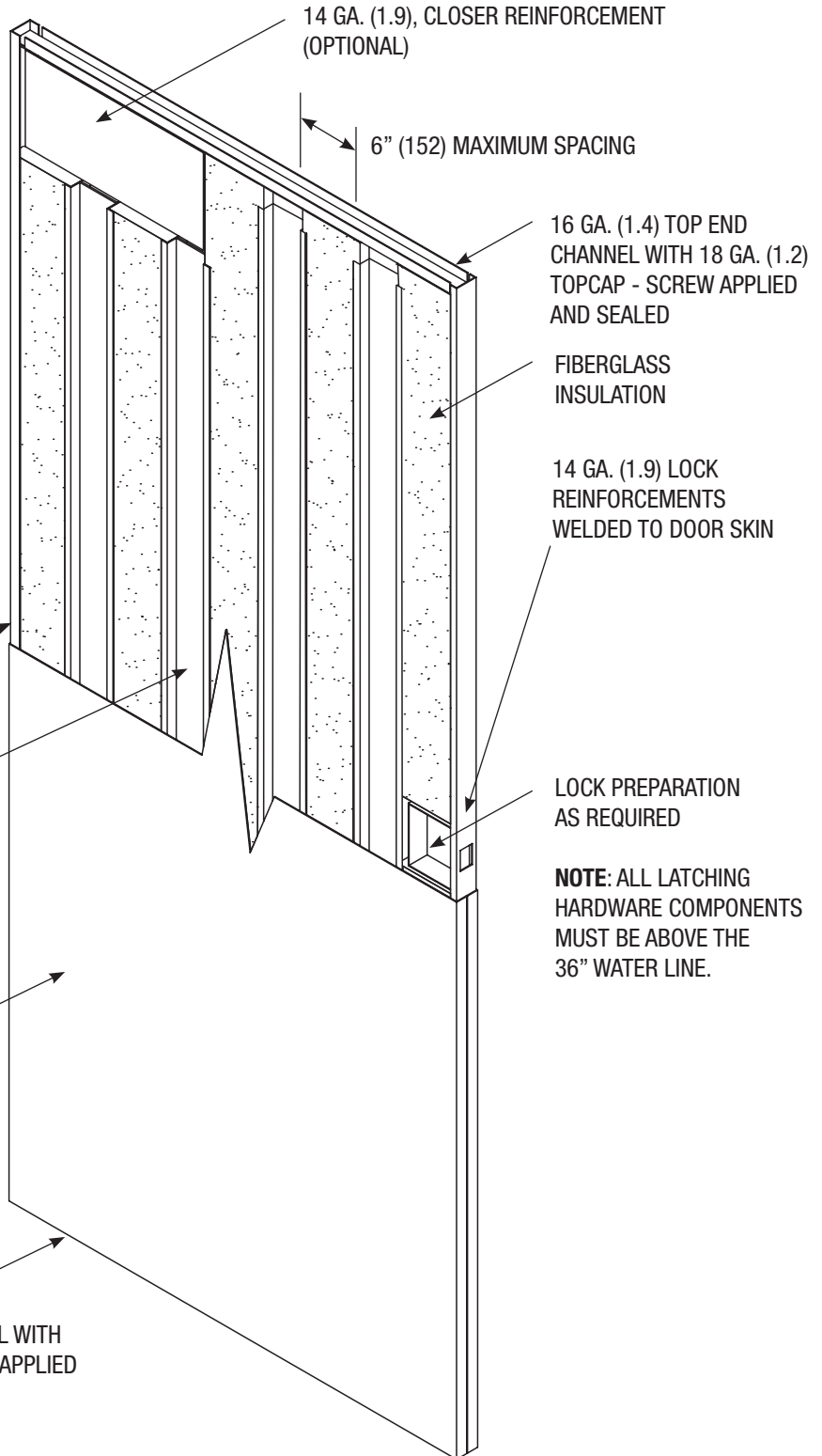


7 GA. (4.5) HINGE REINFORCEMENTS WELDED TO DOOR SKIN

22 GA. (.75) RIBS STANDARD  
20 GA. (.9), 18 GA. (1.2), 16 GA. (1.4) (OPTIONAL)

16 GA. (1.4) OR 14 GA. (1.9), A60 FACE SKINS SPOT WELDED TO RIBS AT 6" (152) MAX. SPACING

16 GA. (1.4) BOTTOM END CHANNEL WITH 18 GA. (1.2) BOTTOM CAP - SCREW APPLIED AND SEALED



16 GA. (1.4) TOP END CHANNEL WITH 18 GA. (1.2) TOPCAP - SCREW APPLIED AND SEALED

FIBERGLASS INSULATION

14 GA. (1.9) LOCK REINFORCEMENTS WELDED TO DOOR SKIN

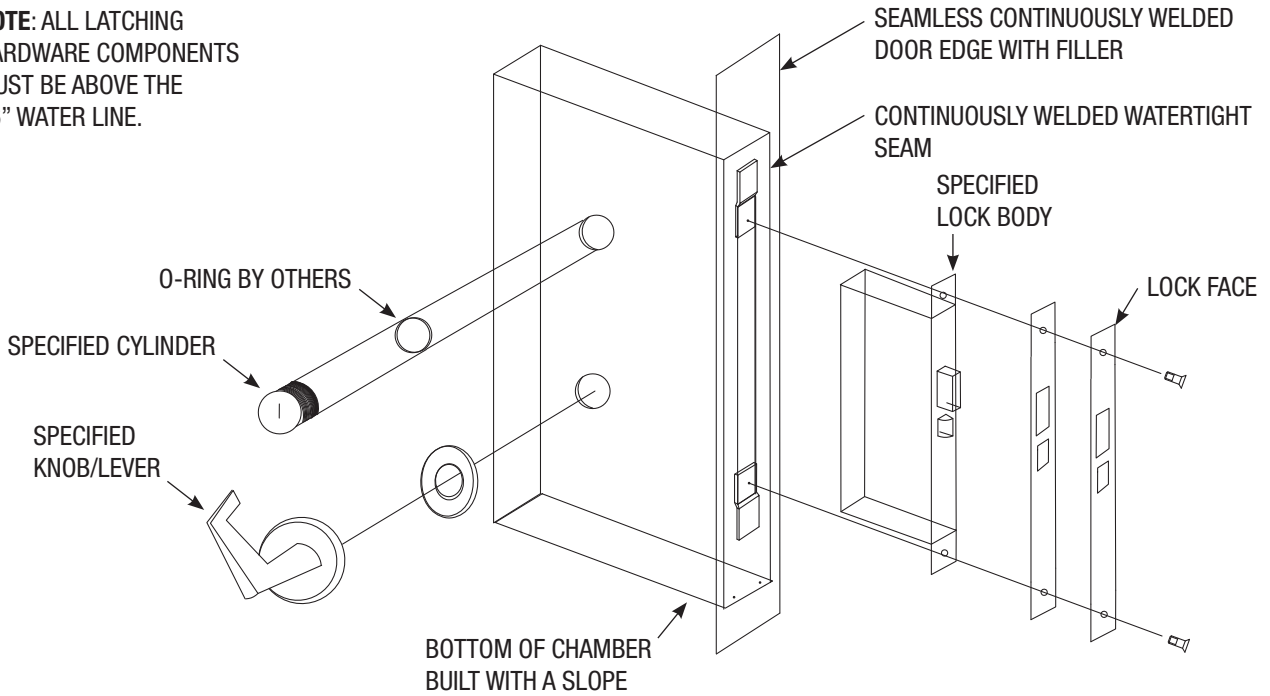
LOCK PREPARATION AS REQUIRED

**NOTE:** ALL LATCHING HARDWARE COMPONENTS MUST BE ABOVE THE 36" WATER LINE.

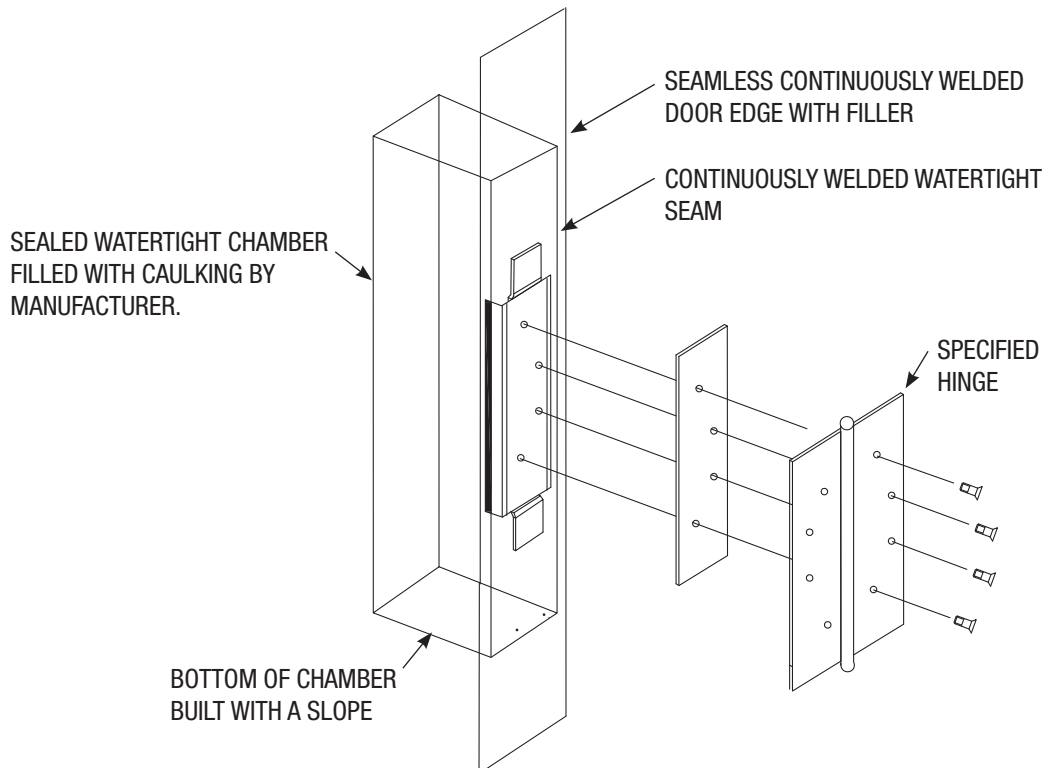


### Lock Prep

**NOTE:** ALL LATCHING HARDWARE COMPONENTS MUST BE ABOVE THE 36" WATER LINE.



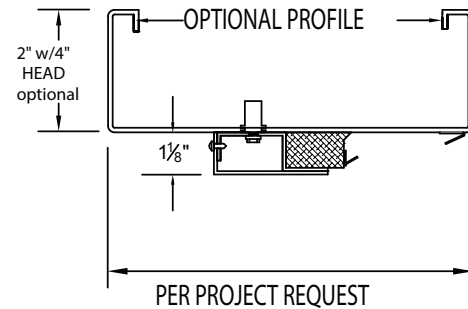
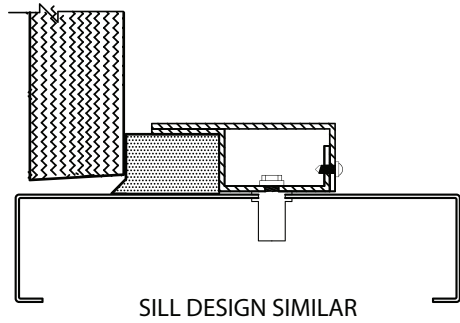
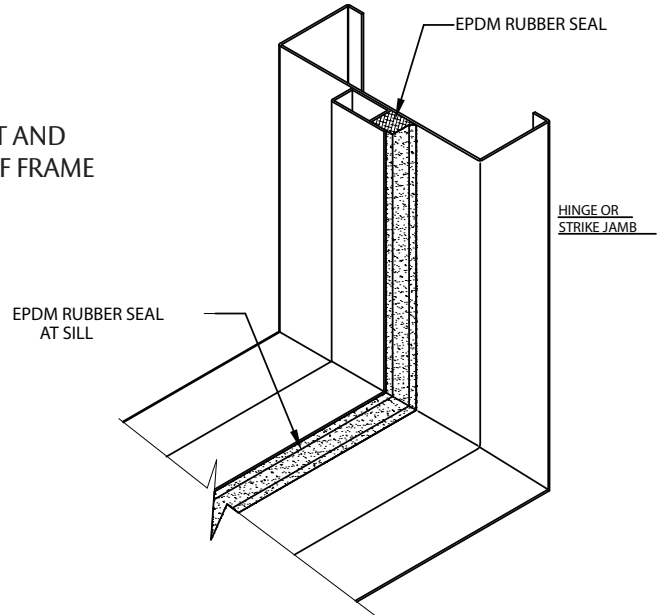
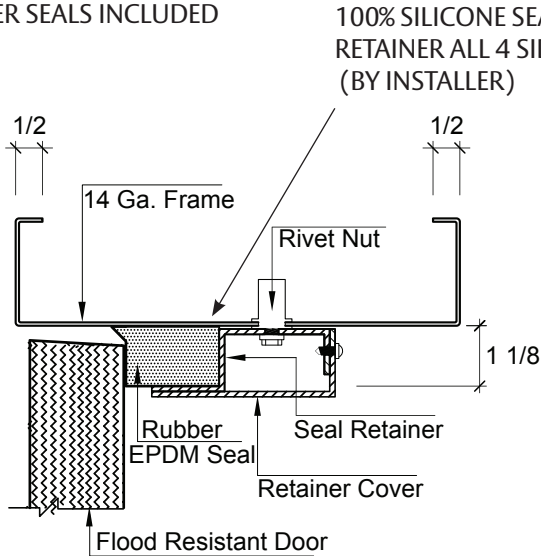
### Hinge Prep



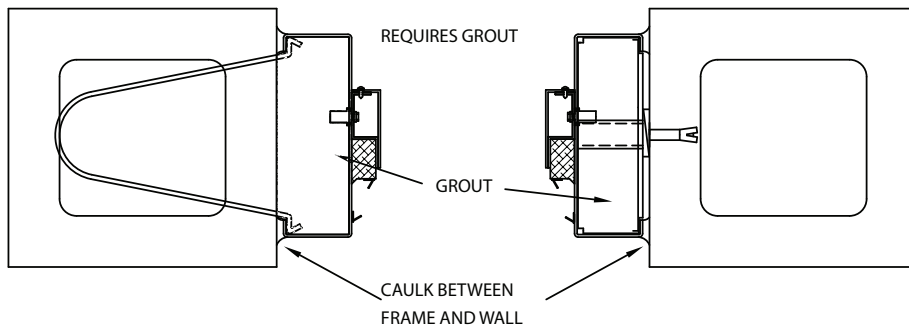
July, 2017

### FRM - MASONRY FRAME

- 4 SIDED WELDED FRAME CONSTRUCTION
- 14 TO 12 GAUGE FRAMES WITH OPTIONAL STAINLESS STEEL
- UP TO AND INCLUDING 3070 SIZES
- FRAMES MUST BE GROUTED
- PERIMETER SEALS INCLUDED



SOME COMMON MASONRY APPLICATIONS SHOWN BELOW.



**NOTE:** ALL LATCHING HARDWARE COMPONENTS MUST BE ABOVE THE 36" WATER LINE.

It is important that flood door systems be properly installed and sealed into the wall to prevent leakage. Flood Resistant systems are furnished with specific detailed seal installation instructions.



**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 items known commercially as finish or door hardware that are required for swing, sliding, and folding doors, except special types of unique hardware specified in the same sections as the doors and door frames on which they are installed. Also included in this Section are electrical hardware devices which shall be coordinated with the security access control and intrusion detection systems.
  - 1. Commercial door hardware for the following:
    - a. Swinging doors.
    - b. Other doors to the extent indicated.
  - 2. Cylinders for doors specified in other Sections.
  - 3. Electrified door hardware.
- B. Hardware specified herein is to cover all necessary material required to fully complete the hardware requirements of specified openings. It is the intention that the hardware specified shall be of sufficient quantities necessary to complete the Work. Notify the Architect of omissions or discrepancies prior to bid date for clarifications or instructions. Items which are not normally provided by the hardware contractor shall be identified in the bid proposal. Adjustments to the Contract Sum will not be allowed for omissions not clarified prior to bid opening.
- C. Coordinate electrical hardware requirements with Electrical Contractor.
- D. Related Sections include the following:
  - 1. Division 08 Section "Hollow Metal Doors and Frames."
  - 2. Division 08 Section "Steel Pedestrian Flood Doors."
  - 3. Division 26 Sections for connections to electrical power system and for low-voltage wiring work.
  - 4. Division 28 Section "Access Control" for access control devices installed at door openings and provided as part of a security access system.
- E. Products furnished, but not installed, under this Section include the following. Coordinating, purchasing, delivering, and scheduling remain requirements of this Section.
  - 1. Cylinders for locks specified in other Sections.

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

2. Permanent cores to be installed by Owner.

### 1.3 REFERENCES

- A. Use date of standard or code in effect as of Bid date.
- B. Local applicable codes.
  1. ANSI A117.1 – Specifications for making buildings and facilities usable by physically handicapped people.
- C. ADA – Americans with Disabilities Act of 1990
- D. DHI – Door and Hardware Institute
- E. ANSI 156.
- F. BHMA – Builders Hardware Manufacturers Association
- G. NFPA – National Fire Protection Association
  1. NFPA 80 – Fire Doors and Windows
  2. NFPA 101 – Life Safety Code
- H. UL – Underwriters Laboratories
- I. UL10C – Fire Tests of Door Assemblies (Positive Pressure)
- J. SDI – Steel Door Institute
- K. ANSI A115. W Series, Wood Door Hardware Standards. (American National Standard Institute)

### 1.4 SUBMITTALS

- A. Product Data: Include construction and installation details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Qualification Data: For Installer.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for locks, latches, delayed-egress locks and closers.
- D. Shop Drawings: Details of electrified door hardware, indicating the following:
  1. Wiring Diagrams: Power, signal, and control wiring. Include the following:
    - a. System schematic.
    - b. Point-to-point wiring diagram.
    - c. Riser diagram.
    - d. Elevation of each door with door number. Indicate standard electrical enclosures detailing the manufacturer's space and attaching requirements
  2. Detail interface between electrified door hardware and fire alarm and access control system.
  3. Operation Narrative: Describe the operation of doors controlled by electrified door hardware.
- E. Templates for doors, frames, and other work specified to be factory prepared for the installation of 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.
- F. Maintenance manuals for each different hardware item, including operation and maintenance instructions, parts listing with sources indicated, recommended parts inventory listing, emergency

instructions, and similar information. Include all diagnostic and repair information available to manufacture's and installer's maintenance personnel. Submit for Owner's information at Project close-out as specified in Division 1.

G. Warranty: Special warranty specified in this Section.

H. 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. 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. Include description and function of each lockset and exit device.
    - 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.
    - 9) Description of each electrified door hardware function, including location, sequence of operation, and interface with other building control systems.
      - a) Sequence of Operation: Include description of component functions that occur in the following situations: authorized person wants to enter; authorized person wants to exit; unauthorized person wants to enter; unauthorized person wants to exit.
    - 10) List of related door devices specified in other Sections for each door and frame.
  - c. 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. Coordinate with Owner's Representative and Security personnel.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by lock manufacturer.
  - 1. Installer's responsibilities include supplying and installing door hardware and providing a qualified Architectural Hardware Consultant available during the course of the Work to consult with Contractor, Architect, and Owner about door hardware and keying.
  - 2. Installer shall have warehousing facilities in Project's vicinity.
  - 3. Scheduling Responsibility: Preparation of door hardware and keying schedules.
  
- B. 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.
  - 1. Electrified Door Hardware Consultant Qualifications: A qualified Architectural Hardware Consultant who is experienced in providing consulting services for electrified door hardware installations.
  
- C. Source Limitations: Obtain each type and variety of door hardware from a single manufacturer, unless otherwise indicated.
  
- D. Approved manufacturers are as specified, acceptable manufacturers are listed for each type to establish minimum requirements
  
- E. Other Manufacturers: Submit Substitution Request prior to bid date conforming to the requirements of Division 1
  
- F. 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. Provide only items of door hardware that are listed and are identical to products tested by UL, Warnock Hersey, FM, or other testing and inspecting organization acceptable to authorities having jurisdiction for use on types and sizes of doors indicated in compliance with requirements of fire-rated door and door frame labels.
  
- G. Where exit devices are required on fire rated doors (with supplementary marking on door label indicating "Fire Door to be Equipped with Fire Exit Hardware"), provide label on exit device indicating "Fire Exit Hardware".
  
- H. 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.
  
- I. Pre-installation: Comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to electrified door hardware including, but not limited to, the following:
  - 1. Inspect and discuss electrical roughing-in and other preparatory work performed by other trades.
  - 2. Review sequence of operation for each type of electrified door hardware.
  - 3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

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4. Review required testing, inspecting, and certifying procedures.

### 1.6 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. Provide secure lock-up for door hardware delivered to the Project, but not yet installed. Control handling and installation of hardware items that are not immediately replaceable so that completion of the Work will not be delayed by hardware losses both before and after installation.
- D. Deliver keys and permanent cores to Owner by registered mail or overnight package service.
  1. Coordinate delivery with Owner's representative.

### 1.7 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.
- B. Electrical System Roughing-in: Coordinate layout and installation of electrified door hardware with connections to power supplies, fire alarm system and detection devices, and access control system.

### 1.8 WARRANTY

- A. General Warranty: Warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
- B. Hardware Manufacturer's Warranty: All hardware shall be free of defects and imperfections in manufacture and finish. Hardware shall be guaranteed by the manufacturer to perform all the various functions required for 12 months from date of Substantial Completion.
  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: Three years from date of Completion, except as follows:

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- a. Locks: Five years from date of Completion.
- b. Locksets & latchsets: Five years from date of Completion.
- c. Exit Devices: Two years from date of Completion.
- d. Manual Closers: 10 years from date of Completion.

### 1.9 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.
- B. Maintenance Service: Beginning at Substantial Completion, provide six months' full maintenance by skilled employees of door hardware Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door hardware operation. Provide parts and supplies same as those used in the manufacture and installation of original products.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
  1. Hinges (ball-bearing hinges):
    - a. Hager
    - b. Ives
  2. Continuous Hinges:
    - a. Markar Products, Inc.
  3. Cylinders, Keying systems and Key Control:
    - a. Best Patented (match Owner's existing standard system).
  4. Commercial Locksets, Deadlocks, & Cylinders:
    - a. Best 93k series (match Owner's existing standard system).
  5. Electric Strikes:
    - a. Von Duprin
  6. Door Closers:
    - a. LCN
  7. Exit Devices:
    - a. Von Duprin
  8. Overhead Stops and Holders:
    - a. Glynn Johnson

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9. Wall Stops, Floor Stops, Door Stops:
  - a. Ives
  - b. Hager
  - c. Trimco
  
10. Flush Bolts and Coordinators:
  - a. Ives
  - b. Hager
  - c. Trimco
  
11. Thresholds, Weather, Smoke Protection:
  - a. Hager
  - b. Pemko
  - c. Zero

### 2.2 SCHEDULED DOOR HARDWARE

- A. Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of finish hardware are indicated in Part 3 "Door Hardware Sets" Article. Manufacturers' names are abbreviated in Part 3 "Door Hardware Sets" Article. Products are identified by using hardware designation numbers as indicated in the Door Hardware Sets.
  
- B. Manufacturer's Product Designations: The product designation and name of one manufacturer are listed for each hardware type required for the purpose of establishing minimum requirements. Provide either the product designated or, where more than one manufacturer is specified under the Article "Manufacturers" in Part 2 for each hardware type, the comparable product of one of the other manufacturers that complies with requirements.
  
- C. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.

### 2.3 HINGES

- A. Templates: Provide only template produced units, except for hinges to be installed entirely (both leaves) into wood doors and frames.
  
- B. Screws: Finish of screw heads to match surface of hinges.
  
- C. Hinge Pins: Except as otherwise indicated, provide hinge pins as follows:
  1. Steel Hinges: Steel Pins.
  2. Non-Ferrous Hinges: Stainless Steel Pins.
  3. Reverse Bevel Doors with Locks Non-Removable Pins.
  
- D. Number of Hinges: Provide number of hinges indicated but not less than 3 ball bearing hinges for door leaf for doors 90 inches or less in height and one additional hinge for each 30 inches of additional height. Unless otherwise specified, hinge size for doors through 3'-0" shall be 4-1/2 inches x 4-1/2 inches.

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- E. Hinges for doors over 3'-0" wide shall be four ball bearing, heavy weight, 0.190 gage inches, 5 inches x 4-1/2 inches.
- F. Continuous hinges shall be pinned stainless steel type: continuous stainless steel 1/4 inch diameter hinge.

### 2.4 CYLINDERS, KEYING SYSTEMS AND KEY CONTROL

- A. Lock manufacturer shall meet with the Owner to finalize keying requirements and obtain keying instructions in writing as outlined in Division 1.
- B. Provide temporary, keyed alike cylinders and keys during construction period for exterior and interior locks. Temporary construction cylinders and operating keys shall not be part of the permanent keying system or furnished on the same keyway as the permanent keying system. Owner shall remove and replace temporary cylinders with specified permanent cylinders and keys.
- C. Permanent cylinders shall be shipped directly to the Owner. Owner will supply the labor to remove the construction cores and install the permanent cylinders.
- D. Key Material: Provide manufacturers standard embossed keys of nickel silver alloy to ensure accuracy in cutting and long cylinder wear. Quantities of permanent keys will be as determined by the Owner. Permanent keys shall be stamped with the applicable key mark as determined by the Owner for identification. In addition furnish 25 each temporary construction keys and 2 each key blanks per cylinder.

### 2.5 LOCKS, LATCHES AND BOLTS:

- A. Locksets and latchsets shall be heavy-duty cylindrical type with 9/16 inch throw, latchbolt.
- B. Provide manufacturer's standard wrought box strike for each latch or lock bolt, with curved lip extended to protect frame. Comply with UL requirements for throw of bolts and latch bolts on rated fire openings.

### 2.6 EXIT DEVICES:

- A. Provide exit devices of single manufacturer with specified functions which can accept exterior and interior cylinders of specified cylinders.
- B. Exit devices shall be touchpad style, plated to the standard architectural finishes to match the balance of the door hardware.
- C. All exit devices shall incorporate a fluid damper, which decelerates the touchpad on its return stroke and eliminates noise associated with exit device operation. All latchbolts to be deadlatching type, with a self-lubricating coating to reduce wear.
- D. End-cap will be sloped to deflect any impact from carts and they shall be flush with the external mechanism case. End caps that overlap and project above the mechanism case are unacceptable. End cap shall utilize a two-point attachment to the mounting bracket.



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- E. Only compression springs will be used in devices, latches, and outside trims or controls.
- F. Strikes shall be roller type and come complete with a locking plate to prevent movement.
- G. All rim and vertical rod exit devices shall have passed a 5 million (5,000,000) cycle test based on ANSI A156.3, 1994, Grade 1 test standards and certified by an independent testing lab.
- H. Exit devices shall be UL listed panic exit hardware. All exit devices for fire rated openings shall be UL labeled fire exit hardware.
- I. Lever trim for exit devices shall be vandal-resistant type, which will travel to a 90-degree down position when more than 35 pounds of torque are applied, and which can easily be re-set.
- J. Except on fire-rated doors equipped with exit devices, equip the units with cylinder dogging device to keep the latch bolt retracted when engaged.
- K. Furnish through bolted fasteners for all devices. Where required, provide projecting glass stop kits to provide clearance when used with projecting glass stops.
- L. Furnish top rod extension as required at vertical rod devices.

### 2.7 DOOR CLOSERS:

- A. Where manual closers are indicated for doors required to be accessible to the physically challenged, provide adjustable units complying with ANSI A117.1 provisions for door opening force and delayed action closing. Except as specifically indicated, comply with manufacturer's recommendations for size of door control units, depending upon size of door, exposure to weather, and anticipated frequency of use. Place closers inside building, stairs and rooms.
- B. Closers shall be certified to exceed 10,000,000 full load operating cycles by a recognized independent testing laboratory.
- C. Closers shall be cast iron construction with forged lever arms, independent adjusting valves for closing, latching and back check. Hydraulic regulation controlled by tamper-proof, non-critical screw valves.
- D. Provide all metal components with special rust inhibitor, powder coat finish. Closer finish shall exceed a minimum 100 hour salt spray test as described in ASTM B 117.
- E. Equip units with extra duty arms, EDA, to protect against excessive force. Where required, provide special template arms to allow clearance and applications of overhead stops and holders.
- F. Install closers to allow maximum degree of opening, position back check to activate well in advance of the stop position to cushion the opening swing and prevent door and frame damage. Unless specified, install closers with through bolt mounting method on metal and wood doors.

### 2.8 OVERHEAD STOPS AND HOLDERS

- A. Provide non-handed overhead stops and holders as listed in the hardware sets. Coordinate overhead holder and stop mounting with door closer to facilitate the optimum degree of door opening. Equip

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units with adjustable jamb bracket to allow adjustment after installation. Where required, furnish special templating application to prevent closer and overhead stop or holder from interfering with operation.

- B. Overhead stops and holders shall be certified to exceed 6,000,000 full load operating cycles by a recognized independent testing laboratory.
- C. Install overhead stops and holders with one piece sex bolts and machine screws. Do not install hold open devices on fire rated openings.

### 2.9 DOOR STOPS

- A. Furnish heavy duty satin nickel base concave wall stops, coincide with lock function, wherever door strikes wall. Where wall stop will not work because there is no adjacent perpendicular wall, an overhead stop shall be used or a "stop arm closer" at outswing doors where a door closer is specified.
- B. Provide gray resilient rubber bumpers.

### 2.10 FLUSH BOLTS AND COORDINATORS:

- A. Provide units UL listed up to 1-1/2 hours for use on wood or metal doors and 3 hours on metal fire rated doors. Furnish in investment cast steel, brass, bronze or stainless steel base material. Wrought materials will not be permitted.
- B. Units shall be non-handed, and feature adjustable rods to accommodate door and frame variations. Automatic flush bolts shall latch the inactive leaf of pair of doors, when the active door is closed. When the active door is opened, bolts will automatically retract, releasing the inactive door.
- C. Coordinators shall be UL Listed for use and applications on pair of doors. Mount coordinators on the stop strip of the frame. Furnish filler bars of necessary length to cover the remaining portion of the stop strip. Where required, provide cast aluminum mounting brackets to allow stop mounted hardware. Units shall be of structural steel components, housed in an aluminum channel. Furnished in a clear anodized finish ready for field painting if required.
- D. Provide spring loaded type dust proof strikes where manual or automatic operated flush bolts are applied. Provide units for applications in floor or threshold conditions.

### 2.11 THRESHOLDS AND SEALS

- A. Provide continuous weather, smoke, and/or light seals at jambs and heads and at door bottoms as specified. Smoke, or sound seals shall be rated in accordance with surrounding wall rating respective to sound or fire rating or as required by code. Unless otherwise indicated, provide metal threshold units of type, size and profile as shown or scheduled. Provide noncorrosive fasteners for exterior applications.
- B. Except as otherwise indicated, provide standard metal threshold unit of type, size, and profile as shown or scheduled.

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- C. Provide flood-resistant seals and thresholds at exterior doors where required as part of a complete pedestrian flood door system.

### 2.12 HARDWARE FINISHES, GENERAL

- A. Provide matching finishes for hardware units at each door opening, to the greatest extent possible, except as otherwise indicated. In general, match items to the manufacturer's standard finish for the lock / latchset color and texture.
- B. The designations used in schedules and elsewhere to indicate hardware finishes are those listed in ANSI Material and Finishes Standard A156.18, which are industry recognized standard commercial finishes.
- C. Refer to Part 3, "Door Hardware Sets" Article for typical hardware finishes.

### 2.13 MATERIALS AND FABRICATION

- A. Base Metals: Produce hardware units of basic metal and forming method indicated using manufacturer's standard metal alloy, composition, temper, and hardness, but in no case of lesser (commercially recognized) quality than specified for applicable hardware units for finish designations indicated.
- B. Fasteners: Provide hardware manufactured to conform to published templates, generally prepared for machine screw installation. Do not provide hardware that has been prepared for self-tapping sheet metal screws, except as specifically indicated.
- C. Furnish screws for installation with each hardware item. Provide Phillips flat-head screws except as otherwise indicated. Finish exposed (exposed under any condition) screws to match hardware finish or, if exposed in surfaces of other work, to match finish of this other work as closely as possible including "prepared for paint" surfaces to receive painted finish.

## 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.

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1. Surface-Applied Door Hardware: Drill and tap doors and frames according to ANSI A250.6.

B. Wood Doors: Comply with DHI A115-W Series.

### 3.3 INSTALLATION

A. Mounting Heights: Mount hardware units at heights indicated in following applicable publications, except as specifically indicated or required to comply with governing regulations and except as otherwise directed by Architect.

1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."

2. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."

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. Key Control System: Tag keys and place them on markers and hooks in key control system cabinet, as determined by final keying schedule.

D. Boxed Power Supplies: Locate power supplies as indicated. Verify location with Architect.

1. Configuration: Provide the least number of power supplies required to adequately serve doors with electrified door hardware.

E. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants."

### 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. Spring Hinges: Adjust to achieve positive latching when door is allowed to close freely from an open position of 30 degrees.

2. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.

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- 3. 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.
- B. Occupancy Adjustment: Approximately six months after date of Completion, Installer's Architectural Hardware Consultant shall examine and readjust, including adjusting operating forces, each item of door hardware as necessary to ensure function of doors, door hardware, and electrified door hardware.
  - 1. Consult with and instruct Owner's personnel in recommended additions to the maintenance procedures.
  - 2. Replace hardware items that have deteriorated or failed due to faulty design, materials, or installation of hardware units.
  - 3. Manufacturer's representatives for, locksets, cylinders, exit devices and door closers, are to inspect and approve, in writing, certification that items have been properly installed and are functioning in accordance with manufacturer's recommended installation procedures after installation. Prepare a written report of current and predictable problems (of substantial nature) in the performance of the hardware

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 Completion.

3.6 DOOR HARDWARE SETS

- A. General: Provide hardware for each door to comply with requirements of Section "Door Hardware," hardware set numbers indicated in door schedule, and in the following schedule of hardware sets.
- B. Hardware sets indicate quantity, item, manufacturer and product designation, size, and finish or color, as applicable.

- 1. Abbreviations used:

BE	Best	LC	LCN
B/O	By Others	PE	Pemko
GJ	Glynn-Johnson	ST	Stanley
HA	Hager	VO	Von Duprin
IV	Ives	YA	Yale
- 2. Typical Finishes:

	<u>BHMA</u>	<u>Nearest US Equivalent</u>
a. Hinge	626	US 26D
b. Locks	626	US 26D
c. Exit Devices	626	US 26D
d. Pulls, Trim	630	US 32D

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e.	Kickplates, Armor plates	630	US 32D
f.	Closer	689	US28, Sprayed Aluminum (AL)
g.	Weatherstripping, Thresholds	628	US28, Satin aluminum, clear anodized

- C. All cylinders to be supplied by contractor shall match the Owner’s existing Best Patented system; IC cores.
- D. Where wall stop will not work because there is no adjacent perpendicular wall, a concealed overhead stop shall be used or a “stop arm closer” at outswing doors where a door closer is specified.
- E. Door and frame manufacturer shall prepare and reinforce for door position switches, magnetic locksets and electric strikes identified by product number in hardware sets and furnished by Security Contractor.

DOOR HARDWARE GROUPS

Group # 1 - Entrance: Exterior Pedestrian Flood Door with Security Access.

EACH OPENING TO HAVE:

4	Ea	Butt Hinges	5BB1HW 4.5 X 4.5 NRP (US32D)	IV
1	Ea	Lockset (Storeroom) - <i>(if no rim device required by code)</i>	93K-7-D-16D-S3	BE
1	Ea	Rim Device <i>(where required by code)</i>	33A	VO
1	Ea	Surface Closer	4041 EDA – ST-1944	LC
1	Ea	Floor Stop	Supplied by BCBS	GJ
1	Set	Weatherstrip (jamb & head)	Per Manuf. requirements	-
1	Ea	Door Bottom	Per Manuf. requirements	-
1	Ea	Threshold (width of opening)	Per Manuf. requirements	-
1	Ea	Electric Strike	6212	VO
1	Ea	Security Access Control Card Reader and Control Device (by others)	Refer to Electrical	
1	Ea.	Door Position Switch (by others)	Refer to Electrical	
1	Ea	Power Supply (by others)	Refer to Electrical	

- Sequence of operation: Electric strike to be unlocked by card reader. Door position switch monitors door position.

Group # 2 - Office

EACH OPENING TO HAVE:

4	Ea	Butt Hinges	5BB1HW 4.5 X 4.5	IV
1	Ea	Lockset (Passage)	73K-0-L-16D-S3	BE
1	Ea	Surface Closer	4041	LC
3	Ea	Silencers	SR64	IV
1	Ea	Wall Stop	WS407CCV	IV

Group # 3 - Storeroom

EACH OPENING TO HAVE:

4	Ea	Butt Hinges	5BB1 4.5 X 4.5	IV
1	Ea	Lockset (Storeroom)	93K-7-AB-16D-S3	BE
3	Ea	Silencers	SR64	IV
1	Ea	Wall Stop	WS407CCV	IV

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Group # 4 - Privacy

EACH OPENING TO HAVE:

4	Ea	Butt Hinges	5BB1 4.5 X 4.5	IV
1	Ea	Lockset (Privacy)	93K-7-D-16D-S3	BE
1	Ea	Surface Closer	4041	LC
3	Ea	Silencers	SR64	IV
1	Ea	Wall Stop	WS407CCV	IV

END OF SECTION 087100

**SECTION 088000 - GLAZING**

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submit Product Data, shop drawings and 12-inch square samples of each exterior glass type.
- B. Comply with written instructions of glass product manufacturers; FGMA's "Glazing Manual"; and publications of AAMA, LSGA, and SIGMA as applicable to products indicated, unless more stringent requirements are indicated.
- C. Insulating-Glass Units: Permanently mark with appropriate certification label of one of the inspecting and testing agencies indicated below:
  - 1. Insulating Glass Certification Council (IGCC).
  - 2. Associated Laboratories, Inc. (ALI).
  - 3. National Certified Testing Laboratories (NCTL).

PART 2 - PRODUCTS

2.1 GLASS

- A. Float Glass: ASTM C 1036, Type I, Class 1 (clear), and Quality q3.
- B. Heat-Treated Float Glass (All interior window glass: ASTM C 1048, Condition A (uncoated) Type I, Class [1 (clear)], Quality q3, Kind FT (fully tempered).
- C. Wired Glass (for rated doors only): ASTM C 1036, Type II, Class 1, Quality q8; Form 1 polished with square mesh, 1/4" thick.
- D. Maximum SHGC: 0.66, maximum U-factor: 0.43.

2.2 FABRICATED GLASS PRODUCTS

- A. All exterior window, storefront and door glass except where noted: Sealed Insulating-Glass Units: 1" thick Preassembled Low-E units complying with ASTM E 774, with two 1/4" thick sheets of glass separated by a 1/2" dehydrated space. All glass tempered where required by code.
  - 1. Inboard lite: 1/4" clear float glass.
  - 2. 1/2" air space.
  - 3. Outboard lite: 1/4" Solargray float glass.
- B. Exterior sally port window glass: Sealed Insulating-Glass Units: 1" thick Preassembled Low-E units complying with ASTM E 774, with two 1/4" thick sheets of glass separated by a 1/2" dehydrated space.
  - 1. Inboard lite: 1/4" frosted float glass.
  - 2. 1/2" air space.
  - 3. Outboard lite: 1/4" Solargray float glass.
- C. All *interior* insulated glass: Sealed Insulating-Glass Units: 1" thick preassembled units



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complying with ASTM E 774, with two 1/4" thick sheets of glass separated by a 1/2" dehydrated space. All glass tempered where required by code.

1. Inboard lite: 1/4" clear float glass.
2. 1/2" air space.
3. Outboard lite: 1/4" clear float glass.

D. Interior non-insulated windows and door glass:

1. 1/4" clear float glass.
2. 1/4" clear tempered where required by code.
3. 1/4" wire glass where required for fire-rated doors.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Comply with combined recommendations of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are contained in FGMA's "Glazing Manual."
- B. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.
- C. Confirm that exterior of lite is set toward the building exterior.
- D. Install sealants to provide complete wetting and bond and to create a substantial wash away from glass.
- E. Remove and replace damaged glass and glazing.

END OF SECTION 088000

**SECTION 092216 - NON-STRUCTURAL METAL FRAMING**

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.
- B. Fire-Resistance-Rated Assemblies: Provide materials and construction identical to those tested in assemblies per ASTM E 119 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.
- C. STC-Rated Assemblies: Provide materials and construction identical to those tested in assemblies per ASTM E 90 and classified per ASTM E 413 by a qualified independent testing and inspecting agency.

PART 2 - PRODUCTS

2.1 METAL FRAMING AND SUPPORTS

- A. Steel Framing Members, General: ASTM C 754.
  - 1. Steel Sheet Components: ASTM C 645. Thickness specified is minimum uncoated base-metal thickness.
  - 2. Protective Coating: manufacturer's standard corrosion-resistant zinc coating.
- B. Soffit Framing:
  - 1. Furring Channels: Steel studs, 25 gauge (0.0179 inch; 0.454 mm) thick, in depth indicated, or steel rigid hat-shaped channels; 7/8 inch (22.2 mm) deep, 25 gauge (0.0179 inch; 0.454 mm).
- C. Partition and Soffit Framing:
  - 1. Studs and Runners: In depth indicated and 25 gauge (0.0179 inch; 0.454 mm) thick unless otherwise indicated.
  - 2. Slip-track SLP-TRK (or equal) system with slotted track in depth indicated and 25 gauge (0.0179 inch; 0.454 mm) thick.
  - 3. Flat Strap and Backing: 25 gauge (0.0179 inch; 0.454 mm) thick.
  - 4. Rigid Hat-Shaped Furring Channels: In depth indicated and 25 gauge (0.0179 inch; 0.454 mm) thick.
  - 5. Resilient Furring Channels: 1/2 inch (12.7 mm) deep, with single- or double-leg configuration.

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### 2.2 ACCESSORIES

- A. General: Comply with referenced installation standards.
  - 1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.
- B. Acoustical Sealant for Concealed Joints: Non-sag latex sealant complying with ASTM C 834.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install steel framing to comply with ASTM C 754 and with ASTM C 840 requirements that apply to framing installation and with United States Gypsum's "Gypsum Construction Handbook."
  - 1. Gypsum Plaster Assemblies: Also comply with ASTM C 841.
  - 2. Portland Cement Plaster Assemblies: Also comply with ASTM C 1063.
  - 3. Gypsum Veneer Plaster Assemblies: Also comply with ASTM C 844.
- B. Install supplementary framing and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- C. Where indicated, isolate steel framing from building structure to prevent transfer of loading imposed by structural movement.
- D. Fire-Resistance-Rated Assemblies: Comply with requirements of listed assemblies.

END OF SECTION 092216

**SECTION 092900 - GYPSUM BOARD**

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.
- B. Fire-Resistance-Rated Assemblies: Provide materials and construction identical to those tested in assemblies per ASTM E 119 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.
- C. STC-Rated Assemblies: Provide materials and construction identical to those tested in assemblies per ASTM E 90 and classified per ASTM E 413 by a qualified independent testing and inspecting agency.

PART 2 - PRODUCTS

2.1 PANEL PRODUCTS

- A. Provide in maximum lengths available to minimize end-to-end butt joints.
- B. Interior Gypsum Board: ASTM C 36/C 36M or ASTM C 1396/C 1396M, 5/8", Type X, with manufacturer's standard edges.
- C. Water-Resistant Gypsum Backing Board: ASTM C 630/C 630M or ASTM C 1396/C 1396M, 5/8", Type X at all restroom walls.

2.2 ACCESSORIES

- A. Trim Accessories: ASTM C 1047, formed from galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized-steel sheet. For exterior trim, use accessories formed from hot-dip galvanized-steel sheet, plastic, or rolled zinc.
  - 1. Provide cornerbead at outside corners unless otherwise indicated.
  - 2. Provide LC-bead (J-bead) at exposed panel edges.
  - 3. Provide control joints where indicated.
- B. Joint-Treatment Materials: ASTM C 475/C 475M.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install gypsum board to comply with ASTM C 840.
  - 1. Isolate gypsum board assemblies from abutting structural and masonry work. Provide edge trim and acoustical sealant.
  - 2. Single-Layer Fastening Methods: Fasten gypsum panels to supports with screws per structural specifications.
- B. Fire-Resistance-Rated Assemblies: Comply with requirements of listed assemblies.
- C. Finishing Gypsum Board: ASTM C 840.
  - 1. At concealed areas, unless a higher level of finish is required for fire-resistance-rated assemblies, provide Level 1 finish: Embed tape at joints.
  - 2. At substrates to receive FRP, provide Level 2 finish: Embed tape and apply separate first coat of joint compound to tape, fasteners, and trim flanges.
  - 3. Unless otherwise indicated, provide Level 4 finish: Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges.

END OF SECTION 092900

**SECTION 095123 - ACOUSTICAL PANEL CEILINGS**

**PART 1 - GENERAL**

1.1 SECTION REQUIREMENTS

- A. Submit Product Data and material Samples.
- B. Acoustical Panel Ceilings: Comply with ASTM E 1264 for Class A materials, as determined by testing identical products per ASTM E 84.
- C. Where fire-rating ceiling assemblies are required, provide acoustical panel ceilings that are identical in materials and construction to those tested for fire resistance per ASTM E 119, and that are listed in UL's "Fire Resistance Directory," in Warnock Hersey's "Certification Listings," or in the listing of another qualified testing and inspecting agency.

**PART 2 - PRODUCTS**

2.1 ACOUSTICAL PANELS:

- A. Armstrong #704 "Cortega" 2' x 2' with 15/16 angled tegular SLT edge, 5/8" thick, Color: White

2.2 CEILING SUSPENSION SYSTEMS

- A. Armstrong Prelude XL 15/16" exposed grid suspension system, non-rated, white, with intermediate duty structural classification according to ASTM C 635.
- B. Size attachment devices for 5 times the design load indicated in ASTM C 635, Table 1, Direct Hung, unless otherwise indicated.
- C. Zinc-coated carbon-steel wire hangers, braces, and ties complying with ASTM A 641 (ASTM A 641M), Class 1 zinc coating, soft temper.
  - 1. Select wire diameter so its stress at 3 times the hanger design load (ASTM C 635, Table 1, Direct Hung) will be less than the yield stress of wire, but provide not less than 0.106-inch- (2.69-mm) diameter wire.

**PART 3 - EXECUTION**

3.1 INSTALLATION

- A. Comply with the following:
  - 1. CISCA's "Ceiling Systems Handbook."
  - 2. CISCA's "Recommendations for Direct-Hung Acoustical Tile and Lay-in Panel Ceilings."
  - 3. ASTM C 636, "Standard for Ceiling Suspension System Installations."
  - 4. U.B.C. Standard 47-18.
- B. For systems requiring seismic restraint, comply with the following:
  - 1. CISCA's "Guidelines for Seismic Restraint of Direct-Hung Suspended Ceiling Assemblies."
  - 2. ASTM E 580, "Standard for Ceiling Suspension Systems Requiring Seismic Restraint."
- C. 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 tiles at borders.

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- D. Suspend ceiling hangers from building's structural members, plumb and free from contact with insulation or other objects within ceiling plenum. Splay hangers only where required, to miss obstructions; offset resulting horizontal forces by bracing, counter splaying, or other equally effective means. Where width of ducts and other construction within ceiling plenum produces hanger spacing's that interfere with location of hangers, use trapezes or equivalent devices.
- E. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels. Screw attach moldings to substrate with concealed fasteners at intervals not more than 16 inches o.c. and not more than 3 inches from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet. Miter corners accurately and connect securely.
- F. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- G. 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 a neat, precise fit.

END OF SECTION 095123

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**SECTION 096519 – RESILIENT TILE FLOORING**

**PART 1 GENERAL**

1.01 THIS SECTION INCLUDES

- A. Flooring and accessories as shown on the drawings and schedules and as indicated by the requirements of this section.

1.02 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract (including General and Supplementary Conditions and Division 1 sections) apply to the work of this section.

1.03 RELATED SECTIONS

- A. Other Division 9 sections for floor finishes related to this section but not the work of this section.
- B. Division 3 Concrete; not the work of this section.
- C. Division 6 Wood and Plastics; not the work of this section.
- D. Division 7 Thermal and Moisture Protection; not the work of this section.

1.04 QUALITY ASSURANCE AND REGULATORY REQUIREMENTS

- A. Select an installer who is competent in the installation of Vinyl Composition Tile flooring using all seaming methods.
- B. If required, provide types of flooring and accessories supplied by one manufacturer, including leveling and patching compounds, and adhesives.
- C. If required, provide flooring material to meet the following fire test performance criteria as tested by a recognized independent testing laboratory:
  - a. ASTM E 648 Critical Radiant Flux of 0.45 watts per sq. cm. or greater, Class I.
  - b. ASTM E 662 (Smoke Generation) Maximum Specific Optical Density of 450 or less.

1.05 SUBMITTALS

- A. Submit shop drawings, seaming plan, coving details, and manufacturer's technical data, installation and maintenance instructions for flooring and accessories.
- B. Submit the manufacturer's standard samples showing the required colors for flooring and applicable accessories.
- C. If required, submit the manufacturer's certification that the flooring has been tested by an independent laboratory and complies with the required fire tests.

1.06 ENVIRONMENTAL CONDITIONS



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- A. Deliver materials in good condition to the jobsite in the manufacturer's original unopened containers that bear the name and brand of the manufacturer, project identification, and shipping and handling instructions.
- B. Store materials in a clean, dry, enclosed space off the ground, and protected from the weather and from extremes of heat and cold. Protect adhesives from freezing. Store flooring, adhesives and accessories in the spaces where they will be installed for at least 48 hours before beginning installation.
- C. Maintain a minimum temperature in the spaces to receive the flooring and accessories of 65°F (18°C) and a maximum temperature of 100°F (38°C) for at least 48 hours before, during, and for not less than 48 hours after installation. Thereafter, maintain a minimum temperature of 55°F (13°C) in areas where work is completed. Protect all materials from the direct flow of heat from hot-air registers, radiators, or other heating fixtures and appliances.
- D. Install flooring and accessories after the other finishing operations, including painting, have been completed. Close spaces to traffic during the installation of the flooring. Do not install flooring over concrete slabs until they are sufficiently dry to achieve a bond with the adhesive, in accordance with the manufacturer's recommended bond and moisture tests.

### PART 2 PRODUCTS

#### 2.01 VINYL COMPOSITION TILE FLOORING MATERIALS

- A. Provide Vinyl Composition Tile Flooring manufactured by Armstrong Flooring, in color selected from the range currently available, 12in x 12 in (305 mm x 305 mm), having a nominal total thickness of 0.100in. (2.5mm). Colors and pattern detail shall be dispersed throughout the thickness of the wear layer. Vinyl Composition Tile shall conform to the requirements of ASTM F 1066, Class II, "Standard Specification for Vinyl Composition Floor Tile"
- B. Style to be Armstrong Standard EXCELON Imperial Series, color "Sterling."

#### 2.02 WALL BASE MATERIALS

- A. For top set wall base: Provide 1/8 in. (3.2 mm) thick, 4 in. (10.16 cm) high rubber wall base per section 096530.

#### 2.03 ADHESIVES

- A. Provide adhesive as recommended by the flooring manufacturer.
- B. Provide seam adhesive at seams as recommended by the manufacturer.

#### 2.04 ACCESSORIES

- A. For patching, smoothing, and leveling monolithic subfloors (concrete, terrazzo, quarry tile, ceramic tile, and certain metals), provide Cement-Based Underlayment and Patch and Skim Coat as recommended by the manufacturer.
- B. Provide transition/reducing strips tapered to meet abutting materials.

### PART 3 EXECUTION

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### 3.01 INSPECTION

- A. Examine subfloors prior to installation to determine that surfaces are smooth and free from cracks, holes, ridges, and other defects that might prevent adhesive bond or impair durability or appearance of the flooring material.
- B. Inspect subfloors prior to installation to determine that surfaces are free from curing, sealing, parting and hardening compounds; residual adhesives; adhesive removers; and other foreign materials that might prevent adhesive bond. Visually inspect for evidence of moisture, alkaline salts, carbonation, dusting, mold, or mildew.
- C. Report conditions contrary to contract requirements that would prevent a proper installation. Do not proceed with the installation until unsatisfactory conditions have been corrected.
- D. Failure to call attention to defects or imperfections will be construed as acceptance and approval of the subfloor. Installation indicates acceptance of substrates with regard to conditions existing at the time of installation.

### 3.02 PREPARATION

- A. Smooth concrete surfaces, removing rough areas, projections, ridges, and bumps, and filling low spots, control or construction joints, and other defects with Cement-Based Underlayment and Patch and Skim Coat as recommended by the flooring manufacturer.
- B. Remove paint, varnish, oils, release agents, sealers, and waxes. Remove residual adhesives as recommended by the flooring manufacturer. Remove curing and hardening compounds not compatible with the adhesives used, as indicated by a bond test or by the compound manufacturer's recommendations for flooring. Avoid organic solvents.
- C. Perform subfloor Calcium Chloride Tests (and Bond Tests) as needed to determine if surfaces are dry; free of curing and hardening compounds, old adhesive, and other coatings; and ready to receive flooring.
- D. Vacuum or broom-clean surfaces to be covered immediately before the application of flooring. Make subfloor free from dust, dirt, grease, and all foreign materials.

### 3.03 INSTALLATION OF TILE FLOORING

- A. Install flooring in strict accordance with the latest edition of the manufacturer's instructions.
- B. Install flooring wall to wall before the installation of floor-set furniture, equipment, lockers, movable partitions, etc. Extend flooring into toe spaces, door recesses, closets, and similar openings as shown on the drawings.
- C. If required, install flooring on pan-type floor access covers. Maintain continuity of color and pattern within pieces of flooring installed on these covers. Adhere flooring to the subfloor around covers and to covers.
- D. Scribe, cut, and fit or flash cove to permanent fixtures, columns, walls, partitions, pipes, outlets, and built-in furniture and cabinets.
- E. Adhere flooring to the subfloor without cracks, voids, raising and puckering at the seams. Roll with a 100-pound (45.36 kilogram) roller in the field areas. Hand-roll flooring at the perimeter and the seams to assure adhesion. Refer to specific rolling instructions of the flooring manufacturer.

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- F. Match edges for color shading and pattern at the seams in compliance with the manufacturer's recommendations.
- G. Install flooring with adhesives, tools, and procedures in strict accordance with the manufacturer's written instructions. Observe the recommended adhesive trowel notching, open times, and working times.
- H. Prepare sealed seams with special seam sealing adhesive supplied for this purpose. Use methods and sequence of work in conformance with written instructions of the flooring manufacturer. Finish all seams flush and free from voids, recesses, and raised areas.

### 3.04 INSTALLATION OF ACCESSORIES

- A. Apply top set wall base to walls, columns, casework, and other permanent fixtures in areas where top-set base is required. Install base in lengths as long as practical, with inside corners fabricated from base materials that are mitered or coped. Tightly bond base to vertical substrate with continuous contact at horizontal and vertical surfaces.

### 3.05 CLEANING AND PROTECTION

- A. Perform initial maintenance according to the latest edition of manufacturer's instructions.
- B. Protect installed flooring as recommended by the flooring manufacturer against damage from rolling loads, other trades, or the placement of fixtures and furnishings.

END OF SECTION 096516

**SECTION 096530 - RESILIENT WALL BASE AND ACCESSORIES**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. This Section includes the following:
  - 1. Rubber wall base.

**1.2 SUBMITTALS**

- A. Product Data: For each product indicated.
- B. Samples: For each product and for each color, pattern, and texture required.
- C. Certify that products furnished are asbestos free.
- D. Certify that products furnished meet or exceed specification requirements.

**1.3 PROJECT CONDITIONS**

- A. Maintain a temperature of not less than 70 deg F or more than 95 deg F in spaces to receive resilient accessories for at least 48 hours before installation, during installation, and for at least 48 hours after installation, unless manufacturer's written recommendations specify longer time periods.
  - 1. After post-installation period, maintain a temperature of not less than 55 deg F or more than 95 deg F.
- B. Install resilient accessories after other finishing operations, including painting, have been completed.

**PART 2 - PRODUCTS**

**2.1 WALL BASE:**

- A. Products: Subject to compliance with requirements, provide one of the following:
  - 1. Roppe Company rubber wall base or approved equal.
- B. Wall Base: Vulcanized SBR Rubber.
  - 1. Color and Pattern: From manufacturer's standard color line.
  - 2. Style: Cove base at all locations of carpet, linoleum/vinyl and concrete flooring (interior at finished wall locations only). Minimum Thickness: 1/8 inch.
  - 3. Height: 4 inches or 6 inches as indicated on drawings.
  - 4. Lengths/Coils in lengths standard with manufacturer, but not less than 48 inches.
  - 5. Outside Corners: Premolded
  - 6. Inside Corners: Premolded
  - 7. Surface: Smooth.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Before installing resilient wall base and accessories:
  - 1. Remove coatings, including curing compounds, 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.
  - 2. Move resilient products and installation accessories into spaces where they will be installed at least 48 hours before installation, unless longer conditioning periods are recommended in writing by manufacturer. Install products only after they are at the same temperature as the space where they are to be installed.
  - 3. Use trowelable leveling and patching compounds to fill cracks, holes, and depressions in substrates.
  - 4. Broom and vacuum clean substrates to be covered immediately before installing resilient products. After cleaning, examine substrates for moisture, alkaline salts, carbonation, or dust. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Adhesively install resilient wall base and accessories. Place resilient products so they are butted to adjacent materials.
- C. Apply resilient wall base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
  - 1. Install wall base in lengths as long as practicable without gaps at seams and with tops of adjacent pieces aligned.
  - 2. Tightly adhere wall base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
  - 3. Do not stretch base during installation.
  - 4. Install premolded outside corners and inside before installing straight pieces.
  - 5. Form outside corners on job, from straight pieces of maximum lengths possible, without whitening at bends. Shave back of base at points where bends occur and remove strips perpendicular to length of base that are only deep enough to produce a snug fit without removing more than half the wall base thickness.
  - 6. Form inside corners on job, from straight pieces of maximum lengths possible, by cutting an inverted V-shaped notch in toe of wall base at the point where corner is formed. Shave back of base where necessary to produce a snug fit to substrate.
- D. Where required, install reducer strips at edges of flooring that otherwise would be exposed.
- E. Immediately after installing resilient products, remove adhesive and other surface blemishes using cleaner recommended by resilient product manufacturers.

END OF SECTION 096530

**SECTION 096800 – CARPET TILE**

**PART 1- GENERAL**

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes new carpet tile and accessories for direct glue down installation.
- B. Related Sections include the following:
  - 1. Division 9 Section 093000 "Ceramic Tile" for coordination of transitions with carpet tile.
- C. Substitutions: Substitute products will not be considered.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include manufacturer's written data on physical characteristics, durability, and fade resistance. Include installation recommendations for each type of substrate.
- B. Shop Drawings: Shop Drawings: Not required for this scope. Contractor is to install per manufacturers recommendation and per contract document plans and details. Any changes to original plan are to be reviewed and approved by the project Architect prior to any installations.
- C. Samples: 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.
  - 1. Carpet Tile: Full-size Sample.
  - 2. Exposed edge, Transition, and other Accessory Stripping: 12-inch long Samples.
- D. Product Schedule: For carpet tile, use same designations as indicated on Drawings.
- E. Qualification Data: For Installer.
- F. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency.
- G. 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 including

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detailed instructions pertaining to hot water extraction methods.

2. Precautions for cleaning materials and methods that could be detrimental to carpet tile.
- H. Warranty: Special warranty specified in this Section.

### 1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer with not less than 5 consecutive years of experience in installation of commercial carpeting of type, quantity and installation methods similar to work of this section.
- B. Manufacturer's Qualifications: Firm (carpet mill) with not less than 5 consecutive years of production experience with carpet similar to type specified in this section; whose published product literature clearly indicates general compliance of products with requirements of this section.
- C. Measurement Verification: Dimensions shown on drawings are approximate. It is the Flooring Contractor's responsibility to verify all dimensions and job site conditions; order sufficient yardage to fully carpet areas as indicated and to fill overage requirements as specified. No substitutions shall be permitted to make up for any shortage of material in overage or in carpet to be installed.
- D. Flooring Contractor shall be totally responsible for the accuracy of his measurements of total yardage, individual floor yardage, and dye lot yardage requirements, extra yardage for pattern match, and roll length requirements; no additional compensation shall be allowed for shortage of materials.
- E. Dye Lots: All carpet of the same type in continuous areas shall be from the same dye lots.
- F. Owner reserves the right to test carpet at their expense to verify that the delivered carpet is as specified. If carpet does not meet specifications, manufacturer will reimburse owner the testing expense and the carpet may be rejected.
- G. Pre-installation Conference: Conduct conference at the project site. Review methods and procedures related to substrate preparation and carpet tile installation including, but not limited to the following:
1. Review delivery, storage, and handling procedures.
  2. Review ambient conditions and ventilation procedures.
  3. Review dust control procedures.
  4. Review requirements/procedures for protecting items to remain i.e.: furnishings, equipment, etc.

### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Comply with CRI 104, Section 5, "Storage and Handling."
- B. Deliver carpeting materials in original mill protective package with mill register numbers and tags attached. Maintain wrappers and protective covers in place until carpet is ready for installation. Store inside, in well-ventilated area, protected from weather, moisture and soiling.

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- C. Cutting: Before beginning installation, it shall be inspected for defects, color variations or shipping damage and be immediately replaced if any of these conditions exist at no additional cost to the Owner. Carpet tiles shall be inspected to insure that carpet is from the same dye lot.
- D. Deliver all required overages and maintenance stock to Owner's specified location prior to beginning installation.

### 1.6 PROJECT CONDITIONS

- A. Comply with CRI 104, Section 7.2, "Site Conditions; Temperature and Humidity" and Section 7.12, "Ventilation."
- B. Environmental Limitations: Maintain temperatures in space in accordance with carpet manufacturer's recommendations, but in no case less than 60 degrees F for 24 hours prior to, during and after installation. Sub-floor temperature should be a minimum of 60 degrees F for 24 hours prior to and after installation.
- C. Precondition: All of the carpet shall be stored in a room on site 24 hours prior to actual installation with the room preconditioned at a minimum of 60 degrees F with humidity between 35% to 65%.

### 1.7 SEAMING REQUIREMENTS

- A. General: In addition to the requirements and recommendations of the Carpet Manufacturer, the following criteria shall be adhered to:
  - 1. Installation layout shall enable future replacement, especially in large open areas and traffic paths, unless specifically indicated in writing by Owner or Owner's Representative.
  - 2. No carpet tile pieces smaller than 6" in width or length shall be used.
  - 3. Seams occurring at doors of different types of carpet shall be parallel to closed door, and be centered directly under the closed door.
  - 4. Flooring Contractor is responsible for trimming all loose yarn and fuzzy edges of carpet tiles.
  - 5. All cutting of carpet for telephone and electrical outlets shall be the responsibility of the Flooring Contractor.

### 1.8 WARRANTY

- A. Warranty for Carpet Tiles: Manufacturer's standard form in which manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.
  - 1. Provide special warranty, signed by Flooring Contractor and Carpet Manufacturer, agreeing to repair or replace defective materials and workmanship of carpeting work during a 10 year warranty period following date of Substantial Completion. Attached copies of product warranties as required in Part 2, item 2.1 of this specification section for warranties required.



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### 1.9 EXTRA MATERIALS

- A. Furnish extra materials described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver to the Owner uncut in clearly marked dust-proof packages prior to commencement of work; store where directed.
  - 1. Carpet Tile: Full-size units equal to 2 percent of amount installed for each type indicated, but not less than 10 sq. yd.

## PART 2 - PRODUCTS

### 2.1 CARPET TILE

- A. Available Products: Subject to compliance with requirements, products are limited to the following.
  - 1. Carpet Tile:
    - a. Manufacturer: Mohawk Group
    - b. Style: Sequences II Collection
    - c. Pattern: Ground Strata II
    - d. Color: Celestial 975
- B. Construction: Tufted
- C. Surface Texture: Textured Patterned Cut & Loop
- D. Pile Thickness: .123"
- E. Gauge: 1/12
- F. Face Weight: 21 oz. per sq. yd.
- G. Face Yarn: Duracolor® Premium Nylon
- H. Fiber Technology: Duracolor® by Mohawk Group's Stain Resistant System. Passes GSA requirements for permanent stain resistant carpet.
- I. Backing Material: EcoFlex NXT
- J. Size: 24" x 24"
- K. Static Control: AATCC 134 Under 3.5 KV
- L. Flammability:
  - 1. Passes DOC-FF-1-70 Pill Test
  - 2. Floor Radiant Panel: Meets NFPA Class 1 when tested per ASTM-E-648 glue down

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- M. NBS Smoke Chamber NFPA 258: Less than 450 Flaming Mode; ASTM E 662
- N. Colorfastness:
  - 1. Lightfastness: AATCC 16E-1982- Dark Color: Gray scale rating of 4 or better after 160 standard fading hours as compared to AATCC Gray Scale for evaluation change in color.
  - 2. Ozone and Gas: AATCC 129-1981- Rating 3 or better per color AATCC transference scale.
- O. Warranties:
  - 1. Definition of Lifetime: Lifetime is defined as the period from which materials are installed until the date in which the Owner removes them from service.
  - 2. Mohawk Group's manufacturer's Lifetime Warranty, non-prorated against product failure covering all costs including freight, labor, and material for the following:
    - a. Edge Ravel/Tuft Bind
    - b. Back lamination
    - c. Static protection as stated above
    - d. Wear -No more than 10% face yarn loss
    - e. Cup, Dome, Dish
    - f. Dimensional stability
    - g. Adhesive bond to floor
    - h. Permanent stain resistance to acid-type spills
  - 3. Installation Warranty: Lifetime Warranty, non-prorated against any installation related failure covering all costs including freight, labor and material co-signed by the flooring contractor and the manufacturer.
- P. Stain Resistance: Built into Fiber
  - 1. Stain resistant properties must be permanent and not removable by commercial cleanings or abrasive wear. Under GSA requirements stain resistant carpets must score no less than 8.0 (10.0 is the best) on the AATCC Red 40 Stain Scale. Test sample must first be exposed to 100 revolutions on the Taber Abrader (1,000-gram weight per H-18 wheel) and then abraded area must be stain tested using AATCC test method 175. Topical stain resistant treatments will not be acceptable. Stain resistant properties must be inherent.

### 2.2 WALK-OFF CARPET TILE

- A. Available Products: Subject to compliance with requirements, products are limited to the following.
- B. Walk-off Carpet Tile:
  - a. Manufacturer: Tandus Centiva
  - b. Style: Triad Mat Systems Geometric Tile
  - c. Pattern: Geo Tile 00979
  - d. Color: Charcoal 00154
- B. Construction: Molded Reinforced Needle-punch Textile

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- C. Surface Texture: Molded Reinforced Needle-punch Textile
- D. Pile Thickness: .250"
- E. Face Weight: 24 oz. per sq. yd.
- F. Fiber Technology: 100% Premium Polypropylene
- G. Size: 18" x 18"
- H. Flammability:
  - 1. Passes CPSC FF 1-70 (ASTM D-2859)
  - 2. Floor Radiant Panel: Meets NFPA Class 2 when tested per ASTM-E-648 glue down
- I. NBS Smoke Chamber NFPA 258: Less than 450 Flaming Mode
- J. Warranties:
  - 1. Definition of Lifetime: Lifetime is defined as the period from which materials are installed until the date in which the Owner removes them from service.
  - 2. Tandus Centiva manufacturer's Lifetime Warranty, non-prorated against product failure covering all costs including freight, labor, and material for the following:
    - a. Edge Ravel/Tuft Bind
    - b. Back lamination
    - c. Static protection as stated above
    - d. Wear -No more than 10% face yarn loss
    - e. Cup, Dome, Dish
    - f. Dimensional stability
    - g. Adhesive bond to floor
    - h. Permanent stain resistance to acid-type spills
  - 3. Installation Warranty: Lifetime Warranty, non-prorated against any installation related failure covering all costs including freight, labor and material co-signed by the flooring contractor and the manufacturer.

### 2.3 INSTALLATION ACCESSORIES

- A. Adhesives: Water-resistant, mildew resistant, non-staining, pressure-sensitive type to suit products and sub-floor conditions indicated, that complies with flammability requirements for installed carpet tile and is recommended by carpet tile manufacturer for releasable installation. All floor sealers, seam sealers and adhesives shall contain no calculated solvents per OSHA Regulation 29 CFRE 1910.1200, have no calculated VOC's and be non-flammable. MSDS and samples required on products used.
- B. At transition from carpet tile to other flooring:  
Schluter brand with clear anodized aluminum finish, or approved equal, style appropriate for transition.
- C. Miscellaneous Materials: As recommended and approved in writing by manufacturer of carpet, and selected by Flooring Contractor to meet project circumstances and requirements.

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- D. Protection Paper: Fortifiber Corporation "Seekure 892", or approved heavy, reinforced, non-staining kraft laminated paper.

### 2.3 SUBMITTAL CHECKLIST

- A. Checklist Instructions: For all submittals for substitutions, submitter must include the checklist at the end of this section, completely filled out and signed by an officer of the company. Failure to provide this documentation will result in rejection of submittal
  1. Fill in the left column with the actual data as it pertains to your substitute. If more room is required, attach additional pages.
  2. Circle either yes or no indicating whether or not the submitted product meets or exceeds the specification requirements for each checklist item.
- B. Checklist Form: See end of this section.

## PART 3- EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance. Examine carpet tile for type, color, pattern, and potential defects against the approved samples prior to installation.
- B. Concrete Sub-floors: Verify that concrete slabs comply with ASTM F 710 and the following:
  1. Slab substrates are dry and free of curing compounds, sealers, hardeners, and other materials that may interfere with adhesive bond. Determine adhesion and dryness characteristics by performing bond and moisture tests recommended by carpet tile manufacturer.
  2. Sub-floors are free of cracks, ridges, depressions, scale, and foreign deposits.
- C. In the event of discrepancy, notify Owner. Do not proceed with installation in areas of discrepancy until all such unsatisfactory conditions have been corrected. Start of carpet installation indicates acceptance of sub-floor conditions and full responsibility for completed work.

### 3.2 PREPARATION, GENERAL

- A. General: Comply with CRI 104, Section 6.2, "Site Conditions; Floor Preparation," and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile installation.

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- B. 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 carpet tile manufacturer.
- C. Prepare the sub-floor to insure a successful installation. Utilize a floor sealer such as Lees Everseal where needed or recommended by Manufacturer.
- D. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

### 3.3 INSTALLATION, GENERAL

- A. General: Comply with CRI 104, Section 14, "Carpet Modules," 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.
- C. 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.
- D. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- E. Carpet shall be installed with pile lying in the same direction. Cut carpet evenly and accurately to fit neatly at walls, columns and projections,
- F. Installed carpet shall be free from ripples, ravel, frays, puckers and raw exposed edges. All loop pile carpets will demonstrate some fuzzy edges due to normal manufacturing conditions. It is the carpet installer's responsibility to trim all edges to eliminate fuzzy seams.
- G. Expansion Joints: Do not bridge building expansion joints with continuous carpeting, provide for movement.

### 3.4 CLEANING AND PROTECTION

- A. Remove and dispose of debris and unusable scraps.
- B. Perform the following operations immediately after installing carpet tile:
  - 1. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet tile manufacturer. Replace carpet where spots cannot be removed.
  - 2. Remove yarns that protrude from carpet tile surface using sharp scissors. Be certain to trim any loose yarns or fibers at all seams.
  - 3. Vacuum carpet tile using two motor, top loading, upright commercial machine with brush only element, utilizing a high filtration dust bag.
- C. Following cleaning and vacuum carefully protect the carpeting from soiling and damage

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until formal acceptance.

- D. Maintenance Materials: Deliver usable, uncut carpet tiles to Owner's designated storage space, properly packaged and identified. Dispose of smaller pieces as construction waste.

END OF SECTION 096800

**SECTION 099100 - PAINTING**

**PART 1: GENERAL**

**1.01 DESCRIPTION OF WORK**

**A. Work Included in This Section:**

1. Provide all labor, material, equipment, and services necessary to complete painting and finishing of all exposed surfaces throughout the interior and exterior of the structure, including appurtenances thereto, and top, bottom, and all edges of all wood doors. Except as specifically indicated otherwise, all "paint" finishes other than factory finish shall be job applied.
2. Coatings specified herein or included in the finish schedule are in addition to other coatings which may be required by other sections.
3. Unless otherwise noted, factory applied finishes on electrical panel covers, and devices; mechanical grilles, registers and louvers; fire extinguisher cabinets, and similar items shall be considered prime coats. Surfaces shall be cleaned and de-glossed by sanding or other means prior to field painting to match adjacent surfaces unless otherwise noted.
4. Mechanical and Electrical equipment exposed and visible from the exterior of the building, including roof mounted units, shall be job painted if directed by the Architect.
5. The painting contractor shall examine the specifications for the various other trades and shall thoroughly familiarize himself with all conditions of the work of this Section.

**B. Related Work Specified Elsewhere:**

1. Prefinishing: Shop priming and factory prefinishing are required on some items described in other Sections of these Specifications.
2. SEALANTS AND CAULKING Section
3. GYPSUM WALLBOARD AND CEMENT BOARD Section
4. ARCHITECTURAL WOODWORK Section
5. FINISH CARPENTRY AND MILLWORK Section
6. METAL DOORS AND FRAMES Section
7. METAL FABRICATIONS Section

**C. Definitions:** The term "paint", as used herein, includes enamels, paints, sealers, fillers, emulsions, and other coatings whether used as prime, intermediate, or finish coats.

**1.02 INCORPORATED DOCUMENTS**

The provisions and requirements of the General and Supplementary Conditions and Division-1 Specifications sections of these Bid Documents apply to this section. The Contractor shall be responsible for, and governed by all requirements thereunder. In addition to the Codes and Standards listed in Division 1, the published specifications, standards and methods of the trade cited below shall apply to work of this Section.

- A. "Standard (Type 1)" as defined by the Painting and Decorating Contractors of America in their "Modern Guide to Paint Specifications", latest edition.
- B. All materials and application of materials shall comply with the latest regulations of the California Air Resources Board and local Air Pollution Control District having jurisdiction.

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### 1.03 SUBMITTALS

Submittals shall be in accordance with SUBMITTALS Section of these Specifications and shall include the following:

#### A. Materials List:

1. Before any paint materials are delivered to the job site, submit to the Architect a complete list of all materials proposed to be furnished and installed under this portion of the Work.
2. Accompanying the materials list submit two copies of the full range of colors available in each of the proposed products.

#### B. Samples:

1. Prepare and deliver to the Architect two (2) identical sets of samples:
  - a. Paint samples of each color and sheen selected on 8-1/2" x 11" card stock.
  - b. Samples of each stain, opaque stain and clear finish selected on the same material as that on which the coating will be applied in the Work. Sample size shall be 12" x 12".

#### C. Manufacturers' Recommendations: In each case where material proposed is not the material specified or specifically described as an acceptable alternate in this Section of these specifications, submit for the Architect's review the current recommended method of application published by the manufacturer of the proposed material.

### 1.04 EXTRA STOCK

Upon completion of this portion of the Work, deliver to the Owner an extra stock of paint of each color used in each coating material used, with all such extra stock tightly sealed in clearly labeled containers. Confirm with Owner for quantities required.

## PART 2: PRODUCTS

### 2.01 PAINT MATERIALS

#### A. Manufacturer:

1. All paint materials selected for coating systems for each type of surface shall be the product of a single manufacturer.
2. Acceptable Manufacturers: The paint standard for this project has been established as the products of Benjamin Moore, Kwal or Sherwin Williams.

#### B. Compatibility:

1. All paint materials and equipment shall be compatible in use; finish coats shall be compatible with prime coats; prime coats shall be compatible with the surface to be coated; all tools and equipment shall be compatible with the coating to be applied.
2. Thinners, when used, shall be only those thinners recommended for that purpose by the manufacturer of the material to be thinned.

### 2.02 COLOR SELECTIONS

Bid price shall include up to four (4) different colors on the exterior of the building and up to eight (8) different colors on the interior of the building.



PART 3: EXECUTION

3.01 SURFACE CONDITIONS

A. Inspection:

1. Prior to all work of this Section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.
2. Verify that paint finishes may be applied in strict accordance with all pertinent codes and regulations and the requirements of these Specifications.

B. Discrepancies: In the event of discrepancy, immediately notify the Architect. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

3.02 PREPARATION OF SURFACE, GENERAL

A. Protection: Prior to all surface preparation and painting operations, completely mask, remove, or otherwise adequately protect all hardware, accessories, machined surfaces, plates, lighting fixtures, and similar items in contact with painted surfaces but not scheduled to receive paint.

B. Priming: Spot prime all exposed nails and other metals which are to be painted with emulsion paints, using a primer recommended by the manufacturer of the coating system.

C. Cleaning:

1. Before applying paint or other surface treatment, thoroughly clean all surfaces involved.
2. Schedule all cleaning and painting so that dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.

3.03 PREPARATION OF WOOD SURFACES

A. Filling: Nail holes, cracks or defects shall be carefully puttied after the first coat, with putty matching color of stain or paint.

B. Smoothing:

1. Unless specifically noted to be left rough, smooth all finished wood surfaces exposed to view, using the proper sandpaper.
2. Where so required, use varying degrees of coarseness in sandpaper to produce uniformly smooth and unmarred wood surfaces.

C. Knots:

1. On small, dry, seasoned knots, thoroughly scrape and clean the surface and apply one coat of good quality knot-sealer before application of the priming coat.
2. On large, open, unseasoned knots, scrape off all pitch and thoroughly clean the area, followed by an application of one coat of good quality knot-sealer.
3. Remove and treat all pitch surfaces as required for large knots.

D. Dryness: Unless specifically approved by the Architect, do not proceed with the painting of wood surfaces until the moisture content of the wood is 12% or less as measured by a moisture-meter approved by the Architect.

3.04 PREPARATION OF METAL SURFACES

A. Galvanized Metal:

1. Clean all surfaces thoroughly with mineral spirits until they are completely free from dirt, oil and grease.

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2. Apply specified pretreatment wash primer or thoroughly treat the cleaned surface with phosphoric acid etch. Remove all excess etching solution and allow to dry completely before application of paint.
- B. Other Metals: Thoroughly clean all surfaces until they are completely free from dirt, oil and grease. Allow to dry thoroughly before application of paint.
- C. Factory applied finishes on electrical panel covers and devices, mechanical grilles, registers and louvers, fire extinguisher cabinets, and similar items shall be cleaned and de-glossed by sanding or other means prior to field painting.

### 3.05 PREPARATION OF MASONRY SURFACES

- A. Clean all masonry surfaces per instructions of paint manufacturer.
- B. Lightly sandblast surface as required to remove stains, efflorescence, or other surface condition that will affect paint application.
  1. Where sandblasting is used, ensure that resulting masonry surface is uniform from corner to corner.
- C. Dryness: Unless specifically approved by the Architect, do not proceed with the painting of masonry surfaces until the moisture content of the masonry is 12% or less as measured by a moisture-meter approved by the Architect.

### 3.06 PAINT APPLICATION

- A. General:
  1. Paint all surfaces except glass, masonry, flat concrete, and similar items not pre-finished and not called out as unfinished.
  2. Paint all grilles, registers, louvers and panel-board covers and other mechanical and electrical items to match adjacent surfaces unless noted otherwise.
  3. Top, bottom and all edges of all wood doors shall be finished as follows:
    - a. Wood Faced Doors: 3 coats same as for face.
- B. Drying:
  1. Allow sufficient drying time between coats. Manufacturer's recommended drying time for re-coating shall be considered as minimum.
  2. Extend the period as recommended by the material manufacturer to suit adverse weather conditions.
  3. The application of another coat of paint shall not cause lifting or loss of adhesion of the undercoat.
- C. Environmental Conditions:
  1. Comply with the manufacturer's recommendations as to environmental conditions under which the coating systems may be applied. No coating shall be applied when ambient temperature is below that recommended by the manufacturer.
  2. Do not apply paint in areas where dust is being generated.
- D. Moisture Content: Do not apply the initial coating until moisture content of surfaces are within the limits recommended by the paint materials manufacturer.
- E. Defects: Sand and dust between coats to remove all defects visible to the unaided eye from a distance of five feet.

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- F. Color of Undercoats: Slightly vary the color of succeeding coats, except with deep tone colors all coats shall be final color.

### 3.07 INSPECTION

- A. General: Do not apply additional coats until completed coats have been inspected and approved by the Architect.
- B. Number of Coats: Only inspected and approved coats of paint will be considered in determining the number of coats applied.

### 3.08 DRY MIL THICKNESS

- A. General: Apply all coatings to the dry mil thickness recommended by the paint manufacturer.
- B. Measurement: When specifically requested by the Architect, provide and use a "Tooke Dry Film Thickness Gage", or other gage approved by the Architect, to prove the dry mil thickness of paint applied.

### 3.09 REINSTALLATION OF REMOVED ITEMS

Following completion of painting in each space, promptly reinstall all items removed for painting, using only workmen skilled in the particular trade.

### 3.10 ADJUST AND CLEAN

- A. General
1. During progress of the Work, do not allow the accumulation of empty containers or other excess items except in areas specifically set aside for that purpose.
  2. Prevent accidental spilling of paint materials and, in event of such spill, immediately remove all spilled material and the waste of other equipment used to clean up the spill, and wash the surfaces to their original undamaged condition or replace damaged material, all at no additional cost to the Owner.
- B. Prior to Final Inspection: Upon completion of this portion of the Work, visually inspect all surfaces and remove all paint and traces of paint from surfaces not scheduled to be painted.

### 3.11 PAINTING SCHEDULE

The painting schedule shall be a standard for coatings in areas designated. Refer to Drawings for finish required at specific items and areas. Some types may not be required for this project. The number of coats indicated shall be considered a minimum. Additional coats shall be required if chromatic hue is not uniform in appearance or if undercoat or substrate ghosting is evident. Apply the following specified finishes to the areas designated and indicated on the Drawings.

#### INTERIOR FINISHES

Type P-1 (interior gypsum drywall, masonry, or plywood – semi-gloss 100% acrylic)

First Coat (at gypsum drywall and plywood): Interior Flat Wall Paint

First Coat (at concrete masonry) Concrete Block Filler - Smooth

Second Coat: Interior Semi-gloss Acrylic Paint

Third Coat: Interior Semi-gloss Acrylic Paint

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EXTERIOR FINISHES

Type P-53 (exterior galvanized and aluminum – gloss 100% acrylic)

First Coat: Epoxy Galvanized/Aluminum Primer

Second Coat: Exterior Acrylic Gloss Paint

Third Coat: Exterior Acrylic Gloss Paint

Paint to match adjacent wall panels.

END OF SECTION 099100

**SECTION 102113 - TOILET COMPARTMENTS**

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data, Shop Drawings, and Samples.

PART 2 - PRODUCTS

2.1 TOILET COMPARTMENTS AND SCREENS

- A. Products:
  - 1. ASI Global Partitions; Solid Plastic Floor Mounted Overhead braced Toilet Partitions; Wall-Hung Urinal and Privacy Screens

2.2 MATERIALS

- A. Panel, Pilaster, and Door Material:
  - 1. Solid-Plastic (HDPE);
  - 2. Color: 9400 Folkstone Gray
- B. Pilaster Shoes and Sleeves (Caps): Stainless steel, not less than 3 inches (75 mm) high.
- C. Brackets: Stirrup.
  - 1. Material: Stainless steel.

2.3 FABRICATION

- A. Toilet Compartments: Overhead braced and floor anchored.
- B. Solid-Plastic Units: Provide aluminum heat-sink strips at exposed bottom edges of panels and doors.
- C. Doors: Unless otherwise indicated, 24-inch- (610-mm-) wide in-swinging doors for standard toilet compartments and 36-inch- (914-mm-) wide out-swinging doors with a minimum 32-inch- (813-mm-) wide clear opening for compartments indicated to be accessible to people with disabilities.
- D. Door Hardware: Stainless steel. Provide units that comply with accessibility requirements of authorities having jurisdiction at compartments indicated to be accessible to people with disabilities.

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1. Hinges: Vault Hinges.
2. Latches and Keepers: Surface-mounted unit designed for emergency access and with combination rubber-faced door strike and keeper.
3. Coat Hook: Combination hook and rubber-tipped bumper, sized to prevent door from hitting compartment-mounted accessories.
4. Door Bumper: Rubber-tipped bumpers at out-swinging doors or entrance screen doors.
5. Door Pull: Provide at out-swinging doors. Provide units on both sides of doors at compartments indicated to be accessible to people with disabilities.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install units rigid, straight, level, and plumb, with not more than 1/2 inch (13 mm) between pilasters and panels and not more than 1 inch (25 mm) between panels and walls. Provide brackets, pilaster shoes, bracing, and other components required for a complete installation. Use theft-resistant exposed fasteners finished to match hardware. Use sleeve nuts for through-bolt applications.
  1. Stirrup Brackets: Align brackets at pilasters with brackets at walls.[ **Locate wall brackets so holes for wall anchors occur in masonry or tile joints.**]
  2. Set hinges on in-swinging doors to hold open approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors and swing doors in entrance screens to return to fully closed position.

END OF SECTION 102113

**SECTION 104413 - FIRE EXTINGUISHER CABINETS**

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.
- B. 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.

PART 2 - PRODUCTS

2.1 FIRE-PROTECTION CABINETS

- A. Fire-Protection Cabinets : Owner Supplied, Contractor Installed

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install cabinets at 48 inches (1219.2 mm) above finished floor to top of cabinet.
- B. Identification: Apply decals at locations indicated.

END OF SECTION 104413

**SECTION 104416 - FIRE EXTINGUISHERS**

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.
- B. Fire Extinguishers: NFPA 10, listed and labeled for the type, rating, and classification of extinguisher.

PART 2 - PRODUCTS

2.1 FIRE EXTINGUISHERS

- A. Portable Fire Extinguishers type designation on Drawings.

~~EXECUTION~~

2.2 INSTALLATION

- A. Install fire extinguishers in cabinets where indicated.

END OF SECTION 104416



**SECTION 105113 - METAL LOCKERS**

PART 1- GENERAL

1.1 RELATED DOCUMENTS:

Refer to architectural drawings.

1.2 SCOPE:

Furnish and install new steel lockers, accessories and finish metal trim as shown or indicated on approved drawings. Wood furring, blocking or trim as may be required by drawings are included in other sections of this specification.

1.2.1 SUBMITTALS:

Shop Drawings: Submit drawings showing locker types, sizes and quantities, including all necessary details relating to anchoring, trim installation and relationship to adjacent surfaces.

Numbering: The locker numbering sequence shall be provided by the approving authority and noted on the approved drawings returned to the locker contractor.

Color Charts: Provide color charts showing manufacturer's available colors. If required by normal office procedures or in the event of non-standard color selection, request samples of paint on metal.

Lock Combination Listings and Master Keys: Use only when combination locks are specified. Delivered directly to the owner's representative.

1.3 QUALITY ASSURANCE:

1.3.1 UNIFORMITY: Provide each type of metal locker as produced by a single manufacturer, including necessary accessories, fittings and fasteners.

1.3.2 JOB CONDITIONS: Do not deliver metal lockers until building is enclosed and ready for locker installation. Protect from damage during delivery, handling, storage and installation.

PART 2- PRODUCTS

2.1 MANUFACTURER:

Republic Storage Systems, LLC or approved equal. Products by other manufacturers may be approved provided they meet the detailed specifications written below. Approval procedure shall be as specified in the General Conditions.

2.2 LOCKERS:

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Style: Single Tier as indicated on drawings.

Type: Standard ventilated metal lockers with recessed latch.

Size and number of Locker Openings: As per drawings.

Color: Manufacturer's standard color as indicated by Architect.

### 2.3 FABRICATION - GENERAL:

2.3.1 MATERIAL: All major steel parts shall be made of mild cold rolled steel, free from imperfections and capable of taking a high grade enamel or powder coat finish.

2.3.2 FINISH: Surfaces of the steel shall be thoroughly cleaned, phosphatized and prepared for baked enamel or powder coat finish in accordance with paint manufacturer's instructions.

2.3.3 CONSTRUCTION: Lockers shall be built on the unit principle - each locker shall have an individual door and frame, an individual top, bottom, back and shelves with common intermediate uprights separating units.

2.3.4 DOOR FRAMES: Door frames shall be 16 gauge formed into 1" wide face channel shapes with a continuous vertical door strike, integral with the frame on both sides of the door opening. Double, triple or four tier locker cross frame members shall be 16 gauge channel shaped securely welded to vertical framing members to ensure a square and rigid assembly. Intermediate cross frame members are not required on box lockers.

2.3.5 DOORS: Shall be 16 gauge or 18 gauge steel for short or narrow doors as required by manufacturer's design, formed with a full channel shape on the lock side to fully conceal the lock bar, channel formation on the hinge side and right angle formation across the top and bottom. Single tier doors 60" and 72" in height and 18" and wider shall have a diagonal reinforcing angle welded to inner surface. Doors for Standard Box Lockers 3, 4, 5 and 6 openings high are 16 or 18 gauge steel and shall be formed with right angle flanges on all four sides. Locker doors shall be ventilated by louvers on the face of each door, top and bottom.

2.3.6 PRE- LOCKING DEVICE: All "tiered" lockers shall be equipped with a positive automatic pre-locking device, whereby the locker may be locked while door is open and then closed without unlocking and without damaging locking mechanism.

2.3.7 LATCHING: Latching shall be a one-piece, pre-lubricated spring steel latch, completely contained within the lock bar under tension to provide rattle-free operation. The lock bar shall be of pre-coated, double-channel steel construction. The lock bar shall be securely contained in the door channel by self-lubricating polyethylene guides that isolate the lock bar from metal-to-metal contact with the door. There shall be three latching points for lockers over 42" in height and two latching points for all tiered lockers 42" and under in height. The lock bar travel is limited by contacting resilient high-quality elastomeric cushioning devices concealed inside the lock bar. Frame hooks to accept latching shall be of heavy gauge steel, set close in and welded to the door frame. Continuous vertical door strike shall protect frame hooks from door slam damage. A soft rubber silencer shall be securely installed on each frame hook to absorb the impact caused by closing of the door. Box locker doors shall be equipped with a padlock hasp and a stainless steel strike plate with an integral handle pull. Box locker doors may also be equipped with built-in locks.

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2.3.8 HANDLES: A non-protruding 14 gauge lifting trigger and slide plate shall transfer the lifting force for actuating the lock bar when opening the door. The exposed portion of the lifting trigger shall be encased in a molded ABS thermoplastic cover that provides isolation from metal-to-metal contact and be contained in a formed 20 gauge stainless steel recessed pocket. This stainless steel pocket shall contain a recessed area for the various lock types available and a mounting area for the number plate.

2.3.9 HINGES: Hinges shall be 2" high, 5-knuckle, full loop, tight pin style, securely welded to frame and double riveted to the inside of the door flange. Locker doors 42" high and less shall have two hinges. Doors over 42" high shall have three hinges.

2.3.10 BODY: The body of the locker consists of 24 gauge upright sheets, backs, tops, bottoms and shelves. Tops, bottoms and shelves are flanged on all four sides; backs are flanged on two sides. Uprights shall be offset at the front and flanged at the rear to provide a double lapped rear corner. All bolts and nuts shall be zinc plated.

2.3.11 INTERIOR EQUIPMENT: Single tier lockers over 42" high shall have one hat/book shelf. Other tiered lockers do not require shelves. All single, double and triple tier lockers shall have one double prong rear hook (single prong in 9" width) and two single prong wall hooks in each compartment. All hooks shall be made of steel, formed with ball points, zinc-plated and attached with two bolts or rivets. Locker openings under 20" high are not equipped with hooks.

2.3.12 NUMBER PLATES: Each locker shall have a polished aluminum number plate with black numerals not less than 1/2" high. Plates shall be attached with rivets to the lower surface within the recessed handle pocket.

2.3.13 COLOR: Doors and exposed body parts shall be finished in colors selected from Republic's collection of twenty-five baked enamel colors. Non-exposed body parts shall be finished in #83 Decorator Tan (baked enamel). Entire locker shall be finished in colors selected from Republic's collection of nine powder coat colors.

2.3.14 ASSEMBLY: Assembly of all locker components shall be accomplished by the use of zinc plated, low round head, slotless, fin neck machine screws with hex nuts, producing a strong mechanical connection.

-OPTION: Keps nuts and bolts or rivets may be used for assembly.

### PART 3 - EXECUTION

3.1 INSTALLATION: Lockers must be installed in accordance with manufacturer's approved drawings and assembly instructions. Installation shall be level and plumb with flush surfaces and rigid attachment to anchoring surfaces. Space fasteners at 36" O.C. or less, as recommended by manufacturer. Use fasteners appropriate to load and anchoring substratum. Use reinforcing plates wherever fasteners could distort metal. Various trim accessories where shown, such as sloping tops, fillers, bases, recessed trim, etc., shall be installed using concealed fasteners. Flush, hairline joints are provided at all abutting trim parts and at adjoining surfaces.

3.2 ADJUSTMENT: Upon completion of installation, inspect lockers and adjust as necessary for proper door and locking mechanism operation

3.3 QUALITY ASSURANCE: Republic reserves the right to modify the design and/or change specifications or colors/finish consistent with our policy of product excellence.

BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

NOTE: For user safety, all lockers must be secured to the wall and/or floor prior to use.

END OF SECTION 105113

**SECTION 123530 - CASEWORK**

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data, Shop Drawings, and material Samples.
- B. Comply with KCMA A161.1.
- C. Comply with KCMA A161.2 for plastic-laminate countertops.
- D. Verify dimensions by field measurements; measure for countertops after base cabinets are installed.
- E. Forest Certification: Provide cabinets produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC 1.2, "Principles and Criteria."

PART 2 - PRODUCTS

2.1 CASEWORK

- A. Cabinets:
  - 1. Face Style: Flat Panel
  - 2. Cabinet Style: Frameless.
  - 3. Door and Drawer Fronts: Plastic-laminate-faced.
  - 4. Face Frame Finish: Melamine.
  - 5. Exposed Cabinet End Finish: Plastic laminate.
  - 6. Exposed Plastic Laminate: NEMA LD 3, Grade VGS.
  - 7. Semiexposed Materials: Medium-density particleboard, with melamine surface.
- B. Plastic-Laminate Countertops and Splashes:
  - 1. Plastic Laminate: NEMA LD 3, Grade HGS.
  - 2. Substrate: Particleboard, ANSI A208.1, Grade M-2 or exterior plywood, PS 1, Grade C-C Plugged, touch sanded. Use exterior plywood at vanities and tops with sinks.
  - 3. Backing: Plastic-laminate backer sheet, NEMA LD 3, Grade BKL.
- C. Countertop Configuration:
  - 1. Front Style: Wood-trimmed edge.
  - 2. Cove Type: Applied backsplash rests on top forming seam at inside corner.
  - 3. Backsplash: Square edge.
  - 4. End Splash: Square edge.

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install cabinets with no variations in flushness of adjoining surfaces by using concealed shims. Where casework abuts other finished work, scribe and cut for accurate fit. Provide filler strips, scribe strips, and moldings in finish to match casework face.
- B. Install cabinets without distortion so doors and drawers fit openings properly and are aligned.
- C. Install level and plumb to a tolerance of 1/8 inch in 8 feet (3.2 mm in 2.4 m).
- D. Fasten each cabinet to adjacent unit and to structural members of wall construction. Fasten wall cabinets through back, near top and bottom, at ends and not less than 24 inches (600 mm) o.c.
- E. Fasten plastic-laminate countertops by screwing through corner blocks in base units into underside of countertop. Spline and glue joints in countertops and use concealed mechanical clamps.
- F. Fasten solid-surface countertops by screwing through corner blocks in base units into underside of countertop. Align adjacent surfaces. Form seams 1/8 inch (3.2 mm) wide and adhere with manufacturer's recommended joint adhesive in color to match countertop. Dress joints smooth, remove surface scratches, and clean entire surface.

END OF SECTION 123530

SECTION 211000 - WATER-BASED FIRE-SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data for valves, sprinklers, specialties, and alarms, for wet sprinkler systems.
  - 1. Submit sprinkler system drawings identified as "working plans" and calculations according to NFPA 13. Submit required number of sets to authorities having jurisdiction for review, comment, and approval. Include system hydraulic calculations.
  - 2. Submit test reports and certificates as described in NFPA 13.
- B. Design and Installation Approval: Acceptable to authorities having jurisdiction.
- C. Hydraulically design sprinkler systems.
- D. UL-listed and -labeled and FMG-approved pipe and fittings.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795.
- B. Copper Tube: ASTM B 88, Type L or M (ASTM B 88M, Type B or C); drawn temper.
- C. CPVC Plastic Pipe: ASTM F 442/F 442M, UL 1821, 175-psig (1207-kPa) rating, made in NPS (DN) for sprinkler service. Include "Listed" and "CPVC Sprinkler Pipe" marks on pipe.
- D. Cast-Iron Threaded Flanges: ASME B16.1, Class 250, raised ground face, bolt holes spot faced.
- E. Cast-Iron Threaded Fittings: ASME B16.4, Class 250, standard pattern.
- F. Grooved-End Fittings: UL-listed and FMG-approved, ASTM A 536, Grade 65-45-12 ductile iron or ASTM A 47 Grade 32510 malleable iron, with grooves or shoulders designed to accept grooved couplings.
- G. Grooved-End Couplings: UL 213, ASTM A 536 ductile-iron or ASTM A 47 malleable-iron housing, with enamel finish. Include gaskets, bolts, and accessories.
- H. Wrought-Copper Fittings: ASME B16.22, streamlined pattern.
- I. Steel Press-Seal Fittings: UL 213, FMG approved, 175-psig (1207-kPa) pressure rating, for use with Schedule 5, plain-end, steel pipe and fittings; with butylene O-rings, and pipe stop.

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

- J. CPVC Plastic Pipe Fittings: ASTM F 438 for NPS 3/4 to NPS 1-1/2 (DN 20 to DN 40) and ASTM F 439 for NPS 2 (DN 50), UL listed, 175-psig (1207-kPa) rating, for sprinkler service. Include "Listed" and "CPVC Sprinkler Fitting" marks on fittings.
- K. Provide hangers, supports, and seismic restraints with UL listing and FMG approval for fire-protection systems.

### 2.2 VALVES

- A. Fire-Protection Service Valves: UL listed and FMG approved, with 175-psig (1207-kPa) nonshock minimum working-pressure rating. Valves for use with grooved piping may be grooved type. Indicating valves shall be butterfly or ball type, bronze body with threaded ends, and integral indicating device with visual indicator.
- B. Gate Valves: UL 262, cast bronze, threaded ends, solid wedge, outside screw and yoke, rising stem.
- C. Swing Check Valves, NPS 2 (DN50) and Smaller: UL 312 or MSS SP-80, Class 150; bronze body with bronze disc and threaded ends.
- D. Swing Check Valves, NPS 2-1/2 (DN 65) and Larger: UL 312, cast-iron body and bolted cap, with bronze disc or cast-iron disc with bronze-disc ring and flanged ends.
- E. Alarm Check Valves: UL 193, 175-psig (1200-kPa) working pressure, designed for horizontal or vertical installation, with cast-iron flanged inlet and outlet, bronze grooved seat with O-ring seals, and single-hinge pin and latch design. Include trim sets for bypass, drain, electric sprinkler alarm switch, pressure gages, retarding chamber, fill-line attachment with strainer, and drip cup assembly.
- F. Ball Drip Valves: UL 1726, automatic drain valve, NPS 3/4 (DN 20), ball check device with threaded ends.

### 2.3 SPRINKLERS

- A. Automatic Sprinklers: With heat-responsive element complying with the following:
  - 1. UL 199, for applications except residential.
  - 2. UL 1626, for residential applications.
  - 3. UL 1767, for early-suppression, fast-response applications.
- B. Sprinkler Types and Categories: Nominal 1/2-inch (12.7-mm) orifice for "Ordinary" temperature classification rating, unless otherwise indicated or required by application.
- C. Sprinkler types include the following:
  - 1. Upright, pendent, and sidewall sprinklers.
  - 2. Extended coverage and quick-response sprinklers.
  - 3. Pendent and sidewall, dry-type sprinklers.
- D. Sprinkler Finishes: Chrome-plated and bronze.



## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

- E. Sprinkler Escutcheons: Chrome-plated steel, one piece, flat; with finish to match sprinklers.
- F. Sprinkler Guards: Wire-cage type, including fastening device.
- G. Sprinkler Cabinets: Finished steel cabinet and hinged cover, with space for minimum of 6 spare sprinklers plus sprinkler wrench, suitable for wall mounting. Include number of sprinklers required by NFPA 13 and one wrench for sprinklers. Include separate cabinet with sprinklers and wrench for each style sprinkler on Project.

### 2.4 PIPING SPECIALTIES AND ALARM DEVICES

- A. Fire Department Connection: UL 405, flush, wall-type, with cast-brass body; NH-standard thread inlets matching local fire department threads.
  - 1. Finish: Polished chrome-plated.
- B. Water-Motor-Operated Alarms: UL 753, mechanical-operation type with pelton-wheel operator with shaft length, bearings, and sleeve to suit wall construction and 10-inch- (250-mm-) diameter, cast-aluminum alarm gong with red-enamel factory finish. Include NPS 3/4 (DN 20) inlet and NPS 1 (DN 25) drain connections.
- C. Water-Flow Indicators: UL 346; electrical-supervision, vane-type water-flow detector; with 250-psig (1725-kPa) pressure rating; and designed for horizontal or vertical installation. Include 2 single-pole, double-throw, circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
- D. Pressure Switches: UL 753; electrical-supervision-type, water-flow switch with retard feature. Include single-pole, double-throw, normally closed contacts and design that operates on rising pressure and signals water flow.
- E. Valve Supervisory Switches: UL 753; electrical; single-pole, double throw; with normally closed contacts. Include design that signals controlled valve is in other than fully open position.
- F. Pressure Gages: UL 393, 3-1/2- to 4-1/2-inch- (90- to 115-mm-) diameter dial with dial range of 0 to 250 psig (0 to 1725 kPa).

## PART 3 - EXECUTION

### 3.1 PIPE AND FITTING APPLICATION

- A. Use steel pipe with threaded, press-seal, roll-grooved, or cut-grooved joints; copper tube with wrought-copper fittings and brazed joints; or CPVC plastic pipe and fittings and metal-to-plastic transition fittings with solvent-cemented joints.
  - 1. For steel pipe joined by threaded fittings, use Schedule 40.
  - 2. For steel pipe joined by welding or roll-grooved pipe and fittings, use Schedule 10.
  - 3. For steel pipe NPS 2 (DN 50) and smaller, joined by press-seal fittings, use Schedule 5 pipe, fabricated with manufacturer's press-seal tools.

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

- B. Pipe between Fire Department Connections and Check Valves: Use galvanized steel pipe with flanged or threaded joints.
- C. Install shutoff valve, check valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water service piping.

### 3.2 PIPING INSTALLATION

- A. Install "Inspector's Test Connections" in sprinkler piping, complete with shutoff valve.
- B. Install sprinkler zone control valves, test assemblies, and drain headers adjacent to standpipes.
- C. Install ball drip valves to drain piping between fire department connections and check valves. Drain to floor drain or outside building.
- D. Install alarm devices in piping systems and connect to fire alarm system.
- E. Protect piping from earthquake damage as required by NFPA 13.
- F. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Install gages to permit removal, and install where they will not be subject to freezing.
- G. Install fire-protection service valves supervised-open, located to control sources of water supply except from fire department connections. Where there is more than one control valve, provide permanently marked identification signs indicating portion of system controlled by each valve.
- H. Install check valve in each water supply connection. Install backflow preventers in potable-water supply sources.
- I. Install alarm check valves for proper direction of flow, including bypass check valve and retard chamber drain line connection.

### 3.3 SPRINKLER APPLICATIONS

- A. Rooms without Ceilings: Upright sprinklers.
- B. Rooms with Suspended Ceilings: Pendent sprinklers with escutcheon.
- C. Wall Mounting: Sidewall sprinklers with escutcheon.
- D. Sprinklers Subject to Freezing: Pendent dry-type, and sidewall dry-type sprinklers with escutcheon.
- E. Special Applications: Use extended coverage and quick-response sprinklers where indicated.
- F. Sprinkler Finishes: Chrome plated.
- G. Install sprinklers in suspended ceilings in center of ceiling panels.

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3.4 TESTING

- A. Flush, test, and inspect sprinkler piping systems according to NFPA 13, Chapter "System Acceptance."

END OF SECTION 211000

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

### PART 3 - EXECUTION

#### 3.1 PREPARATION

- A. Protect existing utilities, sidewalks, structures, pavements, and other facilities to remain free from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
- B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways in accordance with Paragraph 1.7.

#### 3.2 DRAINAGE AND DEWATERING

- A. Prevent surface water and subsurface or groundwater from entering or flowing into excavations, from ponding on prepared subgrades, and from flooding the project site and surrounding area.
- B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
- C. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
- D. Provide pumping to remove any water encountered in accordance with Paragraph 1.7B.

#### 3.3 EXPLOSIVES

- A. Explosives: The use explosives are prohibited on this Project.

#### 3.4 GENERAL EXCAVATION

- A. Excavate to subgrade elevation. Compact subgrade surface in accordance with Paragraph 3.11.
- B. Any soft or unstable material shall be overexcavated and replaced with compacted load bearing fill as directed by the geotechnical engineer. Any areas of instability shall be overexcavated to a depth of at least 2 feet and replaced with structural fill in accordance with Paragraph 3.11.
- C. Provide shoring and bracing necessary to comply with Paragraph 1.7A.

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

- D. All footing excavation surfaces should be protected until the concrete and backfill is placed. Footing bearing surfaces should be cleaned of all material loosened by the excavation process and be recompacted using hand-operated compaction equipment prior to concrete placement. Should loose or soft materials be encountered or if the bearing materials become disturbed or softened, the disturbed materials should be removed and the footing should be lowered to undisturbed bearing materials or the undercut zone should be filled with lean concrete or compacted structural fill.

### 3.5 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicated gradients, lines, depths, and elevations as shown on the drawings.
- B. Excavate trenches to uniform widths to provide a working clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit, unless otherwise indicated.
- C. Clearance: 12 inches on each side of pipe or conduit or as indicated.
- D. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Remove projecting stones and sharp objects along trench subgrade.
  - 1. Provide bedding depth as indicated on the drawings.
  - 2. Shape bedding to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
  - 3. For pipes and conduit less than 6 inches in nominal diameter and flat-bottom, multiple-duct conduit units, hand-excavate trench bottom to accurate elevations and support pipe and conduit on an undisturbed subgrade.

### 3.6 UNAUTHORIZED EXCAVATION

- A. Unauthorized excavations shall be filled with satisfactory fill materials and compacted in accordance with the relevant paragraphs of this Section.
- B. The Contractor is responsible for furnishing all materials, labor, supervision, tools, equipment, tools associated with unauthorized excavations without additional compensation.

### 3.7 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow materials and excavated satisfactory materials sufficiently far away from the edge of excavations to preclude excavation instability. Stockpile soil materials without intermixing. Cover to prevent windblown dust.
- B. Install erosion control measures around stockpiles as required to comply with Paragraph 1.7.

### 3.8 GENERAL BACKFILL

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

- A. Backfill shall not be placed on a subgrade which contains frozen material, or which has been subjected to freeze-thaw action. This prohibition encompasses all subgrade types, including the natural ground, all prepared subgrades (whether in an excavation or in a trench) and all layers of previously placed and compacted earth fill which become the subgrade for successive layers of earth fill. All material that freezes or has been subjected to freeze-thaw action during the construction work, or during periods of temporary shutdowns, such as, but not limited to, nights, holidays, weekends, winter shutdowns, or earthwork operations, shall be removed to a depth that is acceptable to the Owner and replaced with new material. Alternatively, the material will be thawed, dried, reworked, and recompacted to the specified criteria before additional material is placed. The Owner will determine when placement of fill shall cease due to cold weather. The Owner may elect to use average daily air temperatures, and/or physical observation of the soils for his determination.
- B. Place and compact backfill in excavations promptly, but not before completing the following:
  - 1. Construction below finish grade including, where applicable, dampproofing, waterproofing, and perimeter insulation.
  - 2. Surveying locations of underground utilities for record documents.
  - 3. Inspecting and testing underground utilities.
  - 4. Removing concrete formwork.
  - 5. Removing of temporary shoring, bracing, and sheeting unless directed to remain.
  - 6. Removing trash and debris.

### 3.9 UTILITY TRENCH BACKFILL

- A. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies or ducts.
- B. Place and compact bedding material to a height of 12 inches over the utility pipe or conduit.
  - 1. Carefully compact material under pipe haunches and bring backfill up evenly on both sides and along the full length of utility piping or conduit to avoid damage or displacement of utility system.
  - 2. Compaction within the trenches shall be maintained at 95% of the maximum dry-weight density as determined by ASTM D1557.
- C. Coordinate backfilling with utilities testing.
- D. Fill voids with approved backfill or satisfactory soil materials as shoring, sheeting and bracing is removed. Place and compact final backfill of satisfactory soil material to final subgrade.

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

- E. Install warning and identification tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

### 3.10 MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill layer before compaction to within 2 percent of optimum moisture content.
  - 1. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
  - 2. Remove and replace, or scarify and air-dry satisfactory soil material that exceed optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.
  - 3. Construction during wet weather may also create unnecessary delays and undercutting of subgrades due to disturbance by construction traffic.

### 3.11 COMPACTION OF BACKFILLS AND FILLS

- A. Place backfill and fill materials in layers not more than 6 inches in loose depth for material compacted by heavy compaction equipment, and not more than 6 inches in loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.
- C. Compact soil to not less than the following percentages of maximum dry unit weight according ASTM D 1557:
  - 1. Under driveways, pavement, building slabs, and landscaped areas, soil shall be compacted to at least 95 percent of the maximum modified Dry Density as determined by ASTM D 1557.
  - 2. Structural Fill and fill under street pavements shall be compacted to 95 percent of maximum modified Dry Density as determined by ASTM D 698.
- D. The Contractor is responsible for maintenance and protection of approved subgrades or previously placed materials.

### 3.12 GRADING

- A. General: Uniformly grade areas to a smooth surface, free from irregular surface changes in compliance with the soil roughing detail. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
  - 1. Provide a smooth transition between adjacent existing grades and new grades.

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

2. Cut out soft spots, fill low spots, and trim high spots to comply with the required grading surface tolerances.
- B. Site Grading: Slope grades to direct water away from buildings and prevent ponding. Finish grades shall be sloped away from the building by a minimum of 10% in the first 10 feet, unless otherwise indicated.
- 3.13 SUBBASE AND BASE COURSES
- A. Under pavements and walks outside the right-of-way, place base course on prepared subgrade and as follows:
1. Place base course material over prepared subgrade.
  2. Compact base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit density according to ASTM D698.
  3. Shape base to required crown elevations and cross slope grades.
  4. When thickness of compacted base course is 6 inches or less, place materials in a single layer.
  5. When thickness of compacted base course exceeds 6 inches, place materials in equal layers, with no layer more than 6 inches thick or less than 3 inches thick when compacted.
- 3.14 FIELD QUALITY CONTROL
- A. The contractor shall coordinate all earthwork with the testing agency and geotechnical engineer to allow for inspection and testing. The geotechnical engineer shall provide full-time observation and testing of the compaction operations and provide documentation to the Owner.
- B. Allow geotechnical engineer to inspect and test each subgrade and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.
- C. The geotechnical engineer shall test compaction of soils in place according to ASTM D 1556, ASTM D 1557, ASTM D 69 as applicable. Tests shall be performed at the following locations and frequencies:
1. Paved Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2200 sq. ft. or less of paved areas or building slab, but in no case fewer than three tests.
  2. Trench Backfill: At each compacted initial and final backfill layer, at least one test for each 150 feet or less of trench, but no fewer than two tests.



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3. Structural Backfill: At each compacted initial and final backfill layer, at least one test for each 150 feet or less of trench, but no fewer than two tests.
- D. When the geotechnical engineer reports that subgrades, fills or backfills have not achieved degree of compaction specified, recompact and retest until specified compaction is obtained.

### 3.15 PROTECTION

- A. Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. Repair and re-establish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled or where they lose compaction due to subsequent construction operations or weather conditions.
  1. Scarify or remove and replace soil material to depth as directed by the Owner or the geotechnical engineer; reshape and recompact to the required density, at no additional cost to the Owner.
- C. Where settling occurs before the project correction period elapses, remove finished surfacing, backfill with additional approved material, compact, and reconstruct.
  1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to the greatest extent possible at no additional cost to the Owner.
- D. Provide temporary underpinning, bracing, sheeting, and/or shoring as required to maintain the conditions of existing utilities or structures adjacent to excavation work. Prepare shop drawings of design details sealed by a professional engineer.
- E. Provide fencing, barricades, and/or protective barriers for all excavation.

### 3.16 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off site to a regulated and permitted facility. Provide two copies of load manifest and permit from owner of the property where material is deposited.

END OF SECTION 312000

**SECTION 220000 - BASIC PLUMBING REQUIREMENTS**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including the, General and Supplementary Conditions, Division-1 Conditions specification sections apply to the Division 22 specifications and drawings.
- B. Related Sections: Refer to all sections in Division 22 and Division 22 drawings. Refer to Division 26 specification section and Division 26 drawings.

1.2 SUMMARY

- A. This Section specifies the basic requirements for plumbing installations and includes requirements common to more than one (1) section of Division 22. It expands and supplements the requirements specified in sections of Division 1 and Division 22.
- B. The Contractor shall coordinate and co-operate with Owner at all times for all new to existing connections, system shutdowns and restart-up, flushing and filling both new and existing systems.
- C. Provide temporary piping services where required to maintain existing areas operable, as shown on the drawings.
- D. Coordinate all services shutdown with the Owner, provide temporary services as shown on the drawings.
- E. The Contractor shall be responsible for the maintenance operation and servicing of all new plumbing systems which are to be used by the Owner during the time of any occupancy and use of any areas within the construction limitations before final completion or acceptance of the systems. A written record of maintenance, operation and servicing shall be turned over to the Owner prior to final acceptance.

1.3 PROJECT CONDITIONS

- A. The Contractor shall be required to attend a mandatory pre-bid walk-thru and shall make themselves familiar with the existing conditions. No additional costs to the Owner shall be accepted for additional work for these existing conditions.
- B. Field verify all existing conditions prior to submitting bids.
- C. Report any existing damaged equipment or systems to the Owner prior to any work.
- D. Protect all plumbing and electrical work against theft, injury or damage from all causes until it has been tested and accepted.

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

- E. Be responsible for all damage to the property of the Owner or to the work of other contractors during the construction and guarantee period. Repair or replace any part of the Work which may show defect during one (1) year from the final acceptance of all work. Provided such defect is, in the opinion of the Architect, due to imperfect material or workmanship and not due to the Owner's carelessness or improper use.

### 1.4 INSTALLER'S QUALIFICATIONS

- A. All Plumbing Work shall be performed by a State of Colorado Licensed Contractor under the supervision of a Licensed Plumber. The General Contractor shall verify that plumbers are currently licensed by the State of Colorado and shall supply the General Contractor Project Manager with names and license numbers. Plumbing Contractors shall have a minimum of three (3) years of satisfactory performance in conducting the type of work specified.

### 1.5 ACCESSIBILITY

- A. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing.
- B. Furnish hinged steel access doors with concealed latch, whether shown on drawings or not, in all walls and ceilings for access to all concealed valves, shock absorbers, air vents, motors, balancing cocks, and other operating devices requiring adjustment or servicing. Refer to Division 1 for access door specification.
- C. The minimum size of any access door shall not be less than the size of the equipment to be removed or 24-inch x 24-inch if used for service only, unless size is indicated on Drawings.
- D. Furnish doors to trades performing work in which they are to be built, in ample time for building-in as the work progresses. Whenever possible, group valves, cocks, etc., to permit use of minimum number of access doors within a given room or space.
- E. Factory manufactured doors shall be of a type compatible with the finish in which they are to be installed.
- F. Access doors in fire-rated walls and ceilings shall have equivalent UL label and fire rating.

### 1.6 ROUGH-IN

- A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
- B. Refer to equipment shop drawings and manufacturer's requirements for actual provided equipment for rough-in requirements.

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### 1.7 REQUIREMENTS OF REGULATORY AGENCIES

- A. Refer to Division 1.
- B. Execute and inspect all work in accordance with all Underwriters, local and state codes, rules and regulations applicable to the trade affected as a minimum, but if the plans and/or specifications call for requirements that exceed these rules and regulations, the greater requirement shall be followed. Follow recommendations of NFPA, EPA, OSHA and ASHRAE.
- C. Comply with standards in effect at the date of these Contract Documents, except where a standard or specific date or edition is indicated.
- D. The handling, removal and disposal of regulated refrigerants shall be in accordance with U.S. EPA, state and local regulations.
- E. After entering into contract, Contractor will be held to complete all work necessary to meet these requirements without additional expense to the Owner.

### 1.8 REQUIREMENTS OF LOCAL UTILITY COMPANIES

- A. Comply with rules and regulations of local utility companies. Include in bid the cost of all valves, valve boxes, meter boxes, meters and such accessory equipment which will be required for the project.

### 1.9 PERMITS AND FEES

- A. Refer to Division 1.
- B. Owner shall pay all tap, development, meter, etc., fees required for connection to municipal and public utility facilities.
- C. Contractor shall arrange for and pay for all permits, inspections, licenses and certificates required in connection with the Work.

### 1.10 PLUMBING INSTALLATIONS

- A. Drawings are diagrammatic in character and do not necessarily indicate every required offset, valve, fitting, etc.
- B. Drawings and specifications are complementary. Whatever is called for in either is binding as though called for in both.
- C. Drawings shall not be scaled for rough-in measurements or used as shop drawings. Where drawings are required for these purposes or have to be made from field measurement, take the necessary measurements and prepare the drawings.
- D. Before any Work is installed, determine that equipment will properly fit the space; that required piping grades can be maintained and that ductwork can be run as contemplated without interferences between systems, with structural elements or with the work of other trades.

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- E. Coordinate the installation of mechanical materials and equipment above and below ceilings with suspension system, light fixtures, and other building components.
  - 1. Coordinate ceiling cavity space carefully with all trades. In the event of conflict, install mechanical and electric systems within the cavity space allocation in the following order of priority.
    - a. Plumbing waste, vent piping and roof drain mains and leaders
    - b. Supply, return and exhaust ductwork
    - c. Fire sprinkler mains and leaders
    - d. Electrical conduit
    - e. Domestic hot and cold water, medical gas piping
    - f. Pneumatic control piping
    - g. Fire sprinkler branch piping and sprinkler runouts
- F. Verify all dimensions by field measurements.
- G. Arrange for chases, slots, and openings in other building components to allow for plumbing installations.
- H. Coordinate the installation of required supporting devices and sleeves to be set in poured in place concrete and other structural components, as they are constructed.
- I. Sequence, coordinate, and integrate installations of plumbing materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing-in the building.
- J. Coordinate the cutting and patching of building components to accommodate the installation of plumbing equipment and materials.
- K. Where mounting heights are not detailed or dimensioned, install plumbing piping and overhead equipment to provide the maximum headroom possible.
- L. Install plumbing equipment to facilitate maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
- M. Coordinate connection of plumbing systems with exterior underground and overhead utilities, services and Division 33. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

### 1.11 EXCAVATING AND BACKFILLING

- A. General:
  - 1. Provide all necessary excavation and backfill for installation of Plumbing Work in accordance with Division 1.
  - 2. In general, follow all regulations of OSHA as specified in Part 1926, Subpart P, "Excavations, Trenching and Shoring". Follow specifications of Division 22 as they refer specifically to the Plumbing Work.
- B. Contact Owners of all underground utilities to have them located and marked, at least two (2) business days before excavation is to begin. Also, prior to starting excavation, brief employees on marking and color codes and train employees on excavation and safety procedures for

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natural gas lines. When excavation approaches gas lines, expose lines by carefully probing and hand digging.

- C. Provide all necessary pumping, cribbing and shoring.
- D. Walls of all trenches shall be a minimum of 6-inch clearance from the side of the nearest mechanical work. Install pipes with a minimum of 6-inch clearance between them when located in same trench.
- E. Pipe Trenching:
  - 1. Dig trenches to depth, width, configuration, and grade appropriate to the piping being installed. Dig trenches to 6-inches below the level of the bottom of the pipe to be installed. Install 6-inch bed of pea gravel or squeegee, mechanically tamp to provide a firm bed for piping, true to line and grade without irregularity. Provide depressions only at hubs, couplings, flanges, or other normal pipe protrusions.
- F. Backfilling shall not be started until all work has been inspected, tested and accepted. All backfill material shall be reviewed by the Soils Engineer. In no case shall lumber, metal or other debris be buried in with backfill.
- G. Trench Backfill:
  - 1. Backfill to 12-inches above top of piping with pea gravel or squeegee, the same as used for piping bed, compact properly.
  - 2. Continue backfill to finish grade, using friable material free of rock and other debris. Install in 6-inch layers, each properly moistened and mechanically compacted prior to installation of ensuing layer. Compaction by hydraulic jetting is not permissible.
- H. After backfilling and compacting, any settling shall be refilled, tamped, and refinished at this Contractor's expense.
- I. This Contractor shall repair and pay for any damage to finished surfaces.
- J. Complete the backfilling near manholes using pea gravel or squeegee, installing it in 6-inch lifts and mechanically tamping to achieve 95 percent compaction.
- K. Use suitable excavated material to complete the backfill, installed in 6-inch lifts and mechanically compacted to seal against water infiltration. Compact to 95 percent for the upper 30-inches below paving and slabs and 90 percent elsewhere.

### 1.12 CUTTING AND PATCHING

- A. This Article specifies the cutting and patching of mechanical equipment, components, and materials to include removal and legal disposal of selected materials, components, and equipment.
- B. Refer to Division 1.
- C. Do not endanger or damage installed work through procedures and processes of cutting and patching.
- D. Arrange for repairs required to restore other work, because of damage caused as a result of plumbing installations.

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- E. No additional compensation will be authorized for cutting and patching work that is necessitated by ill-timed, defective, or non-conforming installations.
- F. Perform cutting, fitting, and patching of mechanical equipment and materials required to:
  - 1. Uncover work to provide for installation of ill-timed work;
  - 2. Remove and replace defective work;
  - 3. Remove and replace work not conforming to requirements of the Contract Documents;
  - 4. Remove samples of installed work as specified for testing;
  - 5. Install equipment and materials in existing structures;
  - 6. Upon written instructions from the Architect, uncover and restore work to provide for Architect observation of concealed work.
- G. Cut, remove and legally dispose of selected plumbing equipment, components, and materials as indicated, including, but not limited to removal of plumbing piping, plumbing fixtures and trim, and other plumbing items made obsolete by the new work.
- H. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
- I. Provide and maintain an approved type of temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
- J. Locate, identify, and protect mechanical, plumbing and electrical services passing through remodeling or demolition area and serving other areas required to be maintained operational. **When services must be interrupted, provide temporary services for the affected areas and notify the Owner prior to changeover.**

### 1.13 TEMPORARY FACILITIES

- A. New Plumbing Fixtures shall not be used without written permission from the owner.

### 1.14 PRODUCT OPTIONS AND SUBSTITUTIONS

- A. Refer to the Instructions to Bidders and Division 1, "PRODUCTS, OPTIONS AND SUBSTITUTION".

### 1.15 PLUMBING SUBMITTALS

- A. Refer to the Conditions of the Contract (General and Supplementary), Division 1 and AIA Document A201 (1987) Edition, "SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES".
- B. The manufacturer's material or equipment listed in the schedule or identified by name on the drawings are the types to be provided for the establishment of size, capacity, grade and quality. If alternates are used in lieu of the scheduled names, the cost of any changes in construction required by their use shall be borne by Contractor.
- C. All equipment shall conform to the State and/or Local Energy Conservation Standards.
- D. Submittal of shop drawings, product data, and samples will be accepted only when submitted by and stamped by the Contractor. Data submitted from subcontractors and material suppliers

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directly to the Architect will not be processed unless prior written approval is obtained by the Contractor.

- E. Submit all submittal items required for each Specification Division concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
- F. If more than two (2) submittals (either for shop drawings or for as-built drawings) are made by the Contractor, the Owner reserves the right to charge the Contractor for subsequent reviews by their consultants. Such extra fees shall be deducted from payments by the Owner to the Contractor.
- G. Before starting Work, prepare and submit to the Architect all shop drawings and descriptive equipment data required for the project. Unless each item is identified with specification section and sufficient data to identify its compliance with the specifications and drawings, the item will be returned without action or "Revise and Resubmit". Continue to submit shop drawings after each Engineer's action, until a "Reviewed" action is received. The Contractor shall submit the total number of sets as called for in Division 1 to the Architect for final distribution. Submittals shall include the following specified materials and, in addition, any materials not listed below but which are specified in the individual sections of Division 22 which follow.
  - 1. Pipe Markers
  - 2. Sanitary and storm drainage piping, fittings and joining materials
  - 3. Water treatment equipment, including water softeners
  - 4. Plumbing fixtures, trim, fittings and rough-in dimensions, cleanouts and drains
  - 5. Domestic water piping, fittings and joining materials
  - 6. Domestic water heaters and domestic hot water generators
  - 7. Water hammer arresters
  - 8. Medical/Laboratory gas equipment, piping, fittings and joining materials
  - 9. Process piping
  - 10. Valves, including pressure relief and pressure regulating
  - 11. Pumps
  - 12. Tanks, including expansion tanks
  - 13. Thermometers and pressure gauges
  - 14. Boilers, burners, trim and feed equipment
  - 15. Piping specialties, including hot water and steam
  - 16. Supports, anchors and seals
  - 17. Expansion compensators
  - 18. Flexible pipe connectors
  - 19. Water flow meters
  - 20. Vibration isolators
  - 21. Insulation, including plastic pipe fitting insulation covers and manufacturer's installation instructions
  - 22. Heat exchangers
  - 23. Automatic control systems
- H. Wiring diagrams, control panelboards, motor test data, motors, starters and controls for electrically operated equipment furnished by plumbing trades.
- I. Identify each item with equipment tag with specification section and sufficient data to certify its compliance with the specifications.



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### 1.16 REQUESTS FOR INFORMATION

- A. All "Requests for Information" submitted by the Contractor shall include a proposed solution and an estimated cost/schedule impact. Any RFI's that do not contain this required information will be sent back to the Contractor unanswered.

### 1.17 PLUMBING COORDINATION DRAWINGS

- A. Prepare and submit a complete set of Coordination Drawings as necessary or required by the Engineer showing major elements, components, and systems of plumbing equipment and materials in relationship with other trades, sub-trades and building components. Prepare drawings to an accurate scale of 1/4"=1'-0" or larger. Indicate the locations of all equipment and materials, including clearances for installing and maintaining insulation, servicing and maintaining equipment, valve stem movement, and similar requirements. Indicate movement and positioning of large equipment into the building during construction.
- B. Review in detail all floor plans, reflected ceiling plans, elevations, sections, and details to conclusively coordinate with all trades and integrate all installations. Indicate locations where space is limited, and where sequencing and coordination of installations are of importance to the efficient flow of the work, including (but not necessarily limited to) the following:
  - 1. Mechanical equipment room layouts;
  - 2. Specific equipment installations, including:
    - a. Chillers;
    - b. Cooling Towers;
    - c. Boilers;
    - d. Pumps and Compressors;
    - e. Tanks and Heat Exchangers;
    - f. Furnaces;
    - g. Air Handling Units;
    - h. Domestic Water Heaters;
    - i. Backflow Preventers;
    - j. Pressure Reducing Stations;
    - k. Domestic Water Booster Pumps;
    - l. Water Meters;
    - m. Grease and Sand/Oil Interceptors;
    - n. Sewage Ejector Systems;
    - o. Sump Pump Systems;
  - 3. Work in pipe spaces, chases, trenches, and tunnels;
  - 4. Exterior wall penetrations;
  - 5. Ceiling plenums which contain piping, ductwork, or equipment in congested arrangement;
  - 6. Installations in mechanical riser shafts, at typical sections and crucial offsets and junctures;
  - 7. Pipe expansion loops;
  - 8. Numbered valve location diagrams;
  - 9. Exterior underground lines in common excavation;
  - 10. Manifold piping for multiple equipment units;
  - 11. Water Heater flue and roof penetrations.
  - 12. Elevations and locations of Division 33 connections.

### 1.18 PRODUCT LISTING

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- A. Prepare listing of major plumbing equipment and materials for the project, within two (2) weeks of signing the Contract Documents and transmit to the Mechanical Engineer.
- B. Unless otherwise specified, all materials and equipment shall be of domestic (USA) manufacture and shall be of the best quality used for the purpose in commercial practice.
- C. Provide all information requested.
- D. Submit this listing as a part of the submittal requirement specified in Division 1, "PRODUCTS AND SUBSTITUTION".
- E. When two (2) or more items of same material or equipment are required (plumbing fixtures, pumps, valves, etc.) they shall be of the same manufacturer. Product manufacturer uniformity does not apply to raw materials, bulk materials, pipe, tube, fittings (except flanged and grooved types), sheet metal, wire, steel bar stock, welding rods, solder, fasteners, motors for dissimilar equipment units, and similar items used in work, except as otherwise indicated.
- F. Provide products which are compatible within systems and other connected items.

### 1.19 NAMEPLATE DATA

- A. Provide permanent operational data nameplate on each item of plumbing equipment, indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Locate nameplates in an accessible location.

### 1.20 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Division 1.
- B. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.
- C. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage, dirt, dust and moisture.
- D. Coordinate deliveries of plumbing materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.
- E. Provide factory-applied plastic end-caps on each length of pipe and tube, except for hub-and-spigot and no-hub pipe. Maintain end-caps through shipping, storage and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.
- F. Protect stored pipes and tubes. Elevate above grade and enclose with durable, waterproof wrapping. When stored inside, do not exceed structural capacity of the floor.
- G. Protect flanges, fittings, and specialties from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

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### 1.21 RECORD DOCUMENTS

- A. Refer to Division 1. The following paragraphs supplement the requirements of Division 1.
- B. Keep a complete set of record document prints in custody during entire period of construction at the construction site.
- C. Mark drawing prints to indicate revisions to piping, size and location both exterior and interior; including locations of control devices and units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned to column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., strainers, expansion compensators, tanks, etc.); RFI's; change orders; concealed control system devices. Changes to be noted on the drawings shall include final location of any piping relocated more than 1'-0" from where shown on the drawings.
- D. Mark Equipment Schedules on the drawings with changes to Manufacturer, Model Number, and data based on reviewed shop drawings.
- E. At the completion of the project, mark all valve tag numbers on the drawings and turn these drawings over to the General Contractor for his submission to the Architect. This Contract will not be considered completed until these record drawings have been received and reviewed by the Architect.

### 1.22 OPERATION AND MAINTENANCE DATA

- A. Refer to Division 1.
- B. In addition to the information required by Division 1 for maintenance data, include the following information:
  - 1. Description of plumbing equipment, function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.
  - 2. Manufacturer's printed operating procedures to include start-up, break-in, routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
  - 3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
  - 4. Servicing instructions and lubrication charts and schedules.
  - 5. Manufacturer's service manuals for all plumbing equipment provided under this Contract.
  - 6. Include the valve tag list.
  - 7. Name, Address and Telephone Number of party to be contacted for twenty-four (24) hour service for each item of equipment.
  - 8. Starting, stopping, lubrication, equipment identification numbers and adjustment clearly indicated for each piece of equipment.
  - 9. Complete parts list.
  - 10. Plumbing warranties.
- C. This Contract will not be considered completed, nor will final payment be made, until all specified material is received in this Operating and Maintenance Report and the manual is reviewed by the Architect.

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### 1.23 LUBRICATION OF EQUIPMENT

- A. Refer to Division 1. The following paragraphs supplement the requirements of Division 1.
- B. Contractor shall properly lubricate all plumbing pieces of equipment which he provided before turning the building over to the Owner. He shall attach a linen tag or heavy duty shipping tag on the piece of equipment showing the date of lubrication and the type and brand of lubricant used.
- C. Furnish the Engineer with a Electronic Document, of each item lubricated and type of lubricant used, no later than two (2) weeks before completion of the project, or at time of acceptance by the Owner of a portion of the building and the mechanical systems involved.

### 1.24 WARRANTIES

- A. Refer to Division 1 for procedures and submittal requirements for warranties. Refer to individual equipment specifications for warranty requirements. In any case, the entire mechanical system shall be warranted no less than one (1) year from the time of acceptance by the Owner.
- B. Compile and assemble the warranties specified in Division 22, into a separated set of vinyl covered, three-ring binders, tabulated and indexed for easy reference.
- C. Provide complete warranty information for each item to include product or equipment to include date or beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

### 1.25 CLEANING

- A. Refer to Division 1.
- B. Refer to other sections of Division 22, for requirements cleaning strainers and disinfection of plumbing systems prior to final acceptance.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION – NOT USED

END OF SECTION - 220000

**SECTION 220500 - COMMON WORK RESULTS FOR PLUMBING**

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of Piping Specialties Work required by this section is indicated on drawings and schedules and by requirements of this section.
- B. Types of Piping Specialties specified in this section include the following:
  - 1. Escutcheons
  - 2. Dielectric Fittings
  - 3. Mechanical Sleeve Seal
  - 4. Fire and Smoke Barrier Penetration Seal
  - 5. Drip Pan
  - 6. Pipe Sleeve
  - 7. Sleeve Seals
- C. Piping Specialties furnished as part of factory-fabricated equipment, are specified as part of equipment assembly in other Division 22 sections.

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of piping specialties of types and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. Codes and Standards:
  - 1. ASME B 31.9 "Building Services Piping" for materials, products, and installation.
  - 2. Safety valves and pressure vessels shall bear the appropriate ASME label.
  - 3. Fabricate and stamp air separators and compression tanks to comply with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.
  - 4. ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualification" for qualifications for welding processes and operators.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including installation instructions, and dimensioned drawings for each type of manufactured piping specialty. Include pressure drop curve or chart for each type and size of pipeline strainer. Submit schedule showing manufacturer's figure number, size, location, and features for each required piping specialty.
- B. Shop Drawings: Submit for fabricated specialties, indicating details of fabrication, materials, and method of support.

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- C. Maintenance Data: Submit maintenance data and spare parts lists for each type of manufactured piping specialty. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Division 1.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
  - 1. Pipe Escutcheons:
    - a. Chicago Specialty Mfg. Co.
    - b. Producers Specialty & Mfg. Corp.
    - c. Sanitary-Dash Mfg. Co.
  - 2. Dielectric Fittings:
    - a. B & K Industries, Inc.
    - b. Capital Mfg. Co.; Division of Harsco Corp.
    - c. Eclipse, Inc.
    - d. Epcos Sales, Inc.
    - e. Perfection Corp.
    - f. Rockford-Eclipse Division
  - 3. Mechanical Sleeve Seal:
    - a. Thunderline Corp.
    - b. "Metraseal" by Metraflex Co.
  - 4. Fire and Smoke Barrier Penetration Seal:
    - a. Electrical Products Division/3M
    - b. Dow Corning
    - c. Flame Stop, Inc.
    - d. MetaCaulk
    - e. Hilti

#### 2.2 PIPE ESCUTCHEONS

- A. General: Provide pipe escutcheons as specified herein with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or ceilings; and pipe sleeve extension, if any. Furnish pipe escutcheons with nickel or chrome finish for occupied areas, prime paint finish for unoccupied areas.
- B. Pipe Escutcheons for Moist Areas: For waterproof floors, and areas where water and condensation can be expected to accumulate, provide cast brass or sheet brass escutcheons, solid or split hinged.
- C. Pipe Escutcheons for Dry Areas: Provide sheet steel escutcheons, solid or split hinged.

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### 2.3 DIELECTRIC FITTINGS

- A. General: Provide standard products recommended by manufacturer for use in service indicated, which effectively isolate ferrous from non-ferrous piping (electrical conductance), prevent galvanic action, and stop corrosion.
- B. Dielectric Unions: Provide dielectric unions on open systems where indicated on the Drawings. **Not to be used in Closed Heating Systems.**
- C. Dielectric Waterway Fittings:
  - 1. ASTM-A53 Zinc electroplated steel pipe casing with inert, non-corrosive thermoplastic lining (NSF/FDA listed).
  - 2. Thread x thread ends 1/2-inch x 3-inch through 4-inch x 6-inch.
  - 3. Groove x thread ends 1/2-inch x 4-inch through 4-inch x 6-inch.
  - 4. Listed by IAPMO/UPC and SBCC PST and ESI.
  - 5. Dielectric unions are not an acceptable substitute for dielectric waterway fittings.
- D. Dielectric Flange Insulation Kits:
  - 1. Field-assembled, companion flange assembly, full face or ring type.
  - 2. Neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
  - 3. Provide separate companion flanges and steel bolts and nuts.
  - 4. Rated at 175 psi conforming to ANSI B16.42 (iron) B16.24 (bronze).
  - 5. Factory certified to withstand minimum of 600 volts on a dry line without flashover.
  - 6. Meets federal specifications for tensile strength and thread end connections.

### 2.4 MECHANICAL SLEEVE SEALS

- A. General: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

### 2.5 FIRE AND SMOKE BARRIER PENETRATION SEALS

- A. General: Provide UL Listed firestopping systems composed of components that are compatible with each other, the substrates forming openings, and the items, if any, penetrating the firestopping under conditions of service and application, as demonstrated by the firestopping manufacturer based on testing and field experience.
- B. Provide components for each firestopping system that are needed to install fill material. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.
- C. Penetrations in Fire Resistive Rated Walls: Provide firestopping with ratings determined in accordance with UL 1479 or ASTM E 814.
  - 1. F-Rating: Not less than the fire-resistance rating of the wall construction being penetrated.

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- D. Penetration in Horizontal Assemblies: Provide firestopping with ratings determined in accordance with UL 1479 or ASTM E 814.
  - 1. F-Rating: Minimum of 1-hour rating, but not less than the fire-resistance rating of the floor construction being penetrated.
  - 2. T-Rating: When penetrant is located outside of a wall cavity, minimum of 1-hour rating, but not less than the fire-resistance rating of the floor construction being penetrated.
  - 3. W-Rating: Class 1 rating in accordance with water leakage test per UL 1479.
- E. Penetrations in Smoke Barriers: Provide firestopping with ratings determined in accordance with UL1479 or ASTM E 814.
  - 1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at both ambient and elevated temperatures.

### 2.6 FABRICATED PIPING SPECIALTIES

- A. Drip Pans: Provide drip pans fabricated from corrosion-resistant sheet metal with watertight joints, and with edges turned up 2-1/2 inch, and with double sloped to drain bottom. Reinforce top, either by structural angles or by rolling top over 1/4-inch steel rod. Provide hole, gasket, and flange at low point for watertight joint and 1-inch drain line connection.
  - 1. Drip pans shall be located under the drainage piping at the following locations, whether these areas have ceilings or not.
    - a. Operating Rooms
    - b. Delivery Rooms
    - c. Nurseries
    - d. Food Prep Centers
    - e. Food Serving Facilities
    - f. Food Storage Areas
    - g. Central Services (SPD)
    - h. Electronic Data Processing Areas
    - i. Electrical Closets
    - j. Other Sensitive Areas
- B. Pipe Sleeves: Provide pipe sleeves of one (1) of the following:
  - 1. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate from the following gauges: 3-inch and smaller, 20 gauge; 4-inch to 6-inch, 16 gauge; over 6-inch, 14 gauge.
  - 2. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe; remove burrs.
  - 3. Iron Pipe: Fabricate from cast iron or ductile iron pipe; remove burrs.
- C. Sleeve Seals: Provide sleeve seals for sleeves located in foundation walls below grade, or in exterior walls, of one (1) of the following:
  - 1. Mechanical Sleeve Seals: Installed between sleeve and pipe.



PART 3 - EXECUTION

3.1 INSTALLATION OF PIPING SPECIALTIES

- A. Pipe Escutcheons: Install pipe escutcheons on each pipe penetration through floors, walls, partitions, and ceilings where penetration is exposed to view; and on exterior of building. Secure escutcheon to pipe or insulation so escutcheon covers penetration hole, and is flush with adjoining surface.
- B. Dielectric Unions: Install at each piping joint between ferrous and non-ferrous piping. Comply with manufacturer's installation instructions.
- C. Mechanical Sleeve Seals: Loosely assemble rubber links around pipe with bolts and pressure plates located under each bolt head and nut. Push into sleeve and center. Tighten bolts until links have expanded to form watertight seal.
- D. Fire or Fire/Smoke Barrier Penetration Seals: Where pipe penetration occurs in fire or fire/smoke rated walls, provide: a complete listed protection assembly equal to the rating of the wall/floor.
- E. Provide dielectric waterways or insulating flanges, as required by pipe size, on all connections of dissimilar metals.

3.2 SLEEVES AND SEALS

- A. Pipes:
  - 1. Pipes:
    - a. New Construction: Pipes penetrating concrete or masonry construction, whether insulated or not, shall be provided with sheet metal or pipe sleeves fitted into place at time of construction. In poured concrete, the sleeves shall be steel pipe with a full circle, continuously welded water stop plate to also act as a sleeve anchor. When installing Link-Seal the sleeve and Link-Seal shall be of matched sizes. Otherwise, sleeves shall be of such size to provide all around clearance of 1/4-inch to 1-inch. Seal entire space between pipe and sleeve with fire stopping as specified in "Seals".
    - b. Existing Construction: For existing construction or masonry construction, prepare pipe opening by carefully cutting or core drilling, install sheet metal sleeve, and fill any open space with material assembly equal to the listing of the wall. Cutting of concrete or masonry shall be done after approval of Structural Engineer.
    - c. Sleeves in non-fire rated or non-bearing walls, floors or ceilings, new or existing construction, shall be steel pipe or galvanized sheet metal with lock-type longitudinal seam. Pack all open spaces on each end with mineral wool or other non-combustible material, positively fastened in place. Asbestos is not acceptable.
    - d. Where a pipe of any description passes through a concrete floor, the sleeve shall extend at least 2-inch above the finished floor, except when using the ProSet Systems.
    - e. At Contractor's option, where uninsulated pipes penetrate cast-in-place concrete floors, the "ProSet Systems," Atlanta, Georgia, sleeving may be employed.

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- f. For pipes penetrating foundation walls, water-proofing membrane floors or other places where water leakage could be encountered, install Link-Seal wall sleeves by Thunderline Corporation in manner recommended by the manufacturer.
  - B. Where pipe penetrations occur in non-fire rated floors, roof slabs, or walls, the space between pipe insert and the sleeve shall be packed on each end with mineral wool or other non-combustible material, positively fastened in place. Use plenum rated caulk to seal packing around pipe.
  - C. Seals:
    - 1. General:

Seal all holes or voids where mechanical systems penetrate fire rated floors and walls with a fire stopping sealant having a fire rating equal to or greater than that of the construction being penetrated. The sealant shall meet the requirements of ASTM E-814, ASTM E-119 and UL-1479. It shall be installed with strict adherence to the manufacturer's instructions and according to the product's UL Laboratory listing. The use of asbestos in any form is not permitted.
    - 2. Conduct tests according to manufacturer's written recommendations to verify that substrates are free of oil, grease, rolling compounds, incompatible primers, loose mill scale, dirt and other foreign substances capable of impairing bond of firestopping.
    - 3. Do not cover firestopping with other construction until approval of authority having jurisdiction has been received.
  - D. Escutcheons:
    - 1. In finished parts of the building, after painting is completed, install chromium plated escutcheons on all pipes passing through walls and floors where piping is exposed to view.
  - E. Flash and counterflash where mechanical equipment passes through weather or water-proofed walls, floors, and roofs per roof manufacturer's instructions.
  - F. Provide dielectric waterways or insulating flanges, as required by pipe size, on all connections of dissimilar metals.
- ### 3.3 INSTALLATION OF FABRICATED PIPING SPECIALTIES
- A. Drip Pans: Locate drip pans under piping as indicated. Hang from structure with rods and building attachments, weld rods to sides of drip pan. Brace to prevent sagging or swaying. Connect 1-inch drain line to drain connection, and run to nearest plumbing drain or elsewhere as indicated.
  - B. Pipe Sleeves: Install pipe sleeves of types indicated where piping passes through walls, floors, ceilings, and roofs. Do not install sleeves through structural members of work, except as detailed on drawings, or as reviewed by Architect/Engineer. Install sleeves accurately centered on pipe runs. Size sleeves so that piping and insert will have free movement in sleeve, including allowance for thermal expansion; but not less than two (2) pipe sizes larger than piping run. Install length of sleeve equal to thickness of construction penetrated, and finish flush to surface; except floor sleeves. Extend floor sleeves in rooms 1/2-inch above level floor finish, in rooms 3/4-inch above floor finish sloped to drain and 4-inch above finished floor in all Mechanical Equipment Rooms and pipe chases. Provide temporary support of sleeves during

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placement of concrete and other work around sleeves, and provide temporary closure to prevent concrete and other materials from entering sleeves.

1. Install sheet metal sleeves at interior partitions and ceilings other than suspended ceilings.
2. Install iron pipe sleeves at exterior penetrations; both above and below grade.
3. Install steel pipe sleeves except as otherwise indicated.

END OF SECTION 220500

**SECTION 220519 - METERS AND GAUGES FOR PLUMBING PIPING**

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of Meters and Gauges required by this section is indicated on drawings and/or specified in other Division 22 sections.
- B. Types of Meters and Gauges specified in this section include the following:
  - 1. Temperature Gauges and Fittings:
    - a. Glass Thermometers
    - b. Solar/Light Powered Digital Thermometers
    - c. Thermometer Wells
  - 2. Pressure Gauges and Fittings:
    - a. Pressure Gauges
    - b. Pressure Gauge Cocks
- C. Meters and gauges furnished as part of factory-fabricated equipment are specified as part of equipment assembly in other Division 22 sections.

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of meters and gauges, of types and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. Codes and Standards:
  - 1. UL Compliance: Comply with applicable UL Standards pertaining to meters and gauges.
  - 2. ANSI and ISA Compliance: Comply with applicable portions of ANSI and Instrument Society of America (ISA) Standards pertaining to construction and installation of meters and gauges.
  - 3. NSF Compliance: Construct and install thermometers and gauges in compliance with the lead-free requirements of NSF 61 Annex G and/or NSF 372.
- C. Certification: Provide meters and gauges whose accuracies, under specified operating conditions, are certified by manufacturer.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including installation instructions for each type of meter and gauge. Include scale range, ratings, and calibrated performance curves, certified where indicated. Submit meter and gauge schedule showing manufacturer's figure number, scale range, location, and accessories for each meter and gauge.
- B. All flow measuring devices to be provided shall be reviewed and approved by the Test and Balance Contractor for proper scale, rangeability and function prior to submitting shop

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drawings. The Test and Balance Contractor shall provide a typed letter stating this review has been completed and included with shop drawing submittals.

- C. Maintenance Data: Submit maintenance data and spare parts lists for each type of meter and gauge. Include this data and product data in Maintenance Manual; in accordance with requirements of Division 1.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
  - 1. Glass Thermometers:
    - a. Miljoco Corp.
    - b. Weiss Instruments, Inc.
    - c. Dwyer
    - d. Terice
    - e. Winters Instruments
  - 2. Solar/Light Powered Digital Thermometers:
    - a. Terice
    - b. Miljoco
    - c. Weiss Instruments, Inc.
    - d. Winters Instruments
    - e. Dwyer
  - 3. Thermometers and Wells:
    - a. Miljoco Corp.
    - b. Weiss Instruments, Inc.
    - c. Terice
    - d. Winters Instruments
    - e. Dwyer
  - 4. Pressure Gauges, Snubbers and Pressure Gauge Cocks:
    - a. Ametek/U.S. Gauge
    - b. Miljoco Corp.
    - c. Dwyer
    - d. Terice
    - e. Winters Instruments

#### 2.2 GLASS THERMOMETERS

- A. General: Provide glass thermometers of materials, capacities, and ranges indicated, designed and constructed for use in service indicated.
- B. Case: Die cast aluminum finished in baked epoxy enamel or powder coated, glass or acrylic lens front, spring secured, 9-inch long.
- C. Adjustable Joint: Die cast aluminum, finished to match case, 180 degree adjustment in vertical plane, 360 degree adjustment in horizontal plane, with locking device.

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- D. Tube and Capillary: Non-Toxic spirit filled, 1 percent scale range accuracy, shock mounted.
- E. Scale: Aluminum, white background with black graduations and markings.
- F. Stem: Aluminum, or brass, for separable socket, length to suit installation.
- G. Range: Conform to the following:
  - 1. Hot Water: 30 Degree - 240 degree F with 2 degree F scale divisions (0 degree - 160 degree C with 2 degree C scale divisions).

### 2.3 SOLAR/LIGHT POWERED DIGITAL THERMOMETERS

- A. General: Provide light-powered digital thermometers of materials, capacities, and ranges indicated, designed and constructed for use in service indicated.
- B. Case and Solar Panels: Cast aluminum or high-impact ABS with LCD display powered by bi-directional solar panels.
- C. Adjustable Joint: 180 degree adjustment in vertical plane, 360 degree adjustment in horizontal plane, with locking device.
- D. Range: Field switchable temperature scale, -40 to 300 degrees F. (-40 to 150 degrees C.). Accuracy is 1 percent or 1 degree F., whichever is greater.
- E. Stem: Aluminum or brass, for separable socket, length to suit installation.
- F. Sensor: Glass passivated thermistor.

### 2.4 THERMOMETER WELLS

- A. General: Provide thermometer wells constructed of lead-free brass certified to the requirements of NSF 372 or stainless steel, pressure rated to match piping system design pressure. Provide 2-inch extension for insulated piping. Provide cap nut with chain fastened permanently to thermometer well.

### 2.5 PRESSURE GAUGES

- A. General: Provide pressure gauges of materials, capacities, and ranges indicated, designed and constructed for use in service indicated. All wetted parts in contact with water shall be certified to meet the requirements of NSF 372.
- B. Type: General Use, 1 percent accuracy, ANSI B40.1 Grade A, phosphor bronze bourdon type, bottom connection.
- C. Case: Stainless steel, drawn steel, cast aluminum or brass, glass lens, 4-1/2 inch diameter.
- D. Connector: Brass with 1/4-inch male NPT.
- E. Scale: White coated aluminum, with permanently etched markings.

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- F. Range: Conform to the following:
  - 1. Vacuum: 30-Inch Hg - 15 PSI.
  - 2. Water: 0 - 160 PSI.
  - 3. Compressed Air: 0 – 300 PSI

### 2.6 PRESSURE GAUGE COCKS

- A. General: Provide lead-free pressure gauge cocks between pressure gauges and gauge tees on piping systems. Construct gauge cock of brass with 1/4-inch female NPT on each end, and "T" handle brass plug.
- B. Snubber: 1/4-Inch lead-free brass bushing with corrosion resistant porous metal disc, through which pressure fluid is filtered. Select disc material for fluid served and pressure rating.

## PART 3 - EXECUTION

### 3.1 INSPECTION

- A. Examine areas and conditions under which meters and gauges are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

### 3.2 INSTALLATION OF TEMPERATURE GAUGES

- A. General: Install temperature gauges in vertical upright position, and tilted so as to be easily read by observer standing on floor.
- B. Thermometer Wells: Install in piping tee where indicated, in vertical upright position. Fill well with oil or graphite, secure cap.

### 3.3 INSTALLATION OF PRESSURE GAUGES

- A. General: Install pressure gauges in piping tee with pressure gauge cock, located on pipe at most readable position.
- B. Locations: Install in the following locations, and elsewhere as indicated:
  - 1. At suction and discharge of each pump.
  - 2. At discharge of each pressure reducing valve.
  - 3. At water service outlet.
- C. Pressure Gauge Cocks: Install in piping tee with snubber.
- D. All pressure gauges shall have isolation gauge cock, "snubber" valve, to service the gauge and isolate it from the pipe system service without having to drain the piping system.

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- E. For 6-Inch and Larger Piping Service, use ball valve for gauge isolation valve which shall be not less than 1/4-inch diameter for full gauge pipe correction diameter.

### 3.4 ADJUSTING AND CLEANING

- A. Adjusting: Adjust faces of meters and gauges to proper angle for best visibility.
- B. Cleaning: Clean windows of meters and gauges and factory-finished surfaces. Replace cracked or broken windows, repair any scratched or marred surfaces with manufacturer's touch-up paint.

END OF SECTION 220519



**SECTION 220523 - GENERAL-DUTY VALVES FOR PLUMBING PIPING**

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. This Section includes potable cold, hot, and recirculated hot water valves within the building to a point 5-feet outside the building. This section includes the following:
  - 1. Valves

1.2 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with the provisions of the following:
  - 1. Comply with ASME B16.10 and ASME B16.34 for Dimension and Design Criteria.
  - 2. NSF Compliance: NSF 61 Annex G and/or NSF 372 and/or California AB1953 for products that contact drinking water.
  - 3. Local Plumbing Code and Utility Department requirements.
  - 4. Colorado Cross Connection Control Manual.
  - 5. Safe Drinking Water Act – Public Law No. 111-380.

1.3 INSTALLER'S QUALIFICATIONS

- A. All Plumbing Work shall be performed by a State of Colorado Licensed Contractor under the supervision of a Licensed Plumber. Contractors shall verify that plumbers are currently licensed by the State of Colorado and shall supply the Project Manager with names and license numbers. Contractors shall have a minimum of three (3) years of satisfactory performance in conducting the type of work specified.

1.4 SUBMITTALS

- A. Submit under provisions of Division 1.

1.5 CLOSEOUT SUBMITTALS

- A. Submit under provisions of Division 1.
- B. Test Reports.
- C. Valve schedule listing valve designation number, valve type, size, location, and function of all valves.

PART 2 - PRODUCTS

2.1 VALVES

A. General:

1. Valves shall be NSF/ANSI 61 Annex G and/or NSF/ANSI 372 compliant for potable-water service. Valves for domestic water must be 3<sup>rd</sup> Party Certified.
2. Comply with MSS-92 1980 "Valve Users Manual".
3. Sizes: Provide valves of same size as upstream pipe size.
4. Extended Stems: Where insulation is indicated or specified, provide extended stems to allow full operation of the valve without interference by the insulation.
5. Bypass and Drain Connections: Comply with MSS SP-45.

B. Gate Valves:

1. 2-1/2 Inch and Larger: Lead-free, MSS-SP 70, 200 PSI CWP, non-rising stem, bolted bonnet, resilient wedge, NSF epoxy coated ASTM A126 Class B cast iron body or ASTM A536 ductile iron body, handwheel operator.
  - a. Acceptable Manufacturers:
    - 1) Nibco F-619-RW-LF
    - 2) Watts
    - 3) Kennedy Valve
    - 4) Wilkens

C. Ball Valves:

1. 2-1/2 Inch and Smaller: MSS-SP-110, 150 PSI SWP, 600 PSI WOG, two-piece ASTM B-584 lead-free cast bronze body, full port, chrome plated brass/bronze ball, PTFE seats, anti-blowout stem, separate packnut with adjustable stem packing, extended stem, and vinyl covered steel handle. Threaded or soldered end connections. Valve shall be NSF/ANSI 61 Annex G and/or NSF/ANSI 372 compliant for potable-water service. Each valve shall have a certificate or a letter from the manufacturer indicating compliance with the NSF requirements indicated attached with the shop drawing submittal.
  - a. Acceptable Manufacturers:
    - 1) Apollo (Conbraco) Model 77CLF (lead free)
    - 2) Nibco
    - 3) Milwaukee
    - 4) Hammond

D. Butterfly Valves:

1. 2-1/2 Inch and Larger: MSS-SP-67, ASTM A126 cast iron body or ASTM A536 ductile iron body, Class B fully lugged, lead-free aluminum bronze disc, stainless steel stem, EPDM liner, bronze bearings, non-metallic bushing and EPDM or Buna-N stem seals. Rated for 200 PSI bi-directional shutoff and 200 PSI dead-end service with downstream piping removed. The valve design shall be for ANSI 125 or 150 flanges. Provide extended neck for insulation. Sizes 3-inch – 6-inch shall be lever operated with 10- position throttling plate; sizes 8-inch and larger shall have weatherproof gear operators. Valve shall be NSF/ANSI 61 Annex G and/or NSF/ANSI 372 compliant for potable- water service. Each valve shall have a certificate or a letter from the manufacturer

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indicating compliance with the NSF requirements indicated attached with the shop drawing submittal.

2.

a. Acceptable Manufacturers:

- 1) Nibco LD-2000N-3/5
- 2) Watts BF Series
- 3) Val Matic Valve – American BFV
- 4) Milwaukee
- 5) Hammond

E. Check Valves:

1. Swing Check Valve:

a. 2-1/2 Inch and Smaller: MSS SP-80; pressure rating 200 CWP, ASTM B-584 lead-free bronze body and bonnet, horizontal swing design, Y-pattern, with PTFE seat disc. Threaded or soldered end connections. Valve shall be NSF 61 Annex G and/or NSF/ANSI 372 compliant for potable-water service. Each valve shall have a certificate or a letter from the manufacturer indicating compliance with the NSF requirements indicated attached with the shop drawing submittal.

1) Acceptable Manufacturers:

- a) Nibco T/S-413-Y-LF (lead-free)
- b) Milwaukee
- c) Hammond

F. Drain Valve: Lead-free bronze ball valve with threaded hose end and cap with chain. Valve upstream of backflow preventer shall have vacuum breaker and cap. MSS-SP-110, 150 PSI SWP, 600 PSI WOG, two-piece ASTM B-584 lead-free cast bronze body, full port, chrome plated brass/bronze ball, PTFE seats, anti-blowout stem, separate packnut with adjustable stem packing, extended stem, and vinyl covered steel handle. Threaded or soldered end connections. Valve shall be NSF/ANSI 61 Annex G and/or NSF/ANSI 372 compliant for potable-water service. Each valve shall have a certificate or a letter from the manufacturer indicating compliance with the NSF requirements indicated attached with the shop drawing submittal.

1. Acceptable Manufacturers:

- a. Apollo 70LF-100/200-HC (lead-free)
- b. Nibco
- c. Milwaukee
- d. Hammond

G. Calibrated Balancing Valves:

1. 200 PSI, lead-free brass body, brass ball construction or stainless steel cartridge, with handle and memory stop. Differential pressure read-out ports across valve seat.

a. Acceptable Manufacturers:

- 1) Bell & Gossett ITT Circuit Setter CB Lead-free series
- 2) Griswold Controls – K Valve

PART 3 - EXECUTION

3.1 VALVES

A. Installation:

1. Use gate valves only on domestic water service entrances as specified by the Authority Having Jurisdiction.
2. Use ball or butterfly valves for isolation valves unless noted otherwise.
3. Use ball valves for throttling or water meter bypass.
4. Use calibrated balancing valves for balancing valves.
5. Sectional Valves: Install sectional valves on each branch and riser, where branch or riser serves two (2) or more plumbing fixtures or equipment connections, and elsewhere as indicated.
6. Shutoff Valves: Install shutoff valves on inlet of each plumbing equipment item, and stops on inlet of each plumbing fixture, and elsewhere as indicated.
7. Drain Valves: Install drain valves at the base of each riser, at low points of horizontal runs, and elsewhere as required to completely drain distribution piping system.
8. Check Valves: Install check valves on discharge side of each pump, each side of reduced pressure backflow preventers and elsewhere as indicated.
9. Balancing Valves: Install in each hot water recirculating loop, discharge side of each pump, and elsewhere as indicated.
10. Chain Wheel Operators: For valves 2-1/2 inch and larger installed 96-inches or higher above finished floor elevation in mechanical rooms. Extend chains to an elevation of 6'- 0" above finished floor elevation.

3.2 ADJUSTING AND CLEANING

- 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.

END OF SECTION 220523

**SECTION 220529 - HANGERS AND SUPPORTS FOR PLBG PIPING AND EQUIP**

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of Supports and Anchors required by this section is indicated on drawings and/or specified in other Division 22 sections.
- B. Types of Supports and Anchors specified in this section include the following:
  - 1. Horizontal-Piping Hangers and Supports
  - 2. Vertical-Piping Clamps
  - 3. Hanger-Rod Attachments
  - 4. Building Attachments
  - 5. Thermal Shield Inserts and Protective Shields
  - 6. Miscellaneous Materials
  - 7. Roof Equipment Supports
  - 8. Anchors
  - 9. Equipment Supports
- C. Supports and anchors furnished as part of factory-fabricated equipment are specified as part of equipment assembly in other Division 22 sections.

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of supports and anchors, of types and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. Codes and Standards:
  - 1. Regulatory Requirements: Comply with applicable Plumbing Codes pertaining to product materials and installation of supports and anchors.
  - 2. MSS Standard Compliance:
    - a. Provide pipe hangers and supports of which materials, design, and manufacture comply with MSS SP-58.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including installation instructions for each type of support and anchor. Submit pipe hanger and support schedule showing manufacturer's figure number, size, location, and features for each required pipe hanger and support.
- B. Shop Drawings: Submit manufacturer's assembly-type shop drawings for each type of support and anchor, indicating dimensions, weights, required clearances, and methods of assembly of components.

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- C. Product certificates signed by the manufacturer of hangers and supports certifying that their products meet the specified requirements.
- D. Maintenance Data: Submit maintenance data and parts list for each type of support and anchor. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Division 1.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
  - 1. Pipe Hangers and Supports:
    - a. B-Line Systems, Inc.
    - b. Carpenter and Patterson, Inc.
    - c. Fee & Mason Mfg. Co.; Division Figgie International
    - d. PHD Manufacturing, Inc.
    - e. Elcen Metal Products Company
    - f. Erico/Caddy
    - g. Unistrut Metal Framing Systems
    - h. Hubbard Enterprises (Supports for domestic water piping)
    - i. Hilti Construction Chemicals, Inc.
    - j. Anvil
  - 2. Thermal Shields:
    - a. B-Line Systems, Inc.
    - b. Pipe Shields, Inc.
    - c. Insulation Pipe Supports Manufacturing
    - d. Insulated Saddle Shield Insert Product Inc.
    - e. Erico/Caddy
    - f. Component Products Co.
    - g. Value Engineered Products, Inc.
    - h. Snappitz
    - i. Anvil
  - 3. Roof Pipe Supports:
    - a. MAPA
    - b. B-Line Systems, Inc.
    - c. Roof Top Blox
    - d. Miro Industries, Inc.
    - e. Erico/Caddy
  - 4. Concrete Inserts and Anchors:
    - a. Phillips Drill Company
    - b. Erico/Caddy
    - c. Elcen Metal Products Company
    - d. ITW Ramset/Red Head
    - e. Hilti Construction Chemicals, Inc.
    - f. B-Line Systems, Inc.

2.2 PIPE HANGERS AND SUPPORTS

- A. Hangers and support components shall be factory fabricated of materials, design, and manufacturer complying with MSS SP-58.
  - 1. Components shall have galvanized coatings where installed for piping and equipment that will not have field-applied finish.
  - 2. Pipe attachments shall have nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.
- B. Adjustable Clevis Hanger: MSS Type 1
  - 1. Steel Pipe, size 3/8-inch thru 12-inch, B-Line B3100
  - 2. Copper Pipe, size 1/2-inch thru 4-inch, B-Line B3104CT
  - 3. Cast Iron Pipe, size 4-inch thru 24-inch, B-Line B3100
- C. Adjustable Swivel Ring: MSS Type 10
  - 1. Steel Pipe, size 1/2-inch thru 2-inch, B-Line B3170NF
  - 2. Copper Pipe, size 1/2-inch thru 4-inch, B-Line B3170CT
- D. Pipe Clamps: MSS Type 8
  - 1. Steel Pipe, size 3/4-inch thru 20-inch, B-Line B3373
  - 2. Copper Pipe, size 1/2-inch thru 4-inch, B-Line B3373CT
- E. Floor Standpipe Saddle Support: MSS Type 37
  - 1. Steel Pipe, size 1 1/2-inch thru 12-inch, B-Line B3095
- F. Hanger Rods: Continuous threaded steel, sizes as specified.
- G. Pipe Alignment Guides:
  - 1. Pipe Guides: Provide factory-fabricated guides, of cast semi-steel or heavy fabricated steel, consisting of bolted two-section outer cylinder and base with two-section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any), and cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.
- H. Multiple or Trapeze: Structural steel channel (with web vertical), with welded spacers and hanger rods. Provide hanger rods one (1) size larger than for largest pipe in trapeze. If the deflection at center of trapeze exceeds 1/360 of the distance between the end hangers, install an additional hanger at mid-span or use a larger channel.
- I. Wall Supports for Horizontal Pipe:
  - 1. 1/2-Inch thru 3-1/2 Inch: Steel offset hook.
  - 2. 4-Inch and Over: Welded steel bracket and wrought steel clamp.
- J. Supports for Vertical Pipe: Steel or Copper Coated riser clamp.
- K. Upper Attachments:
  - 1. Beam Clamps:
    - a. All thread rod sized 3/8-inch and 1/2-inch, B-Line B3034
    - b. All thread rod sizes 5/8-inch, B-Line B3033
    - c. All thread rod sizes 3/4-inch and up, B-Line B3055

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### 2.3 CONCRETE INSERTS AND ANCHORS

- A. Inserts: Case shall be of galvanized carbon steel with square threaded concrete insert nut for hanger rod connection; 3/4-inch lateral adjustment; top lugs for reinforcing rods, nail holes for attaching to forms. Erico Hanger Models 355 and 355N or equal. This type of upper attachment is to be used for all areas having poured in place concrete construction.
  - 1. Size inserts to suit threaded hanger rods.
- B. Anchors: Carbon steel, zinc plated. Installation shall be in holes drilled with carbide-tipped drill bits or by use of self-drilling anchors.
  - 1. Provide anchors suitable for the location of installation and designed to withstand all forces and movements acting in the anchor. Manufacture pipe anchors in accordance with MSS SP 58. Provide a safety factor of four (4) for the anchor installation.
  - 2. Powder driven fasteners subject to approval of Structural Engineer. Each fastener shall be capable of holding a test load of 1,000 pounds whereas the actual load shall not exceed 50 pounds.
  - 3. Self-drilling expansion shields. The load applied shall not exceed one-fourth the proof test load required.
  - 4. Machine bolt expansion anchor. The load applied shall not exceed one-fourth the proof test load required.

### 2.4 THERMAL SHIELD INSERTS AND PROTECTIVE SHIELDS

- A. General: Provide thermal shield inserts under all insulated piping hangers. Provide thermal shield inserts on all piping through floors, wall and roof construction penetrations. Size saddles and thermal shield inserts for exact fit to mate with pipe insulation or a minimum of 1-inch thick for uninsulated pipe thermal shield inserts.
- B. Galvanized Protection Shields: MSS Type 40; of length recommended by manufacturer to prevent crushing of insulation. See also Part 3.H.3.
  - 1. B-Line B3151
- C. Thermal Shield Inserts: Provide 100-psi average compressive strength, waterproof, asbestos free calcium silicate, encased with a sheet metal enclosure or other listed system manufacturers. Insert and shield shall cover the entire circumference on vertical pipes, or the bottom half circumference of the pipe on horizontal mounting supports, and shall be of length recommended by the manufacturer for pipe size and thickness of insulation or the thickness of the wall, roof or floor construction.
- D. Thermal Mechanical Pipe Shields: Self-locking insulated pipe supports/shields shall be provided at hanger, support, and guide locations on pipe requiring insulation. The insert shall consist of either hydrous calcium silicate or polyisocyanurate foam insulation (urethane) encircling the entire circumference of the pipe with a 360 degree PVC or galvanized steel jacket which complies with the International Mechanical Code for installation in plenum ceilings where applicable. The length of the jacket shall be sized for pipe expansion.

### 2.5 MISCELLANEOUS MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36.



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- B. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix ratio shall be 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.
- C. Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS Standards.

### 2.6 ROOF PIPE SUPPORTS

- A. Factory fabricated roof support system for piping application. Base shall be compatible with roofing membrane. For support materials other than metal, such materials shall be UV resistant. All metal components shall be corrosion resistant by either galvanization or zinc plating.
- B. Supports shall be designed to support the piping system and installed in accordance to manufacturer's requirements. The support shall have a continuous bottom surface to provide even load distribution and minimize point loading of the roof membrane. The support shall not require roof penetrations, flashing or damage to the roofing material.
- C. Install with supplemental pad under support base as required by roofing system design.

## PART 3 - EXECUTION

### 3.1 INSPECTION

- A. Examine areas and conditions under which supports and anchors are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

### 3.2 PREPARATION

- A. Proceed with installation of hangers, supports and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including (but not limited to) proper placement of inserts, anchors and other building structural attachments. **Review Structural Drawings to obtain structural support limitations.**
- B. Prior to installation of hangers, supports, anchors and associated work, Installer shall meet at Project Site with Contractor, installer of each component of associated work, inspection and testing agency representatives (if any), installers of other work requiring coordination with work of this section and Architect/Engineer for purpose of reviewing material selections and procedures to be followed in performing the work in compliance with requirements specified. **Provide Shop Drawing showing method and support locations from structure.**

### 3.3 INSTALLATION OF BUILDING ATTACHMENTS

- A. Install building attachments within concrete or on structural steel. Space attachments within maximum piping span length indicated in MSS SP-69 and tables in this section. Install

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additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert to forms. Where concrete with compressive strength less than 2,500 psi is indicated, install reinforcing bars through openings at top of inserts.

### B. New Construction:

1. Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practicable.
2. Set inserts in position in advance of concrete work. Provide reinforcement rod in concrete for inserts carrying pipe over 4-inch.
3. Where concrete slabs form finished ceiling, finish inserts flush with slab surface.
4. Use drop-in anchors for concrete structures.
5. Use beam clamps for steel structures.

### C. Existing Construction:

1. In existing concrete construction, drill into concrete slab and insert and tighten expansion anchor bolt. Connect anchor bolt to hanger rod. Care must be taken in existing concrete construction not to sever reinforcement rods or tension wires.

## 3.4 INSTALLATION OF HANGERS AND SUPPORTS

- A. Install hangers, supports, clamps and attachments to support piping properly from building structure; comply with MSS SP-69 and SP-89. Arrange for grouping of parallel runs of horizontal piping to be supported together on field fabricated, heavy-duty trapeze hangers where possible. Install supports with maximum spacings complying with MSS SP-69. Where piping of various sizes is supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.
- B. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers and other accessories.
- C. Support fire-water piping independently from other piping systems.
- D. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated, or by other recognized industry methods.
- E. Install hangers and supports to allow controlled movement of piping systems, to permit freedom of movement between pipe anchors, to facilitate action of expansion joints, expansion loops, expansion bends and similar units and within 1'-0" of each horizontal elbow.
- F. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
- G. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ANSI B31.9 Building Services Piping Code is not exceeded.
- H. Insulated Piping: Comply with the following installation requirements:

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1. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ANSIB31.
2. Thermal Protective Shields: Install thermal protective shields MSS Type 40 on domestic water piping that is insulated. Thermal protective shields shall span an arc of 360 degrees and shall have dimensions in inches not less than the following:

<u>NPS</u>	<u>Length</u>	<u>Metal Shield Thickness</u>
1/4 thru 3-1/2	12	0.048
4	12	0.060
5 and 6	18	0.060
8 thru 14	24	0.075
16 thru 24	24	0.105

3. Thermal shield inserts shall be provided where thermal protective metal shields are provided and shall span an arc of 360 degrees and shall match the length of the thermal protective shield.

I. Support vertical runs at each floor.

J. Install steel natural gas piping with the following minimum rod size and maximum spacing.:

<u>Size (NPS)(Inches)</u>	<u>Maximum Span in Feet</u>	<u>Minimum Rod Size - Inches</u>
1/2	6	3/8
3/4 to 1-1/4	8	3/8
1-1/2 to 2	10	3/8
2-1/2 to 3	10	1/2
4 to 5	10	5/8
6 to 8	10	3/4
10 to 12	10	7/8
Vertical, all sizes	Every floor level	

K. Install horizontal water distribution piping with the following maximum hanger spacing and minimum rod sizes:

<u>Nom. Pipe Size - Inches</u>	<u>Steel Pipe Max. Span - Feet</u>	<u>Copper Tube and DWV Copper Max. Span - Feet</u>	<u>Min. Rod Diameter - Inches</u>
Up to 1/2	6	6	3/8
3/4 & 1	8	6	3/8
1-1/4	10	6	3/8
1-1/2	10	6	3/8
2	10	10	3/8
2-1/2	10	10	1/2
3	10	10	1/2

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Nom. Pipe Size - Inches	Steel Pipe Max. Span - Feet	Copper Tube and DWV Copper Max. Span - Feet	Min. Rod Diameter - Inches
4	10	10	5/8
5	10	10	5/8
6	10	10	3/4
8	10	10	3/4

Pipe Size	CPVC		
	Maximum Hanger Spacing (ft.)	Maximum Vertical Spacing (ft.)	Minimum Rod Size (in.)
1/2"	3	10	3/8
3/4"	3	10	3/8
1"	3	10	3/8
1-1/4"	4	10	3/8
1-1/2"	4	10	3/8
2"	4	10	3/8
2-1/2"	4	10	1/2
3"	4	10	1/2
4"	4	10	1/2
5"	4	10	1/2
6"	4	10	5/8
8"	4	10	3/4
10"	4	10	3/4
12"	4	10	3/4

Based on MSS-69 & IPC.  
Provide midstory guides for piping 2 inches and smaller.

- L. Install horizontal polypropylene water distribution and waste piping with the following maximum spacing and minimum rod sizes:

Pipe Size	POLYPROPYLENE		
	Maximum Hanger Spacing (ft.)	Maximum Vertical Spacing (ft.)	Minimum Rod Size (in.)

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1/2"	2.67	10	3/8
3/4"	2.67	10	3/8
1"	2.67	10	3/8
1-1/4"	4	10	3/8
1-1/2"	4	10	3/8
2"	4	10	3/8
2-1/2"	4	10	1/2
3"	4	10	1/2
4"	4	10	1/2
5"	4	10	1/2
6"	4	10	5/8
8"	4	10	3/4
10"	4	10	3/4
12"	4	10	3/4
Based on MSS-69 & IPC. Provide midstory guides for piping 2 inches and smaller.			

- M. Install sanitary drainage and vent systems with the following maximum spacing and minimum rod sizes:

Pipe Size	CAST IRON PIPE – HUB AND SPIGOT AND NO-HUB		
	Maximum Hanger Spacing (ft.)	Maximum Vertical Spacing (ft.)	Minimum Rod Size (in.)
1-1/4" to 2"	5	15	3/8
2-1/2" to 5"	5	15	1/2
6"	5	15	5/8
8" to 12"	5	15	3/4
14" to 16"	5	15	1
Based on MSS-69 & IPC. Provide midstory guides for piping 2 inches and smaller.			

- N. Support horizontal cast iron pipe as follows:
1. Hub and Spigot: All sizes - One (1) hanger to each joint.
  2. No-Hub: All sizes.
    - a. With ASTM C 1540 stainless steel couplings: One (1) hanger to each joint.
    - b. With all other stainless steel band type couplings: One (1) hanger to each side of joint.

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- c. Support all horizontal cast iron pipe within 18-inches of each joint and with 5-feet maximum spacing between hangers, except that pipe exceeding 5-feet in length shall be supported at intervals no greater than 10-feet.
  - d. Support vertical cast iron pipe at each story height and at its base. Secure vertical hub and spigot pipe immediately below the hub. Support vertical no-hub pipe so that the weight is carried from the pipe to the support and not from the joint to the support.
- O. Provide copper or copper plated hangers and supports for copper piping.
- P. Place a hanger within 1-foot (0.305 m) of each horizontal elbow.
- Q. Use hangers which are vertically adjustable 1-1/2 inch (38.1 mm) minimum after piping is erected.
- R. Support vertical steel and copper piping at every story height but at not more than 15-foot intervals for steel and 10-feet for copper.
- S. Where several pipes can be installed in parallel and at same elevation, provide trapeze hangers.
- T. Where practical, support riser piping independently of connected horizontal piping.
- U. All insulated pipes ( $\geq 2$ "d) shall have thermal shield insert at all support points. All piping shall have thermal shield inserts at each penetration through wall, floor and roof.
- V. Each pipe drop to equipment shall be adequately supported. All supporting lugs or guides shall be securely anchored to the building structure.
- W. Install all couplings with torque wrench, torqued to inch-pounds as specified by the manufacturer.
- X. Securely anchor and support plumbing domestic water piping in chases or walls. Use factory manufactured clamps and brackets connected to fixture carriers, waste/vent piping or brackets connected to studs. Wires or straps will not be permitted.
  - 1. When copper supplies are connected to flush valves, support the tubing by the studs or by a fixture carrier, not by clamping to waste/vent piping.
  - 2. Prevent copper tubes from making contact with steel brackets using fire retardant polyethylene inserts or other dielectric insulating material.
  - 3. Place supports every 10-feet on vertical pipe and every 5-feet on horizontal pipe.
- Y. Hang all insulated pipe at the point of support in the following manner:
  - 1. Hanger: See Paragraph 2.2.
  - 2. Thermal Shield/Insert: Provide thermal shield insert of the same thickness as adjoining insulation for insulated pipe. The entire 360 degrees shall be waterproof, asbestos free, calcium silicate or polyisocyanurate foam insulation (urethane).
    - a. On domestic cold water, non potable water and horizontal roof drain pipe the thermal shield insert shall extend 2-inches beyond the construction material and the sheet metal shield shall span an arc of 360 degrees. All hangers shall be properly sized to accommodate the thermal shield insert and no hanger shall penetrate or crush any of the insulating material.

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- Z. Install anchors and fasteners in accordance with manufacturer's recommendations and the following:
1. In the event a self-drilling expansion shield or machine bolt expansion shield is considered to have been installed improperly, the Contractor shall make an acceptable replacement or demonstrate the stability of the anchor by performing an on-site test under which the anchor will be subjected to a load equal to twice the actual load.
  2. Powder-driven fasteners may be used only where they will be concealed after the construction is complete. Where an occasional fastener appears to be improperly installed, additional fastener(s) shall be driven nearby (not closer than six (6) inches) in undisturbed concrete. Where it is considered that many fasteners are improperly installed, the Contractor shall test load any fifty (50) successively driven fasteners. If 10 percent or more of these fasteners fail, the Contractor shall utilize other fastening means as approved and at no additional cost to the Owner.
  3. Hangers for piping shall be attached to cellular steel floor decks with steel plates and bolted rod conforming to the steel deck manufacturer's requirements. Where the individual hanger load exceeds the capacity of a single floor deck attachment, steel angles, beams or channels shall be provided to span the number of floor deck attachments required.
  4. Welding may be used for securing hangers to steel structural members. Welded attachments shall be designed so that the fiber stress at any point of the weld or attachment will not exceed the fiber stress in the hanger rod.

### 3.5 INSTALLATION OF ANCHORS

- A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ANSI B31.9, and to prevent transfer of loading and stresses to connected equipment.
- B. Fabricate and install anchor by welding steel shapes, plates and bars to piping and to structure. Comply with ANSI B31.9 and with AWS Standards D1.1.
- C. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions, to control movement to compensators.
- D. Anchor Spacings: Where not otherwise indicated, install anchors at ends of principal pipe-runs, at intermediate points in pipe-runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

### 3.6 EQUIPMENT SUPPORTS

- A. Fabricate structural steel stands to suspend equipment from structure above or support equipment above floor.
- B. Grouting: Place grout under supports for piping and equipment.
- C. Concrete bases for the mechanical equipment indoors or outdoors will be provided by the General Contractor only if shown on the Architectural or Structural Drawings. Otherwise, all bases shall be provided by this Contractor.

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- D. Housekeeping bases shall be 4-inch thick minimum, extended 4-inch beyond machinery bedplates.
- E. This Contractor shall be responsible for the proper size and location of all bases and shall furnish all required anchor bolts and sleeves. If bases are provided by the General Contractor, furnish him with templates showing the bolt locations.
- F. Equipment shall be secured to the bases with anchor bolts of ample size. Bolts shall have bottom plates and pipe sleeves and shall be securely imbedded in the concrete. All machinery shall be grouted under the entire bearing surface. After grout has set, all wedges, shims and jack bolts shall be removed and the space filled with non-shrinking grout. This Contractor shall provide washers at all equipment anchor bolts.
- G. Construct equipment supports above floor of structural steel members or steel pipe and fittings. Brace and fasten with flanges bolted to structure.
- H. Provide rigid anchors for pipes immediately after vibration connections to equipment.

### 3.7 METAL FABRICATION

- A. Cut, drill, and fit miscellaneous metal fabrications for pipe anchors and equipment supports. Install and align fabricated anchors in indicated locations.
- 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 for procedures of manual shielded metal-arc welding, appearance and quality of welds made, methods used in correcting welding work, and 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 that no roughness shows after finishing.

### 3.8 ADJUSTING

- A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Touch-Up Painting: Immediately after erection of anchors and supports, clean field welds and abraded areas of shop paint and paint exposed areas with same material as used for shop painting to comply with SSPC-PA-1 requirements for touch-up of field-painted surfaces.
  - 1. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.

OR

  - 2. Touch-Up Painting: Cleaning and touch-up painting of field welds, bolted connections, and abraded areas of the shop paint on miscellaneous metal is specified in Division 9 section "PAINTING" of these specifications.



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- C. For galvanized surfaces, clean welds, bolted connections and abraded areas and apply galvanizing repair paint to comply with ASTM A 780.

END OF SECTION 220529

**SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT**

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of Mechanical Identification Work required by this section is indicated on drawings and/or specified in other Division 22 sections.
- B. Types of Identification Devices specified in this section include the following:
  - 1. Painted Identification Materials
  - 2. Plastic Pipe Markers
  - 3. Plastic Tape
  - 4. Underground-Type Plastic Line Marker
  - 5. Valve Tags
  - 6. Valve Schedule Frames
  - 7. Engraved Plastic-Laminate Signs
  - 8. Plasticized Tags
  - 9. Lettering and Graphics
- C. Refer to Division 26 sections for Identification Requirements of Electrical Work; not work of this section.

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of identification devices of types and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. Codes and Standards:
  - 1. ANSI Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each identification material and device required.
- B. Schedules: Submit valve schedule for each piping system, typewritten and reproduced on 8- 1/2" x 11" bond paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), size of valve, and variations for identification (if any). Only tag valves which are intended for emergency shutoff and similar special uses, such as valve to isolate individual system risers, individual floor branches or building system shut-off valves. In addition to mounted copies, furnish extra copies for Maintenance Manuals as specified in Division 1.

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## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
1. Allen Systems, Inc.
  2. Brady (W.H.) Co.; Signmark Division
  3. Brimar Industries, Inc.
  4. Industrial Safety Supply Co., Inc.
  5. Seton Name Plate Corp.

### 2.2 MECHANICAL IDENTIFICATION MATERIALS

- A. General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division 22 sections. Where more than single type is specified for application, selection is Installer's option, but provide single selection for each product category.

### 2.3 PAINTED IDENTIFICATION MATERIALS

- A. Stencils: Standard fiberboard stencils, prepared for required applications with letter sizes generally complying with recommendations of ANSI A13.1 for piping or to match existing size in existing building, but not less than 3/4-inch high letters for access door signs and similar operational instructions.
- B. Stencil Paint: Standard exterior type stenciling enamel; Black, except as otherwise indicated; either brushing grade or pressurized spray-can form and grade.
- C. Identification Paint: Standard identification enamel of colors indicated or, if not otherwise indicated, comply with ANSI A13.1 for colors or to match existing building standard identification.

### 2.4 PLASTIC PIPE MARKERS

- A. Snap-On Type: Provide manufacturer's standard pre-printed, semi-rigid snap-on, color-coded pipe markers, complying with ANSI A13.1.
- B. Insulation: Furnish 1-inch thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125 degree F (52 degree C) or greater. Cut length to extend 2-inch beyond each end of plastic pipe marker.
- C. Small Pipes: For external diameters less than 6-inch (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one (1) of the following methods:
1. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
  2. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4-inch wide; full circle at both ends of pipe marker, tape lapped 1-1/2 inch.

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- D. Large Pipes: For external diameters of 6-inch and larger (including insulation if any), provide either full-band or strip-type pipe markers, but not narrower than three (3) times letter height (and of required length), fastened by one (1) of the following methods:
  - 1. Steel spring or non-metallic fasteners.
  - 2. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 1-1/2 inch wide; full circle at both ends of pipe marker, tape lapped 3-inches.
  - 3. Strapped-to-pipe (or insulation) application of semi-rigid type, with manufacturer's standard stainless steel bands.
- E. Lettering: Comply with piping system nomenclature as specified, scheduled, shown, or to match existing building lettering nomenclature system and abbreviate only as necessary for each application length.
- F. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.

### 2.5 PLASTIC TAPE

- A. General: Provide manufacturer's standard color-coded pressure-sensitive (self-adhesive) vinyl tape, not less than 3 mils thick.
- B. Width: Provide 1-1/2 inch wide tape markers on pipes with outside diameters (including insulation, if any) of less than 6-inch, 2-1/2 inch wide tape for larger pipes.
- C. Color: Comply with ANSI A13.1, except where another color selection is indicated.

### 2.6 UNDERGROUND-TYPE PLASTIC LINE MARKERS

- A. General: Manufacturer's standard permanent, bright-colored, continuous-printed plastic tape, intended for direct-burial service; not less than 6-inch wide x 4 mils thick. Provide tape with printing which most accurately indicates type of service of buried pipe.
- B. Provide multi-ply tape consisting of solid aluminum foil core between 2-layers of plastic tape.

### 2.7 VALVE TAGS

- A. Brass Valve Tags: Provide 19-gauge polished brass valve tags with stamp-engraved piping system abbreviation in 1/4-inch high letters and sequenced valve numbers 1/2-inch high, valve normal position 1/4-inch high letters, and with 5/32-inch hole for fastener.
  - 1. Provide 1-1/2 inch diameter tags, except as otherwise indicated.
  - 2. Fill tag engraving with Black enamel.

OR
- B. Plastic Laminate Valve Tags: Provide manufacturer's standard 3/32-inch thick engraved plastic laminate valve tags, with piping system abbreviation in 1/4-inch high letters and sequenced valve numbers 1/2-inch high, and with 5/32-inch hole for fastener.
  - 1. Provide 1-1/2 inch square Black tags with White lettering, except as otherwise indicated.

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2. Provide size, shape and color combination as specified or scheduled for each piping system.

OR

- C. Plastic Valve Tags: Provide manufacturer's standard solid plastic valve tags with printed enamel lettering, with piping system abbreviation in approximately 3/16-inch high letters and sequenced valve numbers approximately 3/8-inch high, and with 5/32-inch hole for fastener.
  1. Provide 1-1/8 inch square White tags with Black lettering.
  2. Provide size, shape and color combination as specified or scheduled for each piping system.
- D. Valve Tag Fasteners: Provide manufacturer's standard solid brass chain (wire link or beaded type), and solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.
- E. Access Panel Markers: Provide manufacturer's standard 1/16-inch thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve. Include 1/8-inch center hole to allow attachment.

### 2.8 VALVE SCHEDULE

- A. Valve Schedule shall be printed on company letterhead and shall include the following columns:
  1. Valve Tag Number (*example*: HWS-1)
  2. Service (*example*: ISOLATE AHU-1 HEATING COIL)
  3. Room Number (location of valve)
  4. Size of Valve
  5. Type of Valve
  6. Normal Position of the Valve (open or closed)
- B. Frame: For each page of valve schedule, provide glazed display frame, with screws for removable mounting on masonry walls. Provide frames of finished hardwood or extruded aluminum, with non-glare type plexiglass.

### 2.9 ENGRAVED PLASTIC-LAMINATE SIGNS

- A. General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in the sizes and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, Black with White core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
- B. Thickness: 1/8-Inch, except as otherwise indicated.
- C. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

### 2.10 PLASTICIZED TAGS

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- A. General: Manufacturer's standard pre-printed or partially pre-printed accident-prevention tags, of plasticized card stock with matt finish suitable for writing, approximately 3-1/4 inch x 5-5/8 inch, with brass grommets and wire fasteners, and with appropriate pre-printed wording including large-size primary wording (As examples; DANGER, CAUTION, DO NOT OPERATE).

### 2.11 LETTERING AND GRAPHICS

- A. General: Coordinate names, abbreviations and other designations used in mechanical identification work, with corresponding designations shown, specified, scheduled and approved by the Owner/Engineer. Provide numbers, lettering and wording as indicated and approved by the Owner/Engineer for proper identification and operation/maintenance of mechanical systems and equipment.
- B. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as designated on the drawings or schedule as well as service.

## PART 3 - EXECUTION

### 3.1 GENERAL INSTALLATION REQUIREMENTS

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

### 3.2 PIPING SYSTEM IDENTIFICATION

- A. General: Install pipe markers of the following type on each system indicated to receive identification, and include arrows to show normal direction of flow. Existing building identification shall match the existing method which exists in the building.
- B. Plastic pipe markers, with application system as indicated under "MATERIALS" in this section. Install on pipe insulation segment where required for hot non-insulated pipes.  
OR
- C. Stenciled markers, including color-coded background band or rectangle, and contrasting lettering of Black or White. Extend color band or rectangle 2-inch beyond ends of lettering.  
OR
- D. Stenciled markers, with lettering color complying with ANSI A13.1.  
OR
- E. Stenciled markers, Black or White for best contrast, wherever continuous color-coded painting of piping is provided.

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- F. Locate pipe markers and color bands as follows wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations.
- G. Near each valve and control device.
- H. Near each branch, excluding short take-offs for fixtures; mark each pipe at branch, where there could be question of flow pattern.
- I. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
- J. At access doors, manholes and similar access points which permit view of concealed piping.
- K. Near major equipment items and other points of origination and termination.
- L. Spaced intermediately at maximum spacing of 25-foot along each piping run, except reduce spacing to 15-foot in congested areas of piping and equipment.
- M. On piping above removable acoustical ceilings.

### 3.3 UNDERGROUND PIPING IDENTIFICATION

- A. General: During back-filling/top-soiling of each exterior underground piping systems, install continuous underground-type plastic line marker, located directly over buried line at 6-inch to 8-inch below finished grade. Where multiple small lines are buried in common trench and do not exceed overall width of 16-inch, install single line marker. For tile fields and similar installations, mark only edge pipelines of field.

### 3.4 VALVE IDENTIFICATION

- A. General: Provide valve tag on valves in each piping system. List each tagged valve in valve schedule for each piping system.
  - 1. Building services main shutoff valves.
  - 2. Each individual system main shutoff valves.
  - 3. Each individual system riser shutoff valves.
  - 4. Each individual system floor shutoff valves.
  - 5. Each individual system major branch shutoff valves.
- B. Provide the following columns and information for each valve:
  - 1. Valve Tag Number (*example: HWS-1*)
  - 2. Service (*example: ISOLATE AHU-1 HEATING COIL*)
  - 3. Room Number (location of valve)
  - 4. Size of Valve
  - 5. Type of Valve
  - 6. Normal Position of the Valve (open or closed)
- C. Mount valve schedule frames and schedules in mechanical equipment rooms where directed by Architect/Owner/Engineer.

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- D. Where more than one (1) major mechanical equipment room is shown for project, install mounted valve schedule in each major mechanical equipment room, and repeat only main valves which are to be operated in conjunction with operations of more than single mechanical equipment room.

### 3.5 MECHANICAL EQUIPMENT IDENTIFICATION

- A. General: Install minimum 2-inch x 4-inch engraved plastic laminate equipment marker on each individual items of mechanical equipment. Provide signs for the following general categories of equipment.
  1. Main building systems control and operating valves, including safety devices and hazardous units such as gas outlets.
  2. Fuel-burning units including boilers, water heaters, medical gas equipment.
  3. Pumps, and similar motor-driven units.
  4. Heat exchangers, and similar equipment.
  5. Tanks and pressure vessels.
  6. Water treatment systems and similar equipment.
- B. Lettering Size: Minimum 1/4-inch high lettering for name of unit.
- C. Text of Signs: In addition to the identified unit, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

### 3.6 ADJUSTING AND CLEANING

- A. Adjusting: Relocate any mechanical identification device which has become visually blocked by work of this division or other divisions.
- B. Cleaning: Clean face of identification devices, and glass frames of valve charts.

END OF SECTION 220553



**SECTION 220700 - PLUMBING INSULATION**

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. This Section includes:
  - 1. Piping Insulation, Jackets and Accessories
  - 2. Equipment Insulation and Covering
- B. Refer to other Division 22 sections for Shields, Inserts, and Mechanical Identification.
- C. Insulation thickness based on 2007 ASHRAE 90.1 table 6.8.3 recommendations and the International Energy Conservation Code.

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of mechanical insulation products, of types and sizes required, whose products have been in satisfactory use in similar service for not less than three (3) years.
- B. Installer's Qualifications: Firm with at least five (5) years successful installation experience on projects with mechanical insulations similar to that required for this project.
- C. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics and insulating cements.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's installation instructions and schedule listing materials, thickness, K-value, density, and furnished accessories for each service or equipment specified.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard ratings of the products, name of manufacturer, and brand.
- B. Protect insulation against dirt, water, chemical, and mechanical damage.

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## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide product by one of the following:
1. Insulation:
    - a. Armstrong World Industries, Inc. (flexible elastomeric)
    - b. Johns-Manville Products Corp. (fiberglass, calcium silicate)
    - c. Knauf Fiber Glass (fiberglass)
    - d. Manson Insulation Co. (fiberglass, calcium silicate)
    - e. Owens-Corning Fiberglas Corp. (fiberglass)
    - f. Rubatex Corp. (flexible elastomeric)
    - g. Aeroflex (flexible elastomeric)
  2. Jacketing, Coatings, Adhesives, Sealants and Covering Products:
    - a. Childers
    - b. Foster
    - c. Ceel-Co.
    - d. Johns-Manville Products Corp.
    - e. Knauf Fiber Glass
    - f. Venture Tape Corporation
    - g. Design Polymetrics

### 2.2 PIPING INSULATION

- A. Glass Fiber: ASTM C 547, Type 1, rigid molded, noncombustible, 0.23 "K" value at 100 degree F mean temperature, maximum service temperature 850 degree F, moisture sorption less than 0.2% by volume. Composite 25/50-flame spread/smoke developed rating (ASTM E 84, UL 723, and NFPA 255).
- B. Vapor Retarder Jacket: ASTM C 1136, 45lbs/in tensile strength (ASTM D 828), or beach puncture 50 oz in/in tear minimum (ASTM D 781). White Kraft paper reinforced with glass fiber yarn and bonded to aluminum foil, secured with self-sealing longitudinal laps and butt strips.
- C. Connections: Tacks, pressure sensitive color matching vinyl tape, Perma-Weld adhesive.
- D. Calcium Silicate: ASTM C 533, Type I, rigid molded, noncombustible (ASTME E 136), 0.42 "K" value at 300 degree F mean temperature, maximum service temperature 1200 degree F, 160 psi compressive strength for 5 percent compression (ASTM C 165), flexural strength 70 psi (ASTM C 203). 0/0 flame spread/smoke developed rating (ASTM E 84).
- E. Tie Wire: 16-Gauge stainless steel with twisted ends on maximum 12-inch centers.
- F. Flexible Elastomeric Foam: ASTM C 534, Type I, flexible, cellular elastomeric, molded, 0.27 "K" value at 75 degree F mean temperature, maximum service temperature 220 degree F, water vapor permeability of 0.10 perm-inch, 25/50-flame spread/smoke developed rating (ASTM E 84, UL 723, and NFPA 255).

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- G. Field Applied Fittings and Jackets:
1. PVC Plastic:
    - a. One-piece, gloss white, molded fitting covers with factory installed fiberglass insulation inserts.
    - b. 20 Mil (30 mil for exterior applications) cut and curled gloss white jacketing material. Composite 25/50 flame spread/smoke developed rating (ASTM E84, UL 723 and NFPA 90A).
    - c. Connect with tacks and pressure sensitive color matching vinyl tape.
  2. Canvas: UL Listed fabric, 6 oz/sq yd, plain weave cotton treated with dilute fire retardant lagging adhesive. Foster 30-36, Childers CP-50AMV1 or Duct Mate Lag it.
  3. Aluminum: 0.016-Inch thick sheet with factory applied moisture barrier, with longitudinal slip joints and 2-inch laps, die shaped fitting covers.
  4. Stainless Steel: Type 304 stainless steel, 0.010-inch.

### 2.3 EQUIPMENT INSULATION

- A. Rigid Fiberglass Board (Low Temperature): ASTM C 612, Type IA and IB, 3 lb/cu ft density, 0.23 "K" value at 75 degree F mean temperature, maximum service temperature 450 degree F, moisture sorption less than 5.0% by weight, aluminum foil facing reinforced with fiberglass scrim laminated to UL rated Kraft paper. Composite 25/50-flame spread/smoke developed rating (ASTM E 84, UL 723, and NFPA 90A).
1. Secure with UL Listed pressure sensitive tape and/or outward clinched expanded staples and vapor barrier mastic as needed.
- B. Rigid Fiberglass Board (High Temperature): ASTM C 612, Type II, 3 lb/cu ft density, 0.23 "K" value at 75 degree F mean temperature, maximum service temperature 850 degree F, moisture sorption less than 5.0% by weight, 1-inch galvanized hexagonal wire mesh facing stitched on face of insulation. Composite 25/50-flame spread/smoke developed rating (ASTM E 84, UL 723, and NFPA 90A).
1. Secure with UL listed pressure sensitive tape and/or outward clinched expanded staples and vapor barrier mastic as needed.
- C. Flexible Fiberglass Blanket: ASTM C 553, Type II, 1.5 lb/cu ft density, 0.27 "K" value at 75 degree F mean temperature at compressed thickness, maximum service temperature 450 degree F, moisture sorption less than 0.2% by volume, aluminum foil facing reinforced with fiberglass scrim laminated to UL rated Kraft paper. Composite 25/50-flame spread/smoke developed rating (ASTM E 84, UL 40, and NFPA 90A).
1. Secure with UL listed pressure sensitive tape and/or outward clinched expanded staples and vapor barrier mastic as needed.
- D. Calcium Silicate: ASTM C 533, Type I, rigid molded block, noncombustible (ASTME E 136), 0.41 "K" value at 300 degree F mean temperature, maximum service temperature 1200 degree F, 160 psi compressive strength for 5 percent compression (ASTM C 165), flexural strength 70 psi (ASTM C 203). 0/0 flame spread/smoke developed rating (ASTM E 84).
1. Banded in place, tightly butted, joints staggered and secured with 16 gauge galvanized or stainless steel wire or 1/2-inch x 0.015-inch galvanized steel bands on 12-inch maximum centers for large areas.
- E. Flexible Elastomeric Foam: ASTM C 534, Type II, flexible, cellular elastomeric sheet, 0.27 "K" value at 75 degree F mean temperature, maximum service temperature 220 degree F, water

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vapor permeability of 0.10 perm-inch, 25/50-flame spread/smoke developed rating (ASTM E 84, UL 723, and NFPA 255). Waterproof vapor retarder adhesive as needed. UV- protective coating for exterior applications. Foster 30-64 coating.

- F. Jacketing Material for Equipment Insulation: Provide pre-sized glass cloth jacketing material, not less than 7.8 ounces per square yard, or metal jacket at Installer's option, except as otherwise indicated.
- G. Equipment Insulation Accessories: Provide staples, bands, wire, wire netting, tape, corner angles, anchors and stud pins as recommended by insulation manufacturer for applications indicated.
- H. Equipment Insulation Coatings, Mastics and Adhesives: Products shall meet requirements for LEED IEQ 4.1 (adhesives and sealants) or IEQ 4.2 (paints and coatings/mastics) Low Voc emitting materials.
  - 1. Vapor Barrier Coating (Store and apply between 40° F and 100°F, protect from freezing until dry): Used on below ambient piping/duct to prevent moisture ingress. Comply with MIL-PRF-19565C, Type II and be QPD listed. Permeance shall be 0.013 perms or less at 43 mils dry per ASTM E 96, Procedure B.
    - a. Foster 30-80
    - b. Childers CP-38
    - c. Vimasco 749
  - 2. Weather Barrier Mastic (Store and apply between 40° F and 100° F, protect from freezing until dry): Used on above ambient piping/duct outdoors.
    - a. Fosters 46-50
    - b. Childers CP-10/11
    - c. Vimasco WC-5
  - 3. Lagging Adhesive/Coating (Store and apply between 40° F and 100° F, protect from freezing until dry): Comply with MIL-A-3316C, Class 1, Grade A.
    - a. Foster 30-36
    - b. Childers CP-50AHV2
    - c. Vimasco 713
  - 4. Fiberglass Adhesive (Store and apply between 40° F and 100° F, protect from freezing until dry): Comply with LEED for Schools 2009 IEQ Credit 4.1, meet California Dept. of Public Health (CDPH) Standard Method Ver. 1.1, 2010 Small Scale Environmental Chamber Test for VOC's for CA Specification 01350. Comply with ASTM C916, Type II.
    - a. Foster 85-60
    - b. Childers CP-127
    - c. Vimasco 795
  - 5. Metal Jacketing/Flashing Sealant (Store and apply between 40° F and 100° F, protect from freezing until dry): Used to seal metal jacketing laps against water entry and to flash penetrations.
    - a. Foster 95-44
    - b. Childers CP-76
    - c. Pittsburgh Corning PC 727
  - 6. Reinforcing Mesh: Used in conjunction with coatings and mastics.
    - a. Foster Mast a Fab
    - b. Childers Chil Glas #10
    - c. Vimasco Elast a Fab

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions where mechanical insulation is to be installed. Do not proceed until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 PLUMBING PIPING INSULATION

A. Cold Piping:

- 1. Applications:
  - a. Potable and non-potable cold water.
  - b. Potable chilled water.
  - c. Interior aboveground storm water.
  - d. Interior above ground overflow storm piping within six (6) lineal feet of roof bowl.
  - e. Plumbing vents within six (6) lineal feet of roof outlet.
  - f. Roof and overflow drain bowls.
- 2. Insulation:
  - a. Fiberglass or Flexible Elastomeric: 1/2-Inch thickness up to 1-1/4 inch pipe size, 1-inch thickness for 1-1/2 inch pipe size and larger.

B. Hot Piping:

- 1. Applications:
  - a. Potable hot water.
  - b. Potable hot water and hot water circulation.
  - c. Hot equipment drain.
- 2. Insulation:
  - a. Hot water and circulating water; Fiberglass: Piping insulation shall be 1-inch thickness for pipes up to and including 1 1/4 inch and 1 1/2 inch for all other sizes.

3.3 EQUIPMENT INSULATION

A. Cold Equipment (Below Ambient Temperature):

- 1. Applications:
  - a. Cold water storage tanks.
  - b. Water softeners.
  - c. Expansion tanks.
- 2. Insulation:
  - a. Flexible Fiberglass Blanket or Flexible Elastomeric Sheet: 1-1/2 Inch thickness.

B. Hot Equipment (Above Ambient Temperature):

- 1. Applications:
  - a. Boiler surfaces not factory insulated.
  - b. Hot water storage tanks.
  - c. Water heater surfaces not factory insulated.
  - d. Heat exchangers.
  - e. Hot water expansion tanks.
- 2. Insulation:

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- a. Fiberglass (High Temperature): 2-Inch thickness, except 3-inch thickness for low-pressure boilers and steam-jacketed heat exchangers. Do not use for equipment above 450 degree F (232 degree C).
- b. Calcium Silicate: 2-Inch thickness, except 3-inch thickness for low-pressure boilers and steam-jacketed heat exchangers.

### 3.4 INSTALLATION OF PIPING INSULATION

- A. Install insulation after piping system tests and heat trace installation have been completed.
- B. Clean piping to remove foreign substances and moisture prior to applying insulation.
- C. Install insulation products according to manufacturer's written instructions, building codes, and recognized industry standards.
- D. Omit insulation on exposed chrome-plated piping (except for handicapped fixtures), air chambers, unions, balance cocks, flow regulators, drain lines from water coolers, drainage piping located in crawl spaces or tunnels, buried piping, fire protection piping, and pre-insulated equipment.
- E. Secure longitudinal jacket laps and butt strips according to manufacturer's recommendations.
- F. Firmly rub lap and butt strips to pressurize seam and ensure positive closure.
- G. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use scraps.
- H. Apply insulation to piping with all joints tightly fitted to eliminate voids.
- I. Apply insulation on cold surfaces with a continuous, unbroken vapor seal. Hangers, supports, and anchors that are secured directly to cold surfaces must be adequately insulated and vapor sealed to prevent condensation.
- J. Extend surface finishes to protect all surfaces, end, and raw edges of insulation.
- K. Protect vapor-barrier jackets on pipe insulation from puncture or other damage. Avoid the use of staples on vapor barrier jackets. Seal vapor barrier penetrations with vapor barrier coating.
- L. Cover valves, fittings and similar items with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded or job fabricated covers (at Installer's option). Coat all below ambient valves, fittings and similar items with vapor barrier coating and reinforcing mesh before application of PVC covers.
- M. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where fire-stopping materials are required.
- N. Provide thermal shield inserts on all pipe (Refer to 220529). For piping below ambient temperature, apply vapor barrier lap cement on butt joints and seal with 3-inch wide vapor barrier tape.
  1. Minimum insulation insert lengths:
    - a. 1-1/2 – 2-1/2 Inch Pipe: 10-Inches

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- b. 3 – 6-Inch Pipe: 12-Inches
  - c. 8 – 10-Inch Pipe: 16-Inches
  - d. 12-Inch and Larger Pipe: 22-Inches
- O. Apply galvanized metal shields between hangers or supports and pipe insulation. Form shields to fit the insulation and extend up to the centerline of the pipe. The shield length shall be 4- inches less than the associated insulation hanger insert to allow for vapor retarding butt joints on each side of the shields.
- P. Apply adhesives, mastics and coatings at manufacturer's recommended minimum coverage per gallon.
- Q. Replace all damaged insulation in whole; Repair of damaged insulation will not be accepted.
- R. Insulate fittings and valves with PVC insulated fitting covers and insulation inserts per manufacturer's recommendations.

END OF SECTION 220700

**SECTION 221116 - DOMESTIC WATER PIPING**

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. This Section includes potable cold, hot, and recirculated hot water piping, fittings, and specialties within the building to a point 5-feet outside the building. This section includes the following:
  - 1. Pipe and Tube Materials:
    - a. Above Grade, inside buildings.
    - b. Below Grade, inside buildings.
  - 2. Water Meters Inside the Building

1.2 DEFINITIONS

- A. Water Distribution Piping: A pipe within the building or on the premises, which conveys water from the water service pipe or meter to the points of usage.
- B. Water Service Piping: The pipe from the water main or other source of potable water supply to the water distributing system of the building served.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with the provisions of the following:
  - 1. ASME B 31.9 "Building Services Piping" for materials, products and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.
  - 2. ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualification" for Qualifications for Welding Processes and Operators.
  - 3. Comply with ANSI B31 Code for Pressure Piping.
  - 4. Local Plumbing Code and Utility Department requirements.
  - 5. Comply with NSF 61: Drinking Water System Components - Health Effects; Sections 1 through 9," For Potable Domestic Water Piping and Components; NSF 61 Annex G or NSF 372.
  - 6. Colorado Cross Connection Control Manual.
  - 7. Safe Water Drinking Act – Including Public Law 111-380 – Cited as the “Reduction of Lead in Drinking Water Act”.
- B. All piping systems shall be installed to manufacturer's standards and in accordance with the pipe manufacturer's instructions. Contractor shall demonstrate prior to installation of any piping that joining methods and procedures are acceptable to the Engineer and/or Owner with the Factory Representative present. During the installation of the piping system, the Contractor shall be required to provide joint coupons as requested by the Owner or Engineer and repair and/or replace system if joints are deemed unsatisfactory.



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### 1.4 INSTALLER'S QUALIFICATIONS

- A. All Plumbing Work shall be performed by a State of Colorado Licensed Contractor under the supervision of a Licensed Plumber. The General Contractor shall verify that plumbers are currently licensed by the State of Colorado. Plumbing Contractors shall have a minimum of three (3) years of satisfactory performance in conducting the type of work specified.

### 1.5 SUBMITTALS

- A. Submit under provisions of Division 1.

### 1.6 CLOSEOUT SUBMITTALS

- A. Submit under provisions of Division 1.
- B. Test Reports.

## PART 2 - PRODUCTS

### 2.1 PIPE AND TUBE MATERIALS

- A. Above Grade Inside Buildings:
  - 1. Pipe 4-Inch and Smaller: ASTM B 88; Type L lead-free hard drawn copper tube.
    - a. Fittings:
      - 1) Lead-Free Wrought Copper Solder-Joint Fittings: ASME B16.22.
      - 2) Lead-Free Cast Copper Solder-Joint Fittings: ASME B16.18.
      - 3) Lead-Free Cast Copper Alloy Flanges Class 150 and 300, Flat-Face Type: ASME B16.24.
      - 4) Contractor Option: Mechanical Pressure-Seal Fittings as manufactured by Viega or Nibco. System shall be lead-free. Fitting shall be press type with EPDM sealing elements. Contractor shall order valves and other components that are compatible with this press system. Solder joints are acceptable where press system is not the appropriate application.
    - b. Joining Material:
      - 1) Lead-Free Solder: ASTM B32; minimum tensile strength of 5,900 psi. Solder shall be certified to meet NSF 61 Annex G or NSF 372.
    - c. Fluxes:
      - 1) ASTM B813, Lead-Free Water Soluble, Liquid or Paste Type and be certified to meet NSF 61 Annex G or NSF 372.
- B. Below Grade Inside Buildings:
  - 1. Pipe 2-1/2 Inch and Smaller: ASTM B 88; Type K lead-free soft copper or Type K lead-free annealed copper tube.
    - a. Fittings:
      - 1) Lead-Free Wrought Copper Solder-Joint Fittings: ANSI B16.22.
      - 2) Lead-Free Cast Copper Solder-Joint Fittings: ASME B16.18.

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- b. Joining Material:
    - 1) Brazing: ANSI/AWS A5.8.
    - 2) Lead-free.
    - 3) Brazing rods containing cadmium shall not be used.
  - c. Fluxes:
    - 1) ANSI/AWS A5.31, Type FB3-A or FB3-C.
2. Pipe 3-Inch and Larger:
- a. Ductile Iron Pipe: Class 52, ANSI A21.51; AWWA C151; 350 PSI pressure rating.
    - 1) Cement Mortar Lining for Ductile Iron and Gray Iron Pipe and Fittings for Water: ANSI A21.4; AWWA C104.
    - 2) Polyethylene Encasement for Gray and Ductile Cast Iron Piping: ANSI A21.5; AWWA C105.
    - 3) Fittings:
      - a) Gray Iron Fittings: ANSI/AWWA C110/A21.10.
      - b) Ductile Iron Fittings: ANSI/AWWA C110/A21.10.
    - 4) Joint Materials: Rubber gasket joints. ANSI/AWWA C111/A21.11.

2.2 WATER METER

- A. 2-Inch and Smaller: Disc type conforming to AWWA C700. Registration in gallons. Utility company remote registration system. Meter shall be certified to the lead-free requirements of NSF/ANSI 372.
  - 1. Acceptable Manufacturers:
    - a. Badger
    - b. Hersey
    - c. Neptune
    - d. Rockwell Intl.
- B. 3-Inch and Larger: Compound type, conforming to AWWA C702. Registration in gallons. Utility company remote registration system. Meter shall be certified to the lead-free requirements of NSF/ANSI 372.
  - 1. Acceptable Manufacturers:
    - a. Badger
    - b. Hersey
    - c. Neptune
    - d. Rockwell Intl.
- C. Water Meters: Provided by the Utility Company to the site, ready for installation. Meter shall be certified to the lead-free requirements of NSF/ANSI 372. The following is the name and address of the Utility Company:

City of Boulder  
P.O. Box 791  
Boulder, CO 80306  
303.441.3260

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## PART 3 - EXECUTION

### 3.1 PIPING INSTALLATION

- A. Install pipes and pipe fittings in accordance with recognized industry practices to achieve permanently leak proof piping systems, capable of performing service without piping failure. Install each run with minimum joints and couplings, but with adequate and accessible unions for disassembly and maintenance/ replacement of valves and equipment. Reduce sizes by use of reducing fittings. Align piping accurately at connections, within 1/16-inch misalignment tolerance.
- B. Electrical Equipment Spaces: Do not run piping through transformer vaults and other electrical or electronic equipment spaces and enclosures. Only piping serving this type of equipment space shall be allowed.
- C. Use fittings for all changes in direction and all branch connections.
- D. Install piping straight, plumb, level and at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.
- E. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.
- F. Install piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building. Install piping free of sags or bends and allow sufficient space above removable ceiling panels to allow for panel removal.
- G. Locate groups of pipes parallel to each other, spaced to permit application of insulation and servicing of valves.
- H. Install means to drain the system at all low points in mains, risers, and branch lines.
- I. Fire and Smoke Wall Penetrations: Maintain the fire and smoke rated integrity where pipes pass through fire and smoke rated walls, partitions, ceilings, and floors.
- J. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and mechanical sleeve seals. Use steel pipe for sleeves 6-inch and smaller. Use sheet metal for pipe sleeves 6-inch and larger.
- K. Coordinate foundation and all other structural penetrations with Structural Engineer.
- L. Install pipe ends clean and free from indentations, projections, and roll marks in the area from pipe end to groove for proper gasket seating.
- M. Install mechanical couplings and grooved piping systems per the manufacturer's installation instructions.

### 3.2 UNDERGROUND PIPE INSTALLATION

- A. Clean fittings, nipples and other field joints thoroughly before coating.

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- B. Cast Iron Pipe:
  - 1. Protect gray and ductile cast iron pipe installed below grade with polyethylene encasement applied in accordance with ANSI/AWWA C105/A21.5.
  - 2. Install ductile iron pipe below grade as prescribed by AWWA C600.
- C. Provide and install concrete thrust block and 3/4-inch steel threaded tie bar at each direction change on underground pressure pipe. Embed tie bar in thrust block and connect to upstream fitting. Paint tie bar with two (2) coats of Bitumastic #50 paint.
- D. Bury all outside water piping minimum 5'-0" below grade to top of pipe.

### 3.3 SERVICE ENTRANCE

- A. Extend water distribution piping 5'-0" outside of building.
- B. Install sleeve and mechanical sleeve seal at penetrations through foundation wall for watertight installation.
- C. Install shutoff valve at service entrance inside building; complete with strainer, pressure gauge, and test tee with valve.

### 3.4 INSTALLATION OF WATER METER

- A. Install water meter in accordance with Utility Company's installation instructions and requirements.
  - B. Set meter on concrete pad as indicated. Refer to Division 3 for concrete, formwork, and reinforcing requirements.
- OR
- C. Mount meter on wall brackets as indicated.
  - D. Size meter and arrange piping and specialties to comply with Utility Company's requirements.
  - E. Install rough-in piping and specialties for water meter installation in accordance with Utility Company's instructions and requirements.

### 3.5 EQUIPMENT CONNECTIONS

- A. Piping Runouts to Fixtures: Provide hot and cold water piping run outs to fixtures of sizes indicated, but in no case smaller than required by Plumbing Code.
- B. Mechanical Equipment Connections: Provide shutoff valve and union for each connection, provide drain valve on drain connection. For connections 2-1/2 inch and larger, use flanges instead of unions.

### 3.6 FIELD QUALITY CONTROL

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- A. Inspections: Inspect water distribution piping as follows:
1. Do not enclose, cover, or put into operation water distribution piping system until it has been inspected and approved by the Authority Having Jurisdiction.
  2. During the progress of the installation, notify the Plumbing Official Having Jurisdiction, at least forty-eight (48) hours prior to the time such inspection must be made. Perform tests specified below in the presence of the Plumbing Official.
    - a. Rough-In Inspection: Arrange for inspection of the piping system before concealed or closed-in after system is roughed-in, and prior to setting fixtures.
    - b. Final Inspection: Arrange for a final inspection by the Plumbing Official to observe the tests specified below and to insure compliance with the requirements of the Plumbing Code.
  3. Reinspections: Whenever the Plumbing Official finds that the piping system will not pass the test or inspection, make the required corrections and arrange for reinspection by the Plumbing Official.
  4. Reports: Prepare inspection reports, signed by the Plumbing Official.
- B. Piping Tests:
1. General: Provide temporary equipment for testing, including pump and gauges. Test piping system before insulation is installed wherever feasible. Test each natural section of each piping system independently but do not use piping system valves to isolate sections where test pressure exceeds valve pressure rating. Fill each section with water and pressurize for indicated pressure and time.
  2. Test piping that is to be concealed before being permanently enclosed.
  3. As soon as work has been completed, conduct preliminary tests to ascertain compliance with specified requirements. Make repairs or replacements as required.
  4. Give a minimum of twenty-four (24) hours notice to Engineer of dates when acceptance test will be conducted. Conduct tests as specified for each system in presence of representative of Agency Having Jurisdiction or his representative. Submit three (3) copies of successful tests to the Engineer for his review. Report shall state system tested and date of successful test.
  5. Obtain certificates of approval, acceptance and compliance with regulations of Agencies Having Jurisdiction. Work shall not be considered complete until such certificates have been delivered.
  6. All costs involved in these tests shall be borne by Contractor.
  7. System Tests:
    - a. Hydrostatic Test: Pressurize the system to 100psig or 150 percent of system pressure, whichever is greater. Maintain pressure until the entire system has been inspected for leaks, but in no case for a time period of less than four (4) hours.
    - b. Compressed Air or Nitrogen Test: Compressed air tests may be substituted for hydrostatic tests only when ambient conditions prohibit safe use of hydrostatic testing and must be reviewed by the Engineer prior to any testing. For tests of this type, subject the piping system to the gas pressure indicated for that specific system. Maintain the test pressure for the duration of a soapy water test of each joint. The air test is not allowed on CPVC piping systems.
    - c. Repair failed piping sections by disassembly and re-installation, using new materials to extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.
    - d. Drain test water from piping systems after testing and repair work has been completed.

3.7 ADJUSTING AND CLEANING

- A. Clean and disinfect water distribution piping as follows:
  - 1. Purge all new water distribution piping systems and parts of existing systems, which have been altered, extended, or repaired prior to use. Clean and replace strainers.
  - 2. Use the purging and disinfecting procedure prescribed by the Authority Having Jurisdiction, or in case a method is not prescribed by that authority, the procedure described in either AWWA C651, or AWWA C652, or as described below:
    - a. Flush the piping system with clean, potable water until dirty water does not appear at the points of outlet.
    - b. Fill the system or part thereof, with a water/chlorine solution containing at least 50 parts per million of chlorine. Isolate (valve off) the system, or part thereof, and allow to stand for twenty-four (24) hours or fill with a water/chlorine solution containing at least 200 parts per million of chlorine and isolate and allow to stand for three (3) hours.
    - c. Following the allowed standing time, flush the system with clean potable water until chlorine does not remain in the water coming from the system.
    - d. Submit water samples in sterile bottles to the Authority Having Jurisdiction. Repeat the procedure if the biological examination made by the authority shows evidence of contamination.
- B. Prepare reports for all purging and disinfecting activities.

END OF SECTION 221116

**SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES**

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. This Section includes potable cold, hot, and recirculated hot water specialties within the building to a point 5-feet outside the building. This section includes the following:
  - 1. Piping Specialties:
    - a. Water Hammer Arrestors
    - b. Strainers
    - c. Hose Bibbs
    - d. Wall and Yard Hydrants
    - e. Hose Stations
    - f. Backflow Preventers
    - g. Pressure Reducing Valves
    - h. Thermostatic Mixing Valves
    - i. Pressure/Temperature Relief Valves
    - j. Vacuum Relief Valves

1.2 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with the provisions of the following:
  - 1. Local Plumbing Code and Utility Department requirements.
  - 2. NSF 61 Compliance: Drinking Water System Components – Health Effects; Sections 1 through 9 and Annex G.
  - 3. Safe Drinking Water Act – Public Law No. 111-380.
  - 4. Colorado Cross Connection Control Manual.
  - 5. NSF/ANSI 372: Drinking Water System Components, Lead Content, 2010
- B. All piping systems shall be installed to manufacturer's standards and in accordance with the pipe manufacturer's instructions. Contractor shall demonstrate prior to installation of any piping that joining methods and procedures are acceptable to the Engineer and/or Owner with the Factory Representative present. During the installation of the piping system, the Contractor shall be required to provide joint coupons as requested by the Owner or Engineer and repair and/or replace system if joints are deemed unsatisfactory.

1.3 INSTALLER'S QUALIFICATIONS

- A. All Plumbing Work shall be performed by a State of Colorado Licensed Contractor under the supervision of a Licensed Plumber. Contractors shall verify that plumbers are currently licensed by the State of Colorado and shall supply the Project Manager with names and license numbers. Contractors shall have a minimum of three (3) years of satisfactory performance in conducting the type of work specified.

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1.4 SUBMITTALS

- A. Submit under provisions of Division 1.

1.5 CLOSEOUT SUBMITTALS

- A. Submit under provisions of Division 1.
- B. Test Reports.
- C. Valve schedule listing valve designation number, valve type, size, location, and function of all valves.
- D. Backflow Preventer State Certification Test.

PART 2 - PRODUCTS

2.1 PIPING SPECIALTIES

- A. Water Hammer Arresters:
  - 1. Piston type, with copper/brass casing and piston, pressure rated for 250 PSI, tested and certified in accordance with ASSE 1010 and NSF 61 Annex G and/or NSF 372. Water hammer arrestor shall be designed to provide continuous protection, without maintenance, against excessive surge pressure. Size according to the following schedule.
  - 2. Multiple plumbing fixture unit locations where there are more than 2 fixtures shall have a isolation valve and access panel.
  - 3. Single or two fixture locations will not need an isolation valve and access panel if prior approval is first obtained by the authority having jurisdiction and owner.

Drawing Designation	Fixture Unit Rating	P.D.I. Size	Connection Size
SA-1	1-11	A	1/2"
SA-2	12-32	B	3/4"
SA-3	33-60	C	1"
SA-4	61-113	D	1"
SA-5	114-154	E	1"
SA-6	155-330	F	1"

- 4. Acceptable Manufacturers:
  - a. Precision Plumbing Products
  - b. Sioux Chief

- B. Strainers:



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1. Wye Pattern Strainers: ½-inch to 3-inch; 400 PSIG working pressure, lead-free brass or bronze construction, complete with bottom drain connection and removable Type 304 or 302, 20 mesh stainless steel screens. Strainer shall be certified to meet the-lead free requirements of NSF 61 Annex G and/or NSF/ANSI 372.
    - a. Acceptable Manufacturers:
      - 1) Wilkins Model YBXL
      - 2) Watts
      - 3) Apollo
  
  2. Wye Pattern Strainers: 3-inch to 8-inch; 200 PSIG working pressure, cast iron construction body coated with FDA approved epoxy for domestic water service, bottom drain connection, ANSI Class 125 flanged connections, 300 series perforated screens (1/16-inch perforations for 3 and 4 inch size, 1/8-in perforations for 6 and 8-inch size). Strainer shall be certified to meet the lead-free requirements of NSF 61 Annex G and/or NSF/ANSI 372.
    - a. Acceptable Manufacturers:
      - 1) Wilkins Model FSC-DOM
      - 2) Watts
      - 3) Febco
- C. Hose Bibbs:
1. HB: Rough chrome plated bronze body, renewable composition disc, removable handle, ¾-inch NPT inlet, vacuum breaker, ¾-inch hose outlet.
    - a. Acceptable Manufacturers:
      - 1) Chicago Faucet No. 998-RCF
      - 2) Woodford
      - 3) T&S Brass
      - 4) Zurn
- D. Wall Hydrants:
1. WH- Exposed type non-freeze wall hydrant; all brass with chrome plated face plate, "T" handle loose key, two (2) check valves, ASSE 1052 or 1019 approved, self-draining body and shank, exposed ¾-inch male hose thread outlet, ¾-inch male or female thread inlet, renewable seat; shank length to extend through primary exterior wall sufficient distance to prevent freezing.
    - a. Acceptable Manufacturers:
      - 1) Woodford Model 67
      - 2) Josam
      - 3) Wade
      - 4) Prier
- E. Hose Stations:
1. HS: Hot and cold water mixing hose stations exposed, complete with hose, nozzle, hose rack, two stop and check valves with with color coded heat resistant handles on inlets, ASSE 1011 or 1052 listed vacuum breaker, and anchoring. Mixing unit and hose rack to be chrome plated finish.
    - a. Acceptable Manufacturers:
      - 1) Leonard Model #SW-75-EVBD with Model HDH-25 hose and Model N-2 nozzle
      - 2) Strahman

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### F. Backflow Preventers:

1. BFP: (Reduced Pressure Type): All lead-free bronze (1/2-inch – 2-inch) body with two (2) independently operating, spring loaded check valves and one (1) differential relief valve with automatic intermediate atmospheric vent. Assembly to be furnished with full port, positive shutoff isolation valves, in-line strainer, union connections, funnel, and all test cocks. Assembly to have approval of National Sanitary Foundation, U.S.C. Foundation for Cross Connection Control, ASSE 1013, AWWA C511 compliant, IAPMO listed, State and or Local Authorities. Backflow preventer shall be certified to meet the lead-free requirements of NSF 61 Annex G and/or NSF/ANSI 372.
  - a. Acceptable Manufacturers:
    - 1) Watts No. LF009
    - 2) Wilkins
    - 3) Febco

### G. Pressure Reducing Valves - Air/Water (Direct Acting):

1. PRV- Low and Medium Capacity (15 to 120 GPM): All lead-free bronze or brass pressure reducing valves, sensitive spring and diaphragm for accurate pressure control; manual adjustment for outlet pressure, integral strainer, female thread connections. See detail on Mechanical Plans for size, capacity and piping arrangement. Valve shall be certified to meet the lead-free requirements of NSF 61 Annex G and/or NSF 372.
  - a. Acceptable Manufacturers:
    - 1) Watts No. LF223
    - 2) Wilkins
2. PRV- High Capacity (50 to 1800 GPM): Lead-free ductile iron body pressure reducing/sustaining valve, FDA or NSF approved epoxy lined and coated, sensitive spring and large diaphragm area for accurate pressure control, stainless steel tubing; manual adjustment for outlet water pressure; female thread connections for sizes up to 2- 1/2 inch and flanged connections for sizes 3-inch and larger. Provide in-line inlet water strainer; inlet and outlet valves and threaded or flanged connections for easy valve removal. Valve shall be lead-free certified to meet the lead-free requirements of NSF 61 Annex G and/or NSF 372. See detail on Mechanical Plans for size, capacity and piping arrangement.
  - a. Acceptable Manufacturers:
    - 1) Watts ACV-115
    - 2) Wilkins

### H. Thermostatic Mixing Valves:

1. TMV-1: Exposed type, all lead-free brass or bronze thermostatically controlled mixing valve with stainless steel piston, fail safe automatic shut-down if either hot or cold water pressure fails; union connection, integral check valves polished chrome finish. Valve shall be ASSE rated for the application. Valve shall be to meet the lead-free requirements of NSF 61 Annex G and/or NSF 372.
  - a. Acceptable Manufacturers:
    - 1) Powers
    - 2) Leonard
    - 3) Symmons
    - 4) Lawler
    - 5) Bradley

### I. Pressure/Temperature Relief Valves (PTRV):

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1. Fully automatic, lead-free pressure/temperature relief valve with test lever and extension thermostatic element; temperature relief setting at 210 degree F and pressure setting at 150 PSIG; valve to be CSA and ASME rated and ANSI Z21.22 certified. Relief opening to be piped to an indirect connection at nearest floor drain. Valve shall be compliant with NSF 61 Annex G and/or NSF 372.
  - a. Acceptable Manufacturers:
    - 1) Watts Regulator Co.
- J. Vacuum Relief Valves - For storage type water heaters with bottom cold water connection.
  1. Lead-free brass body with protective cap for automatic venting of a closed system to atmosphere when a vacuum is created. The valve shall be ANSI Z21.22 rated and CSA certified. The valve shall be compliant with NSF 61 Annex G and/or NSF 372.
    - a. Acceptable Manufacturers:
      - 1) Watts Model LFN36-M1

### PART 3 - EXECUTION

#### 3.1 INSTALLATION OF PIPING SPECIALTIES

- A. Backflow Preventers:
  1. Install in compliance with the International Plumbing Code , Colorado Cross Connection Control Department (CDPHE – Water Quality Control Division) and Authority Having Jurisdiction. Pipe relief outlet through air gap and without valves, to nearest floor drain.
  2. Provide testing and report on all backflow prevention devices in accordance with the International Plumbing Code and the Colorado Cross Connection Control Manual (Latest Edition) requirements. Attach testing approval tag to all back flow preventers.
- B. Pressure Regulating Valves: Install with inlet and outlet shutoff valves, and balance cock bypass. Install pressure gauge on valve outlet. Install pressure reducing valves to limit maximum static pressure at plumbing fixtures to 65 PSIG.
- C. Water Hammer Arresters:
  1. Install water hammer arresters with isolation valve in accessible location.
  2. Provide access doors located in accordance with architectural recommendations.
  3. Multiple plumbing fixture unit locations where there are more than 2 fixtures shall have a isolation valve and access panel.
  4. Single or two fixture locations will not require an isolation valve and access panel if prior approval is first obtained by the authority having jurisdiction and owner.
- D. Install mixing valves with integral check valves or in-line check valves, unions and isolation valves.

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### 3.2 FIELD QUALITY CONTROL

- A. Inspections: Inspect water distribution piping as follows:
1. Do not enclose, cover, or put into operation water distribution piping system until it has been inspected and approved by the Authority Having Jurisdiction.
  2. During the progress of the installation, notify the Plumbing Official Having Jurisdiction, at least forty-eight (48) hours prior to the time such inspection must be made. Perform tests specified below in the presence of the Plumbing Official.
    - a. Rough-In Inspection: Arrange for inspection of the piping system before concealed or closed-in after system is roughed-in, and prior to setting fixtures.
    - b. Final Inspection: Arrange for a final inspection by the Plumbing Official to observe the tests specified below and to insure compliance with the requirements of the Plumbing Code.
  3. Reinspections: Whenever the Plumbing Official finds that the piping system will not pass the test or inspection, make the required corrections and arrange for reinspection by the Plumbing Official.
  4. Reports: Prepare inspection reports, signed by the Plumbing Official.

### 3.3 ADJUSTING AND CLEANING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Set field-adjustable flow set points of balancing valves.
- C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION 221119

**SECTION 221123 - DOMESTIC WATER PUMPS**

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of Plumbing Pumps Work required by this section is indicated on drawings and schedules, and by requirements of this section.
- B. Types of Pumps specified in this section include the following:
  - 1. In-Line Recirculation Pumps
- C. Pumps furnished as part of factory-fabricated equipment, are specified as part of equipment assembly in other Division 22 sections.
- D. Refer to other Division 22 sections for insulation of pump housings; vibration control of plumbing pumps; not work of this section.
- E. Refer to Division 26 sections for the following work; not work of this section.
  - 1. Power supply wiring from power source to power connection on pumps. Include starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.
  - 2. Interlock wiring between pumps; and between pumps and field-installed control devices.
    - a. Interlock wiring specified as factory-installed is work of this section.
- F. Provide the following Electrical Work as work of this section, complying with requirements of Division 26 sections:
  - 1. Control wiring between field-installed controls, indicating devices, and pump control panels.

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of plumbing pumps with characteristics, sizes, and capacities required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. Codes and Standards:
  - 1. HI Compliance: Design, manufacture, and install plumbing pumps in accordance with HI "Hydraulic Institute Standards".
  - 2. UL Compliance: Design, manufacture, and install plumbing pumps in accordance with UL 778 "Motor Operated Water Pumps".
  - 3. UL and NEMA Compliance: Provide electric motors and components which are listed and labeled by Underwriters Laboratories and comply with NEMA Standards.
  - 4. NSF 61 Compliance: Drinking Water System Components – Health Effects; Sections 1 through 9 and Annex G.
  - 5. Safe Drinking Water Act – Public Law No. 111-380.
  - 6. NSF/ANSI 372: Drinking Water System Components, Lead Content.

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- C. Certification, Pump Performance: Provide pumps whose performances, under specified operating conditions, are certified by manufacturer.

### 1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's pump specifications, installation and start-up instructions, and current accurate pump characteristic performance curves with selection points clearly indicated.
- B. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.
- C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to plumbing pumps. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
- D. Maintenance Data: Submit maintenance data and parts lists for each type of pump, control, and accessory; including "trouble-shooting" maintenance guide. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual; in accordance with requirements of Division 1.

### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Handle plumbing pumps and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged plumbing pumps or components; replace with new.
- B. Store plumbing pumps and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.
- C. Comply with Manufacturer's rigging and installation instructions for unloading plumbing pumps, and moving them to final location.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
  - 1. In-Line Recirculation Pumps – Lead-Free:
    - a. Armstrong Pumps, Inc.
    - b. Bell & Gossett, A Xylem Brand
    - c. Grundfos Pumps Corp.
    - d. Taco, Inc.
  - 2. Aquastats:
    - a. Honeywell
    - b. Johnson Controls
    - c. Bell & Gossett, A Xylem Brand

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- d. Taco

### 2.2 PUMPS

- A. General: Provide factory-tested pumps, thoroughly cleaned, and painted with one (1) coat of machinery enamel prior to shipment. Type, size, and capacity of each pump is listed in pump schedule. Provide pumps of same type by same manufacturer.

### 2.3 IN-LINE RECIRCULATION PUMPS

- A. General: Provide in-line recirculation pumps where indicated, and of capacities as scheduled. Pumps shall be certified to the requirements of NSF/ANSI 372 and UL Listed.
- B. Type: Horizontal, lubricated, designed for 125 psi working pressure, 225 degree F (107 degree C) continuous water temperature, and specifically designed for quiet operation.
- C. Body: Lead-Free bronze or stainless steel construction.
- D. Shaft: Stainless steel or non-metallic.
- E. Bearings: Carbon bearings designed to be lubricated by the circulating fluid.
- F. Seal: Mechanical.
- G. Motor: Non-overloading at any point on pump curve, open, drip-proof, sleeve bearings, quiet operating, rubber mounted construction, built-in thermal overload protection or impedance protection.
- H. Impeller: Non-metallic or non-ferrous.

### 2.4 AQUASTATS

- A. Pipe clip-on type, designed to thermostatically turn on and off B&G NBF or Taco "00" pump circulators. Pump on at [100] degrees F., pump off at [120] degrees F. Suitable for 1/2-inch or 3/4-inch pipe.
  - 1. B&G Model No. AQS-1/2 (1/2-inch pipe) or AQS-3/4 (3/4-inch pipe)
  - 2. Taco Model no. 563-2
- B. Lead-free immersion type domestic water circulation controller with totally enclosed snap- acting switches to operate on temperature rise to setpoint, visible control point scale and external adjustment screw to permit easy setting, immersion well to be lead-free brass, copper or stainless steel and be certified compliant with NSF 61 Annex G and/or NSF/ANSI 372. Controller to be UL Listed.
  - 1. Honeywell
  - 2. Johnson Controls

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### PART 3 - EXECUTION

#### 3.1 INSPECTION

- A. Examine areas and conditions under which plumbing pumps are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

#### 3.2 INSTALLATION OF PUMPS

- A. General: Install plumbing pumps where indicated, in accordance with manufacturer's published installation instructions, complying with recognized industry practices to ensure that plumbing pumps comply with requirements and serve intended purposes.
- B. Access: Provide access space around plumbing pumps for service as indicated, but in no case less than that recommended by manufacturer.
- C. Support:
  - 1. Install in-line pumps, supported from piping system.
- D. Support: Refer to Division 22 section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for support and mounting requirements of plumbing pumps.
- E. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
  - 1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.
- F. Piping Connections: Refer to Division 22 plumbing piping sections. Provide piping, valves, accessories, gauges, supports, and flexible connections as indicated.

#### 3.3 ADJUSTING AND CLEANING

- A. Alignment: Check alignment, and where necessary, realign shafts of motors and pumps within recommended tolerances by manufacturer, and in presence of manufacturer's service representative.
- B. Start-Up: Start-up in accordance with manufacturer's instructions.
- C. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION 221123



**SECTION 221316 - SANITARY WASTE & VENT PIPING**

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. This Section specifies the following:
  - 1. Pipe and Tube Materials:
    - a. Sanitary Drainage, Vents
    - b. Sump Pump Discharge
    - c. Equipment Drains and Overflows

1.2 DEFINITIONS

- A. Building Drain: That part of the lowest piping of a drainage system which receives the discharge from soil, waste, and other drainage pipes inside the walls of the building and conveys it to the building sewer to a point 5'-0" outside the building wall.
- B. Building Sewer: That part of the horizontal piping of a drainage system which extends from the end of the building drain and conveys its discharge to a public sewer, private sewer, individual sewage disposal system, or other point of disposal.
- C. Drainage System: Includes all the piping within a public or private premises which conveys sewage, rain water or other liquid wastes to a point of disposal. It does not include the mains of public sewer systems or a private or public sewage treatment or disposal plant.
- D. Vent System: Pipe or pipes installed to provide a flow of air to or from a drainage system, or to provide a circulation of air within such system to protect trap seals from siphonage and back pressure.

1.3 SUBMITTALS

- A. Submit under provisions of Division 1.

1.4 CLOSEOUT SUBMITTALS

- A. Submit under provisions of Division 1.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with the provisions of the following:
  - 1. Plumbing Code Compliance: Comply with applicable portions of the International and Local Plumbing Code.
  - 2. ANSI Compliance: Comply with applicable ANSI standards pertaining to materials, products, and installation of soil and waste systems.

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3. ASSE Compliance: Comply with applicable ASSE standards pertaining to materials, products, and installation of soil and waste systems.
4. ASTM Compliance: Comply with applicable ASTM Standards pertaining to materials, products, and installation of soil and waste systems.
5. CISPI Compliance: Comply with applicable CISPI Standards pertaining to materials, products, and installation of soil and waste systems.
6. PDI Compliance: Comply with applicable PDI standards pertaining to products and installation of soil and waste systems.
7. PVC, PP and ABS Pipe: Only Contractor's personnel which have received training in the installation of this material and meet the manufacturer's qualifications shall do the assembly of such material.

### PART 2 - PRODUCTS

#### 2.1 SANITARY DRAINAGE AND VENTS

##### A. Above Grade:

1. Pipe 1-1/2 Inch to 10-Inch: Service class hubless cast iron soil pipe: CISPI 301, ASTM A888. Pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute and be listed by NSF International.
  - a. Fittings: CISPI 301, NSF International, hubless cast iron, long sweep bends.
  - b. Joining Material: For ASTM A888 pipe, CISPI 310 coupling, assembly of stainless steel shield and clamp with ASTM C564 elastomeric sealing sleeve. Coupling shall be certified by NSF for CISPI 310 testing and manufactured in the USA.
2. Pipe 1-1/4 Inch to 4-Inch: DWV Copper Tube: ASTM B 306.
  - a. Fittings:
    - 1) Cast Copper Solder-Joint Drainage Fittings: ASME B16.23.
    - 2) Wrought Copper Solder-Joint Drainage Fittings: ASME B16.29.
  - b. Joining Material:
    - 1) Solder: Lead-free ASTM B32, Solder shall be certified to meet NSF 61 Annex G and/or NSF 372.
  - c. Fluxes:
    - 1) Lead-free ASTM B813 liquid or paste type.
3. Manufacturers (Cast Iron Pipe):
  - a. Tyler Pipe
  - b. AB&I
  - c. Charlotte Pipe & Foundry

##### B. Below Grade:

1. Pipe 2-Inch to 15-Inch: Service class cast iron hub-and-spigot soil pipe, ASTM A74. Pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute and be listed by NSF International.
  - a. Fittings: ASTM A74 cast iron service class, hub and spigot compression joint, long sweep bends.
  - b. Neoprene Compression Gaskets: ASTM C564.
2. Pipe 2-Inch to 16-Inch: Iron Pipe Size (IPS) Polyvinyl Chloride (PVC) Schedule 40 DWV.

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- a. Manufactured from virgin Type 1, Grade 1 PVC 1120 (Cell Class 12454-B) per ASTM D-1784.
  - b. Meet the dimensional, physical properties, and tolerances of ASTM D-1785 and ASTM D-2665.
  - c. Mark pipe with ASTM D-2665, nominal pipe size, and the symbols PVC and DWV at 5-foot intervals.
  - d. Fittings: ASTM D2665, PVC, solvent cement with long sweep bends. Injection molded conforming to National Sanitation Standard 14.
  - e. Joining Material:
    - 1) Solvent cement suitable for type and size of pipe installed as recommended by the pipe manufacturer.
    - 2) Make solvent cement joints from a two-step process with ASTM F656 primer manufactured for thermoplastic piping systems and solvent cement conforming to ASTM D-2564.
3. Manufacturers (Cast Iron Pipe):
    - a. Tyler Pipe
    - b. AB&I
    - c. Charlotte Pipe & Foundry

### 2.2 EQUIPMENT DRAINS AND OVERFLOWS

- A. Copper Pipe and Fittings:
  1. DWV Copper Tube: ASTM B 306.
  2. Fittings:
    - a. Cast Copper Solder-Joint Drainage Fittings: ASME B16.23.
    - b. Wrought Copper Solder-Joint Drainage Fittings: ASME B16.29.
  3. Joining Material:
    - a. Solder: Lead-free, ASTM B32, Solder shall be certified to meet NSF 61 Annex G and/or NSF 372.
  4. Fluxes:
    - a. Lead-free, ASTM B813.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. General: Install piping in accordance with Authorities Having Jurisdiction, except where more stringent requirements are indicated.
- B. Inspect piping before installation to detect apparent defects. Mark defective materials with white paint and promptly remove from site.
- C. Verify all dimensions by field measurements. Verify that all drainage and vent piping and specialties may be installed in accordance with pertinent codes and regulations, the original design, and the referenced standards.
- D. Verify all existing grades, inverts, utilities, obstacles, and topographical conditions prior to installations.

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- E. Examine rough-in requirements for plumbing fixtures and other equipment having drain connections to verify actual locations of piping connections prior to installation.
- F. Examine walls, floors, roof, and plumbing chases for suitable conditions where piping and specialties are to be installed.
- G. Do not proceed until unsatisfactory conditions have been corrected.

### 3.2 PIPING INSTALLATION

- A. Install plumbing drainage piping with 1/4-inch per foot (2 percent) downward slope in direction of drain for piping 3-inch and smaller, and 1/8-inch per foot (1 percent) for piping 4-inch and larger.
- B. Install 1-inch thick extruded polystyrene over underground drainage piping above frost line and not under building. Provide width to extend minimum of 12-inch beyond each side of pipe. Install directly over pipe, centered on pipe centerline.
- C. Provide thrust restraints consisting of bracing to structure and rodded joints at branches and changes in direction for cast iron pipe 5-inches and larger suspended within the building and for all changes in diameter greater than two pipe sizes IPC 308.7.1.
- D. Provide sway bracing to prevent shear at joints on cast iron piping suspended in excess of 18-inches on single rod hangers.
- E. Provide rigid support sway bracing at all changes in direction greater than 45 degrees for all suspended cast iron piping for pipe sizes 4-inch and larger IPC 308.6.
- F. Suspended PVC piping shall be installed using the same requirements as cast iron piping for thrust and sway bracing as indicated in the articles above. Hanger spacing shall be as recommended by the manufacturer and code.
- G. Install underground cast iron drain piping to conform with the plumbing code, and in accordance with the Cast Iron Soil Pipe Institute Engineering Manual.
- H. Lay piping beginning at low point of system, true to grades and alignment indicated, with unbroken continuity of invert.
- I. Place bell ends or groove ends of piping facing upstream.
- J. Install gaskets in accordance with manufacturer's recommendations for use of lubricants, cements, and other special installation requirements.
- K. Grade trench bottoms to provide a smooth, firm, and stable foundation, free from rock, throughout the length of the pipe.
- L. Remove unstable, soft, and unsuitable materials at the surface upon which pipes shall be laid, and backfill with clean sand or pea gravel to indicated invert elevation.

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- M. Shape bottom of trench to fit the bottom 1/4 of the circumference of pipe. Fill unevenness with tamped sand. At each pipe joint dig bell holes to relieve the bell of the pipe of all loads, and to ensure continuous bearing of the pipe barrel on the foundation.
- N. Minimum size of waste and vent piping installed under floor slab on grade shall be 2-inches.
- O. Vent termination shall be a minimum 12 - inches above finished roof. Vent termination shall terminate per IPC Chapter 9, Section 904.1.

### 3.3 SERVICE CONNECTIONS

- A. Before commencing work, check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with slope for drainage and cover to avoid freezing.

### 3.4 CONNECTIONS

- A. Piping Runouts to Fixtures: Provide drainage and vent piping runouts to plumbing fixtures and drains, with approved trap, of sizes indicated; but in no case smaller than required by the Plumbing Code.
- B. Locate piping runouts as close as possible to bottom of floor slab supporting fixtures or drains.

### 3.5 FIELD QUALITY CONTROL

- A. Inspections:
  - 1. Do not enclose, cover, or put into operation drainage and vent piping system until it has been inspected and approved by the Authority Having Jurisdiction.
  - 2. During the progress of the installation, notify the Plumbing Official Having Jurisdiction, at least forty-eight (48) hours prior to the time such inspection must be made. Perform tests specified below in the presence of the Plumbing Official.
    - a. Rough-In Inspection: Arrange for inspection of the piping system before concealed or closed-in after system is roughed-in, and prior to setting fixtures.
    - b. Final Inspection: Arrange for a final inspection to observe the tests specified and to insure compliance with the requirements of the Plumbing Code.
  - 3. Re-Inspections: Whenever the piping system fails to pass the test or inspection, make the required corrections, and arrange for re-inspection.
  - 4. Reports: Prepare inspection reports, signed by the Plumbing Official.
- B. Piping System Test: Test drainage and vent system in accordance with the procedures of the Authority Having Jurisdiction, or in the absence of a published procedure, as follows.
  - 1. Subject all waste and vent piping, including building drain, and building sewer to a water test.
  - 2. Tightly close all openings in the piping system except the highest opening, and fill the system with water to the point of overflow.
  - 3. Maintain water in the system, or in the portion under test, for at least fifteen (15) minutes before inspection starts; the system shall then be tight to all points. No section shall be tested with less than a 10-foot head of water.

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3.6 ADJUSTING AND CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Clean drain strainers, domes, and traps. Remove dirt and debris.

3.7 PROTECTION

- A. Protect drains during remainder of construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.
- B. Place plugs in ends of uncompleted piping at end of day or whenever work stops. Piping shall not be left open ended during construction.
- C. Exposed ABS or PVC Piping: Protect plumbing vents exposed to sunlight with two (2) coats of water-based latex paint. Color selected by Architect.

END OF SECTION 221316

**SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES**

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. This Section specifies the following:
  - 1. Drainage Piping Specialties:
    - a. Backwater Valves
    - b. Trap Primers
    - c. Cleanouts
    - d. Floor Drains
    - e. Floor Sinks
    - f. Trench Drains
    - g. Pre-cast Concrete Basins and Manholes

1.2 DEFINITIONS

- A. Building Drain: That part of the lowest piping of a drainage system which receives the discharge from soil, waste, and other drainage pipes inside the walls of the building and conveys it to the building sewer to a point 5'-0" outside the building wall.
- B. Building Sewer: That part of the horizontal piping of a drainage system which extends from the end of the building drain and conveys its discharge to a public sewer, private sewer, individual sewage disposal system, or other point of disposal.
- C. Drainage System: Includes all the piping within a public or private premises which conveys sewage, rain water or other liquid wastes to a point of disposal. It does not include the mains of public sewer systems or a private or public sewage treatment or disposal plant.
- D. Vent System: Pipe or pipes installed to provide a flow of air to or from a drainage system, or to provide a circulation of air within such system to protect trap seals from siphonage and back pressure.

1.3 SUBMITTALS

- A. Submit under provisions of Division 1.

1.4 CLOSEOUT SUBMITTALS

- A. Submit under provisions of Division 1.

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### 1.5 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with the provisions of the following:
1. Plumbing Code Compliance: Comply with applicable portions of the International and Local Plumbing Code.
  2. ANSI Compliance: Comply with applicable ANSI standards pertaining to materials, products, and installation of soil and waste systems.
  3. ASSE Compliance: Comply with applicable ASSE standards pertaining to materials, products, and installation of soil and waste systems.
  4. ASTM Compliance: Comply with applicable ASTM Standards pertaining to materials, products, and installation of soil and waste systems.
  5. CISPI Compliance: Comply with applicable CISPI Standards pertaining to materials, products, and installation of soil and waste systems.
  6. PDI Compliance: Comply with applicable PDI standards pertaining to products and installation of soil and waste systems.
  7. PVC, PP and ABS Pipe: Only Contractor's personnel which have received training in the installation of this material and meet the manufacturer's qualifications shall do the assembly of such material.

## PART 2 - PRODUCTS

### 2.1 DRAINAGE PIPING SPECIALTIES

- A. Acceptable Manufacturers:
1. Josam Mfg. Co.
  2. Smith (Jay R.) Mfg. Co.
  3. Tyler Pipe; Subs. of Tyler Corp.
  4. Zurn Industries Inc; Hydromechanics Division
  5. Wade
  6. Woodford
  7. Precision Plumbing Products
  8. Watts
- B. Backwater Valves: Bronze fitted cast iron valve assembly with bolted cover. Provide a maximum 1/4-inch clearance between flapper and seat for air circulation. Valve ends shall suit piping. All bearing parts of backwater valve shall be of corrosion-resistant material. Valve shall comply with ASME A112.14.1.
1. Jay R. Smith Fig. 7012
- C. Trap Primers:
1. TP- Electronic Type:
    - a. Bronze body valve with vacuum breaker, with 1/2 – inch connections matching piping system. Complying with ASSE 1044 and UL listed.
    - b. Unit shall have electronic solenoid valve operation, recycle timer box with pre-set timer that opens once for 10 seconds every 24 hours, 6-foot solenoid cord..
    - c. Connections: Inlet 1/2-inch male NPT; Outlet 1/2-inch female NPT.
    - d. MP-500-115V- Trap Primer Valve by Precision Plumbing Products, Inc., or equal.
    - e. When more than one (1) trap is to be primed, provide multiple distribution units, as required for application, by the manufacturer.



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### D. Cleanouts:

1. Cleanout Plugs: ASTM A74, Cast brass, threads complying with ANSI B2.1, and Local Plumbing Code.
2. Floor Cleanout: Round, cast iron body with recessed bronze closure plug; scoriated polished bronze frame and cover plate.
3. Wall Cleanout: Cleanout tee with raised head brass plug tapped for 1/4-20 thread; flat style chrome plated wall cover plate with holes for 1/4-inch bolt; 1/4-20 threaded bolt with chrome plated flat head.
4. Grade Cleanout or Interior Locations Subject to Vehicle Traffic: Round cast iron flanged housing with heavy duty ductile iron cover. Set in 36-inch square concrete pad. Available in pipe sizes 2-inch to 6-inch. Josam No. 58680-5.
5. Line Cleanout: Cast iron tapped cleanout ferrule with raised head brass plug.
6. Access Panels: Fire rated assembly compatible with wall rating.

### E. Floor Drains:

1. Refer To Plumbing Fixture Schedule On Drawings

### F. Floor Sinks:

1. Refer To Plumbing Fixture Schedule On Drawings

## 2.2 TRENCH DRAINS

### A. Acceptable Manufacturers:

1. Non-Metallic Trench Drains:
  - a. Smith/ACO Drain Inc.
  - b. Zurn
  - c. ABT, Inc.
  - d. Mea-Josam Company

### B. Non-Metallic Trench Drains: Sheet Molding Compound-Glass Reinforced Polyester (SMC-GRP), Polypropylene, Polyethylene or Polyester resin and quartz aggregate, pre-cast, interlocking design, with bottom radius and minimum 0.5 percent slope.

1. Pre-Cast Material: Load rating Heavy Duty for commercial pneumatic tire traffic patterns, forklifts and tractor trailers, 56,000 lbs – 1,162 psi-
2. Grates: Cast iron or steel as indicated, for heavy-duty truck traffic, with openings designed to prevent entry of bicycle or wheelchair tires.

## 2.3 PRE-CAST CONCRETE BASINS AND MANHOLES

### A. Acceptable Manufacturers: Subject to compliance with requirements, provide drainage and vent systems from one of the following:

1. Copeland
2. Front Range Precast Concrete, Inc.
3. Amcor Precast (Colorado Division of Oldcastle Precast, Inc.)

### B. Manholes:

1. Constructed from pre-cast concrete sections with heavy-duty cast iron traffic cover and rim. All concrete, reinforcing, steps and sealant shall meet or exceed ASTM C478.

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2. Base: Preformed base set on approved bedding material. Refer to Division 1 for compaction requirements. At a minimum compaction shall be to a minimum 90% proctor. Where heavy density concrete is poured in place, a wait time of at least forty- eight (48) hours is required prior to setting the pre-cast sections.
3. Flow Channels: Formed in cement mortar on the base to provide smooth flow and maintain the sewer grade; troweled smooth.
4. Bottom Manhole Section: Set bottom manhole section on base utilizing butyl gasket. Set each additional riser or cone section utilizing a tongue and groove system with butyl gasket in same manner. All joints, holes and imperfections shall be sealed with non- shrink grout.
5. Pipe Connections: Follow manufacturer's recommendations for connections.
6. Manhole Cover: Install with cast iron receiving frame and adjustable rings so that it is flush with pavement or grade. The cover shall be suitable for A.A.S.H.O. H-20 wheel loading.
7. Steps: Meet or exceed ASTM C478 and OSHA requirements.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. General: Install piping in accordance with Authorities Having Jurisdiction, except where more stringent requirements are indicated.
- B. Inspect piping before installation to detect apparent defects. Mark defective materials with white paint and promptly remove from site.
- C. Verify all dimensions by field measurements. Verify that all drainage and vent piping and specialties may be installed in accordance with pertinent codes and regulations, the original design, and the referenced standards.
- D. Verify all existing grades, inverts, utilities, obstacles, and topographical conditions prior to installations.
- E. Examine rough-in requirements for plumbing fixtures and other equipment having drain connections to verify actual locations of piping connections prior to installation.
- F. Examine walls, floors, roof, and plumbing chases for suitable conditions where piping and specialties are to be installed.
- G. Do not proceed until unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION OF PIPING SPECIALTIES

- A. Provide flashing for all floor drains, floor cleanouts and shower drains above grade. Make watertight with Chloraloy 240 underslab moisture vapor barrier as manufactured by the Nobel Co. of Grand Haven, Michigan. Extend flashing at least 24-inch from drain rim into floor membrane or on structural floor. Fasten flashing to drain clamp device and make watertight,

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durable joint. Provide flashing collar extension with all drains and cleanouts installed above grade.

- B. Backwater Valves: Install in sanitary building drain piping as indicated, and as required by the Plumbing Code. For shallow interior installations, provide minimum 13-inch diameter cleanout cover flush to floor centered over backwater valve cover and of adequate size to remove valve cover for service. For deeper installations, provide manhole with steps and gas-tight cover and ring.
- C. Cleanouts: Lubricate plugs with mixture of graphite and linseed oil. Prior to building turnover remove cleanout plugs, re-lubricate and reinstall using only enough force to ensure permanent leakproof joint.
  - 1. Above Ground Cleanouts: Install in above ground piping and building drain piping as indicated, and:
    - a. As required by Plumbing Code;
    - b. At each change in direction of piping greater than 45 degrees below slab;
    - c. At minimum intervals of 50-feet;
    - d. At base of each vertical soil or waste stack;
    - e. At sinks and urinals on grade;
    - f. At each upper terminal;
    - g. At egress of building (surface cleanout).
  - 2. Cleanout Covers: Install floor and wall cleanout covers for concealed piping, types as indicated, and in accessible locations.
  - 3. Access Panels: Where cleanouts are located at a fire rated wall, provide and install fire-rated access panels to maintain wall rating. Provide panel sized to allow access to the cleanout.
- D. Floor Drains:
  - 1. Install floor drains at low points of surface areas to be drained, or as indicated. Set tops of drains flush with finished floor.
  - 2. Trap all drains connected to the sanitary sewer with minimum trap size that of drain connected.
  - 3. Install drain flashing collar or flange so that no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes, where penetrated.
  - 4. Position drains so that they are accessible and easy to maintain.
  - 5. Provide with P-trap the same size as the floor drain unless otherwise noted on Mechanical Drawings.
  - 6. Provide flashing membrane for all floor drains in structure above slab on grade level.
- E. Trap Primers: Install trap primers with piping pitched towards drain trap, minimum of 1/8-inch per foot (1 percent). Adjust trap primer for proper flow. Trap primer piping shall be continuous (no joints) below grade and insulated with 1/2-inch Armaflex insulation. Where a joint below grade is required, such joint shall be brazed.

### 3.3 SERVICE CONNECTIONS

- A. Before commencing work, check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with slope for drainage and cover to avoid freezing.

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### 3.4 FIELD QUALITY CONTROL

#### A. Inspections:

1. Do not enclose, cover, or put into operation drainage and vent piping system until it has been inspected and approved by the Authority Having Jurisdiction.
2. During the progress of the installation, notify the Plumbing Official Having Jurisdiction, at least forty-eight (48) hours prior to the time such inspection must be made. Perform tests specified below in the presence of the Plumbing Official.
  - a. Rough-In Inspection: Arrange for inspection of the piping system before concealed or closed-in after system is roughed-in, and prior to setting fixtures.
  - b. Final Inspection: Arrange for a final inspection to observe the tests specified and to insure compliance with the requirements of the Plumbing Code.
3. Re-Inspections: Whenever the piping system fails to pass the test or inspection, make the required corrections, and arrange for re-inspection.
4. Reports: Prepare inspection reports, signed by the Plumbing Official.

#### B. Piping System Test: Test drainage and vent system in accordance with the procedures of the Authority Having Jurisdiction, or in the absence of a published procedure, as follows.

1. Subject all waste and vent piping, including building drain, roof drain and building sewer to a water test.
2. Tightly close all openings in the piping system except the highest opening, and fill the system with water to the point of overflow.
3. Maintain water in the system, or in the portion under test, for at least fifteen (15) minutes before inspection starts; the system shall then be tight to all points. No section shall be tested with less than a 10-foot head of water.

### 3.5 ADJUSTING AND CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Clean drain strainers, domes, and traps. Remove dirt and debris.
- C. Rod all new piping to ensure there are not blockages or debris in piping..

### 3.6 PROTECTION

- A. Protect drains during remainder of construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.
- B. Place plugs in ends of uncompleted piping at end of day or whenever work stops. Piping shall not be left open ended during construction.

END OF SECTION 221319

**SECTION 223200 - WATER HEATERS**

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of Water Heater Work required by this section is indicated on drawings and schedules, and by requirements of this section.
- B. Refer to other Division 23 sections for piping, specialties, pumps, gas piping; breechings which are required external to water heaters for installation; for field installed automatic temperature controls required in conjunction with water heaters; not work of this section.
- C. Electrical Work: Refer to Division 22 section "Mechanical/Electrical Requirements for Mechanical Equipment" for requirements.
- D. Electrical Work: Provide the following wiring as work of this section, in accordance with requirements of Division 26:
  - 1. Low voltage wiring between water heaters and remote mounted thermostats and controls.
  - 2. Provide factory-mounted and factory-wired controls and electrical devices as specified in this section.
- E. Refer to Division 26 sections for other electrical wiring including motor starters, disconnects, wires/cables, raceways, and other required electrical devices; not work of this section.

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of water heaters of types and capacities required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. Codes and Standards:
  - 1. UL Compliances: Construct water heaters in accordance with the following UL Standards:
    - a. UL 174, "Household Electric Storage-Tank Water Heaters".
    - b. UL 499, "Electric Heating Appliances".
    - c. UL 1261, "Electric Water Heaters for Pools and Tubs".
    - d. UL 1453, "Electric Booster and Commercial Storage Tank Water Heaters".
  - 2. Provide water heater components which are UL-listed and labeled.
  - 3. NSF Compliance: Construct and install water heaters located in food service establishments in accordance with NSF 5, "Standard for Hot Water Generating Equipment for Food Service Establishments using Spray Type Dish Washing Machines".
  - 4. NSF Compliance: Construct and install water heater in accordance with NSF 372.
  - 5. NEC Compliance: Install electric water heaters in accordance with requirements of NFPA 70, "National Electrical Code".
  - 6. NFPA Compliance: Install gas-fired water heaters in accordance with requirements of NFPA 54, "National Fuel Gas Code".

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7. International Plumbing Code Compliance: Install water heaters in accordance with requirements of the "International Plumbing Code".
8. International Fuel Gas Code Compliance: Install gas-fired water heaters in accordance with requirements of the "International Fuel Gas Code".
9. CSA International Labels: Provide water heaters which are listed and labeled by CSA International.
10. ASME Code Symbol Stamps: Provide water heaters and safety relief valves which comply with ASME Boiler and Pressure Vessel Code, and are stamped with appropriate code symbols.
11. ASHRAE Compliance: Provide water heaters with Performance Efficiencies not less than prescribed in the latest edition of ASHRAE 90.1, "Energy Standards for Buildings except Low-Rise Residential Buildings".

### 1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data including rated capacities and efficiencies of selected model clearly indicated; operating weights; furnished specialties and accessories; and installation and start-up instructions.
- B. Shop Drawings: Submit manufacturer's assembly type shop drawings indicating dimensions, required clearances, and methods of assembly of components.
- C. Wiring Diagrams: Submit manufacturer's electrical requirements for electrical power supply wiring to water heaters. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring required for final installation of water heaters and controls. Differentiate between portions of wiring that are factory-installed and portions that are to be field-installed.
- D. Record Drawings: At project closeout, submit record drawings of installed systems products; in accordance with requirements of Division 1.
- E. Maintenance Data: Submit maintenance data and parts lists for each type and size of water heater, control, and accessory; including "trouble-shooting" maintenance guide. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual; in accordance with requirements of Division 1.
- F. Certificates: Submit appropriate Certificates of Shop Inspection and Data Report as required by provisions of ASME Boiler and Pressure Vessel Code.

### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Handle water heaters and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged water heaters or components; remove from site and replace with new.
- B. Store water heaters and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.
- C. Comply with manufacturer's rigging and installation instructions for unloading water heaters, and moving units to final location for installation.

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### 1.5 SPECIAL PROJECT WARRANTY

- A. Warranty on Coil, Heat Exchanger, and Burner: Provide written warranty, signed by manufacturer, agreeing to replace/repair, within warranty period, coils, heat exchangers, and burners with inadequate or defective materials and workmanship, including leakage, breakage, improper assembly, or failure to perform as required; provided manufacturer's instructions for handling, installing, protecting, and maintaining units have been adhered to during warranty period. Replacement is limited to component replacement only, and does not include labor for removal and reinstallation.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Commercial Gas-Fired – High Efficiency, Sealed Combustion
    - a. A.O. Smith
    - b. Rheem
    - c. PVI Industries
    - d. State
    - e. Lochinvar
  - 2. Expansion Tanks
    - a. Amtrol – Therm-X-Trol
    - b. Watts
    - c. State Industries, Inc.

### 2.2 COMMERCIAL GAS-FIRED WATER HEATERS – HIGH EFFICIENCY, SEALED COMBUSTION

- A. General: Provide sealed combustion, gas-fired water heaters of sizes and capacities as indicated on schedule. Product shall comply with the lead-free requirements of NSF 61 Annex G and/or NSF 372, compliant with ASHRAE 90.1 and CSA and/or UL listed and be ASME labeled.
- B. Heater: Water heater shall be gas-fired, fully condensing, operate up to a thermal efficiency of 95%, equipped with control panel, power cord, CSA certified and ASME rated temperature/pressure relief valve. Storage tank construction shall be glass-lined steel or a duplex alloy (stainless steel) with anode rod(s). Water heater shall be ASME listed.
- C. Controls and Control Panel (LCD display):
  - 1. Run history information
  - 2. Blockage sensors of vent or intake.
  - 3. Temperature range setting capability
  - 4. Self-diagnostic capabilities
  - 5. High limit control
  - 6. Remote monitoring capabilities
  - 7. Other controls based on specific manufacturer requirements

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- D. Gas Controls: Provide gas pressure regulator; modulating air/fuel valve and burner; electronic ignition.
- E. Electrical Power: 120 V, single phase.
- F. Condensation Neutralization kit and neutralizing tubing for each heater.
- G. Warranty: 3 years for commercial installations

### 2.3 EXPANSION TANKS

- A. Expansion tank shall be pre-charged, hydropneumatic steel expansion tank, stainless steel connector, rigid polypropylene liner, Butyl diaphragm, welded steel construction, air charge fitting, lead-free and NSF 61 listed and ASME stamped.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and conditions under which water heaters are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

### 3.2 INSTALLATION OF EXPANSION TANKS

- A. Install expansion tanks in accordance with manufacturer's installation instructions.
- B. Adjust pre-charge to equal incoming water pressure support independently from piping system.
- C. Install small expansion tanks in-line with the plumbing piping. Floor mounted expansion tanks shall be mounted on a concrete housekeeping pad.
- D. Provide isolation valve and check valve on supply piping to water heater and locate the expansion tank between the check valve and water heater. Provide an isolation valve on the branch piping to the expansion tank.

### 3.3 FIELD QUALITY CONTROL

- A. Start-Up: Start-up, test, and adjust gas-fired water heaters in accordance with manufacturer's start-up instructions, and utility company's requirements. Check and calibrate controls, adjust burner for maximum efficiency.
- B. Start-Up: Start-up, test, and adjust electric water heaters in accordance with manufacturer's start-up instructions. Check and calibrate controls.



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3.4 CLOSEOUT PROCEDURES

- A. Training: Provide services of manufacturer's technical representative for one-half day to instruct Owner's personnel in operation and maintenance of water heaters.
  - 1. Schedule training with Owner, provide at least seven (7) day notice to Contractor and Engineer of training date.

END OF SECTION 223200

**SECTION 224000 - PLUMBING FIXTURES**

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of Plumbing Fixtures Work required by this section is indicated on drawings and schedules and by requirements of this section.

1.2 QUALITY ASSURANCE

A. Codes and Standards:

1. ASHRAE Standard 18: "Method of Testing for Rating Drinking Water Coolers with Self-Contained Mechanical Refrigeration Systems".
2. ARI Standard 1010: "Drinking-Fountains and Self-Contained Mechanically-Refrigerated Drinking-Water Coolers".
3. ANSI Standard A117.1: "Specifications for Making Buildings and Facilities Accessible To and Usable By Physically Handicapped People".
4. Public Law 90-480: "Architectural Barriers Act of 1968".
5. International Code Council A117.1: "Accessible and Usable Buildings and Facilities".
6. UL Standard 399: "Drinking-Water Coolers".
7. Public Law 101-336: "Americans With Disabilities Act".
8. NSF Standard 61: "Drinking Water Components".
9. Energy Conservation Act - 1992: "Energy Conservation Standards".
10. ANSI Standard: Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment".
11. International Plumbing Code – Comply with version enforced by the Authority Having Jurisdiction.
12. Safe Water Drinking Act and Amendments and includes Section 1417 requiring not more than a weighted average of 0.25 percent lead when used with respect to the wetted surfaces of pipes, pipe fittings, plumbing fittings, and fixtures.

- B. Where fixtures are specified as ADA Accessible, it shall be the sole responsibility for all manufacturers and/or suppliers to provide plumbing fixtures and related trim which meet or exceed the ADA Requirements.

1.3 SUBMITTALS

- A. Submit under provisions of Division 1 and below.
- B. Color Charts: Submit manufacturer's standard color charts for cabinet finishes and fixture colors.
- C. Submit certification of compliance with specified NSF, ANSI, UL, and ASHRAE Standards.
- D. Submit certification of compliance with performance verification requirements specified in this Section.

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### 1.4 CLOSE-OUT SUBMITTALS

- A. Submit under provisions of Division 1.
- B. Extra Stock:
  - 1. Furnish special wrenches and other devices necessary for servicing plumbing fixtures and trim to Owner with receipt in a quantity of one (1) device for each ten (10) fixtures.
  - 2. Furnish faucet repair kits complete with all necessary washers, springs, pins, retainers, packings, O-rings, sleeves, ceramic discs and/or seats in a quantity of one (1) kit for each forty (40) faucets.
- C. Maintenance Data: Submit Maintenance Data and Spare Parts Lists for each type of manufactured plumbing fixtures, valves and trim. Include this data, product data, and shop drawings in Maintenance Manual; in accordance with requirements of Division 1.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturer subject to compliance with requirements, provide products by one of the following:
  - 1. Lavatories, Sinks, Bidets, Service Sinks, Water Closets, Urinals, Bath Tubs, Vitreous China Surgeon Scrub Sinks, Clinical Service Sinks:
    - a. American Standard U.S. Plumbing Products
    - b. Crane Co.
    - c. Kohler Co.
    - d. Toto
  - 2. Stainless Steel Sinks:
    - a. Elkay Mfg. Co.
    - b. Just Mfg. Co.
  - 3. Faucets:
    - a. American Standard; U.S. Plumbing Products
    - b. Chicago Faucet Co.
    - c. Delta Faucet Co./Cambridge Brass
    - d. Kohler Co.
    - e. T & S Brass
    - f. Sloan Valve Co.
    - g. Symmons
  - 4. Faucets – Thermostatic Mixing
    - a. Powers
  - 5. Water Closet Seats:
    - a. Bemis Mfg. Co.
    - b. Beneke Corp.
    - c. Church Seats
    - d. Olsonite Corp.; Olsonite Seats
  - 6. Water Coolers:
    - a. Elkay Mfg. Co.
    - b. Halsey Taylor Division; Household International Co.
    - c. Acorn

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7. Service Sinks:
  - a. Fiat
  - b. American Standard; U.S. Plumbing Products
  - c. Crane Co.
  - d. Kohler Co.
8. Fixture Supports:
  - a. Josam Mfg. Co.
  - b. Wade
  - c. Jay R. Smith
  - d. Zurn Industries, Inc.
9. Emergency Showers, and Eye/Face Washes:
  - a. Guardian Equipment
  - b. Haws Drinking Faucet Co.
  - c. Speakman
  - d. Bradley
  - e. Acorn Safety
10. Mop Service Basins
  - a. Fiat
  - b. Stern-Williams
  - c. Acorn
  - d. Florestone
  - e. Swanstone
11. Shower and Bath Systems and Bases:
  - a. Best Bath
  - b. Aquatic
  - c. Aqua Bath
  - d. Kohler
  - e. American Standard
  - f. Sterling (A Kohler Company)
  - g. Swanstone
  - h. Fiat
  - i. Willoughby
  - j. Florestone Products Company, Inc.
  - k. Praxis (Formerly Aquarius and Comfort Design)
12. Shower and Tub Trim (Pressure Balance):
  - a. American Standard
  - b. Kohler
  - c. Powers
  - d. Symmons
  - e. Chicago Faucets
  - f. T & S Brass
  - g. Delta Faucet Co./Cambridge Brass
  - h. Bradley
13. Food Waste Disposers:
  - a. In-Sink-Erator
  - b. Waste King
14. Clotheswasher Machine Supply/Drain Box:
  - a. Symmons
  - b. Guy Gray
  - c. Sioux Chief
15. Drinking Fountains:

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- a. Kohler
- b. Elkay
- c. Halsey Taylor
- d. Acorn
- e. Haws
16. ADA Sink/Lavatory Pipe Insulation:
  - a. Truebro
  - b. Plumberex Pro-Extreme Series
17. Stops, Supplies, Drains and P-Traps:
  - a. McGuire
  - b. Dearborn
  - c. Brass Craft
  - d. CS&B Company
  - e. Watts
  - f. Nibco
18. Stainless Steel Security Fixtures:
  - a. Acorn
  - b. Bradley
19. Stainless Steel Surgeon Scrub Sinks:
  - a. Acorn
  - b. Amsco
  - c. Whitehall
  - d. Sloan
  - e. Elkay

### 2.2 WATER CLOSETS

- A. Refer To Plumbing Fixture Schedule On Drawings.

### 2.3 LAVATORIES

- A. Refer To Plumbing Fixture Schedule On Drawings.

### 2.4 SHOWERS

- A. Refer To Plumbing Fixture Schedule On Drawings.

### 2.5 SINKS

- A. Refer To Plumbing Fixture Schedule On Drawings.

### 2.6 MOP SERVICE BASINS

- A. Refer To Plumbing Fixture Schedule On Drawings.

### 2.7 WATER COOLERS

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- A. Refer To Plumbing Fixture Schedule On Drawings.

### 2.8 EMERGENCY EQUIPMENT

- A. Refer To Plumbing Fixture Schedule On Drawings.

### 2.9 WASHER SUPPLY AND DRAIN BOX

- A. Refer To Plumbing Fixture Schedule On Drawings.

### 2.10 FITTINGS, TRIM, AND ACCESSORIES

- A. Lead-free supplies and Stops for Lavatories and Sinks: Polished chrome-plated, loose keyed or wheel handle (Refer to schedule on drawings) angle stop having 1/2-inch inlet and 3/8-inch O.D. x 12-inch long flexible tubing outlet, and wall flange and chrome-plated cast brass escutcheon with set screw. Quantity to match trim specified. Supplies and stops shall be certified as lead-free in accordance with NSF/ANSI 61 Annex G and/or NSF/ANSI 372.
- B. Traps for Drinking Fountains and Lavatories: Chrome-plated cast brass, 1-1/4 inch adjustable "P" trap with cleanout, waste to wall and chrome-plated cast brass escutcheon with set screw.
- C. Traps for Sinks: Chrome-plated cast brass, 1-1/2 inch adjustable "P" trap with cleanout, waste to wall and chrome-plated cast brass escutcheon with set screw.
- D. Escutcheons: Chrome-plated cast brass with set screw.
- E. All handicapped compliant lavatories and sinks, supplies and waste, shall be insulated with molded vinyl covers, Truebro Inc. Lav-Guard Insulation Kit, or equivalent by approved manufacturer.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify all dimensions by field measurements. Verify that all plumbing fixtures may be installed in accordance with pertinent codes and regulations, the original design, and the referenced standards.
- B. Examine rough-in for potable water and waste piping systems to verify actual locations of piping connections prior to installing fixtures.
- C. Examine walls, floors, and cabinets for suitable conditions where fixtures are to be installed.
- D. Do not proceed until unsatisfactory conditions have been corrected.

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### 3.2 INSTALLATION

- A. Install plumbing fixtures level and plumb, in accordance with fixture manufacturer's written instructions, rough-in drawings, and pertinent codes and regulations, the original design, and the referenced standards.
- B. Comply with the installation requirements of ANSI A117.1 and Public Law 90-480 with respect to plumbing fixtures for the physically handicapped. Arrange flush valve handles with proper orientation to meet ADA requirements.
- C. Fasten plumbing fixtures securely to supports or building structure. Secure domestic water piping behind or within wall construction to provide rigid installation.
- D. Set shower receptor and mop basins in a leveling bed of cement grout.
- E. Install a stop valve in an accessible location in the water connection to each fixture.
- F. Install escutcheons at each wall, floor, and ceiling penetration in exposed finished locations and within cabinets and millwork. Escutcheon shall be large enough to cover the hole cut for the pipe penetration.
- G. Seal fixtures to walls and floors using silicone sealant as specified in Division 7. Match sealant color to fixture color.
- H. Visible parts of fixture brass and accessories shall be chrome-plated.
- I. External finishes on all trim shall not be chrome-plated plastic.
- J. Where possible, fixtures shall be the product of one manufacturer. Where possible, fittings of same type shall be the product of one manufacturer.
- K. Install hose end faucets and hose connection with vacuum breakers.
- L. Solidly attach floor-mounted water closets to cast iron water closet flange with brass bolts, washers and nuts.

### 3.3 FIELD QUALITY CONTROL

- A. Test fixtures to demonstrate proper operation upon completion of installation and after units are water pressurized. Replace malfunctioning units, then retest.
- B. Inspect each installed unit for damage. Replace damaged fixtures.

### 3.4 ADJUSTING

- A. Adjust water pressure at drinking fountains, faucets, shower valves, and flush valves to provide proper flow and stream.
- B. Replace washers of leaking or dripping faucets and stops.

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- C. Clean fixtures, trim, and strainers using manufacturer's recommended cleaning methods and materials.

3.5 CLEANING

- A. Clean fixtures, trim, and strainers using manufacturer's recommended cleaning methods and materials.

3.6 PROTECTION

- A. Provide protective covering for installed fixtures, water coolers, and trim.
- B. Do not allow use of fixtures for temporary facilities unless expressly approved in writing by the Owner.

3.7 MOUNTING HEIGHTS SCHEDULE

- A. Fixture mounting height and rough-in dimensions shall be as indicated on the Architectural Drawings and Specifications.

END OF SECTION 223300



**SECTION 230000 - BASIC MECHANICAL REQUIREMENTS**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including the General and Supplementary Conditions, Division-1 Conditions specification sections apply to the Division 23 specifications and drawings.
- B. Related Sections: Refer to all sections in Division 23. Refer to Division 26 specification section and Division 26 drawings.

1.2 SUMMARY

- A. This Section specifies the basic requirements for mechanical installations and includes requirements common to more than one (1) section of Division 23. It expands and supplements the requirements specified in sections of Division 1.

1.3 ACCESSIBILITY

- A. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing.
- B. Extend all grease fittings to an accessible location.
- C. Furnish hinged steel access doors with concealed latch, whether shown on drawings or not, in all walls and ceilings for access to all concealed valves, shock absorbers, air vents, motors, fans, balancing cocks, and other operating devices requiring adjustment or servicing. Refer to Division 1 for access door specification and Division 23 for duct access door requirements.
- D. The minimum size of any access door shall not be less than the size of the equipment to be removed or 24-inch x 24-inch if used for service only.
- E. Furnish doors to trades performing work in which they are to be built, in ample time for building-in as the work progresses. Whenever possible, group valves, cocks, etc., to permit use of minimum number of access doors within a given room or space.
- F. Factory manufactured doors shall be of a type compatible with the finish in which they are to be installed. In lieu of these doors, shop fabricated access doors with DuroDyne hinges may be used.
- G. Access doors in fire-rated walls and ceilings shall have equivalent UL label and fire rating.

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### 1.4 ROUGH-IN

- A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
- B. Refer to equipment shop drawings and manufacturer's requirements for actual provided equipment for rough-in requirements.

### 1.5 REQUIREMENTS OF REGULATORY AGENCIES

- A. Refer to Division 1.
- B. Execute and inspect all work in accordance with all Underwriters, local and state codes, rules and regulations applicable to the trade affected as a minimum, but if the plans and/or specifications call for requirements that exceed these rules and regulations, the greater requirement shall be followed. Follow recommendations of NFPA, SMACNA, EPA, OSHA and ASHRAE.
- C. Comply with standards in effect at the date of these Contract Documents, except where a standard or specific date or edition is indicated.
- D. The handling, removal and disposal of regulated refrigerants shall be in accordance with U.S. EPA, state and local regulations.
- E. After entering into contract, Contractor will be held to complete all work necessary to meet these requirements without additional expense to the Owner.

### 1.6 REQUIREMENTS OF LOCAL UTILITY COMPANIES

- A. Comply with rules and regulations of local utility companies. Include in bid the cost of all valves, valve boxes, meter boxes, meters and such accessory equipment which will be required for the project.

### 1.7 PERMITS AND FEES

- A. Refer to Division 1.
- B. Owner shall pay all tap, development, meter, etc., fees required for connection to municipal and public utility facilities.
- C. Contractor shall arrange for and pay for all inspections, licenses and certificates required in connection with the Work.

1.8 MECHANICAL INSTALLATIONS

- A. Drawings are diagrammatic in character and do not necessarily indicate every required offset, valve, fitting, etc.
- B. Drawings and specifications are complementary. Whatever is called for in either is binding as though called for in both.
- C. Drawings shall not be scaled for rough-in measurements or used as shop drawings. Where drawings are required for these purposes or have to be made from field measurement, take the necessary measurements and prepare the drawings.
- D. Before any Work is installed, determine that equipment will properly fit the space; that required piping grades can be maintained and that ductwork can be run as contemplated without interferences between systems, with structural elements or with the work of other trades.
- E. Coordinate the installation of mechanical materials and equipment above and below ceilings with suspension system, light fixtures, and other building components.
  - 1. Coordinate ceiling cavity space carefully with all trades. In the event of conflict, install mechanical and electric systems within the cavity space allocation in the following order of priority.
    - a. Plumbing waste, vent piping and roof drain mains and leaders
    - b. Supply, return and exhaust ductwork
    - c. Fire sprinkler mains and leaders
    - d. Electrical conduit
    - e. Domestic hot and cold water, medical gas piping
    - f. Pneumatic control piping
    - g. Fire sprinkler branch piping and sprinkler runouts
- F. Verify all dimensions by field measurements.
- G. Arrange for chases, slots, and openings in other building components to allow for mechanical installations.
- H. Coordinate the installation of required supporting devices and sleeves to be set in poured in place concrete and other structural components, as they are constructed.
- I. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing-in the building.
- J. Coordinate the cutting and patching of building components to accommodate the installation of mechanical equipment and materials.
- K. Where mounting heights are not detailed or dimensioned, install mechanical services and overhead equipment to provide the maximum headroom possible.
- L. Install mechanical equipment to facilitate maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

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- M. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

### 1.9 EXCAVATING AND BACKFILLING

- A. General:
  - 1. Provide all necessary excavation and backfill for installation of Mechanical Work.
  - 2. In general, follow all regulations of OSHA as specified in Part 1926, Subpart P, "Excavations, Trenching and Shoring". Follow specifications of Division 23 as they refer specifically to the Mechanical Work.
- B. Contact Owners of all underground utilities to have them located and marked, at least two (2) business days before excavation is to begin. Also, prior to starting excavation, brief employees on marking and color codes and train employees on excavation and safety procedures for natural gas lines. When excavation approaches gas lines, expose lines by carefully probing and hand digging.
- C. Provide all necessary pumping, cribbing and shoring.
- D. Walls of all trenches shall be a minimum of 6-inch clearance from the side of the nearest mechanical work. Install pipes with a minimum of 6-inch clearance between them when located in same trench.
- E. Pipe Trenching:
  - 1. Dig trenches to depth, width, configuration, and grade appropriate to the piping being installed. Dig trenches to 6-inches below the level of the bottom of the pipe to be installed. Install 6-inch bed of pea gravel or squeegee; mechanically tamp to provide a firm bed for piping, true to line and grade without irregularity. Provide depressions only at hubs, couplings, flanges, or other normal pipe protrusions.
- F. Backfilling shall not be started until all work has been inspected, tested and accepted. All backfill material shall be reviewed by the Soils Engineer. In no case shall lumber, metal or other debris be buried in with backfill.
- G. Trench Backfill:
  - 1. Backfill to 12-inches above top of piping with pea gravel or squeegee, the same as used for piping bed, compact properly.
  - 2. Continue backfill to finish grade, using friable material free of rock and other debris. Install in 6-inch layers, each properly moistened and mechanically compacted prior to installation of ensuing layer. Compaction by hydraulic jetting is not permissible.
- H. After backfilling and compacting, any settling shall be refilled, tamped, and refinished at this Contractor's expense.
- I. This Contractor shall repair and pay for any damage to finished surfaces.
- J. Complete the backfilling near manholes using pea gravel or squeegee, installing it in 6-inch lifts and mechanically tamping to achieve 95 percent compaction.

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- K. Use suitable excavated material to complete the backfill, installed in 6-inch lifts and mechanically compacted to seal against water infiltration. Compact to 95 percent for the upper 30-inches below paving and slabs and 90 percent elsewhere.

### 1.10 TEMPORARY FACILITIES

- A. Light, Heat, Power, Etc.:
  - 1. Responsibility for providing temporary electricity, heat and other facilities shall be as specified in Division 1.
- B. Use of Permanent Building Equipment for Temporary Heating or Cooling:
  - 1. Permanent building equipment shall not be used without written permission from the Owner. If this equipment is used for temporary heating or cooling, it shall be adequately maintained per manufacturer's instructions and protected with filters, strainers, controls, reliefs, etc. The guarantee period shall not start until the equipment is turned over to the Owner for his use.

### 1.11 PRODUCT OPTIONS AND SUBSTITUTIONS

- A. Materials and equipment of equivalent quality may be substituted for those scheduled or identified by name on the drawings if so reviewed by the Engineer prior to bidding. This may be done by submitting to the Architect, at least seven (7) working days prior to the bid date, a letter in triplicate requesting prior review. This submittal shall include all data necessary for complete evaluation of the substitution and publication in written Addenda.

### 1.12 MECHANICAL SUBMITTALS

- A. Refer to the Conditions of the Contract (General and Supplementary), Division 1 and AIA Document A201 (1987) Edition, "SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES".
- B. The manufacturer's material or equipment listed in the schedule or identified by name on the drawings are the types to be provided for the establishment of size, capacity, grade and quality. If alternates are used in lieu of the scheduled names, the cost of any changes in construction required by their use shall be borne by Contractor.
- C. All equipment shall conform to the State and/or Local Energy Conservation Standards.
- D. Submittal of shop drawings, product data, and samples will be accepted only when submitted by and stamped by the Contractor.
- E. If more than two (2) submittals (either for shop drawings or for as-built drawings) are made by the Contractor, the Owner reserves the right to charge the Contractor for subsequent reviews by their consultants. Such extra fees shall be deducted from payments by the Owner to the Contractor.
- F. Before starting Work, prepare and submit to the Architect all shop drawings and descriptive equipment data required for the project. Unless each item is identified with specification section and sufficient data to identify its compliance with the specifications and drawings, the

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item will be returned without action or "Revise and Resubmit". Continue to submit shop drawings after each Engineer's action, until a "Reviewed" action is received. The Contractor shall submit the total number of sets as called for in Division 1 to the Architect for final distribution. Submittals shall include the following specified materials and, in addition, any materials not listed below but which are specified in the individual sections of Division 23 which follow.

1. Pipe Markers
  2. Process piping
  3. Valves, including pressure relief and pressure regulating
  4. Pumps
  5. Tanks, including expansion and fuel storage
  6. Thermometers and pressure gauges
  7. Boilers, burners, trim and feed equipment
  8. Piping specialties, including hot water and steam
  9. Supports, anchors and seals
  10. Expansion compensators
  11. Flexible pipe connectors
  12. Water flow meters
  13. Insulation, including plastic pipe fitting insulation covers and manufacturer's installation instructions
  14. Heat exchangers
  15. Terminal heat transfer units
  16. Air conditioning equipment and specialties
  17. Fans, ductwork, dampers, louvers, grilles, registers and diffusers
  18. Automatic control systems
- G. Wiring diagrams, control panelboards, motor test data, motors, starters and controls for electrically operated equipment furnished by mechanical trades.
- H. Identify each item with specification section and sufficient data to certify its compliance with the specifications.

### 1.13 REQUESTS FOR INFORMATION

- A. All "Requests for Information" submitted by the Contractor shall include a proposed solution and an estimated cost/schedule impact. Any RFI's that do not contain this required information will be sent back to the Contractor unanswered.

### 1.14 MECHANICAL COORDINATION DRAWINGS

- A. Prepare and submit a complete set of 3-D Coordination/Fabrication Drawings showing major elements, components, and systems of mechanical equipment and materials in relationship with other trades, sub-trades and building components. Indicate the locations of all equipment and materials, including clearances for installing and maintaining insulation, servicing and maintaining equipment, valve stem movement, and similar requirements. Indicate movement and positioning of large equipment into the building during construction.
- B. Review in detail all floor plans, reflected ceiling plans, elevations, sections, and details to conclusively coordinate with all trades and integrate all installations. Indicate locations where

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space is limited, and where sequencing and coordination of installations are of importance to the efficient flow of the work, including (but not necessarily limited to) the following:

1. Mechanical equipment room layouts;
2. Specific equipment installations, including:
  - a. Chillers;
  - b. Boilers;
  - c. Pumps;
  - d. Tanks and Heat Exchangers;
  - e. Air Handling Units;
3. Work in pipe spaces, chases, trenches, and tunnels;
4. Exterior wall penetrations;
5. Ceiling plenums which contain piping, ductwork, or equipment in congested arrangement;
6. Installations in mechanical riser shafts, at typical sections and crucial offsets and junctures;
7. Pipe expansion loops;
8. Numbered valve location diagrams;
9. Exterior underground lines in common excavation;
10. Manifold piping for multiple equipment units;
11. Boiler/Water Heater flue and roof penetrations.

### 1.15 PRODUCT LISTING

- A. Prepare listing of major mechanical equipment and materials for the project, within two (2) weeks of signing the Contract Documents and transmit to the Mechanical Engineer.
- B. Unless otherwise specified, all materials and equipment shall be of domestic (USA) manufacture and shall be of the best quality used for the purpose in commercial practice.
- C. Provide all information requested.
- D. Submit this listing as a part of the submittal requirement specified in Division 1, "PRODUCTS AND SUBSTITUTION".
- E. When two (2) or more items of same material or equipment are required (pumps, valves, air conditioning units, etc.) they shall be of the same manufacturer. Product manufacturer uniformity does not apply to raw materials, bulk materials, pipe, tube, fittings (except flanged and grooved types), sheet metal, wire, steel bar stock, welding rods, solder, fasteners, motors for dissimilar equipment units, and similar items used in work, except as otherwise indicated.
- F. Provide products which are compatible within systems and other connected items.

### 1.16 NAMEPLATE DATA

- A. Provide permanent operational data nameplate on each item of mechanical equipment, indicating manufacturer, product name, model number, serial number, efficiency rating (i.e. EER, etc.) capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Locate nameplates in an accessible location.

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### 1.17 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Division 1.
- B. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.
- C. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage, dirt, dust and moisture.
- D. Coordinate deliveries of mechanical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.
- E. Provide factory-applied plastic end-caps on each length of pipe and tube, except for concrete, corrugated metal, hub-and-spigot, clay pipe. Maintain end-caps through shipping, storage and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.
- F. Protect stored pipes and tubes. Elevate above grade and enclose with durable, waterproof wrapping. When stored inside, do not exceed structural capacity of the floor.
- G. Protect flanges, fittings, and specialties from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

### 1.18 RECORD DOCUMENTS

- A. Refer to Division 1. The following paragraphs supplement the requirements of Division 1.
- B. Keep a complete set of record document prints or electronic mark-ups in custody during entire period of construction at the construction site.
- C. Mark drawing prints to indicate revisions to piping and ductwork, size and location both exterior and interior; including locations of coils, dampers and other control devices, filters, boxes, and similar units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned to column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.); RFI's; change orders; concealed control system devices. Changes to be noted on the drawings shall include final location of any piping or ductwork relocated more than 1'-0" from where shown on the drawings.
- D. Mark Equipment Schedules on the drawings with changes to Manufacturer, Model Number, and data based on reviewed shop drawings.
- E. At the completion of the project, mark all valve tag numbers on the drawings and turn these drawings over to the General Contractor for his submission to the Architect. This Contract will not be considered completed until these record drawings have been received and reviewed by the Engineer.



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### 1.19 OPERATION AND MAINTENANCE DATA

- A. No later than four (4) weeks prior to the completion of the project, make-up a minimum of four (4) electronic disk sets copies Operating and Maintenance Manuals, as specified in sections of Division 1.
- B. The Testing and Balancing Report shall be submitted and received by the Engineer at least five (5) calendar days prior to the Contractor's request for final observation time frame requirements. Final Observation(s) will not proceed without T&B Report. Include in the O&M Manual after review with "Review" or "Make Corrections Noted" has been accomplished.
- C. In addition to the information required above and by Division 1 for maintenance data, include the following information:
  - 1. Description of mechanical equipment, function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.
  - 2. Manufacturer's printed operating procedures to include start-up, break-in, routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
  - 3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
  - 4. Servicing instructions and lubrication charts and schedules.
  - 5. Manufacturer's service manuals for all mechanical equipment provided under this Contract.
  - 6. Include the valve tag list.
  - 7. Name, Address and Telephone Number of party to be contacted for twenty-four (24) hour service for each item of equipment.
  - 8. Starting, stopping, lubrication, equipment identification numbers and adjustment clearly indicated for each piece of equipment.
  - 9. Complete parts list.
  - 10. Mechanical warranties.
- D. This Contract will not be considered completed, nor will final payment be made, until all specified material, including Testing and Balancing Report, is received in this Operating and Maintenance Report and the manual is reviewed by the Engineer.

### 1.20 LUBRICATION OF EQUIPMENT

- A. Refer to Division 1. The following paragraphs supplement the requirements of Division 1.
- B. Contractor shall properly lubricate all mechanical pieces of equipment which he provided before turning the building over to the Owner. He shall attach a linen tag or heavy duty shipping tag on the piece of equipment showing the date of lubrication and the type and brand of lubricant used.
- C. Furnish the Engineer with a typewritten list in quadruplicate, of each item lubricated and type of lubricant used, no later than two (2) weeks before completion of the project, or at time of acceptance by the Owner of a portion of the building and the mechanical systems involved.

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### 1.21 WARRANTIES

- A. Refer to Division 1 for procedures and submittal requirements for warranties. Refer to individual equipment specifications for warranty requirements. In any case, the entire mechanical system shall be warranted no less than one (1) year from the time of acceptance by the Owner.
- B. Compile and assemble the warranties specified in Division 23, into the Operating and Maintenance Manuals.
- C. Provide complete warranty information for each item to include product or equipment to include date or beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

### 1.22 CLEANING

- A. Refer to Division 1.
- B. Refer to Division 23, "TESTING, ADJUSTING AND BALANCING" for requirements for cleaning filters, strainers, and mechanical systems prior to final acceptance.

END OF SECTION 230000

**SECTION 230100 - M&E COORDINATION**

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. Carefully coordinate the interface between Division 23 (Mechanical) and Division 26 (Electrical) before submitting any equipment for review or commencing installation.
- B. Responsibility: Unless otherwise indicated, all motor and controls for Division 23 equipment shall be furnished, set in place and wired in accordance with the following schedule:

<b>COORDINATION SCHEDULE</b>				
<b>ITEM</b>	<b>Furnished Under</b>	<b>Set in Place Under</b>	<b>Power Wiring Under</b>	<b>Control Wiring Under</b>
Equipment Motor	23	23	26	--
Automatically Controlled Starters/Contactors:				
Separate	23	26	26	23
Factory Mounted and Wired	23	23	26	23
Manually Controlled Starter/Contactors:				
Separate	23	26	26	23
Factory Mounted and Wired	23	23	26	23
Special Duty Type Motor (Part Winding, etc.)	23	26	26	23
Disconnect Switches (Note 1)	26	26	26	--
Variable Frequency Drives	23	26	26	23
Contactors	26	26	26	--
Thermal Overload Switches (Note 1)	26	26	26	--
Manual Operating Switches (Note 2)	26	26	26	--
Control Relays (Note 2)	23	23	26	23
Control Transformers	23	23	26	23
Control Circuit Outlets	26	26	26	--
Thermostats (Note 2)	23	23	--	23
Push Button Stations, Pilot Lights (Note 2)	23	23	26	23
Thermostat and Controls Integral with Equipment or Directly Attached to Ducts, Pipes, etc. (Note 2)	23	23	26	23
Equipment in Temperature Control Panels (Note 2)	23	23	26	23
Standalone Control Panels (Note 2)	23	23	26	23

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<b>COORDINATION SCHEDULE</b>				
<b>ITEM</b>	<b>Furnished Under</b>	<b>Set in Place Under</b>	<b>Power Wiring Under</b>	<b>Control Wiring Under</b>
Valve Motors Damper Motors, Solenoid Valves, etc. (Note 2)	23	23	--	23
EP Valves or Switches, P.E. Switches, etc. (Note 2)	23	23	26	23
Fire Alarm System	26	26	26	26
Smoke Detectors Including Relays for Fan Control (Note 3)	26	23	26	23
Fire/Smoke Dampers	23	23	26	26
Control Air Compressor	23	23	26	23
Equipment Interlock	23	23	N/A	23
Boiler	23	23	26	23
Water Heater	22	22	26	23
<b>Notes:</b>				
(1) If furnished as part of factory wired equipment, furnish and set in place under Division 23, wiring and connections under Division 26.				
(2) If float switches, line thermostats, P.E. switches, time switches, or other controls carry the FULL LOAD CURRENT to any motor, they shall be furnished and set in place under Division 23, but they shall be connected under Division 26. If they do not carry the FULL LOAD CURRENT to any motor, they shall be furnished, set in place and wired under Division 23.				
(3) Wiring from alarm contacts to alarm system by Division 26; all control function wiring by Division 23. Division 23 to coordinate locations with Division 26.				

- C. Control Wiring:
  - 1. Consists of wiring in pilot circuits of contactors, starters, sensors, controllers, and relays, and wiring for valve and damper operators.
- D. Connections:
  - 1. Make connections to all controls directly attached to ducts, piping and mechanical equipment with flexible connections.
- E. Starters:
  - 1. Provide magnetic starters for all three phase motors and equipment complete with:
    - a. Control transformers.
    - b. 120V holding coils.
    - c. Integral hand-off auto switch.

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

- d. Auxiliary contacts required for system operation plus one (1) spare.
- F. Remote Switches and Pushbutton Stations:
  - 1. Provide all remote switches and/or pushbutton stations required for manually operated equipment (if no automatic controls have been provided) complete with pilot lights of an approved type lighted by current from load side of starter.
- G. Special Requirement:
  - 1. Motor, starters and other electrical equipment installed in moist areas or areas of special conditions, such as explosion proof, shall be designed and approved for installation in such areas with appropriate enclosure.
- H. Identification:
  - 1. Provide identification of purpose for each switch and/or pushbutton station furnished. Identification may be either engraved plastic sign or permanent mounting to wall below switch, or stamping on switch cover proper. All such identification signs and/or switch covers in finished areas shall match other hardware in the immediate area.
- I. Control Voltage:
  - 1. Maximum allowable control voltage is 120V. Fully protect control circuit conductors in accordance with National Electrical Code.
  - 2. Fully coordinate the requirements of each division with regard to supplying a complete DDC Control System. J-Boxes and control transformer connections shall be provided under Division 26. The transformers shall be furnished and set in place under Div. 23.

### PART 2 - PRODUCTS

#### 2.1 MOTOR HORSEPOWER

- A. In general, all motors 3/4 HP and above shall be three phase, all motors less than 3/4 HP shall be single phase.
- B. Voltage and phase of motors as scheduled on the electrical drawings shall take precedence in the case of a conflict between the mechanical and electrical drawings or general conditions 2.1 A., above.
- C. Work under Division 23 includes coordinating the electrical requirements of all mechanical equipment with the requirements of the work under Division 26, before ordering the equipment.
  - 1. If motor horsepowers are changed under the work of Division 23, without a change in duty of the motor's driven device, coordination of additional electrical work (if any) and additional payment for the work (if any) shall be provided under the section of Division 23 initiating the change. Increases or decreases in motor horsepower from that specified shall not be made without written approval from the Architect.

### PART 3 - EXECUTION - Not used.

END OF SECTION 230100

**SECTION 230500 - COMMON WORK RESULTS FOR HVAC**

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of Piping Specialties Work required by this section is indicated on drawings and schedules and by requirements of this section.
- B. Types of Piping Specialties specified in this section include the following:
  - 1. Escutcheons
  - 2. Mechanical Sleeve Seal
  - 3. Fire and Smoke Barrier Penetration Seal
  - 4. Drip Pan
  - 5. Pipe Sleeve
  - 6. Sleeve Seals
- C. Piping Specialties furnished as part of factory-fabricated equipment, are specified as part of equipment assembly in other Division 23 sections.

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of piping specialties of types and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. Codes and Standards:
  - 1. ASME B 31.9 "Building Services Piping" for materials, products, and installation.
  - 2. Safety valves and pressure vessels shall bear the appropriate ASME label.
  - 3. Fabricate and stamp air separators and compression tanks to comply with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.
  - 4. ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualification" for qualifications for welding processes and operators.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including installation instructions, and dimensioned drawings for each type of manufactured piping specialty. Submit schedule showing manufacturer's figure number, size, location, and features for each required piping specialty.
- B. Shop Drawings: Submit for fabricated specialties, indicating details of fabrication, materials, and method of support.
- C. Maintenance Data: Submit maintenance data and spare parts lists for each type of manufactured piping specialty. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Divisions 23.

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## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
  - 1. Pipe Escutcheons:
    - a. Chicago Specialty Mfg. Co.
    - b. Producers Specialty & Mfg. Corp.
    - c. Sanitary-Dash Mfg. Co.
  - 2. Mechanical Sleeve Seal:
    - a. Thunderline Corp.
    - b. "Metraseal" by Metraflex Co.
  - 3. Fire and Smoke Barrier Penetration Seal:
    - a. Electrical Products Division/3M
    - b. Dow Corning
    - c. Flame Stop, Inc.
    - d. MetaCaulk
    - e. Hilti

### 2.2 PIPE ESCUTCHEONS

- A. General: Provide pipe escutcheons as specified herein with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or ceilings; and pipe sleeve extension, if any. Furnish pipe escutcheons with nickel or chrome finish for occupied areas, prime paint finish for unoccupied areas.
- B. Pipe Escutcheons for Moist Areas: For waterproof floors, and areas where water and condensation can be expected to accumulate, provide cast brass or sheet brass escutcheons, solid or split hinged.
- C. Pipe Escutcheons for Dry Areas: Provide sheet steel escutcheons, solid or split hinged.

### 2.3 MECHANICAL SLEEVE SEALS

- A. General: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

### 2.4 FIRE AND SMOKE BARRIER PENETRATION SEALS

- A. General: Provide UL Listed firestopping systems composed of components that are compatible with each other, the substrates forming openings, and the items, if any, penetrating the firestopping under conditions of service and application, as demonstrated by the firestopping manufacturer based on testing and field experience.

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

- B. Provide components for each firestopping system that are needed to install fill material. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.
- C. Penetrations in Fire Resistive Rated Walls: Provide firestopping with ratings determined in accordance with UL 1479 or ASTM E 814.
  - 1. F-Rating: Not less than the fire-resistance rating of the wall construction being penetrated.
- D. Penetration in Horizontal Assemblies: Provide firestopping with ratings determined in accordance with UL 1479 or ASTM E 814.
  - 1. F-Rating: Minimum of 1-hour rating, but not less than the fire-resistance rating of the floor construction being penetrated.
  - 2. T-Rating: When penetrant is located outside of a wall cavity, minimum of 1-hour rating, but not less than the fire-resistance rating of the floor construction being penetrated.
  - 3. W-Rating: Class 1 rating in accordance with water leakage test per UL 1479.
- E. Penetrations in Smoke Barriers: Provide firestopping with ratings determined in accordance with UL1479 or ASTM E 814.
  - 1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at both ambient and elevated temperatures.

### 2.5 FABRICATED PIPING SPECIALTIES

- A. Pipe Sleeves: Provide pipe sleeves of one (1) of the following:
  - 1. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate from the following gauges: 3-inch and smaller, 20 gauge; 4-inch to 6-inch, 16 gauge; over 6-inch, 14 gauge.
  - 2. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe; remove burrs.
  - 3. Iron Pipe: Fabricate from cast iron or ductile iron pipe; remove burrs.
- B. Sleeve Seals: Provide sleeve seals for sleeves located in foundation walls below grade, or in exterior walls, of one (1) of the following:
  - 1. Mechanical Sleeve Seals: Installed between sleeve and pipe.

## PART 3 - EXECUTION

### 3.1 INSTALLATION OF PIPING SPECIALTIES

- A. Pipe Escutcheons: Install pipe escutcheons on each pipe penetration through floors, walls, partitions, and ceilings where penetration is exposed to view; and on exterior of building. Secure escutcheon to pipe or insulation so escutcheon covers penetration hole, and is flush with adjoining surface.
- B. Mechanical Sleeve Seals: Loosely assemble rubber links around pipe with bolts and pressure plates located under each bolt head and nut. Push into sleeve and center. Tighten bolts until links have expanded to form watertight seal.



## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

- C. Fire or Fire/Smoke Barrier Penetration Seals: Where pipe penetration occurs in fire or fire/smoke rated walls, provide a complete listed protection assembly equal to the rating of the wall/floor.
- D. Provide dielectric waterways or insulating flanges, as required by pipe size, on all connections of dissimilar metals.

### 3.2 SLEEVES AND SEALS

- A. Pipes:
  - 1. Pipes:
    - a. New Construction: Pipes penetrating concrete or masonry construction, whether insulated or not, shall be provided with sheet metal or pipe sleeves fitted into place at time of construction. In poured concrete, the sleeves shall be steel pipe with a full circle, continuously welded water stop plate to also act as a sleeve anchor. When installing Link-Seal the sleeve and Link-Seal shall be of matched sizes. Otherwise, sleeves shall be of such size to provide all around clearance of 1/4-inch to 1-inch. Seal entire space between pipe and sleeve with fire stopping as specified in "Seals".
    - b. Existing Construction: For existing construction or masonry construction, prepare pipe opening by carefully cutting or core drilling, install sheet metal sleeve, and fill any open space with material assembly equal to the listing of the wall. Cutting of concrete or masonry shall be done after approval of Structural Engineer.
    - c. Sleeves in non-fire rated or non-bearing walls, floors or ceilings, new or existing construction, shall be steel pipe or galvanized sheet metal with lock-type longitudinal seam. Pack all open spaces on each end with mineral wool or other non-combustible material, positively fastened in place. Asbestos is not acceptable.
    - d. Where a pipe of any description passes through a concrete floor, the sleeve shall extend at least 2-inch above the finished floor, except when using the ProSet Systems.
    - e. At Contractor's option, where uninsulated pipes penetrate cast-in-place concrete floors, the "ProSet Systems," Atlanta, Georgia, sleeving may be employed.
    - f. For pipes penetrating foundation walls, water-proofing membrane floors or other places where water leakage could be encountered, install Link-Seal wall sleeves by Thunderline Corporation in manner recommended by the manufacturer.

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- B. Where pipe penetrations occur in non-fire rated floors, roof slabs, or walls, the space between pipe insert and the sleeve shall be packed on each end with mineral wool or other non-combustible material, positively fastened in place. Use plenum rated caulk to seal packing around pipe.
- C. Seals:
  - 1. General:

Seal all holes or voids where mechanical systems penetrate fire rated floors and walls with a fire stopping sealant having a fire rating equal to or greater than that of the construction being penetrated. The sealant shall meet the requirements of ASTM E-814, ASTM E-119 and UL-1479. It shall be installed with strict adherence to the manufacturer's instructions and according to the product's UL Laboratory listing. The use of asbestos in any form is not permitted.
  - 2. Conduct tests according to manufacturer's written recommendations to verify that substrates are free of oil, grease, rolling compounds, incompatible primers, loose mill scale, dirt and other foreign substances capable of impairing bond of firestopping.
  - 3. Do not cover firestopping with other construction until approval of authority having jurisdiction has been received.
- D. Escutcheons:
  - 1. In finished parts of the building, after painting is completed, install chromium plated escutcheons on all pipes passing through walls and floors where piping is exposed to view.
- E. Flash and counterflash where mechanical equipment passes through weather or water-proofed walls, floors, and roofs per roof manufacturer's instructions.

### 3.3 INSTALLATION OF FABRICATED PIPING SPECIALTIES

- A. Pipe Sleeves: Install pipe sleeves of types indicated where piping passes through walls, floors, ceilings, and roofs. Do not install sleeves through structural members of work, except as detailed on drawings, or as reviewed by Architect/Engineer. Install sleeves accurately centered on pipe runs. Size sleeves so that piping and insert will have free movement in sleeve, including allowance for thermal expansion; but not less than two (2) pipe sizes larger than piping run. Install length of sleeve equal to thickness of construction penetrated, and finish flush to surface; except floor sleeves. Extend floor sleeves 4-inch above finished floor in all Mechanical Equipment Rooms and pipe chases. Provide temporary support of sleeves during placement of concrete and other work around sleeves, and provide temporary closure to prevent concrete and other materials from entering sleeves.
  - 1. Install sheet metal sleeves at interior partitions and ceilings other than suspended ceilings.
  - 2. Install iron pipe sleeves at exterior penetrations; both above and below grade.
  - 3. Install steel pipe sleeves except as otherwise indicated.

END OF SECTION 230500

**SECTION 230513 – MECH/ELEC REQUIREMENTS FOR MECHANICAL EQUIPMENT**

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. This Section specifies the basic requirements for Electrical Components for Mechanical Equipment. These components include, but are not limited to, motors, starters, and disconnect switches for mechanical equipment.
- B. Wiring of field-mounted switches and similar mechanical-electrical devices provided for mechanical systems, to equipment control panels.
- C. Specific electrical requirements (i.e. horsepower and electrical characteristics) for mechanical equipment are scheduled on the Electrical Drawings. In case of conflict, Electrical Drawings shall take precedence. Do not purchase motors or electrical equipment until power characteristics available at building site location have been confirmed by Contractor.
- D. Refer to Table in Section 230100 for Mechanical/Electrical Coordination.

1.2 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of motors, motor starters and drives of types, ratings and characteristics required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. Installer's Qualifications: Firm with at least three (3) years of successful installation experience on projects utilizing electric motors, motor starters, capacitors and drives similar to that required for this project.
- C. NFPA Compliance: Comply with applicable requirements of NFPA 70E, "Standard for Electrical Safety Requirements for Employee Workplaces."
- D. UL Compliance: Provide equipment and/or components which are UL-listed and labeled.
- E. Standards:
  - 1. NEMA Standards MG 1: Motors and Generators.
  - 2. NEMA Standard ICS 2: Industrial Control Devices, Controllers, and Assemblies.
  - 3. NEMA Standard 250: Enclosures for Electrical Equipment.
  - 4. NEMA Standard KS 1: Enclosed Switches.
  - 5. Comply with National Electrical Code (NFPA 70).
- F. Coordination with Electrical Work: Wherever possible, match elements of electrical provisions of Mechanical Work with similar elements of Electrical Work specified in Division 26 sections. Comply with applicable requirements of Division 26 sections for Electrical Work of this section which are not otherwise specified.

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### 1.3 SUBMITTALS

- A. Listing, Motors of Mechanical Work: Concurrently, with submittal of mechanical products listing, submit separate listing showing rating, power characteristics, efficiencies, power factors, application and general location of every motor to be provided with mechanical work. Submit updated information promptly when and if initial data is revised.
  - 1. Include in listing of motors, notations of whether motor starter is furnished or installed integrally with motor or equipment containing motor.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Subject to compliance with requirements, provide products by one of the following manufacturers for each type of product:
  - 1. Motors:
    - a. Century/MagneTek
    - b. Baldor
    - c. U.S. Motor
    - d. Reliance
    - e. Siemens-Allis
    - f. General Electric
    - g. Louis Allis

### 2.2 MOTORS

- A. The following are basic requirements for simple or common motors. For special motors, more detailed and specific requirements are specified in the individual equipment specifications.
  - 1. Torque characteristics shall be sufficient to satisfactorily accelerate the driven loads with a time limit acceptable to the motor manufacturer. Motors shall be capable of starting the driven equipment while operating at 90 percent rated terminal voltage.
  - 2. Motor sizes shall be large enough so that the driven load will not require the motor to operate in the service factor range.
  - 3. Temperature Rating: Rated for 40 degree C environment with maximum 80 degree C temperature rise for continuous duty at full load (Class B Insulation). Provide Class F insulation for variable frequency drive motors.
  - 4. Starting Capability: Frequency of starts as indicated by automatic control system, and not less than five (5) evenly time spaced starts per hour for manually controlled motors.
  - 5. Service Factor: 1.15 for poly-phase motors and 1.35 for single-phase motors.
  - 6. Motor Construction: NEMA Standard MG 1, general purpose, continuous duty, Design "B", except "C" where required for high starting torque. Design "E" shall not be used.
    - a. Frames: NEMA Standard No. 48 or 54; Use driven equipment manufacturer's standards to suit specific application.
    - b. Bearings:
      - 1) Ball bearings with inner and outer shaft seals.
      - 2) Re-greasable, except permanently sealed where motor is normally inaccessible for regular maintenance.

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- 3) Bearings shall be rated for minimum L-10 life of 40,000 hours.
- 4) Designed to resist thrust loading where belt drives or other drives produce lateral or axial thrust in motor.
- 5) For fractional horsepower, light duty motors, sleeve type bearings are permitted.
- c. Enclosure Type:
  - 1) Open drip-proof motors for indoor use where satisfactorily housed or remotely located during operation.
  - 2) Guarded drip-proof motors where exposed to contact by employees or building occupants.
  - 3) Weather protected Type I for outdoor use; Type II where not housed.
- d. Noise Rating: "Quiet".
- e. Efficiency: "Energy Efficient" motors shall have a minimum efficiency as scheduled in Table 1 in accordance with IEEE Standard 112, Test Method B. If efficiency not specified, motors shall have a higher efficiency than "average standard industry motors", in accordance with IEEE Standard 112, Test Method B.

TABLE 1*				
HP	3600 RPM EFFICIENCY	1800 RPM EFFICIENCY	1200 RPM* EFFICIENCY	MINIMUM POWER FACTOR
1-1/2	82.5	84.0	84.0	85.0
2	82.5	84.0	86.5	85.0
3	84.0	86.5	87.5	85.0
5	85.5	89.5	87.5	85.0
7-1/2	86.5	91.0	89.5	85.0
10	87.5	91.0	90.2	85.0
15	89.5	91.7	91.0	85.0
20	90.2	92.0	91.7	85.0
25	90.2	92.5	92.4	85.0
30	91.7	92.6	92.4	85.0
40	92.4	93.1	93.0	85.0
50	93.0	93.4	93.6	85.0
60	93.0	94.0	93.6	85.0
75	93.0	94.1	93.6	85.0
100	93.0	94.7	94.1	85.0
125	93.0	94.7	94.1	85.0
150	--	95.0	95.8	85.0
200	--	95.4	95.4	85.0

TABLE 1*				
HP	3600 RPM EFFICIENCY	1800 RPM EFFICIENCY	1200 RPM* EFFICIENCY	MINIMUM POWER FACTOR
* Efficiency and power factors may vary from above values for multi-speed motors and/or special hermetic motors packaged with equipment. For these special applications, motors shall be high-efficiency type and are subject to review by the Engineer.				

- f. Nameplate: Indicate the full identification of manufacturer, ratings, characteristics, construction, special features and similar information.
- 7. Phases and Current Characteristics: Unless indicated otherwise, provide squirrel-cage induction polyphase motors for 3/4 HP and larger, and provide capacitor-start single-phase motors for 1/2 HP and smaller, except 1/6 HP and smaller may, at equipment manufacturer's option, be split-phase type. Coordinate current characteristics with power specified in Division 26 sections. Do not purchase motors until power characteristics available at building site have been confirmed by Contractor.
- 8. The Contractor shall be responsible for all additional electrical and other costs involved to accommodate any motors which differ from the scheduled horsepower sizes or correct any motor which does not meet the listed duty or efficiency as called for in Mechanical or Electrical Plans and Specifications.
- 9. Motors shall be of the same manufacturer, except those that are an integral part of a factory assembled packaged unit. These motors shall likewise meet the conditions of the specification in this section except motors which are part of a motor/compressor assembly are exempted from this requirement.
- 10. All motors 75 HP and larger shall be factory test certified for power factor, efficiency, and shall have a three (3) year warranty. Factory certification of motor tests shall be provided to the Owner.
- 11. All equipment specified to operate with Variable Frequency Drives shall be provided with inverter-duty motors specifically designed for variable speed operation with high efficiency at part load conditions and constructed with Class F insulation.
- 12. All motors which will be operated by a Variable Frequency Drive shall be warranted against any damage or defects as a result of being used with a variable frequency drive. VFD driven motors shall have three (3) year warranties.

2.3 MOTOR ACCESSORIES

- A. Shaft Grounding Kits: Provide shaft grounding kits for motors that operate on a VFD, and are rated at 10 HP and above.

2.4 STARTERS

- A. Motor Starters: Refer to Section 230514.

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### 2.5 DISCONNECT SWITCHES

- A. See Division 26 for requirements.

### 2.6 DRIVES

- A. V-Belt Drives:
  1. Capacity of V-Belt Drives at rated RPM shall be not less than 150 percent of motor nameplate horsepower rating.
  2. V-Belt Drive combinations shall be limited to A, B, C and fractional horsepower belts. 3V, 5V and 8V belts and sheaves shall not be used.
  3. All fixed pitch sheaves, including single groove fan sheaves, shall be of the bushed type. Fixed bore sheaves will not be acceptable for adjustable pitch sheaves.
  4. Unit manufacturer shall provide OSHA approved belt guard with tachometer holes.

### 2.7 VARIABLE FREQUENCY DRIVES

- A. Refer to Section 230515.

### 2.8 EQUIPMENT FABRICATION

- A. General: Fabricate mechanical equipment for secure mounting of motors and other electrical items included in work. Provide either permanent alignment of motors with equipment, or adjustable mountings as applicable for belt drives, special couplings and similar indirect coupling of equipment. Provide safe, secure, durable, and removable guards for motor drives, arranged for lubrication and similar running-maintenance without removal of guards.

## PART 3 - EXECUTION

### 3.1 TEST AND TEST DATA

- A. A factory load test shall be performed on each motor of 1,000 watt input or greater to assure compliance with the energy-efficiency section of this specification.
- B. Typical test data on every motor to be used on this project shall be made available upon request.

### 3.2 INSTALLATION

- A. Install motors on motor mounting systems in accordance with motor manufacturer's instructions, securely anchored to resist torque, drive thrusts, and other external forces inherent in mechanical work. Secure sheaves and other drive units to motor shafts with keys and Allen set screws, except motors of 1/3 HP and less may be secured with Allen set screws on flat surface of shaft. Unless otherwise indicated, set motor shafts parallel with machine shafts.
- B. Deliver starters and wiring devices which have not been factory-installed on equipment unit to electrical installer for installation.

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- C. Install power and control connections for motors to comply with NEC and applicable provisions of Division 26 sections. Install grounding except where non-grounded isolation of motor is indicated.

### 3.3 INSTALLATION COORDINATION

- A. Furnish equipment requiring electrical connections to operate properly and to deliver full capacity at electrical service available.
- B. All control wiring to be in accordance with manufacturer's recommendations, and shall be color-coded and individually numbered to facilitate checking.
- C. Unless otherwise indicated, all mechanical equipment motors and controls shall be furnished, set in place, and wired in accordance with the schedule contained in Division 23. The exact furnishing and installation of the equipment is left to the Contractors involved. Contractor should note that the intent of the schedule is to have the Division 23 and 26 Contractors responsible for coordinating all control wiring as outlined, whether or not specifically called for by the Mechanical or Electrical Drawings and Specifications. Comply with the applicable requirements of Division 26 for all electrical work which is not otherwise specified. No extras will be allowed for Contractor's failure to provide for these required items. The Contractor shall refer to the Division 26 and Division 23 specifications and plans for all power and control wiring and shall advise the Architect/Engineer of any discrepancies prior to bidding.

END OF SECTION 230513



**SECTION 230514 - MOTOR CONTROLLERS**

PART 1 - GENERAL

1.1 SUMMARY

- A. Manual Motor Starters
- B. Single Phase Motor Starters
- C. Magnetic Motor Starters
- D. Combination Magnetic Motor Starters
- E. Reduced Voltage Starters

1.2 RELATED DOCUMENTS

- A. Drawings, General and Special Conditions, Division 1 - General Requirements and other applicable technical specifications apply to work of this section.

1.3 RELATED SECTIONS

- A. Division 26 - Electrical: All Sections.
- B. Section 230513 – Mechanical/Electrical Requirements for Mechanical Equipment.

1.4 REFERENCE STANDARDS

- A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents. A listing of applicable reference standards is contained in Division 1.
- B. ANSI/NFPA – 70, National Electrical Code
- C. ANSI/NEMA ICS 6 – 1993: Industrial Control and Systems: Enclosures.
- D. IEC 60947-5, 60947-4, 60947-3.
- E. NEMA AB 1 - Molded Case Circuit Breakers.
- F. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays.
- G. UL 508, and UL 508A Industrial Control Equipment.

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### 1.5 SUBMITTALS

- A. Submit under provisions of Division 1.
- B. Provide product data on motor starters and combination motor starters, relays, pilot devices, and switching and overcurrent protective devices.

### 1.6 OPERATION AND MAINTENANCE DATA

- A. Submit Operation and Maintenance Data under provisions of Division 1.
- B. Include spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of Division 1.
- B. Store and protect products under provisions of Division 23.

## PART 2 - PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. MOTOR STARTERS
  - 1. Allen-Bradley
  - 2. Cerus Industrial
  - 3. Cutler Hammer
  - 4. Square-D
  - 5. Siemens

### 2.2 MANUAL MOTOR STARTERS

- A. Manual Motor Starter: NEMA ICS 2; AC general-purpose Class A manually operated non-reversing full-voltage controller for induction motors rated in horsepower, with solid state electronic overload relay for each phase, phase loss protection, phase imbalance, ground fault protection, low-voltage protection, Red pilot light, field-convertible auxiliary contact, and toggle operator.
- B. Fractional Horsepower Manual Starter: NEMA ICS 2; AC general-purpose Class A manually operated, full-voltage controller for fractional horsepower induction motors, with thermal overload unit, Red pilot light, and key or toggle operator as indicated.
- C. Motor Starting Switch: NEMA ICS 2; AC general-purpose Class A manually operated pole, full-voltage controller for fractional horsepower induction motors, without thermal overload unit, Red pilot light, field convertible auxiliary contact, and toggle operator.

- D. Enclosure: ANSI/NEMA ICS 6; Type 1 for Indoor applications, and Type 3R for Outdoor applications.

### 2.3 SINGLE PHASE MOTOR STARTERS

- A. Single Phase Motor Starter Control: The single phase motor starter shall consist of a manually operated quick-make toggle mechanism lockable in the "Off" position which shall also function as the starter disconnect. Additionally, the starter shall provide thermal overload protection, run status pilot light and fault pilot light. The starter must include the capability to operate in both manual and automatic modes. In automatic modes, the starter shall have the capability to integrate with a building automation system by providing terminals for run input, run status, output and fault output. All control terminals shall be integrated in the starter. At a minimum, each single phase starter shall include an interposing run relay and current sensing status output relay. Single phase motor starter shall be in a surface mount enclosure with the appropriate environmental rating.

### 2.4 MAGNETIC MOTOR STARTERS

- A. Magnetic Motor Starters: NEMA ICS 2; AC general-purpose Class A, combination type magnetic controller as specified herein, for induction motors, rated in horsepower.
- B. Magnetic Motor Starters shall be circuit breaker or motor circuit protector combination type, with external operator, in common enclosure with starter. External circuit breaker operator environmental rating shall match the enclosure rating. Disconnecting means shall be equipped with provisions enabling locking in the "OFF" position.
- C. Full Voltage Starting: Reversing or non-reversing type as indicated.
- D. Two-Speed Starting: Two-speed, one- or two-winding, and variable torque or constant torque as required to match the motor and the driven load. All 2-speed motors with 2:1 ratio shall be single-winding type (Refer to Section 230513); all other 2-speed motors shall be two-winding type. Division under which motor starters will be supplied is responsible for verifying motor winding configuration so as to assure proper motor starter selection. Provide 2-speed/reversing starter, with reversing contactor for low speed operation only, where indicated. Include integral time delay transition between FAST and SLOW speeds, and between FORWARD and REVERSE rotation, as applicable. Starters for motors rated 25 horsepower, or larger shall include controls forcing low-speed start followed by transition to high speed, irrespective of concurrent control systems demand for high-speed operation.
- E. Coil Operating Voltage: Unless otherwise specified, 120 volts, 60 hertz.
- F. Size: NEMA ICS 2; Size as shown on Drawings, or as required for the motor horsepower.
- G. Overload Relay: NEMA ICS 2; self-powered, adjustable trip solid state electronic overload relay type, which protects all 3 phases with selectable trip class operation. Motor protection functions shall include: phase loss, phase unbalance, ground fault, locked rotor and stall protection.

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- H. Enclosure: NEMA ICS 6; Type 1 for Indoor applications, and Type 3R for Outdoor applications.
- I. Auxiliary Contacts: NEMA ICS 2; two (2) field-convertible contacts, (1) NO and (1) NC, in addition to seal-in contact.
- J. Selector Switches: NEMA ICS 2; HAND/OFF/AUTO, maintained type, in front cover.
- K. Provide manual reset push button on the starter cover to restore normal operation after a trip or fault condition. Pushbuttons: NEMA ICS 2; START/STOP in front cover.
- L. Indicating Lights: NEMA ICS 2; RUN: Red LED type, in front cover with press-to-test lamp testing feature.
- M. Relays: NEMA ICS 2; as required.
- N. For 480-Volt applications, an individually fused 480-120 Volt control transformer shall be furnished with each combination starter. The Control Transformer shall be sized by the manufacturer to have a minimum of 20 percent capacity in excess of the continuous volt-ampere requirements of the holding coil, indicating lights and any externally located devices such as solenoid valves, external relays, etc. The control transformer shall be capable of operation with an inrush current twenty (20) percent greater than required by the holding coil, indicating lights and external-device, if any.
- O. When remotely controlled by an automation system, the starter shall include remote run terminals which accept both a voltage input signal and a contact closure. The voltage run input shall accept both AC and DC signals including 24 VAC, 120 VAC, 24 VDC and 48 VDC to allow direct connection of the transistorized signal to the starter.
- P. In applications where the motor is interlocked with a damper or valve, the actuator control must reside within the starter enclosure. The starter must provide a voltage output to operate the actuator to open the damper or valve without closing the motor circuit. The starter will only close the motor circuit and the start the motor after it has received a contact closure from a limit or end switch confirming the damper or valve position.
- Q. The starter shall provide a provision for Fireman's Override operation. When activated, the starter runs the motor in any mode (Hand, Off or Auto) regardless of other inputs or lack of inputs either manual or automatic. The purpose of the Fireman's Override input is to act as a smoke purge function. Fireman's Override has priority over the Emergency Shutdown input.
- R. If the starter is controlled by a fire alarm or life safety system, the starter shall include an Emergency Shutdown input which will disable the starter from operating in either Hand or Auto mode regardless of other inputs either manual or automatic.
- S. Acceptable disconnecting means for combination starters include: motor circuit protectors, UL 489 circuit breakers, or a fused disconnect. All disconnects shall include a lock-out mechanism when in the off position.
- T. The Motor Circuit protector shall be a UL listed 508 current limiting manual motor starter with magnetic trip elements only. The breaker shall carry a UL 508 rating (up to 100A frame size)

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which provides for coordinated short circuit rating for use with motor contactor and provides a minimum interrupting rating of 30,000 AIC for the combination starter.

- U. Fused disconnect shall be UL 98 suitable for service entrance protection. It shall accommodate time delay J-style fuses.
- V. UL 489 breaker shall include thermal and magnetic trip mechanisms.
- W. Provide optional features, as required, to meet design performance according to the following requirements.
  1. Must provide over/under voltage phase monitoring capability. Monitor shall be field adjustable for both over and under voltage levels and a delay time before returning to normal operation after trip.
  2. Starter must measure and display output current on the front cover. If necessary, install digital or analog ammeter.
  3. The starter shall provide the capability to monitor and calculate power consumption (kWh) of the motor load. Each starter shall display the calculated kW and kWh. Additionally, provide either a pulse output (kWh) or 4-20 mA analog signal (kW) to the automation system to monitor the power consumption.
  4. Starter must be capable of communicating over BACnet MS/TP. At a minimum, reported points shall include starter mode, terminal input status, voltage, current, power factor, kW and kWh.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install motor control equipment in accordance with manufacturer's instructions.
- B. Select and adjust electronic overloads to match installed motor characteristics.
- C. Motor Data: Provide neatly typed label inside each motor starter enclosure door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.
- D. Floor mounted equipment shall be on a 4-inch concrete housekeeping pad.
- E. Provide Nameplates per Division 26.

END OF SECTION 230514

**SECTION 230515 - VARIABLE FREQUENCY CONTROLLERS**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Variable Frequency Drives (VFDs)

1.2 RELATED DOCUMENTS

- A. Drawings, General and Special Conditions, General Requirements, and other applicable technical specifications apply to work of this section.

1.3 RELATED SECTIONS

- A. Division 26 – Electrical; All Sections
- B. Section 230513 - Mechanical/Electrical Requirements for Mechanical Equipment
- C. Section 230514 – Motor Controllers

1.4 REFERENCE STANDARDS

- A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents.
- B. NFPA 70 - National Electrical Code.
- C. ANSI/NEMA ICS 6 - Enclosures for Industrial Controls and Systems.
- D. NEMA AB 1 – Molded Case Circuit Breakers.
- E. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies.
- F. NEMA ICS 3.1 - Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems.
- G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- H. ANSI/UL Standard 508.
- I. IEEE Standard 519-1992; For Voltage and Total Demand Distortion.
- J. FCC Rules and Regulations, Part 15, Subpart J; For Radiated RFI.

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### 1.5 SUBMITTALS

- A. Submit under provisions of Division 1.
- B. Shop Drawings: Include front and side views of enclosures with overall dimensions and weights shown; conduit entrance locations and requirements; and nameplate legends.
- C. Product Data: Provide catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.
- D. Test Reports: Indicate field test and inspection procedures and test results.
- E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- F. Manufacturer's Field Reports: Submit under provisions of Division 1.
- G. Manufacturer's Field Reports: Indicate Start-Up Inspection findings.

### 1.6 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Division 1.
- B. Operation Data: Include instructions for starting and operating controllers, and describe operating limits that may result in hazardous or unsafe conditions.
- C. Maintenance Data: Include routine preventive maintenance schedule.

### 1.7 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc., and conforming to referenced standards as suitable for purpose specified and indicated.

### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of Division 1.
- B. Store, protect, and handle products under provisions of Division 23.
- C. Accept controllers on site in original packing. Inspect for damage.
- D. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

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- E. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to components, enclosure, and finish.

### 1.9 FIELD MEASUREMENTS

- A. Verify that field measurements are as on Shop Drawings.

### 1.10 MAINTENANCE SERVICE

- A. Furnish service and maintenance of controller for two (2) years from Date of Substantial Completion.

### 1.11 EXTRA MATERIALS

- A. Provide two (2) of each air filter.
- B. Provide three (3) of each fuse size and type.

## PART 2 - PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. All VFDs provided for this project shall be of a single manufacturer.
- B. Approved Manufacturers:
  1. Asea Brown Boveri (ABB)
  2. Robicon
  3. Danfoss Graham
  4. Toshiba
  5. Cutler-Hammer
  6. Honeywell
  7. Johnson Controls

### 2.2 GENERAL

- A. The VFD shall convert incoming 3-phase 60 Hz AC power to a variable frequency, variable voltage AC output suitable for control of a standard NEMA Design B induction motor over a 10:1 speed range.
- B. The VFD shall consist of a 3-phase full-wave converter section to rectify the incoming AC source, a filtered DC bus section, and a sinusoidal PWM output section utilizing IGBT type output transistors, and utilizing sensorless torque vector control logic, as specified below.
- C. The VFD shall maintain a near unity power factor regardless of speed or load (0.95 or better for drives larger than 5 HP).



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- D. Inverter section shall utilize insulated gate bipolar transistors (IGBTs) with a minimum rating of 1200 VDC, and have an adjustable carrier frequency range of 1 to 6 kHz through 100 HP, and 1 to 3 kHz above 100 HP.
- E. The VFD and options shall be tested to ANSI/UL Standard 508 and listed by either UL or ETL.
- F. Power line noise shall be limited to a 5% voltage distortion factor and total demand distortion factor (TDD) as defined in IEEE Standard 519-1992, Guide for Harmonic Control and Reactive Compensation of Static Power Converters. Submittal data shall include calculations to show TDD based on available short circuit current. The point of common coupling (PCC) shall be at the power wiring immediately downstream of the Building Transformer.
- G. The VFD torque characteristic shall match the driven load.
- H. Input Power: 480 Volt, 3-phase, 60 Hz. in Roaring Fork Dining Hall, 208 Volt, 3-phase, 60 Hz in student housing buildings.
- I. The VFD shall include an integral disconnect to isolate the VFD from input power.
- J. Voltage Tolerance:  $\pm 10\%$ ; Frequency tolerance  $\pm 3\%$ .
- K. The VFD output shall be rated for continuous duty with full load amp ratings that meet or exceed NEC Table 430-150. The VFD shall have overload capability of 110 percent rated current for 60 seconds. Output voltage range shall not exceed input rated voltage.
- L. Ambient Operating Conditions: Temperature, 0-40 degrees C; Relative Humidity, 0-95 percent, non-condensing, 5600 feet elevation, without deration.
- M. All printed circuit boards and power subassemblies shall be burned in at elevated temperature (50 degrees C minimum) for forty-eight (48) hours minimum. The completed, assembled VFD shall be functionally tested under motor load before shipment to ensure proper operation. The manufacturer shall provide certification that these tests have been completed.

### 2.3 BASIC FEATURES

- A. Control power transformer with fused primary and 24V or 120V fused secondary.
- B. VFD AC line input high-speed semi-conductor type current-limiting fuses rated 200,000 AIC minimum.
- C. Operator Controls:
  - 1. "HAND-OFF-AUTO" Selector Switch. In "AUTO" position, drive starts and stops motor from remote contact closure, and motor speed shall be proportional to a remote speed control signal. In "HAND" position, motor is started and stopped from VFD Keypad/Display Module, and the motor speed shall be as set through the VFD Keypad/Display Module.
  - 2. Pilot Lights: LED Type. 22.5mm IEC Style, Red "VFD On", White "Control Power On", and Amber "VFD Fault".
- D. Keypad/Display Module:

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1. A multi-line alpha-numeric backlit display capable of displaying at minimum motor speed (Hz), motor current (A), motor voltage (V), elapsed time meter (Hrs.), inverter load (%) and all drive programming parameters.
  2. Keypad to enable starting and stopping, and manual speed adjustment when the selector switch is in "HAND" position.
- E. Programmable Relay Outputs (three minimum) capable of indicating the following:
1. VFD in Run Mode
  2. VFD at Zero Speed
  3. VFD Fault
- F. Terminals for field-installed external safeties.
- G. Field-selectable Auto Restart on power source failure.
- H. Adjustable voltage boost for starting high torque loads.
- I. Drive shall be capable of starting into a spinning motor by matching frequency and phase angle to the motor back EMF.
- J. Critical Speed Avoidance: Drive shall allow the User to avoid operation at resonant speeds. Selected speeds shall be stepped over. Four (4) critical speeds shall be capable of being avoided, with an adjustable bandwidth for each critical speed.
- K. Signal Follower: In Auto Speed mode, motor speed shall be proportional to an external 4-20 ma speed control signal. Verify with Control Contractor whether the control signal is 4-20 ma. Provide control signal consistent throughout the facility. Loss of reference signal shall cause drive to go to programmable preset speed.

### 2.4 INPUT POWER HARMONIC REDUCTION

- A. All VFDs of 3 HP and larger shall have as a minimum; positive and negative DC link reactors, or AC line input reactors to reduce input power harmonics. If the total harmonics exceed that allowed as defined in paragraph 2.2-F, above, at the PCC; provided additional AC line input reactors, input isolation transformers, or line input filters as required to meet the provisions paragraph 2.2-F.

### 2.5 MOTOR PROTECTION

- A. For all installations where the conductors from the VFD to the motor exceed 100 feet in length, provide a minimum 3 percent reactance motor protecting dv/dt filter at the VFD output terminals.

### 2.6 ADJUSTMENTS

- A. Acceleration Time: 2 to 20 Second minimum range.
- B. Deceleration Time: 2 to 20 Second minimum range.

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- C. Volts/Hz Ratio: Programmable.
- D. Voltage Boost: Programmable.
- E. Critical Speed Lockout: Four (4) critical speeds with adjustable bandwidth.
- F. Current Limit: 30 to 110 percent sine wave current rating.
- G. Carrier Frequency Range: 1 to 6 kHz through 100 HP and 1 to 3 kHz above 100 HP.
- H. Output Frequency Range: 0 to 80 Hz minimum range.
- I. All drive parameters shall be stored in non-volatile memory (EEPROM).

### 2.7 PROTECTIVE FEATURES

- A. VFD shall have built-in protection for power source transients, over-voltage, under-voltage, and phase loss. VFD shall not require an input isolation transformer for transient protection.
- B. DC bus over-voltage protection.
- C. Instantaneous shutdown when load current exceeds 150 percent.
- D. Adjustable electronic Class 20 inverse time characteristic over-current overload protection for the motor.
- E. The VFD shall be capable of withstanding randomly applied short circuit current applied across the output terminals without damage.
- F. Protection of VFD for any external disconnects between the drive and the motor. Provide control terminals for connection of disconnect switch auxiliary contacts, which will immediately stop the drive when opened.
- G. DC bus discharge circuit for protection of service personnel, with "BUS CHARGED" indicator.
- H. Troubleshooting Diagnostic Features:
  - 1. Indicator lights on inverter power module to indicate correct operation (or failure) of individual power switching devices.
  - 2. Indicator lights to show drive fault/ready states, and reason for fault shutdown, including: Instantaneous overload, motor overload, output or DC bus over-voltage, or source over-voltage, under-voltage, or phase loss. The VFD shall store in memory at minimum the previous five (5) alarms.

### 2.8 FABRICATION

- A. Wiring Terminations: Match conductor materials and sizes indicated.
- B. Enclosure:
  - 1. For Dry, Indoor Applications: NEMA 250, Type 1.

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2. For Wet, Indoor, Temperature Controlled Applications, NEMA 250, Type 4, with ventilation provisions, or closed loop heat exchanger, as required for adequate VFD cooling. Any powered enclosure ventilation or heat exchanger shall be configured to operate from a single point of electrical connection, common with the VFD.
3. For Outdoor Applications: NEMA 250, Type 4, with NEMA 250, Type 3R rain shield. In addition, provide panel heaters, and/or panel closed loop heat exchanger or panel air conditioner as required to maintain the temperature within the VFD enclosure, within the allowable operating temperature range of the VFD. Any panel heaters and/or air conditioners shall be configured to operate from a single point of electrical connection, common with the VFD.

C. Finish: Manufacturer's standard enamel.

### 2.9 SOURCE QUALITY CONTROL

- A. Inspect and production-test each product specified in this section.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that surface is suitable for controller installation.
- B. Do not install controller until building environment can be maintained within the service conditions required by the manufacturer.

### 3.2 PREPARATION

- A. For floor-mounted VFDs, provide 4" concrete housekeeping pad.

### 3.3 INSTALLATION

- A. Install controller where indicated, in accordance with manufacturer's written instructions and NEMA ICS 3.1.
- B. Tighten accessible connections and mechanical fasteners after placing controller.
- C. Install fuses in fusible switches.
- D. Provide engraved plastic nameplates under the provisions of Division 26.
- E. Provide neatly typed label inside each motor controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.

### 3.4 FIELD QUALITY CONTROL

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- A. Inspect completed installation for physical damage, proper alignment, anchorage, and grounding.

### 3.5 START-UP SERVICE

- A. Provide minimum two (2) hours of start-up service for each VFD. Service shall be performed by factory-trained service technicians.
- B. Technician shall verify correct installation, start-up the drive, adjust all required operating parameters, and verify proper operation in all operating modes.
- C. Owner Training: Provide minimum eight (8) hours training in operation and trouble-shooting procedures for the installed drives.

### 3.6 ADJUSTING

- A. Make final adjustments to installed drive to assure proper operation of fan system. Obtain performance requirements from installer of driven loads.

### 3.7 CLEANING

- A. Touch up scratched or marred surfaces to match original finish.

### 3.8 DEMONSTRATION

- A. Provide systems demonstration under provisions of Division 26.
- B. Demonstrate operation of controllers in automatic and manual modes.

END OF SECTION 230515

**SECTION 230519 - METERS AND GAUGES**

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of Meters and Gauges required by this section is indicated on drawings and/or specified in other Division 23 sections.
- B. Types of Meters and Gauges specified in this section include the following:
  - 1. Temperature Gauges and Fittings:
    - a. Dial Type Insertion Thermometers
    - b. Thermometer Wells
    - c. Temperature Gauge Connector Plugs
  - 2. Pressure Gauges and Fittings:
    - a. Pressure Gauges
    - b. Pressure Gauge Cocks
    - c. Pressure Gauge Connector Plugs
  - 3. Flow Measuring Meters:
    - a. Venturi Tube Flow Measuring Elements
    - b. Calibrated Balancing Valves
    - c. Automatic Flow Control Valves
    - d. BTU Meters
    - e. Pitot Tube Flow Meters
- C. Meters and gauges furnished as part of factory-fabricated equipment are specified as part of equipment assembly in other Division 23 sections.

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of meters and gauges, of types and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. Codes and Standards:
  - 1. UL Compliance: Comply with applicable UL Standards pertaining to meters and gauges.
  - 2. ANSI and ISA Compliance: Comply with applicable portions of ANSI and Instrument Society of America (ISA) Standards pertaining to construction and installation of meters and gauges.
  - 3. Certification: Provide meters and gauges whose accuracies, under specified operating conditions, are certified by manufacturer.

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### 1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including installation instructions for each type of meter and gauge. Include scale range, ratings, and calibrated performance curves, certified where indicated. Submit meter and gauge schedule showing manufacturer's figure number, scale range, location, and accessories for each meter and gauge.
- B. All flow measuring devices to be provided shall be reviewed and approved by the Test and Balance Contractor and the Temperature Control Contractor for proper scale, rangeability and function prior to submitting shop drawings. The Test and Balance Contractor and Temperature Control Contractor shall provide a typed letter stating this review has been completed and included with shop drawing submittals.
- C. Maintenance Data: Submit maintenance data and spare parts lists for each type of meter and gauge. Include this data and product data in Maintenance Manual; in accordance with requirements of Division 1.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
  - 1. Dial Type Insertion Thermometers and Wells:
    - a. Marsh Instrument Co.; Unit of General Signal
    - b. Taylor Instrument Co.
    - c. Miljoco Corp.
    - d. Weiss Instruments, Inc.
    - e. Terice
  - 2. Temperature Gauge Connector Plugs:
    - a. Fairfax Company
    - b. Peterson Equipment Co.
    - c. Universal Lancaster
    - d. Sisco
    - e. MG Piping Products Co.
    - f. Terice
  - 3. Pressure Gauges:
    - a. Ametek/U.S. Gauge
    - b. Marsh Instrument Co.; Unit of General Signal
    - c. Marshalltown Instruments, Inc.
    - d. Miljoco Corp.
    - e. Weiss Instruments, Inc.
    - f. MG Piping Products Co.
    - g. Dwyer
    - h. Terice
  - 4. Pressure Gauge Connector Plugs:
    - a. Fairfax Company
    - b. Peterson Equipment Co.
    - c. Universal Lancaster

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- d. Sisco
- e. MG Piping Products Co.
- f. Miljoco Corp.
- g. Trerice
- 5. Venturi Tube Flow Measuring Elements:
  - a. Gerand
  - b. Barco/Aeroquip Corp.
  - c. Griswold
  - d. Preso
- 6. Calibrated Balancing Valves:
  - a. Bell & Gossett ITT; Fluid Handling Division
  - b. "Flowset" - Flow Design, Inc.
  - c. Thrush Products, Inc.
  - d. Tour and Anderson, Inc.
  - e. Gerand "Balvalve Indicator"
  - f. Griswold
  - g. Preso
- 7. Automatic Flow Control Valves:
  - a. Griswold
- 8. BTU Meters:
  - a. Onicon
  - b. Insta Energy Systems Corp.
- 9. Pitot Tube Flow Meters:
  - a. Dieterich Standard
  - b. Preso

### 2.2 DIAL TYPE INSERTION THERMOMETERS

- A. General: Provide dial type insertion thermometers of materials, capacities, and ranges indicated, designed and constructed for use in service indicated.
- B. Type: Bi-Metal, stainless steel case and stem, 1-inch diameter dial, dust and leak proof, 1/8-inch diameter stem with nominal length of 5-inch.
- C. Accuracy: 0.5 Percent of dial range.
- D. Range: Conform to the following:
  - 1. Hot Water: 0 Degree - 220 degree F (-20 degree - 110 degree C).
  - 2. Chilled Water: 25 Degree - 125 degree F (0 degree - 50 degree C).

### 2.3 THERMOMETER WELLS

- A. General: Provide thermometer wells constructed of brass or stainless steel, pressure rated to match piping system design pressure. Provide 2-inch extension for insulated piping. Provide cap nut with chain fastened permanently to thermometer well.

### 2.4 TEMPERATURE GAUGE CONNECTOR PLUGS



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- A. General: Provide temperature gauge connector plugs pressure rated for 500 PSI and 200 degree F (93 degree C). Construct of brass and finish in nickel-plate, equip with 1/2-inch NPS fitting, with self-sealing valve core type neoprene gasketed orifice suitable for inserting 1/8-inch O.D. probe assembly from dial type insertion thermometer. Equip orifice with gasketed screw cap and chain. Provide extension, length equal to insulation thickness, for insulated piping.

### 2.5 PRESSURE GAUGES

- A. General: Provide pressure gauges of materials, capacities, and ranges indicated, designed and constructed for use in service indicated.
- B. Type: General Use, 1 percent accuracy, ANSI B40.1 Grade A, phosphor bronze bourdon type, bottom connection.
- C. Case: Stainless steel, drawn steel, or brass, glass lens, 4-1/2 inch diameter.
- D. Connector: Brass with 1/4-inch male NPT. Provide protective syphon when used for steam service.
- E. Scale: White coated aluminum, with permanently etched markings.
- F. Range: Conform to the following:
  - 1. Vacuum: 30-Inch Hg - 15 PSI.
  - 2. Water: 0 - 100 PSI.
  - 3. Steam: 0 - 200 PSI.

### 2.6 PRESSURE GAUGE COCKS

- A. General: Provide pressure gauge cocks between pressure gauges and gauge tees on piping systems. Construct gauge cock of brass with 1/4-inch female NPT on each end, and "T" handle brass plug.
- B. Syphon: 1/4-Inch straight coil constructed of brass tubing with 1/4-inch male NPT on each end.
- C. Snubber: 1/4-Inch brass bushing with corrosion resistant porous metal disc, through which pressure fluid is filtered. Select disc material for fluid served and pressure rating.

### 2.7 PRESSURE GAUGE CONNECTOR PLUGS

- A. General: Provide pressure gauge connector plugs pressure rated for 500 PSI and 200 degree F (93 degree C). Construct of brass and finish in nickel-plate equip with 1/2-inch NPS fitting, with self-sealing valve core type neoprene gasketed orifice suitable for inserting 1/8-inch O.D. probe assembly from dial type insertion pressure gauge. Equip orifice with gasketed screw cap and chain. Provide extension, length equal to insulation thickness, for insulated piping.

### 2.8 VENTURI TUBE FLOW MEASURING ELEMENTS

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- A. Primary flow measuring elements shall consist of Venturi tubes. Arrange piping in accordance with manufacturer's published literature. In horizontal pipes, place connections slightly above horizontal centerline of pipe.
- B. Provide each primary element with integral tab, or metal tag on stainless steel wire, extending outside pipe covering on which is stamped or clearly printed in plainly visible position the following information:
  - 1. Manufacturer's name and address.
  - 2. Serial number of meter to which element is to be connected.
  - 3. Name, number, or location of equipment served.
  - 4. Specified rate of flow.
  - 5. Multiplier (including unity, where applicable) to be applied to meter reading.
- C. Provide taps with shutoff valves and quick connecting hose fittings for portable meters or double-ferrule compression fittings for connection to tubing for permanently located meters or recorders.
- D. Manufacturer shall certify Venturi tubes for actual piping configuration. Any necessary piping changes required for certification shall be provided without cost to Owner. Insert type tubes may be furnished, provided they meet specification requirements in other respects.
- E. Provide Venturi with throat diameter such that specified rate of flow will register scale reading of between 20 percent and 80 percent of full scale value.
- F. Venturi sizes and beta ratios shall be selected so that design flow rates shall read between 20 percent and the full scale range on a linear meter (e.g. between 10-inch and 50-inch on a 0-50-inch meter), with permanent pressure loss of not more than 25 percent of indicated flow rate differential pressure.
- G. Provide Venturi tubes of solid brass or bronze. Tubes larger than 2-inch shall have flanges or butt weld connections and may be cast iron or steel. Steel tubes may be fabricated or cast with cadmium or zinc-plating. Line throats of cast iron tubes with bronze and plate cast iron portion with cadmium.
- H. Tubes shall be calibrated and tested by independent testing laboratory and performance data furnished with shop drawings.
- I. Connections for attachment to portable flow meter hoses shall be readily accessible.
- J. Provide pressure differential transmitter with 4-20 milli-amp output signal for each Venturi where required by temperature control sequence. Foxboro Model #843 (complete with mounting hardware) or equal as reviewed by Engineer.

### 2.9 CALIBRATED BALANCING VALVES

- A. General: Provide as indicated, calibrated balance valves equipped with readout valves to facilitate connecting of differential pressure meter to balance valves. Equip each readout valve with integral EPT check valve designed to minimize system fluid loss during monitoring process. Provide calibrated nameplate to indicated degree of closure of precision machined orifice. Construct balancing valve with internal EPT O-ring seals to prevent leakage around

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rotating element. Provide balance valves with preformed polyurethane insulation suitable for use on heating and cooling systems, and to protect balance valves during shipment.

- B. Balancing Valve Manufacturer shall select valve sizes to provide meter readings between 7-inch and 25-inch w.g. at rated GPM.

### 2.10 AUTOMATIC FLOW CONTROL VALVES

- A. Automatic Flow Control Valves: Class 150, cast iron housing, stainless steel operating parts; threaded connections for 2-inch and smaller, flanged connections for 2-1/2 inch and larger. Factory set to automatically control flow rates within plus or minus 5 percent design, while compensating for system operating pressure differential. Provide quick disconnect valves for flow measuring equipment. Provide a metal identification tag with chain for each valve, factory marked with the zone identification, valve model number, and rate flow in GPM.

### 2.11 BTU METERS

- A. General: Provide BTU Meters as indicated, pressure rated for 125 PSI, consisting of turbine wheel flow meter, bronze housing, solid-state calculator with integral battery pack, two (2) temperature sensors (one (1) with 5-foot cable), integral stop valves on inlet and outlet, strainer, and magnetic trap.
- B. Temperature Range: 40 Degree - 250 degree F (4 - 121 degree C).
- C. Power Input: Twelve (12) month operating life battery pack.
- D. Data Output: 6-Digit electro-mechanical counter with readout in KWH or BTU.
- E. Accuracy: + or - 1 Percent over range of 1 - 12 GPM; + or - 1 percent of temperature difference of 5 degree F (2.8 degree C) and greater.

### 2.12 PITOT TUBE FLOW METERS

- A. Provide permanently mounted meters consisting of bellows type differential pressure element and either indicating or recording and integrating element as noted in schedule or indicated on drawings.
- B. Differential pressure elements and indicating or recording and integrating elements generally shall be direct-connected, but pneumatic electric or electronic transmission elements shall be used when particular installation precludes use of direct-connected units. Pneumatic, electric or electronic transmission elements shall be provided wherever pressure-sensing lines required for, direct transmission would exceed 150-feet in length or cannot be graded properly. Connect each flow meter to primary element as specified and provide with all piping, wiring, and accessories required for complete installation. Provide flow metering equipment supplied by single manufacturer or coordinated by single supplier.
- C. Permanently mounted meter installations (primary flow measuring element and flow meter) shall have overall accuracy of + 2 percent of full scale flow over range of 20 percent to 100

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percent of full-scale flow. Engineer and manufacture primary elements of meters in accordance with ASME recommendations for flow meters.

- D. Design bellows type differential pressure elements (meter bodies) for full-scale pressure differential of 50-inch w.g. to 100-inch w.g. Design shall incorporate rupture-proof stainless steel or copper metal bellows and torque tube drive requiring no lubrication. Design forged meter bodies for not less than 150 percent of maximum system pressure and fully protect against surges, with provision for venting and draining. Provide meter bodies with integral, adjustable pulsation dampers.
- E. Provide meter with complete copper tubing connections of approved sizes between differential pressure elements (meter bodies) and Venturi tubes. Include necessary vent and drain valves as recommended by meter manufacturer.
- F. Dials shall be flush type reading directly in gallons per minute.
- G. Enclose recording and integrating elements of each recording and integrating meter in dust-tight case. Arrange case for flush panel mount. Elements shall record flow continuously on seven (7) day, 123-inch diameter linear chart. Integrators shall be of 7-figure direct-reading type with either 15-second or continuous operating cycle. Furnish one (1) year supply of charts, pens, and ink for each meter and deliver to Contracting Officer.
- H. Design remote transmitters and receivers so that normal changes in air supply system pressure or in electric power supply system voltage or frequency will not affect accuracy of meters. Measuring circuits shall be relieved of all work required to move mechanical parts.

### 2.13 METER KIT

- A. Provide portable flow meters with bellows type differential pressure element and minimum 5-inch diameter indicating dial.
- B. Design pressure elements for full-scale pressure differential of 50-inch or 100-inch water gauge. Design shall incorporate rupture-proof metal beryllium or stainless steel bellows and torque tube drive requiring no lubrication. Design forged bodies for not less than 150 percent of maximum surge pressure, fully protected against surges, with full provision for venting and draining. Provide integral, adjustable pulsation dampers.
- C. Dials of portable meters shall have square root scales not less than 12-inch in developed length. Dials shall read from 0 to 10 gpm to which multiplier is to be applied, as required; also provide with uniform scale reading from 0-inch to 10-inch w.g., to which multiplier of 10 to be applied (100-inch at full scale), or from 0-inch to 5-inch w.g., to which multiplier of 10 is to be applied (50-inch at full scale).
- D. Engineer and manufacture in accordance with ASME recommendations for flow meters. Provide portable meters with overall accuracy of + 5 percent.
- E. Provide flow meter with factory-fabricated carrying case with integral carrying handle. Case shall be fitted to hold meter and following accessories.

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1. Two (2) 10-foot lengths of connecting hose with suitable female connectors for connecting to Venturi tube pressure tap nipples. Design hose for operating pressure of minimum of 150 percent of maximum system operating pressure.
2. Completely assembled 3-valve manifold with two (2) block valves and vent and drain valves shall be piped and mounted on base, which shall be designed for use laying flat on stationary base.
3. Bound set of descriptive bulletins, installation and operating instructions, parts list, and set of curves showing flow verses pressure differential for each orifice or Venturi tube with which meter is to be used.
4. Metal instruction plate, secured inside cover, illustrating use of meter. Deliver meter with case to Owner.

### PART 3 - EXECUTION

#### 3.1 INSPECTION

- A. Examine areas and conditions under which meters and gauges are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

#### 3.2 INSTALLATION OF TEMPERATURE GAUGES

- A. General: Install temperature gauges in vertical upright position, and tilted so as to be easily read by observer standing on floor.
- B. Locations: Install in the following locations, and elsewhere as indicated:
  1. At inlet and outlet of each hydronic zone.
  2. At inlet and outlet of each hydronic boiler and chiller.
  3. At inlet and outlet of each hydronic coil in air handling units, and built-up central systems.
  4. At inlet and outlet of each hydronic heat recovery unit.
  5. At inlet and outlet of each thermal storage tank.
- C. Thermometer Wells: Install in piping tee where indicated, in vertical upright position. Fill well with oil or graphite, secure cap.
- D. Temperature Gauge Connector Plugs: Install in piping tee where indicated, located on pipe at most readable position. Secure cap. Provide portable temperature gauge for each plug connection.

#### 3.3 INSTALLATION OF PRESSURE GAUGES

- A. General: Install pressure gauges in piping tee with pressure gauge cock, located on pipe at most readable position.
- B. Locations: Install in the following locations, and elsewhere as indicated:
  1. At suction and discharge of each pump.

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- C. Pressure Gauge Cocks: Install in piping tee with snubber. Install syphon for steam pressure gauges.
- D. Pressure Gauge Connector Plugs: Install in piping tee where indicated, located on pipe at most readable position. Secure cap. Provide portable pressure gauge for each plug connection.
- E. All pressure gauges shall have coil syphon and isolation gauge cock, "snubber" valve, to service the gauge and isolate it from the pipe system service without having to drain the piping system.
- F. For 6-Inch and Larger Piping Service, use ball valve for gauge isolation valve which shall be not less than 1/4-inch diameter for full gauge pipe correction diameter.

### 3.4 INSTALLATION OF FLOW MEASURING METERS

- A. General: Install flow measuring meters on piping systems located in accessible locations at most readable position.
- B. Calibrated Balance Valves: Install on piping with readout valves in vertical upright position. Maintain minimum length of straight unrestricted piping equivalent to three (3) pipe diameters upstream of valve.
- C. BTU Meters: Install in piping where indicated, in hydronic supply line. Provide thermal well in return line for remote sensor. Mount meter on wall if accessible, if not, provide bracket to support meter.

### 3.5 ADJUSTING AND CLEANING

- A. Adjusting: Adjust faces of meters and gauges to proper angle for best visibility.
- B. Cleaning: Clean windows of meters and gauges and factory-finished surfaces. Replace cracked or broken windows, repair any scratched or marred surfaces with manufacturer's touch-up paint.

END OF SECTION 230519

**SECTION 230529 - SUPPORTS AND ANCHORS**

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of Supports and Anchors required by this section is indicated on drawings and/or specified in other Division 23 sections.
- B. Types of Supports and Anchors specified in this section include the following:
  - 1. Piping Hangers and Supports
  - 2. Vertical-Piping Clamps
  - 3. Hanger-Rod Attachments
  - 4. Building Attachments
  - 5. Saddles and Shields
  - 6. Miscellaneous Materials
  - 7. Roof Equipment Supports
  - 8. Anchors
  - 9. Equipment Supports
- C. Supports and anchors furnished as part of factory-fabricated equipment are specified as part of equipment assembly in other Division 23 sections.

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of supports and anchors, of types and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. Codes and Standards:
  - 1. Regulatory Requirements: Comply with applicable Mechanical Codes pertaining to product materials and installation of supports and anchors.
  - 2. Duct Hangers: SMACNA Duct Manuals.
  - 3. MSS Standard Compliance:
    - a. Provide pipe hangers and supports of which materials, design, and manufacture comply with MSS SP-58.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including installation instructions for each type of support and anchor. Submit pipe hanger and support schedule showing manufacturer's figure number, size, location, and features for each required pipe hanger and support.
- B. Shop Drawings: Submit manufacturer's assembly-type shop drawings for each type of support and anchor, indicating dimensions, weights, required clearances, and methods of assembly of components.

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- C. Product certificates signed by the manufacturer of hangers and supports certifying that their products meet the specified requirements.
- D. Maintenance Data: Submit maintenance data and parts list for each type of support and anchor. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Division 1.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
  - 1. Pipe Hangers and Supports:
    - a. B-Line Systems Inc.
    - b. Carpenter and Patterson, Inc.
    - c. Fee & Mason Mfg. Co.; Division Figgie International
    - d. PHD Manufacturing, Inc.
    - e. Elcen Metal Products Company
    - f. Erico/Caddy
    - g. Unistrut Metal Framing Systems
    - h. Hilti USA.
    - i. Advanced Thermal Systems
    - j. Anvil
  - 2. Saddles and Shields:
    - a. B-Line Systems, Inc.
    - b. Pipe Shields, Inc.
    - c. Insulation Pipe Supports Manufacturing
    - d. Insulated Saddle Shield Insert Product Inc.
    - e. Erico/Caddy
    - f. Component Products Co.
    - g. Value Engineered Products, Inc.
    - h. Snappitz Pipe Inserts by Mechanical Pipe Shields, Inc.
    - i. Anvil
  - 3. Roof Equipment Supports:
    - a. Custom Curb, Inc.
    - b. Pate Co.
    - c. Thycurb Division; Thybar Corp.
    - d. Miro Industries, Inc.
  - 4. Roof Pipe Supports:
    - a. MAPA
    - b. Advanced Support Products
    - c. Erico
    - d. Mifab
    - e. Miro Industries
    - f. PHP Systems
    - g. S-5
    - h. B-Line Systems, Inc.
    - i. Roof Top Blox



5. Concrete Inserts and Anchors:
  - a. Phillips Drill Company
  - b. Erico/Caddy
  - c. Elcen Metal Products Company
  - d. Ramset/Red Head
  - e. Hilti USA.
  - f. Star fasteners
  - g. B-Line

## 2.2 PIPE HANGERS AND SUPPORTS

- A. Hangers and support components shall be factory fabricated of materials, design, and manufacturer complying with MSS SP-58.
  1. Components shall have galvanized coatings where installed for piping and equipment that will not have field-applied finish.
  2. Pipe attachments shall have nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.
- B. Adjustable Clevis Hanger: MSS Type 1
  1. Steel Pipe, size 3/8-inch thru 12-inch, B-Line B3100
  2. Copper Pipe, size 1/2-inch thru 4-inch, B-Line B3104CT
- C. Adjustable Swivel Ring: MSS Type 10
  1. Steel Pipe, size 1/2-inch thru 2-inch, B-Line B3170NF
  2. Copper Pipe, size 1/2-inch thru 2-inch, B-Line B3170CT
- D. Standard Pipe Clamps: MSS Type 8
  1. Steel Pipe, size 3/4-inch thru 20-inch, B-Line B3373
  2. Copper Pipe, size 1/2-inch thru 4-inch, B-Line B3373CT
- E. Floor Stand Pipe Saddle Support: MSS Type 37
  1. Steel Pipe, size 1 1/2-inch thru 12-inch, B-Line B3095
- F. Steel Yoke and Pipe Roller Hanger: MSS Type 43
  1. 2-1/2 inch thru 20-inch, B-Line B3110
- G. Hanger Rods: Continuous threaded steel, sizes as specified.
- H. Pipe Alignment Guides:
  1. Provide factory-fabricated guides, of cast semi-steel or heavy fabricated steel, consisting of bolted two-section outer cylinder and base with two-section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any), and cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.
    - a. Steel Pipe, B-Line B3281 through B3287
- I. Pipe Expansion Anchors
  1. Steel Pipe: Metraflex Company PA-1
  2. Steel Pipe: Field assembled expansion anchors require submitted shop drawings for review by Mechanical and Structural Engineers.

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### 2.3 UPPER ATTACHMENTS

- A. Beam Clamps
  1. All thread rod sized 3/8-inch and 1/2-inch: B-Line B3034
  2. All thread rod sizes 5/8- inch: B-Line B3033
  3. All thread rod sizes 3/4-inch and up: B-Line B3055

### 2.4 CONCRETE INSERTS AND ANCHORS

- A. Inserts: Case shall be of galvanized carbon steel with square threaded concrete insert nut for hanger rod connection; 3/4-inch lateral adjustment; top lugs for reinforcing rods, nail holes for attaching to forms. Erico Hanger Models 355 and 355N or equal Unistrut or Elcen. This type of upper attachment is to be used for all areas having poured in place concrete construction.
- B. Anchors: Carbon steel, zinc plated. Installation shall be in holes drilled with carbide-tipped drill bits or by use of self-drilling anchors.
  1. Provide anchors suitable for the location of installation and designed to withstand all forces and movements acting in the anchor. Manufacture pipe anchors in accordance with MSS SP 58. Provide a safety factor of four (4) for the anchor installation.
  2. Powder driven fasteners subject to approval of Structural Engineer. Each fastener shall be capable of holding a test load of 1,000 pounds whereas the actual load shall not exceed 50 pounds.
  3. Self-drilling expansion shields. The load applied shall not exceed one-fourth the proof test load required.
  4. Machine bolt expansion anchor. The load applied shall not exceed one-fourth the proof test load required.

### 2.5 SADDLES AND THERMAL SHIELD INSERTS AND PROTECTIVE SHIELDS

- A. General: Provide saddles and thermal shield inserts under all insulated piping hangers. Provide thermal shield inserts on all piping through floors, wall and roof construction penetrations. Size saddles and thermal shield inserts for exact fit to mate with pipe insulation or a minimum of 1-inch thick for uninsulated pipe thermal shield inserts.
- B. Protection Saddles: MSS Type 39; fill interior voids with segments of insulation matching adjoining insulation. For use with roller Hangers.
  1. B-Line B3160 to B3165
- C. Galvanized Steel Protection Shields: MSS Type 40; of length recommended by manufacturer to prevent crushing of insulation or insert. (Considering weight, use, temperature). See also Part 3.G.3.
- D. Thermal Shield Inserts: Provide 100-psi average compressive strength, waterproof, asbestos free calcium silicate, encased with a sheet metal enclosure or other listed system manufacturers. Insert and shield shall cover the entire circumference on vertical pipes, or the bottom half circumference of the pipe on horizontal mounting supports, and shall be of length recommended by the manufacturer for pipe size and thickness of insulation or the thickness of the wall, roof or floor construction.

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- E. Thermal Mechanical Pipe Shields: Self-locking insulated pipe supports/shields shall be provided at hanger, support, and guide locations on pipe requiring insulation. The insert shall consist of either hydrous calcium silicate or polyisocyanurate foam insulation (urethane) encircling the entire circumference of the pipe. Provide with a 360 degree PVC or Galvanized steel jacket which complies with the International Mechanical Code for installation in plenum ceilings where applicable. The length of the jacket shall be sized for pipe expansion.

### 2.6 MISCELLANEOUS MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36.
- B. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix ratio shall be 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.
- C. Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS Standards.

### 2.7 ROOF PIPE SUPPORTS

- A. Factory fabricated roof support system for piping application. Base shall be compatible with roofing membrane. For support materials other than metal, such materials shall be UV resistant. All metal components shall be corrosion resistant by either galvanization or zinc plating.
- B. Supports shall be designed to support the piping system and installed in accordance to manufacturer's requirements.
- C. Install with supplemental pad under support base as required by roofing system design.
- D. B-Line C-port CE Series

## PART 3 - EXECUTION

### 3.1 INSPECTION

- A. Examine areas and conditions under which supports and anchors are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

### 3.2 PREPARATION

- A. Proceed with installation of hangers, supports and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including (but not limited to) proper placement of inserts, anchors and other building structural attachments. Review Structural Drawings to obtain structural support limitations.

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- B. Prior to installation of hangers, supports, anchors and associated work, Installer shall meet at Project Site with Contractor, installer of each component of associated work, inspection and testing agency representatives (if any), installers of other work requiring coordination with work of this section and Architect/Engineer for purpose of reviewing material selections and procedures to be followed in performing the work in compliance with requirements specified.

### 3.3 INSTALLATION OF BUILDING ATTACHMENTS

- A. Install building attachments within concrete or on structural steel. Space attachments within maximum piping span length indicated in MSS SP-69 and tables this section. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert to forms. Where concrete with compressive strength less than 2,500 psi is indicated, install reinforcing bars through openings at top of inserts.
- B. New Construction:
  - 1. Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practicable.
  - 2. Set inserts in position in advance of concrete work. Provide reinforcement rod in concrete for inserts carrying pipe over 4-inch or ducts over 60-inch wide.
  - 3. Where concrete slabs form finished ceiling, finish inserts flush with slab surface.
  - 4. Use drop-in anchors for concrete structures.
  - 5. Use beam clamps for steel structures.
- C. Existing Construction:
  - 1. In existing concrete construction, drill into concrete slab and insert and tighten expansion anchor bolt. Connect anchor bolt to hanger rod. Care must be taken in existing concrete construction not to sever reinforcement rods or tension wires.

### 3.4 INSTALLATION OF HANGERS AND SUPPORTS

- A. Install hangers, supports, clamps and attachments to support piping properly from building structure; comply with MSS SP-69 and SP-89. Arrange for grouping of parallel runs of horizontal piping to be supported together on field fabricated, heavy-duty trapeze hangers where possible. Install supports with maximum spacings complying with MSS SP-69 and tables this section. Where piping of various sizes is supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.
- B. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers and other accessories.
- C. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated, or by other recognized industry methods.
- D. Install hangers and supports to allow controlled movement of piping systems, to permit freedom of movement between pipe anchors, to facilitate action of expansion joints, expansion loops, expansion bends and similar units and within 1'-0" of each horizontal elbow.

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- E. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
- F. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ANSI B31.9 Building Services Piping Code is not exceeded.
- G. Insulated Piping: Comply with the following installation requirements:
  - 1. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ANSI B31.
  - 2. Saddles: Install Protection saddles MSS Type 39 where insulation without vapor barrier is indicated. Fill interior voids with segments of insulation that match adjoining pipe insulation.
  - 3. Thermal Protective Metal Shields : Install thermal protective shields MSS Type 40 on cold and chilled water piping that is insulated. Thermal protective shields shall span an arc of 180 degrees and shall have dimensions in inches not less than the following:

NPS	Length	Metal Shield Thickness
1/4 thru 3-1/2	12	0.048
4	12	0.060
5 and 6	18	0.060
8 thru 14	24	0.075
16 thru 24	24	0.105

- 4. Thermal shield inserts shall be provided where thermal protective metal shields are provided and shall span an arc of 360 degrees and shall match the length of the thermal protective shield.
- H. Install refrigerant, and hydronic piping (copper and steel) hangers with the following minimum rod sizes and maximum spacing:

Pipe Size	Sch. 40 & Sch. 80 Steel Pipe		
	Maximum Hanger Spacing (ft.)	Maximum Vertical Spacing (ft.)	Minimum Rod Size (in.)
1/2"	7	15	3/8
3/4"	7	15	3/8
1"	7	15	3/8
1-1/4"	7	15	3/8
1-1/2"	9	15	3/8
2"	10	15	3/8
2-1/2"	11	15	1/2
3"	12	15	1/2
4"	12	15	5/8

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5"	12	15	5/8
6"	12	15	3/4
8"	12	15	3/4
10"	12	15	7/8
12"	12	15	7/8
Based on MSS-69, IMC & IFGC.			

Pipe Size	Sch. 10 Stainless Steel Pipe		
	Maximum Hanger Spacing (ft.)	Maximum Vertical Spacing (ft.)	Minimum Rod Size (in.)
2"	8	10	3/8
2-1/2"	9	10	1/2
3"	10	10	1/2
4"	10	10	1/2
5"	10	10	1/2
6"	10	10	5/8
Based on MSS-69 & IMC.			

Pipe Size	Type K, L, M Copper Pipe		
	Maximum Hanger Spacing (ft.)	Maximum Vertical Spacing (ft.)	Minimum Rod Size (in.)
1/2"	5	10	3/8
3/4"	5	10	3/8
1"	6	10	3/8
1-1/4"	6	10	3/8
1-1/2"	8	10	3/8
2"	8	10	3/8
2-1/2"	9	10	1/2
3"	10	10	1/2
4"	10	10	1/2
5"	10	10	1/2
6"	10	10	5/8
Based on MSS-69 & IMC.			

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Pipe Size	PEX Tubing		
	Maximum Hanger Spacing (ft.)	Maximum Vertical Spacing (ft.)	Minimum Rod Size (in.)
All	2.67	10	3/8
Based on MSS-69 & IMC.			

Pipe Size	PVC & CPVC (20-110 Degree F.)		
	Maximum Hanger Spacing (ft.)	Maximum Vertical Spacing (ft.)	Minimum Rod Size (in.)
1/2"	3	10	3/8
3/4"	3	10	3/8
1"	3	10	3/8
1-1/4"	4	10	3/8
1-1/2"	4	10	3/8
2"	4	10	3/8
2-1/2"	4	10	1/2
3"	4	10	1/2
4"	4	10	1/2
5"	4	10	1/2
6"	4	10	5/8
8"	4	10	3/4
10"	4	10	3/4
12"	4	10	3/4
Based on MSS-69 & IMC.			

- I. Support vertical runs at each floor.
- J. Install steel natural gas piping with the following minimum rod size and maximum spacing. CSST support shall be in accordance with manufacturers installation requirements.:

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<u>Size (NPS)(Inches)</u>	<u>Maximum Span in Feet</u>	<u>Minimum Rod Size - Inches</u>
1/2	6	3/8
3/4 to 1-1/4	8	3/8
1-1/2 to 2	10	3/8
2-1/2 to 3	10	1/2
4 to 5	10	5/8
6 to 8	10	3/4
10 to 12	10	7/8
Vertical, all sizes	Every floor level	

- K. Provide copper or copper plated hangers and supports for copper piping or provide sheet lead packing between hanger or support and piping.
- L. Place a hanger within 1-foot (0.305 m) of each horizontal elbow.
- M. Use hangers which are vertically adjustable 1-1/2 inch (38.1 mm) minimum after piping is erected. Provide and tighten tap locking nut on each hanger.
- N. Support vertical steel and copper piping at every story height but at not more than 15-foot intervals for steel and 10-feet for copper.
- O. Where several pipes can be installed in parallel and at same elevation, provide trapeze hangers.
- P. Where practical, support riser piping independently of connected horizontal piping.
- Q. Support steam supply and condensate return pipe runs on steel yoke and pipe roll hangers with protection saddles.
- R. Each pipe drop to equipment shall be adequately supported. All supporting lugs or guides shall be securely anchored to the building structure.
- S. Install all couplings with torque wrench, torqued to inch-pounds as specified by the manufacturer.
- T. Hang all insulated pipe at the point of support in the following manner:
  1. Hanger: See Paragraph 2.2
  2. All insulated pipes ( $\geq 2$ "d) shall have thermal shield insert insulation protection saddles at all support points. All piping shall have thermal shield inserts at each penetration through wall, floor and roof.
  3. Clevis Hangers: Install 180-degree waterproof, asbestos free, calcium silicate thermal shield insert with 180 degree galvanized steel protection shield.
  4. Steel Yoke and Pipe Roll Hangers: Provide steel protection saddle welded to the pipe. Fill the voids with fiberglass insulation.
  5. Trapeze Hangers Utilizing Unistrut Clamps or U-Bolts: Provide 360 degree waterproof, asbestos free, calcium silicate thermal shield insert with 360 degree steel protection saddle.
  6. All hangers shall be properly sized to accommodate the thermal shield insert and no hanger shall penetrate or crush any of the insulating material.



## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

- U. Install anchors and fasteners in accordance with manufacturer's recommendations and the following:
  - 1. In the event a self-drilling expansion shield or machine bolt expansion shield is considered to have been installed improperly, the Contractor shall make an acceptable replacement or demonstrate the stability of the anchor by performing an on-site test under which the anchor will be subjected to a load equal to twice the actual load.
  - 2. Powder-driven fasteners may be used only where they will be concealed after the construction is complete. Where an occasional fastener appears to be improperly installed, additional fastener(s) shall be driven nearby (not closer than six (6) inches) in undisturbed concrete. Where it is considered that many fasteners are improperly installed, the Contractor shall test load any fifty (50) successively driven fasteners. If 10 percent or more of these fasteners fail, the Contractor shall utilize other fastening means as approved and at no additional cost to the Owner.
  - 3. Hangers for piping and ducts shall be attached to cellular steel floor decks with steel plates and bolted rod conforming to the steel deck manufacturer's requirements. Where the individual hanger load exceeds the capacity of a single floor deck attachment, steel angles, beams or channels shall be provided to span the number of floor deck attachments required.
  - 4. Welding may be used for securing hangers to steel structural members. Welded attachments shall be designed so that the fiber stress at any point of the weld or attachment will not exceed the fiber stress in the hanger rod.

### 3.5 INSTALLATION OF PIPE EXPANSION CONTROL ANCHORS

- A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ANSI B31.9, and to prevent transfer of loading and stresses to connected equipment.
- B. Fabricate and install anchor by welding steel shapes, plates and bars to piping and to structure. Comply with ANSI B31.9 and with AWS Standards D1.1.
- C. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions, to control movement to compensators.
- D. Anchor Spacings: Where not otherwise indicated, install anchors at ends of principal pipe-runs, at intermediate points in pipe-runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

### 3.6 SHEET METAL DUCT HANGERS AND SUPPORTS

- A. Hanger Minimum Sizes:
  - 1. Up to 30-Inch Wide: 1-inch x 16 gauge at 10-foot spacing.
  - 2. 31-Inch to 48-Inch Wide: 1-1/2 inch x 16 gauge at 10-foot spacing.
  - 3. Over 48-Inch Wide: Trapeze hangers with angle iron and 1/2-inch rods spaced not more than 8-foot on centers.
  - 4. Up to 20" round: 1-inch x 20 gauge at 10-foot spacing.
  - 5. Up to 60" round: 1-inch 18 gauge at 10 foot spacing.
- B. Horizontal Duct on Wall Supports Minimum Sizes:

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

1. Up to 18-Inch Wide: 1-1/2 inch x 16 gauge or 1-inch x 1-inch x 1/8 inch at 8-foot spacing.
  2. 19-Inch to 40-Inch Wide: 1-1/2 inch x 1-1/2 inch x 1/8-inch angle at 4-foot spacing.
- C. Vertical Duct on Wall Supports Minimum Sizes:
1. At 10-foot spacing.
  2. Up to 24-Inch Wide: 1-1/2 inch x 16 gauge; 25-inch to 36-inch wide: 1-inch x 1-inch x 1/8-inch angle.
  3. 37-Inch to 48-Inch Wide: 1-1/4 inch x 1-1/4 inch x 1/8-inch angle.
- D. Vertical Duct Floor Supports Minimum Sizes:
1. Riveted or screwed to duct.
  2. Up to 60-Inch Wide: 1-1/2 inch x 1-1/2 inch x 1/8-inch angle.
  3. Over 60-Inch Wide: 2-inch x 1/8-inch.
- E. Provide sway bracing on all ductwork in accordance with local codes and regulations.

### 3.7 EQUIPMENT SUPPORTS

- A. Fabricate structural steel stands to suspend equipment from structure above or support equipment above floor.
- B. Grouting: Place grout under supports for piping and equipment.
- C. Concrete bases for the mechanical equipment indoors or outdoors will be provided by the General Contractor only if shown on the Architectural or Structural Drawings. Otherwise, all bases shall be provided by this Contractor.
- D. For Inertia Bases, see Section 230548.
- E. Housekeeping bases shall be 4-inch thick minimum, extended 4-inch beyond machinery bedplates.
- F. This Contractor shall be responsible for the proper size and location of all bases and shall furnish all required anchor bolts and sleeves. If bases are provided by the General Contractor, furnish him with templates showing the bolt locations.
- G. Equipment shall be secured to the bases with anchor bolts of ample size. Bolts shall have bottom plates and pipe sleeves and shall be securely imbedded in the concrete. All machinery shall be grouted under the entire bearing surface. After grout has set, all wedges, shims and jack bolts shall be removed and the space filled with non-shrinking grout. This Contractor shall provide washers at all equipment anchor bolts.
- H. Construct equipment supports mounted above floor of structural steel members or steel pipe and fittings. Brace and fasten with flanges bolted to structure.
- I. Provide rigid anchors for ducts and pipes immediately after vibration connections to equipment. See also Section 230548.

### 3.8 SPIRAL LOCK SEAM DUCT HANGERS AND SUPPORTS

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- A. Round Duct Hangers Minimum Sizes:
  - 1. At 10-foot spacings.
  - 2. Up to 18-Inch Diameter: 1-inch x 16 gauge.
  - 3. 19-Inch to 36-Inch Diameter: 1-inch x 12 gauge.
  - 4. 37-Inch to 50-Inch Diameter: 1-1/2 inch x 12 gauge.
  - 5. 51-Inch to 84-Inch Diameter: Trapeze hangers with angle iron and 1/2-inch rods spaced not more than 8-foot on center.
- B. Vertical Duct Floor Supports Minimum Sizes:
  - 1. Rivet to duct and tie angles together with rod, angles or cinch band.
  - 2. Up to 48-Inch Wide: 1-1/2 inch x 1-1/2 inch x 1/8-inch angle.
  - 3. Over 48-Inch Wide: 2-inch x 2-inch x 3/16-inch angle.
- C. Additional Hanger Requirements:
  - 1. 2-Inch to 24-inch from flexible connections of fans.
  - 2. 2-Inch to 24-inch from the outlets or flexible connections of VAV control units or mixing boxes.
  - 3. 12-Inch to 36-inch from the main duct to the first hanger of long branch ducts.
  - 4. 2-Inch to 12-inch from the ends of all branch ducts and linear diffuser plenums.
  - 5. 2-Inch to 24-inch from fire or fire/smoke damper break-away joints.
  - 6. Hangers at throat and heel of round or square elbows 48-inch or greater in width.

### 3.9 PREFABRICATED ROOFTOP EQUIPMENT SUPPORTS

- A. Equipment Bases:
  - 1. Equipment base shall be solid top equipment base with stepped cant to match roof insulation. Base shall pitch to match roof pitch and provide level unit installation.
  - 2. Base shall be constructed of reinforced 18 gauge galvanized steel with all welded components, full mitered corners, factory installed 1-1/2 inch thick rigid fiberglass insulation, wood nailer, and galvanized steel counter-flashing. Base shall be shipped as one (1) piece.
- B. Equipment Rails:
  - 1. Equipment rail shall be constructed of 18 gauge galvanized steel shell, base plate, and counterflashing with factory installed wood nailer, fully mitered end sections, stepped cant to match roof insulation. Rails shall pitch to match roof pitch and provide level installation.
- C. All supports shall be installed in accordance with manufacturer's recommendations.

### 3.10 METAL FABRICATION

- A. Cut, drill, and fit miscellaneous metal fabrications for pipe anchors and equipment supports. Install and align fabricated anchors in indicated locations.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

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- C. Field Welding: Comply with AWS D1.1 for procedures of manual shielded metal-arc welding, appearance and quality of welds made, methods used in correcting welding work, and 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 that no roughness shows after finishing.

### 3.11 ADJUSTING

- A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Touch-Up Painting: Immediately after erection of anchors and supports, clean field welds and abraded areas of shop paint and paint exposed areas with same material as used for shop painting to comply with SSPC-PA-1 requirements for touch-up of field-painted surfaces.
  - 1. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- C. For galvanized surfaces, clean welds, bolted connections and abraded areas and apply galvanizing repair paint to comply with ASTM A 780.

END OF SECTION 230529

**SECTION 230553 - MECHANICAL IDENTIFICATION**

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of Mechanical Identification Work required by this section is indicated on drawings and/or specified in other Division 23 sections.
- B. Types of Identification Devices specified in this section include the following:
  - 1. Painted Identification Materials
  - 2. Plastic Pipe Markers
  - 3. Plastic Duct Markers
  - 4. Plastic Tape
  - 5. Underground-Type Plastic Line Marker
  - 6. Valve Tags
  - 7. Valve Schedule Frames
  - 8. Engraved Plastic-Laminate Signs
  - 9. Plasticized Tags
  - 10. Lettering and Graphics
- C. Refer to other Division 23 sections for Identification Requirements at Central-Station Mechanical Control Center; not work of this section.
- D. Refer to Division 26 sections for Identification Requirements of Electrical Work; not work of this section.

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of identification devices of types and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. Codes and Standards:
  - 1. ANSI Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each identification material and device required.
- B. Schedules: Submit valve schedule for each piping system, typewritten and reproduced on 8- 1/2" x 11" bond paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), size of valve, and variations for identification (if any). Only tag valves which are intended for emergency shutoff and similar special uses,

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such as valve to isolate individual system risers, individual floor branches or building system shut-off valves. In include in Operation & Maintenance Manuals as specified in Division 1.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
1. Brady (W.H.) Co.; Signmark Division
  2. Brimar Industries, Inc.
  3. Industrial Safety Supply Co., Inc.
  4. Seton Name Plate Corp.
  5. Holbi.

#### 2.2 MECHANICAL IDENTIFICATION MATERIALS

- A. General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division 23 sections. Where more than single type is specified for application, selection is Installer's option, but provide single selection for each product category.

#### 2.3 PLASTIC PIPE MARKERS

- A. Snap-On Type: Provide manufacturer's standard pre-printed, semi-rigid snap-on, color-coded pipe markers, complying with ANSI A13.1.
- B. Insulation: Furnish 1-inch thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125 degree F (52 degree C) or greater. Cut length to extend 2-inch beyond each end of plastic pipe marker.
- C. Small Pipes: For external diameters less than 6-inch (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one (1) of the following methods:
1. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
  2. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4-inch wide; full circle at both ends of pipe marker, tape lapped 1-1/2 inch.
- D. Large Pipes: For external diameters of 6-inch and larger (including insulation if any), provide either full-band or strip-type pipe markers, but not narrower than three (3) times letter height (and of required length), fastened by one (1) of the following methods:
1. Steel spring or non-metallic fasteners.
  2. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 1-1/2 inch wide; full circle at both ends of pipe marker, tape lapped 3-inches.
  3. Strapped-to-pipe (or insulation) application of semi-rigid type, with manufacturer's standard stainless steel bands.

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- E. Lettering: Comply with piping system nomenclature as specified, scheduled, shown, or to match existing building lettering nomenclature system and abbreviate only as necessary for each application length.
- F. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.

### 2.4 PLASTIC DUCT MARKERS

- A. General: Provide manufacturer's standard laminated plastic, duct markers.
- B. For Hazardous Exhausts, use colors and designs recommended by ANSI A13.1.
- C. Nomenclature: Include the following:
  - 1. Direction of air flow
  - 2. Duct service (supply, return, exhaust, etc.)
  - 3. Duct origin (from)
  - 4. Duct destination (to)
  - 5. Design CFM

### 2.5 PLASTIC TAPE

- A. General: Provide manufacturer's standard color-coded pressure-sensitive (self-adhesive) vinyl tape, not less than 3 mils thick.
- B. Width: Provide 1-1/2 inch wide tape markers on pipes with outside diameters (including insulation, if any) of less than 6-inch, 2-1/2 inch wide tape for larger pipes.
- C. Color: Comply with ANSI A13.1, except where another color selection is indicated.

### 2.6 UNDERGROUND-TYPE PLASTIC LINE MARKERS

- A. General: Manufacturer's standard permanent, bright-colored, continuous-printed plastic tape, intended for direct-burial service; not less than 6-inch wide x 4 mils thick. Provide tape with printing which most accurately indicates type of service of buried pipe.
- B. Provide multi-ply tape consisting of solid aluminum foil core between 2-layers of plastic tape.

### 2.7 VALVE TAGS

- A. Plastic Valve Tags: Provide manufacturer's standard solid plastic valve tags with printed enamel lettering, with piping system abbreviation in approximately 3/16-inch high letters and sequenced valve numbers approximately 3/8-inch high, and with 5/32-inch hole for fastener.
  - 1. Provide 1-1/8 inch square White tags with Black lettering.
  - 2. Provide size, shape and color combination as specified or scheduled for each piping system.

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- B. Valve Tag Fasteners: Provide manufacturer's standard solid brass chain (wire link or beaded type), and solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.
- C. Access Panel Markers: Provide manufacturer's standard 1/16-inch thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve. Include 1/8-inch center hole to allow attachment.

### 2.8 VALVE SCHEDULE

- A. Valve Schedule shall be printed on company letterhead and shall include the following columns:
  - 1. Valve Tag Number (*example: HWS-1*)
  - 2. Service (*example: ISOLATE AHU-1 HEATING COIL*)
  - 3. Room Number (location of valve)
  - 4. Size of Valve
  - 5. Type of Valve
  - 6. Normal Position of the Valve (open or closed)
- B. Provide 3-ring binder with project information labeled on outside for containment of valve tag schedule.

### 2.9 ENGRAVED PLASTIC-LAMINATE SIGNS

- A. General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in the sizes and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, Black with White core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
- B. Thickness: 1/8-Inch, except as otherwise indicated.
- C. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

### 2.10 PLASTICIZED TAGS

- A. General: Manufacturer's standard pre-printed or partially pre-printed accident-prevention tags, of plasticized card stock with matt finish suitable for writing, approximately 3-1/4 inch x 5-5/8 inch, with brass grommets and wire fasteners, and with appropriate pre-printed wording including large-size primary wording (As examples; DANGER, CAUTION, DO NOT OPERATE).

### 2.11 LETTERING AND GRAPHICS

- A. General: Coordinate names, abbreviations and other designations used in mechanical identification work, with corresponding designations shown, specified, scheduled and approved by the Owner/Engineer. Provide numbers, lettering and wording as indicated and approved by



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the Owner/Engineer for proper identification and operation/maintenance of mechanical systems and equipment.

- B. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as designated on the drawings or schedule as well as service.

### PART 3 - EXECUTION

#### 3.1 GENERAL INSTALLATION REQUIREMENTS

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

#### 3.2 DUCTWORK IDENTIFICATION

- A. General: Identify air supply, return, exhaust, intake and relief ductwork and duct access doors with duct markers; or provide stenciled signs and arrows, showing ductwork service and direction of flow, in Black or White (whichever provides most contrast with ductwork color). Existing building identification shall match the existing method which exists in the building.
- B. Location: In each space where ductwork is exposed, or concealed only by removable ceiling system, locate signs near points where ductwork originates or continues into concealed enclosures (shaft, underground or similar concealment), and at 50-foot spacings along exposed runs.
- C. Access Doors: Provide duct markers or stenciled signs on each access door in ductwork and housings, indicating purpose of access (to what equipment), other maintenance and operating instructions, and appropriate safety and procedural information.
- D. Concealed Doors: Where access doors are concealed above acoustical ceilings or similar concealment, plasticized tags may be installed for identification in lieu of specified signs, at Installer's option.
- E. Terminal Box remote identification on ceiling grid shall be provided directly below terminal using plastic laminate tag with plan code only.

#### 3.3 PIPING SYSTEM IDENTIFICATION

- A. General: Install pipe markers of the following type on each system indicated to receive identification, and include arrows to show normal direction of flow. Existing building identification shall match the existing method which exists in the building.
- B. Plastic pipe markers, with application system as indicated under "MATERIALS" in this section. Install on pipe insulation segment where required for hot non-insulated pipes.

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- C. Locate pipe markers and color bands as follows wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations.
- D. Provide identification labels on each ceiling grid or ceiling access door for control device and equipment located above ceiling.
- E. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
- F. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
- G. At access doors, manholes and similar access points which permit view of concealed piping.
- H. Near major equipment items and other points of origination and termination.
- I. Spaced intermediately at maximum spacing of 25-foot along each piping run, except reduce spacing to 15-foot in congested areas of piping and equipment.
- J. On piping above removable acoustical ceilings.

### 3.4 UNDERGROUND PIPING IDENTIFICATION

- A. General: During back-filling/top-soiling of each exterior underground piping systems, install continuous underground-type plastic line marker, located directly over buried line at 6-inch to 8-inch below finished grade. Where multiple small lines are buried in common trench and do not exceed overall width of 16-inch, install single line marker. For tile fields and similar installations, mark only edge pipelines of field.

### 3.5 VALVE IDENTIFICATION

- A. General: Provide valve tag on valves in each piping system. List each tagged valve in valve schedule for each piping system.
  - 1. Building services main shutoff valves.
  - 2. Each individual system main shutoff valves.
  - 3. Each individual system riser shutoff valves.
  - 4. Each individual system floor shutoff valves.
  - 5. Each individual system major branch shutoff valves.
- B. Provide the following columns and information for each valve:
  - 1. Valve Tag Number (*example*: HWS-1)
  - 2. Service (*example*: ISOLATE AHU-1 HEATING COIL)
  - 3. Room Number (location of valve)
  - 4. Size of Valve
  - 5. Type of Valve
  - 6. Normal Position of the Valve (open or closed)

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- C. Mount valve schedule frames and schedules in mechanical equipment rooms where directed by Architect/Owner/Engineer.
- D. Where more than one (1) major mechanical equipment room is shown for project, install mounted valve schedule in each major mechanical equipment room, and repeat only main valves which are to be operated in conjunction with operations of more than single mechanical equipment room.

### 3.6 MECHANICAL EQUIPMENT IDENTIFICATION

- A. General: Install minimum 2-inch x 4-inch engraved plastic laminate equipment marker on each individual items of mechanical equipment. Provide signs for the following general categories of equipment.
  - 1. Main building systems control and operating valves, including safety devices and hazardous units such as gas outlets.
  - 2. Room thermostats, except gun tag labels are acceptable for room thermostats.
  - 3. Fuel-burning units including boilers, furnaces, heaters, stills and absorption chillers.
  - 4. Pumps, compressors, chillers, condensers and similar motor-driven units.
  - 5. Heat exchangers, cooling towers, heat recovery units and similar equipment.
  - 6. Fans and blowers.
  - 7. HVAC units.
  - 8. Tanks and pressure vessels.
  - 9. Water treatment systems and similar equipment.
- B. Lettering Size: Minimum 1/4-inch high lettering for name of unit.
- C. Text of Signs: In addition to the identified unit, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

### 3.7 ADJUSTING AND CLEANING

- A. Adjusting: Relocate any mechanical identification device which has become visually blocked by work of this division or other divisions.
- B. Cleaning: Clean face of identification devices, and glass frames of valve charts.

END OF SECTION 230553

**SECTION 230593 - TESTING, ADJUSTING & BALANCING**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Divisions 1 and 23 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. This section covers Testing and Balancing of Environmental Systems including but not limited to air distribution systems, hydronic distribution systems, and the equipment and apparatus connected thereto. The testing and balancing of all environmental systems shall be the responsibility of one (1) testing, balancing and adjusting firm.
  - 1. Test, Adjust, and Balance all of the following mechanical systems:
    - a. Supply Air Systems;
    - b. Return Air Systems;
    - c. Exhaust Air Systems;
    - d. Hydronic Systems;
    - e. Pumps;
    - f. Refrigeration Equipment;
    - g. Temperature Control System;
    - h. Heat Generating Equipment;
  - 2. Report any systems for excessive sound and vibration levels.

1.3 QUALIFICATIONS OF CONTRACTOR

- A. Procure the services of an independent testing and balancing Agency specializing in the testing, adjusting and balancing of environmental systems to perform the above mentioned work. An independent agency is defined as an organization that is not engaged in engineering design or is not a division of a mechanical contractor entity that installs mechanical systems. It shall be an agency certified by NEBB or TABB. Testing and balancing work shall be directly supervised by a NEBB certified Supervisor or Professional Engineer on the Testing and Balancing Agency's staff. The Supervisor shall represent the Testing and Balancing Agency in progress meetings as requested, and shall be available for interpreting all material found in the Balance Report.
  - 1. All field work shall be performed by qualified technicians who are currently certified by either NEBB or TABB Test and Balance Certification Agencies.
- B. The Testing and Balancing Agency shall have a minimum of three (3) years experience in testing and balancing mechanical systems.

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### 1.4 CONTRACTOR QUALIFICATIONS REVIEW

- A. The Mechanical Contractor shall submit the name of the Testing and Balancing Agency to the Architect within thirty (30) days of contract award to ensure that the Testing and Balancing Agency is on the project from the outset of construction.
- B. Any testing and balancing agency desiring to offer their services for this Work shall submit their qualifications to the Architect, not less than seven (7) working days before the bid date. Review and recommendations to Owner will be given on each request and action on the recommendation will be given in writing prior to bidding the work. Agencies meeting the qualifications of the Specification are those Agencies approved by the Owner.
- C. Acceptable TAB Agencies are:
  - 1. Griffith Engineering Service
  - 2. JPG Engineering, Inc.
  - 3. TAB Services
  - 4. L.H. Finn & Assoc.
  - 5. Complete Mechanical Balancing, Inc.
  - 6. Double T Balancing Company
  - 7. Superior Balance and Commissioning, Inc.

### 1.5 CODES AND STANDARDS

- A. ASHRAE: ASHRAE Handbook 2011, Applications Volume, Chapter 36, Testing, Adjusting, and Balancing.
- B. NEBB: "Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems."
- C. SMACNA: "Tab Procedure Guidelines".

### 1.6 SUBMITTALS

- A. Upon award of the Contract, the Contractor shall submit the name of the Test and Balance Agency who will be performing the work. The submittal shall include a complete list of all technicians who will be performing the field work and include a photocopy of their current certification by either NEBB or TABB Certification Agencies.
- B. Only those technicians included in the submittal shall perform the work. Any personnel or staff used to perform the work who are not included in the submittal shall be grounds for rejecting the Test and Balance Report and the Project in whole.

### 1.7 PROJECT CONDITIONS

- A. Air and water testing and balancing shall not begin until the system has been completed and is in full working order.
- B. Put all heating, ventilating and air conditioning systems and equipment into full operation and continue operation of same during each working day of testing and balancing. Preliminary

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Testing and Balancing requirements shall be ascertained prior to the commencement of work through a review of the project plans and specifications. In addition, visual observations at the site during construction shall be made to determine the location of required balancing devices, that they are being installed properly, and in an accessible location for the need. Report in writing any deficiencies to the Contractor and Mechanical Engineer immediately.

- C. Before any air balance work is done, the system shall be checked for duct leakage, assure filters are installed, see that filters are changed if they are dirty, check for correct fan rotation, equipment vibration, and check automatic dampers for proper operation. All volume control dampers and outlets shall be wide open at this time.
- D. Before any hydronic balancing work is done, the system shall be checked for plugged strainers, proper pump rotation, proper control valve installation and operation, air locks, proper system static pressure to assure a full system, proper flow meter and check valve installation. All throttling devices and control valves shall be open at this time.

### 1.8 SEQUENCING AND SCHEDULING

- A. Coordinate scheduling of Work with the Contractor.
  - 1. Schedule TABB work to coincide with testing and verification of the temperature control systems where practical.
  - 2. Coordinate system start-up and performance verification with the Engineer as TABB work is in progress.
- B. Provide written notification to the Project Manager five (5) working days prior to commencing TABB and a schedule for completing the work.
- C. Provide written notification to the Contractor within twenty-four (24) hours of an equipment failure preventing TABB work from proceeding.

## PART 2 - PRODUCTS

### 2.1 INSTRUMENTS

- A. Calibration and maintenance of instruments shall be in accordance with manufacturer's standards and recommendations and requirements of NEBB.
- B. Calibration histories for each instrument shall be available for examination.
- C. Use a true RMS amp and harmonic distortion electrical test meter, FLUKE Model 41 or equal to test and record operating and performance measurements for all motors operating with variable frequency drives.

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## PART 3 - EXECUTION

### 3.1 TEMPERATURE CONTROLS

- A. Operate all temperature control systems with the Temperature Control Contractor's representative for proper sequence of operation and calibration. Report in writing any deficiencies to the Engineer immediately.

### 3.2 REQUIREMENTS OF WORK

- A. Provide all necessary fan belts and sheaves to balance all fans to the specified air delivery for the actual field conditions.
  - 1. Test and Balance Agency shall provide motor sheave replacement and fan belt and sheave replacement necessary for final balance condition for specified air quantity when the VFD is operating at design conditions. Motor sheaves shall be replaced so motors operate at rated rpm at 60HZ, then fan sheaves shall be replaced to meet design requirements at 60HZ, without placing the motor over its nameplate amp rating.
  - 2. The Test and Balance report shall include voltage readings, both into the VFD, with concurrent motor amp readings.
- B. Balance all air and water flows at terminals within +5 percent to -5 percent of design flow quantities for individual terminals. And +5 percent to -10 percent of individual air outlets or inlets. Measure and record the following data:
- C. Air Balance:
  - 1. Air supply, return and exhaust systems with air quantities for each air device; air handling units including supply, return, mixed, and outside temperatures and fan data including CFM, static pressure, fan RPM, voltage, rated motor amperage, motor running amperage before and after final balance, listed motor power factor and motor running power factor reading. Air diffusion patterns shall be set to minimize objectionable drafts, noise, and local smoke detection device ratings.
  - 2. The supply, return and exhaust fan static pressure shall be set by the balancing firm and the Control Contractor if the systems have fan volume control. The duct static shall be confirmed both through the instrumentation installed on the job and by the Balancing Agency. The system shall be tested in all operating modes (including minimum outside air with full return air, full outside air, modulated damper position, and full cooling with the design diversity). System static pressure and fan motor amperages shall be recorded in all modes. The fan speed resulting in satisfactory system performance shall be determined at full design delivery, inlet or outlet fan. Volume control dampers shall be in the wide open position and variable frequency drive is at 100 percent of design RPM and one (1) path presenting the greatest resistance to flow shall be fully open and unobstructed.
  - 3. Provide full pitot traverse and CFM measurements at each fan in addition to terminal device measurements.
  - 4. Air volume and air temperature rise or drop across each coil, filter, dampers, etc., of air handling section.
  - 5. Measure, adjust, set, balance and record outside air, return air and exhaust/relief air quantities for all air handling systems and supply fans.

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Air quantities shall be determined by direct airflow measuring procedures wherever possible, where duct/inlet conditions do not allow for accurate direct measurement of outside air the following method shall be used:

$$\text{Outside Air CFM} = \frac{\text{Supply Fan Total CFM} - \text{Return Fan Total CFM}}{\text{Return Fan Total CFM}}$$

In addition to the direct measuring of airflow quantities, measure and record outside air, return air and mixed air temperatures, determine thermal/mass energy balance and provide calculations to verify measured airflow quantities. Adjusting and setting the outside air quantity as a percentage of damper position will not be acceptable.

D. Final adjustments shall include but not be limited to the following:

**ITEM**

**ADJUSTMENT**

Fan: Belt Drive

RPM. Include sheave and belt exchange to deliver air flow within limits of installed motor horsepower and mechanical stress limits of the fan. Determine the limiting fan tip speed before increasing RPM. Final fan speed setting shall allow for predicted filter loading and shall establish proper duct pressures for operation of zone CFM regulators.

Fan: Direct Drive

RPM with speed taps. Set fan speed on tap which most closely approaches design CFM. Report tap setting on equipment data sheet as high, medium or low.

RPM with speed control rheostat. Set output of fan at design CFM by adjusting the SCR. After adjustment, check fans ability to re-start after powering down. Increase setting if required for proper starting.

CFM with variable pitch blades. Variable fixed pitch fan blades and variable in motion pitch fan blades shall be adjusted by the manufacturer at pitch required to provide design output. Pitch angle adjustment shall not exceed recommended maximum to prevent "stall."

Terminal Boxes

VAV and Constant Volume Boxes with Reheat. Set regulators to provide design maximum, minimum, heating and cooling CFM.

VAV Boxes: Set volume at 100 percent maximum and minimum flow as on VAV box schedule, of design CFM. Check control sequence operation to assure proper sequencing. Reset PE switches as required when furnished with terminal box.



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<b>ITEM</b>	<b>ADJUSTMENT</b>
Air Devices	All diffusers and registers shall be measured and balanced.
Motor Starter Thermal Heaters	Division 23 Furnished Magnetic and Manual Starters. Furnish and exchange thermals as required for proper motor protection.  Division 26 Furnished Motor Control Center Magnetic Starters. Check for correct sizing. Notify Electrical Contractor of discrepancies.  Existing Magnetic and Manual Starters. Furnish and exchange thermals as required for motor protection.
Variable Frequency Drives	Test, measure and record true RMS amperage, THD for voltage and amperage for each variable frequency drive at both the input power to the drive and the output power to the motor in both the drive mode and through the across the line by-pass mode.

E. Kitchen Hood Evaluation:

1. The Test and Balance Agency shall verify capture and containment performance of the exhaust system. This field test shall be conducted with all appliances under the hood at operating temperatures. Capture and containment shall be verified visually by observing smoke or steam produced by actual or simulated cooking. The Test and Balance Report shall provide a description of the results, as witnessed by the Engineer or Architect.

F. Hydronic Balance:

1. Inlet and outlet water temperatures and pressures of all air handling unit coils, reheat coils, unit heaters, convectors, finned tube radiation, and other heat transfer equipment, as well as the corresponding media flows, and air temperature rise or drops.
2. Chiller inlet and outlet water temperatures, inlet and outlet evaporator and condenser pressures, motor running amperage, refrigerant temperature.
3. Circulating pump flow rates, pressures, running amperage, and full load amperage at design flow and shutoff conditions.
4. The hydronic system shall be proportionally balanced being certain that the path to one (1) terminal is fully open. Total system flow shall be adjusted at the pump by restricting the discharge balancing valve. If the pump must be severely restricted, the impeller may have to be trimmed. This decision will be the responsibility of the Contractor, Supplier, and the Mechanical Engineer.
5. Balancing valves and associated balancing shall not be required on devices where pressure independent control valves are installed. Balancing valves and balancing are required if self-contained pressure independent control valves are not installed.

G. Electric Heat:

1. Full load amperage and voltage of all electric heating elements.

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

2. The Testing and Balancing Agency shall check staging of heating devices and reset if required for proper operation.
- H. When necessary as determined by the Mechanical Engineer, the Test and Balance Agency shall provide additional testing and measurements as required by the Mechanical Engineer including, but not limited to, the following:
1. Static pressure gradient profiles throughout ductwork and/or piping systems.
  2. Temperature gradient profiles throughout ductwork and/or piping system.
  3. Miscellaneous electrical measurements.
  4. Smoke tests of room pressure relationships.  
This work shall be done immediately upon request with complete cooperation and in an expedient schedule at no additional cost to any other party.
- I. All smoke control systems for life safety shall be tested, certified, conducted and reported in accordance with and as required by the Local Building Code Authority and Fire Department who have jurisdiction including, but not limited to, smoke tests, pressurization tests and pressure measurements, door closing forces, system demonstration and system activation, etc.

### 3.3 REPORT OF WORK

- A. The Testing and Balancing Agency shall submit electronic copies of the final Testing and Balancing Report at least five (5) calendar days prior to the Contractor's request for final inspection. All data shall be recorded on applicable reporting forms. The report shall include all operating data as listed in Paragraph 3.2 above, a list of all equipment used in the testing and balancing work, and shall be signed by the Supervising Registered Professional Engineer and affixed with their registration stamp, signed and dated in accordance with State Law. Final acceptance of this project will not take place until a satisfactory report is received.
- B. When deemed necessary by the Mechanical Consulting Engineer, the Testing and Balancing Agency shall run temperature and/or humidity recordings and shall read any of the report quantities in the presence of the Engineer for verification purposes.
- C. When all air balancing is done and all dampers are set, all test holes shall be plugged and all dampers shall be marked with paint. The following information shall be recorded for each fan system in the final report: Design fan and air device inlet or outlet size, actual inlet or outlet size, design and actual CFM and velocity through the orifice, for each terminal in the system. The pitot tube traverse method used and location of pitot tube traverse for determining CFM shall be recorded.
- D. Hydronic Systems With Meters: The system shall be balanced proportionally using the flow meters. On completion of the balance, the following information shall be recorded in the report: Flow meter size and brand, required flow rate and pressure drop, valve settings on meters with a readable scale, flow rate in both full coil flow and full bypass modes. Verify the meters are installed per the manufacturer's recommendations and shall notify the Contractor of any deficiencies before utilizing meter.
- E. Hydronic Systems Without Meters (Thermal or Terminal Rated Pressure Drop Balance): The system shall be balanced proportionally to the terminal ratings. On completion of the balance, the following information shall be recorded in the report: Design entering and leaving water temperature/pressure drop, final balanced entering and leaving water temperature/pressure drop.

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- F. When all hydronic balancing is done, all valves shall be marked or the locking rings set. Control valve bypass loops shall be set with the balancing valve to provide equal flow in either mode. Confirm in writing this work has been completed.
- G. After all balancing is complete and all coordination with the Contractor and the Engineer is complete, the balancing firm shall furnish aforementioned bound report which shall contain the following information:
1. RPM, drive sheave information (as installed and as changed), fan nameplate information, motor nameplate information, motor amperage, motor voltage and power factor to all motors (in all operating modes).
  2. Static pressure across all components of the system.
  3. Required and final balanced CFM at each system terminal. Include the terminal size, reading orifice size, and velocities read to attain the CFM.
  4. Pump and motor nameplate information, amperage and voltage to all motors, pressure drop across all system terminals, pressure rise across the pump in PSI and feet of head.
  5. Thermal protection for all motors shall be recorded; also power factor for all motors drawing 1,000 watts or more. Starter brand, model, enclosure type, installed thermal heaters and the rating of the heaters, required thermal heaters and the rating of the heaters if different than installed shall be recorded. Starter heaters shall be changed to the correct size and so noted in the report. If the starters were furnished by the Division 26, the correct heater sizes shall be noted in the report and the Contractor shall be advised.
  6. The report shall include a sheet which shall report the method of balance, project altitude, and any correction factors.
  7. A **complete** reduced set of the **Black-line** Mechanical Contract Drawings which shall be included in the report with all equipment, flow measuring devices, terminals (VAV boxes, outlets, inlets, coils, unit heaters, fintube loops, radiant panel loops, schedules, etc.) clearly marked and all equipment designated.
  8. Include in the report all variable frequency drive electrical performance test characteristics for each motor as described in this specification section. Include photocopies of all meter chart recorded <measured data> and/or computer printed output.
- H. The Testing and Balancing Agency shall respond and correct all deficiencies within seven (7) days of receiving the Engineer's written review of the Balancing Report. Failure to comply will result in holding retainage of the final payment until all items have been corrected to the satisfaction of the Engineer.

### 3.4 GUARANTEE OF WORK

- A. The Testing and Balancing Agency shall guarantee the accuracy of the tests and balance for a period of ninety (90) days from date of final acceptance of the Test and Balance Report. During this period, the Testing and Balancing Agency shall make personnel available at no cost to the Owner to correct deficiencies that may become apparent in the system balance.

### 3.5 COMPLETION SERVICES

- A. Final Check: Make final checks and do any rebalancing as directed.
- B. Report: Submit Balancing Report as specified above, to the Owner. Submit preliminary copy of report to Engineer for spot-checking as described below.

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- C. Acceptance: Notify Engineer and Owner that work is complete and submit preliminary copy of Balancing Report. Schedule time to meet the Owner and Engineer at the site to perform spot-checking and verification as directed. Test and Balance Agency shall furnish personnel and equipment and spot check:
1. The TAB representative shall be a member of the same team used during the original testing.
  2. Equipment used during the random testing shall be the same equipment used during the original testing.
  3. The system or equipment being verified shall be in the same operating mode as during the original TAB test.
  4. Up to 10 percent of the air readings shall be re-tested. Ninety percent (90%) of the re-tested readings must be within tolerances of the specifications.
  5. Up to 20 percent of the balanced hydronic component readings shall be re-tested. Ninety percent (90%) of the re-tested readings must be within tolerances of the specifications.
  6. Whenever system verifications do not meet specifications, the entire system shall be re-balanced and rechecked.

END OF SECTION 230593

**SECTION 230700 - MECHANICAL INSULATION**

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. This Section includes:
  - 1. Piping Insulation, Jackets and Accessories
  - 2. Ductwork Insulation and Jackets
  - 3. Equipment Insulation and Covering
- B. Refer to other Division 23 sections for Shields, Inserts, and Mechanical Identification.
- C. Insulation thickness based on 2012 IECC requirements.

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of mechanical insulation products, of types and sizes required, whose products have been in satisfactory use in similar service for not less than three (3) years.
- B. Installer's Qualifications: Firm with at least five (5) years successful installation experience on projects with mechanical insulations similar to that required for this project.
- C. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics and insulating cements.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's installation instructions and schedule listing materials, thickness, K-value, density, and furnished accessories for each service or equipment specified.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard ratings of the products, name of manufacturer, and brand.
- B. Protect insulation against dirt, water, chemical, and mechanical damage.

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## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide product by one of the following:
1. Insulation:
    - a. Armstrong World Industries, Inc. (flexible elastomeric)
    - b. Johns-Manville Products Corp. (fiberglass, calcium silicate)
    - c. Knauf Fiber Glass (fiberglass)
    - d. Manson Insulation Co. (fiberglass, calcium silicate)
    - e. Owens-Corning Fiberglas Corp. (fiberglass)
    - f. Rubatex Corp. (flexible elastomeric)
    - g. Aeroflex (flexible elastomeric)
  2. Jacketing, Coatings, Adhesives, Sealants and Covering Products:
    - a. Childers
    - b. Foster
    - c. Ceel-Co.
    - d. Johns-Manville Products Corp.
    - e. Knauf Fiber Glass
    - f. Venture Tape Corporation
    - g. Design Polymetrics

### 2.2 PIPING INSULATION

- A. Glass Fiber: ASTM C 547, Type 1, rigid molded, noncombustible, 0.23 "K" value at 75 degree F mean temperature, maximum service temperature 850 degree F, moisture sorption less than 0.2% by volume. Composite 25/50-flame spread/smoke developed rating (ASTM E 84, UL 723, and NFPA 255).
1. Vapor Retarder Jacket: ASTM C 1136, 45lbs/in tensile strength (ASTM D 828), or beach puncture 50 oz in/in tear minimum (ASTM D 781). White Kraft paper reinforced with glass fiber yarn and bonded to aluminum foil, secured with self-sealing longitudinal laps and butt strips.
  2. Connections: Tacks, pressure sensitive color matching vinyl tape, Perma-Weld adhesive.
- B. Calcium Silicate: ASTM C 533, Type I, rigid molded, noncombustible (ASTME E 136), 0.42 "K" value at 300 degree F mean temperature, maximum service temperature 1200 degree F, 160 psi compressive strength for 5 percent compression (ASTM C 165), flexural strength 70 psi (ASTM C 203). 0/0 flame spread/smoke developed rating (ASTM E 84).
1. Tie Wire: 16-Gauge stainless steel with twisted ends on maximum 12-inch centers.
- C. Flexible Elastomeric Foam: ASTM C 534, Type I, flexible, cellular elastomeric, molded, 0.27 "K" value at 75 degree F mean temperature, maximum service temperature 220 degree F, water vapor permeability of 0.10 perm-inch, 25/50-flame spread/smoke developed rating (ASTM E 84, UL 723, and NFPA 255).

2.3 DUCTWORK INSULATION

- A. Rigid Fiberglass Board: ASTM C 612, Type IA and IB, 3 lb/cu ft density, 0.23 "K" value at 75 degree F mean temperature, maximum service temperature 450 degree F, moisture sorption less than 5.0% by weight, aluminum foil facing reinforced with fiberglass scrim laminated to UL rated Kraft paper. Composite 25/50-flame spread/smoke developed rating (ASTM E 84, UL 723, and NFPA 90A).
  - 1. Secure with UL listed pressure sensitive tape and/or outward clinched expanded staples and vapor barrier mastic as needed.
- B. Flexible Fiberglass Blanket: ASTM C 553, Type II, 3/4 lb/cu ft density, 1-1/2 inch thickness, 0.27 "K" value at 75 degree F mean temperature at compressed thickness, maximum service temperature 250 degree F, moisture sorption less than 0.2% by volume, aluminum foil facing reinforced with fiberglass scrim laminated to UL rated Kraft paper. Composite 25/50-flame spread/smoke developed rating (ASTM E 84, UL 40, and NFPA 90A).
  - 1. Secure with UL Listed pressure sensitive tape and/or outward clinched expanded staples and vapor barrier mastic as needed.
- C. Kitchen exhaust grease ductwork requires 2 layers of fire rated duct wrap, including all access doors. When ducts penetrate a fire rated wall, ceiling or floor, an approved firestop system must be employed to maintain the fire rating of the assembly. Install duct wrap per manufacturer's instructions and procedures.
  - 1. Grease Duct Fire Wrap: Fire resistant, inorganic blanket, encapsulated with a flexible outer layer of foil, must be tested and listed per UL 1978, and ASTM E 81 and ASTM E- 2336 and comply with NFPA 96, IMC, Standard Mechanical and Building Codes. Such material shall be installed in accordance to manufacturer's instructions and with the approved listing agencies.
- D. Ductwork Insulation Accessories: Provide staples, bands, wires, tape, anchors, corner angles and similar accessories as recommended by insulation manufacturer for applications indicated.
- E. Ductwork Insulation Coating, Mastics, Adhesives and Sealants:
  - 1. Vapor Barrier Coating (Store and apply between 40°F and 100°F, protect from freezing until dry): Used on below ambient piping/duct to prevent moisture ingress. Comply with MIL-PRF-19565C, Type II and QPD listed. Permeance shall be 0.013 perms or less at 43 mils dry per ASTM E 96, Procedure B.
    - a. Foster 30-80
    - b. Childers CP-38
    - c. Vimasco 749
  - 2. Weather Barrier Mastic (Store and apply between 40° F and 100° F, protect from freezing until dry): Used on above ambient piping/duct outdoors.
    - a. Fosters 46-50
    - b. Childers CP-10/11
    - c. Vimasco WC-5
  - 3. Lagging Adhesive/Coating (Store and apply between 40° F and 100° F, protect from freezing until dry): Comply with MIL-A-3316C, Class 1, Grade A.
    - a. Foster 30-36
    - b. Childers CP-50AHV2
    - c. Vimasco 713
  - 4. Fiberglass Adhesive (Store and apply between 40° F and 100° F, protect from freezing until dry): Comply with LEED IEQ Credit 4.1, meet California Dept. of Public Health

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(DDPH) Standard Method Ver. 1.1, 2010 Small Scale Environmental Chamber Test for VOC's for CA Specification 01350. Comply with ASTM C916, Type II.

- a. Foster 85-60
  - b. Childers CP-127
  - c. Vimasco 795
5. Metal Jacketing/Flashing Sealant (Store and apply between 40° F and 100° F, protect from freezing until dry): Used to seal metal jacketing laps against water entry and to flash penetrations.
- a. Foster 95-44
  - b. Childers CP-76
  - c. Pittsburgh Corning PC 727
6. Reinforcing Mesh: Used in conjunction with coatings and mastics.
- a. Foster Mast a Fab
  - b. Childers Chil Glas #10
  - c. Vimasco Elast a Fab
7. Self-Adhesive Indoor/Outdoor Jacket (Non Asphaltic): Vapor barrier and waterproofing jacketing for installation over insulation located aboveground outdoors or indoors. Specialized jacket with five layers of laminated aluminum and polyester film with low temperature, acrylic, pressure sensitive adhesive; outer aluminum surface coated with UV resistant coating for protection from environmental contaminants. Permeance: 0.00 perm as tested by ASTM F 1249. Flame Spread <25, Smoke Developed <50 tested by ASTM E-84. Aluminum finish.
- F. Round Ducts and Concealed Rectangular Ducts: Adhere flexible insulation to ductwork with adhesive applied in 6-inch wide strips on 16-inch centers. Butt insulation and seal joints and breaks with 2-inch lap of foil adhered over joint.

### PART 3 - EXECUTION

#### 3.1 INSPECTION

- A. Examine areas and conditions where mechanical insulation is to be installed. Do not proceed until unsatisfactory conditions have been corrected in manner acceptable to Installer.

#### 3.2 HVAC PIPING INSULATION (Based 2009 IECC and ASHRAE 90.1-2010)

- A. Refrigerant Piping:
1. Applications:
    - a. Suction
  2. Insulation:
    - a. Flexible Elastomeric: 1 1/2-Inch thickness.
- B. Cold Piping (40 Degree F (4 Degree C) to Ambient):
1. Applications:
    - a. Cooling coil condensate drain.
  2. Insulation:
    - a. Fiberglass: 1 1/2-Inch thickness.



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- C. Low Temperature Cold Piping (40-60 Degrees F (4-15 Degrees C)).
  - 1. Applications:
    - a. Chilled Water supply and return.
  - 2. Insulation:
    - a. Fiberglass : 1-1/2 Inch thickness.
- D. Hot Piping (105 to 140 Degree F):
  - 1. Applications:
    - a. Hot Gas
    - b. Hot Gas Bypass
  - 2. Insulation:
    - a. Fiberglass: 1 1/2-Inch thickness up to 1-1/2 inch pipe size, 2-inch thickness for all other pipe sizes.
- E. Hot Low Pressure Piping (Water to 250 Degree F (121 Degree C):
  - 1. Applications:
    - a. Hot water supply and return.
    - b. Low-pressure steam vent and relief.
    - c. Boiler feed water.
    - d. Boiler blow down.
  - 2. Insulation:
    - a. Fiberglass: 2-1/2 Inch thickness up to 3" inch pipe, 3-inch thickness for all other pipe sizes.
    - b. Fiberglass for runouts up to 2-inch, 1-inch thickness.

### 3.3 DUCTWORK INSULATION

- A. Flexible Fiberglass Blanket:
  - 1. Concealed supply ductwork without liner: 1-1/2 Inch thickness. (IECC R5 min)
  - 2. Return ductwork in unconditioned spaces without liner: 1-1/2 Inch thickness. (IECC R5 min)
  - 3. Exhaust ductwork within 10 ft. of exterior opening without liner: 1-1/2 Inch thickness.
  - 4. Unit housings that are not factory insulated: 1-1/2 Inch thickness.
- B. Rigid Fiberglass Board:
  - 1. Outside air ductwork and plenums: 1-1/2 Inch thickness.
  - 2. Combustion air ductwork and plenums: 1-1/2 Inch thickness.
  - 3. Mixed air ductwork and plenums: 1-1/2 Inch thickness.
  - 4. Supply and return ducts exposed to the outdoors: 2-Inch thickness. (2006 International Energy Code  $\Rightarrow$  R:8; 2-inch Rigid = R:8.7)
  - 5. Exhaust ducts between the air-handling unit and the exterior opening: 1-1/2 Inch thickness.

### 3.4 INSTALLATION OF PIPING INSULATION

- A. Install insulation after piping system tests have been completed.
- B. Clean piping to remove foreign substances and moisture prior to applying insulation.

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- C. Install insulation products according to manufacturer's written instructions, building codes, and recognized industry standards.
- D. Omit insulation on air chambers, unions, balance cocks, flow regulators, buried piping, and pre-insulated equipment.
- E. Omit insulation on hot piping within radiation enclosures or unit cabinets; on cold piping within unit cabinets provided piping is located over drain pan; on heating piping beyond control valve, located within heated space; on condensate piping between steam trap and union; and on unions, flanges, strainers, flexible connections, and expansion joints.
- F. Secure longitudinal jacket laps and butt strips according to manufacturer's recommendations.
- G. Firmly rub lap and butt strips to pressurize seam and ensure positive closure.
- H. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use scraps.
- I. Apply insulation to piping with all joints tightly fitted to eliminate voids.
- J. Apply insulation on cold surfaces with a continuous, unbroken vapor seal. Hangers, supports, and anchors that are secured directly to cold surfaces must be adequately insulated and vapor sealed to prevent condensation. Seal pipe terminations in chilled water or glycol systems every four (4) pipe sections with vapor barrier coating.
- K. Extend surface finishes to protect all surfaces, end, and raw edges of insulation.
- L. Protect vapor-barrier jackets on pipe insulation from puncture or other damage. Avoid the use of staples on vapor barrier jackets. Seal vapor barrier penetrations with vapor barrier coating.
- M. Cover valves, fittings and similar items with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded or job fabricated covers (at Installer's option). Coat all below ambient valves, fittings and similar items with vapor barrier coating and reinforcing mesh before application of PVC covers.
- N. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where fire-stopping materials are required.
- O. Provide thermal shield inserts on all pipe (Refer to 230529). For piping below ambient temperature, apply vapor barrier lap cement on butt joints and seal with 3-inch wide vapor barrier tape.
  - 1. Minimum insulation insert lengths:
    - a. 1-1/2 – 2-1/2 Inch Pipe: 10-Inches
    - b. 3 – 6-Inch Pipe: 12-Inches
    - c. 8 – 10-Inch Pipe: 16-Inches
    - d. 12-Inch and Larger Pipe: 22-Inches
- P. Apply galvanized metal shields between hangers or supports and pipe insulation. Form shields to fit the insulation and extend up to the centerline of the pipe. The shield length shall be 4- inches less than the associated insulation hanger insert to allow for vapor retarding butt joints on each side of the shields.

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- Q. Apply adhesives, mastics and coatings at manufacturer's recommended minimum coverage per gallon.
- R. Replace all damaged insulation in whole; Repair of damaged insulation will not be accepted.
- S. Insulate fittings and valves with PVC insulated fitting covers and insulation inserts per manufacturer's recommendations.
- T. Install aluminum jacket on exterior piping.
  - 1. Install metal jackets by overlapping seams 2-inches and securing with metal bands on 24-inch centers. Caulk all seams with 1/8" Bead of metal jacketing sealant. Locate longitudinal seams at the bottom of piping. Finish elbows and tees with matching metal fitting covers. Finish other fittings with conventional weather insulation materials with aluminum finish.

### 3.5 INSTALLATION OF DUCTWORK INSULATION

- A. Install insulation products according to manufacturer's written instructions, building codes, and recognized industry standards.
- B. Do not insulate fiberglass ductwork or lined ductwork.
- C. Clean ductwork to remove foreign substances and moisture prior to applying insulation.
- D. Apply insulation to ductwork with all joints tightly fitted to eliminate voids
- E. Seal all vapor retardant jacket seams and penetrations with UL listed tapes or vapor retardant adhesive as recommended by the manufacturer. Coat all seams, breaks, tape patches and penetrations with vapor barrier coating.
- F. Secure insulation to the underside of duct 24-inches or greater with mechanical fasteners or speed clips spaced 18-inches on center. Cut off protruding ends of fasteners after speed clips are installed and seal penetration of vapor barrier.
- G. Extend ductwork insulation without interruption through walls, floors and similar penetrations, except where fire-stopping materials are required.
- H. Install corner angles on all external corners of insulation in exposed finished spaces before covering with jacketing.
- I. Adhere flexible elastomeric sheets to ductwork by compression fit and full coverage of adhesive. Seal butt joints with same adhesive. Apply the same sheet thickness on standing metal duct seams as installed on the duct surface.
- J. Jacket outdoor rigid insulation with Flexible Jacketing Membrane as specified. All longitudinal and circumferential seams must be overlapped a minimum of 3" (75mm). Ensure complete contact at the laps and to the substrate using a tape squeegee or roller applying firm pressure throughout. Install in strict accordance with manufacturer's guidelines.

### 3.6 INSTALLATION OF EQUIPMENT INSULATION

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- A. Install insulation products according to manufacturer's instructions, building codes, and recognized industry standards.
- B. Apply insulation as close as possible to equipment by grooving, scoring, and beveling insulation, if necessary. As required, secure insulation to equipment with studs, pins, clips, adhesive, wires, or bands
- C. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment use vapor retardant cement
- D. Provide insulated dual temperature or cold equipment containing fluids below ambient temperature with vapor retardant jackets
- E. Maintain integrity of vapor-barrier on equipment insulation and protect it to prevent puncture and other damage.
- F. Do not apply insulation to equipment, mufflers, breechings, or stacks while hot.
- G. Apply insulation using staggered joint method and double layer construction. Apply each layer of insulation separately.
- H. Cover insulated surfaces with layer of insulating cement, troweled in workmanlike manner, leaving smooth continuous surface. Fill in scored block, seams, chipped edges and depressions, and cover over with wire netting and joints with 1/4-inch thick cement to remove surface irregularities.
- I. Cover insulated surfaces with all-service jacketing neatly fitted and firmly secured. Lap seams at least 2-inch. Apply over vapor barrier where applicable.
- J. Do not insulate manholes, handholes, cleanouts, ASME stamp, or manufacturer's nameplate. Provide neatly beveled edge at interruptions of insulation.
- K. Provide removable insulation sections with aluminum jacket and stainless steel bands to cover parts of equipment which must be opened for maintenance; include metal vessel covers, fasteners, flanges, frames and accessories.
- L. Provide aluminum jacketing on exterior insulated equipment as recommended by manufacturer. On flexible elastomeric insulation, apply two (2) coats of manufacturer's approved U.V. resistant finish.

### 3.7 EXISTING INSULATION REPAIR

- A. Repair damaged sections of existing mechanical insulation, damaged during this construction period and within 3 ft of new connections.
- B. Provide unit price to repair existing mechanical insulation on piping.

END OF SECTION 230700

**SECTION 230800 - MECHANICAL COMMISSIONING**

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Purpose:
  - 1. Verify operation and functional performance of Central Mechanical HVAC Systems, Controls and Electrical Systems for compliance with "Design Intent", as defined by the Contract Documents.
  - 2. Document Mechanical and Electrical System test and inspections.
  - 3. Verify application of Operation and Maintenance Manuals, As-Built (Record) Documents, spare parts lighting, special tools, controls and other items as may be specified herein for support of Mechanical and Electrical Systems and Equipment.
  - 4. Provide indirect support of the training of personnel for operation and maintenance of Mechanical and Electrical Equipment and Systems.
- B. General:
  - 1. Furnish labor and material to accomplish complete Mechanical and Electrical System Commissioning as specified herein. Complete interim commissioning of HVAC Systems during initial season operation.
- C. Job Conditions: The Commissioning Contractor shall become familiar with the contract documents, all addenda, and change orders issued for this project prior to commencing the commissioning work.

1.2 QUALITY ASSURANCE

- A. Reference: ASHRAE Guideline 1P, "Guideline for Commissioning of HVAC System".
- B. Qualifications: The "Commissioning Authority" shall be defined as a company or agency of experienced personnel, qualified to plan and carry out the overall commissioning progress. The Commissioning Authority shall submit for Owner review, an outline of the organization's personnel qualification resources, commissioning, documentation process and commissioning plan specifically prepared for this project.

1.3 DOCUMENTATION

- A. The Commissioning Authority shall obtain the following:
  - 1. Project Plans and Specification (Contract Documents), Authorized Revisions, Shop Drawings and Submittals (approved), Test and Balance Report, Equipment Start-Up and Certification Reports, Operation and Maintenance Manuals, etc.
  - 2. Records of required Code Authority Inspections, Contractor Test Inspections, Documentation Sign-Offs, etc.

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### 1.4 SUBMITTALS

- A. Commissioning Authority will submit the name of the Commissioning Project Manager approval prior to starting the commissioning process.
  - 1. Commissioning Plan (Describe extent and delivery schedule.)
  - 2. Commissioning Outline Plan (Describe extent of plan, expected duration of observations, personnel involved, schedule, etc.)
  - 3. Tool List: Provide a detailed list of the tools required for the commissioning process.

### 1.5 RESPONSIBILITIES OF OTHERS: Applicable specification sections outline trade responsibilities during the commissioning process.

- A. General Contractor:
  - 1. General Contractor shall verify completeness of the building envelope, perimeter and interior items which effect proper operation and control of HVAC equipment and systems.
  - 2. The General Contractor will assure participation and cooperation of specialty contractors (Mechanical, TAB, Building Automation System, etc.) under his jurisdiction as required for the commissioning process.
- B. Contractors Specialty:
  - 1. Individual Mechanical and Electrical Sub-Contractors will be responsible for providing labor, material, equipment, etc., required within the scope of this specialty to facilitate the commissioning process. The listed Sub-Contractor will perform tests and verification procedures required by the commissioning process when requested by the Commissioning Authority and directed by the General Contractor.
- C. Owner/Operator:
  - 1. Owner/Operator may schedule personnel to participate in commissioning process.
  - 2. Owner/Operator will advise the Commissioning Authority regarding changes in building occupancy, usage, or functional requirements.

## PART 2 - PRODUCTS

### 2.1 INSTRUMENTATION

- A. Instrumentation will be provided by agency performing prior tests. Instruments will be operated by individual agency requested by the Commissioning Authority, as specified elsewhere herein.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. Commissioning Authority will participate in the Final Construction Phase of the Project to assure compliance with specific Commissioning Requirements.

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### 3.2 PROCEDURE

- A. Attend Construction Meeting and establish requirements for the Commissioning Process throughout Construction Phase.
- B. Prepare and submit to the Owner's representative after contract award, a Commissioning Plan which shall outline:
  - 1. Responsibility of each trade affected by Commissioning as required by appropriate section of this specification.
  - 2. Requirement for documentation as listed elsewhere herein.
  - 3. Requirements for documentation of tests and inspections required by Code Authorities.
  - 4. Requirements for the Commissioning Program during specified operational seasons, part and full loads as further delineated in PART 3.3.
- C. Periodically attend construction and coordination meetings.

### 3.3 MECHANICAL SYSTEMS COMMISSIONING

- A. Mechanical System Commissioning shall begin after HVAC equipment and systems, along with related equipment, systems, structures and areas are complete.
- B. Verify TAB Readings, such as:
  - 1. Supply and Return Air CFM Quantities
  - 2. Fan Performance
  - 3. Hydronic Performances
  - 4. Refrigeration Side Performance
  - 5. Chiller Performance
  - 6. Boiler Performance
- C. Verify calibration of thermostats and related controls, such as:
  - 1. VAV Boxes
  - 2. Valve Positions
  - 3. Damper Position
- D. Verify readings of remote data and control systems, such as:
  - 1. Temperature
  - 2. Air Flow
  - 3. Damper Positions
  - 4. Water Pressure
  - 5. Water Temperatures
- E. Verify operation of system modes, such as economy cycle, smoke removal and in specific:
  - 1. Damper and Fan Operation
  - 2. Smoke Detector Response
  - 3. Zone Response
- F. Verify that total HVAC System is performing to provide conditions as outlined in the Contract Documents, including seasonal, part and full load conditions.

**COMMISSIONING CHECKLIST**

The following Commissioning Checklists are provided to illustrate the minimum information which should be included in the Commissioning Checklist Final Report.

**COMMISSIONING CHECKLIST - CHILLER**

1. Prior to Functional Performance Test:
  - a. Chiller has been set in place and piped - hydrostatically leak tested.
  - b. Factory start-up and check out complete with report submitted.
  - c. Chiller safety and protection devices tested, report submitted.
  - d. The following Checklists completed and submitted:
    - 1) Chilled Water
    - 2) Cooling Tower
    - 3) Controls and Instrumentation Checklist
    - 4) Test and Balance Report submitted
2. Personnel present during demonstration:
  - a. General Contractor, Mechanical, Electrical, and Controls Contractor
  - b. Commissioning Authority
  - c. Owner's Representative
3. Functional Performance Test: Contractor shall demonstrate operation of chilled water system, as per specifications, including the following: Start building air handler to provide load for chiller. Activate controls system chiller start sequence as follows:
  - a. Time of day start-up program initiates chiller start.
  - b. Start chilled water pump, establish flow, activate chiller proof of flow switch.
  - c. Control system energizes chiller start sequence.
  - d. Chiller senses chilled water temperature above setpoint, chiller control system activates start.
  - e. Verify functioning of "soft start" sequence, record motor amperage as a time function.
  - f. Chiller load to be calculated by controls system, provide trend log of load imposed.
  - g. Shut-off air handler to remove load on chilled water system.
  - h. Verify chiller shutdown sequence after load is removed.
  - i. Re-start air handler within two (2) minutes of chiller shutdown. Verify chilled water pump controls sequence.
4. Results:
  - a. The Commissioning Authority shall report results obtained in Item 3 above.
    - 1) If specified equipment performance is not verified, Commissioning Authority shall report remedial action required and re-schedule Functional Performance Test.
5. Reports:
  - a. Submit reports of Functional Performance Test in Item 3. above to Architect.

**COMMISSIONING CHECKLIST - PUMPS**

1. Prior to Functional Performance Test:
  - a. Pumps in place, grouted, vibration isolation devices functional, pump alignment, and rotation verified.
  - b. Power available with motor protection, safeties, control system contractors, and interlocks functional.



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- c. Piping system pressure tested, cleaned, chemical water treatment complete and report submitted. Piping systems filled and chemically treated (where applicable).
  - d. Pressure and temperature gauges installed and functional.
  - e. Water balance complete with design maximum flow, pressures obtained, and report submitted.
2. Personnel present during demonstration:
    - a. General Contractor, Mechanical Contractor, Controls Contractor, Electrical Contractor
    - b. Commissioning Authority
    - c. Owner's Representative
  3. Functional Performance Test: Contractor shall demonstrate operation of pumps, as per specification, including the following:
    - a. Activate pump start using control system command.
    - b. Verify pressure drop across strainer, verify strainer is clean. Verify pump inlet/outlet pressure reading, compare to Test and Balance Report, pump design conditions, and pump manufacturer's performance data. Operate pump at shutoff, 50 percent and 100 percent flow. Plot test readings on pump curve. Verify specified flow is obtained.
    - c. Verify motor amperage each phase and voltage phase to phase and phase to ground.
    - d. Check and report unusual vibration, noise, etc.
  4. Results:
    - a. The Commissioning Authority shall report results obtained in Item 3 above.
    - b. If specified equipment performance is not verified, Commissioning Authority shall report remedial action required and re-schedule Functional Performance Test.
  5. Reports:
    - a. Submit reports of Functional Performance Test in Item 3. above to Architect.

### **COMMISSIONING CHECKLIST - HOT WATER BOILERS**

1. Prior to Functional Performance Test:
  - a. Boiler has been set in place and piped - hydrostatically leak tested.
  - b. Factory start-up and check out complete with report submitted.
  - c. Boiler safety and protection devices tested, report submitted.
  - d. The following Checklists completed and submitted:
    - 1) Boiler Water
    - 2) Primary and Secondary Water Pumps
    - 3) Controls and Instrumentation Checklist
    - 4) Test and Balance Report submitted
    - 5) Chemical Treatment Report
    - 6) Natural Gas Delivery Systems
    - 7) Boiler Flues
2. Personnel present during demonstration:
  - a. General Contractor, Mechanical, Electrical, and Controls Contractor
  - b. Commissioning Authority
  - c. Owner's Representative
3. Functional Performance Test: Contractor shall demonstrate operation of hot water boiler system, as per specifications, including the following: Start building air handlers to provide load for boiler. Activate controls system boiler start sequence as follows:
  - a. Time of day start-up program initiates boiler start.
  - b. Start boiler water pump, establish flow, activate boiler proof of flow switch.

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- c. Start boiler internal circulation pump.
  - d. Verify low water cutoff safety and water makeup supply.
  - e. Verify operation of temperature and pressure gauges. Operate high pressure limit control.
  - f. Verify operation of water relief valves.
  - g. Verify operation of temperature controls to operate burner.
  - h. Verify burner operation on natural gas.
  - i. Verify operation of forced draft blower and combustion air modulating damper.
  - j. Inspect boiler control panel for operation of controls and indicating lights.
  - k. Verify ignition timing for pre-combustion purge and post combustion purge and flame failure shutdown.
  - l. Verify chemical treatment report.
  - m. Provide boiler stack analysis to verify full load and part load thermal efficiency.
4. Results:
- a. The Commissioning Authority shall report results obtained in Item 3 above.
  - b. If specified equipment performance is not verified, Commissioning Authority shall report remedial action required and re-schedule Functional Performance Test.
5. Reports:
- a. Submit reports of Functional Performance Test in Item 3. above to Architect.

### **COMMISSIONING CHECKLIST - VAV DEVICES AND DUCTWORK**

1. Prior to Functional Performance Test:
  - a. All VAV boxes are in place, ducted, connected to controls system, heating boxes connected to electrical circuits with local disconnects mounted.
  - b. Ductwork complete, as-built shop drawings submitted, duct pressure and leakage test complete.
  - c. Duct Static Pressure Sensor installed, calibrated and transmitting 4-20 MA signal to fan speed controller. DDC controls system operational with input/output from each VAV box and thermostat verified, local controller functional and monitoring CRT functional.
  - d. Smoke/Fire Dampers installed as required with access; verify status as to open/closed position.
  - e. Test and Balance Operation is complete including each VAV box calibrated for maximum/minimum flow settings, low pressure duct and devices balanced at maximum flow conditions, heating VAV boxes fan speed setting/air flow adjusted.
2. Personnel present during demonstration:
  - a. General Contractor and Mechanical, Controls and Electrical Contractor
  - b. Commissioning Authority
  - c. Owner's Representative
3. Functional Performance Test: Contractor shall demonstrate operation of VAV boxes, as per specifications, including the following:
  - a. Cooling/Heating VAV Boxes: With system as described above, perform all cooling only tests at noted. In addition, for space heating requirement demonstrate the following:
    - 1) VAV Box response to room temperature setpoint adjustment at local controller and CRT. Changes to be 78 degree F to 68 degree F, 72 degree F and 82 degree F.
      - a) Check damper maximum/minimum flow settings.

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- b) Verify damper actuator response to control input changes and rate of response. Record room temperature change, rate of change and overshoot/undershoot of desired temperature.
  - b. VAV Box response to sensor call for heating via setpoint adjustment, local controller and CRT changes. Changes to be warm-up from 55 degree F to 68 degree F, from 68 degree F to 74 degree F. Verify cooling damper closes to minimum position, fan energized to circulate air, and upon further drop in space temperature (T-stat adjustment acceptable), verify hot water reheat activation, deactivation, and shutoff on loss of air flow. Loss of air flow to be demonstrated by interrupting interlock or manual air vane flow sensor adjustment. Record room temperature change, rate of change and overshoot/undershoot of setpoint temperature.
4. Results:
- a. The Commissioning Authority shall report results obtained in Item 3. above.
  - b. If specified equipment performance is not verified, the Commissioning Authority shall report remedial action required and re-schedule Functional Performance Test.
5. Reports:
- a. Submit reports of Functional Performance Test in Item 3. above to Architect.

### **COMMISSIONING CHECKLIST - AIR HANDLING UNITS**

1. Prior to Functional Performance Test:
- a. Verify unit is properly installed, securely fastened to floor with vibration isolators, access doors are operable and sealed, dampers and casing undamaged, insulation, drain pan and interior are not damaged. Check and verify condensate drainage is unobstructed.
  - b. Verify power available to unit disconnect and control panel.
  - c. Verify chilled water piping or DX piping (where applicable) is connected to cooling coils, pressure tested, cleaned, and chemical treatment performed with report submitted.
  - d. Verify control valves and damper actuators are installed, control power is energized and valves/dampers operable.
  - e. Verify variable speed supply fan controller is energized with control power source available (if applicable).
  - f. Verify shipping blocks on supply fan isolation rails are removed, fan drive and motor adjusted, check rotation.
  - g. Verify return fan drive and motor adjusted, check rotation.
  - h. Verify construction start-up T & B filters removed and replaced with new filters. During testing, completely blanket filters with filter media to simulate 0.5 in W.C. pressure drop (1/2 dirty filters).
  - i. Test and Balance Report submitted.
2. Personnel present during demonstration:
- a. General Contractor and Mechanical, Electrical, and Controls Contractor
  - b. Commissioning Authority
  - c. Owner's Representative
3. Functional Performance Test: Contractor shall verify operation of air handling unit (AHU), as per specification, including the following:
- a. Activate AHU's using control system command.
  - b. The following Sequence of Control shall be verified:  
Start-Up:
    - 1) Minimum and economizer outside air damper closed.
    - 2) Return air damper open.

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- 3) Relief air damper closed.
  - 4) Low temperature cut-out allows start of fan if temperature inside unit is above 45 degree F.
  - 5) Multizone AHU's zone dampers motors are installed and operational.
  - c. Normal Day-Time Operation - Ambient temperature above specified economizer changeover.
    - 1) Minimum outside air damper open.
    - 2) Economizer outside air damper closed.
    - 3) Return air damper open.
    - 4) Relief air damper closed.
    - 5) Fan multizone controller receiving signal from temperature sensor.
    - 6) Chilled water control valves modulate to maintain 55 degree F leaving air temperature.
  - d. Economizer Cycle outside air temperature less than specified economizer changeover.
    - 1) Minimum outside air damper open.
    - 2) Economizer outside air damper modulated to maintain 60 degree F supply air.
    - 3) Relief air damper modulates to relief economizer supply air.
    - 4) Chiller and chiller pumps/cooling tower and pumps off.
    - 5) Fan multizone controller receiving signal from temperature sensor.
  - e. Night-Time Shutdown (where applicable).
    - 1) Outside air dampers closed.
    - 2) Return air damper open.
    - 3) Relief air damper closed.
    - 4) Ambient conditions below 45 degree F, activate unit heating coil to maintain 50 degree F inside building.
  - f. Verify VAV fan inlet vane controller calibration and maintenance of duct static pressure 1.5 in W.C.  $\pm$  0.2 in during 20 percent to 100 percent of design air flow.
  - g. Verify chilled water coil control valves sequence to operate 1/3 coil valve to full open, then 2/3 coil valve to full open and the reverse sequence under varying load conditions.
  - h. Verify unit shutdown during fire event initiated by smoke/heat sensors, or day room smoke purge activation.
  - i. Verify air flow balance, outside air/return air, during variable unit air flow conditions.
4. Results:
- a. The Commissioning Authority shall report results obtained in Item 3 above.
  - b. If specified equipment performance is not verified, Commissioning Authority shall report remedial action required and re-schedule Functional Performance Test.
5. Reports:
- a. Submit reports of Functional Performance Test in Item 3. above to Architect.

### **COMMISSIONING CHECKLIST - BAS CONTROLS SYSTEM**

1. Prior to Functional Performance Test:
  - a. All control devices are in place, operable, calibrated, and communicating with local control panels and operator interface terminal communicating with local control panels and operator interface terminal (CRT).
  - b. Test and verify power supplies, wiring, low voltage transformers, allowable voltage drops, and related interlocks are available and meet specifications. Continuity has been checked.
  - c. Verify that control software programs have been loaded, edited and operational.

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- d. Controlled devices, mechanical equipment, actuators, and sensors are complete and operable.
  - e. Interrupt building power supply for thirty (30) minutes, re-energize, verify software packages and programming remained intact and operable after interruption.
2. Personnel present during demonstration:
- a. General, Mechanical, Electrical, and Controls Contractor
  - b. Commissioning Authority
  - c. Owner's Representative
3. Functional Performance Test: Contractor shall verify operation of the controls system, as per specification, and the following:
- a. Sensing Element: Verify wall mounted sensing elements are located per plans, securely mounted on wall with protective cover. Furnish plans, securely mounted on wall with protective cover. Furnish calibrated digital thermometer 40-105 degree F + 0.5 degree F accuracy to verify reporting temperature of each sensing element. At each sensing element, compare temperature sensed vs. actual temperature. Query each sensing element from local control panel and CRT; allowable variance is 0.5 degree F from digital thermometer.
  - b. Follow procedure described in Item a. above for all temperature-sensing devices.
  - c. VAV Box Controllers, refer to demonstration procedure in VAV Section.
  - d. In each VAV Control Zone, reset setpoint from 72 degree F to 60 degree F, then record time to achieve setpoint (as climatic conditions and internal loads permit).
  - e. Night Setback (as climatic conditions allow): Verify heating VAV boxes operate to maintain 55 degree F space temperature.
  - f. Morning Warm-Up Cycle: Verify warm-up time, trend logging function, and reset of warm-up time at different ambient conditions, i.e. 50 degree F ambient and 30 degree F.
  - g. Air Handling Unit: Refer to demonstration procedure in applicable section. At CRT, reset leaving air temperature setpoint, log response of multizone AHU's zone control valves, space temperatures, VAV box reactions, and system flow in system.
  - h. Chiller/Cooling Tower/Pumps: Log chiller load and leaving water temperature as a result of resetting chilled water setpoint from 45 degree F to 50 degree F.
  - i. For all controls Functional Performance Test, prepare report in format as follows:

Binary Points (per specified points list):

1)	Verify	<u>YES</u>	<u>NO</u>
	Command Issued	___	___
	Command Accepted	___	___
	Command Executed	___	___
	Controlled Device Responded	___	___
	Feedback Verified Response	___	___

Analog Points (per specified points list):

2)	Verify	<u>YES</u>	<u>NO</u>	<u>INITIAL*</u>	<u>FINAL*</u>
	Command Issued	___	___	_____	_____
	Command Accepted	___	___	_____	_____
	Command Executed	___	___	_____	_____
	Controlled Device Responded	___	___	_____	_____
	Feedback Verified Response	___	___	_____	_____

\*Status/Readings to be reported as follows:  
Control Signal

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Actual System Effect: Air flow, temperature, pressure, etc.

For interlocked devices, positioners, multiple points of control for each command, list effect and response on all devices.

4. Results:
  - a. The Commissioning Authority shall report results obtained in Item 3 above.
  - b. If specified equipment performance is not verified, Commissioning Authority shall report remedial action required and re-scheduled Functional Performance Test.
5. Reports:
  - a. Submit reports of Functional Performance Test in Item 3. above to Architect.

END OF SECTION 230800

**SECTION 230900 – DIRECT DIGITAL CONTROL SYSTEM**

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Provide a direct-digital control (DDC) system per the project documents, point list, interoperability tables, drawings and specifications. Include all engineering, programming, controls and installation materials, installation labor, commissioning, start-up, training, final project documentation and warranty.
1. The DDC system shall consist of high-speed BACnet IP, peer-to-peer network of DDC controllers, a dedicated server, a Personal Computer Operator Workstation (OWS) and printer. Provide remote access using a standard client server web browser to access the control system graphics, parameters and change adjustable set points with password protection.
  2. The direct-digital control system shall be native BACnet. All new work stations, controllers, devices and components shall be listed by BACnet Testing Laboratories (BTL) with accessibility using a Web browser interface, and shall communicate exclusively using the ASHRAE Standard 135 BACnet communications protocol without the use of gateways, unless otherwise allowed by this Section of the technical specifications and specifically shown on the design drawings.
    - a. If used, gateways shall support the ASHRAE Standard 135 BACnet communications protocol.
  3. The work administered by this Section of the technical specifications shall include all labor, materials, special tools, equipment, enclosures, power supplies, software, software licenses, project specific software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, submittals, testing, verification, commissioning, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, warranty, specified services and items required for complete and fully functional controls systems.
  4. The control systems shall be designed such that each mechanical system shall operate under stand-alone mode. The contractor administered by this Section of the technical specifications shall provide controllers for each mechanical system. In the event of a network communication failure, or the loss of any field controller, the control system shall continue to operate independently. Failure of the operator work station(s) (OWS) shall have no effect on the field controllers, including those involved with global strategies.
  5. The control system shall accommodate no less than two (2) operator work stations, the control system shall also accommodate web-based users simultaneously, and access to the system should be limited only by operator password.
  6. The control system will provide for future expansion to include monitoring of card access, fire alarm, energy management and lighting control systems.

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- B. The Contractor shall become aware of the Commissioning requirements outlined in Specification Section 230800. Change orders shall not be considered for time associated with these requirements.
- C. The Contractor shall become aware of the Method of Procedure requirements outlined in Division 1. Change orders will not be considered for time associated with Method of Procedure requirements.
- D. General: The Control System Contractor shall provide a complete new control system using new control devices to operate as specified. The Contractor shall inspect the existing conditions prior to submitting a proposal. The existing temperature control system devices, dampers, operators, wiring, conduit, air piping, valves, etc., not being modified and which are no longer utilized, shall be removed, and not abandoned in place.
- E. The Control System for this project will be referred to as a Building Automation System(BAS).
- F. Total quantity and type of control points shall consist of specifications, drawings and as required to complete the Sequence of Operation as specified. Additional points shall be provided as required to meet all operational functions, safeties, monitoring and reporting requirements. The Drawings and Specifications are not intended to show all details necessary to make the system complete and operable.
- G. The BAS shall include all control devices, valves, interlocks, field devices, hardware, software, automatic dampers, piping, fittings, wire, conduit, etc., as specified, required and connected so as to perform all functions and operate according to the specified sequences.
- H. This installation shall not be used as a test site for any new products unless explicitly approved by the Owner or Engineer in writing. Unless approved otherwise, all products (including firmware revisions) used in this installation shall have been used in at least twelve (12) projects prior to this installation. The previous sites may be located anywhere in the U.S.A. This requirement is not intended to restrict the Contractor to the use of any outdated equipment. Therefore, all products used in this installation shall also be currently under manufacture and have available, for at least ten (10) years after completion of the contract, including spare parts, board repairs and software revisions. If the above requirements are mutually exclusive, the Contractor shall include a specific statement to this effect in the Bid.
- I. Refer to other Division 23 sections for installation of instrument wells, valve bodies and dampers in mechanical systems.
- J. Provide electrical work as required, complying with requirements of Division 26 sections including, but not limited to raceways, wires, cables, electrical identification, supporting devices and electrical connections for equipment. Work includes, but is not limited to, the following:
  - 1. Interlock and control wiring between field-installed controls, indicating devices and unit control panels.
  - 2. The Contractor shall be responsible for all additional electrical and other costs involved to accommodate the temperature control system panel, motors and electrical devices requiring power which differs from the power requirements shown on the Electrical Drawings.

### 1.2 QUALITY ASSURANCE



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- A. Contractor's Qualifications: Firms regularly engaged in installation, commissioning and servicing of digital control equipment, of types and sizes required, whose firm has been in business in similar service for not less than five (5) years. Contractor shall have an established working relationship with the Control System Manufacturer of not less than three (3) years.
- B. Only those Contractors who are certified to install DDC systems from specified manufacturers are allowed to bid temperature controls. All bidders shall make available, upon the Owner's request, open book unit pricing of all materials and labor.
- C. The system shall be installed by competent mechanics, regularly employed by the Temperature Control Contractor.
- D. No Field Devices shall be multiplexed to a single I/O point unless specified. Each device or sensing point shall be terminated at a unique location on the Control Panel, Dedicated Controller or Slave and be associated with a unique software point on the BAS.
- E. Codes and Standards:
  - 1. All equipment and the installation shall comply with the requirements of all applicable local and national codes including but not limited to the currently enforced edition of the International Building Code, Fire Code, Electrical Code, and all applicable codes of the National Fire Protection Association including the National Electrical Code.
  - 2. Electrical Standards: Provide electrical products which have been tested, listed and labeled by UL and comply with NEMA Standards.
  - 3. NEMA Compliance: Comply with NEMA standards pertaining to components and devices for electric control systems.
  - 4. NFPA Compliance: Comply with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" where applicable to controls and control sequences.
- F. The Temperature Control Contractor shall cooperate with other contractors performing work on this project necessary to achieve a complete and neat installation. To that end, each contractor shall consult the drawings and specifications for all trades to determine the nature and extent of others work.
- G. It will be the responsibility of the Contractor to work in cooperation with the Owner and with all other contractors and employees rendering such assistance and so arrange his work such that the entire project will be delivered complete in the best possible condition and in the shortest time.

### 1.3 PROPRIETARY INFORMATION

- A. Project Documentation: All custom software, passwords, programs, code, databases, graphic files and drawings (whether hard copy or electronic files) prepared for this system shall be the exclusive property of the Owner and shall not be reproduced or distributed without prior written permission from the Owner.

### 1.4 SUBMITTALS

- A. Submit in accordance with Division 1 and 23 submittal requirements.

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- B. In addition to the requirements set forth in Paragraph A above, the following shall be included in the shop drawing submittals including, but not limited to:
1. Product Data: Submit manufacturer's technical product data sheets for each control device furnished, each data sheet shall be labeled indicating its' control drawing descriptor. When manufacturers data sheets apply to a product series rather than a specific product, the data that is specifically applicable to the project shall be highlighted or clearly indicated by other means. Submittals shall include the following:
    - a. Indicating dimensions;
    - b. Capacities;
    - c. Performance characteristics;
    - d. Electrical characteristics;
    - e. Finishes of materials;
    - f. Installation, start-up, test and verification instructions.
  2. Control system drawings containing pertinent data to provide a functional operating system and a sequence of operation.
  3. Detailed wiring diagrams.
  4. Schematic flow diagram of system showing fans, pumps, coils, dampers, valves, and all control devices. Identify all control points with labeling.
  5. Indicate for each control device a set point or adjustable range of control. Provide a bill of materials with manufacturer's part number.
  6. Indicate all required point-to-point electrical wiring. Clearly differentiate between portions of wiring that are existing and portions to be field-installed.
  7. Provide details of faces of control panels, including controls, instruments, and labeling.
  8. Include verbal description of sequence of operation and reference each device described by schematic symbol used.
  9. Provide a point list with database input information to include a point name, address, base and span, action and other required information.
  10. Provide a detailed test plan and procedure for each HVAC system and for each type of terminal unit control including valves. The test plans shall fully define reporting methods, procedure, equipment utilized, milestones for the tests, identifying the simulation programs, and personnel. The test procedures shall be developed from the test plans and shall consist of instructions for test execution and evaluation. A test report form shall be developed for each point and sequence of operation. Commissioning procedures shall be provided for each HVAC system and for each type of terminal unit control system. The procedure shall include set point, prop. band, integral, derivative, mode constraints input, output settings, tuning procedures., etc.
- C. Submit manufacturer's installation instructions.
- D. Submittal Data and Shop Drawings shall be prepared and submitted in the following formats:
1. All drawings prepared for the project shall be developed using the AutoCad CADD program Rev. 14.0 or most current version, (or a CADD package capable of producing AutoCad "DXF" compatible format files).
  2. All submittals data shall be the same size for any group of information and shall be in a three (3) screw and post binder. (NO EXCEPTIONS). All the information shall be indexed and tabbed with reference to the specific section of these specifications.
  3. The format for different groups of submittal information are as follows:
    - a. Control drawings, building plans (including complete floor plans), schematics and system configurations shall be CADD prepared drawing, bound and indexed. Drawings that cannot represent the total information on an individual ANSI size B

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- (11" x 17") drawing, i.e., a building plan, shall be noted with appropriate match lines, cross references and key plans.
- b. Technical data, sequence of operations, material list, point lists, program listings, I/O schedules, operator's and programmer's manuals, etc., shall be type written, original product data sheets or CADD prepared drawings, ANSI Size A or ANSI Size B.
4. Upon completion of the project and acceptance of systems, the Contractor shall provide to the Owner two (2) hard copies and one (1) electronic copy (CD or DVD) of Record (As-Built) Shop Drawings.
- E. Shop drawings shall include riser diagram depicting locations of all controllers and workstations, with associated network wiring. Also included shall be individual schematics of each mechanical system showing all connected points with reference to their associated controller, written operational sequences and testing and commissioning reports and checklists.
  - F. Shop Drawings shall be submitted for approval prior to beginning work. When the Architect/Engineer requires, the Contractor will resubmit with the corrected or additional submittal data. This procedure shall be repeated until all corrections are made to the satisfaction of the Engineer and the submittals are fully reviewed.
  - G. Contractor agrees that shop drawing submittals processed by the Architect/Engineer are not change orders, that the purpose of shop drawing submittals by the Contractor is to demonstrate to the Architect/Engineer that the Contractor understands the design concept, that he demonstrates his understanding by indicating which equipment and material he intends to furnish and install, and by detailing the fabrication and installation methods he intends to use. The Contractor shall be responsible for space requirements, configuration, performance, changes in bases, supports, structural members and openings in structure, and other apparatus that may be affected by their use.
  - H. Contractor further agrees that if deviations, discrepancies, or conflicts between shop drawing submittals and the contract documents in the form of design drawings and specifications are discovered either prior to or after shop drawing submittals are processed by the Architect/Engineer, the design drawings and specifications shall control and shall be followed. If alternates do not meet these requirements, it shall be this Contractor's responsibility to remove them and install material originally specified, at no cost to the Owner.
- 1.5 DELIVERY, STORAGE AND HANDLING
- A. Provide factory shipping cartons for each piece of equipment, and control device. Maintain cartons through shipping, storage and handling as required to prevent any equipment damage, and to eliminate all dirt and moisture from equipment. Store all equipment and materials inside and protected from weather.

## PART 2 - PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS AND CONTRACTORS

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- A. Subject to compliance with requirements, install a direct digital control system from one (1) of the following manufacturers / system integrators:
  - 1. Andover installed by Boulder County
  
- B. All BAS components shall be by one of the above manufacture's, except when "controls provided with the unit," "factory-mounted controls," "unit manufacturer provided controls," etc, are referenced by this specification, "BAS Components" includes BAS Panels/Routers/controllers, and operator interface, color-graphics interface, control and programming software. Valves, actuators, sensors, conventional thermostats and other stand- alone controls and other field devices need not be by the same manufacturer

### 2.2 GENERAL PRODUCTS DESCRIPTION

- A. The Building Automation System (BAS) shall be capable of integrating multiple building functions including equipment supervision and control, alarm management, energy management, historical data collection and archiving, maintenance support, custom processes and manual override monitoring. All products and materials installed shall be suitable for the intended application requirements including but not limited to:
  - 1. Accuracy
  - 2. Rangeability
  - 3. Temperature and pressure ranges
  - 4. Shutoff pressures
  - 5. Differential pressures
  - 6. Repeatability
  - 7. Materials of construction suitable with the environment and/or media in which they are in contact with
  - 8. Code compliance
  - 9. Velocities
  
- B. The BAS shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers, and operator devices. The system architecture shall support a minimum spare capacity of 20% for all types of DDC devices and all point types included in the initial installation. The BAS shall consist of the following:
  - 1. BACnetIP Architecture
  - 2. Operator Work Station
  - 3. Portable Operators Workstation
  - 4. Building Controllers
  - 5. Application Specific Controllers
  - 6. Point Expansion Modules
  - 7. Building Routers
  - 8. Auxiliary Control Devices
  - 9. Valves
  - 10. Dampers
  - 11. Actuators
  - 12. Power Supplies and Line Filtering
  - 13. Wiring and Raceways
  - 14. Sensors/Transmitters

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- C. BAS architecture shall eliminate dependence upon any single device for alarm reporting and control execution. Each DDC controller shall operate independently by performing its' own specified control, alarm management, operator I/O, and historical data collection. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.
- D. Each DDC controller shall continue to execute its control software, sample input points, and update output points without connection to the DDC panel network, Controller network or an operator interface.
- E. All DDC controllers shall be able to access data from, or send control commands and alarm reports directly to, any other DDC controller or combination of controllers on the network without dependence upon a central processing device. All DDC controllers shall also be able to send alarm reports to multiple operator workstations without dependence upon a central processing device.
- F. The BAS shall allow third party software to operate on a personal computer operator workstation without any degradation to the controls operating normally.
- G. Remote Communications: The BAS shall be remotely accessible via an Internet connection provided by others. Inherent in the system's design shall be the ability to expand or modify the network via the local area network, or auto-dial telephone line modem connections, or via a combination of the two (2) networking schemes.
- H. All DDC controllers and application-specific controllers shall be connected to DDC routers via "Controller Network(s)" (BACnet MS/TP). A sufficient number of DDC routers shall be provided to support the number of controllers and application-specific controllers required.
- I. A sufficient number of DDC routers/panels/controllers shall be provided to meet the memory needs of the BAS programming, alarming and trending (24 samples for each point alone, not including that needed for Measurement and Verification (M&V) along with 25% spare capacity for future use.
- J. A sufficient number of DDC routers/panels/controllers and application-specific controllers (here after referred to in general as "DDC device(s)") and point expansion modules shall be provided to meet the point needs of the project. Point termination types shall include:
  - 1. Analog Input (AI) – Thermistor, 0-10 VDC or 4-20 mADC
  - 2. Binary Input (BI) – Monitoring of dry contacts, including contact closure "pulses" up to 10 per second.
  - 3. Analog Output (AO) – 0-10 VDC, 0-20 VDC or 4-20 mADC
  - 4. Binary Output (BO) – Two state DC voltage signal or magnetically held dry contact closure.
- K. An application-specific controller shall not be used for systems/equipment that require custom application programming to meet the Sequence of Operation (i.e., if an application-specific controller is used, the factory-provided control software and program must be able to perform the Sequence of Operation without "upper level" control from a DDC panel, etc.).
- L. Digital Communications to Third-party Controls
  - 1. The BAS is required to send/receive information via digital communication technologies (e.g. Ethernet/IP, EIA-485); application protocols (e.g., BACnet, Modbus)

- to specified Third-Party controls provided under this or other sections of the specification (e.g. chillers, VFDs, BTU meters, electrical submeters, lighting controls, etc.).
2. See the Specification sections of the equipment involved, for the type of communications technology/interface (e.g. the data link layer protocol), and application protocol used by each of the Third-Party controls, and for the list of data to be shared with these controls.
  3. Communications not requiring a gateway (i.e., BACnet): Design the BAS to include the DDC device models (with optional modules if necessary) that provide the necessary data link layer interfaces.
- M. **Hardware Override Monitoring:** The BAS shall monitor the status or position of all overrides, and include this information in logs and summaries to inform the operator that automatic control has been inhibited. The BAS shall also collect override activity information for daily and monthly reports.
- N. **Power Fail Restart:** In the event of the loss of normal power, there shall be an orderly shutdown of all standalone DDC panels to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data, and battery back-up shall be provided to support the real-time clock and all volatile memory for a minimum of seventy-two (72) hours.
1. Upon restoration of normal power, the DDC panel shall automatically resume full operation without manual intervention.
  2. Should DDC panel memory be lost for any reason, the user shall have the capability of reloading the DDC panel via the local area network and Internet connection.

## 2.3 OPERATOR WORK STATION

- A. **Operator Interface Software** – The software shall include the following capabilities:
1. **Graphic screens display of custom graphic screens with dynamic point information and the ability to show animation by shifting image properties based on the status of the point.**
    - a. The terms “graphic screens” and “graphic(s)” in this specification refers to graphical images viewed via a PC running operator interface software or a PC viewing graphical images on web pages via a web browser.
    - b. **Graphic Generation:** Graphic files shall be created with the use of a graphics generation package furnished with the system. The graphics generation package shall also provide the capability of capturing or converting graphics from other programs such as (AutoCAD) (Revit).
    - c. **Graphics Library:** Furnish a library of standard HVAC system/equipment graphics screens such as chillers, boilers, air handlers, terminals, fan coils, unit ventilators, etc.; and standard symbols for HVAC components including fans, pumps, coils valves, piping, dampers, ductwork, etc.
  2. **System Applications** – Provide the following:
    - a. **System Databases Save and Restore:** Automatic (when changes occur) and/or manual backup of the system database (e.g., a DDC panel point database and/or control program). The operator shall also be able to manually initiate a download of a specified database to any DDC device in the BAS.
    - b. **System Configuration:** Provide application for BAS configuration (DDC device communications addressing, point definition, etc.).
    - c. **Help:** Provide a context sensitive help system to assist the operator in operation of the BAS.

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- d. Security: Each operator shall be required to log on to the BAS with a unique name and password in order to view edit, or delete data. System security level shall be configurable for each operator via the site administrator login.
- e. System Diagnostics: the System shall automatically monitor the operation of all DDC devices including network communications and provide an alarm when a failure occurs.
- f. Standard BAS Operating Features:
  - 1) Point/Data Overrides/Modifications: Output points and system data (i.e., set points) shall be modifiable (i.e., auto vs. manual and overridden value) via a link to each item's graphic screen image.
  - 2) Alarm Processing: An alarm log with acknowledgement and alarm clearing functions, the ability to configure alarm limits, and system reactions (e.g., an alarm message, communications method, etc.).
  - 3) Alarm Logs: The ability to define a custom historical trend log for any data in the system. The data can be displayed tabular or graphical.
  - 4) Scheduling: A graphical method for scheduling equipment operation including normal, holiday and exception scheduling.
  - 5) Utilize real time 3-D graphics for building control and visualization.
  - 6) The system is to utilize a Windows based object-oriented navigation system.
  - 7) System must be capable of paging, printing, texting and emailing alarm notifications.
  - 8) System must be able to analyze/display no fewer than eight trend logs in a real-time graph.
- 3. Control Software Editors: The software shall allow for Operator editing of all control applications including the following:
  - a. Application Specific Controller: A full screen graphical editor for each type of application that allows the operator to view and change the configuration, name control parameters, and set points for all controllers.
  - b. Custom Control Programming: A graphic for creating, modifying, and debugging the custom control programming for all routers/panels controllers.
  - c. Graphic Design Software: Software for generating new real-time 3-D graphics for use in the operator work station.
- 4. Web Server: This shall, as a minimum allow PC's running web browser software to perform all the capabilities described above except Graphic Generation, System Database and Restore, System Configuration, and Control Software Editors.
  - a. The software shall support an unlimited amount of client users.
  - b. Point/Data Overrides/Modifications: Output points and system data (i.e., set points) shall be modifiable (i.e., auto vs. manual and overridden value) via a link to each item's graphic screen image.
  - c. Alarm Processing: An alarm log with acknowledgement and alarm clearing functions: and the ability to configure alarm limits, and system reactions (e.g., an alarm message, communications method, etc.).
  - d. Trend Logs: The ability to define a custom historical trend log for any data in the system. The time stamp data can be displayed tabular or graphical.
  - e. Scheduling: a graphical method for scheduling equipment operation including normal, holiday and exception scheduling.
  - f. Utilize real time 3-D graphics for building control and visualization.
  - g. The system is to utilize a Windows based object-oriented navigation system.
  - h. The system shall allow tenant access to view and adjust local set point as well as view equipment in their space.
  - i. System must be capable of paging, printing and emailing alarm notifications.

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- j. System must analyze no fewer than eight trend logs in a real-time graph.
  - 5. Historical Data Management: Record extended periods of data from the DDC system which shall be integrated and viewable within the operator work station. The historical system should automatically restart following a power failure and will automatically determine the optimal time to back up data from the controllers to minimize data loss. The data should be stored in a SQL database to allow for access from third-party tools.
  - 6. Other Requirements:
    - a. Third-Party Software: Provide any other software needed for the operation of the operator interface software, such as Microsoft SQL or .NET, .AWN, Excel, etc.
- B. Hardware – Provide the following:
- 1. General: The specifications for the equipment below shall be the minimum provided. Expanded hardware capabilities (e.g., faster processor, larger hard drive, etc.) shall be provided based on the BAS manufacturer’s operator interface requirements and which are needed to meet the BAS needs for data storage including that for M&V (along with 25% spare capacity).
  - 2. Operator Work Station and Web Server
    - a. Operator Work station PC: Microsoft Windows-based desktop PC including Windows Professional operating system, MS Internet Explorer 8, MS Excel 2007, Intel I7 series processor with 2.5GHz speed minimum, 4GB RAM, 256 MB graphics card, one 16x CD/DVD +/-RW drive, 7200 rpm dual RAID 1TB hard disk drive, 10/100/1000 MHz Ethernet card, a 19” LCD color flatscreen monitor, PS/2 standard keyboard, two button optical mouse and a laser printer with cable.
      - 1) Uninterruptable Power Supply (UPS) – For backup power to all Operator Work station Components: APC Smart 750VA USB and serial 120 VAC, APC art #SUA750, or equivalent.
      - 2) All operator interface software functions listed above (except the Web Server) shall be accessible from this PC (as a Client to the Web Server and/or with the operator interface software installed on this PC).
      - 3) A separate PC shall be provided if the operator interface software architecture does not allow the Web Server software capability to be operated on the same PC as that required for the other operator Interface software capabilities.
    - b. Portable Operator’s Terminal: MS Windows-based notebook-style PC including RAM memory of sufficient capacity to meet the requirements of the operator interface software, color screen (but not 10”), one CD/DVD drive , one 720rpm 160 GB minimum hard disk, integral pointing device, and an Ethernet port. This terminal shall be configured for interface with any DDC device in the BAS: furnish all required serial and/or network communication ports, and all cables for proper BAS operation.
    - c. Number of PCs Supported: The operator interface software provided for the above hardware (except for the Web Server capability) shall be fully functional for two (2) simultaneous PCs (i.e., so that the software can be used simultaneously on both the Work station and Portable PCs).

### 2.4 BUILDING CONTROLLERS

- A. Building Controller is BTL-listed BACnet B-BC device as defined below with non-volatile memory for operating system software; 72-hour battery-backed read/write memory for custom programming; communications support for operator interface and the Controller Network.



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- B. Building Controller Network- Provide 76.8kps BACnet MS/TP communications (as a master).
- C. Point Termination-building controllers shall provide direct point termination through integral point connections, point expansion and/or point expansion modules.
  - 1. Point expansion shall communicate with the Building Control Panel via the Panel's microprocessor bus (i.e., they shall not use EIA-232/485 and/or any type of LAN technology like MS/TP).
  - 2. A "point Expansion Module" as defined below shall be installed within the same enclosure as the associated Building Control Panel.

### 2.5 APPLICATION SPECIFIC CONTROLLERS

- A. An application Specific Controller is a BTL- listed BACnet B-AAC or B-ASC device dedicated for use with specific equipment and applications. It shall be provided with the no volatile memory for operating system software; read/write memory for all other purposes; factory- provided control software; and communications support for operator Interface, and the Controller network.
- B. Application Specific Controllers shall only be used for terminal/zone equipment such as VAV terminal units, constant-volume terminal units, fan coil units, and heat pumps (i.e., when the factory-provided control software meets the Sequence of Operation) or where explicitly allowed by the Sequence of Operation.
  - 1. ASC's for pressure-independent VAV-terminal-unit control shall have an integral differential pressure sensor for air flow measurement and an optionally integral damper actuator.
- C. Each ASC shall have a 76.8Kbps BAC net MS/TP Controller Network connection (as an MS/TP Master).

### 2.6 APPLICATION CONTROLLERS

- A. A DDC panel is a BTL-listed BACnet B-BC or B-AAC device with the BACnet options specified below, non-volatile memory for operating system software: 72-hour battery-backed read/write memory for custom control programming, trending, and alarming; real time clock; integral point or point expansion terminations; and communications support to other DDC routers/panels.
- B. DDC Router/panel Network: Provide 100baseT Ethernet minimum communications with BACnet/IP support for interconnection to other DDC routers/panels, operator interfaces, and to an Internet/intranet connection, if specified.
- C. Point Termination-DDC panels shall provide direct point termination through integral point connections, point expansion and/or point expansion modules.
  - 1. Point expansion shall communicate with the DDC panel via the Panel's microprocessor bus (i.e., they shall not use EIA-232/485 and/or any type of LAN technology like MS/TP).
  - 2. A "point Expansion Module" as defined below shall be installed within the same enclosure as the associated DDC panel.

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### 2.7 POINT EXPANSION MODULE

- A. A point expansion module provides slaved control (i.e., it does not execute its own control software) via a serial or multi-drop communications connection (e.g., EIA-485, MS/TP, etc.) from a DDC device.
- B. A point expansion module cannot be used as a DDC router/panel/controller or Application specific Controller, and shall be mounted within the same enclosure as the DDC router/panel/controller it serves.

### 2.8 BUILDING ROUTER

- A. A Building Panel is BTL-listed BACnet B-BC or B-AAC device with the BACnet options specified below, non-volatile memory for operating system software; 72-hour battery-backed read/write memory for custom control programming, trending, and alarming; real time clock; integral point or expansion terminations; and communications support to other DDC routers/panels.
- B. Building Router/Panel Network: Provide 100base T Ethernet minimum communications using the BACnet/IP data link layer for interconnection to other DDC routers/panels, operator interfaces, and to an Internet/Intranet connection, if specified.
- C. Routing: Provide BACnet Clause 6 Routing (between the specified DDC router and controller network technologies) and BAC/IP Broadcast Management (BBMD).
- D. Controller Network: A building router shall be a Master to one or more 76.8kps BACnet MS/TP data link layer communications connections for DDC controllers and application-specific controllers.
- E. Point Termination- Building routers may not be utilized for direct point termination through integral point connections, point expansion and/or point expansion modules.

### 2.9 AUXILIARY CONTROL DEVICES – ELECTRONIC

- A. Control relays: Plug-in type with dust cover and LED “energized” indicator. Contact rating, configuration, and coil voltage suitable for the application.
- B. Low-Temperature Detection Switches (Freezestats): Provide DPDT low temperature-protection thermostats of manual-reset type, with sensing elements of the proper length, but in no case less than 20’-0” in length. Provide thermostat designed to operate in response to coldest 1’-0” length of sensing element, regardless of temperature at other parts of element. Support element properly to cover entire duct width. Provide separate thermostats for each on 25 sf of coil face area or fraction thereof. The set point shall be 42° F unless otherwise specified on the plans or sequence of operations.
- C. Current Sensing Switches: Use for all motor-status BI point unless otherwise noted; shall be self-powered, solid-state with adjustable trip current. The switch shall be selected to match the current of the application and input requirements of the BAS.

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- D. Differential Pressure Switches: Used only for duct pressure safety cut-offs unless otherwise noted. Adjustable trip pressure with range suitable for the application.
- E. On-Off thermostats: Provide thermostats of bi-metal actuated open contact, bellows-actuated enclosed snap-switch type, or equivalent. Provide solid-state type with electrical rating to meet the application. Provide with surface mounted ventilated enclosure.
- F. Provide duct smoke detectors in HVAC ducts in accordance with NFPA 72 and NFPA 90A, except as indicated otherwise. Provide UL listed or FM approved detectors, designed specifically for duct installation. Smoke detectors are to be double pole/double throw to allow for simultaneous fan shut off and fire alarm detection. Refer to M&E coordination specification section for more details.

### 2.10 VALVES

- A. Control Valves: Provide factory fabricated control valves of appropriate pressure class for the scheduled service. Provide size-modulating valves for a pressure drop of 3 to 5 PSI for water service and 80% of the supply pressure for steam service, unless otherwise noted. Two-position valves shall be line size.
  - 1. Water Service Valves: Equal percentage characteristics with range ability of 50 to 1, and maximum full flow pressure drop of 5 psig.
  - 2. Steam Service Valves: Linear characteristics with rangeability of 30 to 1, and maximum full flow pressure drop of 80 percent of inlet pressure for low pressure systems, and 42 percent for high pressure systems
  - 3. Single Seated Valves: Cage type trim, providing seating and guiding surfaces for plug on “top and bottom” guided plugs.
  - 4. Double Seated Valves: Balanced plug type, with cage trim providing seating and guiding surfaces on “top and bottom” guided plugs.
  - 5. Valve Trim and Stems: Polished stainless steel.
  - 6. Packing: Spring-loaded Teflon, self-adjusting.
  - 7. Terminal Unit Control Valves: Provide control valves for control of terminal units including, but not necessarily limited to, convectors, finned tube radiation, and fan-coil units that are of integral motor type. Provide 2-position or modulating type valves.
  - 8. Select valves to fail safe in normally open or closed position as dictated by freeze, humidity, fire or temperature protection.
  - 9. Valves: 1/2” through 2” : Valves shall be constructed with a cast-brass body and screwed ends. For 1-1/2” and 2” special duty, valves may be selected by the control manufacturer to have either bronze or cast iron bodies with screwed or flanged connections.
  - 10. Valves: 2 1/2” and above: Valves shall be constructed with a cast-iron body and have flanged connections.

11. Butterfly Valves: high performance valves with stainless steel disc and PTFE steel ring shall be used. Body shall be carbon-steel body, 150 lb full ANSI rated bi-directional, lug style butterfly type, bi-directional dead end pressure rating of 285 psi, and temperature rating of -20 to 300 degrees F. Construction features to include 316 SS electroless nickel plated eccentric rotating disc, dynamic sealed, PTFE seal ring, 17-4 Ph (ASTM A 564 Cind. H1075 or H1100) stainless steel shaft, TFE chevron stem packing SS/DU TFE removal of downstream piping and shall be factory pressure tested to 110% of pressure rating. Valves shall be installed by use of cap screws; threaded rod not acceptable. Tyco Keystone Figure 312 or equal.

## 2.11 DAMPERS

- A. Dampers: AMCA-rated, parallel or opposed-blade design as indicated; 0.108-inch minimum thick, galvanized-steel or 0.125-inch minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch thick galvanized steel with maximum blade width of 8 inches and length of 48 inches.
  1. Secure blades to 1/2-inch diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
  2. Operating Temperature Range: From minus 40 to plus 200 deg F.
  3. Edge Seals, Low-Leakage: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 8 cfm per sq. ft. of damper area, at differential pressure of 4-inch wg when damper is held by torque of 50 in. x lbf; when tested according to AMCA 5000.

## 2.12 ACTUATORS

- A. Electronic
  1. Design for direct mounting on the device and attachment to the driving shaft (damper actuator only); adjustable angle of rotation or range of actuation; and built in overload protection. Size each motor for 150% of the application requirement and with sufficient reserve power to provide smooth action.
  2. Modulating actuators shall use a 0-10 VDC or 4-20 mA signal input to match DDC device AO signal output, and 24 VAC power. Three-wire, bi-directional motor actuators controlled by BO point pairs are acceptable on terminal valve boxes, terminal heating/reheat coils, and fan coil units only.
  3. Two-position actuators shall be a 120 VAC, two-wire, spring return. Spring actuation return actuation time shall be less than 30 seconds.
  4. Damper Actuators - 95° rotation maximum, with built-in adjustable mechanical stop to limit rotation to that of the damper and/or to meet TAB requirements.
  5. End switches- Provide actuator with integral, adjustable-position indication end switches (one for each fully actuated position) when the actuated device is specified with an end switch binary input point(s).
- B. Provide valve actuators capable of close-off against a pressure greater than the respective pump system shut-off head.

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- C. Failsafe: Provide spring-return failsafe upon loss of power or control signal to the positions as follows:
  - 1. OA dampers- N.C.
  - 2. Mixed-air dampers- N.O.
  - 3. Relief- and exhaust-air dampers- N.O.
  - 4. HW coil valves- no failsafe required.

### 2.13 POWER SUPPLIES AND LINE FILTERING

- A. Control transformers shall be UL Listed. Furnish Class 2 current limiting type, or furnish over-current protection in both primary and secondary circuits for Class 2 service per NEC requirements. Limit connected loads to 80% of rated capacity.
  - 1. DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak to peak. Regulation shall be 1.0% line and load combined, with 100 microsecond response time for 50% load changes. Unit shall have built in over-voltage and over-current protection, and shall be able to withstand a 150% current overload for at least 3 seconds without trip- out or failure.
    - a. Unit shall operate between 0°C and 50°C [32°F and 120°F]. EM/RF shall meet FCC Class B and VDE 0871 for Class B, and MIL-STD 810C for shock and vibration.
    - b. Line voltage units shall be UL Recognized and CSA Approved.
- B. Power line filtering:
  - 1. DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak to peak. Regulation shall be 1.0% line and load combined, with 100 microsecond response time for 50% load changes. Unit shall have built in over-voltage and over-current protection, and shall be able to withstand a 150% current overload for at least 3 seconds without trip- out or failure.
    - a. Dielectric strength of 1,000 volts minimum.
    - b. Response time of 10 nanoseconds or less.
    - c. Transverse mode noise attenuation of 65 dB or greater.
    - d. Common mode noise attenuation of 150 dB or better at 40 Hz to 100 HZ.

### 2.14 WIRING AND RACEWAYS

- A. General: Provide copper wiring, plenum cable, and raceways as specified in the applicable sections of Division 26.
- B. All insulated wire to be copper conductors, UL labeled for 90C minimum service.
- C. All exposed wiring shall be installed in conduit.
- D. Conduits shall not exceed 40 percent maximum fill for single conductor and jacketed cables.

### 2.15 SENSORS/TRANSMITTERS

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- A. All input accuracies required by this section shall be end-to-end (from sensing point to BAS display). End-to-end accuracy includes all errors due to the sensor, transmitter, wiring and BAS signal measurement and A/D conversion.
- B. Thermistors or solid state sensors shall be provided for temperature sensing applications except where accuracies or ranges required cannot be met by these devices, RTD's shall be used. The sensors shall be powered by the BAS Panel or Dedicated Controller. The solid state sensors shall be accurate to within +/- 0.5 degree F over the following ranges and meet the following requirements:
  - 1. Room Type Instruments: 50 degree F to 100 degree F. Sensor shall be surface mounted with a ventilated cover, insulated baseplate and vandalproof screws.
  - 2. Duct and Plenum Applications: -30 degree F to 240 degree F. Supply, return, exhaust or mixed air averaging type, which shall have an extended element of sufficient length to cover the entire duct cross-section with a minimum of three (3) passes. If a single averaging thermistor of sufficient length to meet the preceding are not available, then two (2) or more sensors and AIs shall be used and averaged in software.
- C. Where RTD's are required, they shall be 1,000 OHM platinum type and be supplied with a 4-20 mA DC transmitter. The sensor and transmitter shall be a single unit. They shall be accurate to within +/- 1.0 degree F over the range of 32 degree F to 600 degree F.
- D. Where thermocouples are required, they shall be Type J and be supplied with a 4-20 mA DC transmitter. They shall be accurate to within +/- 2.0 degree F over the range of 32 degree F to 1,300 degree F.
- E. Provide matched temperature sensors for applications which require both inlet and outlet temperatures of any device. Where a "Matched Temperature Sensor Pair" is shown/specified, the sensors shall be tested and documented by the sensor manufacturer as being accurate to within 0.1°F of each other.
- F. Outdoor Air Temperature and Humidity Transmitter:
  - 1. Provide Vaisala HMT 130 relative humidity and temperature probe with installation kit and radiation shield DTR502B. Probe shall have a temperature measuring range of -40 degree C to +80 degree C with an accuracy of +/- .4 degree C at 68 over the range of the sensor and relative humidity measuring range of 0 to 100 percent RH with an accuracy of 3 percent, 0 to 90 percent RH with a repeatability better than 1 percent RH per year. RH and temperature probe shall be capable of a continuous temperature operating range of -40 degree F to +120 degree F. Provide necessary transmitter for output signals.
- G. Humidity Transmitter:
  - 1. Humidity Transmitter: Humidity transmitter shall be Vaisala or approved equal. Transmitter shall measure relative humidity from 0 to 100 percent RH, +/- 3 percent accuracy, with a long range RH stability better than 1 percent RH/year and temperature compensated over the entire range.
- H. Pressure Sensors, Transmitters and Differential Switches:
  - 1. Air Differential Pressure Transmitters shall be Modus Model T30 or T40 (as required) with an accuracy of +/- 1 percent of range (including non-linearity and hysteresis), solid state circuitry, no moving parts, capacitance principle capable of sensing positive, negative and differential pressures. Transmitter shall have 4-20 mA output signal and be

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- powered by the control system or dedicated controller and capable of withstanding momentary overpressure of eight (8) times the pressure range.
2. Differential air pressure switches for filter or proof of airflow status shall be Dwyer Series 1910, with automatic reset, SPDT.
- I. Air and Vacuum Pressure Transmitter: Kele and Associates Model P100GTE, solid state, 4-20 mA signal, with a full scale accuracy of 1 percent
- J. Flow Elements/Transducers:
1. VAV terminal Unit: Provide differential-pressure transducer integral to the application-specific controller. Connect to pitot-tube element provided with terminal unit.
  2. Water Flow: Provide Onicon F-1200 series dual turbine insertion flow meter.
- K. Differential Pressure Sensors: Differential pressure sensors (air or water) shall be temperature compensated with an accuracy of +/-1% of range and hysteresis of 0.5% of range.
1. Air: Sensor shall be able to withstand a maximum port pressure of 10psig.
  2. Water: Wetted parts shall be stainless steel; sensor shall be able to withstand a maximum port pressure of 250psig and a maximum differential pressure of 150psi or 300% of the rated range, whichever is greater.
  - 3.
- L. Wall/Duct Mount CO<sub>2</sub> Transmitter:
1. Description; Measure and transmit CO<sub>2</sub> levels ranging from 0 to 2,000 parts per million ppm. Silicone-based CARBOCAP® sensor delivers high accuracy and long-term measurement stability (+100 ppm) over a five-year period without calibration. It shall consist of an infrared (IR) source, a sample cell, and IR detector, and a tunable interference filter that enables measurements at two wave lengths. Reference measurements made using a tunable interference filter.
  2. Model;
    - a. Wall Model; CD-Wxx-00-0 Wall Mount CO<sub>2</sub> transmitter.
    - b. Duct Model; CD-Pxx-00-0 Series Duct Mount CO<sub>2</sub> transmitter.
  3. Specifications;
    - a. Measuring Range: 0 to-2000ppm CO<sub>2</sub>.
    - b. Accuracy at 77°: <+30m ppm+ 2.0% of reading, includes manufacturing deviation and drift.
    - c. Non-Linearity: <0.5% of Full Scale.
    - d. Temperature Dependence of Output: <0.056% of Full Scale/F°.
    - e. Response Time (0 to 63%): 1 Minute.
    - f. Operating Temperature Range: 23 to 113°F
    - g. Humidity Range: 0 to 85% RH (non-condensing)
    - h. Power Supply Range: 20 to 30 VAC (18 to 30 VDC), Class 2.
    - i. Power Consumption: <2.5 W Average, 4.1 VA.
    - j. Air Flow Range: 0 to 7,500 ft/minute
    - k. Duct Probe Material: Duct probe meets plenum rating requirements of UL 1995, Heating and Cooling Equipment.
    - l. Agency Listings: UL Listed, CCN XAPX

### 2.16 AIR MEASURING STATIONS

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- A. Provide on the indicated fans, airflow traverse probes mounted in the outside air duct capable of continuously measuring the air handling capacity (air volume) of the respective centrifugal fan(s).
- B. The outside airflow traverse probes shall contain multiple total and static pressure sensors placed at concentric area centers along the exterior surface of the cylindrical probe and internally connected to their respective averaging manifolds. Sensors shall not protrude beyond the surface of the probe, nor be adversely affected by particle contamination normally present in building system airflows.
- C. The outside airflow traverse probes shall not induce a measurable pressure drop, nor shall the sound level within the system be amplified by its presence. The probes shall be capable of producing steady, non-pulsating signals of standard total and static pressure, without need for flow corrections or factors, with an accuracy of 3 percent of actual flow over a fan operating range of 6 to 1 capacity turndown.
- D. Provide electronic flow (air volume, velocity) indicating transmitter capable of receiving signals of total and static pressures from the air measuring station, amplifying, extracting the square root and scaling to produce a dual 4-20 milliamp DC, output signal linear and scaled air volume or velocity. The flow indicating transmitter shall contain an integral digital display capable of continuous indication of air volume and velocity, percent of span, electronic signal units within the following performance application criteria:
  - 1. Calibrated Spans:
    - 0 to 400 FPM up to 8010 FPM
    - Ten (10) adjustable spans
    - Operating static pressures up to negative 10-inch S.P. W.C.
    - Integral 4-digit, .5-inch high LED display
  - 2. Response Time: .5 second for 98 percent span step.
  - 3. The indicating transmitter output shall not be affected by overpressure up to 200 times greater than span and shall be furnished with a factory calibrated span and automatic zeroing circuit. Transmitter shall be housed in a NEMA 1 enclosure with RFI shielding and separate power and output signal connection ports.
  - 4. Acceptable Manufacturer:
    - a. Air Monitor Corporation
    - b. Ultratech Industries
- E. Output Devices:
  - 1. Control Relays: Control relay contacts shall be rated for the application, with a minimum of two (2) sets of Form C contacts enclosed in a dustproof enclosure. Relays shall be rated for a minimum life of one million (1,000,000) operations. Operating time shall be 20 milliseconds or less, with release time of 10 milliseconds or less. Relays shall be equipped with coil transient suppression devices to limit transients to 150 percent of rated coil voltage. Provide with LED to indicate status.
  - 2. Analog output transducers shall be of positioning type with position feedback and control internal to the transducer. As an option, position feedback may also be input to the BAS.
  - 3. Analog output transducers shall meet the following requirements:
    - a. 4-20 mA.
    - b. Two-pipe electro-mechanical design or microprocessor-based design.
    - c. 3-15 psi output range adjustable to a 0-20 psi range minimum.
    - d. Linearity, repeatability and hysteresis no greater than 2 percent of full scale.
    - e. Air capacity of 1,000 SCIM minimum.



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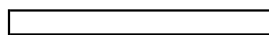
- f. Air consumption of no more than 100 SCIM.
  - g. Pressure gauges shall be installed on the branch and supply lines.
  - h. Acceptable transducers are the Bellofram T1000, Fairchild T5700, Johnson N6810, Mamac EP-310 or an equivalent.
- 4. Electronic analog output transducers shall output a signal to match the controlled device. The Contractor shall be responsible for verifying the required signals for all controlled devices. Transducers shall be completely solid-state with no mechanical parts.
  - 5. Time Delay Relays: Time delay relay contacts shall be rated for the application with a minimum of two (2) sets of Form C contacts enclosed in a dustproof enclosure. Relays shall be rated for a minimum life of one million (1,000,000) operations. Relays shall be equipped with coil transient suppression, devices to limit transients to 150 percent of rated coil voltage. Delayed contact openings or closing shall be adjustable from one (1) to sixty (60) seconds with a minimum accuracy of +/- 2 percent of setting.
  - 6. Latching Relays: Latching Relay contacts shall be rated for the application with a minimum of two (2) sets of Form C contacts enclosed in a dustproof enclosure. Relays shall be rated for a minimum life of one million (1,000,000) operations. Operating time shall be 20 milliseconds or less, with release time of 10 milliseconds or less. Relays shall be equipped with coil transient suppression devices to limit transients to 150 percent of rated coil voltage.

2.17 POWER MONITORING

- A. General: Provide current switches, current transducers, voltage transducers, current transformers as required to meet the specified Sequence of Operation and indicated below.
- B. Current Operated Switches: AC current switch, Neilsen - Kuljian Model PD50AC, or PD75, solid state, five (5) year warranty, three (3) selectable ranges for optimum adjustability and resolution. Provide external current transformer where required.
- C. Current Transducers: AC current to DC current output, +/- .5 percent accuracy, 4-20 mA output signal, Kele and Associates Model 4CMA. Provide external current transformer where required.
- D. Voltage Transducers: Kele and Associates Model PVM or LVM as required for each application, +/- 1/2 percent accuracy, 4-20 mA DC output.

2.18 TEMPERATURE CONTROL CABINETS

- A. General: All controllers and field interface devices shall be installed in control panel cabinet/enclosure as described below.
- B. Cabinets shall be UL listed, 14 gauge furniture grade steel, finished with baked enamel painted finish inside and out, cabinet doors shall have piano hinge and standard key cylinder locking latch.
- C. All devices installed in or on the control cabinet shall be labeled with a fixed mounted, color contrasted, engraved laminated plastic tags, including describing the function of the device, similar to the following example:



ΔP  
TRANSMITTER  
DEVICE

Label

DSP-1, AHU-1 SUPPLY  
DUCT STATIC  
PRESSURE TRANSMITTER

- D. All electrical devices within the panel shall be prewired to terminal strips with all inter-device wiring within the panel completed prior to installation of the system.
- E. Mount control panels adjacent to associated equipment on vibration free walls or free standing steel angle supports or "Unistrut" support stand.

#### 2.19 VARIABLE FREQUENCY DRIVES

- A. Variable frequency drives shall be arranged so they can be operated in an open circuit mode, disconnected from the motors, for start-up adjustments and trouble shooting.
- B. Wire all safeties to operate both in hand and auto positions as well as drive and by-pass sections.
- C. Provide BacNet communication cabling and interface necessary to forward VFD computer communication information to and from the BAS/VFD. See Division 23.

#### 2.20 END SWITCHES

- A. All end switches shall be NEMA rated contacts and NEMA 4X enclosure, either SPDT, DPDT DPST as required to meet the Sequence of Operation, complete the Points List and necessary interlocks or safeties control wiring. End switches shall be as manufactured by Cutler-Hammer or Allen-Bradley.
- B. All end switches shall be designed and configured to provide positive indication of a control device (i.e. damper or valve) position for the service intended.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. The Contractor shall install all equipment, control air piping/tubing, conduit and wiring parallel to building lines.
- B. All automatic control valves and control dampers furnished by the Temperature Control Contractor shall be installed under his supervision by the Mechanical Contractor.

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- C. Install Air Measuring Stations per the manufacturer's requirements.
- D. GENERAL INSTALLATION REQUIREMENTS:
1. Spare conductor capacity, equal to a minimum of two (2) additional sensors shall be provided to each underfloor sensor and pendant type sensors.
  2. Horizontal runs of conduit, trays, tubing or wiring shall be hung from structural members using new supports, or where feasible, utilizing existing temperature control conduit and piping. The Contractor shall verify adequacy of existing systems and warrant these systems as if they were new. Single runs of conduit, tubing or wire shall be by clevis ring and all thread rod. Multiple runs shall be by "Trapeze" or "Unistrut" supports. "Plumber's Strap" shall not be allowed. Maximum distance between supports shall be per the NEC. Existing supports shall only be used upon written concurrence by the Architect, Engineer or Owner.
  3. All vertical runs of conduit or tubing shall be through new core drills. Existing core drills may be used if approved by the Owner. The installation shall be supported above each floor penetration using clamps to "Unistrut".
  4. All wire that enters or leaves a building structure shall be installed with lightning protection per NEC.
  5. All wire terminations shall be with compression type round hole spade lugs under a pan head screw landing; Stay-Kon or equivalent. All wire splices shall be with compression type insulated splice connectors or properly sized "wire-nut" connectors. Hand twisted, soldered and/or taped terminations or splices are not acceptable.
  6. Where tubing, wiring or conduit penetrate floors or walls, sleeves with bushings shall be provided for tubing and wires. The conduit or sleeve opening shall be sealed with fire proof packing so the smoke and fire rating of the wall or floor is maintained.
  7. Under no circumstances shall wire, tubing, tray, J-boxes or any BAS equipment be run in, mounted on, or suspended from any of the telephone system's equipment, cable trays or support structure (Grey Iron).
  8. All the material installed under this contract must be mounted on, or supported from the building structure or supports furnished by this Contractor.
- E. Control Wiring:
1. Run wiring in metallic conduit, tubing or raceways. Exceptions are as follows:
    - a. NEC Class 2 low voltage wiring where not exposed to view such as above suspended ceilings, in shafts, etc., may be run in cable (when approved by Code Authority).
    - b. Wiring enclosed in temperature control panels.
  2. Where conduit is used, provide steel fittings.
  3. Low Voltage Conductors: 18 Gauge minimum, except 19 gauge may be used for home runs to central panels and 22 gauge minimum for resistance or thermistor sensing element connections.
  4. Wire control interlocks and control panels, except one (1) 120V power circuit to each temperature control panel shown on drawings and schedules shall be provided under Division 1.
  5. All wiring shall comply with the requirements of Local and National Electrical Codes.
  6. Do not interlock alarms with starter switching to bypass alarm when equipment is manually disconnected.
  7. All costs of controls, wiring conduit and associated labor shall be included in the Temperature Control Bid. The control wiring shall be installed under the supervision of this Contractor.

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### 3.2 ENCLOSURES

- A. The tubing and wiring within all enclosures shall be run in plastic trays. Tubing and wiring within BAS panels may be run using adhesive-backed tie wraps.
- B. All plastic tubing shall be connected to enclosures through conduit. All copper tubing shall be connected to enclosures through bulkhead fittings.
- C. Mount all enclosures, including those which house BAS Panels, Slaves and Field Device Panels, so that the top of the enclosure does not exceed six feet, six inches (6'-6"); and the center of any keypad/LCD combination does not exceed five foot, six inches (5'-6") from the floor or is less than four feet, zero inches (4'-0") from the floor.
- D. Field Device Panels contain related Field Devices such as relays, control power (24V) transformers, output transducers, etc., that are outboard of the BAS Panels or Dedicated Controllers. Each Field Device shall be mounted within an enclosure. The enclosures shall be provided with lockable latches that will accept a single key common to all Field Device Panels, BAS Panels and Slaves.

### 3.3 EXISTING CONTROLS

- A. Remove all existing control devices including, controllers, receiver/controllers, thermostats, sensors, field devices, gauges, etc. and all associated wiring, piping and mounting hardware whose functions are being replaced by the BAS.
  - 1. When existing equipment is removed, coordinate with a detailed Method of Procedure (MOP). Do not remove until Owner reviews.
  - 2. Refer to General Conditions.

### 3.4 INSTALLATION PRACTICES

- A. The Contractor shall install and calibrate all Field Devices, Sensors and Transducers necessary for the complete operation of the I/O Points described herein.
- B. Sensors shall be removable without shutting down the system in which they are installed.
- C. All immersion sensors shall be installed in new, welded thermowells supplied by the Contractor. Existing thermowells may be reused with concurrence from the Owner. Coordinate any required shutdown with Owner.
- D. Thermistor wire leads shall be permanently terminated at panels or controllers with wire clamps.
- E. Where none exist, furnish and install pressure/temperature gauges adjacent to each immersion type sensor.
- F. Sensors shall be installed with the use of a wet or hot tap without draining the system if required.

### 3.5 IDENTIFICATION

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- A. All control air piping/tubing, J-boxes, conduit and wiring shall be labeled.
- B. Electrical devices, wiring, conduit and J-boxes shall be labeled and identified as required by Division 26.
  - 1. As a minimum regardless of Division 26 requirements, all temperature control J-box covers shall be painted Blue in color on both sides of cover.
- C. Main supply control air piping and tubing shall be labeled with Brady or equivalent markers or pre-printed identification sleeves at each end and junction point, and protected. Identification scheme shall be consistent with the drawings.
- D. Identification shall be provided for all enclosures, panels, junction boxes, controllers or field devices. Laminated, bakelite nameplates shall be used. The nameplates shall be 1/16-inch thick and a minimum of 1-inch by 2-inches. The lettering shall be White on a Blue background with minimum 1/4-inch high engraved letters. The nameplates shall be installed with poprivets.
  - 1. All new devices will be tagged. Color code to differentiate between new devices.
- E. Thoroughly clean the surface to which the label shall be applied with a solvent before applying the identification. Use an epoxy to affix the identification in addition to any adhesive backing on the identification.
- F. The Plan Code Designation shown on all shop drawing identification shall be consistent with the Contract Documents.
- G. All I/O Field Devices that are not mounted within Field Device Panel enclosures shall be identified with engraved plastic laminated nameplates installed so that they are visible from ground level.
- H. The identification shall show the designation used on the Record Documents and identify the function such as "Mixed Air Temperature Sensor" and "Fan Status DP Switch".
- I. Calibration settings shall be marked with paint or indelible ink.

### 3.6 LOCATIONS

- A. All sensing devices and locations shall be located by the Contractor as shown on the submittal shop drawings with final review by the Engineer.
- B. Wall mount space sensors shall be mounted 54" above finished floor. Pendant mount space sensors shall be mounted 8-feet above finished floor.
- C. Enclosures housing Field Devices shall be located immediately adjacent horizontally to the BAS Panels or Slaves which are being interfaced to.

### 3.7 TEMPERATURE SENSORS

- A. Temperature controls trades shall verify all wall mounted temperature sensors locations with the Architect/Engineer/Owner in order to avoid interference with wall mounted and space furnishings.

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1. Where interferences require moving the temperature sensor more than two (2) feet, consult with the Architect/Engineer for relocation.
- B. Temperature sensors shall be mounted on suitable insulated base and secured to the wall in such a way as to be easily removed from wall without damage to the sensor.
- C. Check and verify location of thermostats and other exposed control sensors with plans and room details before installation. Locate thermostats 54" above floor.

### 3.8 EQUIPMENT PROTECTION AND COORDINATION

- A. Where existing walls are penetrated with conduit or piping, provide a fire stop assembly which meets or exceeds the original rating of the assembly. Refer to Division 23.
- B. Extreme care must be exercised while working in existing facilities and around operating equipment, particularly sensitive telephone switching and computer equipment. Close coordination with the Owner is required for the protection of this operating equipment from dust, dirt and construction material while maintaining the operational environment for the equipment. Under no circumstances shall the power or environmental requirements of the operating equipment be interrupted during the installation and check-out without submitting to the Architect, Owner and Engineer for approval.
- C. A detailed Method of Procedure (MOP) stating the steps to be taken, time schedule and impacted systems for the service interruption shall be submitted to the Architect for approval prior to beginning work. Refer to Division 1 and Division 26 for requirements.

### 3.9 CLEANUP

- A. At the completion of the work, all equipment pertinent to this contract shall be checked and thoroughly cleaned and all other areas shall be cleaned around equipment provided under this contract. Clean the exposed surfaces of tubing, hangers, and other exposed metal of all grease, plaster, dust, or other foreign materials.
- B. Upon final completion of work in an area, vacuum and/or damp wipe all finished room surfaces and furnishings. Use extreme care in cleaning around telephone switching and computer equipment and under no circumstances shall water or solvents be used around this equipment.
- C. At the completion of the Work and at the end of each work day, remove from the building, the premises, and surrounding streets, etc., all rubbish and debris resulting from the operations and leave all equipment spaces absolutely clean and ready for use.

### 3.10 SOFTWARE, DATABASE AND GRAPHICS

- A. Software Installation: The Contractor shall provide all labor necessary to install, initialize, start-up and debug all system software as described in this section. This includes any operating system software or other third party software necessary for successful operation of the system.
- B. Database Configuration: The Contractor will provide all labor to configure those portions of the database that are required by the Points List and Sequence of Operation.

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- C. Color Graphics: Unless otherwise directed by the Owner, the Contractor will provide color graphic displays for all systems which are specified with a Sequence of Operation, depicted in the Mechanical Drawings for each system and floor plan. For each system or floor plan, the display shall contain the associated points identified in the Point List and allow for set point changes as required by the Owner.

### 3.11 TEMPERATURE CONTROL DRAWINGS

- A. Upon completion of project and after record drawings of the temperature controls have been prepared and reviewed, the Contractor shall provide one (1) complete set of Temperature Controls Drawings at each Temperature Control Panel. Each set of drawings shall be laminated in a plastic coating. The drawings shall consist of only those control functions associated with the specific control panel and any relevant or pertinent network interface information.
  - 1. The laminated drawings shall have a grommet connection attached to a metal cable or chain which is mechanically fastened to the Temperature Control Cabinet.

### 3.12 START-UP AND TESTING

- A. Prior to Beneficial Use of the BAS, the Contractor shall supply to Architect/Engineer two (2) debugged printouts of all software entered into the BAS. Also supply all user's programming and engineering manuals required to interpret the software. Included in the printouts, though not limited to, shall be the following:
  - 1. Point data base.
  - 2. All custom control programs written in the BAS control language.
  - 3. All parameters required for proper operation of BAS control and utility firmware such as start-stop routines, etc.
  - 4. Printouts or plotted detailed copies of the complete interactive system graphics.
- B. The software printout shall be fully documented for ease of interpretation by the Architect/Engineer and Owner, without assistance from the Contractor. English language descriptions shall be either integrated with or attached to the BAS printout. Specifically, the following shall be documented:
  - 1. All point (I/O and virtual) names.
  - 2. All BAS Programming Language commands, functions, syntax, operators, and reserved variables.
  - 3. Use of all BAS firmware.
  - 4. The intended actions, decisions, and calculations of each line or logical group of lines in the custom control program(s). Sequences of operation are not acceptable for use in this documentation requirement.
  - 5. Complete descriptions of and theories explaining all software and firmware algorithms. The algorithms to be described include, but are not limited to, PID, optimum start/stop, demand limiting, etc.
- C. Documentation that was supplied as part of the submittals need not be submitted at this time.
- D. Upon review of software, a Point-To-Point Test of the BAS installation shall commence. The Contractor shall provide two (2) men equipped with two-way communication and shall test actual field operation of each control and sensing point. This procedure shall occur during off- hour periods. The purpose is to test the calibration, response, and action of every point. Any

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test equipment required to prove the proper operation of the BAS shall be provided by and operated by the Contractor. Demonstrate compliance that system functions per the Sequence of Operation.

1. Upon review of the Point-To-Point demonstration, the Contractor shall start up the BAS by putting all controlled equipment in automatic and enabling software. Contractor shall commence final software and overall BAS hardware/software debugging.
  2. The Point-To-Point demonstration shall include any existing BAS equipment if it affects the operation of the equipment included under this contract.
  3. As a minimum, existing conditions shall be maintained during system changeover.
- E. Final acceptance of the BAS is contingent upon a hardware/software system test. All groups of points that yield a system of control shall be tested for compliance with the sequences of operation. Included in the test, but not limited to, shall be:
1. BAS Loop Response. The Contractor shall supply a trend data output in graphical form showing the step response of each BAS loop. The test shall show the loop's response to a change in set point which represents a change in the actuator position of at least 25 percent of its full range. The sampling rate of the trend shall be from one (1) to three (3) minutes depending on the speed of the loop. The trend data shall show for each sample the set point, actuator position, and controlled variable values. Any loop that does not yield temperature control of + 0.2 degree F or humidity control of + 3 percent RH shall require further tuning by the Contractor.
  2. Interlocks and other sequences.
  3. BAS Control under HVAC equipment failure.
  4. HVAC Operation under BAS equipment failure.
  5. Battery backup.
  6. BAS Control under power failure/restart.
  7. Reset schedules.
  8. BAS Alarm reporting capability.
- F. A detailed test report as defined under Submittals shall be provided indicating its completion and proper system operation.
- G. The BAS will not be accepted as meeting the requirements of Beneficial Use until all tests described in this section have been performed to the satisfaction of both the Architect/Engineer and Owner. Any tests that cannot be performed due to circumstances beyond the control of the Contractor shall be exempt from the Beneficial Use requirements if requested in writing by the Contractor and concurred by the Owner and Architect/Engineer. Such tests shall be performed as part of the BAS Warranty.
1. A typed written document stating that the system has been fully checked out on a point by point basis shall be submitted to the Architect/Engineer. All documentation associated with the check out shall be included.

### 3.13 PROJECT RECORD DOCUMENTS

- A. The Contractor shall be responsible for updating all existing Project Record Documents associated with the Scope of Work outlined in the Drawings and Specifications.
- B. Prior to final completion of the installation, prepare a complete set of Record Drawings on a clear and legible set of ANSI size 'B' (11" x 17") reproducible prints. The content, format and procedure of the submittal shall be as described by the General Conditions.



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- C. Provide one (1) laminated and framed set of Control Drawings for each new BAS Control Panel and one (1) for the Facility Control Room, locate as directed by the Engineer.
- D. Prior to final completion of the installation, prepare two (2) hard copies and one (1) electronic copy (CD or DVD) of the Operation and Maintenance Manuals. The information is to be or provided in a tabbed and index, three (3) screw and post binder. The information shall include:
  - 1. Operator's Manual with step-by-step procedures for logging On/Off, interrogating the system, producing reports, acknowledging alarms, overriding computer control, and changing firmware parameters.
  - 2. Programmer's manual with complete description of the custom control language and associated editor, including sample written programs. Provide complete sets of all programming forms, applications memorandums, and addenda to the programmer's manual. All software or firmware algorithms shall be completely described and documented.
  - 3. Maintenance, Installation, and Engineering Manual(s) that clearly explains how to debug hardware problems, how to repair or replace hardware, preventive maintenance guidelines and schedules, calibration procedures, and how to engineer and install new points, panels, and operator interfaces.
  - 4. Documentation of all software. List separately all software parameters that will need updating by the Owner such as, though not limited to, holiday, seasonal and start/stop schedules, comfort and duty cycling schedules.
  - 5. All programs, passwords, code, databases, graphic files, CADD drawings and symbol libraries generated for operation of the system shall be included as a part of the system documentation. This information shall be submitted both in hard copy bound format and magnetic media format.
  - 6. Input/Output schedules, data sheets, and all other items required under Submittals. Describe all regular maintenance that will need to be performed on the BAS hardware. List replacement parts with part numbers.
  - 7. Complete original issue documentation and software diskettes for all third party software furnished and installed as a part of the system or required for the operation of the system including text editors, control language program and compiler, database managers, graphics and CADD packages, operating systems and communications software.
  - 8. Complete original issue documentation, installation and operational manuals and supporting software for all third party hardware furnished and installed as a part of the system or required for the operation of the system including remote terminals, user's computer workstation, monitors, graphics and memory boards, printers and modems.
  - 9. During the warranty period, all copies of the drawings and manuals shall be updated to include all hardware and software changes.
- A. All of the above documentation shall record the equipment installed under this contract and the exact termination to all other existing control or BAS equipment.
- B. The Record Drawings shall document the complete existing control system. This includes all mechanical equipment in work area which has automatic control.

### 3.14 WARRANTY

- A. The Warranty period shall begin on the date of Beneficial Use Completion as authorized by the Architect/Engineer and Owner in writing. Beneficial use shall not occur before the Contractor has performed the tests required. With these requirements met, beneficial use shall not occur until, in the opinion of the Architect/Engineer, the BAS is sufficiently complete to be utilized for the purposes for which it is intended.

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1. The warranty start date shall not begin until all phases of the Project are complete, i.e., the Project shall have a single warranty start date.
- B. The BAS System shall be guaranteed to be free from defects in material and workmanship and in software design and operation for the period of the warranty after completion of the contract. The Contractor shall provide the necessary skills, labor, and parts to assure the proper operation of, and to provide all required current and preventive maintenance. This warranty shall become effective starting the date of Beneficial Use completion.
1. The hardware warranty shall include all equipment which has been purchased by the Contractor. The existing hardware is not subject to the warranty requirements.
  2. All software work completed by the Contractor, associated with existing hardware, is subject to the warranty requirements outlined herein.
  3. The Contractor shall respond to all calls during the warranty period for all problems or questions experienced in the operation of the installed equipment and shall take steps to correct any deficiencies that may exist.
  4. The response time to any problems shall be four (4) hours maximum (twenty-four) 24-hours per day, seven (7) days per week. Corrective action, temporary or permanent, shall be made within one (1) business day.
- C. The Contractor shall maintain on site a backup of all BAS software installed in the system. The backup shall be updated monthly or whenever a change to the software is made. A reload of backup software into the system shall be performed by the Contractor immediately upon notification by the Owner. The reload shall be free of charge unless it is due to a power failure of a duration longer than the battery backup.
- D. The Contractor shall optimize all control software to assure acceptable operating and space conditions, and peak energy efficiency.

### 3.15 TRAINING

- A. The Contractor shall provide two 2 hours of training for the Owner's Representative. The training sessions shall be broken into one 1 2-hour session. The training session shall be made available to the Owner prior to the end of the warranty period, but after final completion of the contract. The session shall be given at the Owner's facility. Scheduling shall be approved by the Owner. The training shall focus on general design, operation, and maintenance procedures of the products installed, though not necessarily the specific system designed, and shall cover:
1. Hardware configuration including PC boards, switches, communication and point wiring, and location and installation of all sensors and control devices.
  2. Hardware maintenance, calibration, troubleshooting, diagnostics, and repair instructions.
  3. Operation of man-machine interface including logging On/Off, interrogating the system, producing reports, acknowledging alarms, overriding computer control, and changing firmware/software parameters.
  4. Programming the BAS using the editor and the design of custom control software.
  5. Recovery procedures from both BAS and HVAC failures.
- B. The Instructor for the above session shall be an employee of the Contractor, who is qualified to provide customer training and applications support.

END OF SECTION 230900

**SECTION 231123 - NATURAL GAS SYSTEMS**

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. This Section includes Distribution Piping Systems for natural gas within the building and extending from the point of delivery to the connections with gas utilization devices. Piping materials and equipment specified in this section include:
  - 1. Pipes, Fittings, and Specialties
  - 2. Special Duty Valves
- B. Gas pressures for systems specified in this section are limited to 5 psig.
- C. Products installed but not furnished under this section include gas meters, which will be provided by the Utility Company to the site ready for installation

1.2 DEFINITIONS

- A. Pipe sizes used in this specification are Nominal Pipe Size (NPS).
- B. Gas Distribution Piping: A pipe within the building, which conveys gas from the point of delivery to the points of usage.
- C. Gas Service Piping: The pipe from the gas main or other source of supply including the meter, regulating valve, or service valve to the gas distribution system of the building served.
- D. Point of Delivery is the outlet of the service meter assembly, or the outlet of the service regulator (service shutoff valve when no meter is provided).

1.3 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of natural gas systems products, of types, materials, sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. Installer Qualifications: Installation and replacement of gas piping, gas utilization equipment or accessories, and repair and servicing of equipment shall be performed only by a qualified installer. The term qualified is defined as experienced in such work (experienced shall mean having a minimum of five (5) previous projects similar in size and scope to this project), familiar with precautions required, and has complied with the requirements of the Authority Having Jurisdiction. Upon request, submit evidence of such qualifications to the Architect.
- C. Qualifications for Welding Processes and Operators: Comply with the requirements of ASME Boiler and Pressure Vessel Code, "Welding and Brazing Qualification".
- D. Regulatory Requirements: Comply with the requirements of the following codes:

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1. NFPA 54 - National Fuel Gas Code, for gas piping materials and components, gas piping installations, and inspection, testing, and purging of gas piping systems.
2. Local Building Code.
3. Utility Compliance: Fabricate and install natural gas systems in accordance with Local Gas Utility Company.
4. IMC Compliance: Fabricate and install natural gas systems in accordance with "International Mechanical Code".

### 1.4 SUBMITTALS

- A. Submit in accordance with Division 1.
- B. Welders' qualification certificates, certifying that welders comply with the quality requirements specified under "Quality Assurance" below.

### 1.5 CLOSEOUT SUBMITTALS

- A. Submit in accordance with Division 1.
- B. Spare Parts: Furnish to Owner, with receipt, two (2) valve wrenches for each type of gas valve installed.
- C. Test Reports specified in PART 3 below.

### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Handling Flammable Liquids: Remove and legally dispose of liquid from drips in existing gas piping and handle cautiously to avoid spillage or ignition. Notify the gas supplier. Handle flammable liquids used by the installer with proper precautions, and do not leave on the premises from the end of one (1) working day to the beginning of the next.

### 1.7 SEQUENCING AND SCHEDULING

- A. Notification of Interruption of Service: Except in the case of an emergency, notify all affected users when the gas supply is to be turned off.
- B. Work Interruptions: When interruptions in work occur while repairs or alterations are being made to an existing piping system, leave the system in safe condition.
- C. Coordinate the installation of pipe sleeves for foundation wall penetrations.

PART 2 - PRODUCTS

2.1 PIPING AND FITTINGS

A. Above Grade Exposed Locations:

1. Pipe 2-Inches and Smaller: ASTM A 53, Grade B, Type E, Schedule 40 black steel pipe, electric resistance welded.
  - a. Fittings:
    - 1) Malleable Iron Threaded Fittings: ANSI B16.3; (Class 125 and 300).
    - 2) Malleable Iron Threaded Unions: ANSI B16.30, Class 150, 250 or 300; selected by Installer for proper piping fabrication and service requirements, including style, end connections, and metal-to-metal seats (iron, bronze or brass).
    - 3) Forged Steel Socket-Welded and Threaded Fittings: ANSI B16.11, except MSS SP-79 for threaded reducer inserts; rated to match schedule of connected pipe (up to 4-inch pipe size).
2. Pipe 2-1/2 Inch and Larger: ASTM A 53, Grade B, Type S, Schedule 40 seamless black steel pipe.
  - a. Fittings:
    - 1) Steel Flanges/Fittings: ANSI B16.5, including bolting and gasketing of the following material group, end connection and facing, except as otherwise indicated.
      - a) Material Group: Group 1.1
      - b) End Connections: Butt-weld
      - c) Facings: Raised-face
    - 2) Forged Steel Socket-Welded and Threaded Fittings: ANSI B16.11, except MSS SP-79 for threaded reducer inserts; rated to match schedule of connected pipe (up to 4-inch pipe size).
    - 3) Wrought Steel Butt-Welded Fittings: ANSI B16.9, except ANSI B16.28 for short-radius elbows and returns; rated to match connected pipe.

B. Above Grade Concealed Locations:

1. Piping all sizes: ASTM A 53, Grade B, Type S, Schedule 40 seamless black steel pipe.
  - a. Fittings:
    - 1) Steel Flanges/Fittings: ANSI B16.5, including bolting and gasketing of the following material group, end connection and facing, except as otherwise indicated.
      - a) Material Group: Group 1.1
      - b) End Connections: Butt weld
      - c) Facings: Raised-face
    - 2) Wrought Steel Butt-Welded Fittings: ANSI B16.9, except ANSI B16.28 for short-radius elbows and returns; rated to match connected pipe.

C. Below Grade: Outside Building

1. Piping all sizes: Plastic pipe, polyethylene, tubing and fittings shall conform to ASTM D 2513. Pipe shall be marked "Gas" and "ASTM D 2513".
  - a. Transition risers; factory assembled anodeless riser shall be designed and certified to meet the requirements of category I of ASTM D 2513 and U.S. Department of transportation, Code of Federal Regulation, title 49, part 192.281 (e).

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- b. Tracer wire; yellow insulated copper tracer wire. Install adjacent to underground piping. Terminate above ground at each end of the piping. Minimum wire size si 18 AWG, and shall be suitable for direct burial.

### 2.2 NATURAL GAS PIPING SPECIALTIES

- A. Gas Meters: Diaphragm-type, positive displacement gas meters with aluminum cases, temperature compensated, with internal corrosion-resistant components; threaded ends for 2-inch and smaller, flanged ends for 2-1/2 inch and larger; for gas working pressures, specific gravity, and volume flow indicated.
- B. Flexible Connectors: Corrugated Type 304 stainless steel flexible pipe with stainless steel braid and heavy flexible armor shield.
- C. Quick Couplers: One-way quick coupler with gas rating in cubic feet per hour equal to equivalent gas appliance rating.

### 2.3 VALVES

- A. Special Duty Valves are specified in this section by their generic name. Refer to PART 3, "VALVE APPLICATION", for specific uses and applications for valve specified.
- B. Gas Cocks 2-Inch and Smaller: 150 psi WOG, bronze body, straightaway pattern, square head, threaded ends. Acceptable Manufacturers: Lunkenheimer, Nibco, Powell, Stockham.
- C. Gas Cocks 2-1/2 Inch and Larger: MSS SP-78; 175 psi, lubricated plug type, semi-steel body, single gland, wrench operated, flanged ends. Acceptable Manufacturers: Lunkenheimer, Nibco, Powell, Stockham.
- D. Solenoid Valves: Aluminum body, 120 volts AC, 60 Hz, Class B continuous duty molded coil; NEMA 4 coil enclosure; electrically opened/electrically closed; dual coils; normally closed; UL and FM approved and labeled.
- E. Gas Line Pressure Regulators: Single-stage, steel jacketed, corrosion-resistant gas pressure regulators; with atmospheric vent, elevation compensator; with threaded ends for 2-inch and smaller, flanged ends for 2-1/2 inch and larger; for inlet and outlet gas pressures, specific gravity, and volume flow indicated.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Precautions: Before turning off the gas to the premises, or section of piping, turn off all equipment valves. Perform a leakage test as specified in "FIELD QUALITY CONTROL" below, to determine that all equipment is turned off in the piping section to be affected.
- B. Conform to the requirements in NFPA 54, for the prevention of accidental ignition.

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### 3.2 PIPING INSTALLATION

- A. Conform to the requirements of NFPA 54 - National Fuel Gas Code.
- B. Locations and Arrangements: Drawings indicate the general location and arrangement of piping systems. Design locations and arrangements of piping take into consideration pipe sizing, flow direction, slope of pipe, expansion, and other design considerations. So far as practical, install piping as indicated.
- C. Concealed Locations: Except as specified below, install concealed gas piping in an airtight conduit constructed of Schedule 40, seamless Black steel with welded joints. Vent conduit to the outside and terminate with a screened vent cap.
  - 1. Above-Ceiling Locations: Gas piping may be installed in accessible above-ceiling spaces (subject to the approval of the Authority Having Jurisdiction), whether or not such spaces are used as a plenum. Valves shall not be located in such spaces.
  - 2. Piping In Partitions: Concealed piping shall not be located in solid partitions. Tubing shall not be run inside hollow walls or partitions unless protected against physical damage. This does not apply to tubing passing through walls or partitions.
  - 3. Prohibited Locations: Do not install gas piping in or through a circulating air duct, clothes chute, chimney or gas vent, ventilating duct, dumb waiter or elevator shaft. This does not apply to accessible above-ceiling space specified above. Piping shall not be installed beneath slab on grade floors.
- D. Install pipe sleeve and seals at foundation and basement wall penetrations.
- E. Seal pipe penetrations of fire barriers using fire barrier penetration sealers.
- F. Drips and Sediment Traps: Install a drip leg at points where condensate may collect, at the outlet of the gas meter, and in a location readily accessible to permit cleaning and emptying. Do not install drips where condensate is likely to freeze.
  - 1. Construct drips and sediment traps using a tee fitting with the bottom outlet plugged or capped. Use a minimum of three (3) pipe diameters in length for the drip leg. Use same size pipe for drip leg as the connected pipe.
- G. Use fittings for all changes in direction and all branch connections.
- H. Install gas piping at a uniform grade upward to risers, and from the risers to the meter, or service regulator when meter is not provided, or the equipment.
- I. Connect branch outlet pipes from the top of horizontal lines, not from the bottom or sides.
- J. Refer to "Supports and Anchors" specification section.

### 3.3 NATURAL GAS PIPING SPECIALTIES

- A. Gas Meters:
  - 1. Prepare for installation of gas meter in accordance with local Utility Company's installation instructions, and comply with requirements.
  - 2. Set meter on concrete pad as indicated.

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- B. Protective Coating:
  - 1. Provide protective coating on piping and fittings that will be in contact with material or atmosphere exerting a corrosive action, or piping buried in floors. Protective coating shall be applied at the factory.
- C. Flexible Connectors:
  - 1. Provide flexible connectors with full size quick coupler for all kitchen and heavy moveable gas appliance equipment.
  - 2. Connectors shall be of lengths required to displace equipment for complete cleaning under and around gas appliance.
- D. Quick Couplers:
  - 1. Provide quick coupler at service end of flexible connectors.

### 3.4 VALVE APPLICATIONS

- A. General: The Drawings indicate valve types, locations, and arrangements.
- B. Shutoff Duty: Use gas cocks.

### 3.5 VALVE INSTALLATIONS

- A. Install valves in accessible locations, protected from physical damage. Tag valves with a metal tag attached with a metal chain indicating the piping systems supplied.
- B. Install a gas cock upstream of each gas pressure regulator. Where two (2) gas pressure regulators are installed in series in a single gas line, a manual valve is not required at the second regulator.
- C. Install pressure relief or pressure limiting devices so they can be readily operated to determine if the valve is free; so they can be tested to determine the pressure at which they will operate; and examined for leakage when in the closed position. Pipe atmospheric vent to outdoors.
- D. Solenoid valves shall be mounted with the solenoid in the vertical upright position only.
  - 1. Electrical wiring for solenoid valves is specified in Division 26. Coordinate electrical requirements and connections.
- E. Valves shall be installed with unions or other means to facilitate removal or repair without disassembly of connecting piping.

### 3.6 TERMINAL EQUIPMENT CONNECTIONS

- A. Install gas cock upstream and within 6-feet of gas appliance. Install a union or flanged connection downstream from the gas cock to permit removal of controls.
- B. Sediment Traps: Install a tee fitting with the bottom outlet plugged or capped as close to the inlet of the gas appliance as practical. Drip leg shall be a minimum of three (3) pipe diameters in length.



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- C. Flexible Hose Gas Connectors: U.L. Listed, for use connecting to vibrating equipment; corrugated Type 304 stainless steel flexible pipe with stainless steel braid.

### 3.7 ELECTRICAL BONDING AND GROUNDING

- A. Install above ground portions of gas piping systems, upstream from equipment shutoff valves electrically continuous and bonded to a grounding electrode in accordance with NFPA 70 - "National Electrical Code".
- B. Do not use gas piping as a grounding electrode.
- C. Conform to NFPA 70 - "National Electrical Code," for electrical connections between wiring and electrically operated control devices.

### 3.8 FIELD QUALITY CONTROL

- A. Piping Tests: Inspect, test, and purge natural gas systems in accordance with NFPA 54, and Local Utility requirements.
- B. Test system before covering underground lines.
- C. Submit written results of tests to Architect/Engineer.

END OF SECTION 231123

**SECTION 232113 - HYDRONIC PIPING**

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. This section consists of furnishing and installing piping systems associated with heating, chilled, and condenser water systems.

1.2 QUALITY ASSURANCE

- A. Comply with ASME B31.9 (Building Service Piping Code) for materials, products, installation, and testing.
- B. Pipe and Fitting Manufacturer's Qualifications: Firms regularly engaged in manufacture of pipes and pipe fittings of types and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- C. Welder's Qualifications: All welders shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.
- D. Before any welding is performed, the Contractor shall submit to the Architect/Engineer, a copy of the Manufacturer's Record of Welder or Welding Operator Qualification Tests and his Welding Procedure Specification together with the Procedure Qualification Record as required by Section IX of ASME Boiler and Pressure Vessel Code.
- E. The types and extent of non-destructive examinations required for pipe welds are as shown in Table 136.4 of the ASME Code for Pressure Piping, ANSI/ASME B31.1 – Power Piping. If requirements for non-destructive examination are to be other than that stated above, the degree of examination, and basis for rejection shall be a matter of prior written agreement between the fabricator, or contractor and the purchaser.
- F. Each manufacturer or contractor shall be responsible for the quality of welding done by his organization and shall repair or replace any work not in accordance with these specifications.
- G. Soldering and Brazing Procedures shall conform to ANSI B9.1 Standard Safety Code for Mechanical Refrigeration.

1.3 SUBMITTALS

- A. Submit under provisions of Division 1.
- B. Welding Certifications: Submit reports as required for piping work.
- C. Brazing Certifications: Submit reports as required for piping work.

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### 1.4 CLOSEOUT SUBMITTALS

- A. Submit under provisions of Division 1. Additionally, submit the following information:
  - 1. Valve Schedule for all Valves. For each valve, list valve designation number, valve type, size, location, and function.
  - 2. Written report certifying leak testing.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
  - 1. Air Vents (Manual and Automatic):
    - a. Armstrong Machine Works.
    - b. Bell & Gossett ITT; Fluid Handling Division
    - c. Hoffman Specialty ITT; Fluid Handling Division
    - d. Spirax Sarco
  - 2. Air Separators:
    - a. Amtrol, Inc.
    - b. Armstrong Pumps, Inc.
    - c. Bell & Gossett ITT; Fluid Handling Division
    - d. Taco, Inc.
    - e. The John Wood Co.
    - f. Spirotherm
  - 3. Compression Tanks:
    - a. Amtrol, Inc.
    - b. Armstrong Pumps, Inc.
    - c. Bell & Gossett ITT; Fluid Handling Division
    - d. Taco, Inc.
    - e. The John Wood Co.
  - 4. Diaphragm-Type Compression Tanks:
    - a. Amtrol, Inc.
    - b. Armstrong Pumps, Inc.
    - c. Bell and Gossett ITT; Fluid Handling Division
    - d. Taco, Inc.
    - e. The John Wood Co.
  - 5. Pump Suction Diffusers:
    - a. Amtrol, Inc.
    - b. Armstrong Pumps, Inc.
    - c. Bell & Gossett ITT; Fluid Handling Division
    - d. Taco, Inc.
    - e. Victaulic Company of America
  - 6. Hydronic System Safety Relief Valves:
    - a. Kunkle Valve Co., Inc.
    - b. Lunkenheimer Co.
    - c. Watts Regulator Co.
    - d. Lonergan
    - e. Keckley

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- f. Bell & Gossett ITT; Fluid Handling Division
- g. Conbraco
- 7. Pipe Escutcheons:
  - a. Chicago Specialty Mfg. Co.
  - b. Producers Specialty & Mfg. Corp.
  - c. Sanitary-Dash Mfg. Co.
- 8. Low Pressure Strainers:
  - a. Armstrong Machine Works
  - b. Hoffman Specialty ITT; Fluid Handling Division
  - c. Metraflex Co.
  - d. R-P&C Valve; Division White Consolidated Industries, Inc.
  - e. Spirax Sarco
  - f. Trane Co.
  - g. Victaulic Co. of America
  - h. Watts Regulator Co.
- 9. High Pressure Y-Type Strainers:
  - a. Armstrong Machine Works
  - b. Hoffman Specialty ITT; Fluid Handling Division
  - c. Metraflex Co.
  - d. R-P&C Valve; Division White Consolidated Industries, Inc.
  - e. Spirax Sarco
  - f. Trane Co.
  - g. Watts Regulator Co.
- 10. Pressure Independent Control Valves
  - a. Griswold
  - b. Danfoss

### 2.2 PIPING AND FITTINGS

- A. General: Working pressure and temperature maximums, 125 psi and 250 degrees F; water service.
- B. Copper Pipe: ASTM B88, hard-drawn copper tube, Type K for below ground lines and Type L for above ground lines.
  - 1. Fittings:
    - a. Wrought copper solder joint fittings, ASME B16.22
    - b. Bronze pipe flanges/fittings, ANSI B16.24 (Class 150 and 300)
    - c. Mechanical Pressure-Seal Fittings as manufactured by Viega or Nibco.
    - d. Grooved end wrought copper, ASME B16.22 or bronze casting, ASME B16.18 with copper tube dimensioned grooved ends (flaring of tube ends to IPS dimensions is not permitted).
  - 2. Joining Material:
    - a. Solder:
      - 1) ASTM B32, 95-5 tin-antimony, Grade 95TA
      - 2) ASTM B32 (NSF), Silver-Tin-Copper Alloy
    - b. Brazing: AWS A5.8, for underground lines and where copper pipe is connected to brass.
      - 1) Copper phosphorus-Bcup
      - 2) Silver-Bag
    - c. Grooved Mechanical Couplings:

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- 1) Angle Bolt Pattern Design
  3. Unions: ASME B16.22-95. Wrought copper solder joint, ground seat.
  4. Dielectric Connections: Fittings having insulating material isolating joined dissimilar metals.
    - a. Waterway Fittings:
      - 1) ASTM-A53 Zinc electroplated steel pipe casing with inert, non-corrosive thermoplastic lining (NSF/FDA listed).
      - 2) Thread x thread ends 1/2-inch x 3-inch through 4-inch x 6-inch.
      - 3) Groove x thread ends 1/2-inch x 4-inch through 4-inch x 6-inch.
      - 4) Listed by IAPMO/UPC and SBCC PST and ESI.
      - 5) Dielectric unions are not an acceptable substitute for dielectric waterway fittings.
- C. Steel Pipe:
1. ASTM A53, Schedule 40, black steel pipe. (Grade B, Type E, electric resistance welded) (Grade B, Type S or A106 high temperature; seamless)
  2. Fittings:
    - a. Threaded: ASME B16.4, Class 125, cast iron, or ASME B16.3, Class 150, malleable-iron. Standard pattern for threaded joints. Threads shall conform to ASME B1.20.1-83.
    - b. Flanged: ASME B16.1, Class 125, cast iron, raised ground face, bolt holes spot faced.
      - 1) Gaskets: ANSI B16.21, full-faced for cast iron flanges, raised face for steel flanges.
    - c. Welded: ASTM A234, standard weight, seamless black steel, butt weld.
    - d. Grooved: ASTM A536 ductile iron, or ASTM A53 steel, grooved ends with grooved mechanical couplings.
  3. Unions: ASME B16.39-86, malleable-iron, Class 150, hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends.
  4. Dielectric Connections: Construct to isolate dissimilar metals, prevent galvanic action, and prevent corrosion.
    - a. Waterway Fittings:
      - 1) ASTM-A53 Zinc electroplated steel pipe casing with inert, non-corrosive thermoplastic lining (NSF/FDA listed).
      - 2) Thread x thread ends 1/2-inch x 3-inch through 4-inch x 6-inch.
      - 3) Groove x thread ends 1/2-inch x 4-inch through 4-inch x 6-inch.
      - 4) Listed by IAPMO/UPC and SBCC PST and ESI.
      - 5) Dielectric unions are not an acceptable substitute for dielectric waterway fittings.
    - b. Flanged Connection: Dielectric gasket and bolt kit.
- D. Flexible Pipe Connectors: As specified in Section 230548.

### 2.3 VALVES

- A. General:
1. Comply with MSS-92 1980 "Valve Users Manual".
  2. Sizes: Provide valves of same size as upstream pipe size. Size control valves for required flow.

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- B. Extended Stems: Where insulation is indicated or specified, provide extended stems to allow full operation of the valve without interference by the insulation.
- C. Bypass and Drain Connections: Comply with MSS SP-45.
- D. End Connections: As specified in the individual valves specifications.
  - 1. Threads: Comply with ANSI B2.1.
  - 2. Flanges: Comply with ANSI B16.1 for cast iron, ANSI B16.5 for steel, and ANSI B16.24 for bronze.
  - 3. Solder-Joint: Comply with ANSI B16.18. Where soldered end connections are used, use solder having a melting point below 840 degree F for gate, globe, and check valves and below 421 degree F for ball valves.
- E. Ball Valves:
  - 1. 3-Inch and Smaller: MSS-SP-110, 150 psi SWP, 600 psi WOG, two-piece ASTM B584 cast bronze body, full port, chrome plated brass/bronze ball, TFE seats, anti-blowout stem separate packnut with adjustable stem packing, extended stem, and vinyl covered steel handle. Threaded or soldered end connections.
  - 2. Acceptable Manufacturers:
    - a. Nibco T/S 585-70
    - b. Milwaukee
    - c. Apollo (Conbraco)
    - d. Watts
    - e. Grinnell
- F. Eccentric Plug Valves:
  - 1. 2-Inch and Smaller: 150 psi, bronze body; resilient plug, stainless steel bearings, cast iron end, Vitron packing, PTFE U-ring seal, resilient plug facing, square head, level actuator, threaded ends. Provide memory stop feature. Do not use for natural gas services.
    - a. Acceptable Manufacturers:
      - 1) DeZurik Fig. 120
  - 2. 2-1/2 Inch and Larger Sizes: 125 psi, cast iron body, resilient plug, stainless steel bearings, Buna packing, PTFE U-ring seal, resilient plug facings, lever actuators, except hand wheels where indicated, and flanged ends. Provide memory stop feature. Do not use for natural gas services.
    - a. Acceptable Manufacturers:
      - 1) DeZurik Fig. 11
      - 2) Milliken
      - 3) Homestead
- G. Globe Valves:
  - 1. 2-1/2 Inch and Smaller: MSS SP-80, Class 150, ASTM B62 bronze body and bonnet, TFE seat disc and malleable iron or ductile iron hand wheel, union bonnet, non-asbestos packing, silicon bronze ASTM B371 or low-zinc alloy B-99 stem. Threaded or soldered end connections.
    - a. Acceptable Manufacturers:
      - 1) Nibco T/S 235-4
      - 2) Milwaukee
      - 3) Hammond
      - 4) Stockham

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- 5) Grinnell
  2. 3-Inch and Larger: MSS SP-85, Class 125, ASTM A126, Class B cast iron body and bolted bonnet, cast bronze or cast iron disc and cast iron or malleable iron hand wheel, non-asbestos packing, bronze trimmed, OS&Y. Flanged end connection
    - a. Acceptable Manufacturers:
      - 1) Nibco F718-B
      - 2) Milwaukee
      - 3) Hammond
      - 4) Stockham
      - 5) Grinnell
- H. Butterfly Valves:
1. 4-Inch and Larger: MSS-SP-68, ASTM A126, Class B fully lugged iron body, ASTM B148 aluminum bronze disc, ASTM A582 416 stainless steel stem, RTFE seat liner, reinforced nylon bearings, (EPDM) (BUNA) bushing and NBR stem seals. ASTM class 200 WOG rating. (BUNA) (EPDM) liner, Rated for 200 psi bi-directional shutoff and 200 psi dead-end service with downstream piping removed. Provide extended neck for insulation. Sizes 4"-6" shall be lever operated with 10-position throttling plate; sizes 8- inch and larger shall have weatherproof gear operators.
    - a. Acceptable Manufacturers
      - 1) Keystone
      - 2) Nibco
      - 3) Milwaukee, "ML" Series
      - 4) Stockham
      - 5) Centerline
      - 6) Watts
      - 7) Grinnell
      - 8) Victaulic
      - 9) Apollo
      - 10) DeZurik
- I. Check Valves:
1. Swing Check Valve:
    - a. 2-1/2 Inch and Smaller: MSS SP-80; Class 150 SWP, ASTM B62 bronze body and bonnet, horizontal swing design, Y-pattern, with TFE seat disc. Threaded or soldered end connections.
      - 1) Acceptable Manufacturers:
        - a) Nibco T/S 433-Y
        - b) Milwaukee
        - c) Grinnell
        - d) Stockham
    - b. 3-Inch and Larger: MSS SP-71; Class 125, ASTM A126 Class B cast iron body with bronze trim, non-asbestos gasket, horizontal swing, and flanged ends. Valve shall be capable of being refitted without removing from pipe.
      - 1) Acceptable Manufacturers:
        - a) Nibco F918-B
        - b) Milwaukee
        - c) Stockham
        - d) Hammond
        - e) Grinnell

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- J. Drain Valve: Ball valve with threaded hose end and cap with chain. Apollo Fig. 78-100/78-200 Series
- K. Pressure Independent Characterized "Control Valve"
1. "Belimo" characterized control valve, pressure independent, Model #PICCV.
    - a. Provide two-way control valve which provides specific flow rate at each degree of valve opening independent of system pressure.
    - b. Valve shall be forged brass body, chrome plated brass ball valve, Teflon seats with O-rings, characterizing disc, blow-out proof stem with thrust bearing double O-ring, female screwed connection and regulator assembly (spring return, non-spring return).
    - c. Provide with electronic controller which provides signal for remote readout of valve position/flow rate.
- L. Safety Relief Valves:
1. Manufacturer: Subject to compliance with requirements, provide products by the manufacturers listed:
    - a. Amtrol
    - b. Bell & Gossett ITT; Fluid Handling Division
    - c. Kunkle Valve Co., Inc.
    - d. Lonergan
    - e. Lunkenheimer Co.
    - f. Watts
  2. Diaphragm operated, cast iron or brass body valve, with low inlet pressure check valve, inlet strainer removable without system shutdown and non-corrosive valve seat and stem; 125 psig working pressure and 250 degree maximum operating temperature. Valve designed, built, rated, and stamped in accordance with ASME Boiler and Pressure Vessel Code. Select valve to suit actual system pressure and BTU capacity. Factory set valve to relieve at 10 psi above operating pressure with field adjustment capabilities.
- M. Pressure Reducing Valve: Diaphragm operated, cast iron or brass body, fill valve designed to maintain water pressure in a closed water system. Valve includes cleanable strainer, removable seat assembly, purge lever for quick filling, and built-in check valve. Adjustment range of 10 to 25 psig. Maximum operating temperature shall be 225 degrees F, maximum working pressure of 125 psig.
- N. Backflow Preventer: As specified in Section 22000.
- O. [Pressure Independent Actuated Ball Valves and Cartridge (PIC-V)]
1. The modulating control valves shall be pressure independent.
  2. The pressure independent modulating control valve shall include a Pressure Compensating Cartridge, Actuated Ball Valve, and Manual Isolation Ball in a single valve housing.
  3. Valve housing shall consist of forged brass, rated at no less than 360 psi at 250°F.
  4. Valve shall have a factory installed air vent.
  5. A flow tag shall be furnished with each valve.
  6. A universal mounting plate shall allow installation of actuators meeting the system electrical and valve torque requirements.
  7. Pressure Compensating Cartridge (PCC)
    - a. PCC shall automatically compensate for pressure changes in valve and shall maintain a constant pressure drop across the flow limiting actuated ball.



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- b. The operating pressure range shall be available with the minimum range requiring 5.8 PSID to actuate the mechanism.
  - c. Valve internal control mechanism shall include a diaphragm and full travel linear coil spring.
  - d. Valves shall include an accessible/ replaceable cartridge.
  - e. Dual pressure/temperature test valves for verifying the pressure differential across the cartridge and flow limiting ball shall be standard.
8. Actuated Ball Valve
- a. Valve ball shall be stainless steel.
  - b. Actuator stem shall be removable/replaceable without removing valve from line.
  - c. Manufacturer shall be able to provide ball insert to limit flow to maximum flow rate with  $\pm 5\%$  accuracy.
  - d. Valve shall have EPDM O-rings behind the seals to allow for a minimum close-off pressure of 100 psi with 35 in-lbs of torque for 1/2" – 2" sizes.
  - e. Actuator shall provide minimum torque required for full valve shutoff position.
9. Isolation Ball Valve
- a. Valve shall include a 600 WOG manual isolation ball valve
10. The control valve actuator shall be furnished and wired by the controls contractor.]

### 2.4 PIPING ACCESSORIES

- A. Manual Air Vent: Bronze body and nonferrous internal parts; 150 psig working pressure, 212 degree F operating temperature; manually coin operated and having discharge outlet connection and 1/8-inch NPT male connection.
- B. Automatic Air Vent: Float type vent designed to vent automatically; bronze body and nonferrous internal parts. 150 psig working pressure, 240 degree F operating temperature. 1/4- Inch discharge connection and 1/2-inch inlet connection.
- C. Drain Pans: Minimum 18 gauge stainless steel, reinforced to support weight of drain pan and water. Provide not less than 2-inch deep, with a 3/4-inch drain connection.

### 2.5 AIR SEPARATORS

- A. Air Separators: Cast iron; constructed and labeled for minimum 175 psig water working pressure and 300 degree F operating temperature; integral weir designed to decelerate system flow and direct released air into compression tank; inline inlet and outlet connections; screwed connections up to and including 3-inch NPS; flanged connections for 4-inch NPS and above; threaded blowdown connection; sized as indicated for full system flow capacity.
- B. Air Separators:
  - 1. In-Line Air Separator: Heavy-duty cast iron air separator constructed for 175 psi minimum working pressure and 300 degree F with integral weir to maximize air separation. Top outlet connection for air vent and bottom connection for expansion tank.
  - 2. Centrifugal Air Separator: Welded steel tank, ASME constructed and labeled for 125 psig minimum working pressure and 350 degree F maximum operating temperature. Tangential inlet and outlet connections. Threaded blowdown connection sized for full system flow. 1/4-Inch connection located at top of air separator for expansion tank connection. Factory applied enamel finish. Provide screwed connections up to and including 3-inch NPS; flanged connections for 4-inch NPS and above.

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### 2.6 EXPANSION TANKS

- A. Manufacturer: Subject to compliance with requirements, provide products by the manufacturers listed:
1. Amtrol, Inc.
  2. Armstrong Pumps, Inc.
  3. Bell & Gossett ITT; Fluid Handling Division
  4. Taco, Inc.
- B. Diaphragm Compression Tank Type: Welded steel tank suitable for 125 psig working pressure, 350 degrees maximum operating temperature; constructed, tested, and labeled in accordance with ASME Pressure Vessel Code. Flexible diaphragm separates air charge from system water. Include taps for pressure gauge, air charge fitting, and drain. Diaphragm material shall be chemically inert to Propylene Glycol. Provide taps for pressure gauge and air charging fitting, and drain fitting. Support vertical tanks with steel legs or base; support horizontal tanks with steel saddles. Tank, with taps and supports, shall be constructed, tested, and labeled in accordance with ASME Pressure Vessel Code, Section VIII, Division 1.

### 2.7 STRAINERS

- A. Manufacturer: Subject to compliance with requirements, provide products by the manufacturers listed:
1. R-P&C Valve; Division White Consolidated Industries, Inc.
  2. Armstrong Machine Works
  3. Hoffman Specialty ITT; Fluid Handling Division
  4. Keckley
  5. Spirax Sarco
  6. Victaulic Co.
- B. Low Pressure Pipeline Strainers
1. General: Provide strainers full line size of connecting piping, with ends matching piping system materials. Select strainers for 125 psi working pressure, with Type 304 stainless steel screens, with 3/64-inch perforations at 233 per square inch.
  2. Threaded Ends, 2-Inch and Smaller: Cast iron body, screwed screen retainer with centered blowdown fitted with pipe plug.
  3. Threaded Ends, 2-1/2 Inch and Larger: Cast iron body, bolted screen retainer with off-center blowdown fitted with pipe plug.
  4. Flanged Ends, 2-1/2 Inch and Larger: Cast iron body, bolted screen retainer with off-center blowdown fitted with pipe plug.
  5. Butt Welded Ends, 2-1/2 Inch and Larger: Schedule 40 cast carbon steel body, bolted screen retainer with off-center blowdown fitted with pipe plug.
  6. Grooved Ends, 2-1/2 Inch and Larger: Tee pattern, ductile-iron or malleable-iron body and access end cap, access coupling with EDPM gasket.

## PART 3 - EXECUTION

3.1 PIPE APPLICATIONS

- A. 2-Inches and Smaller:
  - 1. Black Steel: Install steel pipe with threaded joints and fittings.
  - 2. Copper Pipe:
    - a. Install Type L copper pipe with wrought copper fittings and solder joints, above ground, within building.
    - b. Install Type K copper pipe with wrought copper fittings and brazed alloy joints below ground.
- B. 2-1/2 Inches and Larger: Install black steel pipe.
  - 1. Welded and Flanged Joints: Install welded fittings on pipe 2-1/2 inches and larger.

3.2 PIPING INSTALLATION, GENERAL

- A. Arrange piping in horizontal groups, each group to be in one plane. Maintain indicated slope.
- B. Conceal pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors.
- C. Install piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building. Install piping parallel to permanent elements of building. Provide space to permit insulation applications, with 1-inch clearance outside insulation. Provide 2-inch space above removable ceiling panels to allow for panel removal.
- D. Fire and Smoke Wall Penetrations: Maintain the fire and smoke rated integrity where pipes pass through fire and smoke rated walls, partitions, ceilings, and floors. Refer to Section 230500.
- E. Sloping, Air Venting, and Draining:
  - 1. Install piping true to line and grade, and free of traps and air pockets. Install piping level except for gravity flow systems such as condenser water and condensate drain piping.
  - 2. Connect branch piping to bottom of mains, except for up-feed risers, which shall have take-off on top of main.
  - 3. Install manual air vents at high points in hydronic piping systems and at all coils. Provide 1/4-inch copper, 180 degree bend pipe to discharge vented water into can.
  - 4. Install automatic air vent on air separator and where shown. Provide valved inlet and route discharge pipe to floor drain.
  - 5. Install drain valves with hose adapters at low points in mains, risers, and branch lines. Drain consists of a tee fitting, 3/4-inch ball valve, and short 3/4-inch threaded nipple and cap.
- F. Fittings: Standard manufactured fittings. Field fabricated fittings and bushings are prohibited on all piping.
- G. Make reductions in pipe sizes using eccentric reducer fitting installed with the level side up.
- H. Unions: Install unions in pipes 2-inch and smaller, adjacent to each valve, at final connections of each piece of equipment and elsewhere to permit alterations and repairs. Install dielectric waterway fittings to join dissimilar metals.

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- I. Flanges: Install flanges on valves and equipment having 2-1/2 inch and larger connections.
- J. Joints:
  - 1. Threaded Joints: Apply Teflon tape to male equipment threads. Do not use pipe with threads that are corroded or damaged.
  - 2. Soldered Joints: Comply with AWS Soldering Manual-98.
- K. Keep openings in piping closed during construction to prevent entrance of foreign matter.
- L. Install flexible connectors or grooved flexible couplings at inlet and discharge connections to base-mounted pumps and other vibration producing equipment.
- M. Electrical Equipment Spaces: Do not run piping through transformer vaults and other electrical spaces.
- N. Pressure-Seal Fittings shall have EPDM seal material compatible with glycol, chemical treatment, corrosion inhibitors, etc.

### 3.3 VALVES

- A. Field check valves for packing and lubricant. Replace leaking packing. Service valves with lubricant for smooth and proper operation before placing in service.
- B. Install valves accessible from floor level, located for easy access.
- C. Install valves in horizontal piping with stem at or above center of pipe. Install valves in position to allow full stem movement. Provide operating handles for valves and cocks without integral operators.
- D. Provide extended valve stems where insulation is specified.
- E. Provide separate support where necessary.
- F. Where soldered end connections are used for valves, use solder having a melting point below 840 degrees F for gate, globe, and check valves; below 421 degrees F for ball valves.
- G. Provide valves same size as line size.
- H. Provide drain valves and hose adapters at strainers for blowoff; same size as strainer blowoff connection.
- I. Provide mechanical actuators with chain operators where valves 2-1/2 inches and larger are mounted more than 6-feet above the floor. Extend chains to elevation of 5-feet above floor.
- J. Check Valves:
  - 1. Install check valves for proper direction of flow as follows:
    - a. Swing Check Valve: Horizontal position with hinge pin level.
    - b. Wafer Check Valve: Horizontal or vertical position, between flanges.
- K. Valve End Selection: Select valves with the following ends or types of pipe/tube connections:
  - 1. Copper Tube Size 2-Inch and Smaller: Solder ends.

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2. Steel Pipe Sizes 2-Inch and Smaller: Threaded or grooved-end.
3. Steel Pipe Sizes 2-1/2 Inch and Larger: Flanged or grooved end.
4. At all piping hot taps provide a gate valve with the hot tap and a butterfly valve for shutoff service. Hot taps shall be provided only where approved by the Engineer.

L. Valve Application: Install valves in accordance with the following table.

<b>SERVICE</b>	<b>VALVE TYPE</b>
Hydronic Isolation; 2" and Smaller	Ball Valve
Hydronic Isolation; 2-1/2" and Larger	Butterfly Valve
Hydronic Throttling or Bypass Valve; All Sizes	Globe Valve
Hydronic Balancing Valve; 2" and Smaller	Calibrated Balancing Valve
Hydronic Balancing Valve; 2-1/2" and Larger	Calibrated Balancing Valve
Hydronic Pump Discharge Check Valves; 2" & Smaller	Swing Check
Hydronic Pump Discharge Check Valve; 2-1/2" & Larger	Wafer Check Valve

**[NOTE: An eccentric plug valve with memory stop may be installed for combination shutoff/balancing service in lieu of a separate balancing valve plus shutoff valve installation at Contractor's option.]**

3.4 EQUIPMENT PIPING

- A. Provide combination balancing and shutoff valves to regulate water flow through piping, coils, and at other equipment and piping where shown or required for proportioning flow.
- B. Install automatic fill valve in cold water make-up to boilers and chillers. Install three-valve bypass with globe valve around automatic fill valve for quick filling system. Install backflow preventer upstream of fill valve and bypass.

3.5 DRAIN PANS

- A. Install drain pan under the entire length of any piping, including valves, joints, and fittings installed over motor, motor starter, switch gear, transformer, or other electrical equipment and under all piping located anywhere in any transformer vault, electrical switchboard room, and telephone equipment room. Pipe drain connection to discharge where shown or at nearest floor drain.

3.6 TESTING

- A. General: Provide temporary equipment for testing including pump and gauges. Test before insulation is installed. Test piping to be concealed prior to permanent enclosure.
- B. Provide the Engineer a minimum of twenty-four hours notice of dates when acceptance test will be conducted. Conduct tests in presence of representative of agency having jurisdiction.

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- C. Test piping systems using ambient temperature water, except where there is risk of damage due to freezing. Engineer approval is required prior to testing if other than hydrostatic tests are used.
- D. Use vents installed at high points in the direction of flow, in the system to release trapped air while filling the system. Use drains installed at low points for complete removal of the liquid.
- E. Examine system to see that equipment and parts that cannot withstand test pressures are properly isolated.
- F. System Tests:
  - 1. Hydrostatic Test: Pressurize the system to 100 psig or 1.5 times the design pressure, whichever is greater. Maintain pressure until the entire system has been inspected for leaks, but in no case for a time period of less than four (4) hours.
  - 2. Compressed Air or Nitrogen Test: Compressed air tests may be substituted for hydrostatic tests only when ambient conditions prohibit safe use of hydrostatic testing and must be reviewed by the Engineer prior to any testing. For tests of this type, subject the piping system to the gas pressure indicated for that specific system. Maintain the test pressure for the duration of a soapy water test of each joint.
  - 3. Maintain test pressure until the entire system has been inspected for leaks, but in no case less than four hours. Examine all piping, joints, and connections for leakage.
- G. Repair failed piping sections by disassembly and re-installation, using new materials to extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.
- H. Drain test water after testing and repair work has been completed.
- I. Prepare written report of testing, indicating locations of leaks corrected, method used to correct leaks, number of tests required, and certification that system is leak free. Provide three (3) copies of test results.

### 3.7 ADJUSTING AND CLEANING

- A. Flush system with clean water. Remove, clean, and replace strainer screens.
- B. After cleaning and flushing but before balancing, remove disposable fine mesh strainers in pump suction diffusers.

### 3.8 PRESSURE INDEPENDENT CHARACTERIZED FLOW CONTROL VALVES

- A. Pressure Independent Characterized Flow Control Valves shall be factory set for flow required and failure mode of operation. Field verification and documentation of flow by local field representative shall be provided.

### 3.9 HYDRONIC SPECIALTIES INSTALLATION

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- A. Manual Air Vent: Provide manual air vents at all high points and drops in the direction of flow, of all mains and risers of the hydronic systems, at heat transfer coils, radiation and elsewhere shown and as required for system air venting.
  - 1. Provide enlarged air collection standpipe where large air quantities can accumulate.
    - 1. Provide a 1/2-inch ball valve, reducer and pipe nipple installed between hydronic system pipe and manual air vent.
  - 2. Provide 1/4-inch discharge pipe from manual air vent discharge connection to nearest floor drain or as indicated.
- B. Dip Tube Fittings: Install dip tube fittings in hydronic systems boiler outlet. Run piping to compression tank with 1/4-inch per foot (2 percent) upward slope towards tank. Connect boiler outlet piping.
- C. Air Separator: Install air separators in hydronic systems pump suction lines. Run piping to compression tank with 1/4-inch per foot (2 percent) upward slope towards tank. Install drain valve on units 2-inch and larger.
- D. Combination Air Separator/Strainer: Install combination air separator/strainer in hydronic systems pump suction lines. Run piping to compression tank with 1/4-inch per foot (2 percent) upward slope towards tank. Install blowdown piping with gate valve; extend to nearest drain.
- E. Pump Suction Diffuser: Install pump suction diffusers on hydronic systems pump suction inlet, adjust foot support to carry weight of suction piping. Install nipple and ball valve in blowdown connection.
- F. Diaphragm-Type Compression Tank: Install diaphragm-type compression tanks in hydronic systems. Vent and purge air from hydronic system, charge tank with proper air charge to suit system design requirements.
  - 1. Support tank as detailed on the drawings. Provide support from the floor or structure adequate to carry twice the weight of the tank, piping connections, fittings, and weight of water assuming a full tank of water. Do not overload building components and structural members.
- G. Strainers: Install strainers full size of pipeline, in accordance with manufacturer's installation instructions. Install pipe nipple and shutoff full port ball valve with 3/4-inch hose end and brass cap with hose "washer" and chain in strainer blowdown connection. Where indicated, provide drain line from shutoff valve to plumbing drain, full size of blowdown connection.
  - 1. Provide strainers in supply line ahead of the following equipment, and elsewhere as indicated.
    - a. Pumps
    - b. Control Valves
    - c. Pressure Reducing Valves
    - d. Temperature or Pressure Regulating Valves
    - e. Solenoid Valves

### 3.10 TRAINING

- A. Provide two (2) hours of instruction on hydronic systems. Include following items as a minimum:
  - 1. Location of automatic and manual air vents.

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2. Location of strainers and blow down valves.
  3. Location of safety and relief valves.
  4. System drain valves.
  5. System fill and associated devices.
  6. Expansion tank and air separator.
- B. A factory-trained field representative shall provide on-site training for contractor's field personnel in the proper use of grooving tools and installation of grooved piping products. Factory-trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed product.

END OF SECTION 232113



**SECTION 232123 - HVAC PUMPS**

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of HVAC Pumps Work required by this section is indicated on drawings and schedules, and by requirements of this section.
- B. Types of Pumps specified in this section include the following:
  - 1. In-Line Booster
  - 2. In-Line Circulator
  - 3. Vertical In-Line
- C. Pumps furnished as part of factory-fabricated equipment are specified as part of equipment assembly in other Division 23 sections.
- D. Refer to other Division 23 sections for other work; not work of this section.
- E. Refer to Division 26 sections for the following work; not work of this section.
  - 1. Power supply wiring from power source to power connection on pumps. This Contractor shall include disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.
  - 2. Interlock wiring between pumps; and between pumps and field-installed control devices.
    - a. Interlock wiring specified as factory-installed is work of this section.
- F. Provide the following Electrical Work as work of this section, complying with requirements of Division 26 sections:
  - 1. Control Wiring between field-installed controls, indicating devices, and pump control panels.
    - a. Control Wiring specified as work of Division 23 for Automatic Temperature Controls is work of that section.

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of general-use centrifugal pumps with characteristics, sizes and capacities required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. Codes and Standards:
  - 1. HI Compliance: Design, manufacture, and install HVAC pumps in accordance with HI "Hydraulic Institute Standards".
  - 2. UL Compliance: Design, manufacture, and install HVAC pumps in accordance with UL 778 "Motor Operated Water Pumps".
  - 3. UL and NEMA Compliance: Provide electric motors and components which are listed and labeled by Underwriters Laboratories and comply with NEMA Standards.

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- C. Certification, Pump Performance: Provide pumps whose performances, under specified operating conditions, are certified by manufacturer.

### 1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's pump specifications, installation and start-up instructions, and current accurate pump characteristic performance curves with selection points clearly indicated.
- B. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.
- C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to HVAC pumps. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
- D. Record Drawings: At project closeout, submit record drawings of installed systems products in accordance with requirements of Division 1.
- E. Maintenance Data: Submit maintenance data and parts lists for each type of pump, control, and accessory; including "trouble-shooting" maintenance guide. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual; in accordance with requirements of Division 1.

### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Handle HVAC pumps and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged HVAC pumps or components; replace with new.
- B. Store HVAC pumps and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.
- C. Comply with Manufacturer's rigging and installation instructions for unloading HVAC pumps, and moving them to final location.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
  - 1. In-Line Booster Pumps:
    - a. Armstrong Pumps, Inc.
    - b. Aurora
    - c. Bell & Gossett ITT; Fluid Handling Division
    - d. Taco
    - e. Paco

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2. In-Line Circulator Pumps:
  - a. Armstrong Pumps, Inc.
  - b. Aurora
  - c. Bell & Gossett ITT; Fluid Handling Division
  - d. Taco
  - e. Paco
3. Vertical In-Line Pumps:
  - a. Armstrong Pumps, Inc.
  - b. Aurora
  - c. Bell & Gossett ITT; Fluid Handling Division
  - d. Taco
  - e. Paco

### 2.2 PUMPS

- A. General: Provide factory-tested pumps, thoroughly cleaned, and painted with one (1) coat of machinery enamel prior to shipment. Type, size, and capacity of each pump is listed in pump schedule. Provide pumps of same type by same manufacturer.
- B. Pump motor shall be sized so as not to be overloaded at any point along impeller curve for specified performance.
- C. All pump couplers shall be suitable for both constant speed and variable speed operation.

### 2.3 IN-LINE BOOSTER PUMPS

- A. General: Provide in-line booster pumps where indicated, and of capacities as scheduled.
- B. Type: Horizontal, oil-lubricated, designed for 125 psi working pressure, 225 degree F (107 degree C) continuous water temperature, and specifically designed for quiet operation.
- C. Body: Cast iron, split vertical volute, rated for 175 psi, flanged suction and discharge.
- D. Impeller: Steel shaft with copper or stainless steel shaft sleeves.
- E. Shaft: Steel, ground and polished, integral thrust collar.
- F. Bearings: Two (2) horizontal sleeve bearings designed to circulate oil.
- G. Seal: Mechanical, with carbon seal face rotating against ceramic seat.
- H. Motor: Pump motor shall be non-overloading at any point on pump curve and meet the requirements of Section 230513.
- I. Coupling: Self-aligning, flexible coupling.

### 2.4 IN-LINE CIRCULATOR PUMPS

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

- A. General: Provide bronze fitted in-line circulator pumps where indicated, and of capacities as scheduled.
- B. Type: Horizontal mount, vertical split case, oil-lubricated, designed for 125 psi working pressure, and 225 degree F (107 degree C) continuous water temperature.
- C. Body: Cast iron, with flanged suction and discharge and gauge tappings.
- D. Shaft: Hardened alloy steel.
- E. Bearings: Oil-lubricated bronze journal bearings.
- F. Seal: Mechanical, with carbon seal ring and ceramic seat.
- G. Motor: Pump motor shall be non-overloading at any point on pump curve and meet requirements of Section 230513.
- H. Coupling: Self-aligning, flexible coupling.
- I. Impeller: Brass or Bronze enclosed type, hydraulically and dynamically balanced, and keyed to shaft.

### 2.5 VERTICAL IN-LINE PUMPS

- A. General: Provide bronze fitted vertical in-line pumps where indicated, and of capacities as scheduled.
- B. Type: Vertical mount, in-line, close-coupled, single stage, designed for 175 psi working pressure.
- C. Body: Cast iron, 125 psi ANSI flanges of equal size, tappings for gauge and drain fittings.
- D. Shaft: Steel with replaceable shaft sleeve.
- E. Seal: Mechanical seal with ceramic seal seat.
- F. Motor: Pump motor shall be non-overloading at any point on pump curve, open and meet requirements of Section 230513.
- G. Impeller: Bronze enclosed type, hydraulically and dynamically balanced, keyed to shaft and secured with locking screw. Assembly components shall be 304 stainless steel.

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

### PART 3 - EXECUTION

#### 3.1 INSPECTION

- A. Examine areas and conditions under which HVAC pumps are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

#### 3.2 INSTALLATION OF PUMPS

- A. General: Install HVAC pumps where indicated, in accordance with manufacturer's published installation instructions, complying with recognized industry practices to ensure that HVAC pumps comply with requirements and serve intended purposes.
- B. Access: Provide access space around HVAC pumps for service as indicated, but in no case less than that recommended by manufacturer.
- C. Support:
  - 1. Install in-line pumps, supported from piping system.
- D. Support: Refer to Division 23 section "Vibration Control" for support and mounting requirements of HVAC pumps.
- E. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
  - 1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment Installer.
- F. Piping Connections: Provide system return connection to inlet strainer with valved bypass to drain. Provide pump discharge connections with check valve, shutoff valve, and balancing valve for each pump.

#### 3.3 ADJUSTING AND CLEANING

- A. Alignment: Adjust shafts of all motors and pumps within recommended tolerances by manufacturer, and in presence of manufacturer's service representative.
- B. Start-Up: Lubricate pumps before start-up. Start-up in accordance with manufacturer's instructions.
- C. Refer to Division 23, Section 230593, for pump system balancing; not work of this section.
- D. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION 232123

**SECTION 233113 - METAL DUCTWORK**

## PART 1 - GENERAL

## 1.1 DESCRIPTION OF WORK

- A. Extent of Metal Ductwork is indicated on the drawings, schedules, and by requirements of this section.

<b>Ductwork Construction Table</b>				
<b>Service</b>	<b>Type</b>	<b>Pressure Class</b>	<b>Insulation</b>	<b>Seal Class</b>
Supply Air between Air Handling Unit and Terminal Air Box	Galvanized steel, round or rectangular	+3"	Lined	B
Supply Air between Terminal Air Box and Air Devices (concealed)	Galvanized steel, rectangular	+1"	Lined (Wrap round duct)	C
Supply Air between Terminal Air Box and Air Devices (exposed)	Spiral seam round galvanized steel suitable for painted finish	+1"	Lined	C
Return Air	Galvanized steel, round or rectangular	-3"	Lined (within 10 feet of AHU, none for RA duct beyond 10' of AHU)	B
Air Handling Unit Exhaust and Outside Air	Rectangular galvanized steel	+3"	Wrapped	B
General Building Exhaust	Galvanized steel round or rectangular	-3"	None	B
Transfer Duct	Rectangular galvanized steel	+1"	Lined	C
Return Grille Sound Boot	Rectangular galvanized steel	+1"	Lined	C
Below Grade Ductwork	PVC piping			

## 1.2 QUALITY ASSURANCE

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of metal ductwork products of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. Installer's Qualifications: Firm with at least three (3) years of successful installation experience on projects with metal ductwork systems similar to that required for project.
- C. References to SMACNA, ASHRAE and NFPA are minimum requirements, the Contractor shall fabricate, construct, install, seal all ductwork as described in this specification and as shown on the drawings, in addition to these minimum standard references.
- D. Codes and Standards:
  - 1. SMACNA "HVAC Duct Construction Standards, Metal and Flexible".
  - 2. SMACNA "HVAC Air Duct Leakage Test Manual".
  - 3. ASHRAE "Systems and Equipment Handbook", Chapter 16, Duct Construction.
  - 4. NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems".
  - 5. NFPA 96 "Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations".
  - 6. SMACNA Industrial Construction Standards.
  - 7. UL 1978 Standards – “Grease Ducts”, UL 2221 – “Standard for Test of Fire Resistive Grease Duct Enclosure Assemblies.”

### 1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions.
- B. Shop Drawings: Submit scale drawings of ductwork and fittings including, but not limited to, duct sizes, locations, elevations, and slopes of horizontal runs, wall and floor penetrations, and connections. Show interface and spatial relationship between ductwork and equipment. Show modifications of indicated requirements, made to conform to local shop practice, and how those modifications ensure that free area, materials, and rigidity are not reduced. Refer also to specification for 3D coordination drawing requirement.
- C. Record Drawings: At project closeout, submit record drawings of installed systems, in accordance with requirements of Divisions 1 and 23.
- D. Maintenance Data: Submit maintenance data and parts lists for metal ductwork materials and products. Include maintenance data and shop drawings in maintenance manual.

### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Protection: Protect ductwork and accessories from damage during shipping, storage, and handling. Prevent dirt and moisture from entering ducts and fittings.
- B. Storage: Where possible, store ductwork inside. Where necessary to store outside, enclose with waterproof wrapping.

## PART 2 - PRODUCTS

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Rectangular Duct Liner:
    - a. CertainTeed Corp.
    - b. Johns-Manville Products Corp.
    - c. Knauf Fiberglass
    - d. Manson
    - e. Owens-Corning Fiberglas Corp.
  2. Round Duct Liner:
    - a. Johns-Manville Products Corp.
  3. Flexible Ducts:
    - a. Flexmaster
    - b. Thermaflex
    - c. Ominair
    - d. JP Lamborn Co.
  4. Spin-In Fittings:
    - a. Flexmaster
    - b. Thermaflex
    - c. Ominair
    - d. Hercules Industries
  5. Factory-Fabricated Round Ductwork
    - a. Semco Mfg., Inc.
    - b. Hercules Industries
    - c. United Sheet Metal Division, United McGill Corp.
    - d. Sheet Metal Products Co.
    - e. Spiral Pipe of Texas, Inc.
    - f. AccuDuct
    - g. Metco, Inc.
  6. Adhesives: Comply with ASTM C916 Type II
    - a. Foster 85-60
    - b. DuroDyne SSG
    - c. McGill Air Seal Uni Grab
    - d. Childers CP-127

### 2.2 DUCTWORK MATERIALS

- A. Exposed Ductwork: Where ductwork is exposed to view in occupied spaces, provide mill phosphatized finish that is free from visual imperfections, including pitting, seam marks, roller marks, stains, dents, discolorations, and other imperfections, including those that would impair painting.
- B. Galvanized Steel Sheet: Except as otherwise indicated, fabricate ductwork from galvanized sheet steel complying with ASTM A 527, lockforming quality; with G 90 zinc coating in accordance with ASTM A 525.
- C. Stainless Steel Sheet: ASTM A 167; Type 304 or 316; with No. 4 finish where exposed to view in occupied spaces, No. 1 finish elsewhere. Protect finished surfaces with factory applied adhesive protective paper, maintained through fabrication and installation.



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- D. Aluminum Sheet: ASTM B 209, Alloy 3003, Temper H14.
- E. Steel: Fabricate ductwork serving Type 1 hoods using steel having a minimum thickness of 0.0058" (16 gauge) or stainless steel not less than 0.045" (No. 18 gage) in thickness.

### 2.3 MISCELLANEOUS DUCTWORK MATERIALS

- A. General: Provide materials of types and sizes required to comply with ductwork system requirements.
- B. Fittings: Provide radius type fittings fabricated of multiple sections with maximum 15-degree change of direction per section. Unless specifically detailed otherwise, use 45-degree laterals and 45-degree elbows for branch takeoff connections. Where 90-degree branches are indicated, provide conical type tees.
- C. Rectangular Duct Liner: ASTM C1071 fiberglass duct liner with UL approved 25/50 flame/smoke development. Factory applied edge and air surface coating of acrylic treated with EPA registered ASTM G21 and G22 anti-microbial agent.
  - 1. K Value: ASTM C 518, 0.25 at 75 degree F mean temperature.
  - 2. Noise Reduction Coefficient: ASTM C 423, 0.70 based on Type A Mounting.
  - 3. Maximum Velocity: 5000 fpm.
  - 4. Adhesive: Meeting ASTM C919.
  - 5. Fasteners: Duct liner galvanized steel pins, welded or mechanically fastened.
  - 6. Interior Ductwork: 1-Inch thick.
  - 7. Exterior Ductwork: 2-Inch thick.
- D. Round Duct Liner: 1-Inch thick rigid preformed round liner with air surface coated with acrylic coating treated with EPA registered ASTM G 21 and G22 anti-microbial agent and UL approved 25/50 flame/smoke development.
  - 1. K Value: ASTM C 518, 0.23 at 75 degree F mean temperature.
  - 2. Noise Reduction Coefficient: ASTM C 423, 0.70 based on Type A mounting.
  - 3. Maximum Velocity: 5,000 fpm.
- E. Duct Sealant: UL 181 Listed, Class 1, flame spread 0, fuel contributed 0, smoke developed 0, water-based sealant, non-toxic, non-combustible, and non-flammable. Non-hardening, non-migrating mastic or liquid elastic sealant, type applicable for fabrication/installation detail, as compounded and recommended by manufacturer specifically for sealing joints and seams in ductwork. Sealant shall meet LEED IEQ 4.1 (meeting VOC tables published by SCAQMD #1168 Criteria for Low Emitting Materials. For outdoor ductwork, sealant shall also be U.V. resistant, water based and weather resistant.
  - 1. Service temperature -20°F to 200°F.
  - 2. Mold and Mildew resistant
  - 3. VOC: Maximum 50g/l (less water and exempt solvents).
- F. Adhesives: Water based; suitable for bonding fibrous duct wrap and duct liner insulation to galvanized duct work. Install evenly and secure with mechanical fasteners in accordance with SMACNA HVAC Duct Construction Standard for Metal and Flexible Duct. Adhesive shall meet LEED EQ 4.1 (SCAQMD Rule #1168 VOC tables) low emitting materials.
  - 1. Non-Oxidizing
  - 2. Meets FDA, USDA and EPA Standards

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3. Meets Requirements of UL 723, ASTM E-84 NFPA 90A & 90B and ASTM C-916 Type II.
- G. Ductwork Support Materials: Except as otherwise indicated, provide hot-dipped galvanized steel fasteners, anchors, rods, straps, trim and angles for support of ductwork.
1. For exposed stainless steel ductwork, provide matching stainless steel support materials.
  2. For aluminum ductwork, provide aluminum support materials except where materials are electrolytically separated from ductwork.
- H. Flexible Ducts: Flexible air ducts shall be listed under UL-181 standards as Class I Air Duct Material and shall comply with NFPA Standards 90A and 90B. Minimum operating pressure rating shall be 6-inch w.c. through a temperature range of -20 degree to 150 degree F; maximum working velocity rating shall be 4,000 fpm. Contractor shall assume responsibility for supplying material approved by the Authority Having Jurisdiction.
1. All insulated flexible ducts shall be constructed on an all metal, CPE, or aluminum laminate inner core, fiberglass insulation with minimum R-Value of 4.0 or greater and an outer jacket made exclusively of fire retardant reinforced material.
  2. Non-insulated flexible ducts shall be constructed from dead soft aluminum sheet, spiral corrugated, or aluminum construction over a steel spring helix.
- I. Spin-in Fittings: Provide spin-in fittings between flexible and round sheet metal duct takeoffs and air devices from main ducts. Spin-in fittings shall include bell mouth and butterfly type manual volume damper, regulator and locking device.
- J. Rectangular-to-Round Taps: Where the round branch take-off will not permit a spin-in fitting, provide a rectangular to round tap. Include manual volume damper with locking devices.
- K. All fasteners and hardware for stainless steel ductwork shall be made of stainless steel.

### 2.4 FABRICATION

- A. Fabricate ductwork of gauges and reinforcement complying with SMACNA "HVAC Duct Construction Standards" and ASHRAE "Systems and Equipment Handbook", Chapter 16, Duct Construction.
- B. Elbows – Rectangular
1. For low pressure systems use 1.0 radius smooth elbows. (From focal point to centerline of duct).
  2. For medium pressure systems use 1.5 radius smooth elbows. (From focal point to centerline of duct).
  3. If radius elbows cannot fit, use mitered elbows with turning vanes.
- C. Limit angular tapers to 30 degree for contracting tapers and 20 degree for expanding tapers.
- D. Refer to Division 23, Section 233300 "Ductwork Accessories" for accessory requirements.

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**2.5 FACTORY-FABRICATED ROUND DUCTWORK (2-Inch Pressure Class and Less)**

- A. Material: Galvanized sheet steel complying with ASTM A 527, lockforming quality, with ASTM A 525, G90 zinc coating, mill phosphatized.
- B. Gauge: 28 Gauge minimum for round and oval ducts and fittings, 4-inch through 24-inch diameter.
- C. Elbows: One-piece construction for 90 degree and 45 degree elbows 14-inch and smaller. Provide multiple gore construction for larger diameters with standing seam circumferential joint. Elbow radius shall be a minimum of 1.5 radius.
- D. Divided Flow Fittings: 90 Degree tees, constructed with saddle tap spot welded and bonded to duct fitting body.

**2.6 FACTORY-FABRICATED ROUND DUCTWORK (3-Inch Pressure Class and Above)**

- A. General: Provide factory-fabricated duct and fittings. All fittings shall be low loss conical type.
- B. Round Ductwork: Construct of galvanized sheet steel complying with ASTM A 527 by the following methods and in minimum gauges listed.

<b>Diameter</b>	<b>Minimum Gauge</b>	<b>Method of Manufacture</b>
3" to 14"	26	Spiral Lockseam
15" to 26"	24	Spiral Lockseam
27" to 36"	22	Spiral Lockseam
37" to 50"	20	Spiral Lockseam
51" to 60"	18	Spiral Lockseam
Over 60"	16	Longitudinal Seam

- 1. Provide locked seams for spiral duct; fusion-welded butt seam for longitudinal seam duct. Provide internal stiffener rings and external reinforcement as required to meet operating static pressures scheduled on drawings.
- 2. Fittings and Couplings: Construct of minimum gauges listed. Provide continuous welds along seams.

<b>Diameter</b>	<b>Minimum Gauge</b>
3" to 36"	20
38" to 50"	18
Over 50"	16

- C. Flat-Oval Ductwork: Construct of galvanized sheet steel complying with ASTM A 527, of spiral lockseam construction, in minimum gauges listed. Ductwork shall be factory lined per liner schedule.

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Maximum Width	Minimum Gauge
Under 25"	24
25" to 48"	22
49" to 70"	20
Over 70"	18

1. Fittings and Couplings: Construct of minimum gauges listed. Provide continuous weld along seams.

Maximum Width	Minimum Gauge
Under 37"	20
37" to 50"	18
Over 50"	16

- D. Internally Insulated Duct and Fittings: Construct with outer pressure shell, 1-inch thick insulation layer, and perforated inner liner. Construct shell and liner of galvanized sheet steel complying with ASTM A 527, of spiral lockseam construction, use longitudinal seam for over 59-inches, in minimum gauges listed.

Nominal Duct Diameter	Outer Shell	Inner Liner
3" to 12"	26 gauge	24 gauge
13" to 24"	24 gauge	24 gauge
25" to 34"	22 gauge	24 gauge
35" to 48"	20 gauge	24 gauge
49" to 58"	18 gauge	24 gauge
Over 59"	16 gauge	20 gauge

1. Fittings and Couplings: Construct of minimum gauges listed. Provide continuous weld along seams of outer shell.

Nominal Duct Diameter	Outer Shell	Inner Liner
3" to 34"	20 gauge	20 gauge
36" to 48"	18 gauge	20 gauge
Over 48"	16 gauge	20 gauge

2. Inner Liner: Perforate with 3/32-inch holes for 22 percent open area. Provide metal spacers welded in position to maintain spacing and concentricity.

PART 3 - EXECUTION

3.1 INSPECTION

- A. General: Examine areas and conditions under which metal ductwork is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF METAL DUCTWORK

- A. General: Assemble and install ductwork in accordance with recognized industry practices that will achieve airtight and noiseless (no objectionable noise) systems. Install each run with minimum number of joints. Align ductwork accurately at connections, within 1/8-inch misalignment tolerance and with internal surfaces smooth. Support ducts rigidly with suitable ties, braces, hangers, and anchors of type that will hold ducts true-to-shape and prevent buckling, popping or compressing. Support vertical ducts at every floor.
- B. Inserts: Install concrete inserts for support of ductwork in coordination with formwork, as required to avoid delays in work.
- C. Routing: Locate ductwork runs vertically and horizontally and avoid diagonal runs wherever possible. Locate runs as indicated by drawings, details and notations or, if not otherwise indicated, run ductwork in shortest route which does not obstruct useable space or block access for servicing building and its equipment. Hold ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building. Limit clearance to 1/2-inch where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any. Where possible, locate insulated ductwork for 1-inch clearance outside of insulation. Wherever possible in finished and occupied spaces, conceal ductwork from view, by locating in mechanical shafts, hollow wall construction, or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.
- D. Electrical Equipment Spaces: Do not route ductwork through transformer vaults and electrical equipment spaces and enclosures.
- E. Slope shower, locker room, and high moisture ductwork down to air device. Do not provide joints on bottom of duct in longitudinal direction.
- F. Penetrations: Where ducts pass through interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same gauge as duct. Overlap opening on all four (4) sides by at least 1-1/2 inch. Fasten to duct only.
- G. Coordination: Coordinate duct installations with installation of accessories, dampers, coil frames, equipment, controls and other associated work of ductwork system.
- H. Installation: Install metal ductwork in accordance with SMACNA HVAC Duct Construction Standards.

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- I. Temporary Closure: At ends of ducts that are not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure of polyethylene film or other covering that will prevent entrance of dust and debris until time connections are to be completed.
- J. Install prefabricated grease ductwork in accordance with manufacturer requirements and NFPA 96.
- K. Grease Ducts:
  - 1. Joints, seams and penetration shall be made with a continuous weld and be liquid tight. Exceptions are joints using listed sealants, internally welded joints that are ground smooth and observable, and listed factory built grease ducts.
  - 2. Joints shall be tested to be liquid tight by a light test and/or other methods approved by the Authority Having Jurisdiction. This test shall be done prior to use of concealment of ductwork.
  - 3. Fasteners of any type shall not penetrate grease ducts.
  - 4. Install ducts to pitch towards hood or approved grease reservoir. Ducts shall slope ¼" per foot. Horizontal ducts exceeding 75' in length shall slope 1" per foot.
  - 5. Grease ducts that are exposed shall have a clearance or not less than 18" from combustible construction materials, and not less than 3" clearance from non-combustible construction and gypsum wallboard.
  - 6. Provide grease duct cleanouts on horizontal sections of ducts that are spaced no less than 20' apart. The opening shall be a minimum of 12" on each side and be located on the side of the duct, no less than 1 ½" above the bottom of duct and no less than 1" from the top.

### 3.3 INSTALLATION OF DUCT LINER

- A. Install duct liner in accordance with SMACNA HVAC Duct Construction Standards.
- B. Adhere insulation to sheet metal with full coverage of adhesive.
- C. Mechanical fasteners should be of length sufficient to limit compression of liner.
- D. All exposed edges of the liner must be factory or field coated.
- E. Repair liner surface penetrations with adhesive.

### 3.4 INSTALLATION OF FLEXIBLE DUCTS

- A. Do not exceed 6'-0" for any flexible duct run.
- B. Install in accordance with Chapter 3 of SMACNA "HVAC Duct Construction Standards, Metal and Flexible".

### 3.5 LEAKAGE TESTS

- A. Kitchen hood exhaust shall be leak tested.

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3.6 ADJUSTING AND CLEANING

- A. Clean ductwork internally, unit by unit as it is installed, of dust and debris. Clean external surfaces of foreign substances. Where ductwork is to be painted, clean and prepare surface for painting.
- B. Balancing: Seal any leaks in ductwork that become apparent in balancing process.

END OF SECTION 233113

**SECTION 233116 - NON-METAL DUCTWORK**

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of Non-Metal Ductwork is indicated on drawings and in schedules, and by requirements of this section.
- B. Types of Non-Metal Ductwork required for project include the following:
  - 1. Fibrous Glass Ductwork
  - 2. PVC Plastic Ductwork

1.2 QUALITY ASSURANCE

- A. Installer: Firm with at least three (3) years of successful installation experience on projects with Non-Metal Ductwork Systems Work similar to that required for project.
- B. Codes and Standards:
  - 1. SMACNA Compliance: Fabricate and install fibrous glass ductwork in accordance with SMACNA "Fibrous Glass Duct Construction Standards".
  - 2. SMACNA Compliance: Fabricate and install thermoplastic ductwork in accordance with SMACNA "Thermoplastic Duct (PVC) Construction Manual".
  - 3. NFPA Compliance: Fabricate and install non-metal ductwork in accordance with NFPA 90A "Standard for the Installation of Air-Conditioning and Ventilating Systems".

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's specifications on materials and manufactured products used for work of this section.
- B. Shop Drawings: Submit dimensioned layouts of ductwork showing both accurately scaled ductwork and its relation to space enclosure. Show modifications of indicated requirements, made to conform to local shop practice, and how those modifications ensure that free area, materials, and rigidity are not reduced.
- C. Record Drawings: At project closeout, submit record drawings of installed systems products, in accordance with requirements of Division 1.
- D. Maintenance Data: Submit maintenance data and parts lists for metal ductwork materials and products. Include this data, product data, shop drawings, and record drawings in maintenance manual; in accordance with requirements of Division 1.



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### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Protect shop-fabricated and factory-fabricated ductwork, accessories and purchased products from damage during shipping, storage and handling. Prevent end damage and prevent dirt and moisture from entering ducts and fittings.
- B. Where possible, store ductwork inside and protect from weather. Where necessary to store outside, store above grade and enclose with waterproof wrapping.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
  - 1. Low Pressure Fibrous Glass Ductwork:
    - a. CertainTeed Corp., Insulation Group
    - b. Knauf Fiber Glass
    - c. Owens-Corning Fiberglas Corp.
    - d. Johns Manville
  - 2. Medium Pressure Fibrous Glass Ductwork:
    - a. Johns Manville
  - 3. PVC Ductwork:
    - a. Air Plastics, Inc.
    - b. Argo Plastic Products Co.
    - c. Duall Industries, Inc.
    - d. Eastman Chemical Products, Inc.
    - e. Harrington Industrial Plastics, Inc.
    - f. Harrison Plastic Systems

### 2.2 LOW PRESSURE FIBROUS GLASS DUCTWORK

- A. Exposed Ductwork Materials: Where ductwork is indicated to be exposed to view in occupied spaces, provide materials which are free from visual imperfections including seam marks, stains and discolorations and other imperfections.
- B. Duct Board: Except as otherwise indicated, fabricate ductwork from 1-inch thick sheets of resin-bonded inorganic and inert glass fibers, with factory-applied facing of aluminum or reinforced aluminum, thermal conductivity (k-factor) of 0.23 Btu-inch/hour-square foot-degree F at mean temperature of 75 degree F (0.033 W/m-degree C at 24 degree C) and a noise reduction coefficient (NRC) of 0.90 per ASTM C423 using a No. 6 mounting and maximum air friction correction factor of 101 at 2,000 fpm. Duct board shall meet the requirements of NFPA 90A and 90B and Underwriters Laboratories UL 181 Class 1 Air Duct listing.

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- C. Miscellaneous Materials: Provide miscellaneous materials and products of types and sizes indicated and, where not otherwise indicated, provide type and size required to comply with ductwork system requirements including proper connection of ductwork and equipment.
- D. Pressure Sensitive Tape. Pressure sensitive tape, 2-1/2 inch wide, complying with SMACNA Performance Standard AFDS-100-73, and with NFPA 90A or NFPA 90B or UL 181, Class 1 requirements.
- E. Ductwork Support Materials: Except as otherwise indicated, provide hot-dipped galvanized steel fasteners, anchors, rods, straps, trim and angles for support of ductwork.
  - 1. Except where space is indicated as "High-Humidity" area, interior steel support materials of not less than 1/4-inch diameter or 3/16-inch thickness may be plain (not galvanized).

### 2.3 PVC DUCTWORK

- A. Materials: Construct ductwork of PVC compounds, in accordance with SMACNA PVC Duct Construction Standard.
- B. Fabrication: Fabricate ductwork, fittings, and accessories in accordance with SMACNA PVC Duct Construction Standard, using material thickness and reinforcement as recommended in Standard, for duct static pressure classifications as indicated on drawings.
- C. Access Doors: Construct access doors in accordance with SMACNA PVC Duct Construction Manual, and locate as indicated.
- D. Dampers: Construct volume dampers in accordance with SMACNA PVC Duct Construction Manual, and locate as indicated.
- E. Flexible Connections: Construct flexible connections in accordance with SMACNA PVC Duct Construction Manual, and locate as indicated.
- F. Expansion Joints: Construct expansion joints in accordance with SMACNA PVC Duct Construction Manual, and locate as indicated.
- G. Drains: Construct drain connections in accordance with SMACNA PVC Duct Construction Manual, and locate as indicated.

## PART 3 - EXECUTION

### 3.1 INSTALLATION OF DUCTWORK

- A. General: Assemble and install ductwork in accordance with recognized industry practices which will achieve air tight and noiseless systems, capable of performing each indicated

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

service. Install each run with minimum of joints. Align ductwork accurately at connections, within 1/8-inch misalignment tolerance and with internal surfaces smooth. Support ducts rigidly with suitable ties, braces, hangers and anchors of the type which will hold ducts true-to-shape and prevent buckling.

- B. Inserts: Provide concrete inserts for support of ductwork for new concrete construction and coordinate with formwork, as required to avoid delays in work. Provide expansion shields concrete anchors for support of ductwork in existing concrete construction.
- C. Construct ductwork to schedule of operating pressures as shown on drawings.
- D. Complete fabrication of work at project as necessary to match shop fabricated work and accommodate installation requirements.
- E. Locate ductwork runs, except as otherwise indicated, vertically and horizontally and avoid diagonal runs wherever possible. Locate runs as indicated by diagrams, details and notations or, if not otherwise indicated, run ductwork in shortest route which does not obstruct usable space or block access for servicing building and its equipment. Hold ducts close to walls, overhead construction, columns, and other structural and permanent-enclosing elements of building. Limit clearance to 1/2-inch where furring is indicated for enclosure or concealment of ducts. Wherever possible in finished and occupied spaces, conceal ductwork from view, by locating in mechanical shafts, hollow wall construction or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically indicated. Coordinate layout with suspended ceiling and lighting layouts, and similar finished work.
- F. Electrical Equipment Spaces: Do not run ductwork through transformer vaults and other electrical equipment spaces and enclosures.
- G. Where ducts pass through interior partitions or exterior walls, conceal space between construction opening and duct with sheet metal flanges. Overlap opening on all sides by at least 1-1/2 inch.
- H. Fire Dampers: Provide fire dampers in accordance with Division 23 Section 233300 "Ductwork Accessories".
- I. Coordinate duct installations with installation of accessories, dampers, coil frames, equipment, controls and other associated work of ductwork system.
- J. Connect ductwork to equipment with mechanical fasteners such as sheet metal clips, screws and washers. In addition, seal airtight with tape.
- K. Include prefabricated air scoops formed of galvanized sheet metal or branch take-offs.
- L. Support ductwork from building structure as required and where not otherwise indicated, anchor with bolts, concrete inserts, steel expansion anchors, welded studs C-clamps or special beam clamps.
- M. Space duct supports (horizontal and vertical) so that not more than one (1) transverse joint will occur between supports.

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- N. Support vertical ducts, at 8'-0" minimum spacing, by attachment to adjacent vertical structural surfaces or by direct bearings at floor penetrations and similar locations. Limit vertical ducts to two (2) stories in height of any continuous duct run.
  - 1. For penetration supports, install internal 18-inch long sheet metal sleeve and attach to 1-inch x 1/8-inch angles spanning the penetration.
  - 2. For adjacent supports, attach 1-inch x 1/8-inch angle brackets to transverse reinforcements.
- O. Low pressure fibrous glass ductwork shall be supported at all fittings and changes in direction. For straight runs support every 48-inches where duct span is 24-inches or more and every 96-inches where duct span is less than 24-inches. Hanger straps shall be 1-inch x 22-inch galvanized sheet metal to 60-inch span and 1-inch x 18-inch gauge over 60-inch span or 12 gauge wire. Suspend in trapeze fashion with 22 gauge 1-inch x 2-inch x 1-inch channels. Provide extra wrapping of closure strip at duct support locations.
- P. Medium pressure fibrous glass fittings shall not be used for at least six (6) diameters downstream of a fan. Straight duct may be directly connected to a unit connection.
- Q. Medium pressure fibrous glass ductwork shall be supported every 36-inches up to 7-inch ID and every 72-inches for 8-inch ID and over at joints using galvanized sheet metal straps, 1-inch minimum width. Smooth to remove burrs or sharp edges and where hanger straps come in contact with the duct wall, apply a piece of tape on the metal to provide extra protection against abrasion and tape strap to duct to restrict movement. Hanger loops should be fastened by bolts of self-tapping metal screws.

### 3.2 LOW PRESSURE FIBROUS GLASS DUCTWORK FABRICATION

- A. Shop fabricate ductwork in 4, 8, 10 or 12-foot lengths, unless otherwise indicated or required to complete runs. Pre-assemble work in shop to greatest extent possible, so as to minimize field assembly of systems. Disassemble systems only to extent necessary for shipping and handling. Match-mark sections for re-assembly and coordinated installation.
- B. Fabricate ductwork with joints, seams and reinforcements as indicated, complying with recognized industry standards. Use centerline method with either V-groove or shiplap groove joints.
- C. Fabricate straight duct and fittings complying with Section II of SMACNA "Fibrous Glass Duct Construction Standards", unless otherwise indicated.
- D. Fabricate ductwork reinforcement complying with Section IV of SMACNA "Fibrous Glass Duct Construction Standards", unless otherwise indicated.
- E. Fabricate ductwork hangers and supports complying with Section V of SMACNA "Fibrous Glass Duct Construction Standards", unless otherwise indicated.
- F. Fabricate preformed round duct complying with Section VI of SMACNA "Fibrous Glass Duct Construction Standards", unless otherwise indicated.
- G. Close longitudinal seams and transverse joints with flare door staples 2-inch o.c. and with pressure sensitive tape, using seaming system listed and recommended by board manufacturer.

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- H. Fabricate duct fittings to match adjoining ducts, and to comply with duct requirements as applicable to fittings. Except as otherwise indicated, fabricate elbows with center-line radius equal to associated duct width; and fabricate to include turning vanes in elbows where shorter radius is necessary. Limit angular tapers to 30 degrees for contracting tapers and 20 degrees for expanding tapers.

### 3.3 TESTING FOR LEAKAGE

#### A. General:

1. Medium pressure ductwork systems shall be tested in their entirety for leaks prior to insulation. Arbitrary sections of low pressure ductwork, as selected by the Engineer, shall be tested.
2. Test Failures: Duct systems shall be repaired if test pressure and leakage requirements are not met or if air noise condition is encountered. Repairs and sealing shall be done with sheet metal, tape, sealant or a combination thereof.
3. Ductwork pressure tests shall be approved by Architect prior to installation of insulation.

#### B. Test Equipment:

1. Portable rotary type blower or tank type vacuum cleaner with control damper. Equipment shall have sufficient capacity to properly test reasonable large duct system section.
2. Orifice assembly consisting of straightening vanes and calibrated orifice plate mounted in a straight tube with properly located pressure taps.
3. Two (2) U-tube manometers, one (1) to measure drop across calibrated orifice and one (1) to measure S.P. in duct being tested.

#### C. Testing Pressures and Maximum Permissible Leakage:

1. Leak Testing Pressure: 25 Percent in excess of designed duct operating pressure.
2. Maximum Permissible Leakage: 2 Percent of total system.

### 3.4 FIELD QUALITY CONTROL

- A. Supplier/Factory representative of all fiberglass ductwork shall be required to make a minimum of one (1) weekly on site inspection of ductwork being installed and submit a written observation report to the Engineer. Representative shall also be required to witness testing for leakage along with the Engineers field representative as stated in this Section.

### 3.5 CLEANING AND PROTECTION

- A. Clean ductwork internally of dust and debris, unit-by-unit as it is installed. Clean external surfaces of foreign substances which might cause corrosive deterioration of facing.
- B. Temporary Closure: At ends of ducts which are not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure of polyethylene film or other covering which will prevent entrance of dust and debris until time connections are to be completed.
- C. Fibrous glass ductwork shall not be stored where subject to water absorption.

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3.6 BALANCING

- A. Refer to Division 23, Section 230593 "Testing, Adjusting, and Balancing" for air distribution balancing of non-metal ductwork; not work of this section. Seal any leaks in ductwork that become apparent in balancing process.

END OF SECTION 233116

**SECTION 233300 - DUCTWORK ACCESSORIES**

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Types of Ductwork Accessories required for project include the following:
  - 1. Manual Volume Dampers
  - 2. Control Dampers
  - 3. Turning Vanes
  - 4. Duct Hardware
  - 5. Duct Access Doors
  - 6. Flexible Connections

1.2 QUALITY ASSURANCE

- A. **Manufacturer's Qualifications:** Firms regularly engaged in manufacture of ductwork accessories, of types and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. **Industry Standards:** Comply with ASHRAE recommendations pertaining to construction of ductwork accessories, except as otherwise indicated.
- C. **UL Compliance:** Construct, test, and label fire dampers in accordance with UL Standard 555 "Fire Dampers and Ceiling Dampers" and UL Standard 555S "Motor-Driven Fire/Smoke Dampers".
- D. **NFPA Compliance:** Comply with applicable provisions of NFPA 90A "Air Conditioning and Ventilating Systems", pertaining to installation of ductwork accessories.
- E. **SMACNA Compliance:** Comply with "Fire Damper and Heat Stop Guide" for the installation of fire, smoke, and fire/smoke dampers.
- F. All fire dampers, smoke dampers, fire/smoke dampers and radiation dampers shall meet the latest local building code requirements.

1.3 SUBMITTALS

- A. **Product Data:** Submit manufacturer's technical product data for each type of ductwork accessory, including dimensions, capacities, and materials of construction, and installation instructions.
- B. **Shop Drawings:** Submit manufacturer's assembly-type shop drawings for each type of ductwork accessory showing interfacing requirements with ductwork, method of fastening or support, and methods of assembly of components. Include details of construction equipment and accessories being provided.

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- C. Submittals for all damper types specified in this section shall include a schedule for each damper indicating net free area, actual face velocity and pressure drop (at sea level) based on net free area and the maximum air quantity which will be passing through the damper. Submittals without this information will be rejected.
- D. Record Drawings: At project closeout, submit record drawings of installed systems products, in accordance with requirements of Division 1.
- E. Maintenance Data: Submit manufacturer's maintenance data including parts lists for each type of duct accessory. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Division 1.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
  - 1. Dampers:
    - a. American Warming and Ventilating
    - b. Air Balance, Inc.
    - c. Arrow Louver & Damper; Division of Arrow United Industries, Inc.
    - d. Louvers & Dampers, Inc.
    - e. Penn Ventilator Co.
    - f. Dowco Corp.
    - g. Air Stream
    - h. Cesco-Advanced Air
    - i. Ruskin
    - j. Vent Products Inc.
    - k. Greenheck
    - l. Pottorff
  - 2. Turning Vanes:
    - a. Aero Dyne Co.
    - b. Airsan Corp.
    - c. Barb-Aire
    - d. Duro Dyne Corp.
    - e. Environmental Elements Corp.; Subs. Koppers Co., Inc.
    - f. Hart & Cooley Mfg. Co.
    - g. Hercules
  - 3. Duct Hardware:
    - a. Ventfabrics, Inc.
    - b. Young Regulator Co.
  - 4. Duct Access Doors:
    - a. Flexmaster (Inspector Series)
    - b. Cesco-Advanced Air
    - c. Duro Dyne Corp.
    - d. Ventfabrics, Inc.
  - 5. Flexible Connections:
    - a. Duro Dyne Corp.



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- b. Ventfabrics, Inc.
- c. General Rubber Corp. (Process and Exhaust Only)

### 2.2 DAMPERS

- A. Low Pressure Rectangular Dampers (Less than 2,000 FPM and Under 4-Inch W.C. S.P. Differential):
  - 1. For 12-inch in height or larger, use multiple opposed blade type and close fitted to ducts. 16 Gauge galvanized steel frame and blades with carbon steel shaft mounted with stainless steel bearings, stainless steel jamb seals and silicone blade edge seals. Linkage shall be in-jamb fixed type located outside the airstream made of plated steel tie bar and crank plates, with stainless steel pivots. Maximum damper panel width is 48-inch. Provide jack shafting when duct size required is greater than 48-inch wide. Provide notched shaft end indicating damper position, locking quadrant to fix damper position and handle. For flat oval and round ductwork, provide Type C housing.
  - 2. For ducts less than 12-inch in height, use 16 gauge frame and 20 gauge blade galvanized steel, steel axle with nylon bearings, locking quadrant handle and notched shaft end indicating damper position.
- B. Low Pressure Round Dampers (Less than 1,500 FPM and Under 1-Inch W.C. S.P. Differential):
  - 1. For Dampers 4-inch diameter through 18-inch diameter use 18 gauge galvanized steel frame and the following blade construction:

4-Inch thru 12-inch diameter	22 gauge galvanized steel
13-Inch thru 18-inch diameter	20 gauge galvanized steel
  - 2. Carbon steel axle shaft with retainers mounted on stainless steel bearings with notched end shaft indicating damper position, locking quadrant and handle.
- C. Medium High Pressure Rectangular Dampers (Less than 4,000 FPM and Under 6-Inch W.C. (48-Inch Wide or Less) S.P. or 8-Inch W.C. S.P. (36-Inch Wide or Less)):
  - 1. Use opposed blade dampers for volume control and parallel blade for isolation/shutoff service.
  - 2. 16 Gauge galvanized steel frame with welded corners. Double skin galvanized steel blades with single-lock seam, airfoil shape. Double durometer vinyl blade edge seals and metallic compression seals at the jambs. Solid carbon steel axles mounted on stainless steel bearings. In-jamb type linkage located outside the air stream. 48-Inch wide and 60- inch high maximum damper size. For fixed position balancing damper, delete blades to maintain 30 percent free area with all other damper blades are 100 percent closed. For isolation or shutoff duty, damper leakage shall not exceed 9.5 CFM/square foot at 4-inch W.C. S.P. differential. Provide extended shaft with notched end indicating damper position, locking quadrant and handle.

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### Air Balance Model AC-515/AC-516 (Steel)

#### 2.3 TURNING VANES

- A. Fabricated Turning Vanes: Provide fabricated 22 gauge, single blade 4-1/2 inch radius, 3-1/4 inch spacing turning vanes and Type 2, 4-1/2 inch wide runners, constructed in accordance with SMACNA "HVAC Duct Construction Standards" Fig 2.3.
- B. Do not use trailing edge turning vanes.

#### 2.4 DUCT HARDWARE

- A. General: Provide duct hardware, manufactured by one manufacturer for all items on project, for the following:
  - 1. Test Holes: Provide in ductwork at fan inlet and outlet, and elsewhere as indicated, duct test holes, consisting of slot and cover, for instrument tests.
  - 2. Quadrant Locks: Provide for each manual volume damper, quadrant lock device on one (1) end of shaft; and end bearing plate on other end for damper lengths over 12-inch. Provide extended quadrant locks and end extended bearing plates for externally insulated ductwork.

#### 2.5 DUCT ACCESS DOORS

- A. General: Provide access doors, whether shown or not, at all fire dampers, smoke dampers, temperature control dampers, branch balancing dampers, outside air plenums, inlet of fans, upstream of all duct smoke detectors and all other equipment requiring service and/or access.
- B. Construction: Construct of same or greater gauge as ductwork served, provide insulated doors for insulated ductwork. Provide flush frames for uninsulated ductwork, extended frames for externally insulated duct. All access doors shall have gasket and will be air-tight. Provide one (1) side hinged, other side with one (1) handle-type latch for doors 12-inch high and smaller, two (2) handle-type latches for larger doors. For spiral ductwork, use United McGill combination access section type ARF-SD for non-insulated duct systems and type ARF-ID double wall insulated door for insulated ducted systems (all supply ductwork).

#### 2.6 FLEXIBLE CONNECTIONS

- A. General: Provide flexible duct connections wherever ductwork connects to vibration isolated equipment. Construct flexible connections of neoprene-coated flameproof fabric crimped into duct flanges for attachment to duct and equipment. Make air-tight joint. Provide adequate joint flexibility to allow for thermal, axial, transverse, and torsional movement, and also capable of absorbing vibrations of connected equipment. Shelf life shall be verified to not exceed six (6) months. Any sign of cracking on interior or exterior shall be cause for replacement immediately.
- B. Use the following product types for each application accordingly:

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1. Indoor Equipment Non-Corrosive Air Systems: Heavy glass fabric, double-coated with DuPont's NEOPRENE, non-combustible fabric, fire retardant coating with good resistance to abrasion and flexing. Fabric shall be 30 ounce per square yard, capable of operating at –10 degree F to 200 degree F, waterproof, air tight, 6-inches wide, complies with NFPA 90 and UL Standard #214. "Ventglas" Model as manufactured by VentFabric, Inc.
2. Outdoor Equipment Non-Corrosive Air Systems (Exposed to Weather and Sun): Heavy glass fabric, double-coated with DuPont's HYPALON, non-combustible fabric, fire retardant coating with superb resistance to sunlight, ozone and weather which has documented 20-year-old exposure tests. Fabric shall be 26 ounce per square yard, capable of operating at –10 degree F to 250 degree F, waterproof, air tight, 6-inches wide, complies with NFPA 90 and UL Standard #214. "Ventlon" Model as manufactured by VentFabrics, Inc.
3. High Temperature Non-Corrosive Air Systems: Heavy glass fabric coated with silicone rubber, non-combustible fabric, fire retardant coating, capable of operating and maintaining flexibility between temperatures of –25 degree F to 500 degree F. Fabric shall be 16 ounce per square yard, waterproof, air tight, 6-inches wide, complies with NFPA 90, UL Standard #214. "Ventsil" Model as manufactured by VentFabrics, Inc.
4. Indoor Corrosive Air System: Heavy glass fabric coated with DuPont's teflon fluorocarbon resins, capable of operating between temperatures of –20 degree F and 500 degree F. Fabric shall be 14 ounce per square yard, water tight, air tight, chemically resistant to most chemicals including but not limited to sulfuric acid, acetic acid, chlorine, dimethyl ether, xylene, hexane, ozone, nitric acid, butyl acetate, ammonia gas and liquid, acetone, mercury, cyclohexane, methanol, 6-inches wide "Ventel" model as manufactured by VentFabrics, Inc.
5. Outdoor Corrosive Air Systems: Composite a 2-layer flexible duct connection using one (1) layer Vent Fabrics Ventlon (sun-resistant) and one (1) layer of VentFabrics Ventel (corrosion resistant), installing the Ventlon exposed to the weather and the Ventel exposed to air stream.

### PART 3 - EXECUTION

#### 3.1 INSPECTION

- A. Examine areas and conditions under which ductwork accessories will be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to the Engineer.

#### 3.2 INSTALLATION OF DUCTWORK ACCESSORIES

- A. Install ductwork accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA standards, and in accordance with recognized industry practices to ensure that products serve intended function.
- B. Install turning vanes in square or rectangular 90 degree elbows in supply, return and exhaust air systems, and elsewhere as indicated.

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- C. Install access doors to open against system air pressure, with latches operable from either side, except outside only where duct is too small for person to enter.
- D. Coordinate with other work, including ductwork, as necessary to interface installation of ductwork accessories properly with other work.
- E. Provide duct access doors whether shown or not for inspection and cleaning before and after all filters, coils, fans, automatic dampers, at fire dampers (minimum 16-inch x 24-inch in ducts larger than 18-inch), fire/smoke dampers, upstream of duct smoke detectors and elsewhere as indicated. Review locations prior to fabrication. Provide multiple access doors for large ductwork to provide adequate reach to equipment.
- F. Install fire dampers and smoke dampers in accordance with manufacturer's instructions.
- G. Provide fire dampers and smoke dampers at locations shown, where ducts and outlets pass through fire rated components, and where required by Authorities Having Jurisdiction.
- H. Provide balancing dampers at points on low pressure supply, return, and exhaust systems where branches are taken from larger ducts and as required for air balancing.
- I. Provide balancing dampers on high pressure systems where indicated. Use splitter dampers only where indicated on Drawings.
- J. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and equipment subject to forced vibration. Provide matching flanged backing frame with flexible connector where flanged fan connections are provided.
- K. Where fire and smoke dampers are installed in fire and smoke rated construction, provide firestopping between fire and fire smoke damper sleeve and substrate.

### 3.3 FIELD QUALITY CONTROL

- A. Operate installed ductwork accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories, as required to obtain proper operation and leakproof performance.
- B. Test every fire and fire/smoke damper for proper operation, provide letter to the Architect/Engineer certifying this work is complete and all dampers are functioning properly.

### 3.4 ADJUSTING AND CLEANING

- A. Adjusting: Adjust ductwork accessories for proper settings, install fusible links in fire dampers and adjust for proper action.
- B. Label access doors in accordance with Division 23 Section "Mechanical Identification".
- C. Final positioning of manual dampers is specified in Division 23 Section "Testing, Adjusting, and Balancing".

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- D. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.
- E. Touch up all scratches in PVC coated surfaces with respective coating finish.

3.5 EXTRA STOCK

- A. Furnish extra fusible links to Owner, one (1) link for every ten (10) installed of each temperature range; obtain receipt.

END OF SECTION 233300

**SECTION 233413 - AIR HANDLING FANS**

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of Air Handling Equipment Work required by this section is indicated on drawings and schedules, and by requirements of this section.
- B. This Section includes the following types of Air-Handling Equipment:
  - 1. Utility Set Fans
  - 2. Centrifugal Roof Ventilators
- C. Refer to other Division 23 sections for vibration control; control system; sequence of operation; testing, adjusting and balancing.
- D. Refer to Division 26 section for the following work; not work of this section.
  - 1. Power supply wiring from power source to power connections at air handling units.
- E. Refer to Division 23 section "Mechanical/Electrical Requirements for Mechanical Equipment".

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of air handling equipment of types and sizes required, whose products have been in satisfactory use in similar service for not less than three (3) years.
- B. Codes and Standards:
  - 1. Fans Performance Ratings: Establish flow rate, pressure, power air density, speed of rotation, and efficiency by factory tests and ratings in accordance with AMCA Standard 210/ASHRAE Standard 51 - Laboratory Methods of Testing Fans for Rating.
  - 2. UL Compliance: Provide air handling equipment which are listed by UL and have UL label affixed.
  - 3. UL Compliance: Provide air handling equipment which are designed, manufactured, and tested in accordance with UL 805 "Power Ventilators".
  - 4. NEMA Compliance: Provide motors and electrical accessories complying with NEMA Standards.
  - 5. Sound Power Level Ratings: Comply with AMCA Standard 301 "Method for Calculating Fan Sound Ratings from Laboratory Test Data". Test fans in accordance with AMCA Standard 300 "Test Code for Sound Rating". Fans shall be licensed to bear the AMCA Certified Sound Ratings Seal.
  - 6. Nationally Recognized Testing Laboratory and NEMA Compliance (NRTL): Fans and components shall be NRTL listed and labeled. The term "NRTL" shall be defined in OSHA Regulation 1910.7.
  - 7. Electrical Component Standards: Components and installation shall comply with NFPA 70 "National Electrical Code".

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### 1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical data for air handling equipment including specifications, capacity ratings, sound data, dimensions, weights, materials, operating and service/access clearance accessories furnished, and installation instructions.
- B. Shop Drawings: Submit assembly-type shop drawings showing unit dimensions, construction details, methods of assembly of components, and field connection details.
- C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to air-handling units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are manufacturer-installed and portions to be field-installed.
- D. Record Drawings: At project closeout, submit record drawings of installed systems products; in accordance with requirements of Division 1.
- E. Maintenance Data: Submit maintenance data and parts list for each type of power and gravity ventilator, accessory, and control. Include this data, product data, shop drawings, and wiring diagrams in maintenance manuals in accordance with requirements of Division 1.

### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Lift and support units with the manufacturer's designated lifting or supporting points.
- B. Disassemble and reassemble units as required for movement into the final location following manufacturer's written instructions.
- C. Deliver fan units as a factory-assembled unit to the extent allowable by shipping limitations, with protective crating and covering.

### 1.5 SEQUENCING AND SCHEDULING

- A. Coordinate the size and location of concrete equipment pads. Cast anchor bolt inserts into pad.
- B. Coordinate the installation of roof curbs, equipment supports, and roof penetrations.
- C. Coordinate the size and location of structural steel support members.

### 1.6 EXTRA MATERIALS

- A. Furnish one (1) additional complete set of belts for each belt-driven fan.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

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- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Utility Sets:
    - a. Acme Engineering & Mfg. Corp.
    - b. Howden Buffalo
    - c. Loren Cook Co.
    - d. Solar & Palau Ventilation Group.
    - e. New York Blower Co.
    - f. Penn Barry.
    - g. Twin City Fan & Blower Co.
    - h. Greenheck
  - 2. Centrifugal Roof Ventilators:
    - a. Acme Engineering & Manufacturing Corp.
    - b. Aerovent, Inc.
    - c. Briedert Co.
    - d. Carnes Company, Inc.
    - e. Loren Cook Co.
    - f. Jenn Co Fan.
    - g. Penn Barry.
    - h. Greenheck

### 2.2 FANS, GENERAL

- A. General: Provide fans that are factory fabricated and assembled, factory tested, and factory finished, with indicated capacities and characteristics.
- B. Fans and Shafts: Statically and dynamically balanced and designed for continuous operation at the maximum rated fan speed and motor horsepower.
  - 1. Fan Shaft: Turned, ground, and polished steel designed to operate at no more than 70 percent of the first critical speed at the top of the speed range of the fan's class.
- C. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
  - 1. Service Factor: 1.4.
- D. Belts: Oil-resistant, non-sparking, and non-static.
- E. Motors and Fan Wheel Pulleys: Adjustable pitch for use with motors through 15 HP; fixed pitch for use with motors larger than 15 HP. Select pulley so that pitch adjustment is at the middle of the adjustment range at fan design conditions. Provide premium energy efficient motor.
  - 1. Belt Guards: Provide steel belt guards for motors mounted on the outside of the fan cabinet.
- F. Shaft Bearings: Provide type indicated, having a median life "Rating Life" AFBMA L10 of 200,000 hrs calculated in accordance with AFBMA Standard 9 for ball bearings and AFBMA Standard 11 for roller bearings.
- G. Factory Finish: The following finishes are required:
  - 1. Sheet Metal Parts: Prime coating prior to final assembly.
  - 2. Exterior Surfaces: Baked-enamel finish coat after assembly.



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- H. Vibration: Provide vibration isolators as scheduled and specified in other Division 23 sections.

### 2.3 UTILITY SET FANS

- A. General Description: Belt-driven, centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and accessories.
- B. Housings: Fabricated from heavy-gauge steel with side sheets fastened to scroll sheets by means of welding or deep lock seam.
  - 1. Inlet: Round duct collar.
  - 2. Discharge: Slip-joint duct connection.
  - 3. Housings Discharge Arrangement: Adjustable to eight (8) standard positions.
- C. Fan Wheels: Single-width, single-inlet, welded to cast iron or cast steel hub and spun steel inlet cone, with hub keyed to the shaft.
  - 1. Blade Materials: Steel.
  - 2. Blade Type: Backward-curved, die-formed.
  - 3. Blade Type: Forward-curved, die-formed.
- D. Shaft Bearings: Pre-lubricated and sealed, self-aligning, pillow-block-type ball bearings.
- E. Accessories: The following accessories are required where indicated:
  - 1. Backdraft Dampers: Gravity-actuated with counterweight and interlocking aluminum blades and felt edges in steel frame installed on fan discharge.
  - 2. Access Doors: Gasketed doors with latch-type handles.
  - 3. Scroll Dampers: Single-blade damper installed at fan scroll top with adjustable linkage.
  - 4. Spark-Resistant Construction: AMCA Construction Option A, B, or C as indicated.
  - 5. Inlet Screens: Removable, heavy wire mesh.
  - 6. Drain Connections: 3/4-Inch, threaded coupling drain connection installed at lowest point of housing.
  - 7. Weather Hoods: Weather-resistant with stamped vents over motor and drive compartment.
  - 8. Special Coatings: Provide protective coatings on fans as indicated.

### 2.4 CENTRIFUGAL ROOF VENTILATORS

- A. General Description: Belt-driven or direct-drive as indicated, centrifugal consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.
- B. Housing: Heavy-gauge, removable, spun-aluminum, dome top and outlet baffle; square, one-piece, hinged, aluminum base with venturi inlet cone.
  - 1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.
- C. Fan Wheel: Aluminum hub and wheel with backward-inclined blades.
- D. Belt-Driven Drive Assembly: Resiliently mounted to the housing, with the following features:
  - 1. Pulleys: Cast iron, adjustable-pitch.

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2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
  3. Fan Shaft: Turned, ground, and polished steel drive shaft keyed to wheel hub.
  4. Fan and motor isolated from exhaust air stream.
- E. Accessories: The following items are required as indicated:
1. Disconnect Switch: Non-fusible type, with thermal overload protection mounted inside fan housing, factory-wired through an internal aluminum conduit.
  2. Bird Screens: Removable 1/2-inch mesh, 16 gauge, aluminum or brass wire.
  3. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base, factory set to close when fan stops.
  4. Roof Curbs: Prefabricated, heavy-gauge, galvanized steel; mitered and welded corners; 2-inch thick, rigid, fiberglass insulation adhered to inside walls; built-in cant and mounting flange for flat roof decks; and 2-inch wood nailer. Size as required to suit roof opening and fan base.
    - a. Overall Height: 12-Inches above roofing.

### 2.5 PREFABRICATED ROOF CURBS

- A. Furnish and install roof curbs as scheduled for duct openings through the roof and for exhaust fan support. The curbs shall be galvanized steel self-flashing type. If the curbs are to have sound attenuation qualities, they shall be not less than those catalogued for the equipment specified.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances, housekeeping pads, and other conditions affecting performance of fans.
- B. Do not proceed until unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION, GENERAL

- A. Install fans level and plumb, in accordance with manufacturer's written instructions. Support units using vibration control devices as indicated. Vibration control devices are specified in Division 23 Section "Vibration Controls".
1. Secure roof-mounted fans to roof curbs with cadmium-plated hardware.
    - a. Installation of roof curbs is specified in Division 7.
  2. Suspended Units: Suspend units from structural steel support frame using threaded steel rods and vibration isolation springs.
- B. Arrange installation of units to provide access space around air-handling units for service and maintenance.

### 3.3 EQUIPMENT BASES

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- A. Construct concrete equipment pads as follows:
  - 1. Coordinate size of equipment bases with actual unit sizes provided. Construct base 4-inches larger in both directions than the overall dimensions of the supported unit.
  - 2. Form concrete pads with steel channels conforming to ASTM A 36, size and location as indicated. Miter and weld corner and provide cross bracing. Anchor or key to floor slab.
  - 3. Form concrete pads with framing lumber with form release compounds. Chamfer top edge and corners of pad.
  - 4. Install reinforcing bars, tied to frame, and place anchor bolts and sleeves to facilitate securing units.
  - 5. Place concrete and allow to cure before installation of units. Use Portland Cement conforming to ASTM C 150, 4,000 psi compressive strength, and normal weight aggregate.
  - 6. Clean exposed steel form in accordance with SSPC Surface Preparation Specifications SP 2 or SP 3 and apply two (2) coats of rust-preventive metal primer.

### 3.4 CONNECTIONS

- A. Duct installations and connections are specified in other Division 23 sections. Make final duct connections on inlet and outlet duct connections with flexible connections.
- B. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
  - 1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Ensure that rotation is in direction indicated and intended for proper performance. Do not proceed with centrifugal fan start-up until wiring installation is acceptable to Centrifugal Fan Installer.
  - 2. Temperature control wiring and interlock wiring are specified in Division 23.
  - 3. Grounding: Connect unit components to ground in accordance with the National Electrical Code.

### 3.5 FIELD QUALITY CONTROL

- A. Upon completion of installation of air handling equipment, and after motor has been energized with normal power source, test equipment to demonstrate compliance with requirements. Where possible, field correct malfunctioning equipment, then retest to demonstrate compliance. Replace equipment which cannot be satisfactorily corrected.
- B. Manufacturer's Field Inspection: Arrange and pay for a factory-authorized service representative to perform the following:
  - 1. Inspect the field assembly of components and installation of fans including ductwork and electrical connections.
  - 2. Prepare a written report on findings and recommended corrective actions.

### 3.6 ADJUSTING, CLEANING, AND PROTECTING

- A. Start-up, test and adjust air handling equipment in presence of manufacturer's authorized representative.

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- B. Adjust damper linkages for proper damper operation.
- C. Clean unit cabinet interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheel and cabinet.

### 3.7 SPARE PARTS

- A. General: Furnish to Owner with receipt one (1) spare set of belts for each belt driven air handling equipment.

### 3.8 PRE-STARTUP CHECK

- A. Final Checks Before Start-Up: Perform the following operations and checks before start-up:
  1. Remove shipping blocking and bracing.
  2. Verify unit is secure on mountings and supporting devices and that connections for piping, ductwork, and electrical are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects.
  3. Perform cleaning and adjusting specified in this Section.
  4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.
  5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
  6. Verify manual and automatic volume control and that fire and smoke dampers in connected ductwork systems are in the full-open position.
  7. Disable automatic temperature control operators.
- B. Starting Procedures for Fans:
  1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM.
  2. Replace fan and motor pulleys as required to achieve design conditions.
  3. Measure and record motor electrical values for voltage and amperage.
- C. Shut unit down and reconnect automatic temperature control operators.
- D. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for procedures for air-handling-system testing, adjusting, and balancing.

### 3.9 DEMONSTRATION

- A. Demonstration Services: Arrange and pay for a factory-authorized service representative to train Owner's maintenance personnel on the following:
  1. Procedures and schedules related to start-up and shutdown, troubleshooting, servicing, preventative maintenance, and how to obtain replacement parts.
  2. Familiarization with contents of Operating and Maintenance Manuals specified in Division 1 Section "Project Closeout" and Division 23 Section "Basic Mechanical Requirements".

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- B. Schedule training with at least seven (7) days' advance notice.

END OF SECTION 233413

**SECTION 233600 - AIR TERMINALS**

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of Air Terminals Work required by this section is indicated on drawings and schedules, and by requirements of this section.
- B. Types of Air Terminals specified in this section include the following:
  - 1. Variable Volume Air Terminals
    - a. Shutoff Single Duct
    - b. Reheat
- C. Refer to other Division 23 sections for external insulation of air terminals; testing, adjusting and balancing of air terminals; temperature controls which are to be furnished by others but installed as work of this section.
- D. Refer to Division 26 sections for the following work; not work of this section.
  - 1. Power supply wiring from power source to power connection on air terminals. Include starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.
- E. Provide the following electrical work as work of this section, complying with requirements of Division 26 sections:
  - 1. Control wiring between field-installed controls and air terminals.
    - a. Control wiring specified as work of Division 23 for Automatic Temperature Controls is work of that section.

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of air terminals with characteristics, sizes, and capacities required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. Codes and Standards:
  - 1. ADC Compliance: Provide air terminals which have been tested and rated in accordance with ADC standards, and bear ADC Seal.
  - 2. ARI Compliance: Provide air terminals which have been tested and rated in accordance with ARI 880 "Industry Standard for Air Terminals" and bear ARI certification seal.
  - 3. NFPA Compliance: Construct air terminals using acoustical and thermal insulations complying with NFPA 90A "Air Conditioning and Ventilating Systems".

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

### 1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including performance and sound data for each size and type of air terminal furnished; schedule showing drawing designation, room location, number furnished, model number, size, and accessories furnished; and installation and start-up instructions.
- B. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.
- C. Wiring Diagrams: Submit ladder-type wiring diagrams for electric power and control components, clearly indicating required field electrical connections.
- D. Record Drawings: At project closeout, submit record drawings of installed systems products, in accordance with requirements of Division 23.
- E. Maintenance Data: Submit maintenance data and parts list for each type of air terminal; including "trouble-shooting" maintenance guide. Include this data, product data, shop drawings, and maintenance data in maintenance manual; in accordance with requirements of Division 23.

### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver air terminals wrapped in factory-fabricated fiber-board type containers. Identify on outside of container type of air terminal and location to be installed. Avoid crushing or bending and prevent dirt and debris from entering and settling in boxes.
- B. Store air terminals in original cartons and protect from weather and construction work traffic. Where possible, store indoors; when necessary to store outdoors, store above grade and enclose with waterproof wrapping.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
  - 1. Supply Air Terminals:
    - a. Carnes Co.
    - b. Titus Products Division
    - c. Carrier Corp.
    - d. Trane (The) Co.
    - e. Metal-Aire
    - f. Price
    - g. Nailor Industries, Inc.
    - h. Anemostat
    - i. York/Johnson Controls
    - j. Krueger

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

### 2.2 SUPPLY AIR TERMINALS

- A. General: Provide factory-fabricated and tested air terminals as indicated, selected with performance characteristics which match or exceed those indicated on schedule.
- B. Air terminal units shall be low pressure drop, single duct throttling type pressure independent and suitable for use in medium pressure variable volume air distribution systems.
- C. Casing shall be 22 gauge galvanized steel construction with internal acoustical coated 1-inch thick, 1-1/2 lb. density fiberglass insulation, inlet and outlet duct connection and discharge sound attenuator, where scheduled.
- D. Internal damper blade shall be extruded aluminum or 18 gauge steel with keyed fit shaft and nylon bushing. Damper shall seal against gasketed stops maximum 2 percent leakage at 3.0-inch S.P. All mechanical parts shall be galvanized or non-ferrous.
- E. Hot water heating coils shall be designed for 200 psig maximum working pressure and 200 degree F maximum operating temperature. Coil shall be serpentine-type, 2-row minimum, constructed of 1/2-inch O.D. copper tubes mechanically bonded to aluminum fins; galvanized steel casing.
- F. Provide factory-installed framed duct access door complete with quarter-turn quick release fasteners in terminal box casing upstream of reheat coil.
- G. Provide label on each air terminal unit, indicating plan designation, unit size, CFM range and settings and calibration curve.
- H. Controls shall include wall mounted thermostat, modulating damper, damper operator furnished by the Temperature Control Contractor, and factory installed by the equipment manufacturer, pressure independent pneumatic cross-shaped flow sensor with amplifying total pressure pickup points connected in parallel to a central averaging chamber (an inlet velocity sensor with pickup points connected in series shall not be accepted), for measuring inlet volume. The sensor shall amplify duct velocity pressure by a factor of 1.75 and shall maintain control accuracy with the same size inlet duct in any configuration. Specific control component requirements are specified in Division 23 Section Direct Digital Control Systems.

## PART 3 - EXECUTION

### 3.1 INSPECTION

- A. Examine areas and conditions under which air terminals are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.



## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

### 3.2 INSTALLATION OF AIR TERMINALS

- A. General: Install air terminals as indicated, and in accordance with manufacturer's installation instructions.
- B. Location: Install each unit level and accurately in position indicated in relation to other work; and maintain sufficient clearance for normal service and maintenance, but in no case less than that recommended by manufacturer.
- C. Duct Connections: Connect ductwork to air terminals in accordance with Division 23 ductwork sections.

### 3.3 FIELD QUALITY CONTROL

- A. Upon completion of installation and prior to initial operation, test and demonstrate that air terminals, and duct connections to air terminals, are leak-tight.
- B. Repair or replace air terminals and duct connections as required to eliminate leaks, and retest to demonstrate compliance.

### 3.4 CLEANING

- A. Clean exposed factory-finished surfaces. Repair any marred or scratched surfaces with manufacturers touch-up paint.

END OF SECTION 233600

**SECTION 233713 - AIR OUTLETS & INLETS**

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of Air Outlets and Inlets Work is indicated by drawings and schedules, and by requirements of this section.
- B. Types of Air Outlets and Inlets required for project include the following:
  - 1. Diffusers
  - 2. Registers and Grilles
  - 3. Louvers
- C. Refer to other Division 23 sections for ductwork, duct accessories; testing and balancing; not work of this section.

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of air outlets and inlets of types and capacities required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. Codes and Standards:
  - 1. ARI Compliance: Test and rate air outlets and inlets in accordance with ARI 650 "Standard for Air Outlets and Inlets".
  - 2. ASHRAE Compliance: Test and rate air outlets and inlets in accordance with ASHRAE 70 "Method of Testing for Rating the Air Flow Performance of Outlets and Inlets".
  - 3. ADC Compliance: Test and rate air outlets and inlets in certified laboratories under requirements of ADC 1062 "Certification, Rating and Test Manual".
  - 4. ADC Seal: Provide air outlets and inlets bearing ADC Certified Rating Seal.
  - 5. AMCA Compliance: Test and rate louvers in accordance with AMCA 500L-99 "Laboratory Method of Testing Louvers for Rating".
  - 6. AMCA Seal: Provide louvers bearing AMCA Certified Rating Seal.
  - 7. NFPA Compliance: Install air outlets and inlets in accordance with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems".

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for air outlets and inlets including the following:
  - 1. Schedule of air outlets and inlets indicating drawing designation, room location, number furnished, model number, size, and accessories furnished.
  - 2. Data sheet for each type of air outlet and inlet, and accessory furnished; indicating construction, finish, and mounting details.

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3. Performance data for each type of air outlet and inlet furnished, including aspiration ability, temperature and velocity traverses, throw and drop, and noise criteria ratings. Indicate selections on data.
  - B. Shop Drawings: Submit manufacturer's assembly-type shop drawing for each type of air outlet and inlet, indicating materials and methods of assembly of components.
  - C. Record Drawings: At project closeout, submit record drawings of installed systems products, in accordance with requirements of Division 1.
  - D. Maintenance Data: Submit maintenance data, including cleaning instructions for finishes, and spare parts lists. Include this data, product data, and shop drawings in maintenance manuals; in accordance with requirements of Division 1.
- 1.4 DELIVERY, STORAGE AND HANDLING
- A. Deliver air outlets and inlets wrapped in factory-fabricated fiber-board type containers. Identify on outside of container type of outlet or inlet and location to be installed. Avoid crushing or bending and prevent dirt and debris from entering and settling in devices.
  - B. Store air outlets and inlets in original cartons and protect from weather and construction work traffic. Where possible, store indoors; when necessary to store outdoors, store above grade and enclose with waterproof wrapping.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
  1. Diffusers, Registers and Grilles:
    - a. Anemostat Products Division; Dynamics Corp. of America
    - b. Carnes Co.; Division of Wehr Corp.
    - c. Krueger; Division of Philips Industries, Inc.
    - d. Titus Products Division; Philips Industries, Inc.
    - e. Metal-Aire
    - f. Nailor Industries, Inc.
    - g. E.H. Price.
  2. Louvers:
    - a. Air Balance
    - b. American Warming & Ventilating, Inc.
    - c. Arrow United Industries, Inc.
    - d. Dowco Corp.
    - e. Louvers & Dampers, Inc.
    - f. Penn Ventilator Co., Inc.
    - g. Ruskin
    - h. Pottorff
    - i. Greenheck

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### 2.2 AIR DIFFUSERS

- A. General: Except as otherwise indicated, provide manufacturer's standard air diffusers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.
- B. Performance: Provide air diffusers that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.
- C. Surface (Wall or Ceiling) compatibility: Provide diffusers with border styles that are compatible with adjacent systems, and that are specifically manufactured to fit into surface with accurate fit and adequate support. Refer to general construction drawings and specifications for types of systems which will contain each type of air diffuser.
- D. Types: Provide diffusers of type, capacity, and with accessories and finishes as listed on Air Device Schedule.

### 2.3 REGISTERS AND GRILLES

- A. General: Except as otherwise indicated, provide manufacturer's standard registers and grilles where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.
- B. Performance: Provide registers and grilles that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.
- C. Wall Compatibility: Provide registers and grilles with border styles that are compatible with adjacent wall systems, and that are specifically manufactured to fit into wall construction with accurate fit and adequate support. Refer to general construction drawings and specifications for types of wall construction which will contain each type of wall register and grille.
- D. Types: Provide registers and grilles of type, capacity, and with accessories and finishes as listed on air device schedule.

### 2.4 LOUVERS

- A. General: Provide stationary extruded aluminum louvers in sizes and locations indicated on the Drawings.
- B. Performance: Provide beginning of water penetration (0.01 oz. per sq.ft.) at a free area velocity of no less than 624 fpm at standard air conditions based on mill finish, 48-inch x 48-inch test size per AMCA Standard 511.
- C. Frame: 4-Inch deep channel, 0.81-inch thick 6063-T5 extruded aluminum alloy. Coordinate with wall construction shown on the Architectural Drawings and provide frame and sill style necessary to provide a weatherproof installation.

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- D. Blades: K-Design, 0.81-inch thick, 6063-T5 extruded aluminum alloy.
- E. Mullions: Provide concealed mullions using an extruded concealed blade brace of the same material as the louvers.
- F. Louver Screens: On inside face of louvers inside face of exhaust air louvers and outside face of outside air louvers, provide removable 1/2-inch expanded mesh framed aluminum bird screen.
- G. Finish: Mill, provide standard color chart for color selection by Architect.

### PART 3 - EXECUTION

#### 3.1 INSPECTION

- A. Examine areas and conditions under which air outlets and inlets are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION

- A. General: Install air outlets and inlets in accordance with manufacturer's written instructions and in accordance with recognized industry practices to insure that products serve intended functions.
- B. Coordinate with other work, including ductwork and duct accessories, as necessary to interface installation of air outlets and inlets with other work.
- C. Locate ceiling air diffusers, registers, and grilles, as indicated on general construction "Reflected Ceiling Plans". Unless otherwise indicated, locate units in center of acoustical ceiling modules.

#### 3.3 SPARE PARTS

- A. Furnish to Owner, with receipt, three (3) operating keys for each type of air outlet and inlet that require them.

END OF SECTION 233713

**SECTION 235216 - CONDENSING BOILERS**

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.
- B. Extent of Condensing Boiler Work required by this section is indicated on drawings and schedules, and by the requirements of this section.
- C. Types of Condensing Boilers specified in this section include packaged, factory fabricated, and assembled Gas-fired Boilers, Trim, and accessories for generating hot water.
- D. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3 for Concrete Pads; not work of this section.
- E. Refer to other Division 23 Sections for piping, specialties, water treatment, pumps, breechings, temperature controls, etc., required external to boilers for installation; not work of this section.
- F. Electrical Work: Refer to Division 23 Section "Mech/Elec Requirements for Mechanical Equipment" for requirements.
- G. Electrical Work: Provide the following wiring as work of this section, in accordance with requirements of Division 26;
  - 1. Furnish to Electrical Installer, burner emergency shutoff switch.
  - 2. Provide wiring between boiler control panel and thermostats, aquastats, pressurestats, and any other control device.
  - 3. Provide factory-mounted and wired controls and electrical devices as specified in this section.
- H. Refer to Division 26 section for other electrical work including motor starters, disconnects, wires/cables, raceways, and other required electrical devices; not work of this section

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of condensing boilers, of types and capacities required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. Manufacturer's Test: All boilers shall be factory assembled and tested. Submit test results to Architect/Engineer prior to shipping.

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### C. Codes and Standards:

#### 1. Condensing Boilers

- a. NFPA Compliance: Install gas-fired condensing boilers in accordance with NFPA Code 54 “National Fuel Gas Code”.
- b. ASME Compliance: Construct condensing boilers in accordance with ASME Boiler and Pressure Vessel Code, Section IV “Heating Boilers”. Controls shall be per ASME, CSD-1.
- c. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to “Gas and Oil Fired Boilers – Minimum Efficiency Requirements”.
- d. UL and NEMA Compliance: Provide condensing boiler ancillary electrical components which have been “Listed” and “Labeled” by UL, and comply with NEMA standards. “Listed” and “Labeled” shall be defined by NEC, Article 100.
- e. UL Compliance: Test boilers for compliance with UL 705, “Commercial-Industrial Gas Heating Equipment”. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.
- f. FM Compliance: Provide control devices and control sequences in accordance with requirements of Factory Mutual (FM).

### 1.3 SUBMITTALS

- A. Product Data: Submit manufacturer’s technical product data, including rated capacities of selected model clearly indicated, weights (shipping and operating), furnished specialties, flue sizing and materials recommendations and accessories; and installation and start-up instructions.
- B. Shop Drawings: Submit manufacturer’s assembly-type shop drawings indicating dimensions, weights, loadings, required clearances, and method of field assembly, components and location and size of each field connection.
- C. Wiring Diagrams: Submit manufacturer’s electrical requirements for power supply wiring to condensing boilers. Submit manufacturer’s ladder-type wiring diagrams and control wiring required for final installation of condensing boilers and controls. Clearly differentiate between portions of wiring that are factory installed and portions to be field-installed.
- D. Record Drawings: At project closeout, submit record drawings of installed products in accordance with requirements of Division 1.
- E. Maintenance Data: Submit maintenance data and parts list for each condensing boiler, control, and accessory; including “trouble-shooting” maintenance guide. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual; in accordance with requirements of Division 1.

### 1.4 DELIVERY, STORAGE AND HANDLING

- A. Handle boiler sections and equipment carefully to prevent damage, breaking and scoring. Do not install damaged sections or components; replace with new.

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- B. Store boiler sections and equipment in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.
- C. Comply with manufacturer's rigging and moving instructions for unloading boilers, and moving them to final location.

### 1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period for Water-Tube Condensing Boilers: 20 years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturer's: Subject to compliance with requirements, provide products by one of the following.
  - 1. Condensing Boilers
    - a. AERCO International
    - b. Lochinvar Corporation
    - c. Patterson-Kelly
    - d. RBI: A Division of Mastek
    - e. Viessmann
    - f. HTP: Heat Transfer Products

### 2.2 WATER-TUBE BOILERS

- A. Description: Factory-fabricated, -assembled, and -tested, water-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls.
- B. Heat Exchanger: Finned-copper primary and stainless-steel secondary heat exchangers.
- C. Combustion Chamber: Stainless steel, sealed.
- D. Burner: Natural gas, forced draft drawing from gas premixing valve.
- E. Blower: Centrifugal fan to operate during each burner firing sequence and to prepurge and postpurge the combustion chamber.
  - 1. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
    - a. 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.



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- F. Gas Train: Combination gas valve with manual shutoff and pressure regulator.
- G. Ignition: Silicone carbide hot-surface ignition that includes flame safety supervision and 100 percent main-valve shutoff.
- H. Integral Circulator: Cast-iron body and stainless-steel impeller sized for minimum flow required in heat exchanger.
- I. Casing:
  - 1. Jacket: Sheet metal, with snap-in or interlocking closures.
  - 2. Control Compartment Enclosures: NEMA 250, Type 1A.
  - 3. Finish: Textured epoxy.
  - 4. Insulation: Minimum 2-inch thick, mineral-fiber insulation surrounding the heat exchanger.
  - 5. Combustion-Air Connections: Inlet and vent duct collars.
  - 6. Mounting base to secure boiler.

### 2.3 CONTROLS

- A. Refer to Division 23 Sections.
- B. Boiler operating controls shall include the following devices and features:
  - 1. Control transformer.
  - 2. Set-Point Adjust: Set points shall be adjustable.
  - 3. Operating Pressure Control: Factory wired and mounted to cycle burner.
  - 4. Low-Water Cutoff and Pump Control: Cycle feedwater pump(s) for makeup water control.
  - 5. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to maintain space temperature in response to thermostat with heat anticipator located in heated space.
  - 6. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to reset supply-water temperature inversely with outside-air temperature.
  - 7. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to maintain a constant supply water temperature. Maintain pressure set point plus or minus 10 percent.
    - a. Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.
- C. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.
  - 1. High Cutoff: Automatic reset stops burner if operating conditions rise above maximum boiler design temperature or pressure.
  - 2. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be automatic-reset type.
  - 3. Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.
  - 4. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.

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- D. Building Automation System Interface: Factory install hardware and software to enable building automation system to monitor, control, and display boiler status and alarms.
  - 1. Hardwired Points:
    - a. Monitoring: On/off status, common trouble alarm, low water level alarm.
    - b. Control: On/off operation, hot water supply temperature set-point adjustment.
  - 2. A communication interface with building automation system shall enable building automation system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building automation system.

### 2.4 ELECTRICAL POWER

- A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.
- B. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
  - 1. House in NEMA 250, Type 1 enclosure.
  - 2. Wiring shall be numbered and color-coded to match wiring diagram.
  - 3. Install factory wiring outside of an enclosure in a metal raceway.
  - 4. Field power interface shall be to nonfused disconnect switch.
  - 5. Provide branch power circuit to each motor and to controls with a disconnect switch.
  - 6. Provide each motor with overcurrent protection.

### 2.5 VENTING KITS

- A. Kit: Complete system, ASTM AL 959, Type AL 29-4C stainless steel, pipe, vent terminal, thimble, indoor plate, vent adapter, condensate trap and dilution tank, and sealant.
- B. Combustion-Air Intake: Complete system, stainless steel pipe, PVC/CPVC, AL-29-4C, aluminum pipe, vent terminal with screen, inlet air coupling, and sealant. Follow manufacturer's recommendations.

### 2.6 CONDENSATE NEUTRALIZATION SYSTEM

- A. Provide Condensate Neutralization System for flue condensation (as recommended by mfg), prior to routing condensate to the sanitary sewer system.

## PART 3 - EXECUTION

### 3.1 INSPECTION

- A. Examine areas and conditions under which condensing boilers are to be installed, and substrate which will support boilers. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

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### 3.2 INSTALLATION OF CONDENSING BOILERS

- A. General: Install boilers in accordance with manufacturer's installation instructions, in accordance with State and local code requirements, and in accordance with requirements of local Utility Company. Install units plumb and level, to tolerance of 1/8-inch in 10'-0" in both directions. Maintain manufacturer's clearances around and over boilers.
- B. Support: Install boilers on 4-inch thick concrete pad, 6-inch larger on each side than base of unit.
- C. Erection: Factory assemble boiler sections in proper sequence and with sealing between each section. Assemble boiler trim shipped loose, or unassembled for shipping purposes. Follow manufacturer's installation instructions.
- D. Electrical Work: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram to electrical installer.
  - 1. Verify that electrical work installation is in accordance with manufacturer's submittal and installation requirements of Division 26 Sections. Do not proceed with equipment start-up until electrical work is acceptable to equipment installer.
- E. Gas Piping: Refer to Division 23 section "Natural Gas Systems". Connect gas piping to boiler, full size of boiler gas train inlet, provide union with sufficient clearance for burner removal and service.
- F. Hot Water Piping: Refer to Division 23 section "Hydronic Piping". Connect supply and return boiler tapings as indicated, with shutoff valve and union or flange at each connection.
- G. Install piping adjacent to boiler to allow service and maintenance.
- H. 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.
- I. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Division 23 Section "Common Work Results for HVAC."
- J. Install piping from safety relief valves to nearest floor drain.
- K. Boiler Venting:
  - 1. Install flue venting kit and combustion-air intake.
  - 2. Connect full size to boiler connections.
- L. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- M. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

### 3.3 FIELD QUALITY CONTROL

- A. Flush and clean boilers upon completion of installation, in accordance with manufacturer's start-up instructions.

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- B. Hydrostatically test assembled boiler and piping in accordance with applicable sections of ASME Boiler and Pressure Vessel Code.
- C. Arrange with National Board of Boiler and Pressure Vessel Inspectors for inspection of boiler piping, observation of hydrostatic testing, and for certification of completed boiler units.
- D. Start-up boilers, in accordance with manufacturer's start-up instructions, and in presence of boiler manufacturer's representative. Test controls and demonstrate compliance with requirements. Adjust burner for maximum burning efficiency. Replace damaged or malfunctioning controls and equipment.

### 3.4 CLOSEOUT PROCEDURES

- A. Owner's Instructions: Provide services of manufacturer's technical representative for one (1) 8-hour day to instruct Owner's personnel in operation and maintenance of boilers.

### 3.5 ADJUSTING AND CLEANING

- A. Clean and flush hydronic piping systems. 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.
- B. Mark calibrated nameplates of pump discharge valves after hydronic system balancing has been completed, to permanently indicate final balanced position.
- C. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

### 3.6 DEMONSTRATION

- A. Services: After testing and inspection is complete, provide the services of an authorized factory service representative to perform start-up and operation demonstration service.
- B. Start-up: Perform services in accordance with manufacturer's written start-up instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
- C. Maintenance and Operation Training: As a part of the maintenance and operating instructions, review data in operating and maintenance manual, including preventative maintenance schedule and procedures, and procedures for obtaining repair parts and technical assistance. Demonstrate all phases of operation including start-up and shutdown.
  - 1. Schedule training with Owner, provide at least seven (7) day notice to Architect/Engineer.
- D. Provide Combustion Test Record for each Boiler, which shall include a minimum of the following information submitted following the test.

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TIME:  
DATE:

FUEL SOURCE:

Natural Gas: \_\_\_\_\_ BTU/cu.ft.

Propane: \_\_\_\_\_ BTU/cu.ft.

Mid-Range Manifold Pressure: \_\_\_\_\_ Water Column Inches (w.c.in.)

TEST RESULTS:

Combustion Efficiency: \_\_\_\_\_%

Ambient Temperature: \_\_\_\_\_ degree F

Stack Temperature: \_\_\_\_\_ degree F

Oxygen: \_\_\_\_\_%

Carbon Monoxide: \_\_\_\_\_ PPM

Carbon Dioxide: \_\_\_\_\_%

Combustible Gases: \_\_\_\_\_%

Stack Draft: \_\_\_\_\_ (Inches H<sub>2</sub>O)

Excess Air: \_\_\_\_\_%

Oxides of Nitrogen: \_\_\_\_\_ PPM

Sulfur Dioxide: \_\_\_\_\_ PPM

Carbon Monoxide Alarm: \_\_\_\_\_ PPM

TEST PERFORMED BY:

END OF SECTION 235216

**SECTION 236423 - SCROLL CHILLERS**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 and 23 Specification sections, apply to work of this section.

1.2 REFRIGERANTS

- A. All refrigerants used for each condensing unit shall be on the latest EPA list of approved refrigerants and environmentally friendly.
- B. No CFC based refrigerants shall be used.

1.3 DESCRIPTION OF WORK

- A. Extent of Scroll Liquid Chiller Work required by this section is indicated on drawings and schedules, and by requirements of this section.
- B. Types of Scroll Liquid Chillers specified in this section include the following:
  - 1. Packaged Outdoor Air Cooled
- C. Refer to other Division 23 sections for concrete pads, piping, piping specialties, pumps, and valves, which are required external to chillers for installation.
- D. Refer to other Division 23 sections for field-installed automatic temperature controls required in conjunction with chillers.
- E. Refer to Division 23 section "Vibration Control" for vibration control work required in connection with chillers.
- F. Manufacturers shall be responsible to provide any information to the contractor prior to bidding which may impact the installed cost for the Contractor including but not limited to:
  - 1. Power wiring sizing quantity and type of conductors
  - 2. Control power
  - 3. Auxiliary piping connections

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

### 1.4 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of chillers, of types and capacities required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. Installer's Qualifications: Firm with at least five (5) years of successful installation experience with projects utilizing chillers similar to those required for this project.
- C. ASHRAE Compliance: Construct and install chillers in accordance with ASHRAE Standard 15, "Safety Code for Mechanical Refrigeration". Provide Energy Efficiency Ratio (EER) for chillers not less than prescribed by ASHRAE Standard 90A, "Energy Conservation in New Building Design".
- D. NEC Compliance: Comply with applicable NEC requirements pertaining to electrical power and control wiring for construction and installation of chillers.
- E. ANSI/ASHRAE Compliance: Comply with ANSI 15 safety code requirements pertaining to unit construction of chillers.
- F. ASME Compliance: Construct and test air-cooled liquid chiller in accordance with ASME Boiler and Pressure Vessel Code, Section 8.
- G. NEMA Compliance: Provide high-efficiency motors for chillers which comply with NEMA Standards Pub./No.'s MG 1, 2, 3, 10, and 11.
- H. ANSI/UL 984: Safety standards for hermetic motor compressors.

### 1.5 SUBMITTALS

- A. Each manufacturer shall describe in writing, how their company is addressing the CFC legislation issue. Provide equipment capable of accepting a substitute refrigerant. Provide description of alternative refrigerant including:
  - 1. Potential lifetime in years
  - 2. Ozone depletion factor potential
  - 3. Global warming potential

The equipment provided shall provide the scheduled capacity when the substitute refrigerant proposed, the nominal equipment capacity reduction effects (if any), performance in KW/TON, the refrigerant change out procedure and long term maintenance effects the new refrigerant has on the equipment.
- B. Product Data: Submit manufacturer's technical product data, including rated capacities for chillers indicated, sound power levels, weights (shipping, installed, and operating), furnished specialties and accessories; and rigging, installation, and start-up instructions.
- C. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, methods of assembly of components, and location and size of each field-connection.

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- D. Provide templates for anchor bolt placement in concrete pad. Deliver templates to concrete Installer so work by others is not delayed.
- E. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
- F. Record Drawings: At project closeout, submit record drawings of installed systems products in accordance with requirements of Division 1.
- G. Maintenance Data: Submit maintenance data and parts list for each chiller, control, and accessory; including "trouble-shooting" maintenance guide. Include this data and product data in maintenance manual; in accordance with requirements of Division 1.

### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Handle chillers and components properly to prevent damage, breaking, denting and scoring. Do not install damaged reciprocating chillers or components; replace with new. Comply with manufacturer's rigging and installation instructions for unloading chillers, and transporting them to final location.
- B. Store reciprocating chiller and components in clean dry space. Protect from weather, dirt, fumes, water, construction debris, and physical damage. Storage temperatures for unit controls are not to exceed 185 degree F (85 degree C).

### 1.7 WARRANTY

- A. Provide five (5) year motor/compressor replacement warranty in addition to the one (1) year warranty required under Division 23. Warranty shall include parts and labor.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Outdoor Air-Cooled Scroll Liquid Chillers:
    - a. AAON
    - b. Bohn Heat Transfer Division; Gulf + Western Mfg Co.
    - c. Carrier Corporation
    - d. Daikin Group
    - e. Trane Company
    - f. York/Johnson Controls
    - g. Motivair

### 2.2 OUTDOOR AIR-COOLED SCROLL LIQUID CHILLERS



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- A. General: Provide factory-assembled and tested outdoor air-cooled liquid chillers as indicated, consisting of compressors, evaporator, condensers, thermal expansion valves, and control panels. Provide capacity and electrical characteristics as scheduled.
- B. Refrigerant: Provide full operating charge of refrigerant and oil.
- C. Housing: Housing shall be minimum 14 gauge welded galvanized steel frame with 14 and 16 gauge galvanized steel panels and access doors with corrosion protection coating, and exterior finish. Provide removable panels and/or access doors for inspection and access to internal parts and components.
- D. Evaporator: Provide shell-and-tube design with seamless copper tubes roller expanded into tube sheets. Design, test, and stamp for refrigerant side working pressure of 650 PSIG minimum, and water side working pressure of 150 PSIG minimum, in accordance with ASME Pressure Vessel Code. Provide one (1) water pass with series of internal baffles. Insulate with 3/4-inch minimum flexible unicellular insulation with maximum K-value of 0.26. Provide water drain connection and bulb wells for temperature controller and low-temperature cutout.
  - 1. Heater Tapes: Provide electrical resistance heater tape on evaporator to protect against freezing at -20 degree F (-29 degree C) ambient at no-flow condition.
  - 2. Multiple-Compressor Units: Provide independent multiple refrigerant circuits with gasketed evaporator heads.
- E. Condenser: Construct coils with configured aluminum fins mechanically bonded to seamless copper tubing. Provide integral subcooling circuit with liquid accumulators. Leak test coils with air under water at 425 PSIG air pressure. Provide protective grilles over exposed coil faces.
  - 1. Multiple-Compressor Units: Provide multiple circuited condenser coils.
  - 2. Condenser Fans: Provide propeller fans, direct driven, draw-through design, statically and dynamically balanced. Provide permanently lubricated ball-bearing motors with overload protection. Provide protective grille over air discharge.
  - 3. Low Ambient Control: Provide head pressure control, designed to operate at temperatures down to 30 degree F.
- F. Compressors: Provide direct drive 3600 RPM, multi-cylinder scroll compressors with crankcase heater; either semi-hermetic or hermetic. Mount compressors on vibration isolators within chiller housing.
  - 1. Lubrication: Provide oil pump, oil filter, oil level sight glass, and oil charging valve.
- G. Capacity Modulation: Provide step-control by means compressor staging, from return water temperature.
- H. Refrigerant Circuit: Provide for each refrigerant circuit the following:  
Provide multiple independent separate refrigerant circuits with a minimum of two (2).
  - 1. Liquid line solenoid valve.
  - 2. Filter dryer.
  - 3. Liquid line sight glass and moisture indicator.
  - 4. Thermal expansion valve.
  - 5. Insulated suction line.
  - 6. Suction and discharge valves.
- I. Controls and Control Panels:

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1. Locate on chiller, factory wired NEMA 1 unit control panel, containing both a controls section as well as a starter section.
2. Provide the following devices in starter section:
  - a. Factory wired single point power hook-up to unit mounted, non-fused disconnect switch.
  - b. Three-phase solid-state overload protection.
  - c. Customer wired grounding lug.
  - d. Control power transformer with primary and secondary fused protection.
  - e. Non-recycling compressor overloads.
  - f. Phase loss/reversal/imbalance and undervoltage monitor on main power connection. A 15 percent under voltage condition for 4-5 seconds will shut unit OFF and require manual reset.
3. Provide the following devices in the control panel:
  - a. Compressor run lights.
  - b. System start-stop switch.
  - c. Low pressure lockout lights.
  - d. Terminal strips.
  - e. Central micro-processor
    - 1) Leaving fluid setpoint
    - 2) Delta T setpoint
    - 3) Number of stages
  - f. Control power fuses.
  - g. Motor protection/oil failure controller.
  - h. Indicating lights for load limit.
  - i. Stages of unit unloading.
4. Provide the following safety controls arranged so that operating any one (1) will shutdown machine and require manual reset:
  - a. Low chilled water temperature switch.
  - b. High discharge pressure switch for each circuit.
  - c. Low suction pressure switch for each circuit.
  - d. Oil pressure switch.
  - e. Current overload.
  - f. Motor temperature.
5. Provide the following safety controls so there is automatic shutdown of the machine with automatic reset:
  - a. Over voltage.
  - b. Under voltage.
  - c. Phase reversal.
  - d. Chilled water flow interlock.
  - e. Condenser water flow interlock.
6. Provide the following operating controls:
  - a. Multi-step chilled water temperature controller which cycles compressor.
  - b. Five-minute OFF timer prevents compressor from short cycling.
  - c. Solid state start timer.
  - d. Provide automatic circuit-to-circuit lead-lag capability to allow for equal run time per compressor.
  - e. Periodic pump-out timer to pump down on chilled water flow and high evaporator refrigerant pressure.
  - f. Load limit thermostat to limit compressor loading on high return water temperature.

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- g. Power supply monitor to protect unit by stopping compressor on phase loss, phase reversal, incorrect phase sequence, and low voltage.
    - h. Cycle counter and operating hour meter.
  - 7. Provide readout for suction and discharge refrigerant pressures, and oil pressures for each compressor.
  - 8. Provide unit mounted microprocessor-based panel that allows multiple units to operate in series or parallel.
  - 9. Provide chilled water reset algorithm in the microprocessor that resets leaving water temperature based on ambient or zone temperature. Provide field-installed sensor.
- J. Accessories: Provide the following accessories:
  - 1. Hot gas bypass valve, factory-piped and wired.
  - 2. Load limit thermostat, if required.
  - 3. Vapor-proof chilled water flow switch.
  - 4. Suction and discharge gauges.
  - 5. Vibration Isolators of the following type:
    - a. Fabricated equipment base and spring isolators.
  - 6. Low ambient dampers for 30 degree F ambient start-up and run.
  - 7. Copper condenser fins.

### PART 3 - EXECUTION

#### 3.1 INSPECTION

- A. Installer must examine areas and conditions under which reciprocating chillers are to be installed and notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

#### 3.2 INSTALLATION OF SCROLL CHILLERS

- A. General: Install reciprocating chillers in accordance with manufacturer's written instructions. Install units plumb and level, firmly anchored in locations indicated; maintain manufacturer's recommended clearances.
- B. Support: Install floor-mounted units on reinforced concrete pad. Furnish anchor bolts which are to be inserted in concrete pad to Concrete Installer.
- C. Support: Install roof-mounted units on structural steel mechanical equipment stand. Anchor unit to stand with removable type fasteners.
  - 1. Construct mechanical equipment stand as indicated, and in accordance with NRCA Handbook of Accepted Roofing Knowledge, Detail "N".
  - 2. Mechanical Equipment Stand is specified in Division 5; not work of this section.
- D. Chilled Water Piping: Refer to Division 23. Connect inlet to evaporator with controller bulb well, shutoff valve, thermometer, strainer, flow switch, flexible pipe connector, drain valve, pressure gauge, and union or flange. Connect outlet to evaporator with shutoff valve, balancing

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cock, flow meter, thermometer, flexible pipe connection, pressure gauge, drain valve, and union or flange.

- E. Condenser Water Piping: Refer to Division 23. Provide flanged or union connections to condenser, arranged to allow removal of condenser heads. Connect inlet to condenser with shutoff valve, thermometer, plugged tee, pressure gauge, flexible pipe connector, and union or flange. Connect outlet to condenser with shutoff valve, flow meter, thermometer, drain valves and shutoff valve, strainer, plugged tee, flexible pipe connector, and union or flange.
- F. Refrigerant Piping: Refer to Division 23. Provide piping between chiller and condenser as indicated, and in accordance with installation instructions of both chiller and condenser manufacturers.
- G. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
  - 1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to manufacturer and equipment Installer.
- H. Control: Furnish field-installed automatic temperature control requirements to Control Installer.
- I. Start-up: Chiller start-up shall be by factory authorized service representative in accordance with manufacturer's recommendations. Test controls and demonstrate compliance with requirements. Replace damaged, or malfunctioning, controls and equipment and retest.
  - 1. Do not place chillers in sustained operation prior to initial balancing of mechanical systems which interface with the reciprocating chillers.

### 3.3 TRAINING OF OWNER'S PERSONNEL

- A. Provide services of manufacturer's technical representative for one (1) 8-hour day to instruct Owner's personnel in operation and maintenance of chillers.
  - 1. Schedule training with Owner, provide at least seven (7) day notice to Contractor and Engineer of training date.

END OF SECTION 236423

**SECTION 237200 - ENERGY RECOVERY UNITS**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. Extent of Energy Recovery Units Work required by this section is indicated on drawings and schedules, and by requirements of this section.
- B. Types of Energy Recovery Units specified in this section include the following:
  - 1. Packaged Energy Recovery Units
- C. Refer to other Division 23 sections for piping; specialties; pumps; ductwork; temperature controls; testing and balancing; required external to energy recovery units for installation; not work of this section.
- D. Refer to Division 26 sections for the following work; not work of this section.
  - 1. Power supply wiring from power source to power connection on energy recovery units. Include starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.
  - 2. Interlock wiring between electrically-operated equipment units; and between equipment and field-installed control devices.
    - a. Interlock wiring specified as factory-installed is work of this section.
- E. Provide the following Electrical Work as work of this section, complying with requirements of Division 26 sections:
  - 1. Control wiring between field-installed controls, indicating devices, and energy recovery unit control panels.
    - a. Control wiring specified as work of Division 23 for Automatic Temperature Controls is work of that section.

1.3 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of energy recovery units, of types and capacities required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. Codes and Standards:
  - 1. ASHRAE Compliance: Provide capacity ratings for energy recovery devices in accordance with ASHRAE 84 "Methods of Testing Air-to-Air Heat Exchangers".
  - 2. NRCA Compliance: Provide roof curbs for roof mounted equipment constructed in accordance with recommendations of NRCA.

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3. ARI Compliance: Test and rate energy recovery units in accordance with ARI 1060 "Standard for Air-to-Air Heat Recovery Equipment".
4. ASHRAE Compliance: Design, construct, and install heat pipe heat exchangers in accordance with ASHRAE 15 "Safety Code for Mechanical Refrigeration".
5. NFPA Compliance: Construct and install energy recovery units incorporating electrical equipment in accordance with NFPA 70 "National Electrical Code".
6. UL Labels: Provide energy recovery units ancillary electrical components which have been listed and labeled by UL.

### 1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicated, weights (shipping, installed, and operating), furnished specialties and accessories; and installation and start-up instructions.
- B. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.
- C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
- D. Record Drawings: At project closeout, submit record drawings of installed systems products, in accordance with requirements of Division 1.
- E. Maintenance Data: Submit maintenance data and parts list for each energy recovery unit, control, and accessory; including "trouble-shooting" maintenance guide. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual; in accordance with requirements of Division 1.

### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Handle energy recovery units and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged units or components; replace with new.
- B. Store energy recovery units and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.
- C. Comply with manufacturer's rigging and installation instructions for unloading energy recovery units, and moving them to final location.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
  - 1. Energy Recovery Units:
    - a. Innovent
    - b. Temptrol
    - c. Gaylord Industries, Inc.
    - d. Wing Co.; Division Wing Industries Inc.
    - e. Des Champs Laboratories, Inc.

2.2 PACKAGED ENERGY RECOVERY UNITS

- A. General: Provide as indicated, factory-assembled and tested energy recovery units, of capacity and for electrical characteristics as scheduled.
- B. Housing: Construct of heavy-gauge galvanized steel panels fastened to structural steel or formed galvanized steel internal frame, gasketed and caulked weather tight. Provide pitched top to shed water and overhang sides by 4-inch minimum. Provide waterproof floor with upturned seams and collars at all penetrations. Finish housing with manufacturer's standard paint finish. Provide four (4) lifting lugs.
  - 1. Insulate housings with 1-inch thick, 3-lb. density fiberglass, coated on airstream side in accordance with NFPA 90A.
  - 2. Provide access to internal components by access doors, double wall insulated, one (1) side hinged and minimum of two (2) cam latches operated from either side.
  - 3. Provide louvers for air inlet and exhaust, stormproof type, with gravity backdraft damper equipped with blade seals for exhaust, and spring-return 2-position motor-operated damper with blade seals for supply.
  - 4. Provide roof curb to support unit. Construct in accordance with NRCA recommendations.
- C. Heat Exchanger: Fixed plate heat exchanger.
- D. Fans: Provide supply and exhaust fans of scheduled capacity and design, isolated from unit housing with spring isolation base and flexible duct connections. Provide adjustable belt drive, TEFC motors on adjustable motor bases.
- E. Filters: Provide 2-inch thick disposable filters in galvanized steel frame, on upstream side of wheel in both supply and exhaust air streams.
- F. Heating and Cooling Coils: Provide heating and cooling coils, of type and capacity as scheduled and as specified.
- G. Piping and Wiring: Provide chase within housing for piping and electrical conduits. Factory- pipe coils and factory-wire motors and controls, so only external connections are required.

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### PART 3 - EXECUTION

#### 3.1 INSPECTION

- A. Examine areas and conditions under which energy recovery units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION

- A. Install energy recovery units where indicated, in accordance with equipment manufacturer's written instructions, and with recognized industry practices to ensure that units comply with requirements and serve intended purposes.
- B. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
  - 1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.
- C.

#### 3.3 TESTING

- A. Upon completion of installation of energy recovery units, and after air-side and water-side balancing has been completed, test units to ascertain percent effectiveness of heat transfer device. Adjust units for maximum effectiveness.
  - 1. Furnish test report, similar to SMACNA Form, ER-1-78, include report in each copy of maintenance manual.

#### 3.4 EXTRA STOCK

- A. Provide one (1) complete extra set of filters for each filter bank in energy recovery units. Install new filters at completion of energy recovery system work, and prior to testing, adjusting, and balancing work. Obtain receipt from Owner that new filters have been installed.
- B. Provide one (1) spare set of belts for each belt-driven fan in energy recovery units. Obtain receipt from Owner that belts have been received.

END OF SECTION 237200



**SECTION 237313 - AIR HANDLING UNITS**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. Extent of Air Handling Unit Work is indicated on drawings and schedules, and by requirements of this section.
- B. Types of Packaged Air Handling Units specified in this section include the following:
  - 1. Outdoor Air Handling Units
  - 2. Indoor Air Handling Units
- C. Refer to other Division 23 sections for vibration control units used in conjunction with air handling units; field-applied insulation to air handling units; piping required in conjunction with packaged air handling units; not work of this section.
- D. Refer to Division 23 section "Variable Frequency Controllers"
- E. Electrical Work: Refer to Division 23 section "Electrical Provisions of Mechanical Work" for requirements.
- F. Provide the following electrical work as work of this section, complying with requirements of Division 26 sections:
  - 1. Control wiring between field-installed controls, indicating devices, and unit control panels.
    - a. Control wiring specified as work of Division 23 for Automatic Temperature Controls is work of that section.

1.3 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of packaged air handling units with characteristics, sizes, and capacities required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. Codes and Standards:
  - 1. AMCA Compliance: Test and rate air handling units in accordance with AMCA standards.
  - 2. ARI Compliance: Test and rate air handling units in accordance with ARI 430 "Standard for Central-Station Air Handling Units", display certification symbol on units of certified models.

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3. ASHRAE Compliance: Construct and install refrigerant coils in accordance with ASHRAE 15 "Safety Code for Mechanical Refrigeration".
4. NFPA Compliance: Provide air handling unit internal insulation having flame spread rating not over twenty-five (25) and smoke developed rating no higher than fifty (50); and complying with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems".
5. UL and NEMA Compliance: Provide electrical components required as part of air handling units, which have been listed and labeled by UL and comply with NEMA Standards.
6. NEC Compliance: Comply with National Electrical Code (NFPA 70) as applicable to installation and electrical connections of ancillary electrical components of air handling units.

### 1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for air handling units showing dimensions, weights, capacities, ratings, fan performance with operating point clearly indicated, motor electrical characteristics, gauges and finishes of materials, and installation instructions.
- B. Shop Drawings: Submit assembly-type shop drawings showing unit dimensions, weight loadings, required clearances, construction details, and field connection details.
- C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to air handling units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
- D. Record Drawings: At project closeout, submit record drawings of installed systems products in accordance with requirements of Division 1.
- E. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in maintenance manuals; in accordance with requirements of Division 1.

### 1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver air handling units with factory-installed shipping skids and lifting lugs; pack components in factory-fabricated protective containers.
- B. Handle air handling units carefully to avoid damage to components, enclosures, and finish. Do not install damaged components; replace and return damaged components to air handling unit manufacturer.
- C. Store air handling units in clean dry place and protect from weather and construction traffic.
- D. Comply with Manufacturer's rigging and installation instructions for unloading air handling units, and moving them to final location.

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- E. Air handling units shall be broken down and shipped in components as field conditions require. A factory authorized representative shall inspect the final installation to certify that the unit has been reassembled per factory recommendations and specifications.
- F. All indoor units, painted or unpainted, shall be completely shrink-wrapped from the factory for protection during shipment. Tarping of bare units is unacceptable.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide air handling units of one of the following:
  - 1. Packaged Indoor Air Handling Units:
    - a.
    - a. Temtrol
    - b. McQuay, Inc.; Air Conditioning Division
    - c. Trane (The) Co.
    - d. York / Johnson Controls
    - e. Carrier
    - f. Haakon
    - g. Mammoth

#### 2.2 AIR HANDLING UNITS (Modular Type)

- A. General: Provide factory-fabricated and factory-tested air handling units as indicated, of sizes and capacities as scheduled, and as specified herein.
  - 1. Provide variable air volume units consisting of fan section, coil section, adjustable fan motor mounting, and drain pan.
  - 2. Provide multi-zone units consisting of single zone components, diffuser section, damper section, zoning dampers, and balancing plate when required to equalize resistances through cooling and heating passes.

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- B. Casings: Construct casings of galvanized steel, designed to withstand specific operating pressures. Provide casing panels and/or access doors that are easily and quickly removable for inspection and access to internal parts. The housing panel deflections are limited to 1/200th at 8" W.C. of the span dimension while under positive and negative pressure.
1. Provide reinforced points of support for either setting or hanging units.
  2. Provide double sloped drain pan, stainless steel located under cooling coil section and humidifier section, extensive enough to catch condensate leaving coil at highest catalogued face velocity. Provide at least one (1) drain connection at low point in drain pan.
  3. Provide lights in accessible sections with wire guards, factory wired to switch mounted on casing exterior. In spray coil or humidifier sections provide marine lights of glass and wire sealed design.
  4. Units shall be provided with double wall construction throughout. The fan interior section shall be constructed of 20 gauge, perforated sheet metal. The walls shall be 2-inch. The panels shall be fully insulated.
  5. The access doors shall be of double wall construction. Three (3) lever type handles shall be provided on each access door. The doors shall be fully gasketed with neoprene material.
    - a. Access doors shall be provided with double glazed wire glass windows with gasketing suitable to meet pressure ratings of unit.
  6. Indoor Enclosures: Cover casing and frame with protective finish on both sides.
  7. Outdoor Enclosures: Provide weather resistant, outdoor type enclosures for units exposed to weather. Pitch tops of casings for water run-off. Provide gaskets for assembled joints, calk weather-tight.
- C. Insulation: Insulate unit casing, throughout. Insulation shall be R-13 minimum.
1. Provide insulation with fire-retarding characteristics, complying with NFPA 90A.
  2. Insulate drain pans as required to prevent condensate formation on unit exterior at ambient conditions to be encountered.
- D. Coils: Provide heating and cooling coils of scheduled capacity, mounted in unit in manner permitting removal.
1. Construct coils with copper tubing primary surface and aluminum secondary surface bonded to tubes by method approved by specified manufacturer. Provide chilled water coils with drain and vent connections.
  2. Coils shall be constructed with a minimum of two rows.
  3. Provide steam coil as either single tube standard type, or double tube steam distribution type in accordance with schedule. Pitch coils in unit casing for drainage.
  4. Provide indirect cooling coils, which are supplied with water directly from the cooling tower with removable brass plugs on each return bend to allow the coils to be cleaned.

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5. Provide electric heating coil with automatic reset thermal cutouts for primary over temperature protection and with load-carrying manual reset thermal cutouts, factory-wired in series with each heater stage, for secondary protection. Include overcurrent cutouts and sub-circuit fusing in assembly, and construct with the following additional construction features:
  - a. Finned Tubular Electric Coils: Construct coils with resistance wire of 80 percent nickel/20 percent chromium, mounted in copper plated steel tube and surrounded by compacted magnesium-oxide powder. Provide spiral-wound copper plated steel fins continuously brazed to tubes.
  - b. Open-Coil Electric Element: Construct coils with resistance wire of 80 percent nickel/20 percent chromium, insulated by floating ceramic bushings. Recess bushings into casing openings and secure on supporting brackets, spaced 4-inch o.c. maximum.
- E. Coil Sections: Provide common or individual casing for heating and cooling coils as required. Design internal structure of coil section to allow for removal of coils, and provide suitable baffles to assure no air bypass around coils. Provide condensate pans and drain connections to cooling coil sections of sufficient size to contain and remove coil condensate. Insulate coil section casings and drain pans as specified in "Insulation" paragraph. For reheat coils, make provisions to allow simultaneous dehumidification and reheating at maximum cooling face velocity cataloged by manufacturer.
- F. Gas Fired Heating Section: Provide indirect fired gas furnace with minimum 80% efficiency, ETL listed and have a blow through fan design. Furnace shall be dual fuel capable of operation with natural or LP gas and have a power venting system. The heat exchanger shall be constructed of aluminized steel or stainless steel. Unit shall include main gas pressure regulator, main gas valve, electronic staged or electronic modulating controls, direct spark ignition system with timed lockout, high limit and a 24 volt control transformer. The makeup air system shall be design certified by CSA International and bear the CSA label.
- G. Energy Recovery Section: Provide energy recovery equipment to meet the performance criteria scheduled on the drawings.
- H. Face and Bypass Dampers: Provide multi-blade face, airfoil type and bypass dampers as scheduled, rotating in sintered bronze or nylon bearings, with both sets of dampers encased in single sturdy frame. Secure damper blades firmly in correct position, and provide sealing edges. Connect damper shafts together with one (1) continuous linkage bar. Provide automatic operation. Arrange dampers for parallel blade operation.
  1. Dampers shall be provided with both blade and edge seals.
- I. Fan Sections: Provide fans specifically designed and suitable for class of service indicated. Provide adjustable motor base, adjusted with mounting bolts, to provide variation in center distance. Provide locking nuts, or similar devices, to secure base in proper position. Provide belt-driven fans with adjustable pitch pulley permitting fan speed to be varied. Select pulley for mid-point of adjustable range. Design fan shafts so as not to pass through first critical speed when unit comes up to rated RPM. Provide grease-lubricated fan bearings with externally accessible fittings for lubrication. Statically and dynamically balance fan assemblies in fan housing after final assembly.
- J. Air Blenders: Factory-built and tested. Fabricated from 0.080 gauge aluminum, and all welded construction. Completely fixed device, with no moving parts, capable of providing mixed air temperature within +/- 6 degrees F standard deviation from the theoretical mixed air temperature.
- K. Filter Boxes: Provide filter boxes with either hinged access doors or quickly removable panels, at each end. Provide racks to receive filters in either flat or angle type pattern.

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- L. Humidifiers: Provide humidifiers of the following type, of size and capacity as scheduled.
  - 1. Steam Pan Humidifiers: Provide humidifiers consisting of corrosion-resistant pan in which copper tube coil is submerged for use with steam. Include ball float valve for maintaining correct water level in pan.
  - 2. Steam Grid Humidifiers: Provide humidifiers consisting of galvanized steel pipe with properly sized and spaced orifices to inject steam upward into air stream.
  - 3. Infra-Red Humidifiers: Provide humidifiers consisting of high intensity heat source lamps, reflecting media, stainless steel evaporator pan, and float box with overflow and drain lines. Install units within air stream as indicated, and provide easy access to lamps.
  
- M. Mixing Boxes: Provide mixing boxes of physical size to match basic unit, and include equal-sized flanged openings capable of handling full air flow. Arrange openings as indicated. Provide dual action parallel dampers with blade seals and edge seals, arranged to operate automatically with one (1) set of linkage. Provide dampers of balanced construction, rotating in sintered bronze or nylon bearings.
  - 1. Provide dampers with leakage limited to 10 cfm/square foot at 4-inch w.g.
  - 2. Dampers shall be aluminum, air foil type dampers.
  
- N. Spray Coil Assemblies: Provide base pan extending under coil and spray, with connections for spray water supply and suction, drain, overflow trap, and removable strainer. Maintain water level in base pan by means of factory-supplied float valve.
  - 1. Provide track pan to separate sections of multiple-coil assemblies. Provide upper and lower tracks for coils and eliminators for water drainage from upper sections in manner that will eliminate flooding of lower coils with spray water.
  - 2. Provide eliminator sections with at least 3-bend non-corrosive material blades assembled to assure that no moisture carryover will occur at highest catalogued face velocity for cooling coil. Provide sections and/or individual blades to be readily removable for cleaning or replacement.
  - 3. Provide spray pumps with capacities as scheduled, non-corrosive pipe headers, risers, nozzle connections with cleanable spray nozzles, shutoff valve, and pressure gauge.
  
- O. Zoning Damper Sections: Provide zoning damper sections for multi-zone units, furnished with series of equal-sized discharge openings, each with set of dampers to regulate air flow from heating pass and cooling pass. Permanently secure damper blades in correct position on single shaft, rotating in sintered bronze or nylon bearings, and extend either upward or downward for connection to damper motor. Provide blade seals and edge seals on damper blades. Connect

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damper shafts together with one (1) continuous linkage bar which may be cut in field to separate dampered openings into groupings as required. Provide damper section capable of either horizontal or vertical air discharge, factory-installed for orientation indicated.

- P. Air Filters: Refer to Division 23 section "Air Cleaning" for air filters required for air handling units; not work of this section.
- Q. Direct Evaporative Cooling Sections:
  - 1. Provide a direct evaporation cooling section which shall have a saturation effectiveness of 90 percent. Sump shall be constructed of stainless steel. Provide make-up water float valve, centrifugal type spray pump with separate grounded disconnect. Piping header shall be constructed of Type L copper.
- R. Provide water bleed system to allow removal of a small amount of water (during operation only) to minimize mineral deposits.
- S. Sound Attenuators: Provide sound attenuators to meet the acoustical performance scheduled on the drawings. Refer to Specification Section "Sound Attenuators" for additional details.
  - 1.

### PART 3 - EXECUTION

#### 3.1 INSPECTION

- A. Examine areas and conditions under which air handling units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

#### 3.2 INSTALLATION OF AIR HANDLING UNITS

- A. General: Install air handling units where indicated, in accordance with equipment manufacturer's published installation instructions, and with recognized industry practices, to ensure that units comply with requirements and serve intended purposes.
- B. Coordination: Coordinate with other work, including ductwork, floor construction, roof decking, and piping, as necessary to interface installation of air handling units with other work.
- C. Access: Provide access space around air handling units for service as indicated, but in no case less than that recommended by manufacturer.
- D. Support: Install floor-mounted air handling units on 4-inch high reinforced concrete pad, 4-inch larger on each side than unit base.
- E. Support: Install roof-mounted air handling units on structural steel mechanical stand. Anchor unit to stand with removable fasteners.
  - 1. Construct mechanical equipment stand as indicated, and in accordance with NRCA Handbook of Accepted Roofing Knowledge, Detail "N".
  - 2. Mechanical equipment stand is specified in Division 5; not work of this section.

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- F. Mounting: Mount air handling units on vibration isolators, in accordance with manufacturer's instructions.
- G. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
  - 1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to Equipment Installer.
- H. Piping Connections: Refer to Division 23 HVAC sections. Provide piping, valves, accessories, gauges, supports, and as indicated.
  - 1. Provide flexible connectors shutoff valves, balancing valves, unions, thermometers (supply and return), P and T types (supply and return) and other accessories on all piping connections.
- I. Duct Connections: Refer to Division 23 Air Distribution sections. Provide ductwork, accessories as indicated.
  - 1. Provide flexible connections, manual volume dampers with lock and quadrant on all duct connections.
- J. Grounding: Provide positive equipment ground for air handling unit components.

### 3.3 FIELD QUALITY CONTROL

- A. Testing: Upon completion of installation of air handling units, start-up and operate equipment to demonstrate capability and compliance with requirements. Field correct malfunctioning units, then retest to demonstrate compliance.
- B. Provide the services of a factory authorized service representative to provide start-up service and to demonstrate and train the Owner's maintenance personnel as specified below.
- C. One representative from both the owner and the engineer shall witness the test. Manufacturer shall pay food, lodging and transportation expenses for two witnesses.

### 3.4 EXTRA STOCK

- A. Provide one (1) complete extra set of filters for each air handling unit. Install new filters at completion of air handling system work, and prior to testing, adjusting, and balancing work. Obtain receipt from Owner that new filters have been installed.
- B. Provide one (1) spare set of belts for each belt-driven air handling unit, obtain receipt from Owner that belts have been received.



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3.5 TRAINING

- A. Schedule a minimum of four (4) hours of training with Owner. The manufacturer's representative and the Division 23 Contractor shall be present. The training shall be coordinated by the Division 23 Contractor and the Owner in conjunction with the other mechanical equipment on the project.
- B. Training:
  - 1. Train the Owner's maintenance personnel on start-up and shutdown procedures, troubleshooting procedures, and servicing and preventative maintenance schedules and procedures. Review with the Owner's personnel, the contents of the Operating and Maintenance Data specified in Division 1.
  - 2. Schedule training with Owner through the Architect/Engineer with at least seven (7) days prior notice.

END OF SECTION 237313

**SECTION 237323 – MAKEUP AIR UNITS**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. Extent of makeup air unit work is indicated on drawings and schedules, and by requirements of this section.
- B. Types of Makeup Units specified in this section include the following:
  - 1. Outdoor Makeup Units
- C. Electrical Work: Refer to Division 23 Section "Mech/Elec Requirements for Mechanical Equipment".
- D. Provide the following electrical work as work of this section, complying with requirements of Division 26 sections:
  - 1. Control wiring between field-installed controls, indicating devices, and unit control panels.
    - a. Control wiring specified as work of Division 23 Automatic Temperature Controls is work of that section.

1.3 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of makeup air units with characteristics, sizes, and capacities required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. Codes and Standards:
  - 1. AMCA Compliance: Test and rate makeup air units in accordance with AMCA standards.
  - 2. ARI Compliance: Test and rate makeup air units in accordance with ARI 430 "Standard for Central-Station Air Handling Units". Display certification symbol on units of certified models.
  - 3. ASHRAE Compliance: Construct and install refrigerant coils in accordance with ASHRAE 15 "Safety Code for Mechanical Refrigeration".
  - 4. NFPA Compliance: Provide makeup air unit internal insulation having flame spread rating not over 25 and smoke developed rating no higher than 50; and complying with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems".
  - 5. UL and NEMA Compliance: Provide electrical components required as part of makeup air units, which have been listed and labeled by UL and comply with NEMA Standards.

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6. NEC Compliance: Comply with National Electrical Code (NFPA 70) as applicable to installation and electrical connections of ancillary electrical components of makeup air units.

### 1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for makeup air units showing dimensions, weights, capacities, ratings, fan performance with operating point clearly indicated, motor electrical characteristics, gages and finishes of materials, and installation instructions.
- B. Shop Drawings: Submit assembly-type shop drawings showing unit dimensions, weight loadings, required clearances, construction details, and field connection details.
- C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to makeup air units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
- D. Record Drawings: At project closeout, submit record drawings of installed systems products in accordance with requirements of Division 1.
- E. Maintenance Data: Submit maintenance instructions, including instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in maintenance manuals; in accordance with requirements of Division 23.
- F. LEED Submittals:
  1. Product data for prerequisite EQ1:
    - a. Documentation indicates that units comply with ASHRAE 62.1, Section 5- "Systems and Equipment".

### 1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver makeup air units with factory-installed shipping skids and lifting lugs; pack components in factory-fabricated protective containers.
- B. Handle makeup air units carefully to avoid damage to components, enclosures, and finish. Do not install damaged components; replace and return damaged components to makeup air unit manufacturer.
- C. Store makeup air units in clean dry place and protect from weather and construction traffic.
- D. Comply with Manufacturer's rigging and installation instructions for unloading makeup air units, and moving them to final location.
- E. Makeup air units shall be broken down and shipped in components, as field conditions require. A factory-authorized representative shall inspect the final installation to certify that the unit has been reassembled per factory recommendations and specifications.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Makeup Air Units

1. Manufacturer: Subject to conformance with specified requirements, products of the following manufacturers are acceptable:
  - a. Valent
  - b. Greenheck
  - c. Reznor
  - d. Sterling.
  - e. Modine

2.2 MAKEUP AIR UNITS

- A. General: Provide factory-fabricated and factory-tested makeup air units as indicated, of sizes and capacities as scheduled, and as specified herein.
- B. Casings: Outdoor installation; provide casings of G90 galvanized steel, designed to withstand specific operating pressures. Provide casing panels and/or access doors that are easily and quickly removable for inspection and access to internal parts. Where top panels are joined there shall be a standing seam to ensure positive weather protection. All metal to metal surfaces exposed to the weather shall be sealed. Provide casing walls of double wall construction. Casing insulation shall be manufacturers standard glass fiber insulation, in accordance with NFPA 90A and tested to meet UL 181 erosion requirements.
- C. Fan Section: Centrifugal forward curved fan shall be double width, double inlet. Fan and motor shall be mounted on a common base and shall be internally isolated. All blower wheels shall be statically and dynamically balanced. Ground and polished steel fan shafts shall be mounted in permanently lubricated ball bearings. Bearings shall be selected for a minimum (L10) life in excess of 100,000 hours at a maximum cataloged speeds.
- D. Filter Section: 2-inch thick fiberglass throwaway filters in factory installed filter rack, with maximum face velocity of 300 fpm.
  1. Holding Frames: PVC extruded, channel frame with 2"x 2" welded wire fabric on outlet side and inlet side, hinged with pull and retaining handles.
  2. Shall be permanent-style designed for replaceable media. Metal filter frames shall be provided by the manufacturer of the air handling equipment.
  3. Frames shall be vinyl channel design that pressure locks the filter media in place. The wire mesh shall be 1"x 1", 16 gauge welded wire.
  4. Frame construction shall provide a competent seal of the filter media in order to minimize air flow bypass. Frames shall have mitered corners secured by spring steel corner clips, one at each corner for the 1-1/2 inch frames. Wire mesh shall be continuously supported on all sides and held in place by metal rivets or retainer clips. Frame size shall be clearly marked on one side of each frame.
  5. Replaceable Filter Media:
    - a. Media shall be UL-Class II.
    - b. Minimum media performance and particle efficiency shall be:
      - 1) Weight: 11.0 oz. per sq. yd.

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- 2) Minimum performance (24" x 24: x 1-1/2" media):
    - a) 0.21" w.c resistance at 300 fpm.
    - b) 30 percent ASHRAE efficiency.
    - c) 92 percent average weight arrestance.
    - d) 221 gm. Dust holding capacity at 1.0" w.c.
  - 3) Minimum particle efficiency:
    - a) 46.1 percent at 1 to 5 microns.
    - b) 86.1 percent at 5 to 10 microns.
    - c) 89.3 percent over 10 microns.
  6. Provide magnehelic differential pressure gauge across filters. Indicate filter replacement pressure drop on the gauge.
  7. If system is operated by the Contractor prior to completion of construction, provide a temporary set of minimum 2-inch thick, 30% efficient filters during the construction period. Upon completion of construction, remove the temporary filters and install the final set of filters.
- E. Weatherhood: Weatherhood shall be constructed of G90 galvanized steel with birdscreen mounted at the intake.
- F. Evaporative Cooling Section: Evaporative cooling section shall be provided with 12-thick Glasdek media, fan cooled water pump, float switch with bleed line, overflow and drain connections in bottom of unit, 300 series grade stainless steel water reservoir, weatherized cabinet with mesh intake screen, fill and drain valves and controls.
- G. The following accessories shall also be provided:
1. 200 degree firestat (installed).
  2. Freezestat (low limit), remote reset, for minimum discharge air temperature.
  3. SPST relay exhaust fan interlock.
  4. SPDT relay Fire Protection.
  5. Vibration Isolation.
  6. Remote Panel with lights, on/off, heat/vent/cool, room override.
  7. Cooling Control.
  8. Factory-mounted combination starters.

### PART 3 - EXECUTION

#### 3.1 INSPECTION

- A. Examine areas and conditions under which makeup air units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

#### 3.2 INSTALLATION OF MAKEUP AIR UNITS

- A. General: Install units where indicated, in accordance with equipment manufacturer's published installation instructions, and with recognized industry practices, to ensure that units comply with requirements and serve intended purposes.

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

- B. Coordination: Coordinate with other work, including ductwork, floor construction, roof decking, and piping, as necessary to interface installation of makeup air units with other work.
- C. Access: Provide access space around makeup air units for service as indicated, but in no case less than that recommended by manufacturer.
- D. Support: Install makeup air units on factory roof curb.
- E. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
  - 1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment Installer.
- F. Piping Connections: Refer to Division 23 HVAC sections. Provide piping, valves, accessories, gauges, supports, and as indicated. Install evaporative cooling drain and water piping per manufacturer's installation requirements.
  - 1. Provide flexible connectors and shutoff valves, balancing valves, unions, thermometers (supply and return), P and T taps (supply and return) and other accessories on all piping connections.
- G. Duct Connections: Refer to Division 23 Air Distribution sections. Provide ductwork and accessories as indicated. Provide flexible connections.
- H. Grounding: Provide positive equipment ground for makeup air unit components.

### 3.3 FIELD QUALITY CONTROL

- A. Testing: Provide startup services by a factory authorized representative. Upon completion of installation of makeup air units, start-up and operate equipment to demonstrate capability and compliance with requirements. Field correct malfunctioning units, then retest to demonstrate compliance.

### 3.4 EXTRA STOCK

- A. Provide one (1) spare set of belts for each belt-driven makeup air unit. Obtain receipt from Owner that belts have been received.

END OF SECTION 237323

**SECTION 237414 - ROOFTOP HEATING & COOLING 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 DESCRIPTION OF WORK

- A. Extent of Packaged Rooftop Heating and Cooling Units Work required by this section is indicated on drawings and schedules, and by requirements of this section.
- B. Refer to other Division 23 sections for metal ductwork, air devices, automatic temperature controls not factory-installed, and required for conjunction with packaged heating and cooling units; not work of this section.
- C. Electrical Work: Refer to Division 23 section "Electrical Provisions of Mechanical Work" for requirements.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicated, dimensions, required clearances, sound power characteristics, weights, furnished specialties and accessories; and installation and start-up instructions.
- B. Shop Drawings:
  - 1. Submit shop drawings detailing the manufacturer's electrical requirements for power supply wiring for rooftop heating and cooling units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
  - 2. Submit shop drawings detailing the mounting, securing, and flashing of the roof curb to the roof structure. Indicate coordinating requirements with roof membrane system.
- C. Samples for Initial Selection: For units with factory-applied color finishes.
- D. Record Drawings: At project closeout, submit record drawings of installed systems products in accordance with requirements of Division 1. Markup Drawing Schedule for installed equipment data.
- E. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.
- F. Maintenance Data: Submit maintenance data and parts list for each rooftop heating and cooling unit, control, and accessory, including "trouble-shooting" maintenance guide. Include this data in operation and maintenance manual; in accordance with requirements of Division 1.

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### 1.4 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of rooftop heating and cooling units, of types and capacities required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. Codes and Standards:
  - 1. Gas-fired furnace section construction shall be in accordance with CSA Safety Standards. Furnace section shall bear the CSA label.
  - 2. Testing and rating of rooftop units of 135,000 BTU/Hr capacity or over shall be in accordance with ARI 360 "Standard for Commercial and Industrial Unitary Air-Conditioning Equipment".
  - 3. Testing and rating of rooftop units under 135,000 BTU/Hr capacity shall be in accordance with ARI 210 "Standard for Unitary Air-Conditioning Equipment", and provide Certified Rating Seal. Sound testing and rating of units shall be in accordance with ARI 270 "Standard for Sound Rating of Outdoor Unitary Equipment". Units shall bear Certified Rating Seal.
  - 4. Refrigerating system construction of rooftop units shall be in accordance with ASHRAE 15 "Safety Code for Mechanical Refrigeration".
  - 5. Energy Efficiency Ratio (EER) of rooftop units shall be equal to or greater than prescribed by ASHRAE 90.1 A "Energy Conservation in New Building Design".
  - 6. Provide rooftop units which are UL listed and labeled.
  - 7. Rooftop units shall be designed, manufactured, and tested in accordance with UL requirements.

### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Handle units and components carefully to prevent damage. Replace damaged rooftop units or components with new.
- B. Store units and components in clean dry place, off the ground, and protect from weather, water, and physical damage.
- C. Rig units to comply with manufacturer's rigging and installation instructions for unloading units, and moving them to final location.

### 1.6 SCHEDULING AND SEQUENCING

- A. Coordinate installation of roof mounting curb with roof structure.
- B. Coordinate roof opening locations and for mechanical and electrical connections.

### 1.7 SPECIAL WARRANTY

- A. Warranty on Compressor and Heat Exchanger: Provide written warranty, signed by manufacturer, agreeing to replace/repair, within warranty period, compressors and heat exchangers with inadequate and defective materials and workmanship, including leakage, breakage, improper assembly, or failure to perform as required; provided manufacturer's



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instructions for handling, installing, protecting, and maintaining units have been adhered to during warranty period. Replacement is limited to component replacement only, and does not include labor for removal and reinstallation.

1. Warranty Period: Five (5) years from date of substantial completion.

### 1.8 EXTRA MATERIALS

- A. Extra Materials: Furnish to Owner, with receipt, the following spare parts for each rooftop heating and cooling unit:
  1. One (1) set of matched fan belts for each belt-driven fan.
  2. One (1) set of filters for each unit.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Rooftop Units:
    - a. Daikin
    - b. Aeon
    - c. Carrier Air Conditioning; Division of Carrier Corp.
    - d. McQuay Air Conditioning Group; McQuay Inc.
    - e. Trane (The) Co; Division of American Standard Inc.
    - f. York; Division of York International

### 2.2 ROOFTOP UNITS LESS THAN 20 TONS

- A. General Description: Units shall be factory-assembled and tested, designed for roof or slab installation, and consisting of compressors, condensers, evaporator coils, condenser and evaporator fans, refrigeration and temperature controls, filters, condenser coil guards and dampers.
- B. Casing: Manufacturer's standard casing construction, having corrosion protection coating, and exterior finish. Casings shall have removable panels or access doors for inspection and access to internal parts, a minimum of 1/2-inch thick thermal insulation, knockouts for electrical and piping connections and an exterior condensate drain connection and lifting lugs.
- C. Roof Curbs: Manufacturer's standard construction, insulated and having corrosive protective coating, complete with factory-installed wood nailer and drain nipple. Construction shall be in accordance with NRCA Standards.
- D. Evaporator Fans: Forward-curved, centrifugal, belt-driven fans with adjustable sheaves or direct-driven fans; and permanently lubricated motor bearings.

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- E. Coils:
  - 1. General: Aluminum plate fin and seamless copper tube type. Fins shall have collars drawn, belled and firmly bonded to the tubes by means of mechanical expansion of the tubes. No soldering or tinning shall be used in the bonding process. Coils shall have a galvanized steel casing. Coils shall be mounted in the coil casing with same end connections accessible for service. Coils shall be removable from the unit through the roof or through the piping enclosure. Coil section shall be completely insulated.
  - 2. Water Heating Coils: Pitched in the unit casing for proper drainage. Coils shall have metering orifices and a supply header to ensure distribution of hot water to each tube. Coils shall be proof (300 psig) and leak (200 psig) tested with air pressure under water continuous tube type, and proof (300 psig) and leak (200 psig) tested with air pressure under water.
- F. Provide water detection device (safe-t-switch or similar) in the drain pan to shut unit down if primary drain becomes blocked.
- G. Economizer Control: Return and outside air dampers, outside air filter, fully modulating electric control system with enthalpy control, and adjustable mixed-air thermostat. System shall have 100 percent outside air capability. Provide automatic changeover through adjustable enthalpy control device.
- H. Variable Air Volume Control: Discharge air step controller, and electric control system with enthalpy control.
- I. Air Filtration Section:
  - 1. General Requirements for Air Filtration Section:
    - a. Comply with NFPA 90A.
    - b. Minimum Arrestance: According to ASHRAE 52.1 and MERV-A 13 ASHRAE 52.2.
    - c. Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.
  - 2. Disposable Panel Filters:
    - a. Factory-fabricated, viscous-coated, flat-panel type.
    - b. Thickness: 2 inch.
    - c. Media: Interlaced glass fibers sprayed with nonflammable adhesive.
    - d. Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, and hinged; with pull and retaining handles.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine areas and conditions under which rooftop units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

#### 3.2 INSTALLATION

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- A. General: Install rooftop units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.
- B. Support: Install and secure roof curb to roof structure, in accordance with National Roofing Contractor's Association (NRCA) installation recommendations and shop drawings. Install and secure rooftop units on curbs and coordinate roof penetrations and flashing.
- C. Electrical Connections: Refer to Division 26 for final connections to equipment and installation of loose shipped electrical components.

### 3.3 DEMONSTRATION

- A. Start-Up Services:
  - 1. Provide the services of a factory-authorized service representative to start-up rooftop units, in accordance with manufacturer's written start-up instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
- B. Operating and Maintenance Training:
  - 1. Provide services of manufacturer's service representative to instruct Owner's personnel in operation and maintenance of rooftop units. Training shall include start-up and shutdown, servicing and preventative maintenance schedule and procedures, and troubleshooting procedures plus procedures for obtaining repair parts and technical assistance. Review operating and maintenance data contained in the Operating and Maintenance Manuals specified in Division 1.
  - 2. Schedule training with Owner, provide at least seven (7) day prior notice to the Architect/Engineer.

END OF SECTION 237414

**SECTION 238200 - TERMINAL HEAT UNITS**

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of Terminal Unit Work is indicated on drawings and schedules, and by requirements of this section.
- B. Types of Terminal Units required for project include the following:
  - 1. Unit Heaters
  - 2. Cabinet Unit Heaters
  - 3.
- C. Refer to other Division 23 sections for piping; ductwork; testing, adjusting and balancing of terminal units; not work of this section.
- D. Refer to Division 26 section for the following work; not work of this section.
  - 1. Power supply wiring from power source to power connection on terminal units.
  - 2. Provide the following electrical work as work of this section, complying with requirements of Division 26 sections:
    - a. Control wiring between field-installed controls, indicating devices, and terminal unit control panels.
      - 1) Control wiring specified as work of Division 23 for Automatic Temperature Controls is work of that section.
- E. Refer to other Division 23 sections for automatic temperature controls not factory installed, required in conjunction with terminal units; not work of this section.

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of terminal units, of types and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. Codes and Standards:
  - 1. I=B=R Compliance: Test and rate baseboard and finned tube radiation in accordance with I=B=R, provide published ratings bearing emblem of I=B=R.
  - 2. ARI Compliance: Provide coil ratings in accordance with ARI Standard 410 "Forced-Circulation Air-Cooling and Air-Heating Coils".
  - 3. ASHRAE Compliance: Test coils in accordance with ASHRAE Standard 33 "Methods of Testing Forced Circulation Air Cooling and Heating Coils".
  - 4. ARI Compliance: Test and rate fan-coil units in accordance with ARI Standard 440 "Room Fan-Coil Air Conditioners".
  - 5. UL Compliance: Construct and install fan-coil units in compliance with UL 883 "Safety Standards for Fan Coil Units and Room Fan Heater Units".

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6. UL Compliance: Provide electrical components for terminal units which have been listed and labeled by UL.
7. ARI Compliance: Test and rate ventilators in accordance with ARI Standard 330 "Unit Ventilators".
8. Electric Heating Equipment: All equipment with a heating coil capacity exceeding a 48 amp rating shall have the heating elements subdivided and protected by an overcurrent protection device rated at not more than 60 amps. Equipment not exceeding 48 amps shall also have overcurrent protection. Overcurrent protection devices shall be factory wired and installed in accordance with the National Electric Code. All equipment shall be factory assembled and wired in accordance with the National Fire Protection Association and shall be listed by Underwriters' Laboratories.

### 1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, for terminal units showing dimensions, capacities, ratings, performance characteristics, gauges and finishes of materials, and installation-startup instructions.
- B. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating terminal unit dimensions, weight loading, required clearances, construction details, field connection details and methods of assembly of components.
- C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to terminal units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
- D. Record Drawings: At project closeout, submit record drawings of installed systems products in accordance with requirements of Division 1.
- E. Maintenance Data: Submit maintenance instructions, including lubrication instructions, filter replacement, motor and drive replacement, control, accessories, "trouble-shooting" maintenance guide, and spare parts lists. Include this data, product data, and shop drawings in maintenance manuals; in accordance with requirements of Division 1.

### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Handle terminal units and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged terminal units or components; replace with new.
- B. Store terminal units and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.
- C. Comply with Manufacturer's rigging and installation instructions for unloading terminal units, and moving them to final location.

## PART 2 - PRODUCTS

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

### 2.1 MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
  - 1. Unit Heaters:
    - a. Airtherm Mfg. Co.
    - b. Buffalo Forge Co.
    - c. Dunham-Bush, Inc.
    - d. McQuay Inc.
    - e. Modine Mfg. Co.
    - f. Trane (The) Co.
    - g. Wing (The) Co.; Division Wing Industries, Inc.
    - h. Young Radiator Co.
    - i. Vulcan Radiator Corp.
  - 2. Cabinet Unit Heaters:
    - a. Airtherm Mfg. Co.
    - b. Dunham-Bush, Inc.
    - c. McQuay Inc.
    - d. Modine Mfg. Co.
    - e. Trane (The) Co.
    - f. Young Radiator Co.
    - g. Vulcan Radiator Corp.

### 2.2 UNIT HEATERS

- A. General: Provide unit heaters in locations as indicated, and of capacities, style, and having accessories as scheduled.
- B. Horizontal Unit Heaters:
  - 1. Casings: Construct of steel, phosphatized inside and out, and finished with standard color baked enamel finish. Provide motor-mounted panel, minimum of 18 gauge steel. Fabricate casing to enclose coil, louvers, and fan blades. Provide louvers for 4-way air diffusion.
  - 2. Fans: Construct of aluminum, and factory-balance. Provide fan inlet orifice, smooth, and drawn into casing back panel.
- C. Coils: Construct of plate-type aluminum fins, mechanically bonded to copper tubes. Design coil for use in hot water applications.
- D. Motors: Provide totally enclosed motors, with built-in overload protection, having electrical characteristics as scheduled.

### 2.3 CABINET UNIT HEATERS

- A. General: Provide hot water cabinet heaters having cabinet sizes and in locations as indicated, and of capacities, style, and having accessories as scheduled. Include in basic unit chassis, coil, fanboard, fan wheels, housings, motor, and insulation.
- B. Chassis: Galvanized steel wrap-around structural frame with edges flanged.

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- C. Insulation: Faced, heavy density glass fiber.
- D. Cabinet: 16 Gauge removable front panel, 18 gauge top and side panels. Insulate front panel over entire coil section. Provide access door on coil connection side. Clean cabinet parts, bonderize, phosphatize, and flow-coat with standard color as selected by Architect in baked enamel finish.
- E. Water Coils: Construct of 5/8-inch seamless copper tubes mechanically bonded to configured aluminum fins. Design for 300 psi and leak test at 300 psi under water. Provide same end connections for supply and return.
- F. Fans: Provide centrifugal, forward curved double width fan wheels constructed of non-corrosive, molded, fiberglass-reinforced thermoplastic material. Construct fan scrolls of galvanized steel.
- G. Motors: Provide shaded pole motors with integral thermal overload protection, and motor cords for plug-in to junction box in unit.
- H. Filters: Provide replaceable "sock" type filters. Provide tack-welded wire frame custom made for CUH to replace factory filters.
- I. Accessories: Provide the following accessories as indicated and/or scheduled:
  - 1. Wall Boxes: Provide aluminum wall boxes with integral eliminators and insect screen.
  - 2. Recessing Flanges: Provide 18 gauge steel flanges for recessing cabinet heaters into wall or ceiling.
  - 3. Sub-bases: Provide 18 gauge steel sub-base for vertical units, height as indicated.
  - 4. Extended Oilers: Provide plastic motor oiler tubes extending to beneath top discharge grille.

### PART 3 - EXECUTION

#### 3.1 INSPECTION

- A. Examine areas and conditions under which terminal units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

#### 3.2 INSTALLATION OF UNIT HEATERS

- A. General: Install unit heaters as indicated, and in accordance with manufacturer's installation instructions.
- B. Uncrate units and inspect for damage. Verify that nameplate data corresponds with unit designation.
- C. Hang units from building substrate, not from piping. Mount as high as possible to maintain greatest headroom possible unless otherwise indicated.
- D. Support units with rod-type hangers anchored to building substrate.

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- E. Install piping as indicated.
- F. Protect units with protective covers during balance of construction.

### 3.3 INSTALLATION OF CABINET HEATERS

- A. General: Install cabinet heaters as indicated, and in accordance with manufacturer's installation instructions.
- B. Locate cabinet heaters as indicated, coordinate with other trades to assure correct recess size for recessed units.
- C. Install piping as indicated.
- D. Protect units with protective covers during balance of construction.

### 3.4 ELECTRICAL WIRING

- A. General: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
  - 1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment Installer.

### 3.5 ADJUSTING AND CLEANING

- A. General: After construction is completed, including painting, clean unit exposed surfaces, vacuum clean terminal coils and inside of cabinets.
- B. Retouch any marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.
- C. Install new filter units for terminals requiring same.

### 3.6 START-UP

- A. Start-up, test, and adjust terminal units in accordance with manufacturer's published start-up instructions. Adjust for proper air flow where applicable.

END OF SECTION 238200



**SECTION 260500 - BASIC ELECTRICAL REQUIREMENTS**

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. Description: Work shall consist of furnishing all labor, equipment, supplies, and materials, unless otherwise specified, necessary for the installation of complete electrical systems as required by the specifications and as shown on the drawings, subject to the terms and conditions of the contract. The Work shall also include the completion of those details of electrical work not mentioned or shown which are necessary for the successful operation of all electrical systems.
- B. Certain labor, materials, and equipment may be furnished under other Sections of these specifications, by Utility Companies or by the Owner. When this is the case, the extent, source and description of these items will be as indicated on the drawings or as described in the specifications.

1.3 RELATED SECTIONS

- A. Basic Electrical Requirements specifically applicable to Division 26 Sections, in addition to Division 1 - General Requirements.

1.4 REFERENCE STANDARDS

- A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents. A listing of applicable reference standards is contained in Division 1.
- B. Latest editions of the following:
  - 1. ANSI/NFPA 70 - National Electrical Code.
  - 2. ANSI/IEEE C2 - National Electrical Safety Code.
  - 3. NECA - Standard of Installation.
  - 4. Other references as listed elsewhere in these specifications.

1.5 DEFINITIONS

- A. "Furnish" or "Provide": To supply, install and connect up complete and ready for safe and regular operation of particular work unless specifically otherwise noted.

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- B. "Install": To erect, mount and connect complete with related accessories.
- C. "Supply": To purchase, procure, acquire and deliver complete with related accessories.
- D. "Work": Labor, materials, equipment, apparatus, controls, accessories, and other items required for proper and complete installation.
- E. "Wiring": Raceway, fittings, wire, boxes and related items.
- F. "Concealed": Embedded in masonry, concrete or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces, or in enclosures.
- G. "Exposed": Not installed underground or "concealed" as defined above.
- H. "Indicated," "Shown" or "Noted": As indicated, shown or noted on drawings or specifications.
- I. "Similar" or "Equal": Equal in materials, weight, size, design, construction, capacity, performance, and efficiency of specified product.
- J. "Reviewed," "Satisfactory," "Accepted," or "Directed": As reviewed, satisfactory, accepted, or directed by or to Engineer.
- K. "Related Work" includes, but is not necessarily limited to, mentioned work associated with, or affected by, the work specified.
- L. Refer to Article 100 of the currently adopted National Electrical Code for other definitions as applicable to this project.

### 1.6 WORK SEQUENCE

- A. Construct Work in sequence under provisions of Division 1 where applicable.

### 1.7 DRAWINGS AND SPECIFICATIONS

- A. The drawings indicate the general arrangement of circuits and outlets, locations of switches, panelboards and other work. Information shown on the drawings is schematic, however, recircuiting will not be permitted without specific acceptance. Drawings and specifications are complementary each to the other. What is called for by one shall be as binding as if called for by both. Data presented on these drawings is as accurate as planning can determine, but accuracy is not guaranteed and field verification of all dimensions, locations, levels, etc., to suit field conditions is directed. Review all Architectural, Structural and Mechanical Drawings and Specifications; adjust all work to conform to all conditions shown therein. The Architectural drawings shall take precedence over all other drawings.
- B. Prior to submitting a bid, visit the site of the job and ascertain all conditions affecting the proposed installation and adjust all work accordingly. Make provisions for these costs.
- C. Discrepancies between different plans, between plans and specifications, between specifications, or regulations and codes governing this installation shall be brought to the attention of the Engineer in writing before the date of bid opening. In the event such

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discrepancies exist, and the Engineer is not so notified, the adjudication of responsibility shall be solely at the discretion of the Engineer.

### 1.8 COORDINATION

- A. Prior to fabrication or installation of any electrical work, participate in detailed coordination planning meetings with all other building utilities system trades, under the direction of the General Contractor, so as to completely establish routings, elevations, space requirements, and coordination of access, layout, and suspension requirements in relationship to the building structure and the work of all other trades.

### 1.9 SUBMITTALS (Refer to Division 1)

- A. Submit shop drawings and product data in accordance with provisions of Division 1.
- B. Prior to submission, shop drawings, material lists and catalog cuts or manufacturer's printed data shall be thoroughly checked for compliance with contract requirements, compatibility with equipment being furnished by the Contractor or Owner, accuracy of dimensions, coordination with work of other trades, and conformance with sound and safe practice as to erection of installation. Each submittal shall bear Contractor's signed statement evidencing such checking.
- C. Clearly mark each shop drawing as follows for purposes of identification:
  - 1. Shop Drawing
  - 2. Equipment Identification Used on Contract Drawings
  - 3. Date
  - 4. Name of Project
  - 5. Branch of Work
  - 6. Engineer's Name
  - 7. Contractor's Name
- D. Clearly mark printed material, catalog cuts, pamphlets or specification sheets, and shop drawings with the same designation shown on the contract document schedules. Identify specific item proposed, showing catalog number, recess openings, dimensions, capacities, electrical characteristics, etc. Submittals which are incomplete will be returned to the Contractor without review.
- E. Contractor agrees that submittals processed by the Engineer are not change orders; that the purpose of submittals is to demonstrate to the Engineer that the Contractor understands the design concept; and that the Contractor demonstrates this understanding by indicating which equipment and material he intends to furnish and install and by detailing the fabrication and installation methods he intends to use.
- F. Contractor shall be responsible for dimensions (which he shall confirm and correlate at the job site), fabrication processes and techniques of construction, and coordination of his work with that of other trades. The Contractor shall check and verify all measurements and review shop drawings before submitting them. If any deviations from the specified requirements for any item of material or equipment exist, such deviation shall be expressly stated in writing and incorporated with the submittal.

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- G. Maintain one copy of shop drawings at the project field office until completion of the project, and make this copy available, upon request, to representatives of the Engineer and Owner.
- H. No equipment or materials shall be installed or stored at the jobsite until submittals for such equipment or materials have been given review action permitting their use.
- I. Shop drawings and manufacturer's published data shall be submitted for:
  - 1. All switchboards, panelboards
  - 2. Transformers
  - 3. Luminaires (catalog cuts)
  - 4. Fire alarm system
  - 5. Automatic transfer switch
  - 6. Security system
  - 7. Motor control centers
  - 8. Packaged Generator Set

### 1.10 RECORD DOCUMENTS

- A. Maintain a contract set of electrical drawings at the site. Neatly mark all changes, discoveries and deviations from the original drawings. Use a color which contrasts with the prints. This shall be a separate set of drawings, not used for construction purposes, and shall be kept up to date as the job progresses and shall be made available for inspection by the Engineer at all times. Upon completion of the contract, this set of record drawings shall be delivered to the Engineer. Record documents to be provided by the Contractor shall clearly and accurately show the following:
  - 1. Major raceway systems, size and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.
  - 2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
  - 3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.

### 1.11 REGULATORY REQUIREMENTS

- A. Conform to those editions of the following as currently adopted by the local code enforcement authority:
  - 1. ANSI/NFPA 70.
  - 2. ANSI/IEEE C2.
  - 3. Denver Building Code, and applicable requirements of the Fire Prevention Bureau.
  - 4. Comply with requirements of the utility and telephone companies furnishing service to this installation.
  - 5. Other requirements as listed elsewhere in these specifications.
- B. Obtain electrical permits, plan review, and inspections from authority having jurisdiction in accordance with Division 1.

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- C. The drawings and specifications take precedence when they are more stringent than codes, statutes, or ordinances in effect. Applicable codes, ordinances, standards and statutes take precedence when they are more stringent than, or conflict with the drawings and specifications.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS AND EQUIPMENT

- A. Materials and Equipment: Acceptable to the authority having jurisdiction as suitable for the use intended, except where more stringent requirements are indicated by the Contract Documents.
- B. Compatibility with Available Space: Equipment layouts shown are based on use of equipment as specified. If the Contractor chooses equipment available from any other manufacturer listed as an acceptable manufacturer, or offers equipment under the provision for substitutions, the Contractor shall be solely responsible for first ascertaining that the offered equipment can be installed in the space available with ample clearances for maintenance. Include coordination drawings, as specified herein, when required.
- C. All equipment and materials installed shall be new, unless otherwise specified.
- D. Defective or damaged materials shall be replaced or repaired, prior to final acceptance, in a manner acceptable to the Engineer or Owner and at no additional cost to the Owner.
- E. All electrical materials shall be acceptable for installation only if labeled or listed by a nationally recognized testing laboratory and if accepted by local authorities.
- F. All major equipment components shall have the manufacturer's name, address, model number, and serial number permanently attached in a conspicuous location.

#### 2.2 STORAGE AND PROTECTION

- A. Store products in accordance with manufacturer's instructions, with seals and labels intact and legible. Store sensitive products in weather-tight enclosures; maintain within temperature and humidity ranges required by manufacturer's instructions.
- B. For exterior storage of fabricated products, place on sloped supports above ground. Cover products subject to deterioration with impervious sheet covering; provide ventilation to avoid condensation.
- C. Arrange storage to provide access for inspection. Periodically inspect to assure products are undamaged, and are maintained under required conditions.

#### 2.3 PRODUCT OPTIONS

- A. Products Specified by Reference Standards or by Description Only: Any product meeting those standards.

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- B. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not specifically named.
- C. Products Specified by Naming One or More Manufacturers without a Provision for Substitutions: Products of named manufacturers meeting specifications; no options, no substitutions allowed.

### 2.4 PRODUCTS LIST

- A. Within 30 days after date of Owner-Contractor Agreement, submit complete list of major products required for submittal under these specifications, with name of manufacturer, trade name, and model number of each product.

### 2.5 SUBSTITUTIONS

- A. Refer to Division 1.

### 2.6 GUARANTEE

- A. The entire electrical system installed under this Contract shall be left in proper working order. Replace, at no additional cost to the Owner, any work, materials, or equipment which evidences defects in design, construction, or workmanship within two years, or as specifically noted elsewhere in these specifications, from date of final acceptance.

## PART 3 - EXECUTION

### 3.1 WORKMANSHIP

- A. Install work using procedures defined in NECA Standard of Installation.
- B. Workmanship shall conform to highest industry standards for each trade involved in erection of the work.
- C. Contractor's personnel and subcontractors selected to perform the work shall be well versed and skilled in the trades involved.
- D. Any changes or deviations from the drawings and specifications must be accepted in writing by the Engineer. All errors in installation shall be corrected at the expense of the Contractor. All specialties shall be installed as detailed on the drawings. Where details or specific installation requirements are not provided, manufacturer's recommendations shall be followed.
- E. Upon completion of work, all equipment and materials shall be installed complete, thoroughly checked, correctly adjusted, and left ready for intended use or operation. All work shall be thoroughly cleaned and all residue shall be removed from surfaces. Exterior surfaces of all material and equipment shall be delivered in a perfect, unblemished condition.

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- F. Contractor shall provide a complete installation, including all required labor, material, cartage, insurance, permits, and taxes.

### 3.2 CHASES, OPENINGS, CUTTING AND PATCHING

- A. Carefully lay out all work in advance so as to eliminate where possible, cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings and roofs. Any damage to the building, structure, piping, ducts, equipment or any defaced finish shall be repaired by skilled mechanics of the trades involved at no additional cost to the Owner and to the satisfaction of the Architect/Engineer. Any necessary cutting, channeling, drilling or welding as required for the proper support, concealment, installation or anchoring of raceways, outlets, or other electrical equipment shall be performed in a careful manner, and as approved by the Engineer.
- B. All openings made in fire-rated walls, floors, or ceilings shall be patched and made tight in a manner to conform to the fire rating for the surface penetrated.
- C. All penetrations required through completed concrete construction shall be core drilled at minimum size required. Precautions shall be taken when drilling to prevent damage to structural concrete. The Contractor shall obtain permission from the Engineer before proceeding with drilling.

### 3.3 ELECTRICAL INSTALLATIONS

- A. Coordinate electrical systems, equipment, and materials installation with other building components. If equipment of a different size is furnished by the Contractor, the Contractor shall furnish and install the proper motor starter, fuses, circuit breaker, disconnect switch, wire and conduit required for the equipment furnished, at no additional cost to the Owner and shall be approved by the Owner.

### 3.4 PROGRESS OF WORK

- A. Order the progress of electrical work to conform to the progress of the work of the other trades. Complete the entire installation as soon as the condition of the building will permit. Any cost resulting from defective or ill-timed work performed under this Section shall be borne by this Contractor.

### 3.5 TRENCHING AND BACKFILLING

- A. Perform all trenching and backfilling required by work performed under this Section in accordance with the excavating and grading specifications and as herein specified.
- B. Excavate trenches to the depth required for the utilities involved. The trench bottom shall be graded true and free from stones or soft spots, bottom of trenches must be compacted.
- C. After installation of electrical work, backfill, tamp, and compact to insure against the possibility of differential settling, in conformity with Division 2 Specifications. Verify location of existing or new utilities and, if damaged by this Contractor, replace or repair.

3.6 ELECTRICAL COMPLETION

- A. Indoctrination of Operating and Maintenance Personnel: Furnish the services of a qualified representative of the supplier of each item or system itemized below who shall instruct specific personnel, as designated by the Owner, in the operation and maintenance of that item or system.
  - 1. Instruction shall be given when the particular system is complete, and shall be of the number of hours indicated and at the time requested by the Owner. A representative of the Contractor shall be present for all demonstrations.

<u>System</u>	<u>Hours Of Instruction</u>
Fire Alarm System	4 (2 2-hour sessions)
Electrical Distribution Equipment (under 600 volts)	4 (2 2-hour sessions)
Security System	2 (1 2-hour sessions)
Emergency System	4 (1 4-hour sessions)
Packaged Generator Set	8 (2 4-hour sessions)
Lighting Control System	4 (2 2-hour sessions)

- B. Operating and Maintenance Manuals and Parts Lists: Deliver three (3) complete operating & maintenance manuals and parts lists to the Owner at the time of the above required indoctrination. Fully explain the contents of the manuals as part of required indoctrination and instruct the Owner's personnel in the correct procedure in obtaining service, both during and after the guarantee period.
  - 1. The operating and maintenance manuals and parts lists shall give complete information as to whom the Owner shall contact for service and parts. Include address and phone number. Furnish evidence that an authorized service organization regularly carries a complete stock of repair parts for these items (or systems), and that the organization is available for service. Service shall be furnished within 24 hours after requested.
- C. Operating and Acceptance Tests: Provide all labor, instruments, and equipment for the performance of tests as specified below and elsewhere in these specifications. Submit three copies of a typewritten test report to the Engineer for his approval.
  - 1. For a seven-day period after building has been placed into normal service, record the full load current in each phase or line at the main service entrance and submit to the Engineer.
  - 2. Perform a careful inspection of the main switchboard bus structure and cable connections to verify that all connections are torqued to manufacturer's recommendations.
- D. Clean-Up: Remove all materials, scrap, etc., relative to the electrical installation, and leave the premises and all equipment, lamps, luminaires, etc. in a clean, orderly condition. Any costs to the Owner for clean-up of the site will be charged against the Contractor.
- E. Acceptance Demonstration: Upon completion of the work, at a time to be designated by the Engineer, the Contractor shall demonstrate for the Owner the operation of the entire installation, including all systems provided under this contract.
- F. Final acceptance by the Owner will not occur until all operating instructions are received and Owner's personnel have been thoroughly indoctrinated in the maintenance and operation of all equipment.

END OF SECTION 260500



**SECTION 260519 - BUILDING WIRE AND CABLE**

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. Building Wire and Cable.
- B. Metal Clad Cable.
- C. Wiring Connections and Terminations

1.3 RELATED SECTIONS

- A. Section 260532 - Conduit
- B. Section 260534 – Electrical Boxes and Fittings.
- C. Section 260529 - Supporting Devices and Seals
- D. Section 260553- Electrical Identification

1.4 REFERENCE STANDARDS

- A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents. A listing of applicable reference standards is contained in Division 1.
- B. NEMA WC 70 – Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
- C. NEMA WC 70 – Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

1.5 SUBMITTALS

- A. Submit shop drawings and product data under the provisions of Section 260500.

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### 1.6 PROJECT CONDITIONS

- A. Verify that field measurements are as shown on Drawings.
- B. Conductor sizes are based on copper.
- C. Wire and cable routing shown on Drawings is appropriate unless dimensioned. Route wire and cable as required to meet project conditions.
- D. Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required.

### 1.7 COORDINATION

- A. Coordinate Work under provisions of Section 260500.
- B. Determine required separation between wiring and other work.
- C. Determine routing to avoid interference with other work.

## PART 2 - PRODUCTS

### 2.1 BUILDING WIRE

- A. Thermoplastic-Insulated Building Wire: NEMA WC 70.
- B. Rubber-Insulated Building Wire: NEMA WC 70.
- C. Feeders and Branch Circuits: Copper, 600 volt, insulation, THHN/THWN, or XHHW. Conductors #10 AWG and larger shall be stranded. Conductors smaller than #10 shall be solid.
- D. Control Circuits: Copper, stranded conductor 600 volt insulation, THHN/THWN, or XHHW.

### 2.2 METAL CLAD CABLE

- A. Description: ANSI/NFPA 70, Type MC.
- B. Conductor: Copper.
- C. Insulation Voltage Rating: 600 volts.
- D. Insulation Temperature Rating: 75 degrees C.
- E. Insulation Material: Thermoplastic and thermosetting.
- F. Armor Material: Steel.
- G. Armor Design: Interlocked metal tape.

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- H. Jacket: PVC jacket when installed in damp and wet locations.
- I. Cable to be provided with a separate equipment grounding conductor sized per NEC.

### 2.3 REMOTE CONTROL AND SIGNAL CABLE

- A. Control Cable for Class 1 Remote Control and Signal Circuits: Copper conductor, 600 volt insulation, rated 60 degree C, individual conductors twisted together, shielded, and covered with a PVC jacket.
- B. Control Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, 300 volt insulation, rated 60 degrees C, individual conductors twisted together, shielded, and covered with a PVC jacket; UL listed.
- C. Plenum Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, 300 volt insulation, rated 60 degrees C, individual conductors twisted together, shielded, and covered with a non-metallic jacket; UL listed for use in air handling ducts, hollow spaces used as ducts, and plenums.
- D. Install all remote control and signal cables in cable tray, raceways, or supported every 4'-0" on bridal rings.

## PART 3 - EXECUTION

### 3.1 GENERAL WIRING METHODS

- A. Use no wire smaller than No. 12 AWG for power and lighting circuits, and no smaller than No. 16 AWG for control wiring.
- B. Use No. 10 AWG conductor for 20 ampere, 120-volt branch circuit home runs longer than 75 feet, and for 20 ampere, 277-volt branch circuit home runs longer than 200 feet.
- C. Place an equal number of conductors for each phase of a circuit in same raceway or cable.
- D. Splice only in accessible junction or outlet boxes.
- E. Neatly train and lace wiring inside boxes, equipment, and panelboards. Make temporary connections to panelboard devices with sufficient slack conductor to facilitate reconnections required for balancing loads between phases.
- F. Damaged conductors during installation shall be replaced.
- G. Install products in accordance with manufacturer's instructions.

### 3.2 WIRING INSTALLATION IN RACEWAYS

- A. Pull all conductors into a raceway at the same time. Use UL listed wire pulling lubricant for pulling No. 4 AWG and larger wires.

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- B. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.
- C. Completely and thoroughly swab raceway system before installing conductors.

### 3.3 CABLE INSTALLATION

- A. When approved install in interior partitions only and for flexible connection to luminaires. (Flexible connection not to exceed 6'-0".)
- B. Use suitable cable fittings and connectors.
- C. Cable shall not be installed below windows in exterior walls.
- D. Cable shall not be used for branch circuit homeruns. Branch circuit homeruns shall be building wire in raceway.
- E. Run concealed cable parallel and perpendicular to building elements at right angles. Parallel cable runs shall be run together. Run high and tight to structure. Coordinate cable runs with other trades.
- F. Support cable every four feet and within 12 inches of every outlet box, junction box, cabinet, or fitting.
- G. Cable shall not be used in emergency circuits.
- H. Cable shall not be used as flexible connection to motors, transformers or other vibrating equipment.
- I. Support cables above accessible ceiling, using spring metal clips or metal cable ties to support cables from structure. Do not rest cable on ceiling panels.
- J. Provide protection for exposed cables where subject to damage.

### 3.4 WIRING CONNECTION AND TERMINATIONS

- A. Splice only in accessible junction boxes.
- B. For No. 8 AWG and smaller, use insulated spring wire connectors with plastic caps.
- C. Use split bolt connectors for copper wire splices and taps, No. 6 AWG and larger. Tape un-insulated conductors and connectors with electrical tape to 150 percent of the insulation value of conductor.
- D. Thoroughly clean wires before installing lugs and connectors.
- E. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.

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- F. Terminate up to #10 AWG spare conductors with wire nuts. Use electrical tape for spare conductor #8 AWG and larger.
- G. Terminate aluminum conductors with tin-plated, aluminum-bodied compression connectors only. Fill with anti-oxidant compound before installing conductor.
- H. Use suitable reducing connectors or mechanical connector adaptors for connecting aluminum conductors to copper conductors.
- I. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.
- J. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

### 3.5 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Division 1.
- B. Inspect wire and cable for physical damage and proper connection.
- C. Torque test conductor connections and terminations to manufacturer's recommended values.
- D. Perform continuity test on all power and equipment branch circuit conductors. Verify proper phasing connections.

### 3.6 WIRE AND CABLE INSTALLATION SCHEDULE

- A. Concealed Interior Locations: Building wire in raceways or cable as approved herein.
  - 1. If specified, cables may be used for luminaire connections and in interior partitions for branch circuits.
- B. Exposed Interior Locations: Building wire in raceways.
- C. Above Accessible Ceilings: Building wire in raceways or cable as approved herein.
- D. Wet or Damp Interior Locations: Building wire in raceway.
- E. Exterior Locations: Building wire in raceways.
- F. Underground Locations: Building wire in raceways.

### 3.7 WIRE AND CABLE COLOR CODING

- A. Wires No. 6 AWG and smaller shall be factory color coded. Wire No. 4 AWG and larger shall be color-coded with color tape 6-inch length of exposed ends, and at every accessible junction box on the branch circuit or feeder.

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120/208 Volts

A = Black

B = Red

C = Blue

Neutral = White

Ground = Green

- B. Maintain the color coding throughout the system from panel to the last device on the branch circuit.

3.8 FIELD QUALITY CONTROL

- A. Prior to energizing, all feeders from transformers, switchboards, and building service cables, are to be tested with a 500-volt insulation megohm meter to determine insulation resistance levels to assure requirements are fulfilled. All field test data is to be recorded and submitted. Test is to include meggering for one minute between conductors and between each conductor and ground. Cables are to be meggered after installation with cables disconnected at both ends. The values must be not less than as follows:

<u>Conductor Size</u> <u>(AWG or MCM)</u>	<u>Resistance</u> <u>Megohms 1000 ft.)</u>
#16 AWG to #8 AWG	200
#6 AWG to #2/0 AWG	100
#3/0 AWG to 500 KCMIL	50

END OF SECTION 260519

**SECTION 260526 - GROUNDING AND BONDING**

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. Power System Grounding
- B. Communication System Grounding
- C. Electrical Equipment and Raceway Grounding and Bonding

1.3 REFERENCE STANDARDS

- A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents.
- B. NFPA Compliance: NFPA 70 "National Electrical Code (NEC).
- C. UL Compliance: Applicable requirements of UL Standards Nos. 467 "Electrical Grounding and Bonding Equipment," and 869, "Electrical Service Equipment," pertaining to grounding and bonding of systems, circuits and equipment. In addition, require compliance with UL Std 486A, "Wire Connectors". Grounding and bonding products which are to be UL-listed and labeled for their intended usage.
- D. IEEE Compliance: Applicable requirements and recommended installation practices of IEEE Standards 80, 81, 141 and 142 pertaining to grounding and bonding of systems, circuits and equipment.

1.4 SYSTEM DESCRIPTION

- A. Ground the electrical service system neutral at service entrance equipment to metallic cold water service, building steel and to supplementary grounding electrodes, as indicated on drawings.
- B. Ground each separately-derived system neutral to nearest metallic cold water pipe 2-inch diameter or larger, building steel and where present to the referenced ground bar as shown on drawings.
- C. Provide communications system grounding conductor at point of service entrance and connect to nearest referenced ground bar as shown on drawings.

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- D. Bond together system neutrals, service equipment enclosures, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, and plumbing systems.

### 1.5 SUBMITTALS

- A. Submit shop drawings under provisions of Section 260500.
- B. Indicate layout of ground ring, location of system grounding electrode connections, and routing of grounding electrode conductors.
- C. Submit all field test reports.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Ground Rods: Copper or copper-clad steel, 3/4-inch diameter, minimum length 10 feet.
- B. Mechanical Grounding Connectors: For all grounding connections above grade.
  - 1. Manufacturer: Burndy Electrical
  - 2. Material: Copper.
  - 3. Compression Type: Irreversible.
  - 4. UL listed under Standard UL467.
- C. Wire:
  - 1. Material: Copper.
  - 2. Size: As indicated on the drawings. When size is not indicated, size per Article 250 of NEC requirements.
- D. Grounding Connection Accessories:
  - 1. Electrical insulating tape, heat-shrinkable insulating tubing, welding materials, bonding straps, as recommended by accessories manufacturers for type service required.

- 2.2 Field Welding: Exothermic welded connections are required where grounding conductors connect to underground grounding conductors and to underground grounding electrodes, and for bonding to steel. All underground connection shall be exothermic welded.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Provide a separate, insulated equipment grounding conductor in feeder and branch circuits. Terminate each ground conductor to the bushing and ground lug.



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- B. Connect grounding electrode conductors to metal water pipe using a suitable ground clamp. Make connections to flanged piping at street side of flange.
- C. Supplementary Grounding Electrode: Use grounding mats, or driven ground rods, where indicated. Install ground rods in suitable recessed well; fill with gravel after connection is made.
- D. Use minimum No. 6 AWG copper conductor for communications service grounding conductor. Leave 10-foot slack conductor at terminal board or cabinet.
- E. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, connections are to be tightened to comply with tightening torque values specified in UL 486A to assure permanent and effective grounding.
- F. Provide code-sized ground cable bonding jumpers, installed with ground clamps, across all conduit expansion couplings and fittings.
- G. Route grounding connections, conductors to ground, and grounding conductors to protective devices in the shortest and straightest paths possible to minimize transient voltage rises.
- H. Provide a corrosion-resistant finish to field connections, buried metallic bonding products, and where factory applied protective coatings have been destroyed, where subject to corrosive action.
- I. All continuous runs of cable tray and all isolated sections of cable tray shall be grounded at intervals not to exceed 20 feet.
- J. Provide an equipment grounding conductor in all non-metallic conduits.
- K. Provide an equipment grounding conductor in all flexible metallic conduits.
- L. Grounding conductor in feeders and branch circuits extend ground conductor to switches, receptacle, equipment enclosures, equipment, and panels etc. and ground as required.

### 3.2 FIELD QUALITY CONTROL

- A. Upon completion of installation of electrical grounding and bonding systems, the ground resistance shall be tested with an earth ground resistance tester in accordance with IEEE 81, "Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System". Where tests show resistance-to-ground is over values in Table 1 below, Contractor shall take appropriate action to reduce resistance to the values in Table 1, by driving additional ground rods; and then retest to demonstrate compliance. All results shall be recorded and submitted.

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Table 1

<u>Earth Ground Resistance to Equipment</u>	<u>Equipment (Ohms)</u>
Pad Mount Transformer	5
Secondary Neutrals and Other Ground	10

END OF SECTION 260526

**SECTION 260529- SUPPORTING DEVICES AND SEALS**

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. Conduit and equipment supports.
- B. Fastening hardware.
- C. Wall and floor seals.

1.3 RELATED DOCUMENTS

- A. Drawings, general and special conditions, Division 1 - General Requirements and other applicable technical specifications apply to work of this Section.

1.4 RELATED SECTIONS

- A. Division 3 - Cast-in-Place Concrete. Concrete equipment pads.
- B. Coordinate size, shape and location of concrete pads with Division 3.
- C. Refer to Section 260500 for coordination requirements.

1.5 REFERENCE STANDARDS

- A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents. A listing of applicable reference standards is contained in Division 1.

1.6 QUALITY ASSURANCE

- A. Support systems shall be adequate for weight of equipment and conduit, including wiring, which they carry.

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## PART 2 - PRODUCTS

### 2.1 MATERIAL

- A. Support Channel: Galvanized or painted steel for non-corrosive environment.
- B. Hardware: Corrosion-resistant.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Fasten hanger rods, conduit clamps, and outlet and junction boxes to building structure using precast insert system, expansion anchors, preset inserts, or beam clamps. Do not use spring steel clips and clamps; however, caddy fasteners are accepted.
- B. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors or preset inserts in solid masonry walls; self-drilling anchors or expansion anchor on concrete surfaces; sheet metal screws in sheet metal studs; and wood screws in wood construction.
- C. Do not fasten supports to piping, ductwork, mechanical equipment, or conduit.
- D. Do not drill structural steel members.
- E. Fabricate supports from structural steel or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts.
- F. Install all free-standing electrical equipment on a 4-inch concrete housekeeping pad.
- G. Install surface-mounted cabinets and panelboards with minimum of four anchors.
- H. Bridge studs top and bottom with channels to support flush-mounted cabinets and panelboards in stud walls.
- I. Where conduit penetrates fire-rated walls, concrete and/or masonry walls and floors, it shall be sleeved. Seal opening around conduit with UL listed foamed silicone elastomer compound.
- J. Where conduit penetrates waterproofed floors or exterior walls subject to entry of moisture, provide pipe sleeves two sizes larger than conduit, suitably flashed or sealed where appropriate. Seal annular space around conduit with UL listed foamed silicone elastomer compound.
- K. Route conduit through roof openings for piping and ductwork where possible; otherwise, route through roof jack with pitch pocket.
- L. No suspended conduit or box supports shall be less than 1/4-inch diameter steel rod. Rod used as pedestal support is not acceptable. The contractor shall not use tie wire or wire of any type to support conduits, junction boxes or pull boxes.

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- M. No more than five (5) 1/2-inch conduits, three (3) 3/4-inch conduits or two (2) 1-inch conduits shall be supported on a single 1/4-inch diameter steel rod.
- N. All conduits shall be supported by approved hangers. Supports installed and used by other trades such as duct hangers, pipe hangers, ceiling hangers, etc. shall not be used for conduit support. No conduit shall be hung from air handling duct of any type. Electrical conduit systems "shall stand alone."
- O. All light luminaires shall be independently supported at opposite corners from structural steel or from trapeze supported from structural steel by electrical contractor.
- P. Wall-mounted luminaires shall be supported from building structure with approved backing support to prevent any damage to the wall.
- Q. Concrete anchors shall not be used to suspend heavy electrical loads such as electrical switch panels or four-inch and larger conduits. Anchors shall be designed to support conduits and cable tray when full fitted to maximum capacity with cables.

### 3.2 EQUIPMENT BASES

- A. Provide equipment pad bases of concrete type, construction, and finish as herein specified. Bases shall be of dimensions indicated or, where not specifically indicated or specified, dimensions shall be 4 inches height with width and length providing 4 inches of projection of base beyond outline dimension of supported equipment.
  - 1. Concrete shall be Class 3000, prepared in conformity with ACI 301, ASTM C 33, and ASTM C 94, as applicable. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping, using equipment and procedures for consolidation of concrete in accordance with ACI 309. Perform consolidation so that concrete is thoroughly worked around reinforcement and other embedded items and into corners. Perform curing of concrete by moist curing, by moisture-retaining cover curing, or by combinations thereof, as directed or approved.
  - 2. Provide oiled wood forms for concrete placement, adequately braced to ensure straight and vertical sides for bases. Finished bases shall provide a 3/4-inch chamfer at all exposed edges. Except where vibration attenuating base mountings are specified, provide No. 4 dowels (conforming to ASTM A 615, Grade 60), grouted into place, for anchorage of bases to substrate for all applications for which imposed strains or dynamic forces produced by equipment operation introduce the possibility of displacement of bases. Spacing of dowels shall be not less than 24 inches o.c., with a minimum of 4 dowels for each base.
  - 3. Bases where indicated shall be reinforced by installation of 6 x 6 No. 8 AWG welded wire fabric conforming to ASTM A 185. Apply measures, during concrete placement, to ensure that fabric remains vertically centered in bases.
  - 4. Bring slab surfaces to correct level with straightedge and strikeoff. Do not disturb slab surfaces prior to beginning finishing operations. Float finish surfaces and provide steel trowel final finish.

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- B. For all equipment to be installed on concrete bases or other concrete construction, provide templates, anchor bolts, and accessories as required. When installing equipment, set equipment into final position, shim equipment bases, skids or rails for level positioning, and install non-shrink grout for uniform support, and securely bolt into final position.

END OF SECTION 260529

**SECTION 260532 - CONDUIT**

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 SECTION INCLUDES

- A. Metal Conduit
- B. Flexible Metal Conduit
- C. Liquidtight Flexible Metal Conduit
- D. Electrical Metallic Tubing
- E. Nonmetallic Conduit
- F. Fittings and Conduit Bodies

1.3 RELATED SECTIONS

- A. Division 1 - Cutting and Patching.
- B. Division 2 - Trenching: Excavation and backfill for conduit and utilities on site.
- C. Division 3 - Cast-In-Place Concrete: Protective envelope for underground conduit installations.
- D. Division 7 - Sheet Metal Flashing and Trim
- E. Section 260526 - Grounding and Bonding
- F. Section 260529 - Supporting Devices and Seals
- G. Section 260534 - Electrical Boxes and Fittings
- H. Section 260553 - Electrical Identification

1.4 REFERENCES

- A. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.
- B. ANSI C80.3 - Electrical Metallic Tubing, Zinc Coated.

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- C. ANSI/NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
- D. ANSI/NFPA 70 - National Electrical Code.
- E. NECA - "Standard of Installation".
- F. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
- G. NEMA TC 2 - Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80).
- H. NEMA TC 3 – PVC Fittings for Use with Rigid PVC Conduit and Tubing.

### 1.5 DESIGN REQUIREMENTS

- A. Conduit Size: ANSI/NFPA 70.

### 1.6 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 260500.
- B. Accurately record actual routing of conduits larger than two (2) inches or larger, regardless of location (i.e., above ceiling, below slab, etc.). Dimension from building columns.
- C. Accurately record actual routing of all conduits installed in and under the slab. Dimension from the building columns.

### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect, and handle products under provisions of Section 260500 and Division 1.
- B. Accept conduit on site. Inspect for damage.
- C. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
- D. Protect PVC conduit from sunlight.

### 1.8 PROJECT CONDITIONS

- A. Verify that field measurements are as shown on Drawings.
- B. Verify routing and termination locations of conduit prior to rough-in.
- C. Conduit routing is shown on Drawings in approximate locations unless dimensioned. Route as required to complete wiring system and to coordinate with the work of other trades.



PART 2 - PRODUCTS

2.1 CONDUIT REQUIREMENTS

- A. Minimum Size, unless otherwise specified:
  - 1. Homeruns:
    - a. 3/4-Inch above accessible ceilings.
    - b. 3/4-Inch above unaccessible ceilings and in concrete slab.
    - c. 1-Inch below grade and below slab on grade.
- B. Branch Circuits after the first junction point: 1/2-Inch C unless otherwise specified.
- C. Underground Installations:
  - 1. More than 5-Feet from Foundation Wall: Use PVC Schedule 40 nonmetallic conduit, except as otherwise noted.
  - 2. Within 5-Feet from Foundation Wall: Use rigid steel plastic coated conduit.
  - 3. In or Under Slab on Grade: Use PVC Schedule 40 nonmetallic conduit.
  - 4. Minimum Size: 1-Inch.
- D. Outdoor Locations, Above Grade: Use rigid steel conduit.
- E. In Slab Above Grade:
  - 1. Use PVC Schedule 40 nonmetallic conduit, unless otherwise specified.
  - 2. Maximum Size Conduit in Slab: 3/4-Inch or as permitted by the Structural Engineer, based on field conditions.
- F. Wet and Damp Locations: Use rigid steel conduit if subject to physical damage. Thickwall nonmetallic conduit in areas not subject to physical damage and acceptable to the local authority.
- G. Dry Locations:
  - 1. Concealed: Use electrical metallic tubing.
  - 2. Exposed: Use rigid steel conduit if subject to damage below 8-feet, otherwise use electrical metallic tubing.

2.2 METAL CONDUIT

- A. Rigid Steel Conduit: ANSI C80.1.
- B. Intermediate Metal Conduit (IMC): Rigid steel.
- C. Fittings and Conduit Bodies: ANSI/NEMA FB 1; material to match conduit.

2.3 PVC COATED METAL CONDUIT

- A. Description: NEMA RN 1; rigid steel conduit with external PVC coating, 20 mil thick.
- B. Fittings and Conduit Bodies: ANSI/NEMA FB 1; steel fittings with external PVC coating to match conduit.

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### 2.4 FLEXIBLE METAL CONDUIT

- A. Description: Interlocked steel construction.
- B. Fittings: ANSI/NEMA FB 1.

### 2.5 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

- A. Description: Interlocked steel construction with PVC jacket.
- B. Fittings: ANSI/NEMA FB 1.

### 2.6 ELECTRICAL METALLIC TUBING (EMT)

- A. Description: ANSI C80.3; galvanized tubing.
- B. Fittings and Conduit Bodies: ANSI/NEMA FB 1; steel, compression or set screw type.

### 2.7 NONMETALLIC CONDUIT

- A. Description: NEMA TC 2; Schedule 40 PVC.
- B. Fittings and Conduit Bodies: NEMA TC 3.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install conduit in accordance with NECA "Standard of Installation".
- B. Install nonmetallic conduit in accordance with manufacturer's instructions.
- C. Arrange supports to prevent misalignment during wiring installation.
- D. Support conduit using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.
- E. Group related conduits; support using conduit rack. Construct rack using steel channel, provide space on each for 25 percent additional conduits.
- F. Fasten conduit supports to building structure and surfaces under provisions of Section 260529.
- G. Do not support conduit with wire or perforated pipe straps. Remove wire used for temporary supports
- H. Do not attach conduit to ceiling support wires.

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- I. Arrange conduit to maintain headroom and present neat appearance.
- J. Route exposed conduit parallel and perpendicular to walls.
- K. Route conduit installed above accessible ceilings parallel and perpendicular to building elements and walls.
- L. Route conduit in and under slab from point-to-point. Dimension from building columns.
- M. Do not cross conduits in slab except with written approval from the Structural Engineer.
- N. Routing conduits parallel in the slab is prohibited except with written approval from the Structural Engineer.
- O. Maintain adequate clearance between conduit and piping.
- P. Maintain 12-inch clearance between conduit and surfaces with temperatures exceeding 104 degrees F.
- Q. Cut conduit square using saw or pipecutter; de-burr cut ends.
- R. Bring conduit to shoulder of fittings; fasten securely.
- S. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for twenty (20) minutes, minimum.
- T. Use conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.
- U. Install no more than equivalent of four 90-degree bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams. Use hydraulic one-shot bender to fabricate or factory elbows for bends in metal conduit larger than 2-inch size.
- V. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.
- W. Provide suitable fittings to accommodate expansion and deflection where conduit crosses, control and expansion joints.
- X. Provide suitable pull string in each empty conduit except sleeves and nipples.
- Y. Use suitable caps to protect installed conduit against entrance of dirt and moisture.
- Z. Ground and bond conduit under provisions of Section 260526.
- AA. Identify conduit under provisions of Section 260553.
- BB. Transition from underground nonmetallic conduit to above grade metal conduit or electrical metallic tubing shall be made in or below the slab. The transition between nonmetallic conduit and above grade conduit shall be made with a rigid steel, plastic coated elbow.

3.2 INTERFACE WITH OTHER PRODUCTS

- A. Install conduit to preserve fire resistance rating of partitions and other elements, using approved materials and methods.
- B. Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket. Coordinate location with roofing installation specified.

END OF SECTION 260532

SECTION 260534 - ELECTRICAL BOXES AND FITTINGS

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. Wall and Ceiling Outlet Boxes
- B. Floor Boxes
- C. Pull and Junction Boxes

1.3 RELATED DOCUMENTS

- A. Drawings, general and special conditions, Division 1 - General Requirements and other applicable technical specifications apply to work of this Section.

1.4 RELATED SECTIONS

- A. Division 7 - Firestopping.
- B. Division 8 - Access Doors: Wall and ceiling access doors.
- C. Section 262726 - Wiring Devices: Service fittings and fire-rated poke-through fittings for floor boxes.
- D. Section 260535 - Cabinets and Enclosures.
- E. Section 260580 – Equipment Wiring Systems.

1.5 REFERENCE STANDARDS

- A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents. A listing of applicable reference standards is contained in Division 1.
- B. ANSI/NEMA FB 1 - Fittings and Supports for Conduit and Cable Assemblies.
- C. ANSI/NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports.

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- D. ANSI/NFPA 70 - National Electrical Code.
- E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

### 1.6 PROJECT CONDITIONS

- A. Verify field measurements are as shown on Drawings.
- B. Verify locations of floor boxes and outlets prior to rough-in.
- C. Electrical boxes are shown on Drawings in approximate locations unless dimensioned. Install at location required for box to serve intended purpose. Include installation within 10-feet of location shown. Refer to Architectural Drawings.

## PART 2 - PRODUCTS

### 2.1 OUTLET BOXES

- A. Sheet Metal Outlet Boxes: ANSI/NEMA OS 1; galvanized steel, with 2-inch male luminaire studs where required.
- B. Cast Boxes: NEMA FB 1, Type FD, cast ferroalloy. Provide gasketed cover by box manufacturer. Provide threaded hubs.

### 2.2 FLOOR BOXES

- A. Floor Boxes: ANSI/NEMA OS 1 or NEMA FB 1, fully adjustable.

### 2.3 PULL AND JUNCTION BOXES

- A. Sheet Metal Boxes: NEMA OS 1; galvanized steel.
- B. Sheet Metal Boxes Larger than 12-Inches in Any Dimension: Hinged enclosure in accordance with Section 260535.
- C. Surface-Mounted Cast Metal Box: NEMA 250, Type 6; flat-flanged, surface-mounted junction box.
  - 1. Material: Galvanized cast iron.
  - 2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install electrical boxes as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.
- B. Install electrical boxes to maintain headroom and to present neat mechanical appearance.
- C. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
- D. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.
- E. Install boxes to preserve fire resistance rating of partitions and other elements, using materials and methods under the provisions of Division 7.
- F. Align adjacent wall-mounted outlet boxes for switches, thermostats, and similar devices with each other.
- G. Use flush mounting outlet boxes in finished areas.
- H. Do not install flush mounting boxes back-to-back in walls; provide minimum 6-inch separation. Provide minimum 12-inch separation between back-to-back boxes in acoustic-rated walls.
- I. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
- J. Use stamped steel bridges to fasten flush mounting outlet box between studs.
- K. Install flush mounting box without damaging wall insulation or reducing its effectiveness.
- L. Use adjustable steel channel fasteners for hung ceiling outlet box.
- M. Do not fasten boxes to ceiling support wires.
- N. Support boxes independently of conduit, except cast box that is connected to two (2) rigid metal conduits both supported within 12 inches of box.
- O. Use gang box where more than one (1) device is mounted together. Do not use sectional box.
- P. Use gang box with plaster ring for single device outlets.
- Q. Use cast outlet box in exterior locations exposed to the weather and wet locations.
- R. Use cast floor boxes for installations in slab on grade; formed steel boxes are acceptable for other installations.
- S. Set floor boxes level.

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- T. Large Pull Boxes: Boxes larger than 100 cubic inches in volume or 12-inches in any dimension.
  - 1. Interior Dry Locations: Use hinged enclosure under provisions of Section 260535.
  - 2. Other Locations: Use surface-mounted cast iron box.
- U. Minimum junction and pull box size 4-11/16" x 4-11/16" x 2-1/4".
- V. Minimum outlet box size 4" x 4" x 1-1/2".
- W. Minimum telephone outlet box size 4-11/16" x 4-11/16" x 2-1/4".
- X. Minimum junction box size for fire alarm pull stations, control module, monitor module, 4" x 4" x 2-3/4". Provide plaster ring at all pull station locations.

### 3.2 INTERFACE WITH OTHER PRODUCTS

- A. Coordinate installation of outlet box for products furnished under other sections.
- B. Coordinate locations and sizes of required access doors with Division 8.
- C. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.
- D. Coordinate mounting heights and locations of outlets mounted above counters, benches and backsplashes.
- E. Position outlet boxes to locate luminaires as shown on reflected ceiling plan.

### 3.3 ADJUSTING

- A. Adjust floor box flush with finish flooring material.
- B. Adjust flush-mounting outlets to make front flush with finished wall material.
- C. Install knockout closure in unused box openings.

END OF SECTION 260534



**SECTION 260535 - CABINETS AND ENCLOSURES**

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 SECTION INCLUDES

- A. Hinged cover enclosures.
- B. Cabinets.
- C. Terminal blocks.
- D. Accessories.

1.3 RELATED SECTIONS

- A. Section 260529 - Supporting Devices and Seals

1.4 REFERENCES

- A. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- B. NEMA ICS 4 - Terminal Blocks for Industrial Control Equipment and Systems.
- C. ANSI/NFPA 70 - National Electrical Code.

1.5 SUBMITTALS

- A. Submit under provisions of Section 260500.
- B. Product Data: Provide manufacturer's standard data for enclosures and cabinets.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of products.

1.6 EXTRA MATERIALS

- A. Provide two of each cabinet key.

PART 2 - PRODUCTS

2.1 HINGED COVER ENCLOSURES

- A. Construction: NEMA 250, Type 1 steel enclosure.
- B. Covers: Continuous hinge, held closed by flush latch operable by key.
- C. Provide interior plywood panel for mounting terminal blocks and electrical components; finish with matte white enamel.
- D. Enclosure Finish: Manufacturer's standard enamel.

2.2 CABINETS

- A. Boxes: Galvanized steel with removable endwalls.
- B. Box Size: As indicated
- C. Backboard: Provide 3/4-inch thick plywood backboard for mounting terminal blocks. Paint matte white enamel.
- D. Fronts: Steel, surface type with concealed hinge, and flush lock keyed to match branch circuit panelboard. Finish with gray baked enamel.
- E. Knockouts: As required
- F. Provide metal barriers to separate compartments containing control wiring operating at less than 50 volts from power wiring.
- G. Provide accessory feet for free-standing equipment.

2.3 TERMINAL BLOCKS

- A. Terminal Blocks: ANSI/NEMA ICS 4.
- B. Power Terminals: Unit construction type with closed back and tubular pressure screw connectors, rated 600 volts.
- C. Signal and Control Terminals: Modular construction type, suitable for channel mounting, with tubular pressure screw connectors, rated 300 volts.
- D. Provide ground bus terminal block, with each connector bonded to enclosure.

2.4 FABRICATION

- A. Shop assemble enclosures and cabinets housing terminal blocks or electrical components in accordance with ANSI/NEMA ICS 6.

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- B. Provide conduit hubs on enclosures.
- C. Provide protective pocket inside front cover with schematic diagram, connection diagram, and layout drawing of control wiring and components within enclosure.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that surfaces are ready to receive Work.

3.2 INSTALLATION

- A. Install Products in accordance with manufacturer's instructions.
- B. Install enclosures and boxes plumb. Anchor securely to wall and structural supports at each corner.
- C. Install cabinet fronts plumb.

END OF SECTION 260535

**SECTION 260553 - ELECTRICAL IDENTIFICATION**

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. Buried and Duct Bank Warnings
- B. Electrical Power, Control and Communication Conductors and Conduit
- C. Operational Instructions and Warnings
- D. Danger Signs
- E. Equipment/System Identification Signs

1.3 RELATED SECTIONS

- A. Division 9 - Painting.

1.4 REFERENCE STANDARDS

- A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents. A listing of applicable reference standards is contained in Division 1.

1.5 QUALITY ASSURANCE

- A. ANSI Compliance: Applicable requirements of ANSI A13.1, "Piping and Piping Systems".
- B. FS Compliance: Applicable requirements of FS L-P-387 "Plastic Sheet, Laminated, Thermosetting (for designation plates)".
- C. UL Compliance: Applicable requirements of UL Standard 969, "Marking and Labeling Systems," pertaining to electrical identification systems.
- D. NEMA Compliance: Applicable requirements of NEMA Standard Nos. WC-1 and WC-2 pertaining to identification of power and control conductors.
- E. Comply with "OSHA" sign standards for danger, caution, warning, etc.

1.6 SUBMITTALS

- A. Submit product data under provisions of Division 1.
- B. Include schedule for all specified applications of electrical identification.

PART 2 - PRODUCTS

2.1 ELECTRICAL IDENTIFICATION MATERIALS

- A. General: The manufacturer's standard products of categories and types required are to be used for each application.
- B. Color-Coded Emergency Power Conduit Markers:
  - 1. Manufacturer's standard self-adhesive vinyl tape not less than 3 mils thick. Tape 1-1/8-inch wide by 4-1/2-inch long marker for 2-inch and smaller conduit. Tape 2-1/4-inch wide by 9-inch long marker for 2-1/2-inch and larger conduit. Black lettering is to indicate highest voltage of cable(s) in conduit.
  - 2. Colors: Red tape.
- C. Underground Type Plastic Line Marker:
  - 1. Manufacturer's standard permanent, bright-colored, continuous-printed plastic tape, intended for direct-burial service; not less than 6-inches wide x 4 mils thick. Printing is required on tape, which most accurately indicates type of service.
  - 2. Color: Yellow
- D. Cable/Conductor Identification Bands:
  - 1. For cables smaller than No. 2/0 manufacturer's standard vinyl-cloth self-adhesive cable/conductor markers of wrap-around type, either pre-numbered plastic coated type, or write-on type with clear plastic self-adhesive cover flap are to be used and numbered to show circuit identification.
  - 2. For cables No. 2/0 AWG and larger, heat shrink sleeving is to be used for phase color coding.
- E. Plasticized Tags:
  - 1. Manufacturer's standard preprinted or partially preprinted accident-prevention and operational tags, on plasticized card stock with matte finish suitable for writing, approximately 3-1/4-inch x 5-5/8-inch, with brass grommets and wire fasteners, and with appropriate preprinted wording including large-size primary wording, e.g., DANGER, CAUTION, DO NOT OPERATE.
- F. Baked Enamel Danger Signs:
  - 1. Manufacturer's standard "DANGER" signs of baked enamel finish on .40 aluminum; of standard Red, Black and White graphics; 14-inch x 10-inch size except where 10-inch x 7-inch is the largest size which can be applied where needed; with recognized standard explanation wording, e.g., XXXX VOLTS, KEEP AWAY, BURIED CABLE, DO NOT TOUCH SWITCH, etc.
- G. Engraved Plastic-Laminate Signs:

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1. Engraved stock melamine plastic laminate, complying with FS L-P-387, in sizes and thicknesses indicated, engraved with engraver's standard letter style of sizes and wording indicated, White face and Black core (Black letters on a White background) except as otherwise required (emergency power and fire alarm shall be Red with White letters), punched for mechanical fastening with a minimum of two (2) screws.
2. Thickness: 1/16-Inch, for units up to 20 square inches or 8-inch length; 1/8-inch for larger units.
3. Fasteners: A minimum of two (2) self-tapping stainless steel screws.
4. Minimum letter height shall be as follows:
  - a. 1/4-Inch:
    - 1) Panelboard name.
    - 2) Switchboard name.
    - 3) Transformer name.
    - 4) Transformer switch name.
    - 5) System control panel name.
    - 6) Voltage rating.
    - 7) Ampere rating.
    - 8) Source circuit ("Fed from Normal or Generator").
    - 9) Individual circuit breaker number and load name.
    - 10) Individual switch circuit number and load name.
    - 11) Individual motor starter circuit number and load name.
    - 12) Individual indicating light function.
    - 13) Individual pushbutton function.
    - 14) Individual selector switch functions.

### H. Lettering and Graphics:

1. Names, abbreviations and other designations used in electric identification work are to be coordinated with corresponding designation shown, specified or scheduled. Numbers, lettering and wording as required or as recommended by manufacturer or as required for proper identification and operation/maintenance of electrical systems and equipment.

### I. Adhesive Marking Tape for Device Cover Plates:

1. Avery-type or equal with 3/16-inch minimum height letters. Labels shall have black letters on clear labels for normal and red letters on clear labels for emergency. Embossed Dymo-Tape labels are not acceptable.

## PART 3 - EXECUTION

### 3.1 APPLICATION AND INSTALLATION

#### A. General Installation Requirements:

1. Regulations: Governing regulations and requests of governing authorities are to be complied with for identification of electrical work.

#### B. Underground Conduit and Ductbank Identification:

1. During back-filling/top-soiling of each exterior underground conduit and ductbank, a continuous underground-type plastic line marker, located directly over conduit or ductbank at 12-inches below finished grade or 4-inches below paving, shall be provided.

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- C. Cable/Conductor Identification:
1. The application of cable/conductor identification, with circuit number, on each cable/conductor in each box/enclosure/cabinet where wires of more than one circuit or communication/signal system are present is required. The identification is to match the marking system used in panelboards, shop drawings, contract documents, and similar previously established identification for project's electrical work.
- D. Junction Box and Pull Box Identification:
1. On the Cover of each junction box and pull box: The circuit number(s) of the enclosed conductors are to be legibly written with a Black permanent ink broad tip marking pen and the system identified for FA (Fire Alarm) EM (Emergency) PA (Public Address), S (Security) TC (Temperature Control).
  2. Covers for emergency system junction boxes and pull boxes shall be painted Red.
  3. Covers for the Fire Alarm System junction boxes and pull boxes shall be painted Red.
- E. Conduit Identification:
1. All conduit fittings associated with emergency system shall be painted red.
  2. All conduit fittings associated with optional stand-by conduit shall not be painted.
- F. Operational Identification and Warnings:
1. Wherever required to ensure safe and efficient operation and maintenance of electrical systems, and electrically connected mechanical systems and general systems and equipment, including prevention of misuse of electrical facilities by unauthorized personnel, self-adhesive plastic signs or similar equivalent identification, instruction or warnings on switches, outlets and other controls, devices and covers of electrical enclosures shall be provided. Where detailed instructions or explanations are needed, provide plasticized tags with clearly written messages adequate for intended purposes.
- G. Caution Signs:
1. The following caution sign is to be provided for all circuit breakers and switchboards where turning off a circuit will automatically start an emergency operation:  

"CAUTION TURNING OFF THIS CIRCUIT WILL  
AUTOMATICALLY START EMERGENCY OPERATION."
  2. The following caution sign is to be provided for all automatic transfer switches, switches, circuit breakers, equipment, and emergency panels that are energized by the emergency power system:  

"CAUTION AUTOMATICALLY ENERGIZED BY  
EMERGENCY POWER SUPPLY SYSTEM."
- H. Equipment/System Identification:
1. An engraved plastic-laminated sign is to be provided on each major unit of electrical equipment in the building; including central or master unit of each electrical system including communication/control/signal/alarm systems, unless unit is specified with its own self-explanatory identification or signal system. Except as otherwise indicated, provide single line of text, letter height as specified, black lettering on white field. Provide text matching terminology and numbering of the contract documents and shop drawings. The sign shall include unit designation, source circuit number, circuit voltage, and other data specifically indicated. Also, the sign shall indicate normal source circuit number ("Fed from . . .") and emergency source circuit number when the equipment is a

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transfer switch or fed directly from a transfer switch. Include signs for each unit of the following categories of electrical work:

- a. Switchboards, panelboards (include main bus ampacity on sign), electrical cabinets and enclosures.
  - b. Access panel/doors to electrical facilities.
  - c. Disconnect switch.
  - d. Push buttons, selector switches, indicating lights. (Circuit number and voltage not required on sign).
  - e. Power transfer equipment: Contactors and transfer switches.
  - f. Power generating units.
  - g. Telephone cabinets and switching equipment. (Circuit number and voltage not required on sign.)
  - h. Fire Alarm Control Panel.
2. The installation of signs are required at locations indicated or, where not otherwise indicated, at location for best convenience of viewing without interference with operation and maintenance of equipment. The sign shall be secured to the substrate with fasteners, except use adhesive where fasteners should not or cannot penetrate substrate.
- I. For panelboards, provide framed, typed circuit schedules (label all spares and spaces in pencil) with explicit description and identification of items controlled by each individual breaker.
  - J. Provide tape labels for identification of individual receptacles and switches. Locate tape on front of plate and indicate associated source panelboard and circuit number.

END OF SECTION 260553



**SECTION 260580 - EQUIPMENT WIRING SYSTEMS**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, general and special conditions, Division 1 - General Requirements and other applicable technical specifications apply to work of this Section.

1.2 SUMMARY

- A. Electrical connections to equipment specified under other Sections or furnished by Owner.

1.3 RELATED SECTIONS

- A. Division 1 - Owner-furnished equipment.
- B. Divisions 22 & 23 - Electrical Requirements for Mechanical Equipment.
- C. Division 21 - Fire Protection.
- D. Division 22 - Plumbing Pumps.
- E. Division 22 - Water Heaters.
- F. Division 23 - HVAC pumps.
- G. Division 23- Air Handling Units.
- H. Section 260532 - Conduit.
- I. Section 260519 – Building Wire and Cable.
- J. Section 260534 - Electrical Boxes and Fittings.

1.4 REFERENCE STANDARDS

- A. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents. A listing of applicable reference standards is contained in Divisions 1.
- B. NEMA WD 1 - General-Purpose Wiring Devices.
- C. NEMA WD 5 - Specific-Purpose Wiring Devices.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS - CORDS AND CAPS

- A. Hubbell
- B. General Electric
- C. Pass & Seymour
- D. Arrow, Hart & Hegeman

2.2 CORDS AND CAPS

- A. Straight-Blade Attachment Plug: NEMA WD 1.
- B. Locking-Blade Attachment Plug: NEMA WD 5.
- C. Attachment Plug Configuration: Match receptacle configuration at outlet provided for equipment.
- D. Cord Construction: Oil-resistant thermoset insulated Type SO multi-conductor flexible cord with identified equipment grounding conductor, suitable for hard usage in damp locations.
- E. Cord Size: Suitable for connected load of equipment and rating of branch circuit overcurrent protection.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.2 PREPARATION

- A. Review equipment submittals prior to installation and electrical rough-in. Verify location, size, and type of connections. Coordinate details of equipment connections with supplier and installer.

3.3 INSTALLATION

- A. Use wire and cable with insulation suitable for temperatures encountered in heat-producing equipment.
- B. Make conduit connections to equipment using flexible conduit. Use liquid-tight flexible conduit in damp or wet locations.

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- C. Install pre-finished cord set where connection with attachment plug is indicated or specified, or use attachment plug with suitable strain-relief clamps.
- D. Provide suitable strain-relief clamps for cord connections to outlet boxes and equipment connection boxes.
- E. Make wiring connections in control panel or in wiring compartment of pre-wired equipment in accordance with manufacturer's instructions. Provide interconnecting wiring where indicated.
- F. Install disconnect switches, controllers, control stations, and control devices such as limit switches and temperature switches as indicated. Connect with conduit and wiring as indicated.

3.4 EQUIPMENT CONNECTION SCHEDULE

- A. Furnish, set in place, and wire, except as may be otherwise indicated, all heating, ventilating, air conditioning, plumbing, fire protection, and other motors and controls in accordance with the following schedule. Carefully coordinate with work performed under the Mechanical and other Divisions of these specifications.
- B. Symbols:
  - SD = Section in which driven equipment is specified.
  - E = Electrical Contractor.
  - M = Mechanical Contractor.
  - C = Controls Contractor

<u>Item</u>	<u>Furnished By</u>	<u>Set in Place By</u>	<u>Control Wiring</u>
Equipment Motors, Controls and Integral Disconnect Switches			
1. Automatically controlled, with or without HOA switches except as otherwise specified (including integral disconnect if specified).	SD	E	C/M
2. Automatically controlled with or without HOA switches & which are furnished as part of factory-wired equipment (including integral disconnect if specified).	SD	SD	C/M
3. Manually controlled (including integral disconnect if specified).	SD	E	E
4. Manually controlled and which are furnished as part of factory-wired equipment (including integral disconnect if specified).	SD	SD	C/M
5. Special duty types (part winding, etc.) (including integral disconnect if specified).	SD	E	C/M

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Variable frequency drives	SD	E	C/M
Line voltage thermostats	M	E	
Time clocks, remote bulb thermostats, motor valves, float controls, etc., which are an integral part of or directly attached to ducts, pipes, etc.	M	M	M
Environmental control panels	C/M	C/M	C/M
Motor valves, dampers, solenoid valves	SD	M	C/M
Alarm bells	SD	SD	E
Control circuit power supply	E	E	
Low voltage controls, thermostats, valves, actuators, damper motors, EP and PE switches, etc.	C/M	C/M	C/M
Fire protection controls	M	M	E
Duct-mounted fire and smoke detectors, relays for fan shutdown	E	M	C/M
Boiler and water heater controls, boiler burner control panels, internally wired	M	M	M
Stand alone disconnect switches, thermal overload switches, manual operating switches	E	E	

C. Notes to the Schedule:

1. Not all equipment indicated in the schedule is used in this project. Apply as required.
2. Complete wiring diagrams for installation purposes shall be furnished under the Mechanical or other Divisions, as applicable.
3. All line and low voltage wiring shall be installed utilizing materials and methods as specified in the Electrical Division of the specifications.
4. Provide NEMA-rated motors and equipment suitable for operation on the voltage systems as designated below with tolerances for the allowable voltage variations above and below the nominal:

	<u>Rated Motor Voltage</u>	
<u>Service Voltage</u>	<u>½-HP and Smaller</u>	<u>¾-HP and Larger</u>
<u>And Phase</u>	<u>1-Phase</u>	<u>3-Phase</u>
120/208V, 3ph	115V	200V

END OF SECTION 260580

**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. This Section includes the following lighting control devices:
  - 1. Time switches.
  - 2. Outdoor photoelectric switches.
  - 3. Indoor occupancy sensors.
  - 4. Outdoor motion sensors.
  - 5. Lighting contactors.
  - 6. Emergency shunt relays.
- B. Related Sections include the following:
  - 1. Division 26 Section "Network Lighting Controls" for low-voltage, manual and programmable lighting control systems.
  - 2. Division 26 Section "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

1.3 DEFINITIONS

- A. LED: Light-emitting diode.
- B. PIR: Passive infrared.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show installation details for occupancy and light-level sensors.
  - 1. Interconnection diagrams showing field-installed wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

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### 1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

### 1.6 COORDINATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including luminaires, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

## PART 2 - PRODUCTS

### 2.1 TIME SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Area Lighting Research, Inc.; Tyco Electronics.
  - 2. Grasslin Controls Corporation; a GE Industrial Systems Company.
  - 3. Intermatic, Inc.
  - 4. Leviton Mfg. Company Inc.
  - 5. Lightolier Controls; a Genlyte Company.
  - 6. Lithonia Lighting; Acuity Lighting Group, Inc.
  - 7. Paragon Electric Co.; Invensys Climate Controls.
  - 8. Square D; Schneider Electric.
  - 9. TORK.
  - 10. Touch-Plate, Inc.
  - 11. Watt Stopper (The).
- B. Electronic Time Switches: Electronic, solid-state programmable units with alphanumeric display; complying with UL 917.
  - 1. Contact Configuration: SPST.
  - 2. Contact Rating: 20-A ballast load, 120/240-V ac.
  - 3. Programs: channels; each channel shall be individually programmable with 40 on-off operations per week and an annual holiday schedule that overrides the weekly operation on holidays.
  - 4. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program on selected channels.
  - 5. Astronomic Time: All channels.
  - 6. Battery Backup: For schedules and time clock.

2.2 OUTDOOR PHOTOELECTRIC SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Area Lighting Research, Inc.; Tyco Electronics.
  2. Grasslin Controls Corporation; a GE Industrial Systems Company.
  3. Intermatic, Inc.
  4. Lithonia Lighting; Acuity Lighting Group, Inc.
  5. Novitas, Inc.
  6. Paragon Electric Co.; Invensys Climate Controls.
  7. Square D; Schneider Electric.
  8. TORK.
  9. Touch-Plate, Inc.
  10. Watt Stopper (The).
- B. Description: Solid state, with SPST dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.
1. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lx), with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of photocell to prevent fixed light sources from causing turn-off.
  2. Time Delay: 15-second minimum, to prevent false operation.
  3. Surge Protection: Metal-oxide varistor, complying with IEEE C62.41.1, IEEE C62.41.2, and IEEE 62.45 for Category A1 locations.
  4. Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

2.3 INDOOR PHOTOELECTRIC SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Allen-Bradley/Rockwell Automation.
  2. Area Lighting Research, Inc.; Tyco Electronics.
  3. Eaton Electrical Inc; Cutler-Hammer Products.
  4. Grasslin Controls Corporation; a GE Industrial Systems Company.
  5. Intermatic, Inc.
  6. Lithonia Lighting; Acuity Lighting Group, Inc.
  7. MicroLite Lighting Control Systems.
  8. Novitas, Inc.
  9. Paragon Electric Co.; Invensys Climate Controls.
  10. Square D; Schneider Electric.
  11. TORK.
  12. Touch-Plate, Inc.
  13. Watt Stopper (The).
  14. Lutron

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- B. Ceiling-Mounted Photoelectric Switch: Solid-state, light-level sensor unit, with separate relay unit, to detect changes in lighting levels that are perceived by the eye. Cadmium sulfide photoresistors are not acceptable.
1. Sensor Output: Contacts rated to operate the associated relay, complying with UL 773A. Sensor shall be powered from the relay unit.
  2. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
  3. Light-Level Monitoring Range: 10 to 200 fc (108 to 2152 lx), with an adjustment for turn-on and turn-off levels within that range.
  4. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling, with deadband adjustment.
  5. Indicator: Two LEDs to indicate the beginning of on-off cycles.

### 2.4 INDOOR OCCUPANCY SENSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Hubbell Lighting.
  2. Leviton Mfg. Company Inc.
  3. Lithonia Lighting; Acuity Lighting Group, Inc.
  4. Novitas, Inc.
  5. RAB Lighting, Inc.
  6. Sensor Switch, Inc.
  7. TORK.
  8. Watt Stopper (The).
  9. Lutron
- B. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.
1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
  2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
  3. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
  4. Mounting:
    - a. Sensor: Suitable for mounting in any position on a standard outlet box.
    - b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
    - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
  5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.



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6. Bypass Switch: Override the on function in case of sensor failure.
  7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lx); keep lighting off when selected lighting level is present.
- C. PIR Type: Ceiling mounting; detect occupancy by sensing a combination of heat and movement in area of coverage.
1. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm).
  2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
  3. Detection Coverage (Corridor): Detect occupancy within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling.
- D. Ultrasonic Type: Ceiling mounting; detect occupancy by sensing a change in pattern of reflected ultrasonic energy in area of coverage.
1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
  2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. (56 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
  3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
  4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. (186 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
  5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling in a corridor not wider than 14 feet (4.3 m).
- E. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
  2. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
  3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

### 2.5 LIGHTING CONTACTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Allen-Bradley/Rockwell Automation.

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2. ASCO Power Technologies, LP; a division of Emerson Electric Co.
3. Eaton Electrical Inc.; Cutler-Hammer Products.
4. GE Industrial Systems; Total Lighting Control.
5. Grasslin Controls Corporation; a GE Industrial Systems Company.
6. Hubbell Lighting.
7. Lithonia Lighting; Acuity Lighting Group, Inc.
8. MicroLite Lighting Control Systems.
9. Square D; Schneider Electric.
10. TORK.
11. Touch-Plate, Inc.
12. Watt Stopper (The).
13. Lutron

B. Description: Electrically operated and electrically held, combination type with nonfused disconnect, complying with NEMA ICS 2 and UL 508.

1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
3. Enclosure: Comply with NEMA 250.
4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.

### 2.6 EMERGENCY SHUNT RELAY

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Lighting Control and Design, Inc.

B. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.

1. Coil Rating: 120 V.

### 2.7 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 22 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

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- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 16 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

### PART 3 - EXECUTION

#### 3.1 SENSOR INSTALLATION

- A. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

#### 3.2 CONTACTOR INSTALLATION

- A. Mount electrically held lighting contactors with elastomeric isolator pads, to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

#### 3.3 WIRING INSTALLATION

- A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 1/2 inch (13 mm).
- B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
- D. 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 Division 26 Section "Identification for Electrical Systems."
  - 1. Identify controlled circuits in lighting contactors.
  - 2. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.
- B. Label time switches and contactors with a unique designation.

#### 3.5 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:

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1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
2. Operational Test: Verify operation of each lighting control device, and adjust time delays.

B. Lighting control devices that fail tests and inspections are defective work.

### 3.6 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

### 3.7 DEMONSTRATION

- A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control system specified in Division 26 Section "Network Lighting Controls."
- B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 260923

**SECTION 260943 - NETWORK LIGHTING CONTROLS**

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 manually operated lighting controls with relays and control module.
- B. Related Sections include the following:
  - 1. Division 26 Section "Lighting Control Devices" for time switches, photoelectric switches, occupancy sensors, and multipole contactors.

1.3 DEFINITIONS

- A. BACnet: A networking communication protocol that complies with ASHRAE 135.
- B. BAS: Building automation system.
- C. DALI: Digital addressable lighting interface.
- D. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.
- E. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling and power-limited circuits.
- F. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.
- G. PC: Personal computer; sometimes plural as "PCs."
- H. Power Line Carrier: Use of radio-frequency energy to transmit information over transmission lines whose primary purpose is the transmission of power.
- I. RS-485: A serial network protocol, similar to RS-232, complying with TIA/EIA-485-A.

1.4 SUBMITTALS

- A. Product Data: For control modules, power distribution components, manual switches and plates, and conductors and cables.
- B. Shop Drawings: Detail assemblies of standard components, custom assembled for specific application on this Project.
  - 1. Outline Drawings: Indicate dimensions, weights, arrangement of components, and clearance and access requirements.
  - 2. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
  - 3. Wiring Diagrams: Power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.
- C. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.
  - 1. Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
  - 2. For networked controls, list network protocols and provide statements from manufacturers that input and output devices meet interoperability requirements of the network protocol.
- D. Software and Firmware Operational Documentation:
  - 1. Software operating and upgrade manuals.
  - 2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
  - 3. Device address list.
  - 4. Printout of software application and graphic screens.
- E. Field quality-control test reports.
- F. Software licenses and upgrades required by and installed for operation and programming of digital and analog devices.
- G. Operation and Maintenance Data: For lighting controls to include in emergency, operation, and maintenance manuals.
- H. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain lighting control module and power distribution components through one source from a single manufacturer.

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- 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 47 CFR, Subparts A and B, for Class A digital devices.
- D. Comply with NFPA 70.

### 1.6 COORDINATION

- A. Coordinate lighting control components to form an integrated interconnection of compatible components.
  - 1. Match components and interconnections for optimum performance of lighting control functions.
  - 2. Coordinate lighting controls with HVAC controls. Design display graphics showing building areas controlled; include the status of lighting controls in each area.
  - 3. Coordinate lighting controls with that in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.
- B. Coordinate lighting control components specified in this Section with components specified in Division 26 Section "Panelboards."

### 1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of lighting controls that fail in materials or workmanship or from transient voltage surges within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Failure of software input/output to execute switching or dimming commands.
    - b. Failure of modular relays to operate under manual or software commands.
    - c. Damage of electronic components due to transient voltage surges.
  - 2. Warranty Period: Two years from date of Substantial Completion.
  - 3. Extended Warranty Period Failure Due to Transient Voltage Surges: Eight years.
  - 4. Extended Warranty Period for Electrically Held Relays: 10 years from date of Substantial Completion.

### 1.8 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. Electrically Held Relays: Equal to three percent of amount installed for each size indicated, but no fewer than three relays.

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### 1.9 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning with Substantial Completion, provide software support for two years.
- B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revise licenses for use of the software.
  - 1. Provide 30-day notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment, if necessary.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Easylite Ballasts and Controls, Inc.
  - 2. Intelligent Lighting Controls, Inc.
  - 3. Leviton Mfg. Company Inc.
  - 4. Lighting Control & Design, Inc.
  - 5. Lightolier Controls; a Genlyte Company.
  - 6. Lithonia Lighting; Acuity Lighting Group, Inc.
  - 7. Lutron Electronics Company, Inc.
  - 8. MicroLite Lighting Control Systems.
  - 9. NexLight; Northport Engineering Group.
  - 10. Square D; Schneider Electric.
  - 11. Starfield Controls, Inc.
  - 12. Touch-Plate, Inc.
  - 13. TRIATEK, Inc.
  - 14. ULTRAWATT Energy Systems, Inc.
  - 15. Watt Stopper (The).

### 2.2 SYSTEM REQUIREMENTS

- A. Expandability: System shall be capable of increasing the number of control functions in the future by 25 percent of current capacity; to include equipment ratings, housing capacities, spare relays, terminals, number of conductors in control cables, and control software.
- B. Performance Requirements: Manual switch operation sends a signal to programmable-system control module that processes the signal according to its programming and routes an open or close command to one or more relays in the power-supply circuits to groups of luminaires or other loads.



2.3 CONTROL MODULE

- A. Control Module Description: Comply with UL 916 (CSA C22.2, No. 205); microprocessor-based, solid-state, 365-day timing and control unit. Output circuits shall be switched on or off by internally programmed time signals or by program-controlled analog or digital signals from external sources. Output circuits shall be pilot-duty relays compatible with power switching devices. An integral keypad shall provide local programming and control capability. A key-locked cover and a programmed security access code shall protect keypad use. An integral alphanumeric LCD or LED shall display menu-assisted programming and control.

2.4 POWER DISTRIBUTION COMPONENTS

- A. Modular Relay Panel: Comply with UL 508 (CSA C22.2, No. 14) and UL 916 (CSA C22.2, No. 205); factory assembled with modular single-pole relays, power supplies, and accessory components required for specified performance.
  - 1. Cabinet: Steel with hinged, locking door.
    - a. Barriers separate low-voltage and line-voltage components.
    - b. Directory: Mounted on back of door. Identifies each relay as to load groups controlled and each programmed pilot device if any.
    - c. Control Power Supply: Transformer and full-wave rectifier with filtered dc output.
  - 2. Single-Pole Relays: Mechanically held unless otherwise indicated; split-coil, momentary-pulsed type.
    - a. Low-Voltage Leads: Plug connector to the connector strip in cabinet and pilot light power where indicated.
    - b. Rated Capacity (Mounted in Relay Panel): 20 A, 125-V ac for tungsten filaments; 20 A, 277-V ac for ballasts.
    - c. Endurance: 50,000 cycles at rated capacity.
    - d. Mounting: Provision for easy removal and installation in relay cabinet.
- B. Line-Voltage Surge Suppression: Factory installed as an integral part of 120- and 277-V ac, solid-state control panels.

2.5 MANUAL SWITCHES AND PLATES

- A. Push-Button Switches: Modular, momentary-contact, low-voltage type.
  - 1. Match color specified in Division 26 Section "Wiring Devices."
  - 2. Integral green LED pilot light to indicate when circuit is on.
  - 3. Internal white LED locator light to illuminate when circuit is off.
- B. Manual, Maintained Contact, Full- or Low-Voltage Switch: Comply with Division 26 Section "Wiring Devices."
- C. Wall-Box Dimmers: Comply with Division 26 Section "Wiring Devices."
- D. Wall Plates: Single and multigang plates as specified in Division 26 Section "Wiring Devices."

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- E. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

### 2.6 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG, complying with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cables: Multiconductor cable with copper conductors not smaller than No. 22 AWG, complying with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than No. 16 AWG, complying with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- D. Digital and Multiplexed Signal Cables: Unshielded, twisted-pair cable with copper conductors, complying with TIA/EIA-568-B.2, Category 5e for horizontal copper cable and with Division 27 Section "Communications Horizontal Cabling."

## PART 3 - EXECUTION

### 3.1 WIRING INSTALLATION

- A. Comply with NECA 1.
- B. Wiring Method: Install wiring in raceways. Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 1/2 inch (13 mm).
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions.
- D. Install field-mounting transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.
- E. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
- F. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in terminal cabinets, equipment enclosures, and in junction, pull, and outlet boxes.
- G. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."

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### 3.2 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
  - 1. Test for circuit continuity.
  - 2. Verify that the control module features are operational.
  - 3. Check operation of local override controls.
  - 4. Test system diagnostics by simulating improper operation of several components selected by Architect.

### 3.3 SOFTWARE INSTALLATION

- A. Install and program software with initial settings of adjustable values. Make backup copies of software and user-supplied values. Provide current licenses for software.

### 3.4 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors and to assist Owner's personnel in making program changes to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

### 3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting controls. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 260943

**SECTION 262416 - PANELBOARDS**

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. Distribution panelboards.
  - 2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. RFI: Radio-frequency interference.
- D. RMS: Root mean square.
- E. SPDT: Single pole, double throw.

1.4 SUBMITTALS

- A. Product Data: For each type of panelboard, overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
  - 1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:
    - a. Enclosure types and details for types other than NEMA 250, Type 1.
    - b. Bus configuration, current, and voltage ratings.
    - c. Short-circuit current rating of panelboards and overcurrent protective devices.
    - d. UL listing for series rating of installed devices.
    - e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

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2. Wiring Diagrams: Power, signal, and control wiring.
- C. Qualification Data: For testing agency.
- D. Field quality-control test reports including the following:
  1. Test procedures used.
  2. Test results that comply with requirements.
  3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- E. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.
- F. Operation and Maintenance Data: For panelboards and components 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 overcurrent protective devices.
  2. Time-current curves, including selectable ranges for each type of overcurrent protective device.

### 1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
  1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories through one source from a single manufacturer.
- C. Product Options: Drawings indicate size, profiles, and dimensional requirements of panelboards and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- D. 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.
- E. Comply with NEMA PB 1.
- F. Comply with NFPA 70.

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

### 1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
  - 1. Ambient Temperature: Not exceeding 104 deg F (40 deg C).
  - 2. Altitude: Not exceeding 6600 feet (2000 m).
- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
  - 1. Ambient temperatures within limits specified.
  - 2. Altitude not exceeding 6600 feet (2000 m).

### 1.7 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

### 1.8 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. Keys: Six spares for each type of panelboard cabinet lock.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Panelboards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:
    - a. Eaton Corporation
    - b. General Electric Co.; Electrical Distribution & Protection Div.
    - c. Siemens Energy & Automation, Inc.
    - d. Square D.

### 2.2 MANUFACTURED UNITS

- A. Enclosures: Surface-mounted cabinets. NEMA PB 1, Type 1.

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1. Rated for environmental conditions at installed location.
    - a. Outdoor Locations: NEMA 250, Type 3R.
    - b. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
  2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
  3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
  4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
  5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
  6. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.
  7. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.
  8. Directory Card: With transparent protective cover, mounted in metal frame, inside panelboard door.
- B. Phase and Ground Buses:
1. Material: Hard-drawn copper, 98 percent conductivity.
  2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.
- C. Conductor Connectors: Suitable for use with conductor material.
1. Main and Neutral Lugs: Compression type.
  2. Ground Lugs and Bus Configured Terminators: Compression type.
  3. Feed-Through Lugs: Compression type suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
- D. Service Equipment Label: UL labeled for use as service equipment for panelboards with main service disconnect switches.
- E. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.
- ### 2.3 PANELBOARD SHORT-CIRCUIT RATING
- A. Fully rated to interrupt symmetrical short-circuit current available at terminals.
- ### 2.4 DISTRIBUTION PANELBOARDS
- A. Doors: Secured with vault-type latch with tumbler lock; keyed alike. Omit for fused-switch panelboards.
- B. Main Overcurrent Protective Devices: Circuit breaker.

C. Branch Overcurrent Protective Devices:

1. For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
2. For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
3. Fused switches.

2.5 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- B. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.6 OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker: UL 489, with interrupting capacity to meet available fault currents.
  1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
  2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
  3. Electronic trip-unit circuit breakers shall have RMS sensing; field-replaceable rating plug; and with the following field-adjustable settings:
    - a. Instantaneous trip.
    - b. Long- and short-time pickup levels.
    - c. Long- and short-time time adjustments.
    - d. Ground-fault pickup level, time delay, and  $I^2t$  response.
  4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
  5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
  6. GFCI Circuit Breakers: Single- and two-pole configurations with 30-mA trip sensitivity.
- B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.
  1. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
  2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
  3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.



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4. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
5. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
6. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
7. Multipole units enclosed in a single housing or factory-assembled to operate as a single unit.

### 2.7 ACCESSORY COMPONENTS AND FEATURES

- A. Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Furnish portable test set to test functions of solid-state trip devices without removal from panelboard.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- C. Mount top of trim 74 inches (1880 mm) above finished floor, unless otherwise indicated.
- D. Mount plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.
- E. Install overcurrent protective devices and controllers.
  1. Set field-adjustable switches and circuit-breaker trip ranges.
- F. Install filler plates in unused spaces.
- G. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.
- H. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

### 3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

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- B. Create a directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

### 3.3 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Division 26 Section "Building Wire and Cable."

### 3.4 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
  - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- B. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:
- C. Perform the following field tests and inspections and prepare test reports:
  - 1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
  - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- D. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
  - 1. Measure as directed during period of normal system loading.
  - 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
  - 3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
  - 4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.
- E. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scanning of each panelboard. Remove panel fronts so joints and connections are accessible to portable scanner.

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1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies panelboards checked and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

### 3.5 CLEANING

- A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 262416

**SECTION 262726 – WIRING 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. This Section includes the following:
  - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
  - 2. Twist-locking receptacles.
  - 3. Wall-box motion sensors.
  - 4. Isolated-ground receptacles.
  - 5. Tamper-resistant receptacles.
  - 6. Weather-resistant receptacles.
  - 7. Toggle switches and wall-box dimmers.
  - 8. Communications outlets.
  - 9. Pendant cord-connector devices.
  - 10. Cord and plug sets.
  - 11. Floor service outlets, poke-through assemblies, service poles, and multioutlet assemblies.
- B. Related Sections include the following:
  - 1. Division 27 Section "Communications Horizontal Cabling" for workstation outlets.

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. SPD: Surge Protective Device.
- F. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

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

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- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
- C. Samples: One for each type of device and wall plate specified, in each color specified.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

### 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.

### 1.7 EXTRA MATERIALS

- A. Furnish extra materials described in subparagraphs below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Floor Service Outlet Assemblies: One for every 10, but no fewer than one.

## PART 2 - PRODUCTS

### 2.1 STRAIGHT-BLADE RECEPTACLES

- A. Manufacturers' Names: Shortened versions (shown in parentheses)
  - 1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
  - 2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
  - 3. Leviton Mfg. Company Inc. (Leviton).
  - 4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

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- B. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

1. Description: Heavy duty, straight blade, single-piece, high strength nylon face with finger grooves and brass heavy duty grounding straps. Back and side wired to accept #12 AWG through #10 AWG solid or stranded conductors.

### 2.2 GFCI RECEPTACLES

- A. Manufacturers' Names: Shortened versions (shown in parentheses)

1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
3. Leviton Mfg. Company Inc. (Leviton).
4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

- B. Duplex GFCI Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, UL 943 Class A, and FS W-C-596.

1. Description: Heavy duty, straight blade, non-feed-through type, high strength nylon face and brass heavy duty grounding straps. Indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection. Back and side wired to accept #12 AWG through #10 AWG solid or stranded conductors.

- C. Weather-Resistant Duplex GFCI Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, UL 943 Class A, and FS W-C-596.

1. Description: Heavy duty, straight blade, non-feed-through type, high strength UV resistant nylon face and brass heavy duty grounding straps. Indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection. Back and side wired to accept #12 AWG through #10 AWG solid or stranded conductors.

### 2.3 TWIST-LOCKING RECEPTACLES

- A. Manufacturers' Names: Shortened versions (shown in parentheses)

1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
3. Leviton Mfg. Company Inc. (Leviton).
4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

- B. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.

1. Description: Twist-locking, single-piece, high impact nylon face with color coded voltage indicator and brass heavy duty grounding straps. Back and side wired to accept #12 AWG through #10 AWG solid or stranded conductors.

2.4 CORD AND PLUG SETS

- A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
  - 1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.
  - 2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.5 TOGGLE SWITCHES

- A. Manufacturers' Names: Shortened versions (shown in parentheses)
  - 1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
  - 2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
  - 3. Leviton Mfg. Company Inc. (Leviton).
  - 4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).
- B. Single Pole Switches, 120/277 V, 20 A: Comply with NEMA WD 1, UL 20, and FS W-S-896.
  - 1. Description: Heavy duty specification grade, with thermoplastic polycarbonate toggle and heavy duty toggle bumpers for smooth and quiet operation, amperage marking on face. Back and side wired to accept #12 AWG through #10 AWG solid or stranded conductors.
- C. Three Way Switches, 120/277 V, 20 A: Comply with NEMA WD 1, UL 20, and FS W-S-896.
  - 1. Description: Heavy duty specification grade, with thermoplastic polycarbonate toggle and heavy duty toggle bumpers for smooth and quiet operation, amperage marking on face. Back and side wired to accept #12 AWG through #10 AWG solid or stranded conductors.
- D. Four Way Switches, 120/277 V, 20 A: Comply with NEMA WD 1, UL 20, and FS W-S-896.
  - 1. Description: Heavy duty specification grade, with thermoplastic polycarbonate toggle and heavy duty toggle bumpers for smooth and quiet operation, amperage marking on face. Back and side wired to accept #12 AWG through #10 AWG solid or stranded conductors.
- E. Pilot-Light Switches, 20 A: Comply with NEMA WD 1, UL 20, and FS W-S-896.
  - 1. Description: Heavy duty specification grade, single pole, with thermoplastic polycarbonate illuminated toggle, illuminated when switch is "on" toggle and heavy duty toggle bumpers for smooth and quiet operation, amperage marking on face. Back and side wired to accept #12 AWG through #10 AWG solid or stranded conductors.
- F. Key-Operated Switches, 120/277 V, 20 A: Comply with NEMA WD 1, UL 20, and FS W-S-896.

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1. Description: Heavy duty specification grade, single pole, with factory-supplied key in lieu of switch handle and heavy duty toggle bumpers for smooth and quiet operation, amperage marking on face. Back and side wired to accept #12 AWG through #10 AWG solid or stranded conductors.
- G. Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A: Comply with NEMA WD 1, UL 20, and FS W-S-896.
1. Description: Heavy duty specification grade, with thermoplastic polycarbonate toggle and heavy duty toggle bumpers for smooth and quiet operation, amperage marking on face. Side wired to accept #12 AWG through #10 AWG solid or stranded conductors.

### 2.6 WALL-BOX DIMMERS

- A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.
- B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.
- C. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.
1. 600 W; dimmers shall require no derating when ganged with other devices. Illuminated when "off."
- D. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 5 percent of full brightness.

### 2.7 WALL PLATES

- A. Single and combination types shall match corresponding wiring devices.
1. Plate-Securing Screws: Metal with head color to match plate finish.
  2. Material for Finished Spaces: Smooth, high-impact thermoplastic.
  3. Material for Unfinished Spaces: Galvanized steel.
  4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

### 2.8 FLOOR SERVICE FITTINGS

- A. Type: Modular, flush-type, dual-service units suitable for wiring method used.
- B. Compartments: Barrier separates power from voice and data communication cabling.



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- C. Service Plate: Round, die-cast aluminum with satin finish.
- D. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.
- E. Voice and Data Communication Outlet: Blank cover with bushed cable opening

### 2.9 PREFABRICATED MULTIOUTLET ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Hubbell Incorporated; Wiring Device-Kellems
  - 2. Wiremold/Legrand
- B. Description:
  - 1. Two-piece surface metal raceway, with factory-wired multioutlet harness.
  - 2. Components shall be products from single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
- C. Raceway Material: Metal, with manufacturer's standard finish.
- D. Multioutlet Harness:
  - 1. Receptacles: 15-A, 125-V, NEMA WD 6 Configuration 5-15R receptacles complying with NEMA WD 1, UL 498, and FS W-C-596.
  - 2. Receptacle Spacing: 12 inches (300 mm).
  - 3. Wiring: No. 12 AWG solid, Type THHN copper, single circuit or two circuit, connecting alternating receptacles.

### 2.10 FINISHES

- A. Device Color:
  - 1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
  - 2. Wiring Devices Connected to Emergency Power System: Red.
- B. Wall Plate Color: For plastic covers, match device color.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.
- B. Coordination with Other Trades:

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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.

### C. 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.

### D. 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 (152 mm) 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 pigtails 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.
10. Install wall switches 42 inches above floor, OFF position down.
11. Install convenience receptacles 18 inches above floor, 2 inches above counters or backsplash, grounding pole on bottom.
12. The use of devices with prefabricated wiring termination is permitted.

### E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.

### F. 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.

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### G. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

### H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates. Do not group adjacent dimmer switches under multigang wall plate.

### I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

## 3.2 IDENTIFICATION

### A. Comply with Division 26 Section "Identification for Electrical Systems."

1. Receptacles and Switches: Identify panelboard and circuit number from which served.

## 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.

END OF SECTION 262726

**SECTION 262813 - FUSES**

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 SECTION INCLUDES

- A. Fuses.
- B. Spare fuse cabinet.

1.3 RELATED SECTIONS

- A. Division 9: Painting of spare fuse cabinet.

1.4 REFERENCES

- A. NFPA 70 - National Electric Code.
- B. NEMA FU 1 - Low Voltage Cartridge Fuses.

1.5 SUBMITTALS

- A. Submit under provisions of Section 260500.
- B. Product Data: Provide data sheets showing electrical characteristics including time-current curves.

1.6 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 260500.
- B. Record actual fuse sizes.

1.7 QUALIFICATIONS

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

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### 1.8 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Furnish products listed and classified by UL and referenced standards as suitable for purpose specified and indicated.

### 1.9 MAINTENANCE MATERIALS

- A. Provide two fuse pullers.

### 1.10 EXTRA MATERIALS

- A. Provide three of each size and type fuse installed.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers:
  - 1. Bussman.
  - 2. Littelfuse.
  - 3. Ferraz-Shawmut.
  - 4. Substitutions: Under provisions of Division 1.

### 2.2 FUSE REQUIREMENTS

- A. Dimensions and Performance: NEMA FU 1, Class as specified or indicated.
- B. Voltage: Provide fuses with voltage rating suitable for circuit phase-to-phase voltage.
- C. Main Service Switches Larger than 600 amperes: Class L (time delay).
- D. Main Service Switches: Class RK1 (time delay).
- E. Power Load Feeder Switches Larger than 600 amperes: Class L (time delay).
- F. Power Load Feeder Switches: Class RK1 (time delay).
- G. Motor Load Feeder Switches: Class RK1 (time delay).
- H. Lighting Load Feeder Switches Larger than 600 amperes: Class L time delay.
- I. Lighting Load Feeder Switches: Class RK1 (time delay).
- J. Other Feeder Switches Larger than 600 amperes: Class L time delay.

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- K. Other Feeder Switches: Class RK1 (time delay).
- L. Power Branch Circuits: Class RK1 (time delay).
- M. Motor Branch Circuits: Class RK1 (time delay).
- N. Lighting Branch Circuits: Class G.

2.3 SPARE FUSE CABINET

- A. Description: Wall-mounted sheet metal cabinet, suitably sized to store spare fuses and fuse pullers specified.
- B. Doors: Hinged, with hasp for Owner's padlock.
- C. Finish: Prime finish for field painting.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install fuses in accordance with manufacturer's instructions.
- B. Install fuse with label oriented such that manufacturer, type, and size are easily read.
- C. Install spare fuse cabinet.

END OF SECTION 262813

**SECTION 262816 - ENCLOSED SWITCHES**

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 SECTION INCLUDES

- A. Fusible Switches
- B. Nonfusible Switches

1.3 RELATED SECTIONS

- A. Section 262813- Fuses.

1.4 REFERENCES

- A. NECA - Standard of Installation (published by the National Electrical Contractors Association).
- B. NEMA FU1 - Low Voltage Cartridge Fuses.
- C. NEMA KS1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
- D. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems (published by the International Electrical Testing Association).
- E. NFPA 70 - National Electrical Code.

1.5 SUBMITTALS FOR REVIEW

- A. Section 260500: Procedures for submittals.
- B. Product Data: Provide switch ratings and enclosure dimensions.

1.6 SUBMITTALS FOR CLOSEOUT

- A. Record actual locations of enclosed switches in project record documents.

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### 1.7 QUALIFICATIONS

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

### 1.8 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Products: Listed and classified by testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Acceptable Manufacturers
  1. Eaton Corporation
  2. General Electric
  3. Square-D
  4. Siemens
  5. Substitutions: Under provisions of Section 260500.

### 2.2 FUSIBLE SWITCH ASSEMBLIES

- A. Description: NEMA KS 1, Type HD, enclosed load interrupter knife switch. Handle lockable in OFF position.
- B. Fuse Clips: Designed to accommodate NEMA FU1, Class R fuses.

### 2.3 NONFUSIBLE SWITCH ASSEMBLIES

- A. Description: NEMA KS 1, Type HD enclosed load interrupter knife switch. Handle lockable in OFF position.

### 2.4 ENCLOSURES

- A. Fabrication: NEMA KS 1.
  1. Interior Dry Locations: Type 1.
  2. Exterior Locations: Type 3R.



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PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with NECA "Standard of Installation".
- B. Install fuses in fusible disconnect switches.
- C. Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

3.2 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS, except Section 4.
- B. Perform inspections and tests listed in NETA ATS, Section 7.5.

END OF SECTION 262816

**SECTION 262817 - ENCLOSED CIRCUIT BREAKERS**

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 SECTION INCLUDES

- A. Enclosed circuit breakers.

1.3 RELATED WORK

- A. Section 260529 - Supporting Devices and Seals
- B. Section 260553 - Electrical Identification: Engraved nameplates.

1.4 REFERENCES

- A. NECA (National Electrical Contractors Association) "Standard of Installation."
- B. NEMA AB 1 - Molded Case Circuit Breakers
- C. NFPA 70 - National Electrical Code.

1.5 SUBMITTALS

- A. Submit under provisions of Section 260500.
- B. Product Data: Provide catalog sheets showing ratings, trip units, time current curves, dimensions, and enclosure details.
- C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with NECA Standard of Installation.

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### 1.7 QUALIFICATIONS

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

### 1.8 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Furnish products listed and classified by UL and referenced standards as suitable for purpose specified and indicated.

### 1.9 EXTRA MATERIALS

- A. Provide three of each size and type current limiter.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Acceptable Manufacturers
  1. General Electric
  2. Eaton
  3. Square-D
  4. Siemens
  5. Substitutions: Under provisions of Section 260500.

### 2.2 MOLDED CASE CIRCUIT BREAKER

- A. Circuit Breaker: NEMA AB 1.
- B. Service Conditions:
  1. Temperature: Not exceeding 104 degrees F.
  2. Altitude: Not exceeding 6600 feet.

### 2.3 TRIP UNITS

- A. Field-Adjustable Trip Circuit Breaker: Provide circuit breakers with frame sizes 200 amperes and larger with mechanism for adjusting long time short time continuous current setting for automatic operation.
- B. Field-Changeable Ampere Rating Circuit Breaker: Provide circuit breakers with frame sizes 200 amperes and larger with changeable trip units.

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- C. Current Limiting Circuit Breaker: Provide circuit breaker as indicated with automatically-resetting current limiting elements in each pole. Let-through Current and Energy: Less than permitted for same size Class RK-5 fuse.
- D. Solid-State Circuit Breaker: Provide circuit breaker as scheduled with electronic sensing, timing and tripping circuits for adjustable current settings; ground fault trip with integral ground fault sensing; instantaneous trip; and adjustable short time trip.

### 2.4 CURRENT LIMITERS

- A. Current Limiter: Designed for application with molded case circuit breaker.
- B. Coordinate limiter size with trip rating of circuit breaker to prevent nuisance tripping and to achieve interrupting current rating specified for circuit breaker.
- C. Provide interlocks to trip circuit breaker and to prevent closing circuit breaker when limiter compartment cover is removed or when one or more limiter is not in place or has operated.

### 2.5 PRODUCT OPTIONS AND FEATURES

- A. Provide accessories as scheduled, to NEMA AB 1.
- B. Shunt Trip Device: 120 volts, AC.
- C. Undervoltage Trip Device: 120 volts, AC.
- D. Auxiliary Switch: 120 volts, AC.
- E. Alarm Switch: 120 volts, AC.
- F. Electrical Operator: 120 volts, AC.
- G. Handle Lock: Include provisions for padlocking.
- H. Provide mechanical trip device.
- I. Provide grounding lug in each enclosure.
- J. Provide products suitable for use as service entrance equipment where so applied.

### 2.6 ENCLOSURE

- A. Enclosure: NEMA AB 1, Type 1.
- B. Fabricate enclosure from steel.
- C. Finish using manufacturer's standard enamel finish.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install enclosed circuit breakers where indicated, in accordance with manufacturer's instructions.
- B. Install enclosed circuit breakers plumb. Provide supports in accordance with Section 260529.
- C. Height: 5 ft to operating handle.
- D. Provide engraved plastic nameplates under the provisions of Section 260553.

3.2 FIELD QUALITY CONTROL

- A. Inspect and test each circuit breaker to NEMA AB 1.
- B. Inspect each circuit breaker visually.
- C. Perform several mechanical ON-OFF operations on each circuit breaker.
- D. Verify circuit continuity on each pole in closed position.
- E. Determine that circuit breaker will trip on overcurrent condition, with tripping time to NEMA AB 1 requirements.
- F. Include description of testing and results in test report.

3.3 ADJUSTING

- A. Adjust trip settings so that circuit breakers coordinate with other overcurrent protective devices in circuit.
- B. Adjust trip settings to provide adequate protection from overcurrent and fault currents.

END OF SECTION 262817

**SECTION 263600 - TRANSFER SWITCHES**

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 transfer switches rated 600 V and less, including the following:
  - 1. Automatic transfer switches.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.
  - 1. Single-Line Diagram: Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.
- C. Qualification Data: For manufacturer.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For each type of product 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. Features and operating sequences, both automatic and manual.
  - 2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.

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- B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
  - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- C. Source Limitations: Obtain automatic transfer switches through one source from a single manufacturer.
- D. 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.
- E. Comply with NEMA ICS 1.
- F. Comply with NFPA 70.
- G. Comply with NFPA 110.
- H. Comply with UL 1008 unless requirements of these Specifications are stricter.

### 1.5 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Contactor Transfer Switches:
    - a. AC Data Systems, Inc.
    - b. Caterpillar; Engine Div.
    - c. Emerson; ASCO Power Technologies, LP.
    - d. Generac Power Systems, Inc.
    - e. GE Zenith Controls.
    - f. Kohler Power Systems; Generator Division.
    - g. Onan/Cummins Power Generation; Industrial Business Group.
    - h. Russelectric, Inc.
    - i. Spectrum Detroit Diesel.

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

- A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.
- B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.
  - 1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.
- C. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.
- D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.
- E. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.
- F. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
  - 1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
  - 2. Switch Action: Double throw; mechanically held in both directions.
  - 3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.
- G. Neutral Terminal: Solid and fully rated, unless otherwise indicated.
- H. Heater: Equip switches exposed to outdoor temperatures and humidity, and other units indicated, with an internal heater. Provide thermostat within enclosure to control heater.
- I. Battery Charger: For generator starting batteries.
  - 1. Float type rated 2 A.
  - 2. Ammeter to display charging current.
  - 3. Fused ac inputs and dc outputs.
- J. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.
- K. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations.



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Color-coding and wire and cable tape markers are specified in Division 26 Section "Identification for Electrical Systems."

1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
  2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
  3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
- L. Enclosures: General-purpose NEMA 250, Type [1] [3R] [12], complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

### 2.3 AUTOMATIC TRANSFER SWITCHES

- A. Comply with Level 1 equipment according to NFPA 110.
- B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.
- C. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.
- D. Manual Switch Operation: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.
- E. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.
- F. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.
- G. Motor Disconnect and Timing Relay: Controls designate starters so they disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to motor starters is through wiring external to automatic transfer switch. Time delay for reconnecting individual motor loads is adjustable between 1 and 60 seconds, and settings are as indicated. Relay contacts handling motor-control circuit inrush and seal currents are rated for actual currents to be encountered.
- H. Programmed Neutral Switch Position: Switch operator has a programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Pause is adjustable from 0.5 to 30 seconds minimum and factory set for 0.5 second, unless otherwise indicated. Time delay occurs for both transfer directions. Pause is disabled unless both sources are live.
- I. Automatic Transfer-Switch Features:
1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of

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- nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
  3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
  4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
  5. Test Switch: Simulate normal-source failure.
  6. Switch-Position Pilot Lights: Indicate source to which load is connected.
  7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.
    - a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    - b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
  8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
  9. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
  10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
  11. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
  12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
    - a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
    - b. Push-button programming control with digital display of settings.
    - c. Integral battery operation of time switch when normal control power is not available.

### 2.4 SOURCE QUALITY CONTROL

- A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for

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compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Floor-Mounting Switch: Anchor to floor by bolting.
  - 1. Concrete Bases: 4 inches (100 mm) high, reinforced, with chamfered edges. Extend base no more than 4 inches (100 mm) in all directions beyond the maximum dimensions of switch, unless otherwise indicated or unless required for seismic support. Construct concrete bases according to Division 26 Section "Hangers and Supports for Electrical Systems."
- B. Identify components according to Division 26 Section "Identification for Electrical Systems."
- C. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

#### 3.2 CONNECTIONS

- A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.
- B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- C. Connect wiring according to Division 26 Section "Building Wire and Cable."

#### 3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified independent testing and inspecting agency to perform tests and inspections and prepare test reports.
- B. Perform tests and inspections and prepare test reports.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installation, including connections, and to assist in testing.
  - 2. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
  - 3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages

and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

- a. Check for electrical continuity of circuits and for short circuits.
  - b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
  - c. Verify that manual transfer warnings are properly placed.
  - d. Perform manual transfer operation.
5. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
- a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
  - b. Simulate loss of phase-to-ground voltage for each phase of normal source.
  - c. Verify time-delay settings.
  - d. Verify pickup and dropout voltages by data readout or inspection of control settings.
  - e. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
  - f. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
6. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
- a. Verify grounding connections and locations and ratings of sensors.

C. Testing Agency's Tests and Inspections:

1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
3. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
  - a. Check for electrical continuity of circuits and for short circuits.
  - b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
  - c. Verify that manual transfer warnings are properly placed.
  - d. Perform manual transfer operation.
4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.

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- a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
  - b. Simulate loss of phase-to-ground voltage for each phase of normal source.
  - c. Verify time-delay settings.
  - d. Verify pickup and dropout voltages by data readout or inspection of control settings.
  - e. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
  - f. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool- down and shutdown.
5. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
- a. Verify grounding connections and locations and ratings of sensors.
- D. Coordinate tests with tests of generator and run them concurrently.
- E. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.
- F. Remove and replace malfunctioning units and retest as specified above.
- G. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.
1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
  2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  3. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- 3.4 DEMONSTRATION
- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Division 01 Section "Demonstration and Training."
  - B. Coordinate this training with that for generator equipment.

END OF SECTION 263600

**SECTION 264313 – SURGE-PROTECTIVE 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. This Section includes Surge Protective Devices (SPD's) for low-voltage power, control, and communication equipment.
- B. Related Sections include the following:
  - 1. Division 26 Section "Panelboards" for factory-installed SPD's.

1.3 DEFINITIONS

- A. ATS: Acceptance Testing Specifications.
- B. SVR: Suppressed voltage rating.
- C. SPD: Surge Protective Devices.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating weights, operating characteristics, furnished specialties, and accessories.
- B. Product Certificates: For surge protective devices, signed by product manufacturer certifying compliance with the following standards:
  - 1. UL 1283.
  - 2. UL 1449.
- C. Qualification Data: For testing agency.
- D. Field quality-control test reports, including the following:
  - 1. Test procedures used.
  - 2. Test results that comply with requirements.
  - 3. Failed test results and corrective action taken to achieve requirements.

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- E. Operation and Maintenance Data: For surge protective devices to include in emergency, operation, and maintenance manuals.
- F. Warranties: Special warranties specified in this Section.

### 1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
  - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. Source Limitations: Obtain suppression devices and accessories through one source from a single manufacturer.
- C. Product Options: Drawings indicate size, dimensional requirements, and electrical performance of suppressors and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- D. 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.
- E. Comply with IEEE C62.41, "IEEE Guide for Surge Voltages in Low Voltage AC Power Circuits," and test devices according to IEEE C62.45, "IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits."
- F. Comply with NEMA LS 1, "Low Voltage Surge Protection Devices."
- G. Comply with UL 1283, "Electromagnetic Interference Filters," and UL 1449, "Transient Voltage Surge Suppressors."

### 1.6 PROJECT CONDITIONS

- A. Service Conditions: Rate surge protection devices for continuous operation under the following conditions, unless otherwise indicated:
  - 1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
  - 2. Operating Temperature: 30 to 120 deg F (0 to 50 deg C).
  - 3. Humidity: 0 to 85 percent, noncondensing.
  - 4. Altitude: Less than 20,000 feet (6090 m) above sea level.

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### 1.7 COORDINATION

- A. Coordinate location of field-mounted surge suppressors to allow adequate clearances for maintenance.

### 1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within five years from date of Substantial Completion.

### 1.9 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. Replaceable Protection Modules: One of each size and type installed.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Current Technology, Inc.
  - 2. Eaton Corporation.
  - 3. General Electric Company.
  - 4. LEA International.
  - 5. Leviton Mfg. Company Inc.
  - 6. Liebert Corporation; a division of Emerson.
  - 7. Northern Technologies, Inc.
  - 8. Siemens Energy & Automation, Inc.
  - 9. Square D; Schneider Electric.

### 2.2 SERVICE ENTRANCE SUPPRESSORS

- A. Surge Protection Device Description: Non-modular, sine-wave-tracking type with the following features and accessories:
  - 1. LED indicator lights for power and protection status.
  - 2. Audible alarm, with silencing switch, to indicate when protection has failed.
  - 3. One set of dry contacts rated at 5 A and 250-V ac, for remote monitoring of protection status.
- B. Surge Protection Device Description: Modular design with field-replaceable modules, sine-wave-tracking type with the following features and accessories:



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1. Fuses, rated at 200-kA interrupting capacity.
2. Fabrication using bolted compression lugs for internal wiring.
3. Integral disconnect switch.
4. Redundant suppression circuits.
5. Redundant replaceable modules.
6. Arrangement with copper bus bars and for bolted connections to phase buses, neutral bus, and ground bus.
7. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
8. LED indicator lights for power and protection status.
9. Audible alarm, with silencing switch, to indicate when protection has failed.
10. One set of dry contacts rated at 5 A and 250-V ac, for remote monitoring of protection status. Coordinate with building power monitoring and control system.
11. Surge-event operations counter.

C. Peak Single-Impulse Surge Current Rating: 240 kA per phase.

D. Connection Means: Permanently wired.

E. Protection modes and UL 1449 SVR for grounded wye circuits with voltages of 208Y/120, 3-phase, 4-wire circuits shall be as follows:

1. Line to Neutral: 400 V for 208Y/120.
2. Line to Ground: 400 V for 208Y/120.
3. Neutral to Ground: 400 V for 208Y/120.

F. Protection modes and UL 1449 SVR for 240/120-V, single-phase, 3-wire circuits shall be as follows:

1. Line to Neutral: 400 V.
2. Line to Ground: 400 V.
3. Neutral to Ground: 400 V.

G. Protection modes and UL 1449 SVR for 240/120-V, 3-phase, 4-wire circuits with high leg shall be as follows:

1. Line to Neutral: 400 V, 800 V from high leg.
2. Line to Ground: 400 V.
3. Neutral to Ground: 400 V.

### 2.3 ENCLOSURES

A. NEMA 250, with type matching the enclosure of panel or device being protected.

## PART 3 - EXECUTION

### 3.1 INSTALLATION OF SURGE PROTECTION DEVICES

A. Install devices at service entrance on load side, with ground lead bonded to service entrance ground.

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- B. Install devices for panelboard and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
  - 1. Provide multipole, 100-A circuit breaker as a dedicated disconnect for suppressor, unless otherwise indicated.

### 3.2 PLACING SYSTEM INTO SERVICE

- A. Do not energize or connect service entrance equipment to their sources until surge protection devices are installed and connected.

### 3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust equipment installation, including connections, and to assist in field testing. Report results in writing.
  - 1. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
- B. Testing: Engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports:
- C. Testing: Perform the following field tests and inspections and prepare test reports:
  - 1. After installing surge protection devices, but before electrical circuitry has been energized, test for compliance with requirements.
  - 2. Complete startup checks according to manufacturer's written instructions.
  - 3. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, "Surge Arresters, Low-Voltage Surge Protection Devices" Section. Certify compliance with test parameters.
- D. Remove and replace malfunctioning units and retest as specified above.

### 3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain surge protective devices. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 264313

**SECTION 265100 - INTERIOR LIGHTING**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:

- 1. Interior luminaires, lamps, and ballasts.
- 2. Emergency lighting units.
- 3. Exit signs.
- 4. Luminaire supports.

- B. Related Sections include the following:

- 1. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
- 2. Division 26 Section "Network Lighting Controls" for manual or programmable control systems with low-voltage control wiring or data communication circuits.
- 3. Division 26 Section "Wiring Devices" for manual wall-box dimmers for incandescent lamps.

1.3 DEFINITIONS

- A. BF: Ballast factor.
- B. CRI: Color-rendering index.
- C. CU: Coefficient of utilization.
- D. HID: High-intensity discharge.
- E. LER: Luminaire efficacy rating.
- F. Luminaire: Complete luminaire, including ballast housing if provided.
- G. RCR: Room cavity ratio.

1.4 SUBMITTALS

- A. Product Data: For each type of luminaire, arranged in order of luminaire designation. Include data on features, accessories, finishes, and the following:
1. Physical description of luminaire including dimensions.
  2. Emergency lighting units including battery and charger.
  3. LED.
  4. Energy-efficiency data.
  5. Life, output, and energy-efficiency data for lamps.
  6. Photometric data, in IESNA format, based on laboratory tests of each luminaire type, outfitted with lamps, ballasts, and accessories identical to those indicated for the luminaire as applied in this Project.
    - a. For indicated luminaires, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by the manufacturer.
    - b. Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.
- B. Shop Drawings: Show details of nonstandard or custom luminaires. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.
1. Wiring Diagrams: Power 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, based on input from installers of the items involved:
1. Luminaires.
  2. Suspended ceiling components.
  3. Structural members to which suspension systems for luminaires will be attached.
  4. Other items in finished ceiling including the following:
    - a. Air outlets and inlets.
    - b. Speakers.
    - c. Sprinklers.
    - d. Smoke and fire detectors.
    - e. Occupancy sensors.
    - f. Access panels.
  5. Perimeter moldings.
- D. Product Certificates: For each type of ballast for bi-level and dimmer-controlled luminaire, signed by product manufacturer.
- E. Qualification Data: For agencies providing photometric data for luminaires.
- F. Field quality-control test reports.

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- G. Operation and Maintenance Data: For lighting equipment and luminaires to include in emergency, operation, and maintenance manuals.
- H. Warranties: Special warranties specified in this Section.

### 1.5 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7.
- 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. Coordinate layout and installation of luminaires and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

### 1.7 WARRANTY

- A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period for Emergency Lighting Unit Batteries: 10 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.
  - 2. Warranty Period for Emergency Fluorescent Ballast Batteries: Seven years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.
- B. Special Warranty for Ballasts: Manufacturer's standard form in which ballast manufacturer agrees to repair or replace ballasts that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period for Electronic Ballasts: Five years from date of Substantial Completion.
- C. Special Warranty for T8 Fluorescent Lamps: Manufacturer's standard form, made out to Owner and signed by lamp manufacturer agreeing to replace lamps that fail in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
  - 1. Warranty Period: Two year(s) from date of Substantial Completion.

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### 1.8 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. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
  - 2. Plastic Diffusers and Lenses: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
  - 3. Battery and Charger Data: One for each emergency lighting unit.
  - 4. Ballasts: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
  - 5. Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- 1. Products: Subject to compliance with requirements, provide product indicated on Drawings.

### 2.2 LUMINAIRES AND COMPONENTS, GENERAL REQUIREMENTS

- A. Recessed Luminaires: Comply with NEMA LE 4 for ceiling compatibility for recessed luminaires.
- B. Incandescent Luminaires: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A.
- C. Fluorescent Luminaires: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
- D. HID Luminaires: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.
- E. Metal Parts: Free of burrs and sharp corners and edges.
- F. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.
- G. 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.
- H. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
  - 1. White Surfaces: 85 percent.
  - 2. Specular Surfaces: 83 percent.

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3. Diffusing Specular Surfaces: 75 percent.
4. Laminated Silver Metallized Film: 90 percent.

### I. Plastic Diffusers, Covers, and Globes:

1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
  - a. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless different thickness is indicated.
  - b. UV stabilized.
2. Glass: Annealed crystal glass, unless otherwise indicated.

## 2.3 BALLASTS FOR LINEAR FLUORESCENT LAMPS

- A. Electronic Ballasts: Comply with ANSI C82.11; programmed-start type, unless otherwise indicated, and designed for type and quantity of lamps served. Ballasts shall be designed for full light output unless dimmer or bi-level control is indicated.
  1. Sound Rating: A.
  2. Total Harmonic Distortion Rating: Less than 10 percent.
  3. Transient Voltage Protection: IEEE C62.41, Category A or better.
  4. Operating Frequency: 42 kHz or higher.
  5. Lamp Current Crest Factor: 1.7 or less.
  6. BF: 0.85 or higher.
  7. Power Factor: 0.98 or higher.
  8. Parallel Lamp Circuits: Multiple lamp ballasts shall comply with ANSI C 82.11 and shall be connected to maintain full light output on surviving lamps if one or more lamps fail.
- B. Single Ballasts for Multiple Luminaires: Factory-wired with ballast arrangements and bundled extension wiring to suit final installation conditions without modification or rewiring in the field.
- C. Ballasts for Low-Temperature Environments:
  1. Temperatures 0 Deg F (Minus 17 Deg C) and Higher: Electronic type rated for 0 deg F (minus 17 deg C) starting and operating temperature with indicated lamp types.
  2. Temperatures Minus 20 Deg F (Minus 29 Deg C) and Higher: Electromagnetic type designed for use with indicated lamp types.
- D. Ballasts for Dimmer-Controlled Luminaires: Electronic type.
  1. Dimming Range: 100 to 5 percent of rated lamp lumens.
  2. Ballast Input Watts: Can be reduced to 20 percent of normal.
  3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.
- E. Ballasts for Bi-Level Controlled Luminaires: Electronic type.

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1. Operating Modes: Ballast circuit and leads provide for remote control of the light output of the associated lamp between high- and low-level and off.
  - a. High-Level Operation: 100 percent of rated lamp lumens.
  - b. Low-Level Operation: 50 percent of rated lamp lumens.
2. Ballast shall provide equal current to each lamp in each operating mode.
3. Compatibility: Certified by manufacturer for use with specific bi-level control system and lamp type indicated.

### 2.4 BALLASTS FOR COMPACT FLUORESCENT LAMPS

- A. Description: Electronic programmed rapid-start type, complying with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:
  1. Lamp end-of-life detection and shutdown circuit.
  2. Automatic lamp starting after lamp replacement.
  3. Sound Rating: A.
  4. Total Harmonic Distortion Rating: Less than 20 percent.
  5. Transient Voltage Protection: IEEE C62.41, Category A or better.
  6. Operating Frequency: 20 kHz or higher.
  7. Lamp Current Crest Factor: 1.7 or less.
  8. BF: 0.95 or higher, unless otherwise indicated.
  9. Power Factor: 0.98 or higher.
  10. Interference: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
  11. Ballast Case Temperature: 75 deg C, maximum.
- B. Ballasts for Dimmer-Controlled Luminaires: Electronic type.
  1. Dimming Range: 100 to 5 percent of rated lamp lumens.
  2. Ballast Input Watts: Can be reduced to 20 percent of normal.
  3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.

### 2.5 EMERGENCY FLUORESCENT POWER UNIT

- A. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting luminaire body and compatible with ballast. Comply with UL 924.
  1. Emergency Connection: Operate 2 fluorescent lamp(s) continuously at an output of 700 lumens each. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire ballast.
  2. Night-Light Connection: Operate two fluorescent lamps continuously.
  3. Test Push Button and Indicator Light: Visible and accessible without opening luminaire or entering ceiling space.



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- a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
  - b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
4. Battery: Sealed, maintenance-free, nickel-cadmium type.
  5. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.

### 2.6 EXIT SIGNS

- A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
  1. Lamps for AC Operation: LEDs, 70,000 hours minimum rated lamp life.

### 2.7 EMERGENCY LIGHTING UNITS

- A. Description: Self-contained units complying with UL 924.
  1. Battery: Sealed, maintenance-free, lead-acid type.
  2. Charger: Fully automatic, solid-state type with sealed transfer relay.
  3. Operation: Relay automatically turns lamp on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
  4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
  5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
  6. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

### 2.8 FLUORESCENT LAMPS

- A. Low-Mercury Lamps: Comply with EPA's toxicity characteristic leaching procedure test; shall yield less than 0.2 mg of mercury per liter when tested according to NEMA LL 1.
- B. T8 rapid-start low-mercury lamps, rated 32 W maximum, nominal length of 48 inches (1220 mm), 2800 initial lumens (minimum), CRI 75 (minimum), color temperature 3500 K, and average rated life 20,000 hours, unless otherwise indicated.

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- C. T8 rapid-start low-mercury lamps, rated 17 W maximum, nominal length of 24 inches (610 mm), 1300 initial lumens (minimum), CRI 75 (minimum), color temperature 3500 K, and average rated life of 20,000 hours, unless otherwise indicated.
- D. T5 rapid-start low-mercury lamps, rated 28 W maximum, nominal length of 45.2 inches (1150 mm), 2900 initial lumens (minimum), CRI 85 (minimum), color temperature 3500 K, and average rated life of 20,000 hours, unless otherwise indicated.
- E. T5HO rapid-start, high-output low-mercury lamps, rated 54 W maximum, nominal length of 45.2 inches (1150 mm), 5000 initial lumens (minimum), CRI 85 (minimum), color temperature 3500 Insert value K, and average rated life of 20,000 hours, unless otherwise indicated.
- F. Compact Fluorescent Lamps: 4-Pin, low mercury, CRI 80 (minimum), color temperature 3500 K, average rated life of 10,000 hours at 3 hours operation per start, and suitable for use with dimming ballasts, unless otherwise indicated.
  - 1. 13 W: T4, double or triple tube, rated 900 initial lumens (minimum).
  - 2. 18 W: T4, double or triple tube, rated 1200 initial lumens (minimum).
  - 3. 26 W: T4, double or triple tube, rated 1800 initial lumens (minimum).
  - 4. 32 W: T4, triple tube, rated 2400 initial lumens (minimum).
  - 5. 42 W: T4, triple tube, rated 3200 initial lumens (minimum).
  - 6. 55 W: T4, triple tube, rated 4300 initial lumens (minimum).

### 2.9 LUMINAIRE SUPPORT COMPONENTS

- A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- C. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single luminaire. Finish same as luminaire.
- D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).
- E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage (2.68 mm).
- F. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.
- G. Hook Hangers: Integrated assembly matched to luminaire and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Luminaires: Set level, plumb, and square with ceilings and walls. Install lamps in each luminaire.
- B. Support for Luminaires in or on Grid-Type Suspended Ceilings: Use grid as a support element.
  - 1. Install a minimum of four ceiling support system rods or wires for each luminaire. Locate not more than 6 inches (150 mm) from luminaire corners.
  - 2. Support Clips: Fasten to luminaires and to ceiling grid members at or near each luminaire corner with clips that are UL listed for the application.
  - 3. Luminaires of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support luminaires independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.
  - 4. Install at least one independent support rod or wire from structure to a tab on lighting luminaire. Wire or rod shall have breaking strength of the weight of luminaire at a safety factor of 3.
- C. Suspended Luminaire Support:
  - 1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
  - 2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers.
  - 3. Continuous Rows: 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.
- D. Air-Handling Luminaires: Install with dampers closed and ready for adjustment.
- E. Adjust aimable luminaires to provide required light intensities.
- F. Connect wiring according to Division 26 Section "Building Wire and Cable."

3.2 FIELD QUALITY CONTROL

- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.
- B. 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.

END OF SECTION 265100

**SECTION 265600 - EXTERIOR LIGHTING**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
  - 1. Exterior luminaires with lamps and ballasts.
  - 2. Luminaire-mounted photoelectric relays.
  - 3. Poles and accessories.
  - 4. Luminaire lowering devices.
- B. Related Sections include the following:
  - 1. Division 26 Section "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.

1.3 DEFINITIONS

- A. CRI: Color-rendering index.
- B. HID: High-intensity discharge.
- C. Luminaire: Complete luminaire, including ballast housing if provided.
- D. Pole: Luminaire support structure, including tower used for large area illumination.
- E. Standard: Same definition as "Pole" above.

1.4 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

- A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4.
- B. Live Load: Single load of 500 lbf (2224 N), distributed as stated in AASHTO LTS-4.
- C. Ice Load: Load of 3 lbf/sq. ft. (143.6 Pa), applied as stated in AASHTO LTS-4.
- D. Wind Load: Pressure of wind on pole and luminaire, calculated and applied as stated in AASHTO LTS-4.

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1. Wind speed for calculating wind load for poles 50 feet (15 m) or less in height is 110 mph (177 km/h).

### 1.5 SUBMITTALS

- A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
  1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
  2. Details of attaching luminaires and accessories.
  3. Details of installation and construction.
  4. Luminaire materials.
  5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.
    - a. For indicated luminaires, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
    - b. Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
  6. Photoelectric relays.
  7. Ballasts, including energy-efficiency data.
  8. Lamps, including life, output, and energy-efficiency data.
  9. Materials, dimensions, and finishes of poles.
  10. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
  11. Anchor bolts for poles.
  12. Manufactured pole foundations.
- B. Shop Drawings:
  1. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
  2. Design calculations, certified by a qualified professional engineer, indicating strength of screw foundations and soil conditions on which they are based.
  3. Wiring Diagrams: Power wiring.
- C. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4 and that load imposed by luminaire has been included in design.
- D. Qualification Data: For agencies providing photometric data for luminaires.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals.

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- G. Warranty: Special warranty specified in this Section.

### 1.6 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7.
- 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 IEEE C2, "National Electrical Safety Code."
- D. Comply with NFPA 70.

### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store poles on decay-resistant-treated skids at least 12 inches (300 mm) above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
- B. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

### 1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.
  - 1. Warranty Period for Luminaires: Five years from date of Substantial Completion.
  - 2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
  - 3. Warranty Period for Color Retention: Five years from date of Substantial Completion.
  - 4. Warranty Period for Lamps: Replace lamps and fuses that fail within 12 months from date of Substantial Completion; furnish replacement lamps and fuses that fail within the second 12 months from date of Substantial Completion.
  - 5. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than three years from date of Substantial Completion.

### 1.9 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.

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1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
2. Glass and Plastic Lenses, Covers, and Other Optical Parts: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
3. Ballasts: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
4. Globes and Guards: 10 for every 20 of each type and rating installed. Furnish at least one of each type.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
- B. In Exterior Lighting Device Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

#### 2.2 LUMINAIRES, GENERAL REQUIREMENTS

- A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
- B. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
- C. Metal Parts: Free of burrs and sharp corners and edges.
- D. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.
- E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
- F. 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. Designed to disconnect ballast when door opens.
- G. Exposed Hardware Material: Stainless steel.
- H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

- I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
- J. 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.
- K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- L. 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.
- M. 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, "Solvent Cleaning," 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, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
  - 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.
    - a. Color: As selected from manufacturer's standard catalog of colors.

### 2.3 POLES AND SUPPORT COMPONENTS, GENERAL REQUIREMENTS

- A. Structural Characteristics: Comply with AASHTO LTS-4.
  - 1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in Part 1 "Structural Analysis Criteria for Pole Selection" Article, with a gust factor of 1.3.
  - 2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.
- B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.
- C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
  - 1. Materials: Shall not cause galvanic action at contact points.
  - 2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication, unless stainless-steel items are indicated.



## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

3. Anchor-Bolt Template: Plywood or steel.
- D. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."
- E. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole base flange and strength required to support pole, luminaire, and accessories.
- F. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4.

### 2.4 STEEL POLES

- A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig (317 MPa); 1-piece construction up to 40 feet (12 m) in height with access handhole in pole wall.
  1. Shape: Round, straight.
  2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
- B. Brackets for Luminaires: Detachable, cantilever, without underbrace.
  1. Adapter fitting welded to pole and bracket, then bolted together with galvanized-steel bolts.
  2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire.
  3. Match pole material and finish.
- C. Grounding and Bonding Lugs: Welded 1/2-inch (13-mm) threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.
- D. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.
- E. Factory-Painted Finish: 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, "Solvent Cleaning," 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, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
  2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

3. 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.
  - a. Color: As selected by Architect from manufacturer's full range.

### 2.5 POLE ACCESSORIES

- A. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.

## PART 3 - EXECUTION

### 3.1 LUMINAIRE INSTALLATION

- A. Install lamps in each luminaire.
- B. Fasten luminaire to indicated structural supports.
  1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

### 3.2 POLE INSTALLATION

- A. Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.
- B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features, unless otherwise indicated on Drawings:
  1. Fire Hydrants and Storm Drainage Piping: 60 inches (1520 mm).
  2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet (3 m).
  3. Trees: 15 feet (5 m).
- C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03 Section "Cast-in-Place Concrete."
- D. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6- inch- (150-mm-) wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab. Fill unpaved ring with **[pea gravel]** <Insert material> to a level 1 inch (25 mm) below top of concrete slab.
- E. Raise and set poles using web fabric slings (not chain or cable).

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

### 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 Division 26 Section "Raceway and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

### 3.4 GROUNDING

- A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
  - 1. Install grounding electrode for each pole, unless otherwise indicated.
  - 2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

### 3.5 FIELD QUALITY CONTROL

- A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.
- B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
  - 1. Verify operation of photoelectric controls.
- C. Illumination Tests:
  - 1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):
    - a. IESNA LM-5, "Photometric Measurements of Area and Sports Lighting."
    - b. IESNA LM-50, "Photometric Measurements of Roadway Lighting Installations."
    - c. IESNA LM-52, "Photometric Measurements of Roadway Sign Installations."
    - d. IESNA LM-64, "Photometric Measurements of Parking Areas."
    - e. IESNA LM-72, "Directional Positioning of Photometric Data."
- 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.

BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain luminaire lowering devices. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 265600

**SECTION 312000 - EARTHWORK**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. The Work in this Section includes furnishing all materials, labor, supervision, tools, equipment, and performing all operations and incidentals necessary for earthwork. Earthwork activities include but are not limited to subgrade preparation, excavating, backfilling, and compaction for structures and foundations, pavements, sidewalks, landscape areas, and utilities. The Contractor shall pay for and coordinate the services of a geotechnical engineer and testing agency to perform quality control of the earthworks.
- B. Comply with this section and the “Subsurface investigation for the Proposed Boulder County Coroner Facility, 5600 Flatiron Parkway, Boulder, Colorado” project prepared by Scott, Cox & Associates, 1530 55th Street, Boulder Colorado Ph. 303.444.3051 dated November, 2012. Any conflicts shall be brought to the attention of the Architect immediately for resolution. The most stringent shall take precedent.

1.3 REFERENCES

- A. Reference Standards: Comply with following:
  - 1. Excavation: Colorado Division of Labor Rules and Regulations.
  - 2. Compaction Standard: Standard Proctor Density ASTM D698-78.
  - 3. City of Boulder Design and Construction Standards (current edition).

1.4 SUBMITTALS

- A. Material Test Reports: Shall be provided from the testing agency indicating and interpreting test results for compliance on the following:
  - 1. Classification according to ASTM D 698 of each on-site or borrow soil material proposed for fill and backfill.
  - 2. Laboratory compaction curve according to ASTM D 698 for each on-site or borrow soil material proposed for fill and backfill; provide for each material type and for every 5,000 cubic yards of each material.

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

### 3. Material Gradation Tests

#### 1.5 QUALITY ASSURANCE

- A. The Owner shall engage the services of a geotechnical engineer and testing agency to perform quality control of the earthworks.

#### 1.6 DEFINITIONS

- A. Backfill: Soil materials used to fill an excavation.
- B. Base Course: Layer placed between the subgrade and paving.
- C. Bedding Course: Layer placed over the excavated subgrade in a trench before laying pipe.
- D. Borrow: Approved soil materials imported from off-site for use as fill or backfill.
- E. Classification: No consideration will be given to the nature of earthen materials, and all excavation required for this Project will be designated as unclassified.
- F. Degree of Compaction: Degree of compaction required is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D698, abbreviated hereinafter as percent laboratory maximum density.
- G. Excavation: Removal of material encountered above sub-grade elevations and to lines and dimensions indicated.
  - 1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions changes in the Work.
  - 2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.
- H. Hard Material: Weathered rock, dense consolidated deposits, or buried construction debris (i.e., demolished brick walls, concrete, etc.) which are not included in the definition of “rock” but which usually require the use of heavy excavation equipment, ripper teeth, or jack hammers for removal.
- I. Rock: Rock material in beds, ledges, unstratified masses, and conglomerate deposits and boulders of rock material exceeding 1 cubic yard. for bulk excavation or 3/4 cubic yard. for footing, trench, and pit excavation that cannot be removed by rock excavating equipment without systematic drilling, ram hammering, ripping, or blasting, when permitted

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

- J. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below base or topsoil materials.
- K. Subbase: Material shown on the Drawings between the pavement base and subgrade.
- L. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

### 1.7 REGULATORY COMPLIANCE

- A. Codes and Standards: Perform earthwork complying with federal, state, and local regulations including the Occupational Safety and Health Act of 1970 as amended. Excavation and trenching are regulated by OSHA. The Contractor shall perform all excavation and trenching work in accordance with 29 CFR 1926 Subpart P.
- B. Any runoff or pumped water shall be discharged from the Site in accordance with federal, state and local codes and regulations.

### 1.8 PROJECT CONDITIONS

- A. Notify the Colorado One-Call System at 1-800-922-1987 in accordance with Colorado Revised Statutes §9-1.5-101 and all amendments. Retain the services of a utility locator for identification of underground utilities on private property.
- B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Owner and then only after arranging to provide temporary utility services according to requirements indicated:
  - 1. Notify the Owner not less than 72 hours in advance of proposed utility interruptions.
  - 2. Do not proceed with utility interruptions without the Owner's written permission.
- C. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.
- D. Existing improvements, adjacent property, and other facilities and trees and plants that are not to be removed shall be protected from injury or damage, which may result from Contractor's operation.

## PART 2 - PRODUCTS

### 2.1 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil or suitable backfill materials are not available from excavations.

BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

- B. Fill Associated with Areas to be Paved: Fill associated with areas to be paved included all areas directly under paving as well as embankments and fill slopes supporting area to be paved. All fill in these areas shall utilize materials with an "R" of 25 (the "R" value being determined in accordance with Colorado Department of Transportation Standards) and shall be free of rock larger than 6" in any dimension, debris, waste, frozen materials, vegetation and other deleterious matter and approved by the Soils Engineer.
- C. Unsatisfactory Soils:
  - 1. Unsatisfactory soils include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
  - 2. Debris, waste, frozen materials, vegetation and other deleterious matter.
  - 3. Otherwise not meeting the requirements for satisfactory soil materials.
  - 4. Materials containing excessive amounts of deleterious materials including construction debris, wood, glass, ash, or organic material as determined by Owner.
- D. Backfill and Fill Materials: Satisfactory soil materials.
- E. Structural Fill: Satisfactory soil materials.
- F. Base Course: Class 6, as specified in CDOT specifications, Section 703.
- G. Bedding for all pipe – Squeegee sand (Per City of Boulder Standards):
  - 1. Gradation:

Sieve Size (#)	¾"	3/8"	#4	#8	#200
% Passing	-	100	-	-	0-5

2.2 ACCESSORIES

- A. PVC Pressure Pipe: All PVC Pressure pipe shall be buried with detectable tracer wire. Refer to the City of Boulder - Design and Construction Standards section 9.04 for tracer wire requirements.
- B. Detectable Warning Identification Tape: Acid-and-alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities. Warning tape shall be a minimum 6 inches wide, 6 mils thick, have a minimum tensile strength 7,500 lbs/in<sup>2</sup>, continuously inscribed with a description of the utility in permanent printing with caution striping, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; APWA color-coded as follows:
  - 1. Red: Electric
  - 2. Yellow: Gas, oil, steam, and dangerous materials.



**SECTION 312000 - EARTHWORK**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. The Work in this Section includes furnishing all materials, labor, supervision, tools, equipment, and performing all operations and incidentals necessary for earthwork. Earthwork activities include but are not limited to subgrade preparation, excavating, backfilling, and compaction for structures and foundations, pavements, sidewalks, landscape areas, and utilities. The Contractor shall pay for and coordinate the services of a geotechnical engineer and testing agency to perform quality control of the earthworks.
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- A. Reference Standards: Comply with following:
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  - 2. Compaction Standard: Standard Proctor Density ASTM D698-78.
  - 3. City of Boulder Design and Construction Standards (current edition).

1.4 SUBMITTALS

- A. Material Test Reports: Shall be provided from the testing agency indicating and interpreting test results for compliance on the following:
  - 1. Classification according to ASTM D 698 of each on-site or borrow soil material proposed for fill and backfill.
  - 2. Laboratory compaction curve according to ASTM D 698 for each on-site or borrow soil material proposed for fill and backfill; provide for each material type and for every 5,000 cubic yards of each material.

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

### 3. Material Gradation Tests

#### 1.5 QUALITY ASSURANCE

- A. The Owner shall engage the services of a geotechnical engineer and testing agency to perform quality control of the earthworks.

#### 1.6 DEFINITIONS

- A. Backfill: Soil materials used to fill an excavation.
- B. Base Course: Layer placed between the subgrade and paving.
- C. Bedding Course: Layer placed over the excavated subgrade in a trench before laying pipe.
- D. Borrow: Approved soil materials imported from off-site for use as fill or backfill.
- E. Classification: No consideration will be given to the nature of earthen materials, and all excavation required for this Project will be designated as unclassified.
- F. Degree of Compaction: Degree of compaction required is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D698, abbreviated hereinafter as percent laboratory maximum density.
- G. Excavation: Removal of material encountered above sub-grade elevations and to lines and dimensions indicated.
  - 1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions changes in the Work.
  - 2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.
- H. Hard Material: Weathered rock, dense consolidated deposits, or buried construction debris (i.e., demolished brick walls, concrete, etc.) which are not included in the definition of "rock" but which usually require the use of heavy excavation equipment, ripper teeth, or jack hammers for removal.
- I. Rock: Rock material in beds, ledges, unstratified masses, and conglomerate deposits and boulders of rock material exceeding 1 cubic yard. for bulk excavation or 3/4 cubic yard. for footing, trench, and pit excavation that cannot be removed by rock excavating equipment without systematic drilling, ram hammering, ripping, or blasting, when permitted

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

- J. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below base or topsoil materials.
- K. Subbase: Material shown on the Drawings between the pavement base and subgrade.
- L. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

### 1.7 REGULATORY COMPLIANCE

- A. Codes and Standards: Perform earthwork complying with federal, state, and local regulations including the Occupational Safety and Health Act of 1970 as amended. Excavation and trenching are regulated by OSHA. The Contractor shall perform all excavation and trenching work in accordance with 29 CFR 1926 Subpart P.
- B. Any runoff or pumped water shall be discharged from the Site in accordance with federal, state and local codes and regulations.

### 1.8 PROJECT CONDITIONS

- A. Notify the Colorado One-Call System at 1-800-922-1987 in accordance with Colorado Revised Statutes §9-1.5-101 and all amendments. Retain the services of a utility locator for identification of underground utilities on private property.
- B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Owner and then only after arranging to provide temporary utility services according to requirements indicated:
  - 1. Notify the Owner not less than 72 hours in advance of proposed utility interruptions.
  - 2. Do not proceed with utility interruptions without the Owner's written permission.
- C. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.
- D. Existing improvements, adjacent property, and other facilities and trees and plants that are not to be removed shall be protected from injury or damage, which may result from Contractor's operation.

## PART 2 - PRODUCTS

### 2.1 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil or suitable backfill materials are not available from excavations.

BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

- B. Fill Associated with Areas to be Paved: Fill associated with areas to be paved included all areas directly under paving as well as embankments and fill slopes supporting area to be paved. All fill in these areas shall utilize materials with an "R" of 25 (the "R" value being determined in accordance with Colorado Department of Transportation Standards) and shall be free of rock larger than 6" in any dimension, debris, waste, frozen materials, vegetation and other deleterious matter and approved by the Soils Engineer.
- C. Unsatisfactory Soils:
  - 1. Unsatisfactory soils include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
  - 2. Debris, waste, frozen materials, vegetation and other deleterious matter.
  - 3. Otherwise not meeting the requirements for satisfactory soil materials.
  - 4. Materials containing excessive amounts of deleterious materials including construction debris, wood, glass, ash, or organic material as determined by Owner.
- D. Backfill and Fill Materials: Satisfactory soil materials.
- E. Structural Fill: Satisfactory soil materials.
- F. Base Course: Class 6, as specified in CDOT specifications, Section 703.
- G. Bedding for all pipe – Squeegee sand (Per City of Boulder Standards):
  - 1. Gradation:

Sieve Size (#)	¾"	3/8"	#4	#8	#200
% Passing	-	100	-	-	0-5

2.2 ACCESSORIES

- A. PVC Pressure Pipe: All PVC Pressure pipe shall be buried with detectable tracer wire. Refer to the City of Boulder - Design and Construction Standards section 9.04 for tracer wire requirements.
- B. Detectable Warning Identification Tape: Acid-and-alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities. Warning tape shall be a minimum 6 inches wide, 6 mils thick, have a minimum tensile strength 7,500 lbs/in<sup>2</sup>, continuously inscribed with a description of the utility in permanent printing with caution striping, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; APWA color-coded as follows:
  - 1. Red: Electric
  - 2. Yellow: Gas, oil, steam, and dangerous materials.

BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

- B. Fill Associated with Areas to be Paved: Fill associated with areas to be paved included all areas directly under paving as well as embankments and fill slopes supporting area to be paved. All fill in these areas shall utilize materials with an "R" of 25 (the "R" value being determined in accordance with Colorado Department of Transportation Standards) and shall be free of rock larger than 6" in any dimension, debris, waste, frozen materials, vegetation and other deleterious matter and approved by the Soils Engineer.
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BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

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- A. PVC Pressure Pipe: All PVC Pressure pipe shall be buried with detectable tracer wire. Refer to the City of Boulder - Design and Construction Standards section 9.04 for tracer wire requirements.
- B. Detectable Warning Identification Tape: Acid-and-alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities. Warning tape shall be a minimum 6 inches wide, 6 mils thick, have a minimum tensile strength 7,500 lbs/in<sup>2</sup>, continuously inscribed with a description of the utility in permanent printing with caution striping, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; APWA color-coded as follows:
  - 1. Red: Electric
  - 2. Yellow: Gas, oil, steam, and dangerous materials.

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

### PART 3 - EXECUTION

#### 3.1 PREPARATION

- A. Protect existing utilities, sidewalks, structures, pavements, and other facilities to remain free from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
- B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways in accordance with Paragraph 1.7.

#### 3.2 DRAINAGE AND DEWATERING

- A. Prevent surface water and subsurface or groundwater from entering or flowing into excavations, from ponding on prepared subgrades, and from flooding the project site and surrounding area.
- B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
- C. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
- D. Provide pumping to remove any water encountered in accordance with Paragraph 1.7B.

#### 3.3 EXPLOSIVES

- A. Explosives: The use explosives are prohibited on this Project.

#### 3.4 GENERAL EXCAVATION

- A. Excavate to subgrade elevation. Compact subgrade surface in accordance with Paragraph 3.11.
- B. Any soft or unstable material shall be overexcavated and replaced with compacted load bearing fill as directed by the geotechnical engineer. Any areas of instability shall be overexcavated to a depth of at least 2 feet and replaced with structural fill in accordance with Paragraph 3.11.
- C. Provide shoring and bracing necessary to comply with Paragraph 1.7A.

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

- D. All footing excavation surfaces should be protected until the concrete and backfill is placed. Footing bearing surfaces should be cleaned of all material loosened by the excavation process and be recompacted using hand-operated compaction equipment prior to concrete placement. Should loose or soft materials be encountered or if the bearing materials become disturbed or softened, the disturbed materials should be removed and the footing should be lowered to undisturbed bearing materials or the undercut zone should be filled with lean concrete or compacted structural fill.

### 3.5 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicated gradients, lines, depths, and elevations as shown on the drawings.
- B. Excavate trenches to uniform widths to provide a working clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit, unless otherwise indicated.
- C. Clearance: 12 inches on each side of pipe or conduit or as indicated.
- D. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Remove projecting stones and sharp objects along trench subgrade.
  - 1. Provide bedding depth as indicated on the drawings.
  - 2. Shape bedding to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
  - 3. For pipes and conduit less than 6 inches in nominal diameter and flat-bottom, multiple-duct conduit units, hand-excavate trench bottom to accurate elevations and support pipe and conduit on an undisturbed subgrade.

### 3.6 UNAUTHORIZED EXCAVATION

- A. Unauthorized excavations shall be filled with satisfactory fill materials and compacted in accordance with the relevant paragraphs of this Section.
- B. The Contractor is responsible for furnishing all materials, labor, supervision, tools, equipment, tools associated with unauthorized excavations without additional compensation.

### 3.7 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow materials and excavated satisfactory materials sufficiently far away from the edge of excavations to preclude excavation instability. Stockpile soil materials without intermixing. Cover to prevent windblown dust.
- B. Install erosion control measures around stockpiles as required to comply with Paragraph 1.7.

### 3.8 GENERAL BACKFILL



## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

- A. Backfill shall not be placed on a subgrade which contains frozen material, or which has been subjected to freeze-thaw action. This prohibition encompasses all subgrade types, including the natural ground, all prepared subgrades (whether in an excavation or in a trench) and all layers of previously placed and compacted earth fill which become the subgrade for successive layers of earth fill. All material that freezes or has been subjected to freeze-thaw action during the construction work, or during periods of temporary shutdowns, such as, but not limited to, nights, holidays, weekends, winter shutdowns, or earthwork operations, shall be removed to a depth that is acceptable to the Owner and replaced with new material. Alternatively, the material will be thawed, dried, reworked, and recompacted to the specified criteria before additional material is placed. The Owner will determine when placement of fill shall cease due to cold weather. The Owner may elect to use average daily air temperatures, and/or physical observation of the soils for his determination.
- B. Place and compact backfill in excavations promptly, but not before completing the following:
  - 1. Construction below finish grade including, where applicable, dampproofing, waterproofing, and perimeter insulation.
  - 2. Surveying locations of underground utilities for record documents.
  - 3. Inspecting and testing underground utilities.
  - 4. Removing concrete formwork.
  - 5. Removing of temporary shoring, bracing, and sheeting unless directed to remain.
  - 6. Removing trash and debris.

### 3.9 UTILITY TRENCH BACKFILL

- A. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies or ducts.
- B. Place and compact bedding material to a height of 12 inches over the utility pipe or conduit.
  - 1. Carefully compact material under pipe haunches and bring backfill up evenly on both sides and along the full length of utility piping or conduit to avoid damage or displacement of utility system.
  - 2. Compaction within the trenches shall be maintained at 95% of the maximum dry-weight density as determined by ASTM D1557.
- C. Coordinate backfilling with utilities testing.
- D. Fill voids with approved backfill or satisfactory soil materials as shoring, sheeting and bracing is removed. Place and compact final backfill of satisfactory soil material to final subgrade.

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

- E. Install warning and identification tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

### 3.10 MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill layer before compaction to within 2 percent of optimum moisture content.
  - 1. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
  - 2. Remove and replace, or scarify and air-dry satisfactory soil material that exceed optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.
  - 3. Construction during wet weather may also create unnecessary delays and undercutting of subgrades due to disturbance by construction traffic.

### 3.11 COMPACTION OF BACKFILLS AND FILLS

- A. Place backfill and fill materials in layers not more than 6 inches in loose depth for material compacted by heavy compaction equipment, and not more than 6 inches in loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.
- C. Compact soil to not less than the following percentages of maximum dry unit weight according ASTM D 1557:
  - 1. Under driveways, pavement, building slabs, and landscaped areas, soil shall be compacted to at least 95 percent of the maximum modified Dry Density as determined by ASTM D 1557.
  - 2. Structural Fill and fill under street pavements shall be compacted to 95 percent of maximum modified Dry Density as determined by ASTM D 698.
- D. The Contractor is responsible for maintenance and protection of approved subgrades or previously placed materials.

### 3.12 GRADING

- A. General: Uniformly grade areas to a smooth surface, free from irregular surface changes in compliance with the soil roughing detail. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
  - 1. Provide a smooth transition between adjacent existing grades and new grades.

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

2. Cut out soft spots, fill low spots, and trim high spots to comply with the required grading surface tolerances.
- B. Site Grading: Slope grades to direct water away from buildings and prevent ponding. Finish grades shall be sloped away from the building by a minimum of 10% in the first 10 feet, unless otherwise indicated.
- 3.13 SUBBASE AND BASE COURSES
- A. Under pavements and walks outside the right-of-way, place base course on prepared subgrade and as follows:
1. Place base course material over prepared subgrade.
  2. Compact base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit density according to ASTM D698.
  3. Shape base to required crown elevations and cross slope grades.
  4. When thickness of compacted base course is 6 inches or less, place materials in a single layer.
  5. When thickness of compacted base course exceeds 6 inches, place materials in equal layers, with no layer more than 6 inches thick or less than 3 inches thick when compacted.
- 3.14 FIELD QUALITY CONTROL
- A. The contractor shall coordinate all earthwork with the testing agency and geotechnical engineer to allow for inspection and testing. The geotechnical engineer shall provide full-time observation and testing of the compaction operations and provide documentation to the Owner.
- B. Allow geotechnical engineer to inspect and test each subgrade and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.
- C. The geotechnical engineer shall test compaction of soils in place according to ASTM D 1556, ASTM D 1557, ASTM D 69 as applicable. Tests shall be performed at the following locations and frequencies:
1. Paved Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2200 sq. ft. or less of paved areas or building slab, but in no case fewer than three tests.
  2. Trench Backfill: At each compacted initial and final backfill layer, at least one test for each 150 feet or less of trench, but no fewer than two tests.

## BOULDER COUNTY WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

3. Structural Backfill: At each compacted initial and final backfill layer, at least one test for each 150 feet or less of trench, but no fewer than two tests.
- D. When the geotechnical engineer reports that subgrades, fills or backfills have not achieved degree of compaction specified, recompact and retest until specified compaction is obtained.

### 3.15 PROTECTION

- A. Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. Repair and re-establish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled or where they lose compaction due to subsequent construction operations or weather conditions.
  1. Scarify or remove and replace soil material to depth as directed by the Owner or the geotechnical engineer; reshape and recompact to the required density, at no additional cost to the Owner.
- C. Where settling occurs before the project correction period elapses, remove finished surfacing, backfill with additional approved material, compact, and reconstruct.
  1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to the greatest extent possible at no additional cost to the Owner.
- D. Provide temporary underpinning, bracing, sheeting, and/or shoring as required to maintain the conditions of existing utilities or structures adjacent to excavation work. Prepare shop drawings of design details sealed by a professional engineer.
- E. Provide fencing, barricades, and/or protective barriers for all excavation.

### 3.16 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off site to a regulated and permitted facility. Provide two copies of load manifest and permit from owner of the property where material is deposited.

END OF SECTION 312000

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P101	PLUMBING PLANS
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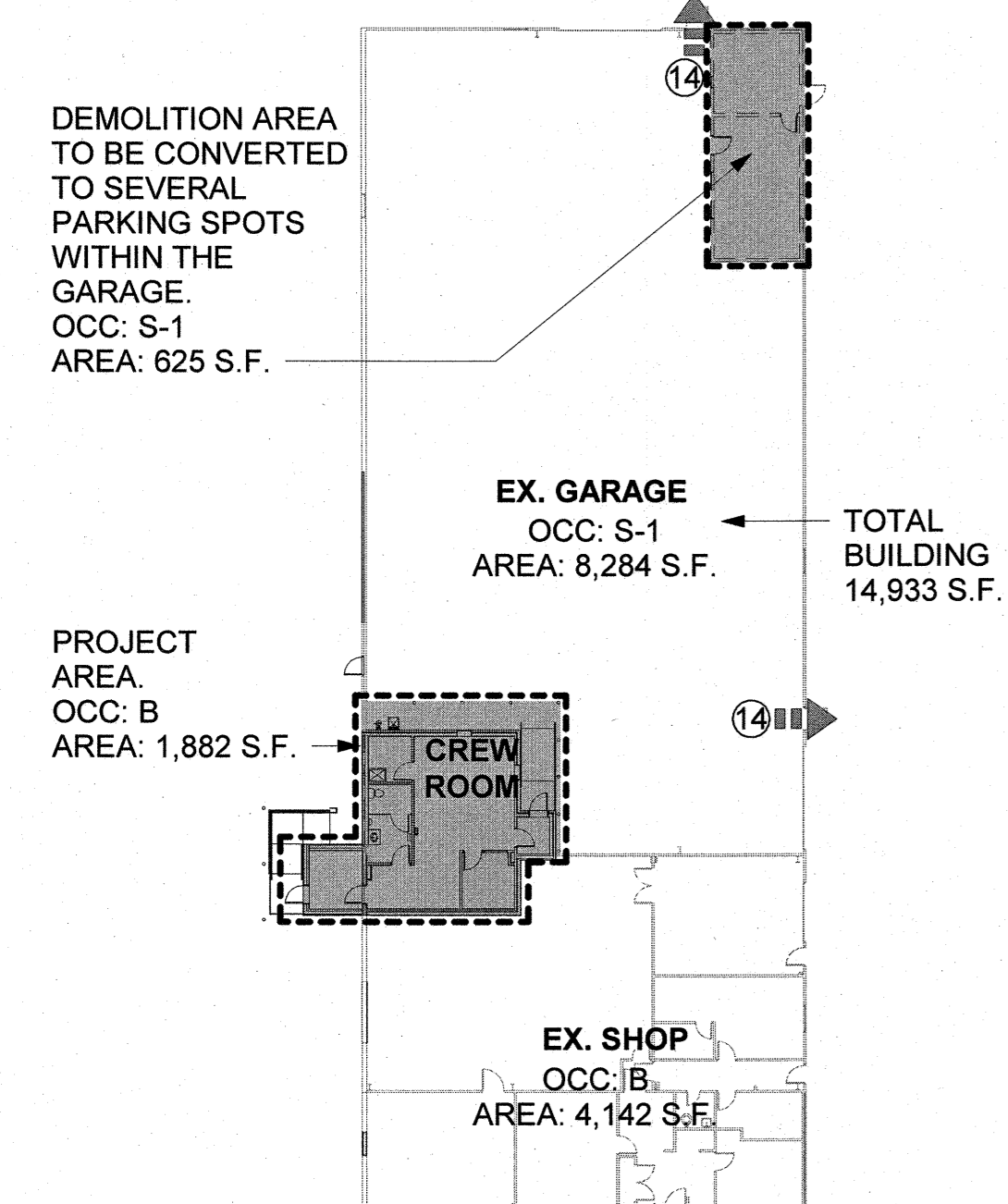
# WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

3897 N. 75TH STREET  
BOULDER, COLORADO 80301

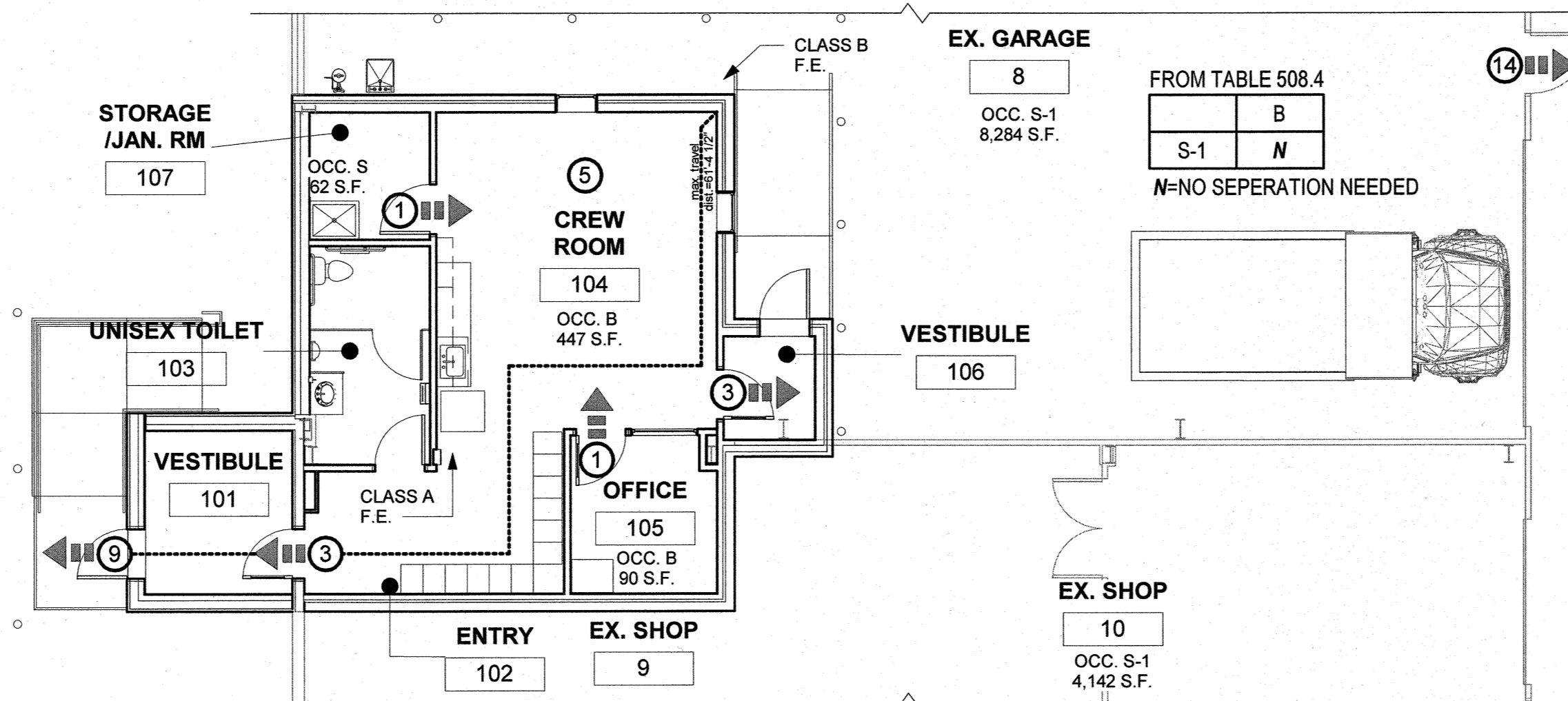
## Building Permit Submittal



VICINITY MAP



1 A001 TRANSPORTATION BUILDING  
1" = 30'-0"



2 A001 CODE ASSESSMENT PLAN  
1/8" = 1'-0"

### PROJECT DATA

**PROJECT ADDRESS:**  
3897 N. 75th Street, Boulder, CO 80301

**PROJECT DESCRIPTION:**  
Tenant Remodel of Boulder County Transportation Division Office and Crew Room. Deconstruction and removal of existing crew room and office. Construction of new, exterior load-bearing and interior non-bearing walls, new mechanical, additional plumbing, and new finishes.

**RENOVATION SQUARE FOOTAGE:**  
BUILDING TOTAL: 14,933 SF  
REMODEL: 882 SF

**FLOOR & FLOOD ELEVATIONS:**  
F.F.E. 5127.3' = 100'-0"  
F.P.E. 5129.3'

### PROJECT DIRECTORY

**OWNER:**  
BOULDER COUNTY  
BUILDING SERVICES  
JANA PETERSEN  
303-441-4549  
P.O. BOX 471  
BOULDER, CO 80306

**ARCHITECT:**  
BOULDER COUNTY ADMIN. SERVICES  
BUILDING SERVICES DIVISION  
2020 13TH ST  
BOULDER, CO 80302  
ARCHITECT OF RECORD: MACKENZIE SCHOOFs  
mschoofs@bouldercounty.org  
303-441-3187

**ELECTRICAL ENGINEER:**  
PCD ENGINEERING  
323 THIRD AVENUE, #100  
LONGMONT, CO 80501  
THOMAS RAY WHITE  
tom@pcdengineering.com  
303-678-1008

**MECHANICAL ENGINEER:**  
PCD ENGINEERING  
323 THIRD AVENUE, #100  
LONGMONT, CO 80501  
PETER C. D'ANTONIO  
peter@pcdengineering.com  
BRIAN EHLE  
brian@pcdengineering.com  
303-678-1008

**STRUCTURAL ENGINEER:**  
JVA CONSULTING ENGINEERS  
1319 SPRUCE ST.  
BOULDER, CO 80302  
ADAM TEUNISSEN  
ateunissen@jvajva.com  
303-565-4936

**GENERAL CONTRACTOR:**  
BOULDER COUNTY ADMIN. SERVICES  
BUILDING SERVICES DIVISION  
2020 13TH ST  
BOULDER, CO 80302  
JOE MAY, 303-441-1263  
jmaj@bouldercounty.org

**ELECTRICAL CONTRACTOR:**  
BOULDER COUNTY ADMIN. SERVICES  
BUILDING SERVICES DIVISION  
2020 13TH ST  
BOULDER, CO 80302  
MARTIN MARINO, 303-434-4834  
mmarino@bouldercounty.org

### GENERAL NOTES:

- A: The contract document include the drawings and the owner-contractor agreement. Any discrepancies found among the drawings, the specification, these general notes, and the site conditions shall be reported to the architect who shall address such inconsistencies in writing. Any work done by the contractor after discovery of such error shall be done at the contractor's risk. The contractor shall verify and familiarize themselves with all drawings prior to proceeding with any work or fabrication.
- B: If there is a conflict between a large scale drawing and the smaller scale drawing of the same area, the large scale drawing is to be considered more precise. Notify Architect of any discrepancies.
- C: Test any material that could be asbestos containing material. Notify architect and/or project manager of results.
- D: All walls are dimensioned from finish face unless noted otherwise.
- E: BC Jobsite Construction Recycling Checklist will be followed. Weight ticket receipts will be collected throughout project, and use of a commercial hauler that provides trash and deconstruction waste recycling services.

### CODE INFORMATION

CONSTRUCTION SHALL COMPLY WITH THE 2015 IBC, IEBC, IECC, IMC, IPC, & 2017 NEC.

**OCCUPANCY TYPE:** B - BUSINESS (CREW ROOM AND OFFICE AREAS)  
S1 - STORAGE (SHOP AND GARAGE)

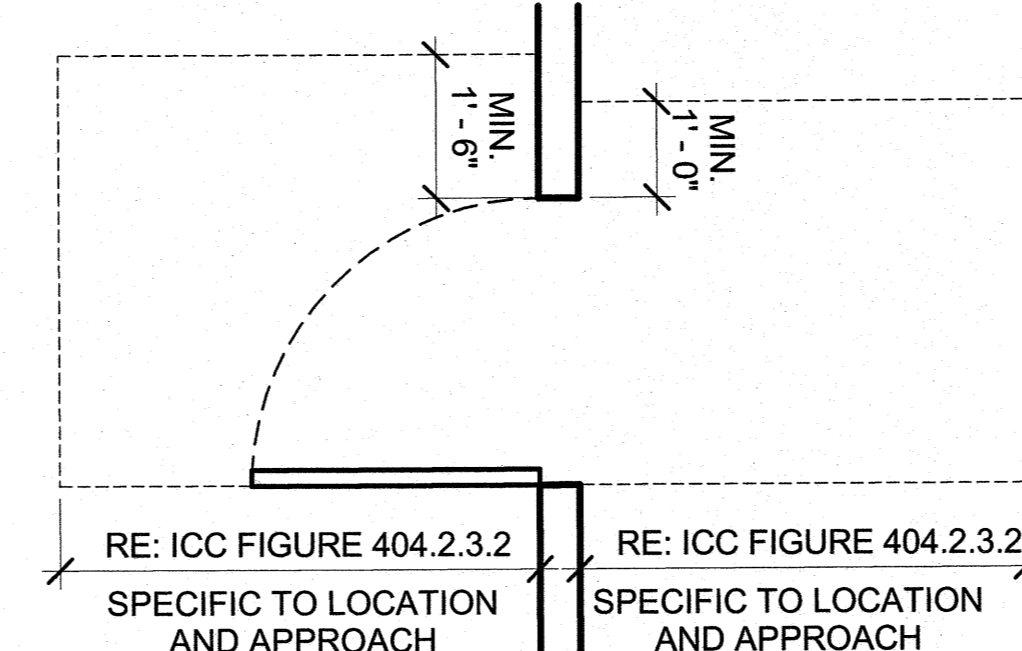
**TYPE OF CONSTRUCTION:** 2B / FULLY SPRINKLED

**ZONE:** A (Agricultural)

THIS PROJECT WILL MEET IBC AND BOULDER COUNTY LAND USE REQUIREMENTS. ANYTHING ENTERING/EXITING RATED ASSEMBLIES WILL BE IN COMPLIANCE.

### OFFICE AREAS

**EXIT DOOR CALCULATION**  
MAXIMUM NUMBER OF OCCUPANTS THROUGH AN EXIT DOOR / OTHER MEANS OF EGRESS = 14 X 2 INCHES PER OCCUPANT = 2.8 INCHES MIN WIDTH - CLEAR DOOR WIDTH OF STANDARD PROJECT DOOR CLEAR WIDTH OF 36 INCHES. (PER 1005.3.1 OTHER EGRESS COMPONENTS)



3 A001 DOOR CLEARANCES  
1/2" = 1'-0"

### TYPICAL ABBREVIATIONS

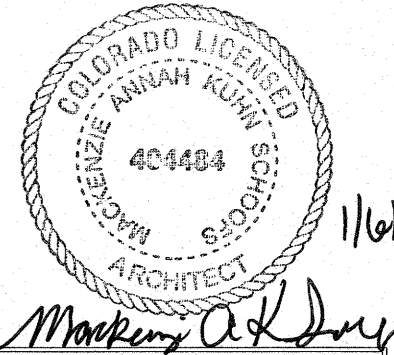
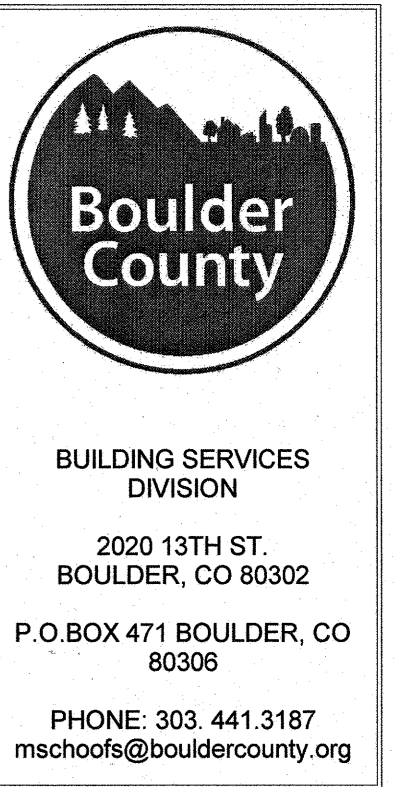
A-	ASSEMBLY OCCUPANCY
AC	ACOUSTIC ONLY HERMAN MILLER
AC/GL	ACOUSTIC AND GLASS HERMAN MILLER
A.D.A	AMERICAN DISABILITY ACT (COMPLIES WITH)
A.F.F.	ABOVE FINISHED FLOOR
ARCH.	ARCHITECT
B	BUSINESS OCCUPANCY
B.O.	BOTTOM OF
BLDG.	BUILDING
BM	BEAM
CA	CARD ACCESS
C.L.	CENTER LINE
CIRC.	CIRCULAR
CJ	CONTROL JOINT
CLG.	CEILING
CONC.	CONCRETE
CONTR.	CONTINUOUS
CONST.	CONSTRUCTION
COORD.	COORDINATE
CPT.	CARPET
CT	CERAMIC TILE
D.F.	DRINKING FOUNTAIN
DIA.	DIAMETER
EA.	EACH
EL.	ELEVATION
EJ	EXPANSION JOINT
EQUIPT.	EQUIPMENT
ES	ELECTRONIC STRIKE
ETC.	ET CETERA
EX	EXISTING
EXP.	EXPOSED
EXT.	EXTERIOR
F.E.	FIRE EXTINGUISHER
F.D.	FLOOR DRAIN
FR	FIRE RATED
G.C.	GENERAL CONTRACTOR
GA.	GAGE
GALV.	GALVANIZED
G.F.	GROUT FILLED
G.W.B.	GYPHUM WALL BOARD
HDWR.	HARDWARE
HGHT.	HEIGHT
I.C.F.	INSULATED CONCRETE FORM (WALL)
I.B.C.	INTERNATIONAL BUILDING CODE
INS.	INSULATION
INT.	INTERIOR
J	JOINT
KIT.	KITCHEN
LNM	LINOLEUM
MAN.	MANUFACTURER
MAT.	MATERIAL
MAX.	MAXIMUM
MECH.	MECHANICAL
MET.	METAL
MIR.	MIRROR
MIN.	MINIMUM
N.I.C.	NOT IN CONTRACT
O.C.	ON CENTER
OCC.	OCCUPANCY
O.DIA.	OUTSIDE DIAMETER
OPP.	OPPOSITE
OTS.	OPEN TO STRUCTURE
P.E.	PUBLIC ESTABLISHED ZONING
PL.	PLATE
PERF.	PERFORATED
PH.	PHASE
PRMT.	PERMIT
PROP.	PROPERTY
P.T.D.	PAPER TOWEL DISPENSER
PTD.	PAINTED
R.	RISER
R.C.P.	REFLECTED CEILING PLAN
RE.	REFERENCE
R.O.W	RIGHT OF WAY
RB	RUBBER BASE
S.A.C.	SUSPENDED ACOUSTICAL CEILING
SB	SOUND BOARD
S.C.	SOLID CORE
SIM.	SIMILAR
SPEC.	SPECIFICATION
SS	STAINLESS STEEL
STL.	STEEL
STO.	STORAGE
STRUCT.	STRUCTURAL
THICK.	THICKNESS
T.	TREAD
T.O.	TOP OF
T.P.	TOILET PAPER DISPENSER
TYP.	TYPICAL
U.N.O.	UNLESS NOTED OTHERWISE
V.B.	VAPOR BARRIER
V.I.F.	VERIFY IN FIELD
W	WITH
WC	WATER CLOSET
WD.	WOOD
WP	WORK POINT

### GRAPHICS LEGEND

PROJECT BOUNDARY - - - - -

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BOULDER COUNTY  
3897 N. 75TH STREET  
WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

**PROJECT:**  
WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

**LOCATION:**  
3897 N. 75TH STREET  
BOULDER, COLORADO 80301

**SHEET:**  
COVER PAGE

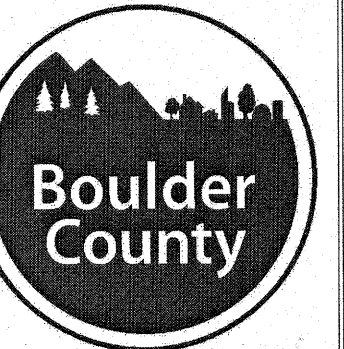
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DATE: 7/28/2019  
DRAWN BY: MS  
CHECKED BY: JB

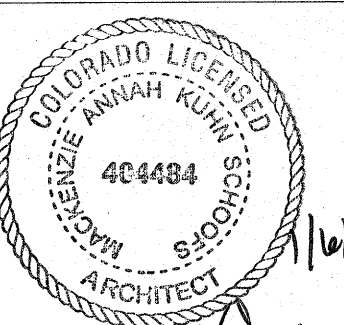
**REVISIONS:**

1-COMMENT FROM 6/7/2019  
2-F.P. REVIEW COMMENTS FROM 7/16/2019  
3-COMMENTS FROM 9/29/2019  
4-COMMENTS FROM 10/4/2019  
5-COMMENTS FROM 11/10/2019  
6-COMMENTS FROM 11/17/2019

SHEET  
A001



Boulder County  
 BUILDING SERVICES  
 DIVISION  
 2020 13TH ST.  
 BOULDER, CO 80302  
 P.O. BOX 471 BOULDER, CO  
 80306  
 PHONE: 303.441.3187  
 mschoofs@bouldercounty.org



Mark A. R. Decker

**BOULDER COUNTY**  
 3897 N. 75TH STREET  
 WALDEN TRANSPORTATION CREW ROOM AND  
 OFFICE REMODEL

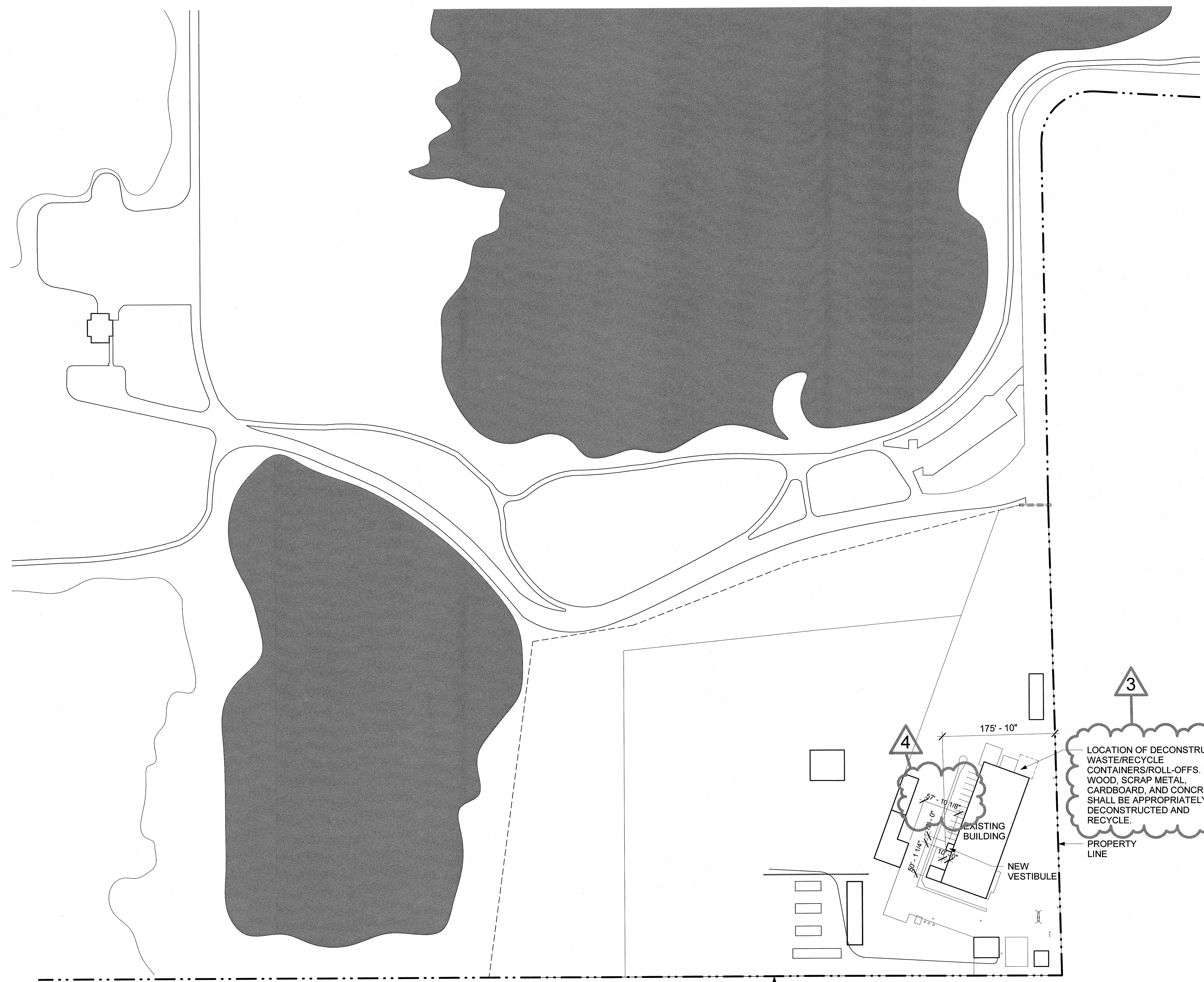
PROJECT  
 WALDEN  
 TRANSPORTATION CREW  
 ROOM AND OFFICE  
 REMODEL  
 LOCATION  
 3897 N. 75TH STREET  
 BOULDER, COLORADO  
 80301  
 SHEET  
 PARTIAL SITE PLAN

FILE NAME  
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 MAINTENANCE OFFICE AND  
 MAINTENANCE BUILDING 2019 REMODEL.dwg  
 ACCT 999704  
 DATE: 7/26/2019  
 DRAWN BY: MK  
 CHECKED BY: JB

REVISIONS

1-COMMENT FROM	6/7/2019
2-F.P. REVIEW COMMENTS	7/18/2019
3-COMMENTS FROM	9/29/2019
4-COMMENTS FROM	10/4/2019
5-COMMENTS FROM	10/10/2019
6-COMMENTS FROM	10/17/2019

SHEET  
**A002**


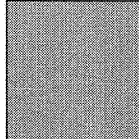
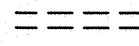






LOCATION OF DECONSTRUCTION  
 WASTE/RECYCLE  
 CONTAINERS/ROLL-OFFS. ALL  
 WOOD, SCRAP METAL,  
 CARDBOARD, AND CONCRETE  
 SHALL BE APPROPRIATELY  
 DECONSTRUCTED AND  
 RECYCLE.

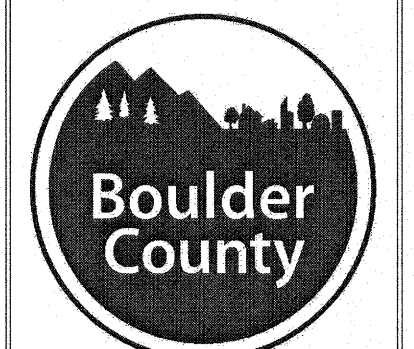
**1** PARTIAL SITE PLAN  
 A002 1" = 80'-0"

KEY PLAN

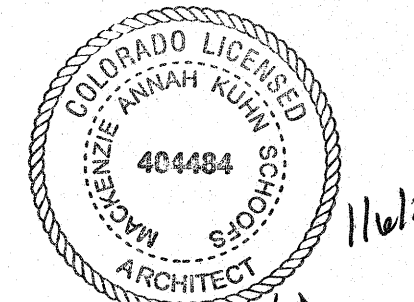
**DEMOLITION PLAN LEGEND**

-  OUTLINE OF PROJECT
-  AREA NOT IN SCOPE
-  REMOVE EXISTING WALL OR PORTION OF WALL
-  REMOVE EXISTING DOOR AND FRAME
-  FLOORING & BASE TO BE REMOVED.
-  REMOVE EXISTING CASEWORK.
-  REMOVE EXISTING FIXTURES.

NOTE: WALLS TO BE REMOVED ARE NON-LOAD BEARING. NOTIFY ARCHITECT IMMEDIATELY IF DURING DEMOLITION ANY MEMBERS ARE UNCOVERED THAT RESEMBLE STRUCTURAL COMPONENTS.



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P.O. BOX 471 BOULDER, CO 80306  
PHONE: 303.441.3187  
mschools@bouldercounty.org



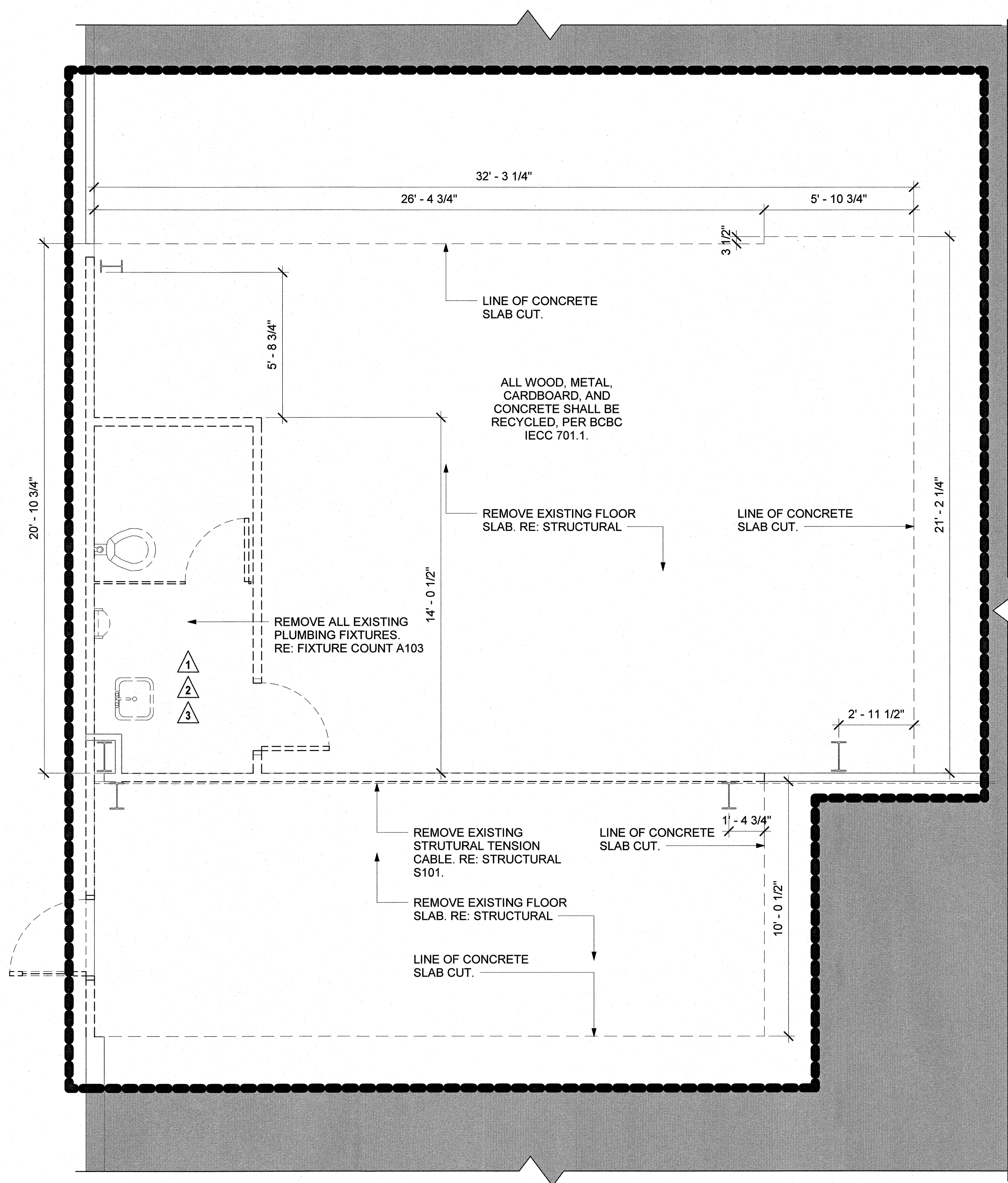
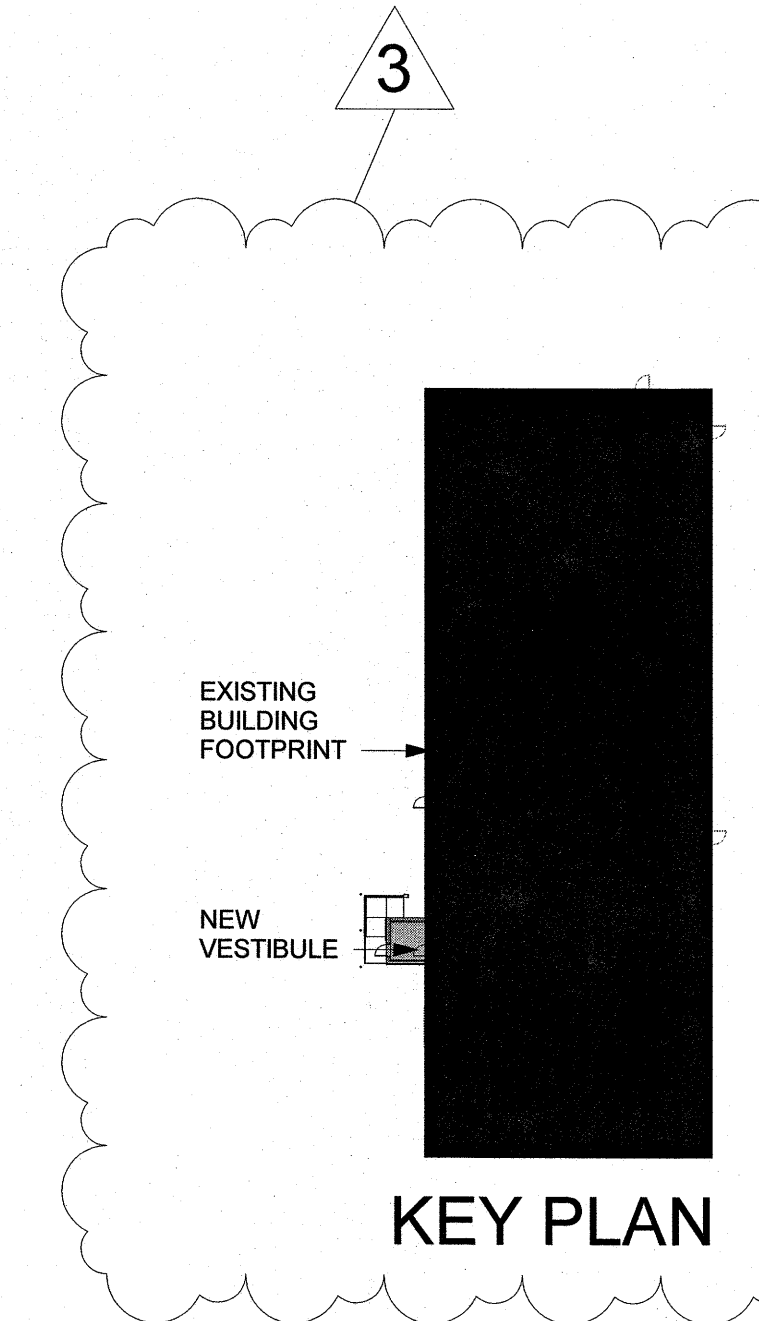
*Mark A. Doherty*

**BOULDER COUNTY**  
3897 N. 75TH STREET  
WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

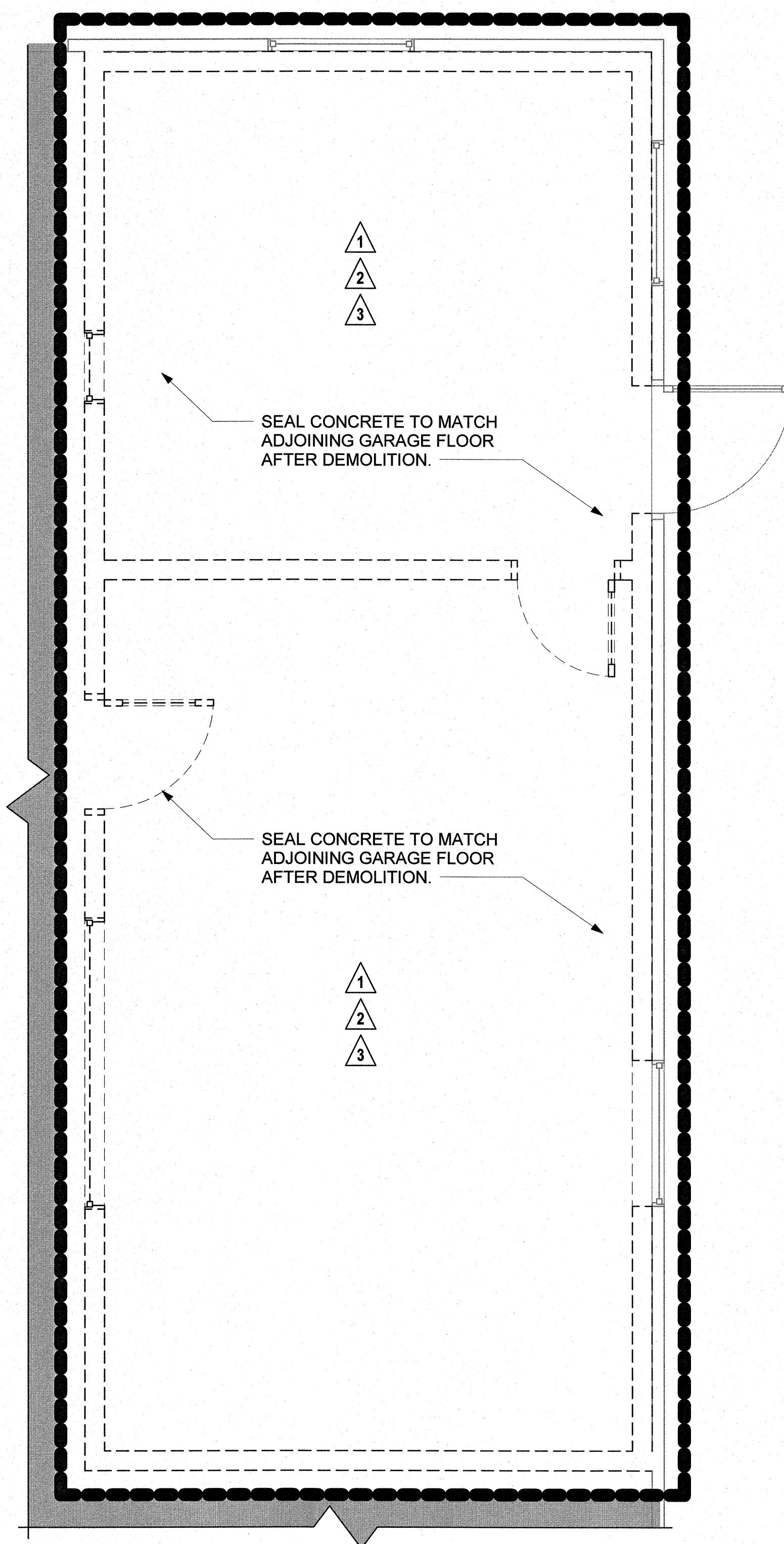
PROJECT  
WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL  
LOCATION  
3897 N. 75TH STREET BOULDER, COLORADO 80301  
SHEET  
CREW ROOM AND OFFICE DEMOLITION PLAN  
FILE NAME  
G:\PROJECTS\TRANSPORTATION CREW ROOM AND OFFICE REMODEL\3897 N. 75TH STREET\WALDEN CREW ROOM AND OFFICE DEMOLITION PLAN.rvt  
ACC'T 999704  
DATE: 7/28/2019  
DRAWN BY: MS  
CHECKED BY: JB

REVISIONS  
1-COMMENT FROM 6/7/2019  
2-F.P. REVIEW COMMENTS FROM 7/16/2019  
3-COMMENTS FROM 9/23/2019  
4-COMMENTS FROM 10/4/2019  
5-COMMENTS FROM 10/10/2019  
6-COMMENTS FROM 10/17/2019

SHEET  
**A101**



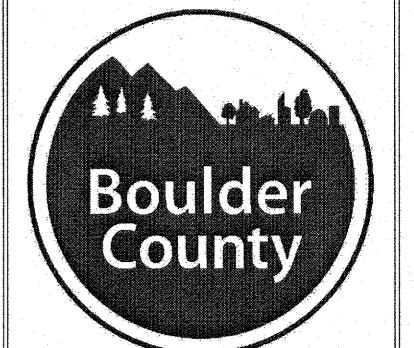
**1**  
A101  
TRANSPORTATION CREW ROOM AND OFFICE  
DEMOLITION PLAN - SW  
3/8" = 1'-0"



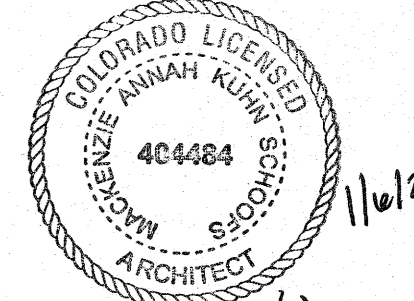
**2**  
A101  
TRANSPORTATION CREW ROOM AND OFFICE  
DEMOLITION PLAN - NE  
3/8" = 1'-0"







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 BOULDER, CO 80302  
 P.O. BOX 471 BOULDER, CO 80305  
 PHONE: 303.441.3187  
 mschoofs@bouldercounty.org



Matthew A. Schmitt

**BOULDER COUNTY**  
 3897 N. 75TH STREET  
 WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

**PROJECT**  
 WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

**LOCATION**  
 3897 N. 75TH STREET  
 BOULDER, COLORADO 80301

**SHEET**  
 CREW ROOM AND OFFICE FLOOR PLAN

**FILE NAME**  
 G:\PROJECTS\2019\107 - WALDEN FORDS ROAD - TRANSPORTATION CREW ROOM AND OFFICE REMODEL\107 - WALDEN FORDS ROAD - TRANSPORTATION CREW ROOM AND OFFICE REMODEL.rvt

**ACCT** 999704  
**DATE** 7/26/2019  
**DRAWN BY** MS  
**CHECKED BY** JB

**REVISIONS**

1	COMMENT FROM	6/7/2019
2	P. REVIEW COMMENTS FROM	7/16/2019
3	COMMENTS FROM	9/29/2019
4	COMMENTS FROM	10/4/2019
5	COMMENTS FROM	10/10/2019
6	COMMENTS FROM	10/17/2019

**SHEET**  
**A102**

**FLOOR PLAN LEGEND**

- OUTLINE OF PROJECT
- AREA NOT IN SCOPE
- NEW BOLLARD
- NEW FLOOD WALL
- LINE OF NEW SLAB
- NEW CARD ACCESS
- RELOCATED EYE WASH STATION
- NEW SLOP SINK
- NEW FIRE EXTINGUISHER
- NEW CABINETRY
- NEW MOP SINK
- ALL WALLS TO GO TO STRUCTURE.  
 APPLY STAINLESS STEEL CORNER GUARDS TO EVERY EXPOSED CORNER.

**PLUMBING FIXTURE COUNT**

OFFICE & CREW ROOM = 537 S.F. = 6 OCCUPANTS  
 GARAGE = 9,751 S.F. = 20 OCCUPANTS  
 # OF OCCUPANTS = 20 + 6 = 26

**REQUIRED FIXTURES**

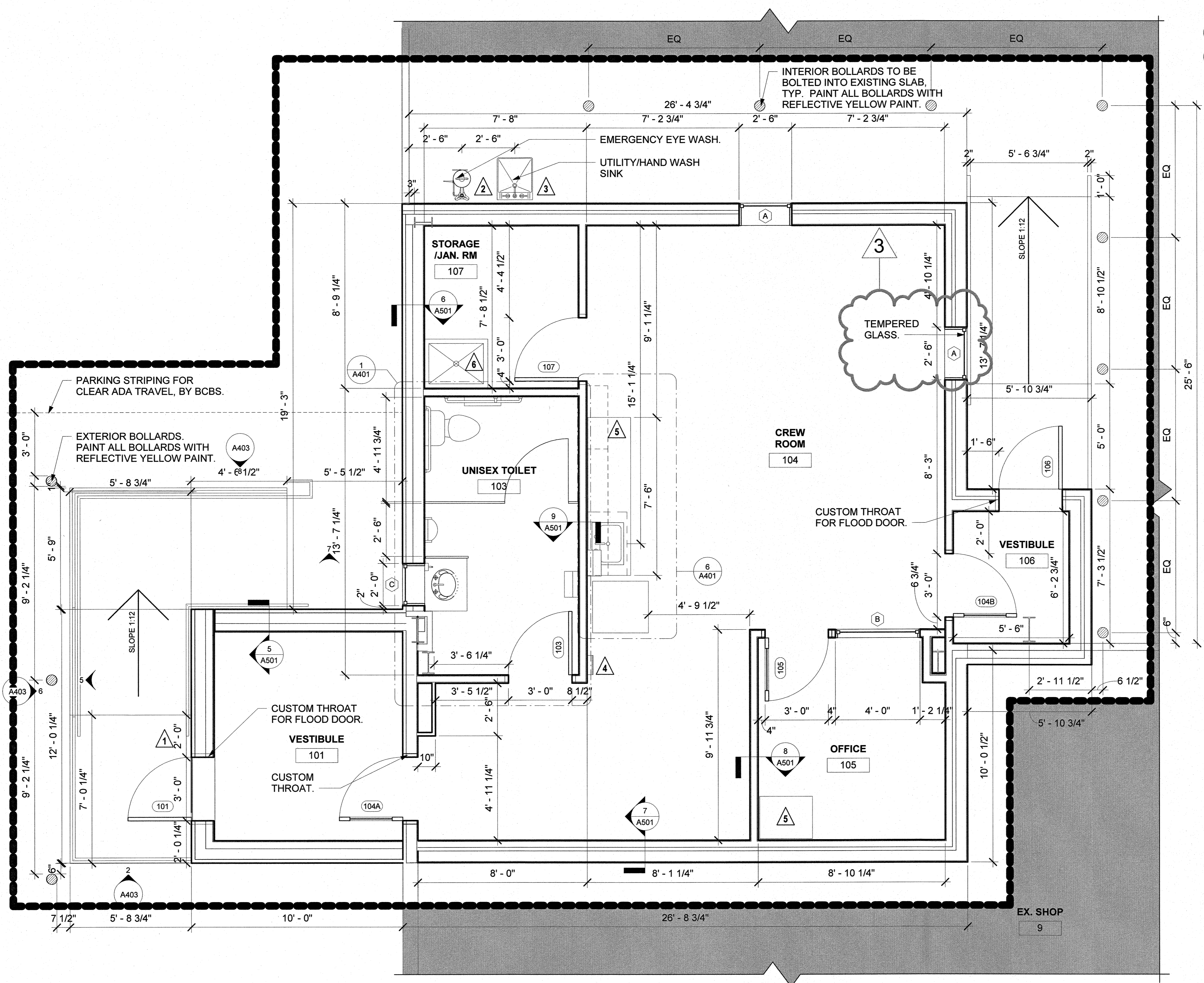
- 1 TOILET
- 1 BATHROOM SINK
- 1 MOP SINK

**EXISTING**

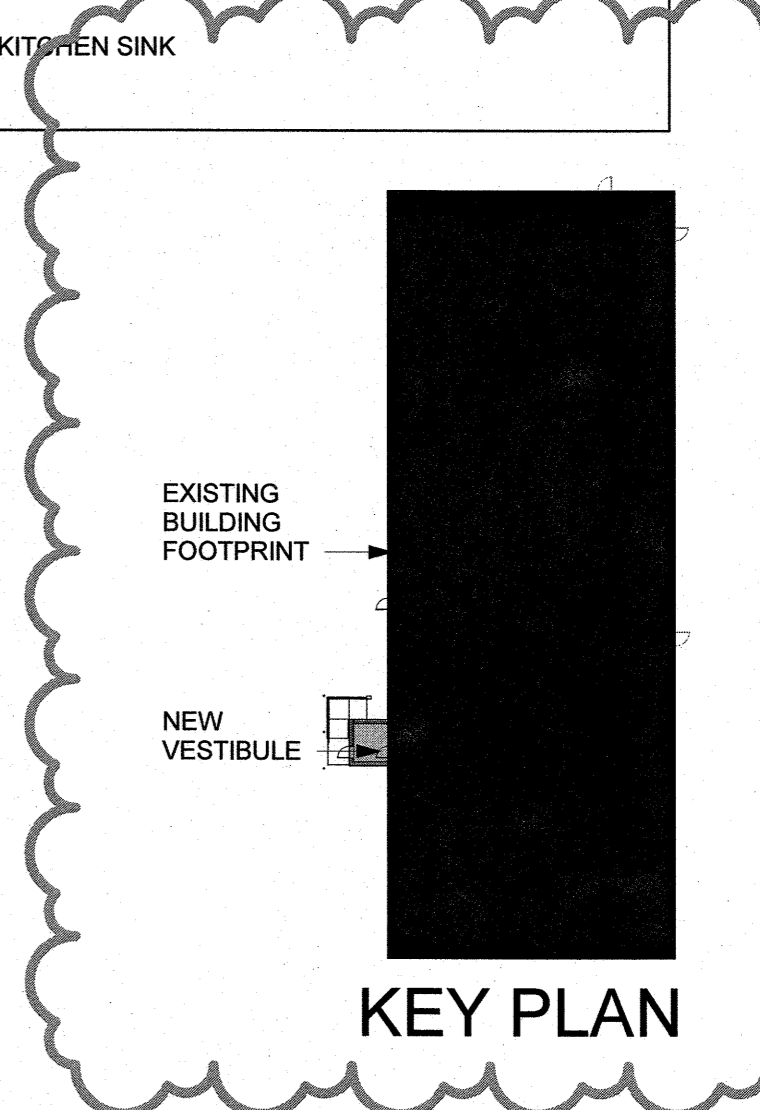
- 1 TOILET (TO BE REMOVED)
- 1 URINAL (TO BE REMOVED)
- 1 BATHROOM SINK (TO BE REMOVED)
- 1 EMERGENCY EYE WASH (TO BE RELOCATED)

**NEW**

- 1 TOILET
- 1 URINAL
- 1 BATHROOM SINK
- 1 EMERGENCY EYE WASH
- 1 MOP SINK
- 1 SLOP SINK
- 1 KITCHEN SINK

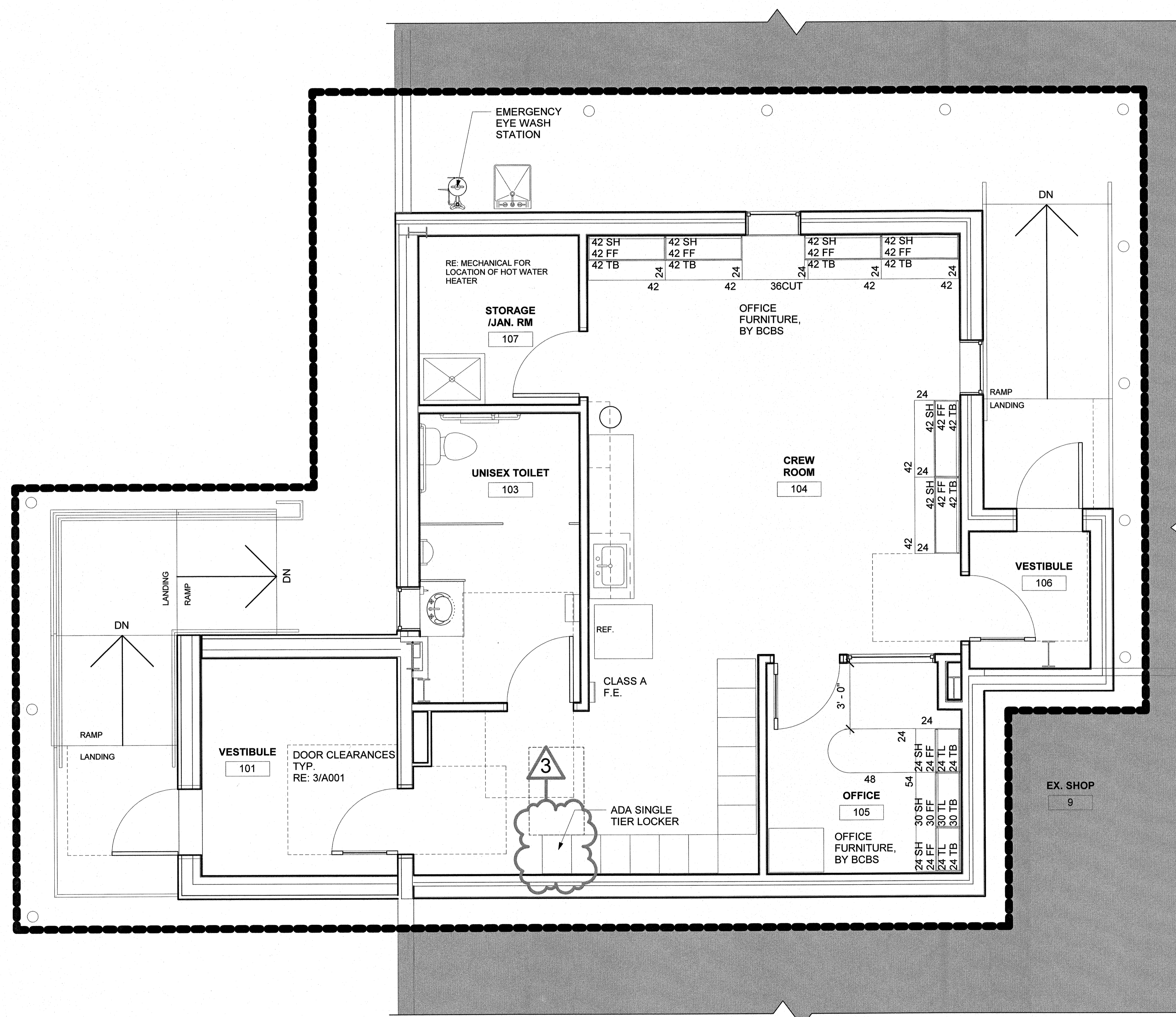


**1**  
 A102 TRANSPORTATION CREW ROOM AND OFFICE FLOOR PLAN  
 3/8" = 1'-0"



**KEY PLAN**

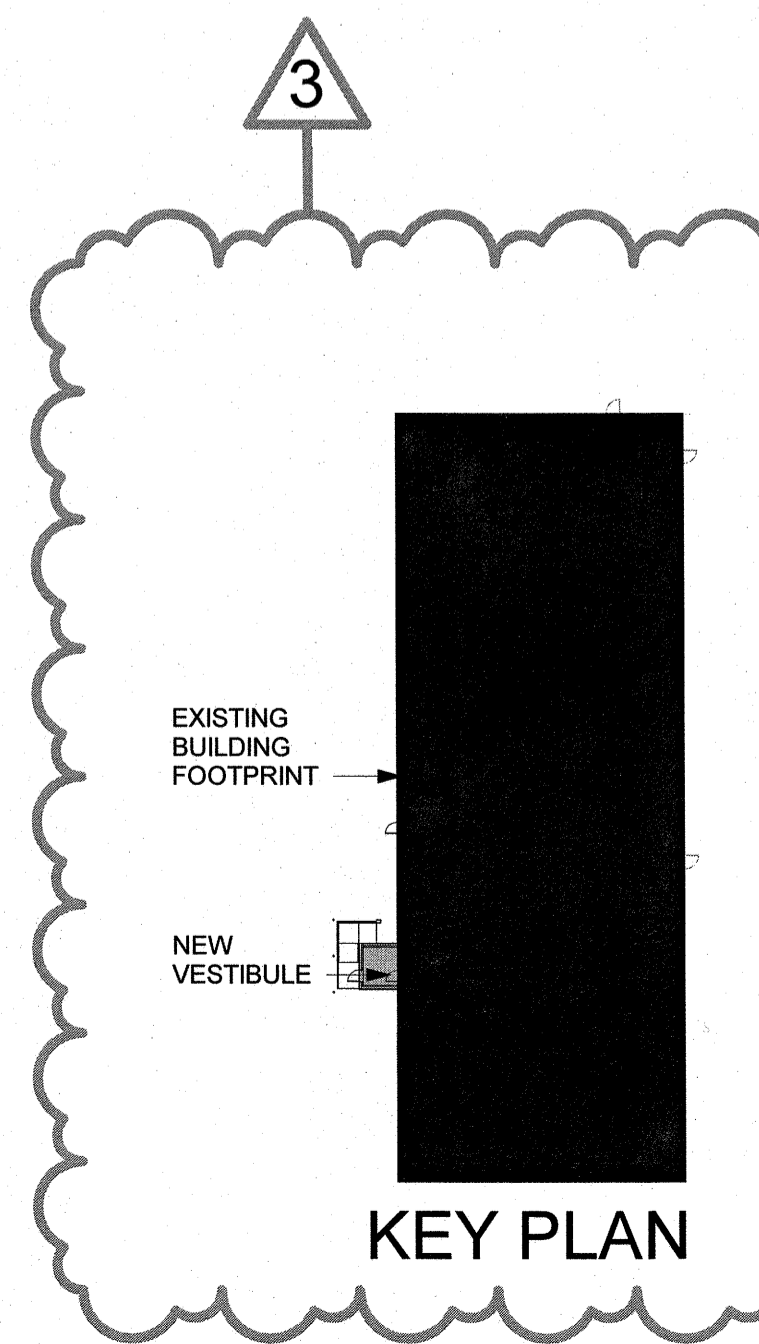
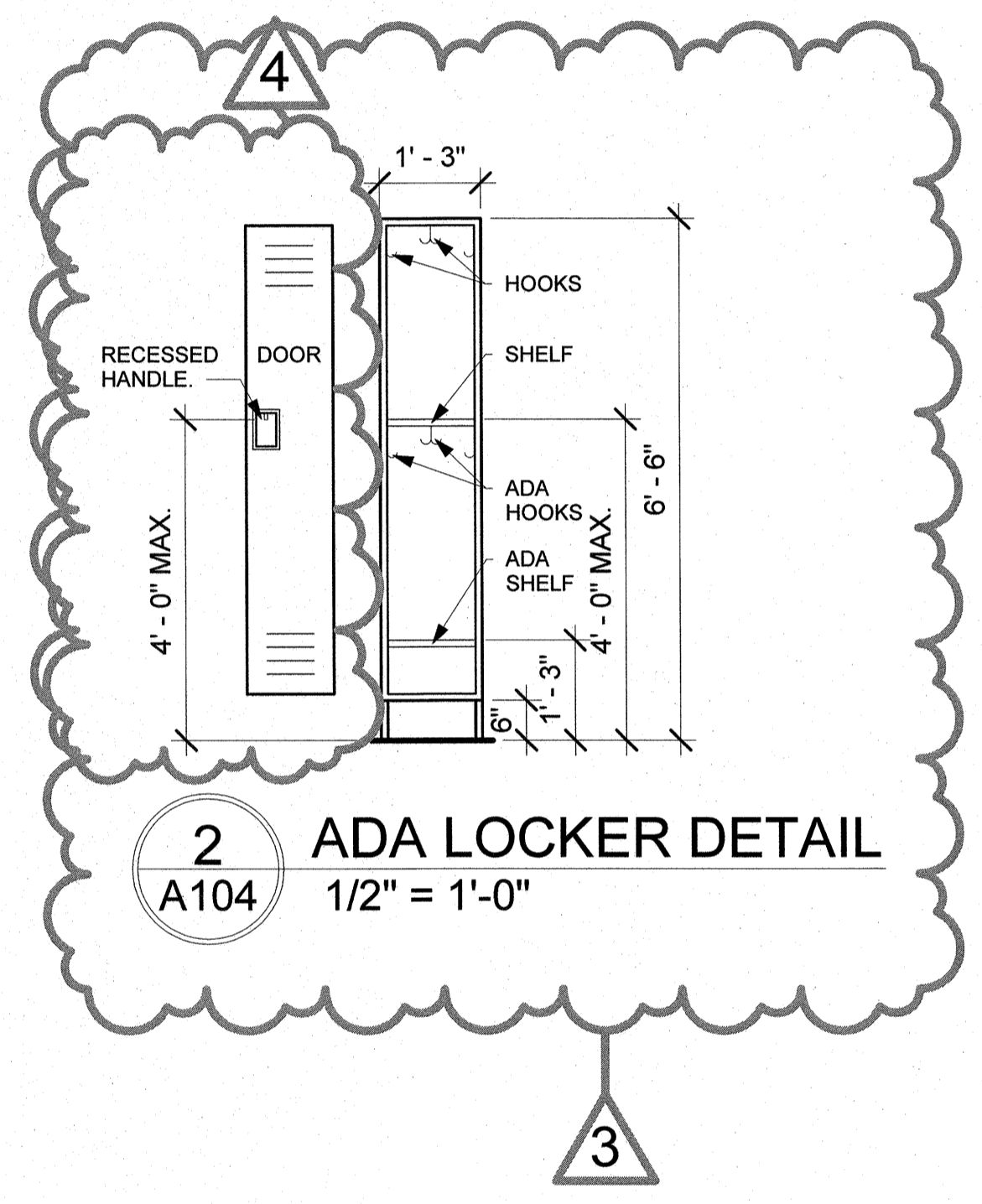




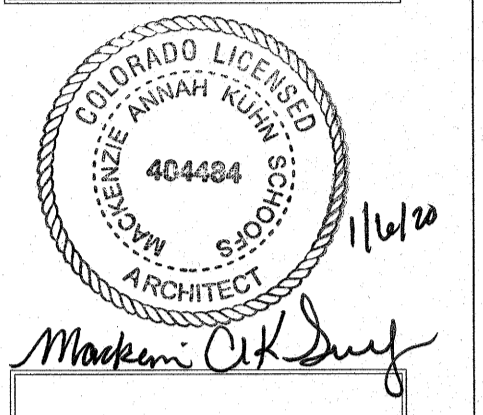
**1** TRANSPORTATION CREW ROOM AND OFFICE FURNITURE PLAN  
 A104 3/8" = 1'-0"

**FURNITURE PLAN LEGEND**

- OUTLINE OF PROJECT
- AREA NOT IN SCOPE
- FF HERMAN MILLER FLIPPER DOOR UNIT
- SH HERMAN MILLER SHELF
- HSH HERMAN MILLER HALF SHELF
- TB HERMAN MILLER TACK BOARD
- TL HERMAN MILLER TASK LIGHT



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 BOULDER, CO 80302  
 P.O. BOX 471 BOULDER, CO 80306  
 PHONE: 303.441.3187  
 mschoofs@bouldercounty.org



**BOULDER COUNTY**  
 3897 N. 75TH STREET  
 WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

**PROJECT**  
 WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

**LOCATION**  
 3897 N. 75TH STREET  
 BOULDER, COLORADO 80301

**SHEET**  
 CREW ROOM AND OFFICE FURNITURE PLAN

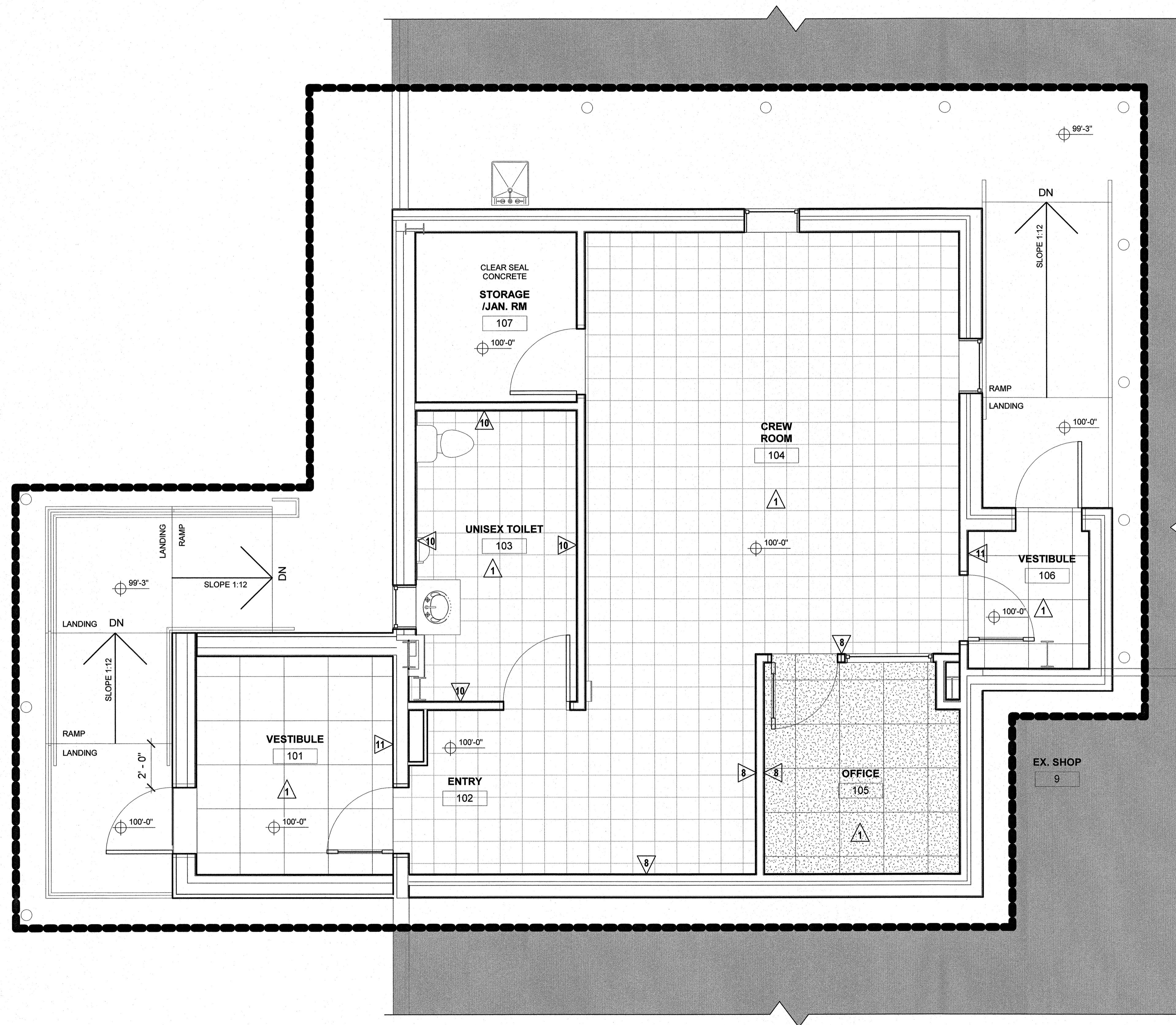
**FILE NAME**  
 PROJECT MANAGEMENTS - Main  
 P:\PROJECTS\3897 - WALDEN POND ROAD MAINTENANCE OFFICE AND TRANSPORTATION CREW ROOM REMODEL\3897 WALDEN POND ROAD MAINTENANCE OFFICE AND TRANSPORTATION CREW ROOM REMODEL.rvt

**ACCT** 999704  
**DATE** 7/26/2019  
**DRAWN BY** MS  
**CHECKED BY** JB

**REVISIONS**

1	COMMENT FROM	6/7/2019
2	P. REVIEW COMMENTS FROM	7/16/2019
3	COMMENTS FROM	9/29/2019
4	COMMENTS FROM	10/4/2019
5	COMMENTS FROM	10/10/2019
6	COMMENTS FROM	10/17/2019

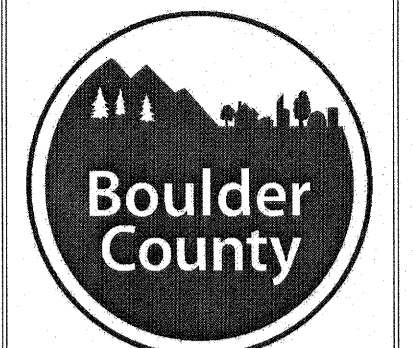
**SHEET**  
**A104**



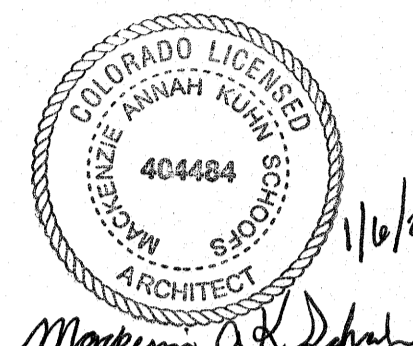
**FINISH PLAN LEGEND**

- OUTLINE OF PROJECT
- AREA NOT IN SCOPE
- WALK-OFF CARPET TILES  
TANDUS CENTIVA  
TRIAD MAT SYSTEMS  
GEOMETRIC TILE  
GEO TILE 00979  
CHARCOAL 00154
- VINYL COMPOSITE TILES  
ARMSTRONG  
STANDARD EXCELON IMPERIAL TEXTURE  
DIAMOND 10 TECH  
FIELD GRAY  
Z1927  
12"x12"
- CARPET TILES  
MOHAWK GROUP  
SEQUENCES II COLLECTION  
GROUND STRATA II  
CELESTIAL 975  
24"x24"

- ALL WALLS TO BE PAINTED LIGHT MOVES UNLESS OTHERWISE NOTED.
- PAINT RED
- PAINT TAN
- PAINT BRWON
- PAINT DARK BLUE
- PAINT LIGHT BLUE
- PAINT YELLOW
- PAINT DARK GREEN
- PAINT LIGHT GREEN
- PAINT LIGHT GRAY
- PAINT DARK GRAY



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2020 13TH ST.  
BOULDER, CO 80302  
P.O. BOX 471 BOULDER, CO 80306  
PHONE: 303.441.3187  
mschoofs@bouldercounty.org



Mark A. Johnson

**BOULDER COUNTY**  
3897 N. 75TH STREET  
WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

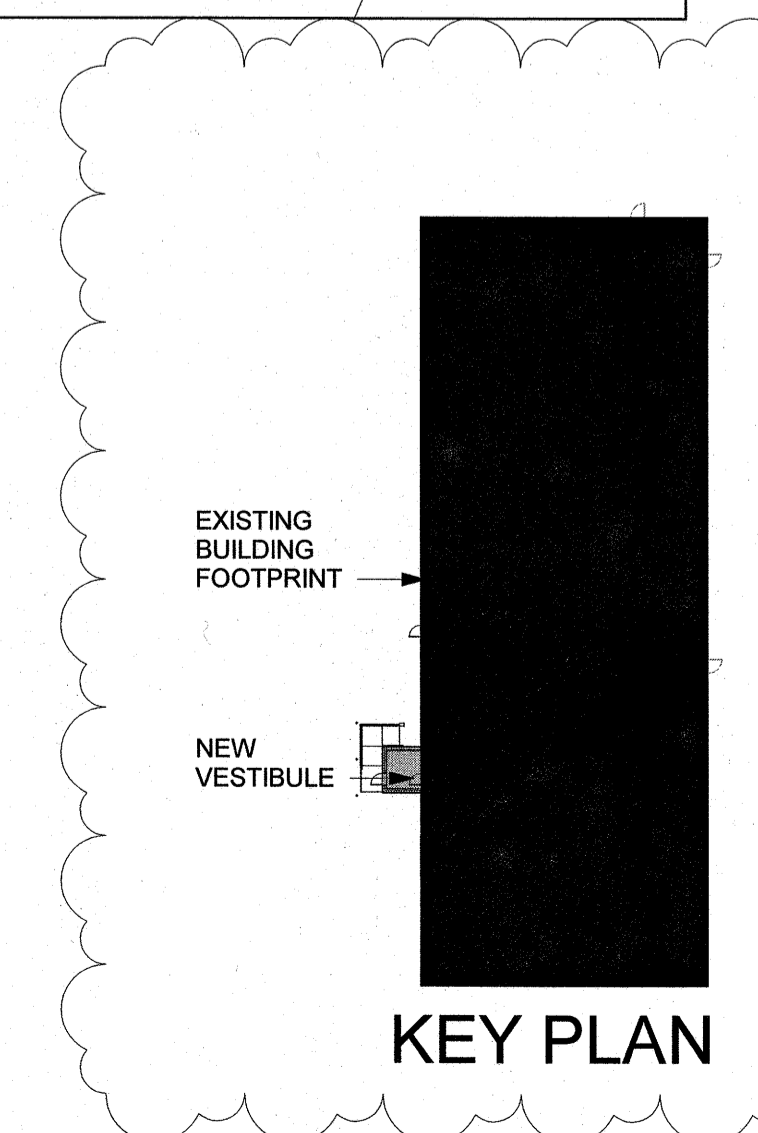
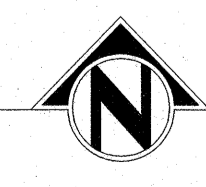
PROJECT  
WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL  
LOCATION  
3897 N. 75TH STREET  
BOULDER, COLORADO 80301  
SHEET  
CREW ROOM AND OFFICE FINISH PLAN  
FILE NAME  
G:\PROJECTS\2019\07 - WALDEN FORKS ROAD - WEST TOWER OFFICE AND BREAKROOM\COMMISSION\FINAL\A105.FINISH PLAN

ACCT 999704  
DATE: 7/28/2019  
DRAWN BY: MS  
CHECKED BY: JB

REVISIONS  
1-COMMENTS FROM 6/7/2019  
2-F.P. REVIEW COMMENTS FROM 7/16/2019  
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4-COMMENTS FROM 10/4/2019  
5-COMMENTS FROM 10/10/2019  
6-COMMENTS FROM 10/17/2019

SHEET  
**A105**

**1** TRANSPORTATION CREW ROOM AND OFFICE FINISH PLAN  
A105 3/8" = 1'-0"

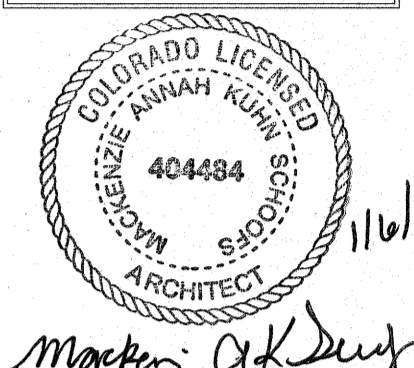




FINISH LEGEND	
FRP	CRANE VARIETEX 4'X10' COTTON WHITE LINEN 1130
COUNTERTOP	WILSONART GRAPHITE NEBULA MATTE 4623-60
CABINETS	WILSONART FUSION MAPLE MATTE 7909-60

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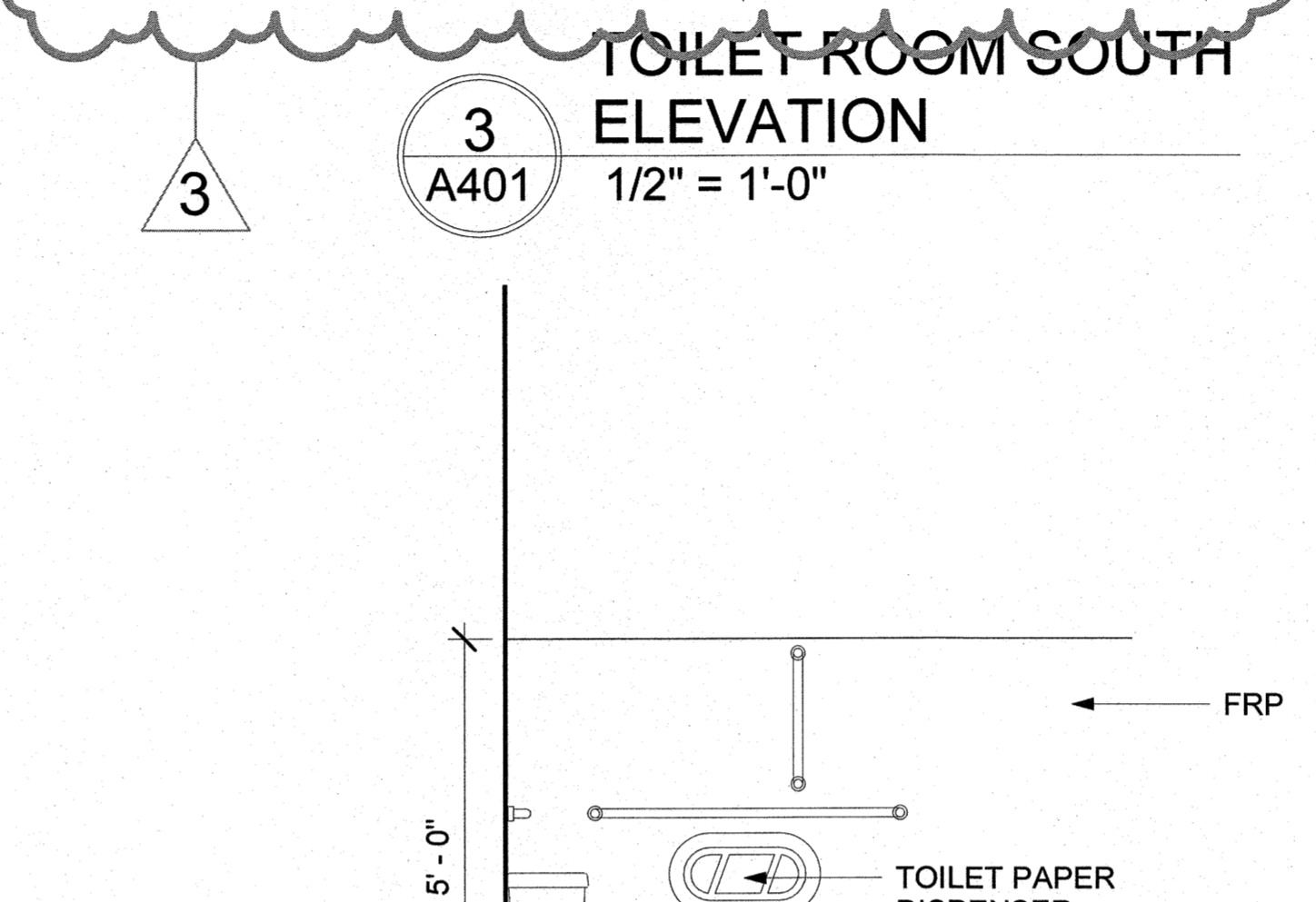
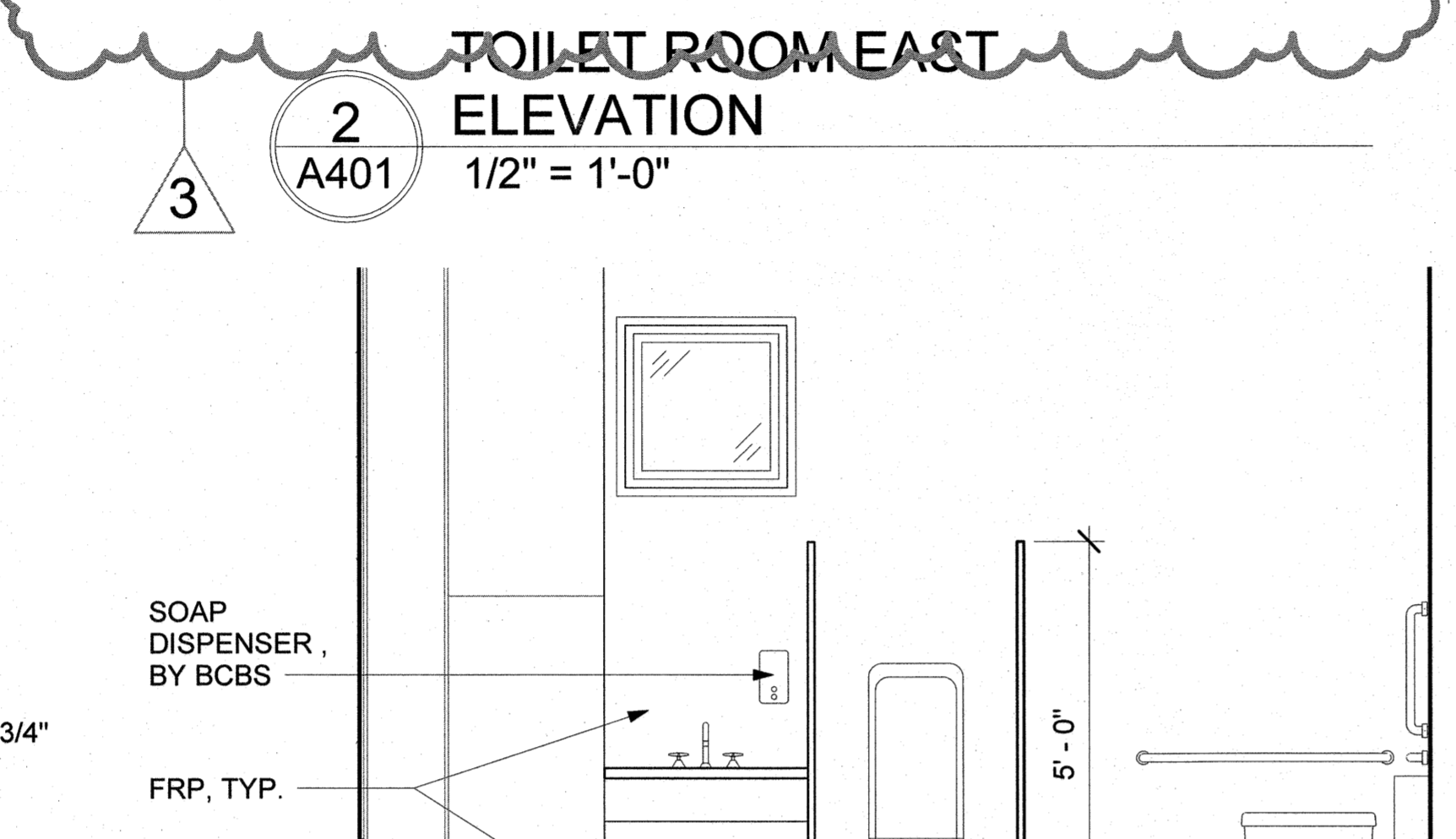
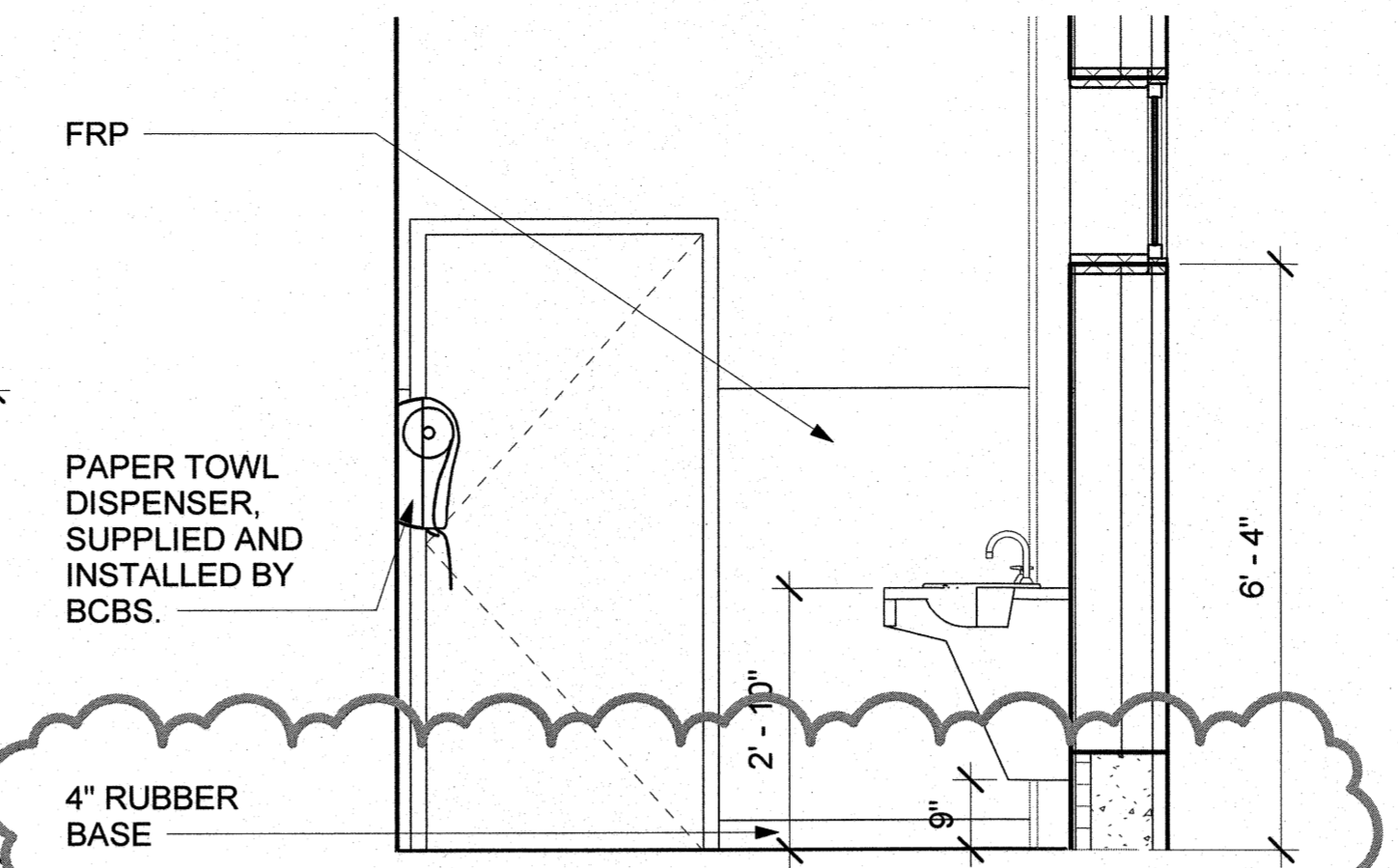
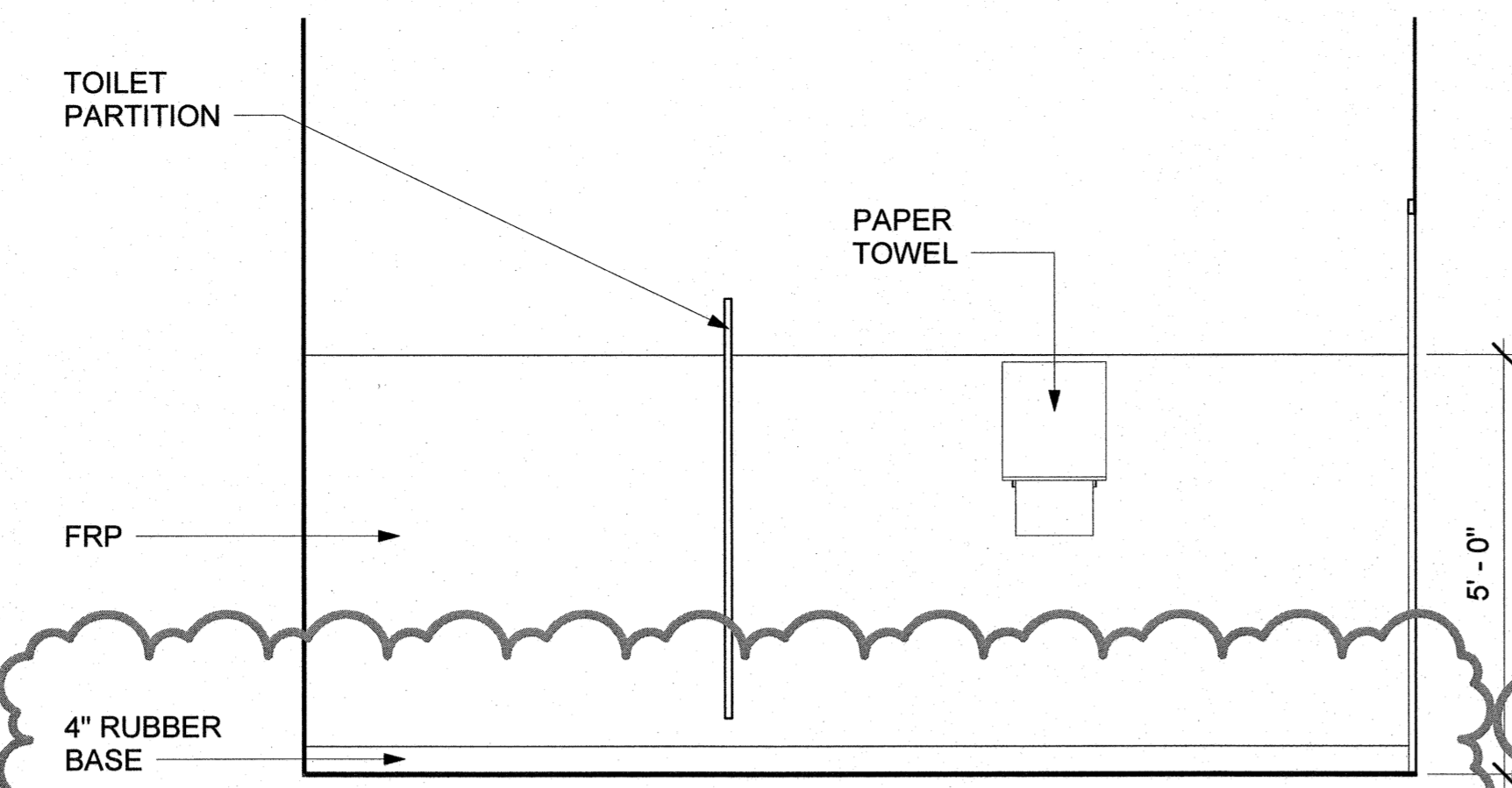
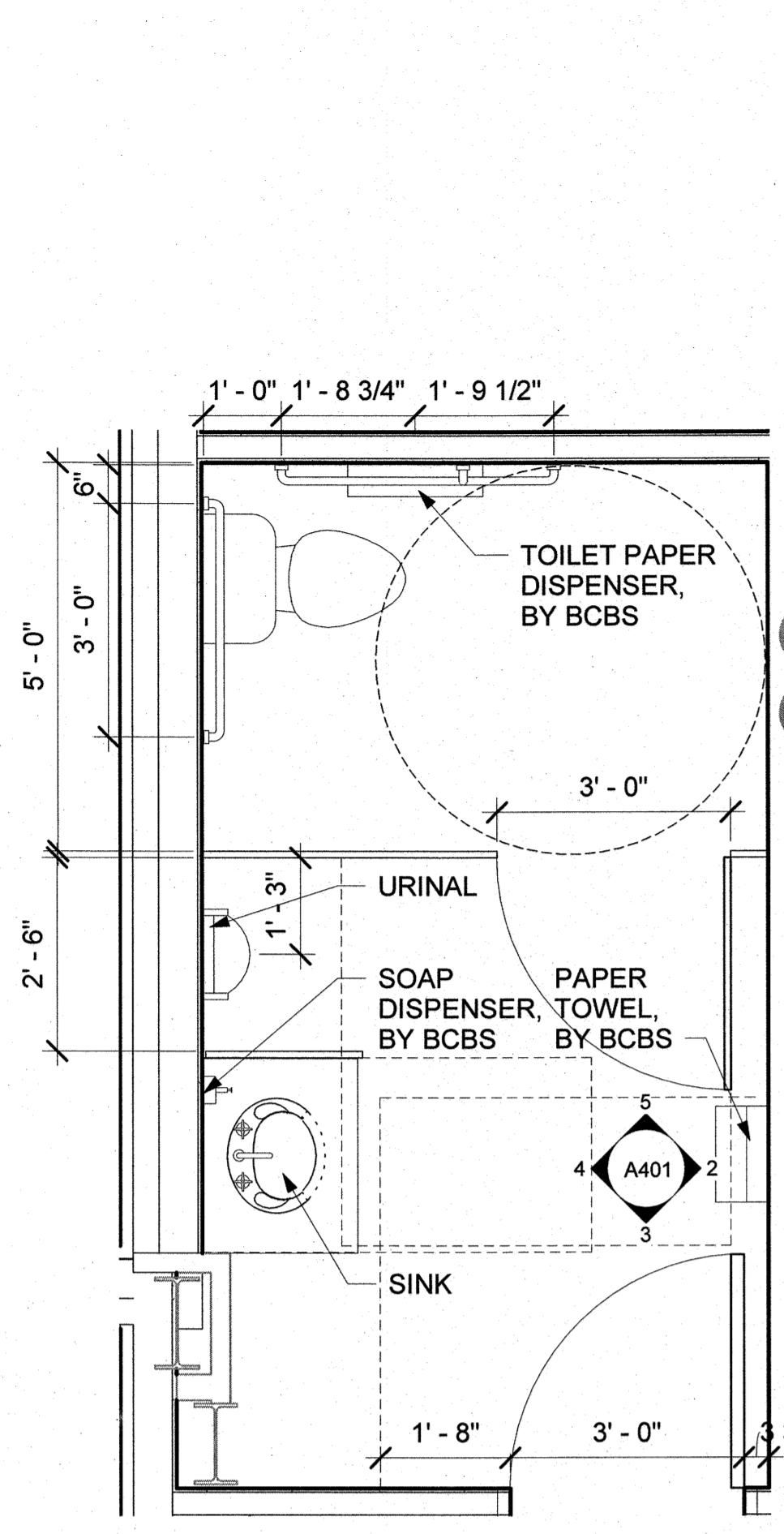


**BOULDER COUNTY**  
3897 N. 75TH STREET  
WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

PROJECT: WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL  
LOCATION: 3897 N. 75TH STREET BOULDER, COLORADO 80301  
SHEET: ENLARGED PLANS AND ELEVATIONS  
FILE NAME: G:\SET\WALDEN\PROJECTS\WALDEN\_TRANSPORTATION\_CREW\_ROOM\_AND\_OFFICE\_REMODEL\DWG\WALDEN\_TRANSPORTATION\_CREW\_ROOM\_AND\_OFFICE\_REMODEL.dwg  
ACCT: 999704  
DATE: 7/26/2019  
DRAWN BY: MS  
CHECKED BY: JB

REVISIONS:  
1-COMMENT FROM 6/7/2019  
2-F.P. REVIEW COMMENTS FROM 7/16/2019  
3-COMMENTS FROM 9/29/2019  
4-COMMENTS FROM 10/4/2019  
5-COMMENTS FROM 10/10/2019  
6-COMMENTS FROM 10/17/2019

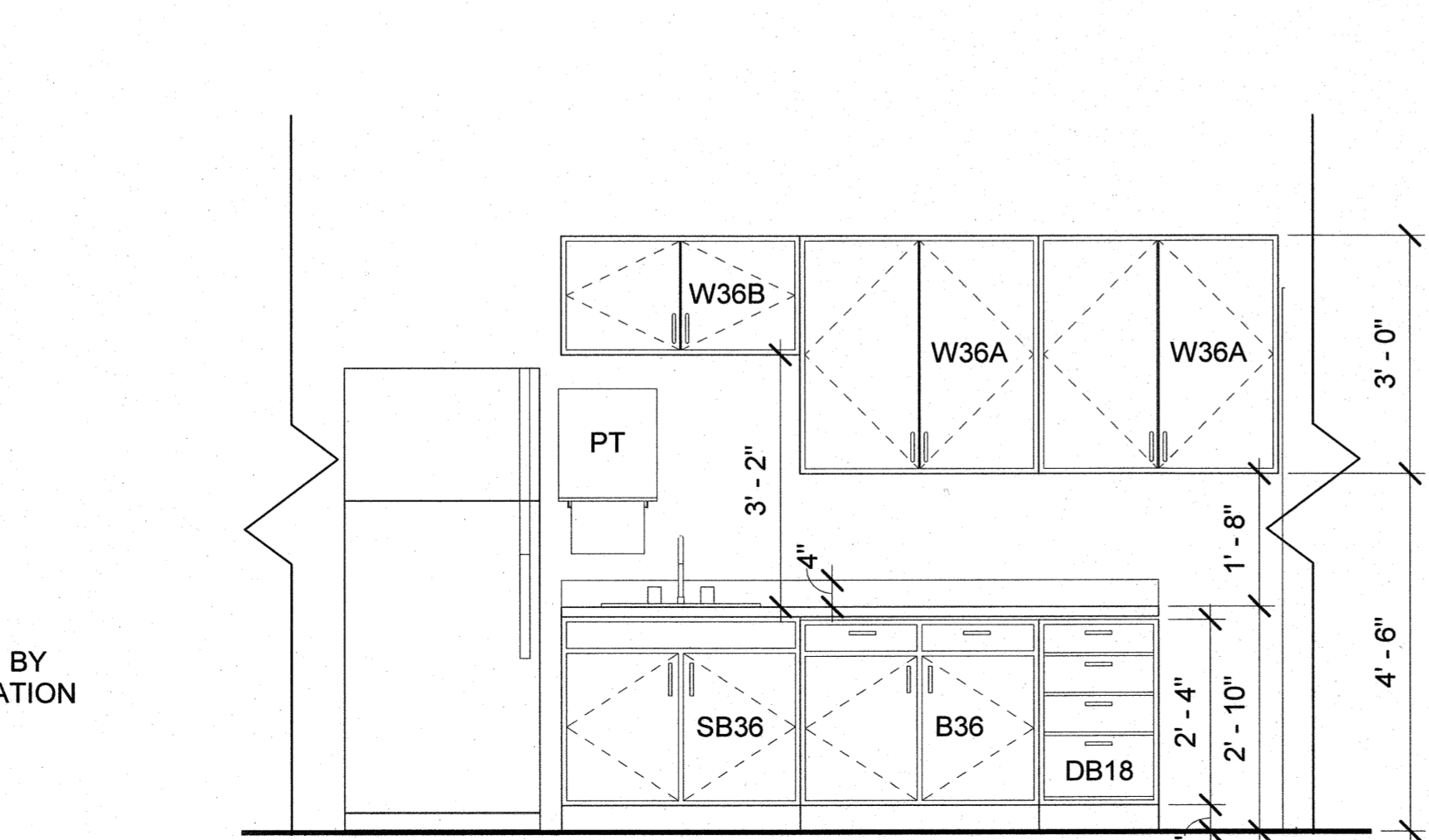
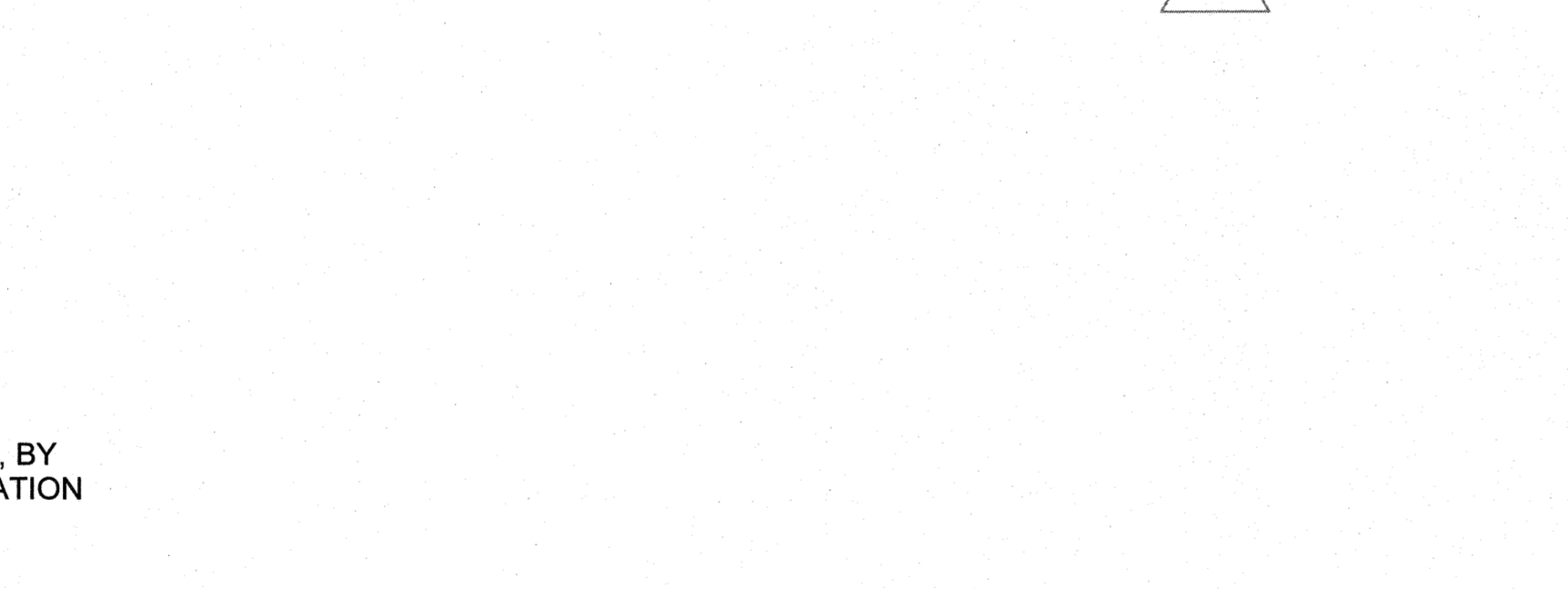
SHEET  
**A401**



**1**  
A401 1/2" = 1'-0"

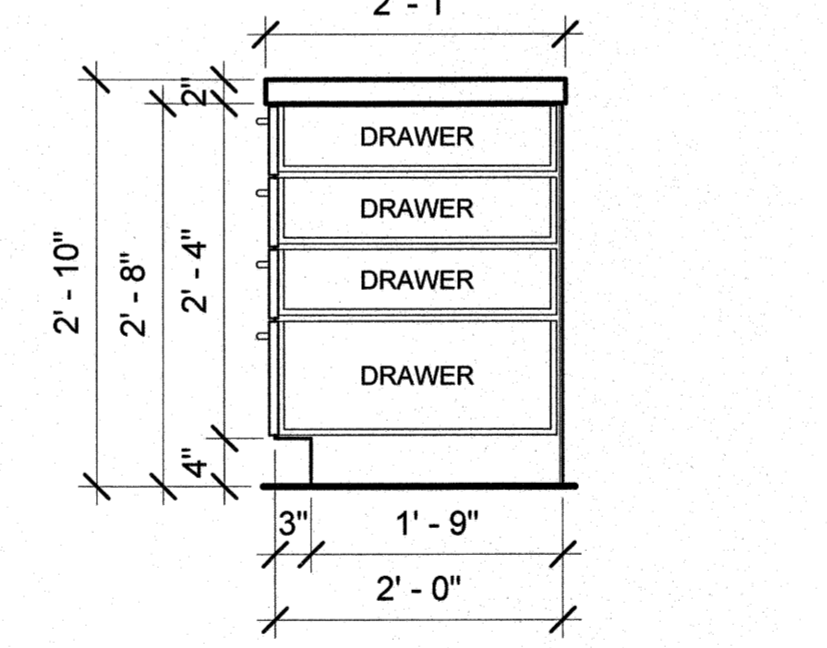
**2**  
A401 1/2" = 1'-0"

**3**  
A401 1/2" = 1'-0"

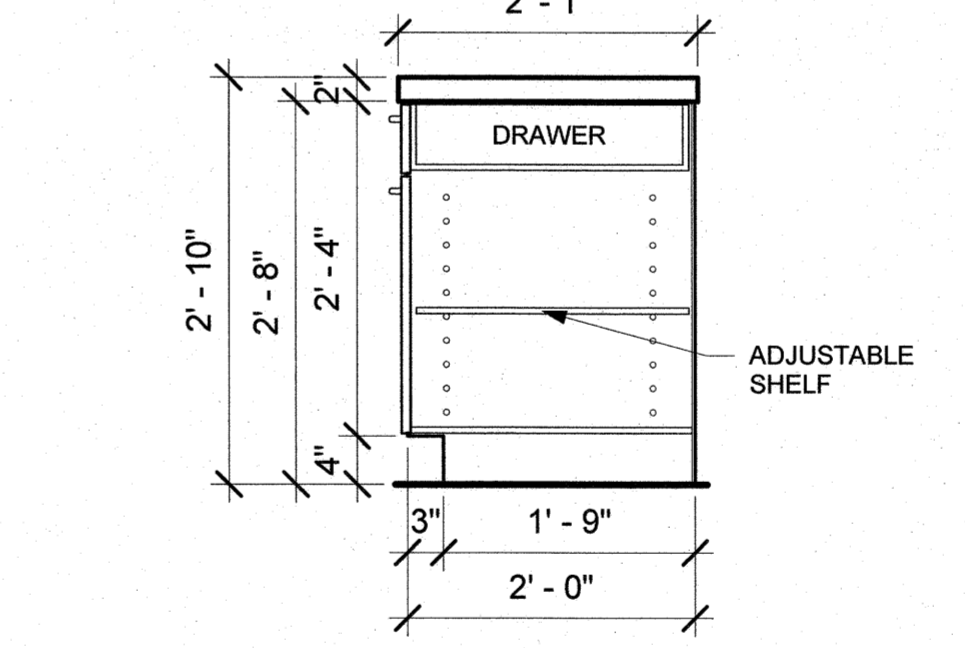


**6**  
A401 1/2" = 1'-0"

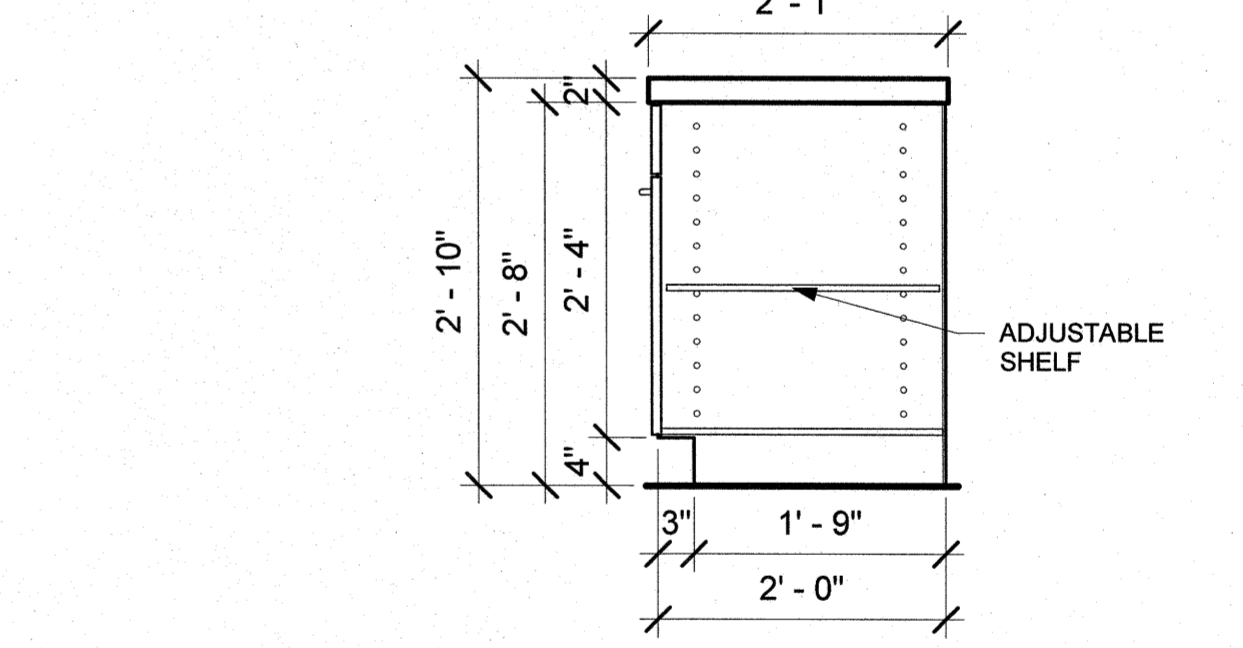
**7**  
A401 1/2" = 1'-0"



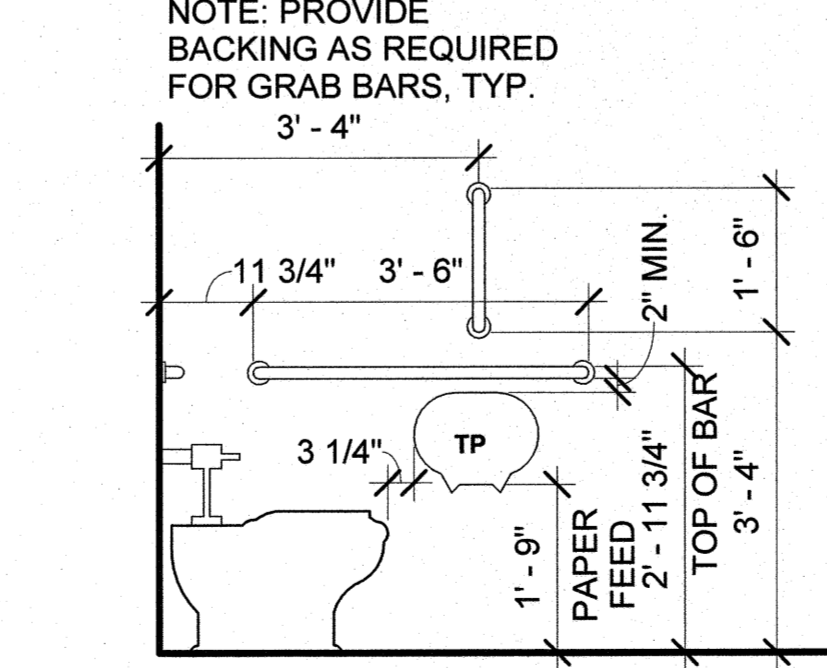
**8**  
A401 3/4" = 1'-0"



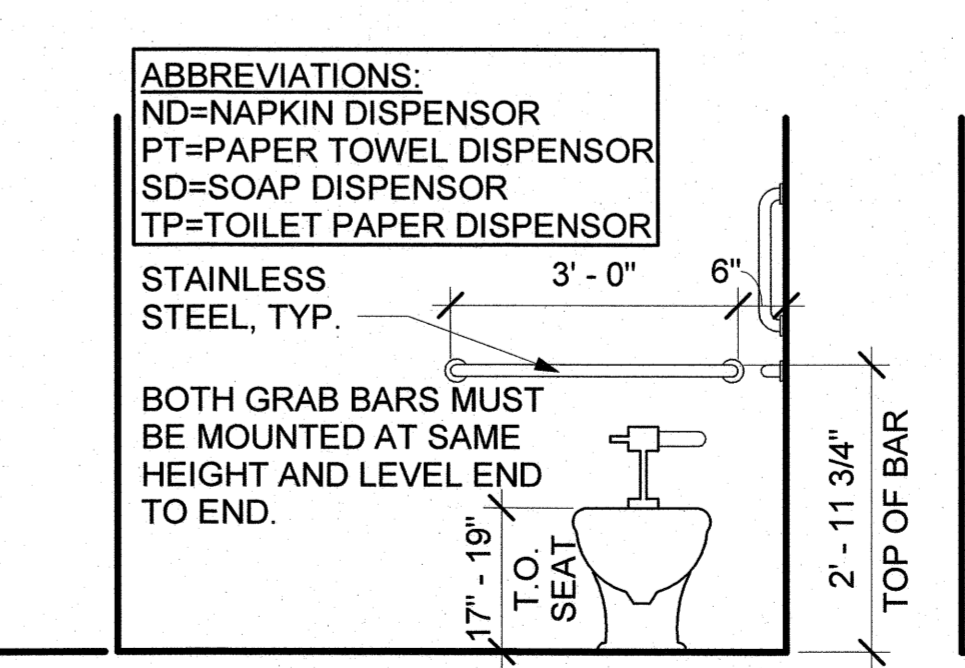
**9**  
A401 3/4" = 1'-0"



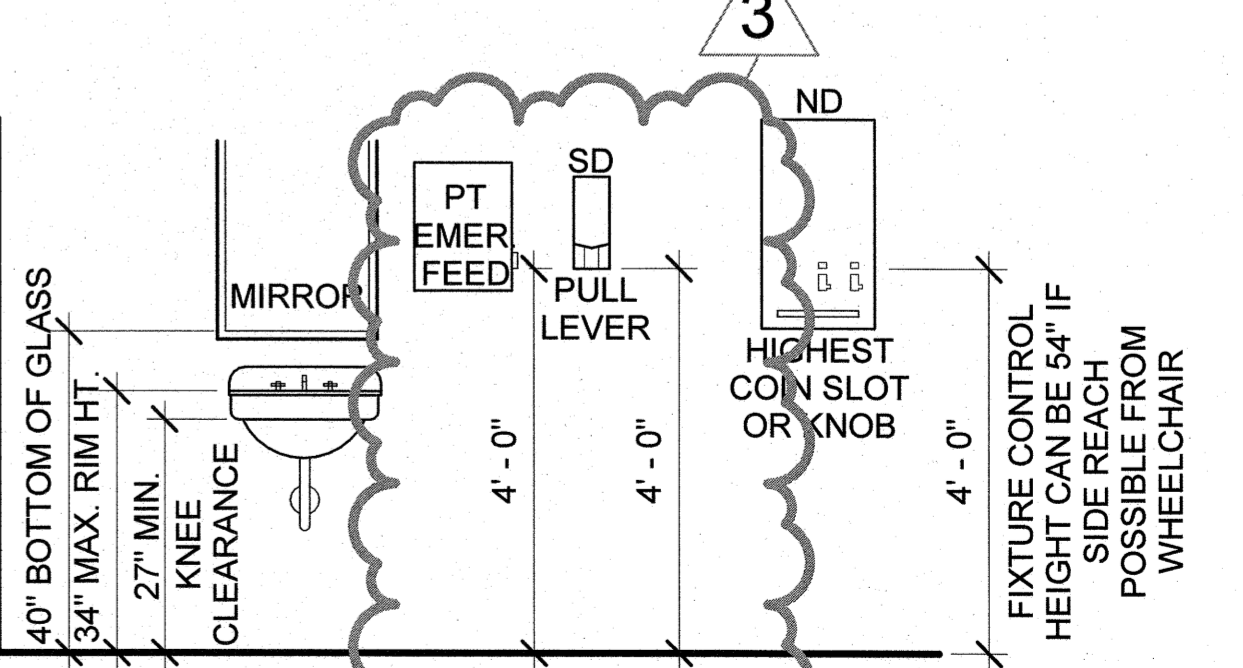
**10**  
A401 3/4" = 1'-0"



**11**  
A401 1/2" = 1'-0"

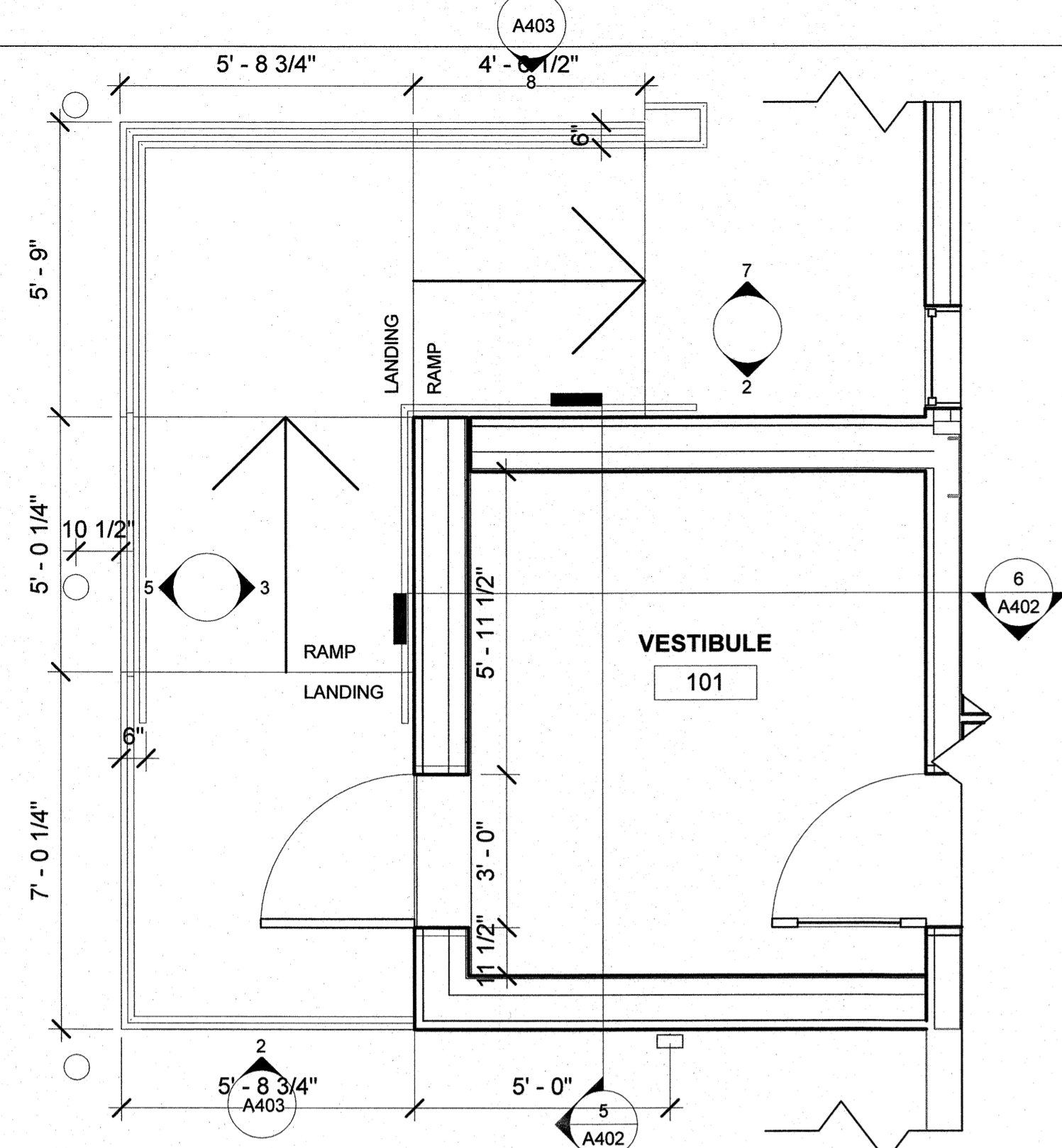


**11**  
A401 1/2" = 1'-0"

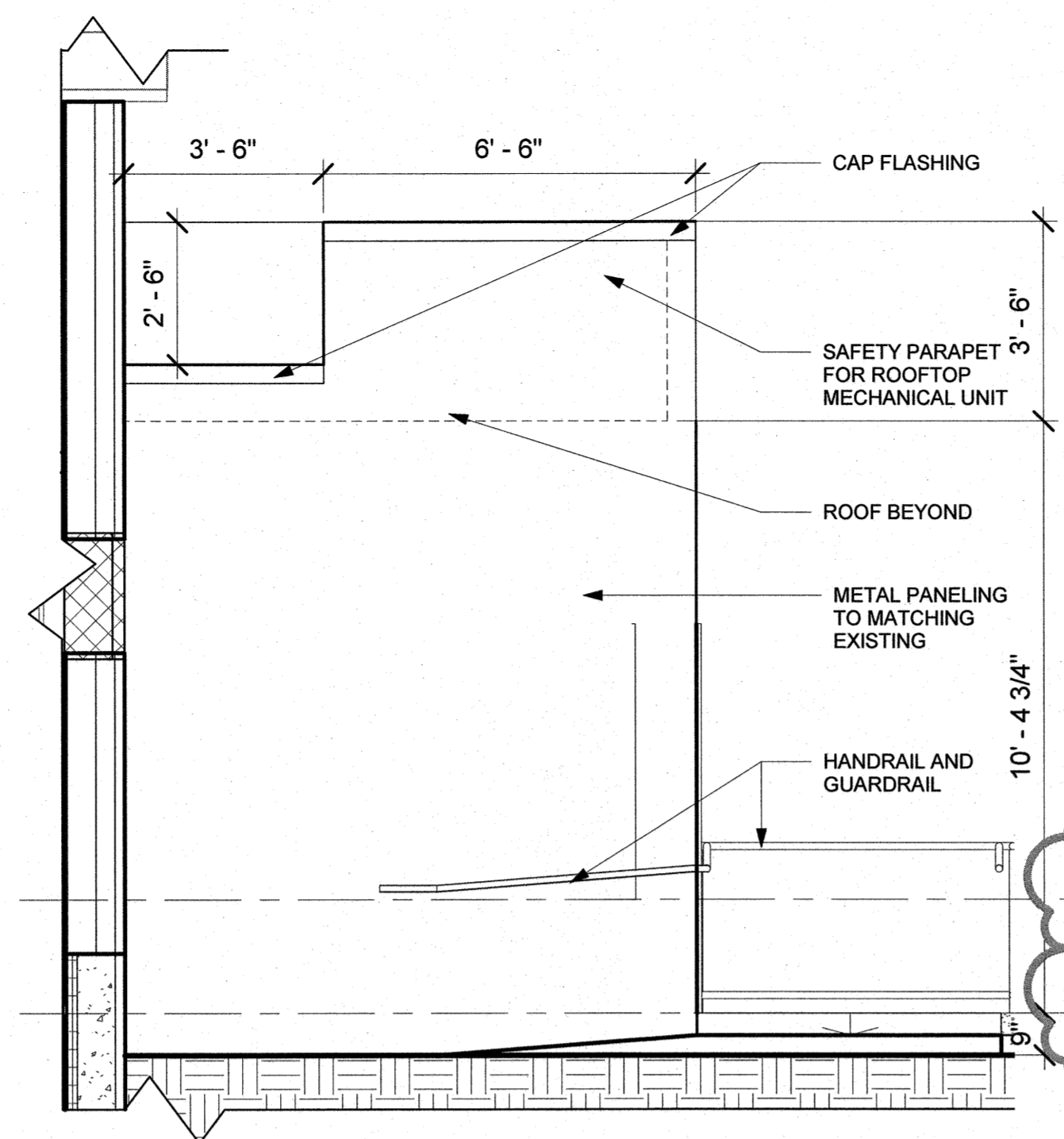


**11**  
A401 1/2" = 1'-0"

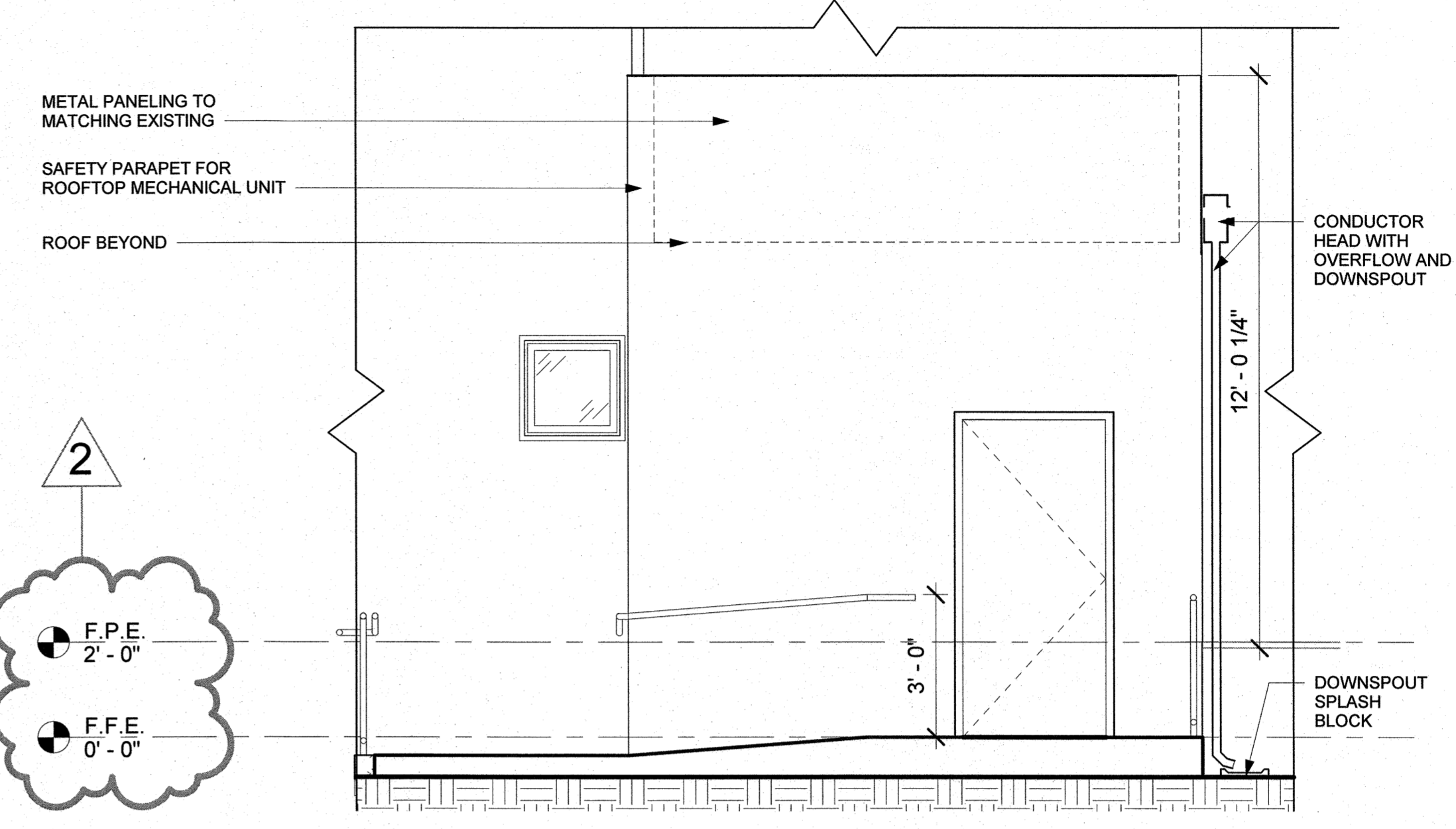
**11**  
A401 1/2" = 1'-0"



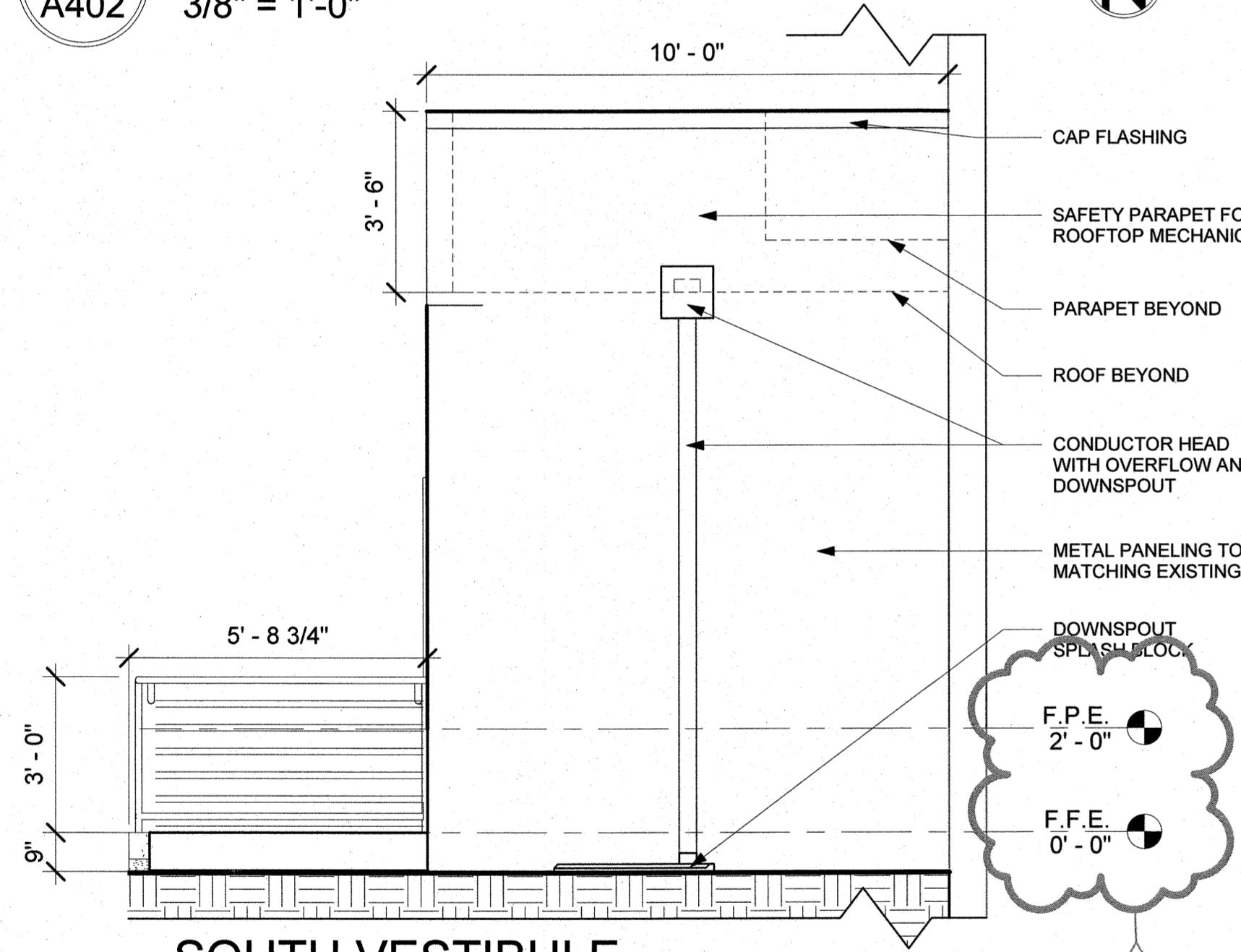
**1**  
TRANSPORTATION CREW ROOM ENLARGED VESTIBULE PLAN  
3/8" = 1'-0"



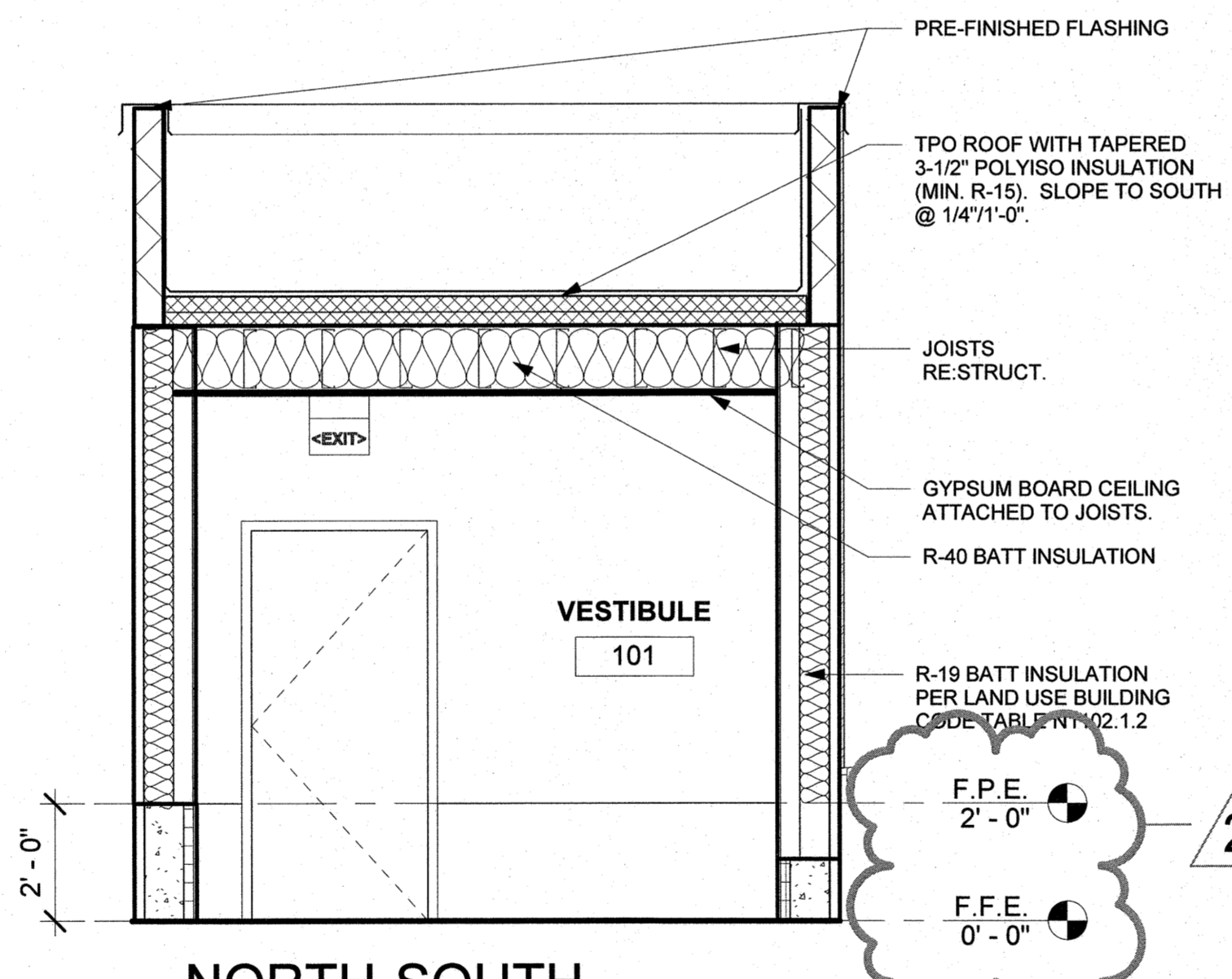
**2**  
NORTH VESTIBULE ELEVATION  
3/8" = 1'-0"



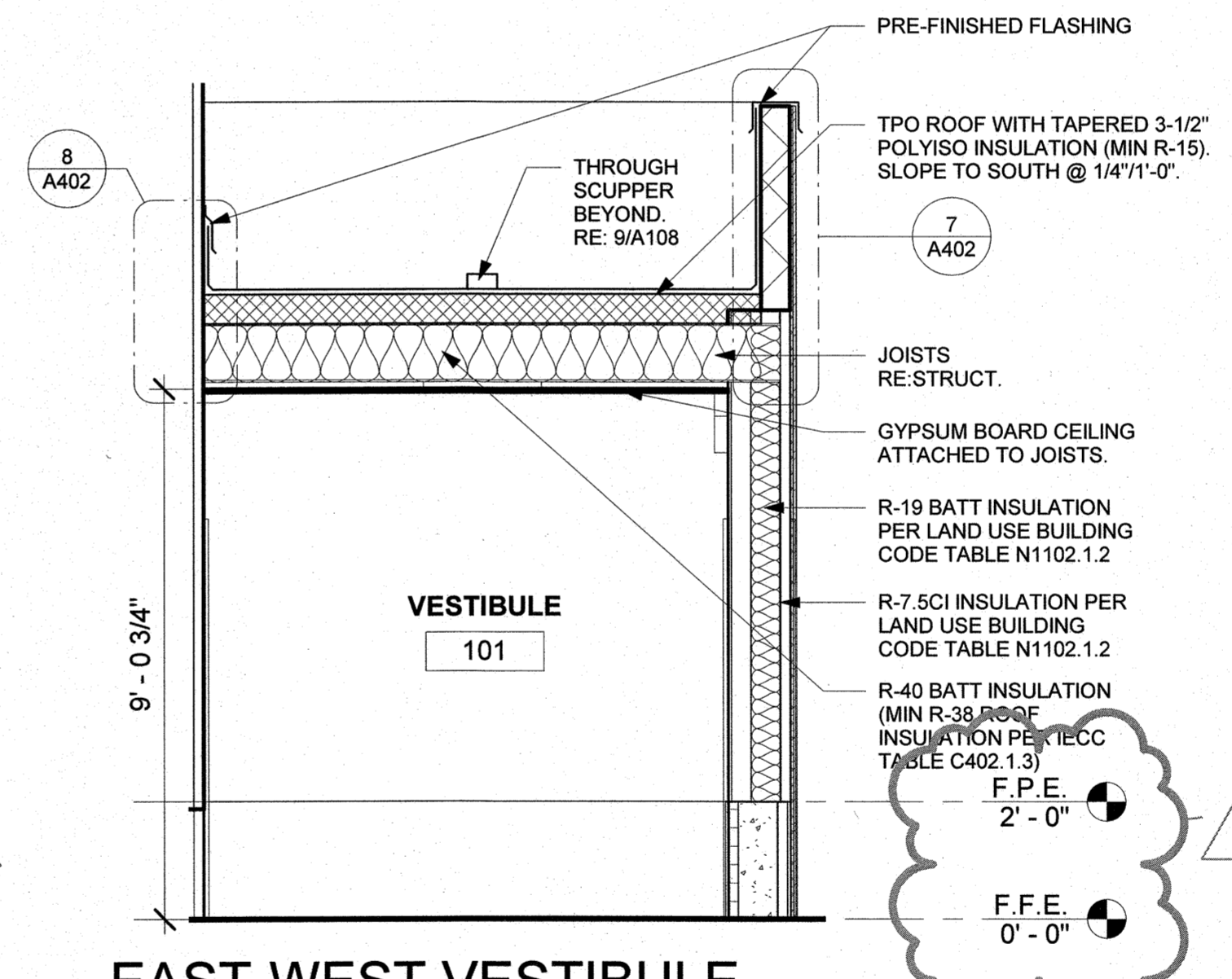
**3**  
WEST VESTIBULE ELEVATION  
3/8" = 1'-0"



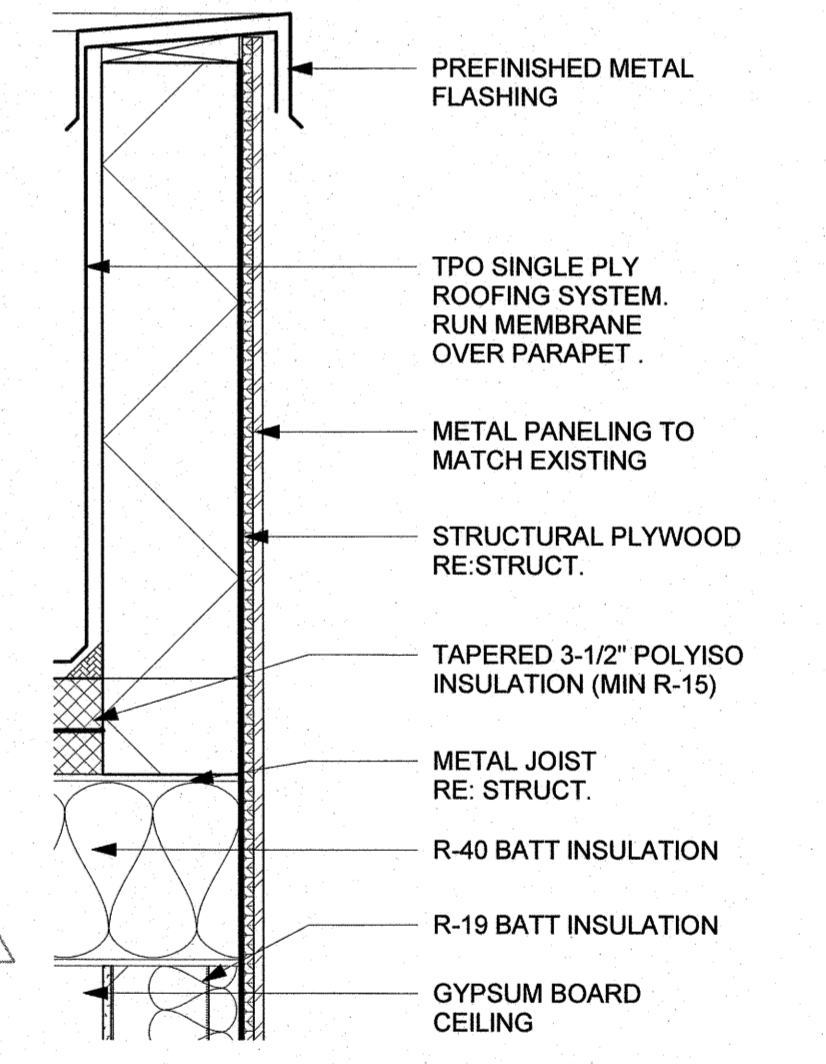
**4**  
SOUTH VESTIBULE ELEVATION  
3/8" = 1'-0"



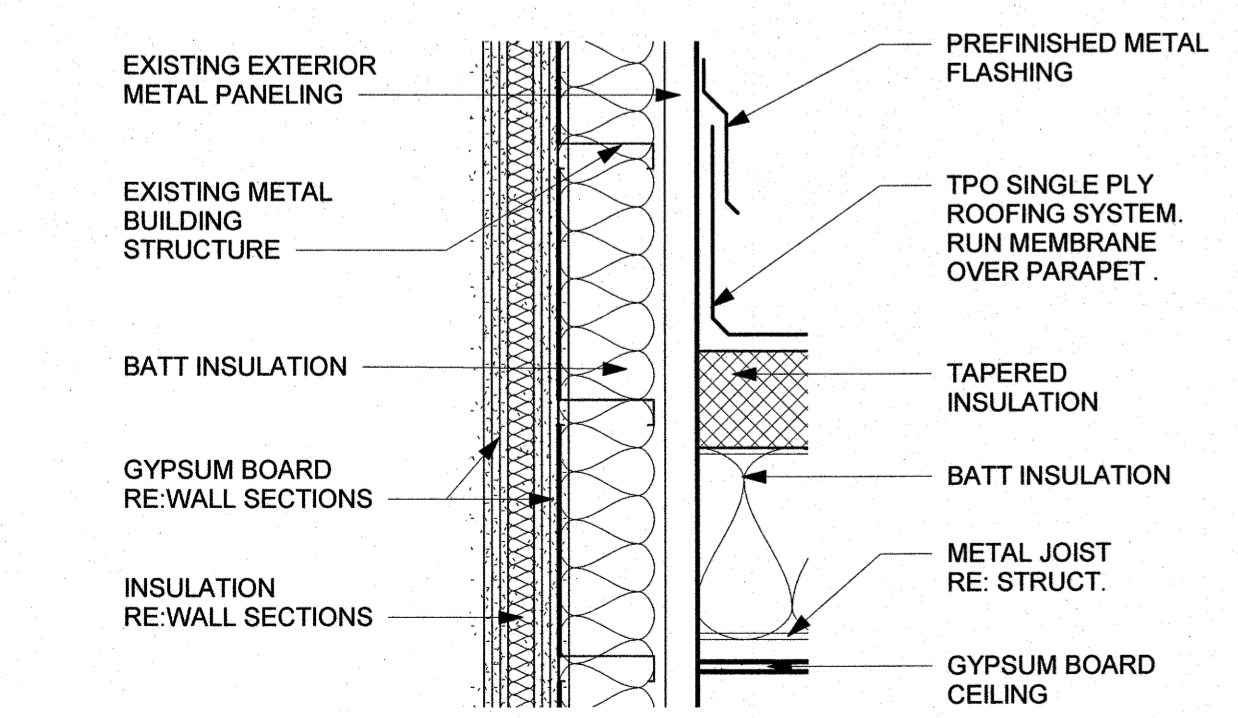
**5**  
NORTH-SOUTH VESTIBULE SECTION  
3/8" = 1'-0"



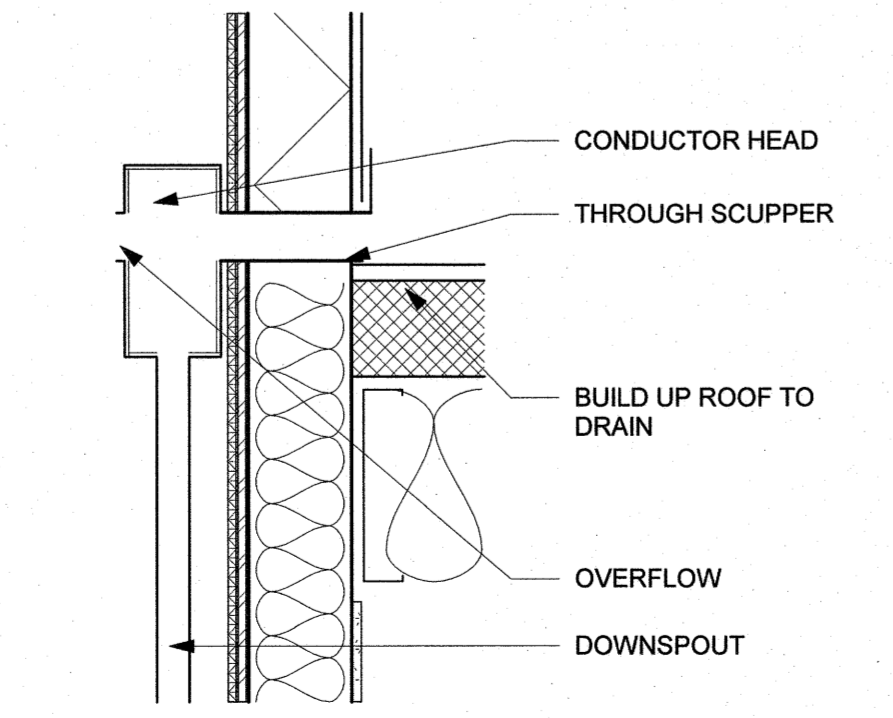
**6**  
EAST-WEST VESTIBULE SECTION  
3/8" = 1'-0"



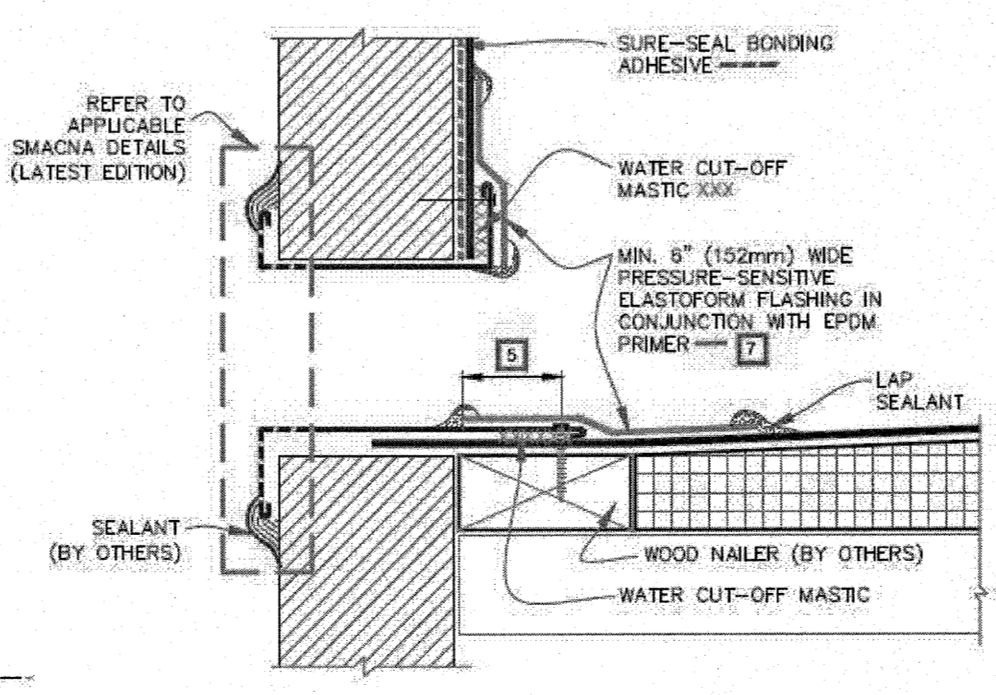
**7**  
VESTIBULE PARAPET DETAIL  
1" = 1'-0"



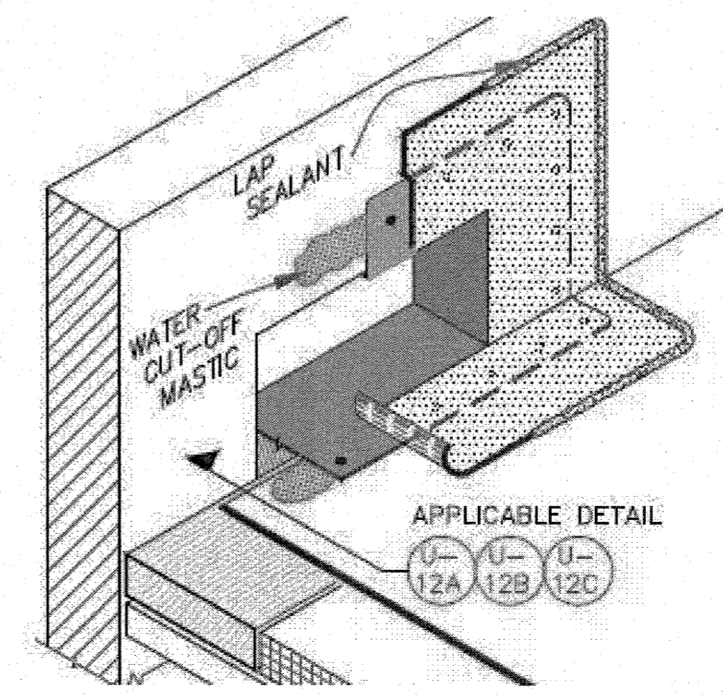
**8**  
VESTIBULE CONNECTION DETAIL  
1" = 1'-0"



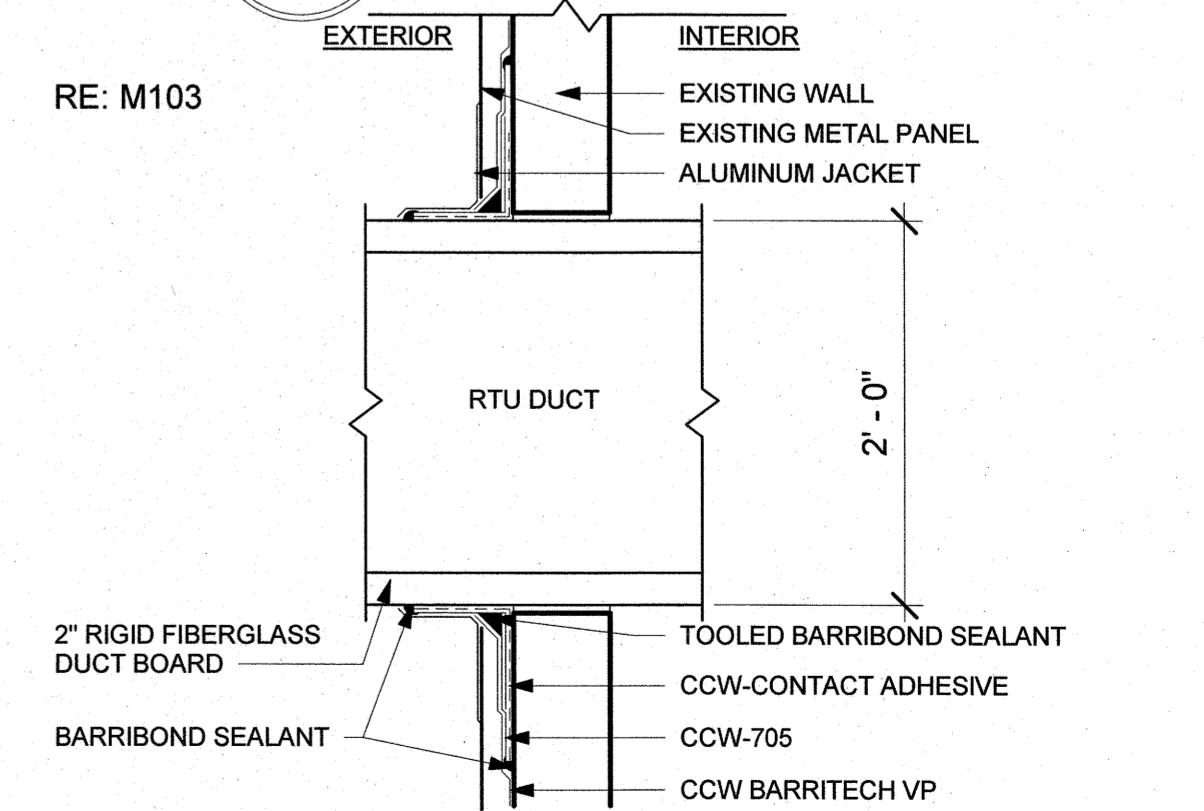
**9**  
THROUGH SCUPPER  
1" = 1'-0"



**10**  
CARLISLE FLASHING SECTION  
NOT TO SCALE

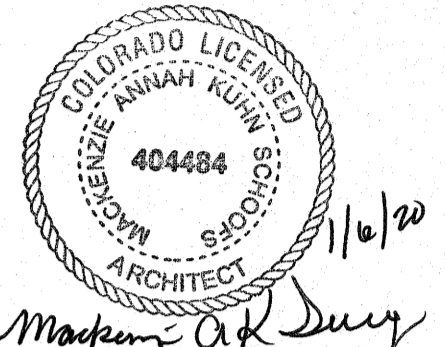


**11**  
CARLISLE FLASHING ISOMETRIC  
NOT TO SCALE



**12**  
EXTERIOR WALL DUCT PENETRATION DETAIL  
1" = 1'-0"

**Boulder County**  
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**BOULDER COUNTY**  
3897 N. 75TH STREET  
WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

PROJECT  
WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL  
LOCATION  
3897 N. 75TH STREET BOULDER, COLORADO 80301  
SHEET  
VESTIBULE ELEVATIONS AND SECTIONS  
FILE NAME  
PROJECT: 3897 N. 75TH STREET BOULDER, COLORADO 80301  
DATE: 7/26/2019  
DRAWN BY: Author  
CHECKED BY: Checker

REVISIONS  
1-COMMENT FROM 6/7/2019  
2-F.P. REVIEW COMMENTS FROM 7/16/2019  
3-COMMENTS FROM 9/29/2019  
4-COMMENTS FROM 10/4/2019  
5-COMMENTS FROM 10/10/2019  
6-COMMENTS FROM 10/17/2019

SHEET  
**A402**





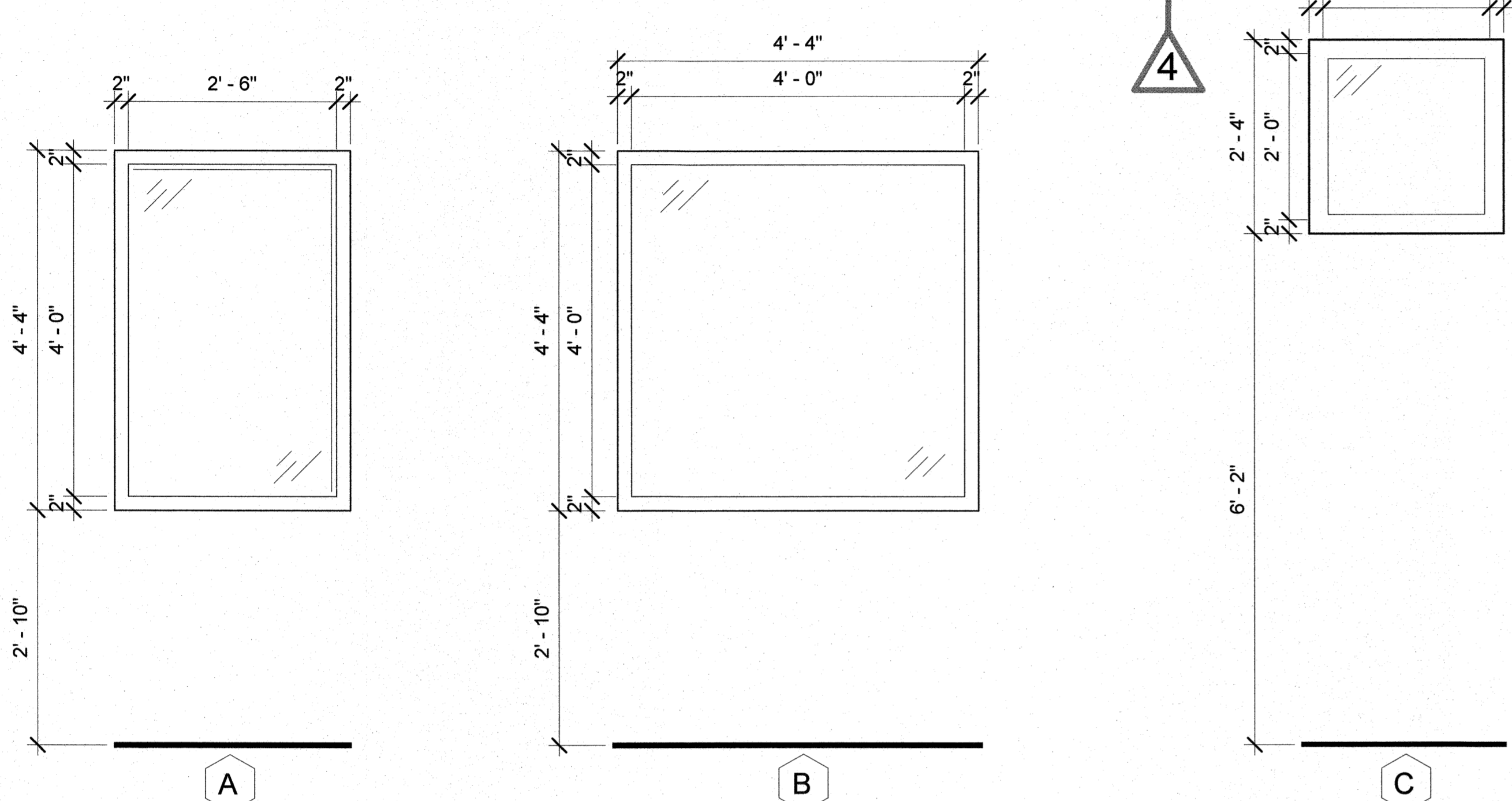
WALDEN POND CREW ROOM AND OFFICE REMODEL DOOR AND FRAME SCHEDULE

OPG. NO.	DOORS						FRAMES				HDWE. GROUP	REMARKS
	WIDTH	HEIGHT	THICK	MAT.	FINISH	TYPE	MAT.	FINISH	TYPE	DEPTH		
101	3'-0"	7'-0"	1-3/4"	H.M.	PAINT	B	H.M./G.F.	PAINT	BB	12 3/4"	1	PAINT LIGHT MOVES; CLOSER; FLOOD DOOR; GROUT FILLED TO F.P.E.; CUSTOM THROAT; PEMKO 2008 PK THRESHOLD
103	3'-0"	7'-0"	1-3/4"	H.M.	PAINT	B	H.M.	PAINT	BB	4 3/4"	4	PAINT LIGHT MOVES; CLOSER
104A	3'-0"	7'-0"	1-3/4"	H.M.	PAINT	B	H.M.	PAINT	AA	8 5/8"	2	PAINT LIGHT MOVES; CLOSER; CUSTOM THROAT
104B	3'-0"	7'-0"	1-3/4"	H.M.	PAINT	B	H.M.	PAINT	AA	4 3/4"	2	PAINT LIGHT MOVES; CLOSER
105	3'-0"	7'-0"	1-3/4"	H.M.	PAINT	B	H.M.	PAINT	AA	4 3/4"	2	PAINT LIGHT MOVES; LOCKING HARDWARE ENTRANCE AB
106	3'-0"	7'-0"	1-3/4"	H.M.	PAINT	B	H.M./G.F.	PAINT	BB	12 3/4"	1	PAINT LIGHT MOVES; CLOSER; FLOOD DOOR; GROUT FILLED TO F.P.E.; PEMKO 2008 PK THRESHOLD
107	3'-0"	7'-0"	1-3/4"	H.M.	PAINT	B	H.M.	PAINT	BB	4 3/4"	3	PAINT LIGHT MOVES;
												ALL WALLS TO GO TO STRUCTURE.

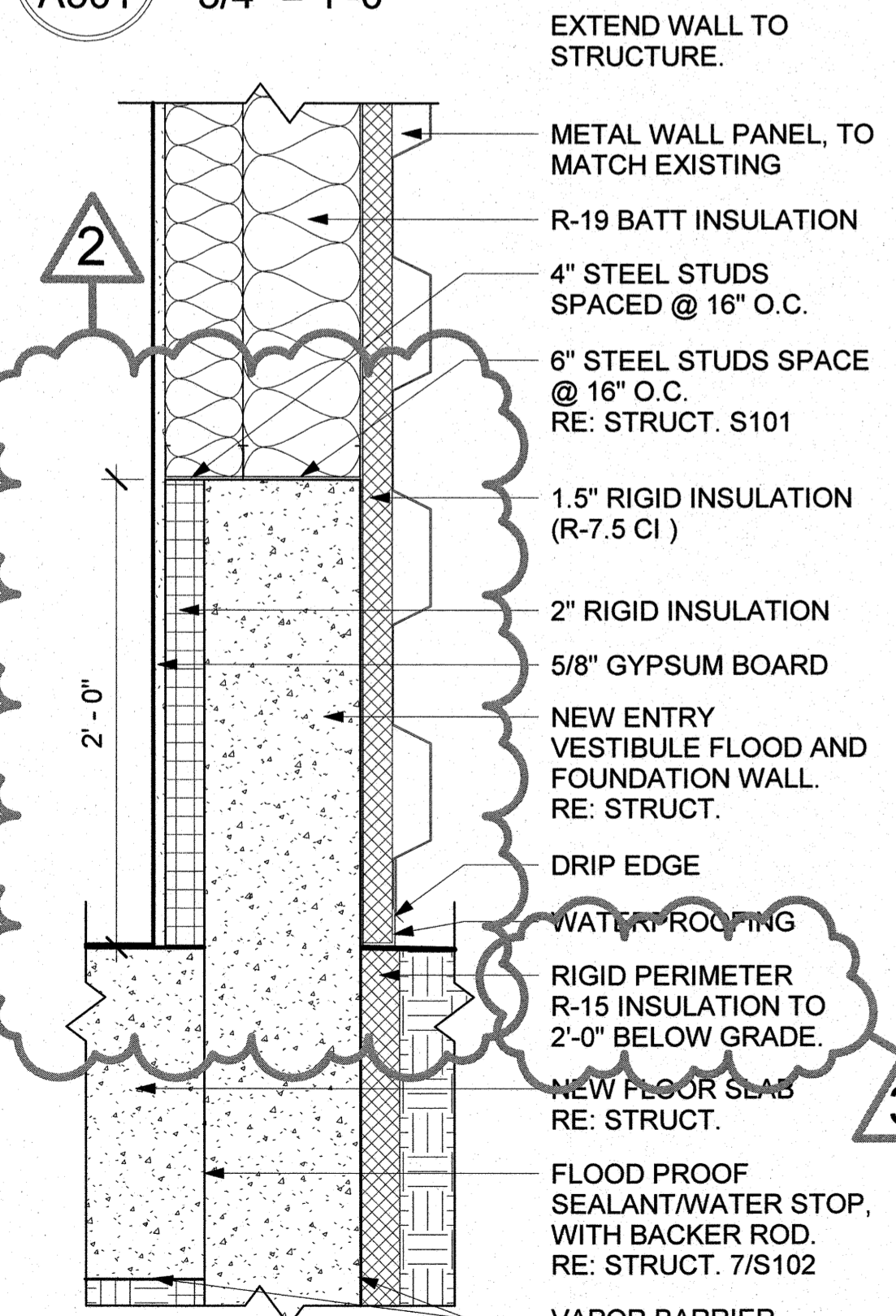
**HARDWARE GROUPS**

- ENTRANCE
  - 1 PASSAGE SET
  - 1 SURFACE CLOSURE
  - 1 CARD ACCESS
- OFFICE
  - 1 PASSAGE SET
  - 1 WALL DOOR STOP
- STOREROOM
  - 1 STOREROOM SET
  - 1 WALL DOOR STOP
  - 1 SURFACE CLOSURE
- PRIVACY
  - 1 PRIVACY SET
  - 1 WALL DOOR STOP

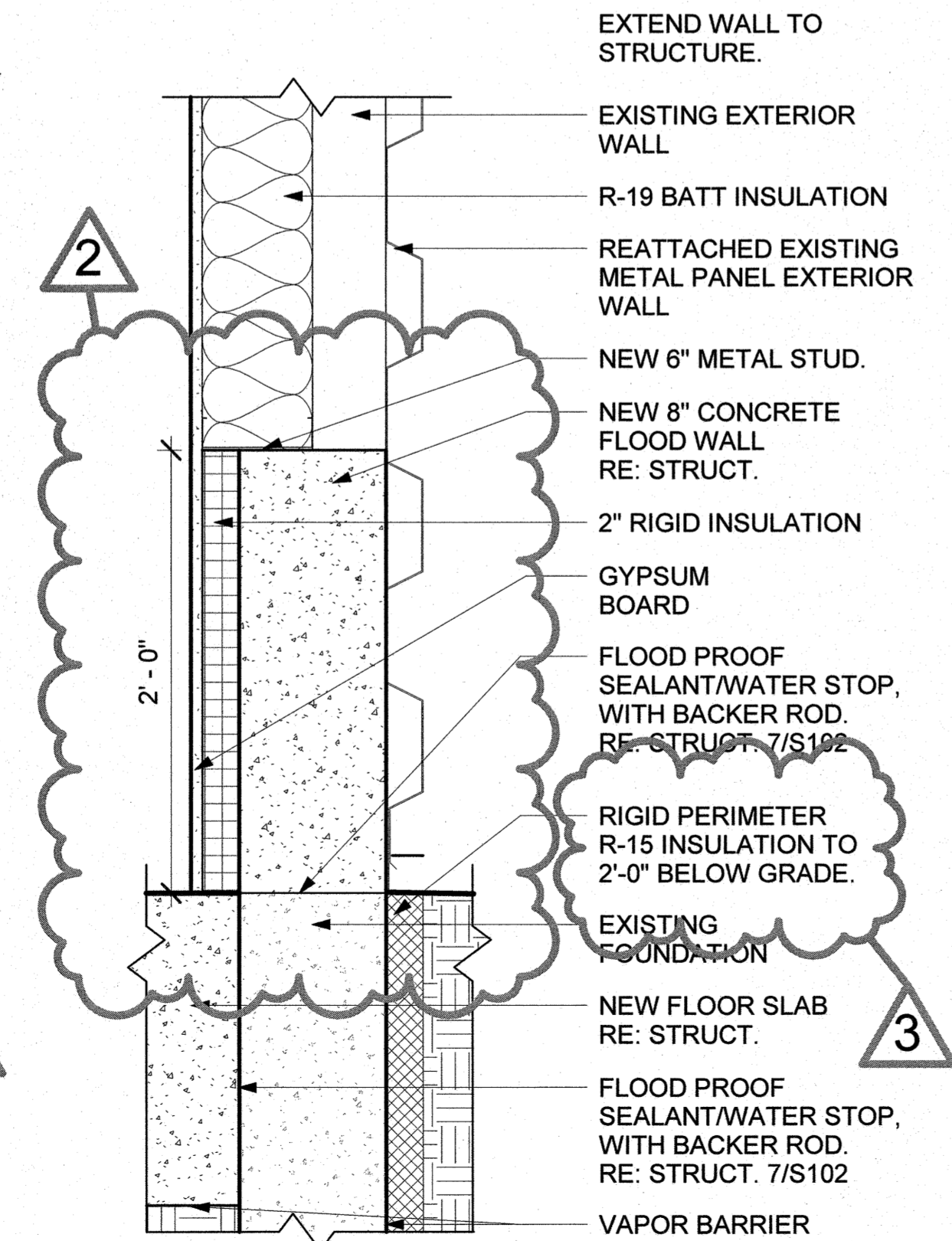
NOTE: BEST 9K SERIES LEVER SETS; ADA COMPLIANT. TYPICAL FOR ALL DOOR HARDWARE PACKAGES.



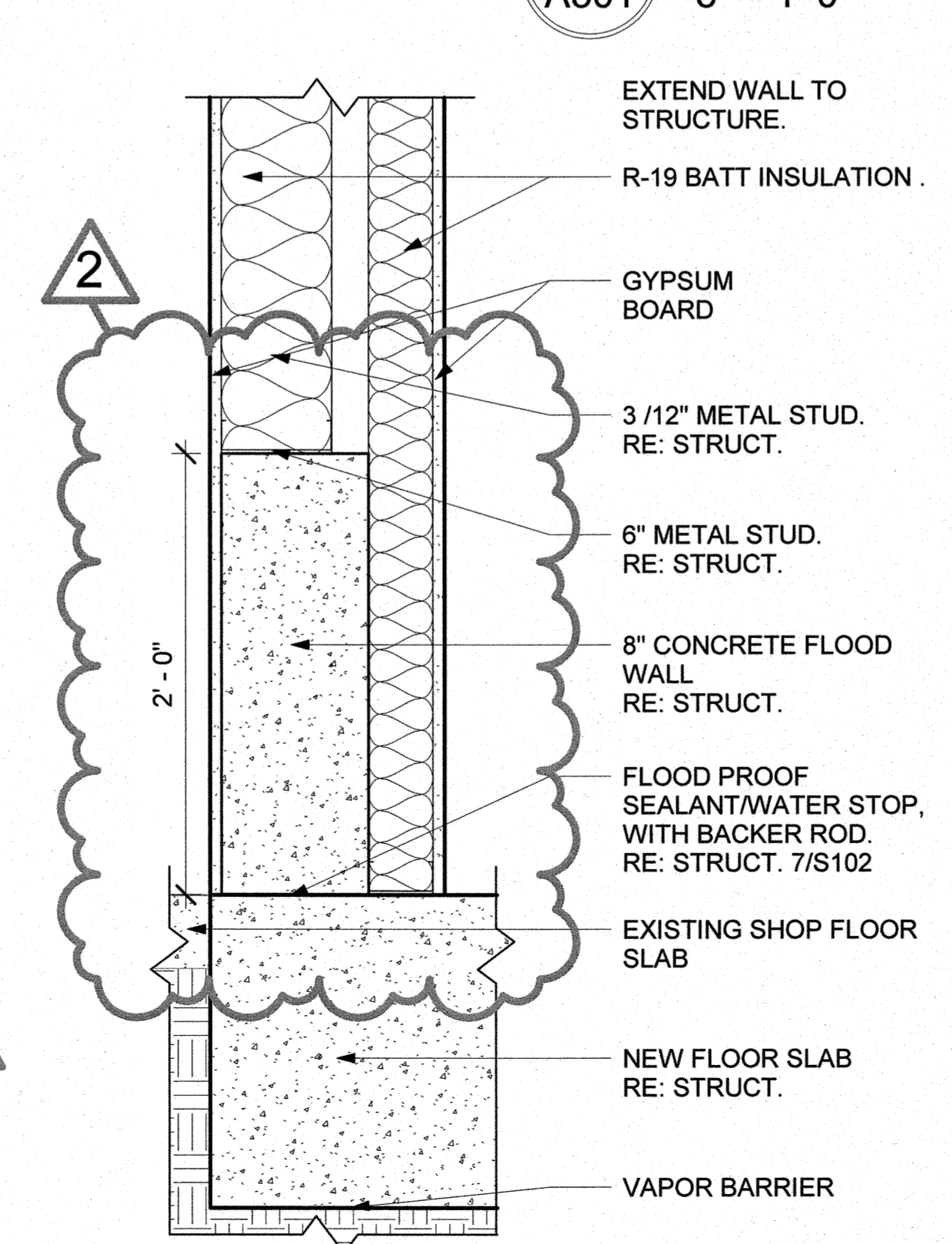
**1 WINDOW TYPES**  
A501 3/4" = 1'-0"



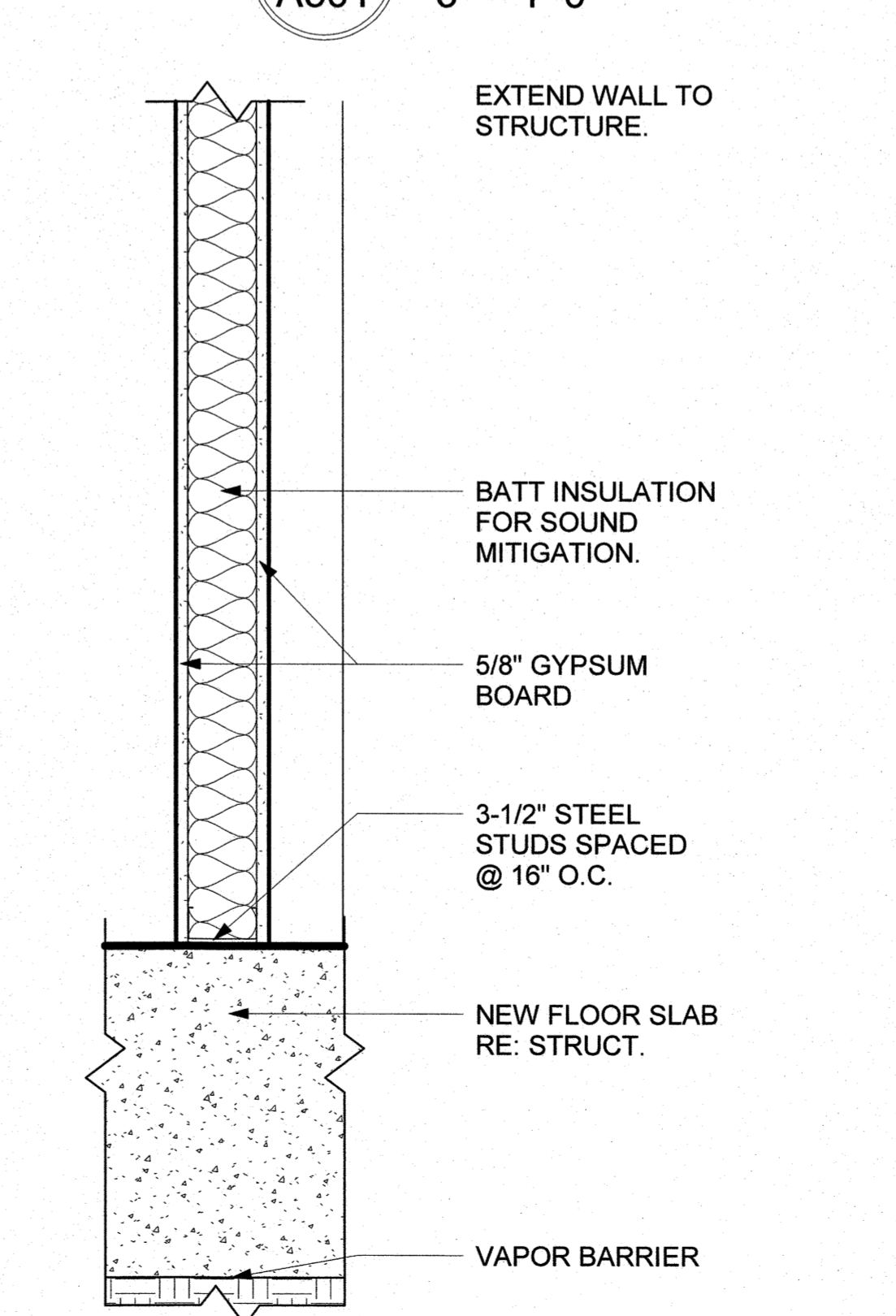
**5 EXTERIOR WALL SECTION @ ENTRY VESTIBULE**  
A501 1 1/2" = 1'-0"



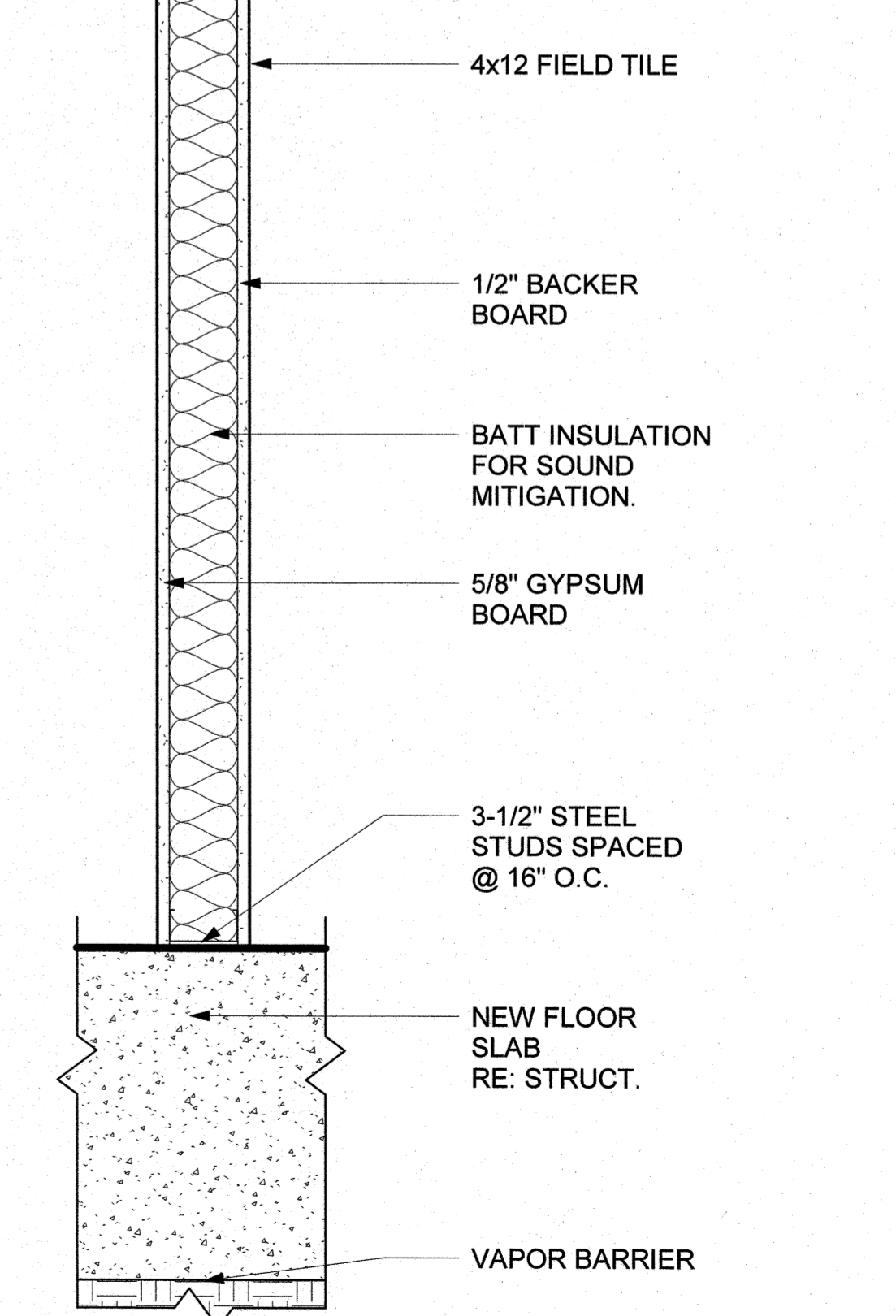
**6 EXTERIOR WALL SECTION @ EXISTING EXTERIOR WALL**  
A501 1 1/2" = 1'-0"



**7 INTERIOR WALL SECTION @ FLOOD WALL**  
A501 1 1/2" = 1'-0"

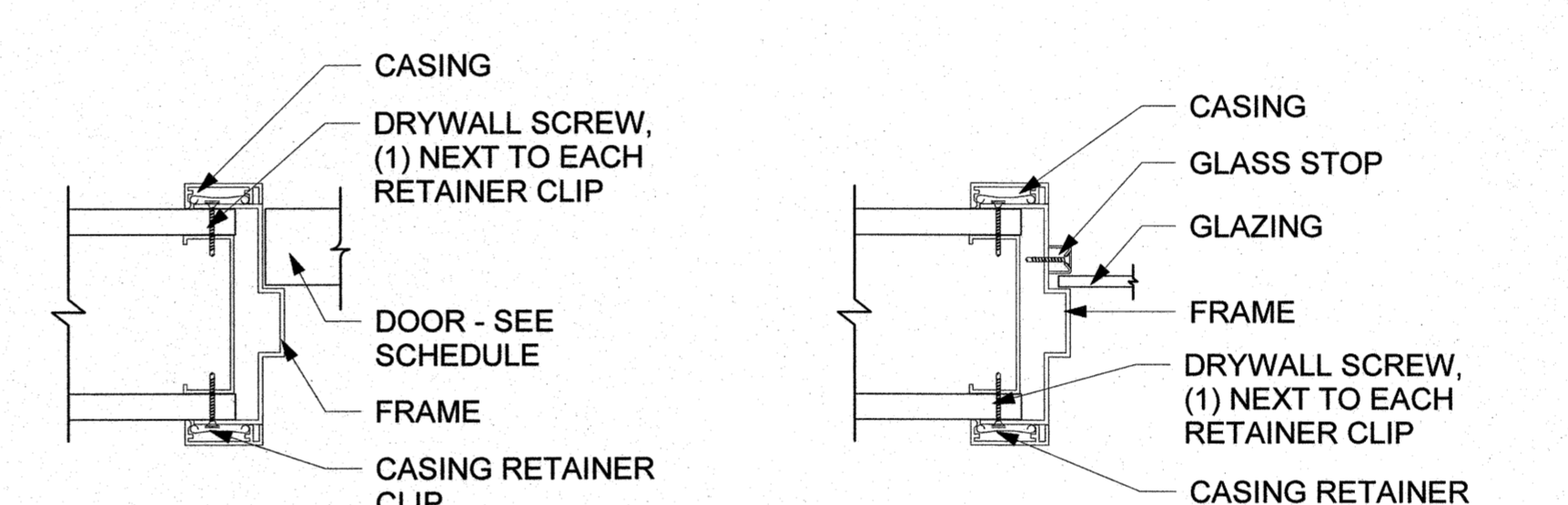


**8 INTERIOR WALL SECTION TYPICAL**  
A501 1 1/2" = 1'-0"



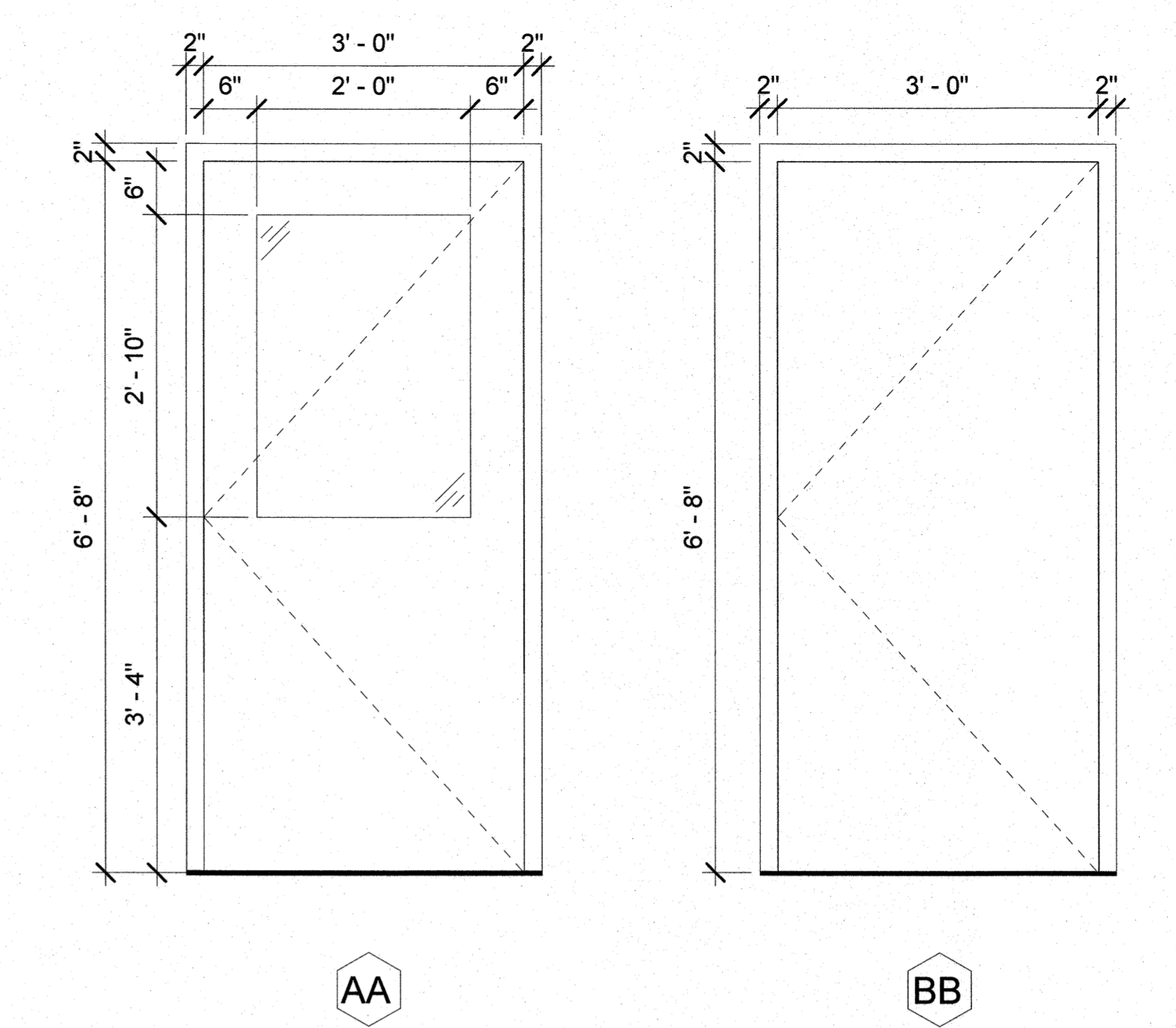
**9 INTERIOR WALL SECTION @ UNISEX TOILET ROOM**  
A501 1 1/2" = 1'-0"

**2 DOOR TYPES**  
A501 3/4" = 1'-0"



**3 DOOR HEAD/JAMB DETAIL**  
A501 3" = 1'-0"

**4 WINDOW HEAD/JAMB DETAIL**  
A501 3" = 1'-0"



**Boulder County**  
BUILDING SERVICES DIVISION  
2020 13TH ST.  
BOULDER, CO 80302  
P.O. BOX 471 BOULDER, CO 80306  
PHONE: 303.441.3187  
mschoofs@bouldercounty.org



Macken Architects

**BOULDER COUNTY**  
3897 N. 75TH STREET  
WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

PROJECT: WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL  
LOCATION: 3897 N. 75TH STREET BOULDER, COLORADO 80301  
SHEET: WALL SECTIONS  
FILE NAME: ACCT 999704 DATE: 7/28/2019 DRAWN BY: MAKS CHECKED BY: JB

REVISIONS:  
1-COMMENT FROM 8/7/2019  
2-F.P. REVIEW COMMENTS FROM 7/16/2019  
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SHEET  
**A501**

# STRUCTURAL GENERAL NOTES

## DESIGN LOADS:

- DESIGN LOADS: 2015 INTERNATIONAL BUILDING CODE WITH BOULDER COUNTY AMENDMENTS, ASCE 7-10
- RISK CATEGORY: II STANDARD
- ROOFS:
  - ROOF DEAD LOAD 20 PSF
  - ROOF LIVE LOAD 20 PSF, 300 LBS
  - GROUND SNOW LOAD,  $P_g$  40 PSF
  - FLAT-ROOF SNOW LOAD,  $P_f$  30 PSF
  - SNOW EXPOSURE FACTOR,  $C_e$  1.0
  - SNOW IMPORTANCE FACTOR,  $I_s$  1.0
  - THERMAL FACTOR,  $C_t$  1.1
- WIND:
  - ULTIMATE DESIGN WIND SPEED,  $V_{ult}$ , (3-SECOND GUST) 155 MPH
  - NOMINAL DESIGN WIND SPEED,  $V_{mb}$ , (3-SECOND GUST) 120 MPH
  - INTERNAL PRESSURE COEFFICIENT 0.18 (ENCLOSED)
  - WIND EXPOSURE C
  - AIR DENSITY COEFFICIENT 0.86
  - COMPONENTS AND CLADDING ULTIMATE DESIGN WIND PRESSURES
    - WALLS:
      - WITHIN 3 FEET OF CORNERS +36.1 PSF -44.5 PSF
      - AWAY FROM CORNERS +36.1 PSF -39.5 PSF
    - PARAPETS:
      - WITHIN 3 FEET OF CORNERS +103.9 PSF -83.2 PSF
      - AWAY FROM CORNERS +103.9 PSF -72.8 PSF
    - ROOFS:
      - WITHIN 3 FEET OF CORNERS +38.2 PSF -61.9 PSF
      - WITHIN 3 FEET OF EDGES +38.2 PSF -61.9 PSF
      - AWAY FROM EDGES +38.2 PSF -43.2 PSF
- SEISMIC:
  - SPECTRAL RESPONSE ACCELERATION PARAMETERS
    - SHORT PERIOD
      - $S_s$  0.194g
      - $S_{s1}$  0.206g
    - ONE SECOND
      - $S_1$  0.060g
      - $S_{01}$  0.096g
  - SOILS SITE CLASS D
  - SEISMIC IMPORTANCE FACTOR 1.00
  - SEISMIC DESIGN CATEGORY B
  - BASIC SEISMIC FORCE-RESISTING SYSTEM(S)
    - LIGHT FRAME WALLS SHEATHED WITH WOOD STRUCTURAL PANELS RATED FOR SHEAR RESISTANCE
  - DESIGN BASE SHEAR(S) <1 KIP
  - SEISMIC RESPONSE COEFFICIENT(S),  $C_d$  0.03
  - RESPONSE MODIFICATION COEFFICIENT(S),  $R$  1.5
  - ANALYSIS PROCEDURE EQUIVALENT LATERAL FORCE ANALYSIS PROCEDURE
- FLOOD:
  - FLOOD DESIGN CLASS 2
  - BASE FLOOD ELEVATION,  $E_{BF}$  5127.30'
  - DESIGN FLOOD ELEVATION,  $E_{DFE}$  5128.30'
  - ELEVATION OF PROPOSED LOWEST FLOOR: 5127.04'
  - ELEVATION TO WHICH BUILDING WILL BE DRY FLOORPROOFED: 5128.30'
  - AVERAGE VELOCITY OF WATER 1.9 FT/SEC
  - DRY FLOODPROOFING IS DESIGNED IN ACCORDANCE WITH ASCE 24 "FLOOD RESISTANT DESIGN AND CONSTRUCTION"

## FOUNDATION DESIGN:

- MINIMUM FROST DEPTH SHALL BE 2'-6" BELOW EXTERIOR GRADE.

## FOOTINGS:

- DESIGN OF FOOTINGS IS BASED ON
  - MAXIMUM ASSUMED ALLOWABLE BEARING PRESSURE 1500 PSF
- BEAR ON THE NATURAL UNDISTURBED SOIL OR COMPACTED STRUCTURAL FILL. EXTERIOR FOOTINGS SHALL BEAR BELOW FROST DEPTH.

## REINFORCED CONCRETE:

- DESIGN IS BASED ON ACI 318 "BUILDING CODE REQUIREMENTS FOR STRUCTURAL CONCRETE."
- CONCRETE WORK SHALL CONFORM TO ACI 301 "STANDARD SPECIFICATIONS FOR STRUCTURAL CONCRETE."
- STRUCTURAL CONCRETE SHALL HAVE THE FOLLOWING PROPERTIES:

INTENDED USE	EXPOSURE CLASS	$f_c$ , PSI	MAX WCM	MAXIMUM AGGREGATE	SLUMP, INCHES (+/- 1")	AIR CONTENT PERCENT (+/- 1.5%)	CEMENT TYPE
STEM WALLS & WALLS	F2-S0-W1-C1	4500	0.45	3/4" STONE	4	6%	III
FOOTINGS	F0-S0-W0-C1	3000	0.52	3/4" STONE	5	2%	III
INTERIOR SLAB ON GRADE	F0-S0-W0-C0	4000	0.45	3/4" STONE	4	3%	III
EXTERIOR SLAB ON GRADE	F3-S0-W0-C2	5000	0.40	3/4" STONE	4	6%	III

- DETAILING, FABRICATION, AND PLACEMENT OF REINFORCING STEEL SHALL BE IN ACCORDANCE WITH ACI 318 "DETAILS AND DETAILING OF CONCRETE REINFORCEMENT."
- REINFORCING BARS SHALL CONFORM TO ASTM A615, GRADE 60.
- EXCEPT AS NOTED ON THE DRAWINGS, CONCRETE PROTECTION FOR REINFORCEMENT IN CAST-IN-PLACE CONCRETE SHALL BE AS FOLLOWS:
  - CAST AGAINST AND PERMANENTLY EXPOSED TO EARTH:
    - EXPOSED TO EARTH OR WEATHER:
      - #6 THROUGH #18 BARS 2"
      - #5 BAR, W#1 OR D#1 WIRE, AND SMALLER 1-1/2"
    - NOT EXPOSED TO WEATHER OR IN CONTACT WITH GROUND:
      - SLABS, WALLS, JOISTS: #11 BARS AND SMALLER 3/4"
      - BEAMS AND COLUMNS:
        - PRIMARY REINFORCEMENT 1-1/2"
        - STIRRUPS, TIES, SPIRALS 1-1/2"

## POST-INSTALLED ANCHORS

- ALL CAST IN PLACE ANCHORS DESIGNED IN ACCORDANCE WITH ACI 318.
- POST-INSTALLED ANCHORS SHALL ONLY BE USED WHERE SPECIFIED ON THE CONSTRUCTION DOCUMENTS. THE CONTRACTOR SHALL OBTAIN APPROVAL FROM THE ENGINEER-OF-RECORD PRIOR TO INSTALLING POST-INSTALLED ANCHORS IN PLACE OF MISSING OR MISPLACED CAST-IN-PLACE ANCHORS.
- CARE SHALL BE TAKEN IN PLACING POST-INSTALLED ANCHORS TO AVOID CONFLICTS WITH EXISTING REBAR. EXISTING REINFORCING BARS SHALL NOT BE CUT UNLESS APPROVED BY THE EOR.
- ALL ANCHORS MUST BE INSTALLED IN STRICT ACCORDANCE WITH THE MANUFACTURER'S PRINTED INSTALLATION INFORMATION (MPI) IN CONJUNCTION WITH EDGE DISTANCE, SPACING, AND EMBEDMENT DEPTH AS INDICATED ON THE DRAWINGS. HOLES SHALL BE DRILLED AND CLEANED IN ACCORDANCE WITH THE MPI.
- SUBSTITUTION REQUESTS, FOR PRODUCTS OTHER THAN THOSE SPECIFIED, SHALL BE SUBMITTED BY THE CONTRACTOR TO THE ENGINEER-OF-RECORD ALONG WITH CALCULATIONS THAT ARE PREPARED & SEALED BY A REGISTERED PROFESSIONAL ENGINEER. REGISTRATION MUST BE IN THE STATE IN WHICH THE PROJECT IS LOCATED. THE CALCULATIONS SHALL DEMONSTRATE THAT THE SUBSTITUTED PRODUCT IS CAPABLE OF ACHIEVING EQUIVALENT PERFORMANCE VALUES (MINIMUM) OF THE SPECIFIED PRODUCT USING THE APPROPRIATE DESIGN PROCEDURE AND/OR STANDARD(S) AS REQUIRED BY THE AUTHORITY HAVING JURISDICTION.
- THE CONTRACTOR SHALL ARRANGE FOR A MANUFACTURER'S FIELD REPRESENTATIVE TO PROVIDE INSTALLATION TRAINING FOR ALL PRODUCTS TO BE USED, PRIOR TO THE ANCHOR INSTALLATION. A RECORD OF TRAINING SHALL BE KEPT ON SITE AND MADE AVAILABLE TO THE EOR/SPECIAL INSPECTOR AS REQUESTED.
- ADHESIVE ANCHORS INSTALLED IN HORIZONTAL TO VERTICALLY OVERHEAD ORIENTATION THAT SUPPORT SUSTAINED TENSION LOADS SHALL BE DONE BY A CERTIFIED ANCHOR INSTALLER (AAI) AS CERTIFIED THROUGH ACI/ORS (ACI 318-11 D 9.2.2, ACI 318-14 17.8.2.2). PROOF OF CURRENT CERTIFICATION SHALL BE SUBMITTED TO THE EOR FOR APPROVAL PRIOR TO COMMENCEMENT OF INSTALLATION.
- ADHESIVE ANCHORS MUST BE INSTALLED IN CONCRETE AGED A MINIMUM OF 21 DAYS (ACI 318-11 D 2.2, ACI 318-14 17.1.2)
- ALL POST INSTALLED ANCHORS SHALL BE INSTALLED IN DRY HOLES THAT HAVE BEEN DRILLED, CLEANED, AND PREPARED IN STRICT ACCORDANCE WITH THE MANUFACTURER'S PRINTED INSTALLATION INFORMATION AND THE RESPECTIVE ICC-ES EVALUATION REPORTS.
- PROVIDE SPECIAL INSPECTION FOR ALL MECHANICAL AND ADHESIVE ANCHORS PER THE APPLICABLE BUILDING CODE AND PER THE CURRENT ICC-ES REPORT (IBC 2012/2015 TABLE 1705.3 NOTE B).

CONCRETE POST INSTALLED ANCHORS			
ANCHOR TYPE	HILTI	DEWALT / POWERS	SIMPSON
EXPANSION	KWIK BOLT TZ (ICC ESR-1917)	POWER-STUD+ SD2 (ICC ESR-2502)	STRONG-BOLT 2 (ICC ESR-3037)
CONCRETE SCREW	KWIK HUS-EZ (ICC ESR-3027)	SCREW-BOLT+ (ICC ESR 3889)	TITEN HD (ICC ESR 2713)
ADHESIVE	HIT-HY 200 (ICC ESR-3187)	AC208+ (ICC ESR-4027)	AT-XP (UES ER-263)

## COLD FORMED STEEL FRAMING:

- MEMBER FORMING SHALL CONFORM TO THE AISI NORTH AMERICAN SPECIFICATION FOR THE DESIGN OF COLD-FORMED STEEL STRUCTURAL MEMBERS.
- ALL STRUCTURAL FRAMING (STUDS, JOISTS, TRACK, RUNNERS, BRACING, AND BRIDGING) SHALL BE GALVANIZED G-60 SHEET STEEL CONFORMING TO ASTM A1003.
- STUDS AND JOISTS 54 MILS (16 GAUGE) AND HEAVIER SHALL BE 50 KSI YIELD. 43 MILS (18 GAUGE) AND LIGHTER SHALL BE 33 KSI YIELD UNLESS NOTED.
- SUBCONTRACTOR SHALL PROVIDE BRIDGING AND BLOCKING AT A MAXIMUM OF 6 FOOT SPACING OR AS REQUIRED FOR STABILITY AND STIFFNESS OF THE FINAL ASSEMBLY WHEREVER SHEATHING DOES NOT PROVIDE ADEQUATE BRACING.
- WHERE PUNCHOUTS ARE WITHIN 8" OF MEMBER ENDS, INSTALL UNPUNCHED STIFFENERS WITH (4) #10 SCREWS EACH EDGE TO THE STIFFENER MEMBER.
- PARALLEL MEMBERS IN CONTACT SHALL HAVE #10 SCREWS @ 16" MAX ALONG EACH CONTACT EDGE IN THE FIELD OF THE MEMBER.
- THE SSMA PRODUCT IDENTIFICATION CODES ARE USED TO LABEL MEMBERS ON THE DRAWINGS: [MEMBER DEPTH IN 1/100 INCHES][STYLE][FLANGE WIDTH IN 1/100 INCHES][MATERIAL THICKNESS IN MILS][YIELD STRENGTH KSI]

## SHOP DRAWINGS:

- THE STRUCTURAL DRAWINGS ARE COPYRIGHTED AND SHALL NOT BE COPIED FOR USE AS ERECTION PLANS OR SHOP DETAILS. USE OF JVA'S ELECTRONIC FILES AS THE BASIS FOR SHOP DRAWINGS REQUIRES PRIOR APPROVAL BY JVA. A SIGNED RELEASE OF LIABILITY BY THE GENERAL CONTRACTOR AND/OR HIS SUBCONTRACTORS, AND DELETION OF JVA'S NAME AND LOGO FROM ALL SHEETS SO USED.
- THE GENERAL CONTRACTOR SHALL SUBMIT IN WRITING ANY REQUESTS TO MODIFY THE STRUCTURAL DRAWINGS OR PROJECT SPECIFICATIONS.
- ALL SHOP AND ERECTION DRAWINGS SHALL BE CHECKED AND STAMPED (AFTER HAVING BEEN CHECKED) BY THE GENERAL CONTRACTOR PRIOR TO SUBMISSION FOR STRUCTURAL ENGINEER REVIEW. SHOP DRAWING SUBMITTALS NOT CHECKED BY THE GENERAL CONTRACTOR PRIOR TO SUBMISSION TO THE STRUCTURAL ENGINEER WILL BE RETURNED WITHOUT REVIEW.
- FURNISH ELECTRONIC VERSION (PDF) OF SHOP AND ERECTION DRAWINGS TO THE STRUCTURAL ENGINEER FOR REVIEW PRIOR TO FABRICATION FOR:
  - REINFORCING STEEL
  - LIGHT GAGE STEEL DATA
- SUBMIT IN A TIMELY MANNER TO PERMIT 10 WORKING DAYS FOR REVIEW BY THE STRUCTURAL ENGINEER.
- SHOP DRAWINGS SUBMITTED FOR REVIEW DO NOT CONSTITUTE "REQUEST FOR CHANGE IN WRITING" UNLESS SPECIFIC SUGGESTED CHANGES ARE CLEARLY MARKED. IN ANY EVENT, CHANGES MADE BY MEANS OF THE SHOP DRAWING SUBMITTAL PROCESS BECOME THE RESPONSIBILITY OF THE ONE INITIATING THE CHANGE.

## FIELD VERIFICATION OF EXISTING CONDITIONS:

- THE GENERAL CONTRACTOR SHALL THOROUGHLY INSPECT AND SURVEY THE EXISTING STRUCTURE TO VERIFY CONDITIONS THAT AFFECT THE WORK SHOWN ON THE DRAWINGS.
- THE GENERAL CONTRACTOR SHALL REPORT ANY VARIATIONS OR DISCREPANCIES TO THE ARCHITECT AND STRUCTURAL ENGINEER BEFORE PROCEEDING.

## STRUCTURAL ERECTION AND BRACING REQUIREMENTS:

- THE STRUCTURAL DRAWINGS ILLUSTRATE AND DESCRIBE THE COMPLETED STRUCTURE WITH ELEMENTS IN THEIR FINAL POSITIONS, PROPERLY SUPPORTED, CONNECTED, AND/OR BRACED.
- THE STRUCTURAL DRAWINGS ILLUSTRATE TYPICAL AND REPRESENTATIVE DETAILS TO ASSIST THE GENERAL CONTRACTOR. DETAILS SHOWN APPLY AT ALL SIMILAR CONDITIONS UNLESS OTHERWISE INDICATED. ALTHOUGH DUE DILIGENCE HAS BEEN APPLIED TO MAKE THE DRAWINGS AS COMPLETE AS POSSIBLE, NOT EVERY DETAIL IS ILLUSTRATED AND NOT EVERY EXCEPTIONAL CONDITION IS ADDRESSED.
- ALL PROPRIETARY CONNECTIONS AND ELEMENTS SHALL BE INSTALLED IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDATIONS.
- ALL WORK SHALL BE ACCOMPLISHED IN A WORKMANLIKE MANNER AND IN ACCORDANCE WITH THE APPLICABLE CODES AND LOCAL ORDINANCES.
- THE GENERAL CONTRACTOR IS RESPONSIBLE FOR COORDINATION OF ALL WORK, INCLUDING LAYOUT AND DIMENSION VERIFICATION, MATERIALS COORDINATION, SHOP DRAWING REVIEW, AND THE WORK OF SUBCONTRACTORS. ANY DISCREPANCIES OR OMISSIONS DISCOVERED IN THE COURSE OF THE WORK SHALL BE IMMEDIATELY REPORTED TO THE ARCHITECT AND STRUCTURAL ENGINEER FOR RESOLUTION.
- CONTINUATION OF WORK WITHOUT NOTIFICATION OF DISCREPANCIES RELIEVES THE ARCHITECT AND STRUCTURAL ENGINEER FROM ALL CONSEQUENCES.
- UNLESS OTHERWISE SPECIFICALLY INDICATED, THE STRUCTURAL DRAWINGS DO NOT DESCRIBE METHODS OF CONSTRUCTION.
- THE GENERAL CONTRACTOR, IN THE PROPER SEQUENCE, SHALL PERFORM OR SUPERVISE ALL WORK NECESSARY TO ACHIEVE THE FINAL COMPLETED STRUCTURE, AND TO PROTECT THE STRUCTURE, WORKMEN, AND OTHERS DURING CONSTRUCTION. SUCH WORK SHALL INCLUDE, BUT NOT BE LIMITED TO TEMPORARY BRACING, SHORING FOR CONSTRUCTION EQUIPMENT, SHORING FOR EXCAVATION, FORMWORK, SCAFFOLDING, SAFETY DEVICES AND PROGRAMS OF ALL KINDS, SUPPORT AND BRACING FOR CRANES AND OTHER ERECTION EQUIPMENT.
- TEMPORARY BRACING SHALL REMAIN IN PLACE UNTIL ALL FLOORS, WALLS, ROOFS AND ANY OTHER SUPPORTING ELEMENTS ARE IN PLACE.
- THE ARCHITECT AND STRUCTURAL ENGINEER BEAR NO RESPONSIBILITY FOR THE ABOVE ITEMS, AND OBSERVATION VISITS TO THE SITE DO NOT IN ANY WAY INCLUDE INSPECTIONS OF THESE ITEMS.

## PRECAUTIONARY NOTES ON STRUCTURAL BEHAVIOR:

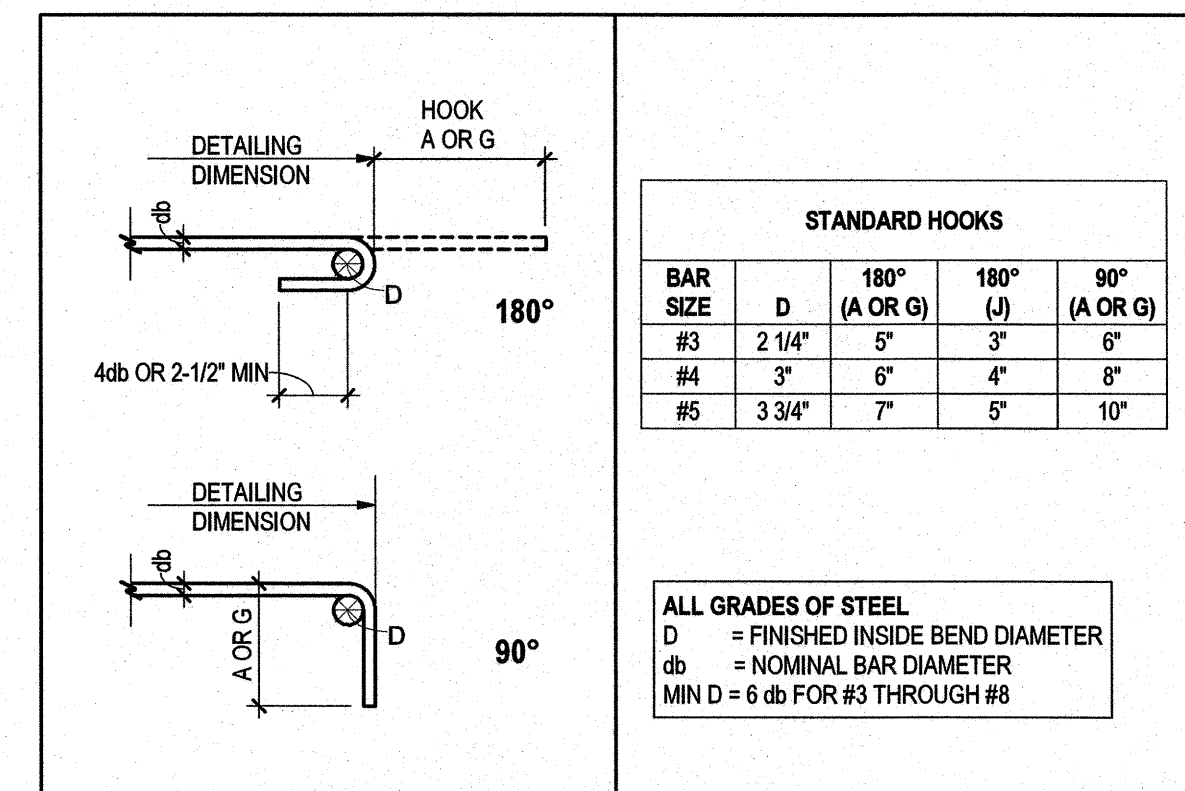
- INTERIOR ARCHITECTURAL FINISH DETAILINGS MUST ACCOMMODATE THE RELATIVE DIFFERENTIAL MOVEMENTS OF SUPPORTING STRUCTURAL ELEMENTS.
- THE FLOOR IS A FLOATING CONCRETE SLAB-ON-GRADE AND MAY EXPERIENCE MOVEMENTS INDEPENDENT OF THE STRUCTURAL FOUNDATIONS. INTERIOR ELEMENTS SUPPORTED ON THE SLAB-ON-GRADE FLOOR WILL MOVE WITH THE FLOOR. INTERIOR ELEMENTS SUPPORTED ON FOUNDATIONS AND COLUMNS WILL NOT EXPERIENCE SIMILAR OR MEASURABLE MOVEMENTS.

## LETTERS OF CONSTRUCTION COMPLIANCE:

- THE GENERAL CONTRACTOR SHALL DETERMINE FROM THE LOCAL BUILDING AUTHORITY, AT THE TIME THE BUILDING PERMIT IS OBTAINED, WHETHER ANY LETTERS OF CONSTRUCTION COMPLIANCE WILL BE REQUESTED FROM THE STRUCTURAL ENGINEER.
- THE CONTRACTOR SHALL NOTIFY THE STRUCTURAL ENGINEER OF ALL SUCH REQUIREMENTS IN WRITING PRIOR TO THE START OF CONSTRUCTION.
- TWO-DAY ADVANCE NOTICE SHALL BE GIVEN WHEN REQUESTING SITE VISITS NECESSARY AS THE BASIS FOR THE COMPLIANCE LETTER.
- THE GENERAL CONTRACTOR SHALL PROVIDE COPIES OF ALL THIRD-PARTY TESTING AND INSPECTION REPORTS TO THE ARCHITECT AND STRUCTURAL ENGINEER A MINIMUM OF ONE WEEK PRIOR TO THE DATE THAT THE COMPLIANCE LETTER IS NEEDED.

## SPECIAL INSPECTIONS:

- THE FOLLOWING SPECIAL INSPECTIONS AND TESTING SHALL BE PERFORMED BY A QUALIFIED SPECIAL INSPECTOR, RETAINED BY THE OWNER, IN ACCORDANCE WITH THE FOLLOWING SECTIONS OF IBC CHAPTER 17:
  - SECTION 1704 SPECIAL INSPECTIONS, CONTRACTOR RESPONSIBILITY, AND STRUCTURAL OBSERVATIONS AND THE FOLLOWING SUB-SECTIONS:
    - 1704.2 SPECIAL INSPECTIONS AND TESTS
    - 1704.3 STATEMENT OF SPECIAL INSPECTIONS
  - SECTION 1705 REQUIRED VERIFICATION AND INSPECTION AND THE FOLLOWING SUB-SECTIONS:
    - 1705.3 CONCRETE CONSTRUCTION
    - 1705.6 SOILS
    - SECTION 1705.11 SPECIAL INSPECTIONS FOR WIND RESISTANCE AND THE FOLLOWING SUB-SECTIONS:
      - 1705.11.1 STRUCTURAL WOOD
      - 1705.11.2 COLD-FORMED STEEL LIGHT-FRAME CONSTRUCTION
- THE SPECIAL INSPECTOR SHALL BE A QUALIFIED PERSON WHO SHALL DEMONSTRATE COMPETENCE, TO THE SATISFACTION OF THE BUILDING OFFICIAL, FOR INSPECTION OF THE PARTICULAR TYPE OF CONSTRUCTION OR OPERATION REQUIRING SPECIAL INSPECTION. THE APPROVED INSPECTOR MUST BE INDEPENDENT FROM THE CONTRACTOR RESPONSIBLE FOR THE WORK BEING INSPECTED.
- DUTIES AND RESPONSIBILITIES OF THE SPECIAL INSPECTOR SHALL BE TO INSPECT AND/OR TEST THE WORK OUTLINED ABOVE AND WITHIN THE STATEMENT OF SPECIAL INSPECTIONS IN ACCORDANCE WITH CHAPTER 17 OF THE IBC FOR CONFORMANCE WITH THE APPROVED CONSTRUCTION DOCUMENTS.
- ALL DISCREPANCIES SHALL BE BROUGHT TO THE IMMEDIATE ATTENTION OF THE CONTRACTOR FOR CORRECTION.
- PER SECTION 1704.2.4 THE SPECIAL INSPECTOR SHALL FURNISH REGULAR REPORTS TO THE BUILDING OFFICIAL AND THE STRUCTURAL ENGINEER. PROGRESS REPORTS FOR CONTINUOUS INSPECTION SHALL BE FURNISHED WEEKLY. INDIVIDUAL REPORTS OF PERIODIC INSPECTIONS SHALL BE FURNISHED WITHIN ONE WEEK OF INSPECTION DATES. THE REPORTS SHALL NOTE UNCORRECTED DEFICIENCIES, CORRECTION OF PREVIOUSLY REPORTED DEFICIENCIES, AND CHANGES TO THE APPROVED CONSTRUCTION DOCUMENTS AUTHORIZED BY THE STRUCTURAL ENGINEER OF RECORD.
- THE SPECIAL INSPECTOR SHALL SUBMIT A FINAL SIGNED REPORT WITHIN 10 DAYS OF THE FINAL SPECIAL INSPECTION STATING WHETHER THE WORK REQUIRING SPECIAL INSPECTION WAS, TO THE BEST OF THE INSPECTOR'S KNOWLEDGE, IN CONFORMANCE WITH THE APPROVED CONSTRUCTION DOCUMENTS AND THE APPLICABLE WORKMANSHIP PROVISIONS OF THE IBC. WORK NOT IN COMPLIANCE SHALL BE NOTED IN THE REPORT.
- THE CONTRACTOR SHALL SUBMIT A WRITTEN STATEMENT OF RESPONSIBILITY TO THE BUILDING OFFICIAL AND THE OWNER PRIOR TO THE COMMENCEMENT OF WORK ON A MAIN WIND- OR SEISMIC-FORCE-RESISTING SYSTEM PER SECTION 1704.4. THE STATEMENT SHALL ACKNOWLEDGE THE AWARENESS OF THE SPECIAL LISTED REQUIREMENTS OF DESIGNATED SEISMIC SYSTEM OR A WIND- OR SEISMIC-RESISTING COMPONENT IN THE STATEMENT OF SPECIAL INSPECTIONS PER SECTION 1705.
- EXCEPT AS NOTED, THE SPECIAL INSPECTIONS OUTLINED ABOVE ARE IN ADDITION TO, AND BEYOND THE SCOPE OF, PERIODIC STRUCTURAL OBSERVATIONS AS DEFINED IN SECTION 1704.5. STRUCTURAL OBSERVATIONS ARE INCLUDED IN THE STRUCTURAL ENGINEER'S DESIGN AND CONSTRUCTION ADMINISTRATION SERVICES PROVIDED BY THE STRUCTURAL ENGINEER.

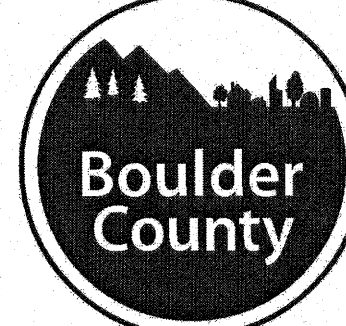


2 SCHEDULE  
 S002 3/4" = 1'-0"

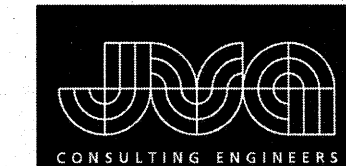
TYPICAL CONCRETE REINFORCING LAP & EMBEDMENT LENGTHS (UNO)							
BAR SIZE	TYPE	$f_c = 3000$ PSI		$f_c = 4000$ PSI		$f_c = 5000$ PSI	
		(TOP)	(OTHER)	(TOP)	(OTHER)	(TOP)	(OTHER)
#4	EMBED	29	22	25	19	22	17
	LAP	37	29	32	25	29	22
#5	EMBED	36	28	31	24	28	22
	LAP	47	36	40	31	36	28
#6	EMBED	43	33	37	29	33	26
	LAP	56	43	48	37	43	33

NOTES:  
 1. TOP BARS ARE HORIZONTAL BARS WITH MORE THAN 12 INCHES OF FRESH CONCRETE CAST BELOW BAR.  
 2. TABULATED VALUES ARE BASED ON GRADE 60 NON-EPOXY-COATED REINFORCING BARS AND NORMAL WEIGHT CONCRETE.  
 3. VALUES ARE IN INCHES.

1 SCHEDULE  
 S002 3/4" = 1'-0"



BUILDING SERVICES DIVISION  
 2020 13TH ST.  
 BOULDER, CO 80302  
 P.O. BOX 471 BOULDER, CO 80308  
 PHONE: 303.441.3187  
 mschoofs@bouldercounty.org



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BOULDER COUNTY  
 3897 N. 75TH STREET  
 WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

PROJECT  
 WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

LOCATION  
 3897 N. 75TH STREET  
 BOULDER, COLORADO 80301

SHEET  
 GENERAL STRUCTURAL FILES

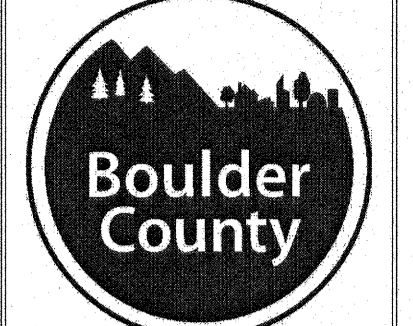
FILE NAME  
 3897N75thStreet\_S002\_S002.rvt

ACCT# 19006  
 DATE: 06/07/2019  
 DRAWN BY: AJT/DSA  
 CHECKED BY: ISS

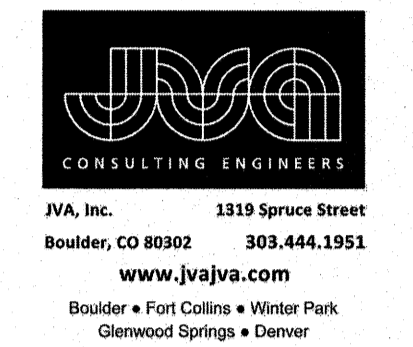
REVISIONS  
 PERMIT SET 3/28/2019  
 RESUBMITTAL 6/7/2019  
 P.P. REVIEW RESUBMITTAL 7/28/2019

SHEET  
 S002

7.26.19



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 BUILDING SERVICES DIVISION  
 2020 13TH ST.  
 BOULDER, CO 80302  
 P.O. BOX 471 BOULDER, CO 80306  
 PHONE: 303.441.3187  
 mschoofs@bouldercounty.org



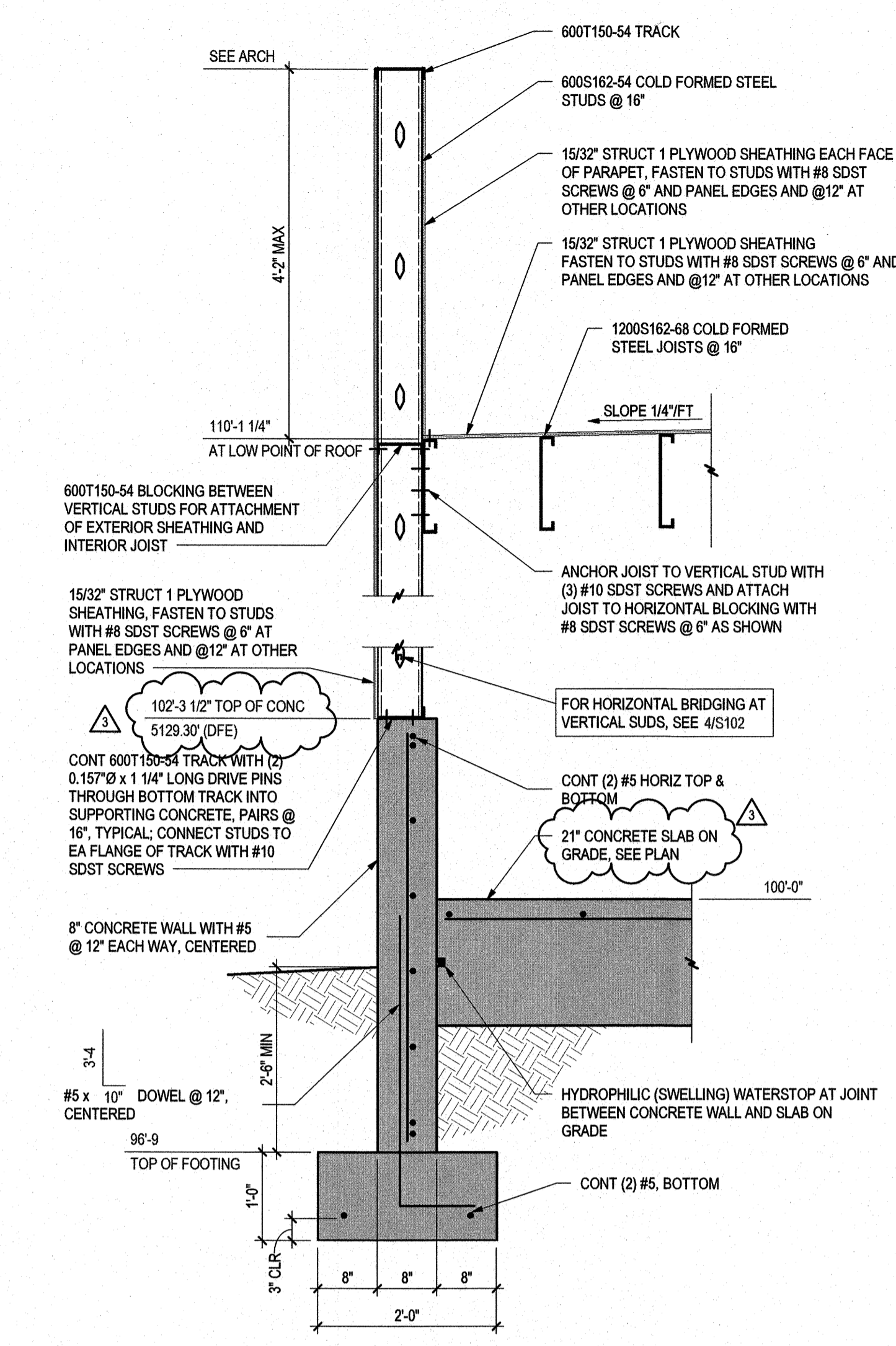
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**BOULDER COUNTY**  
**3897 N. 75TH STREET**  
**WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL**

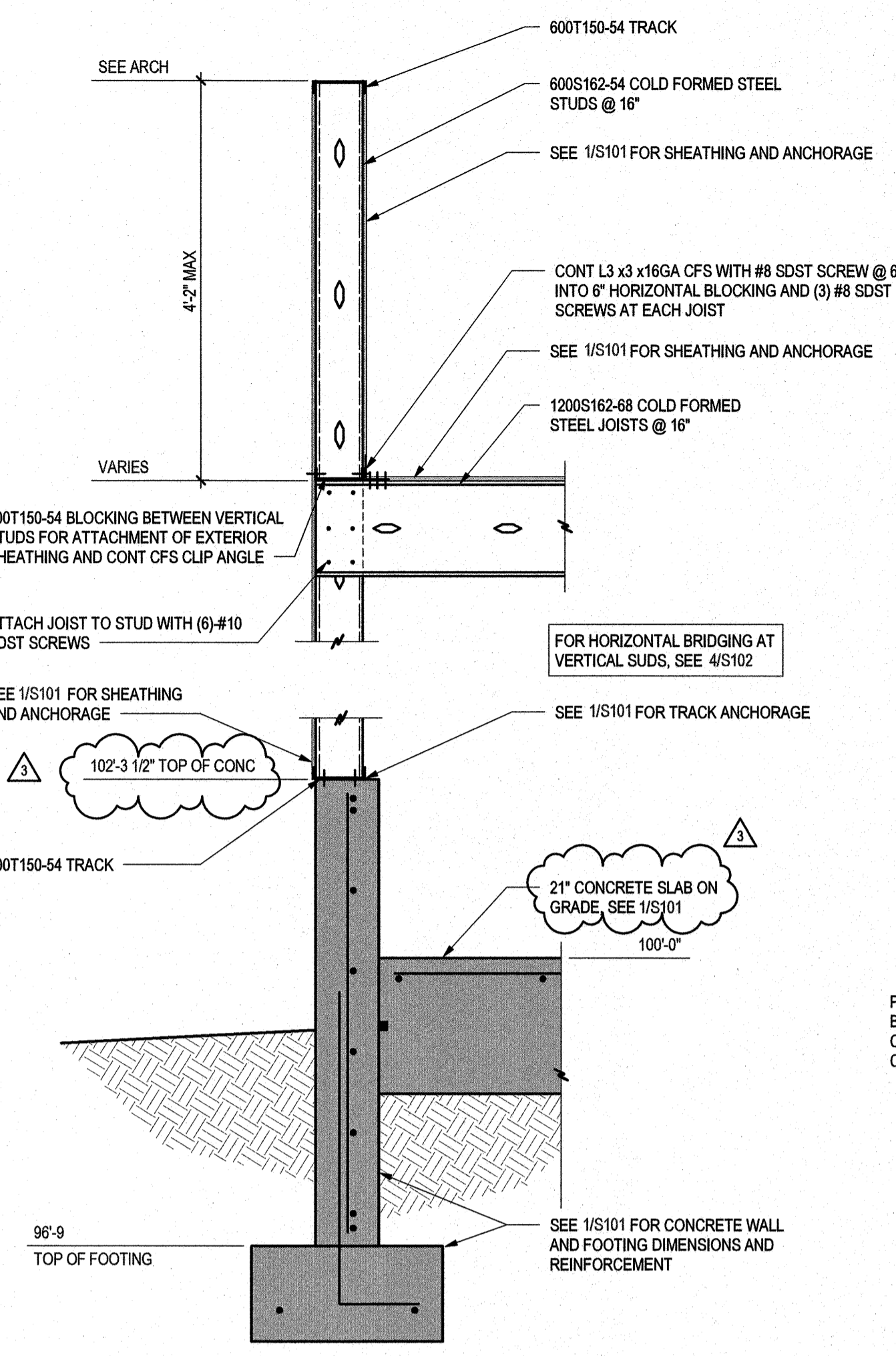
**PROJECT**  
 WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL  
**LOCATION**  
 3897 N. 75TH STREET BOULDER, COLORADO 80301  
**SHEET**  
 PLANS AND SECTIONS  
**FILE NAME**  
 311616020001020\_CrewRoom\_0107\_2019.dwg  
**ACCT** 19008  
**DATE** 06/07/2019  
**DRAWN BY** AJT/DJA  
**CHECKED BY** TSS

REVISIONS	
PERMIT SET	3/28/2019
RESUBMITTAL	6/7/2019
F.P. REVIEW RESUBMITTAL	7/26/2019

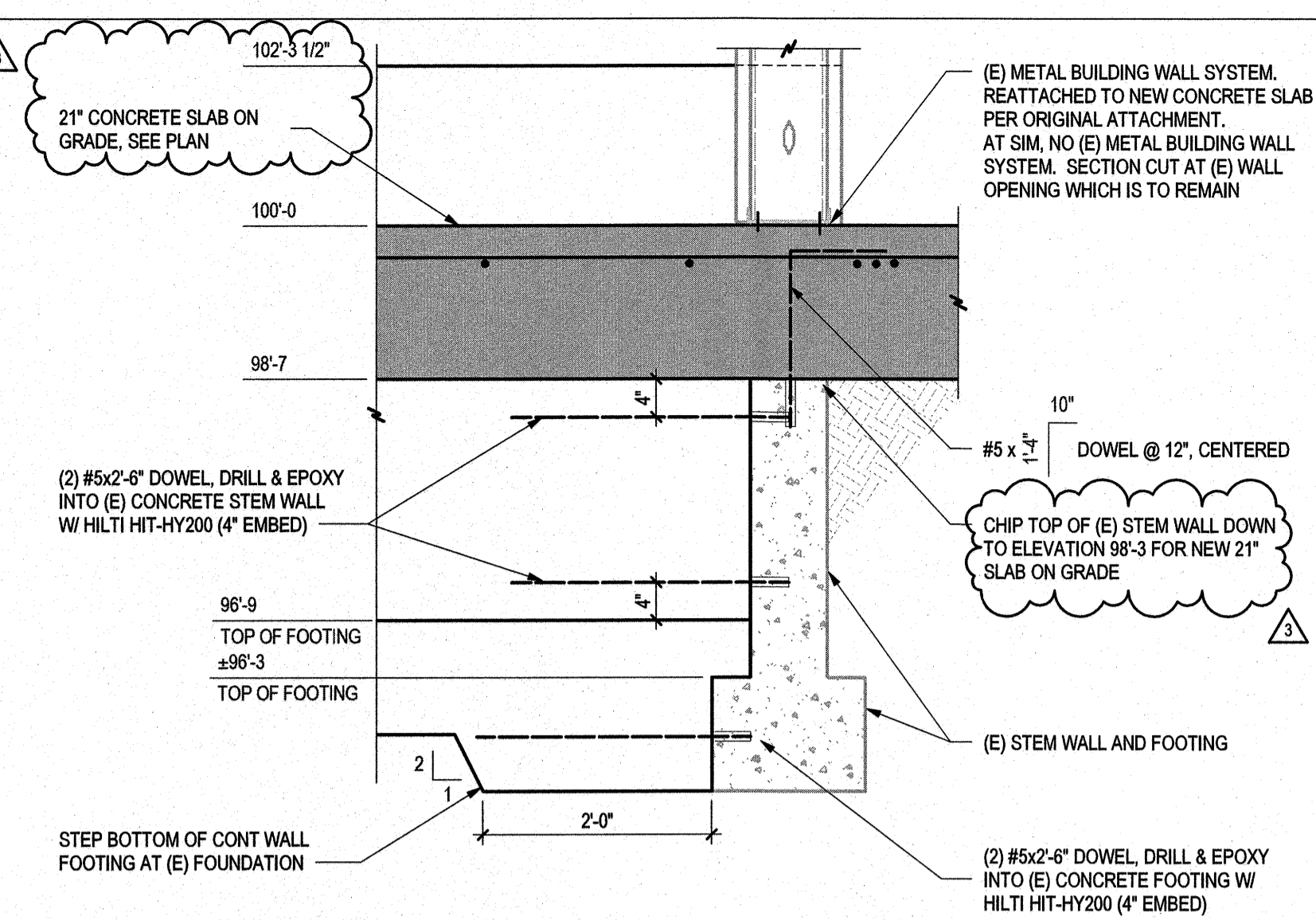
SHEET  
**S101**



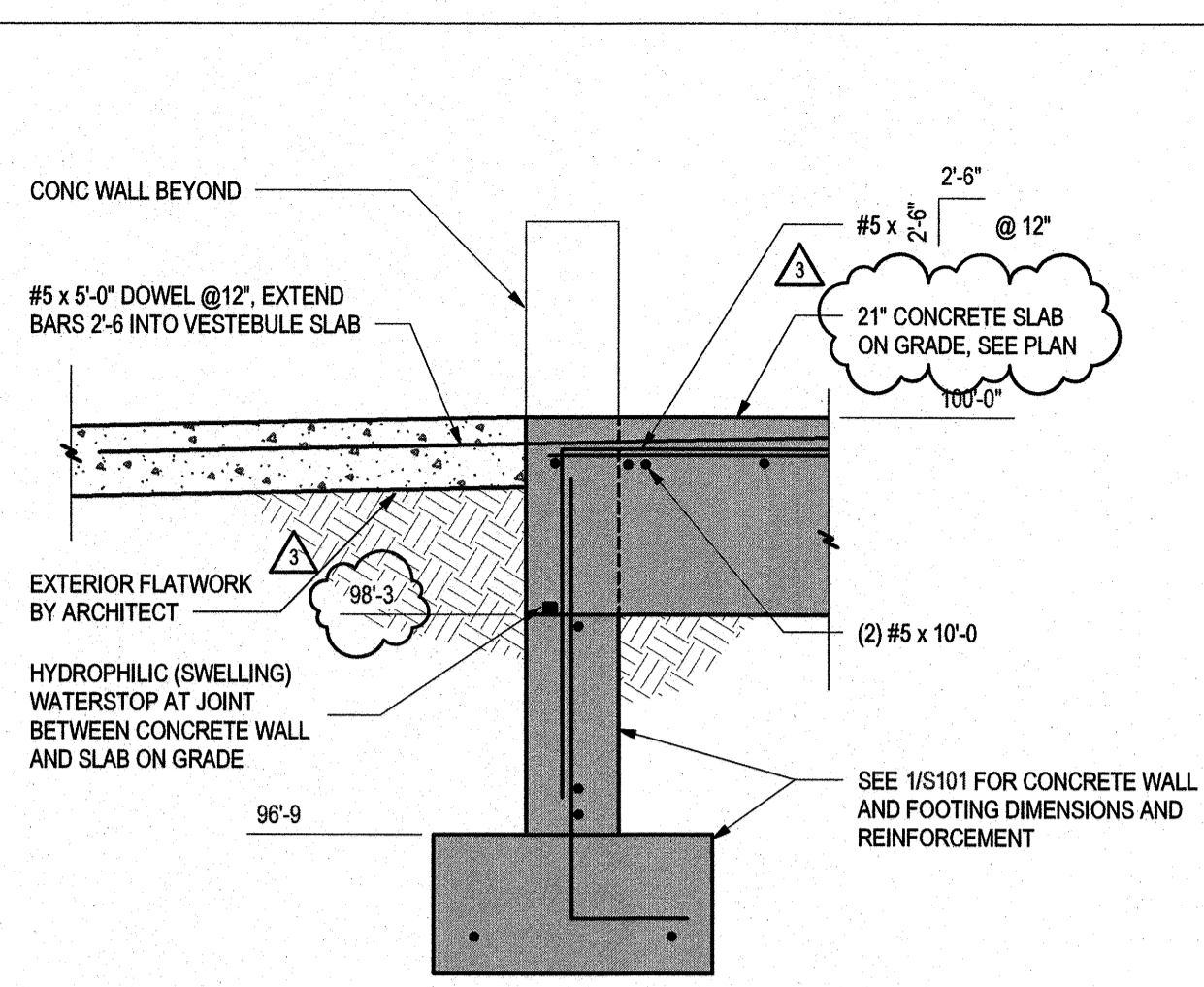
**1 SECTION**  
 S101 3/4" = 1'-0"  
 0 6" 1' 2' 3'



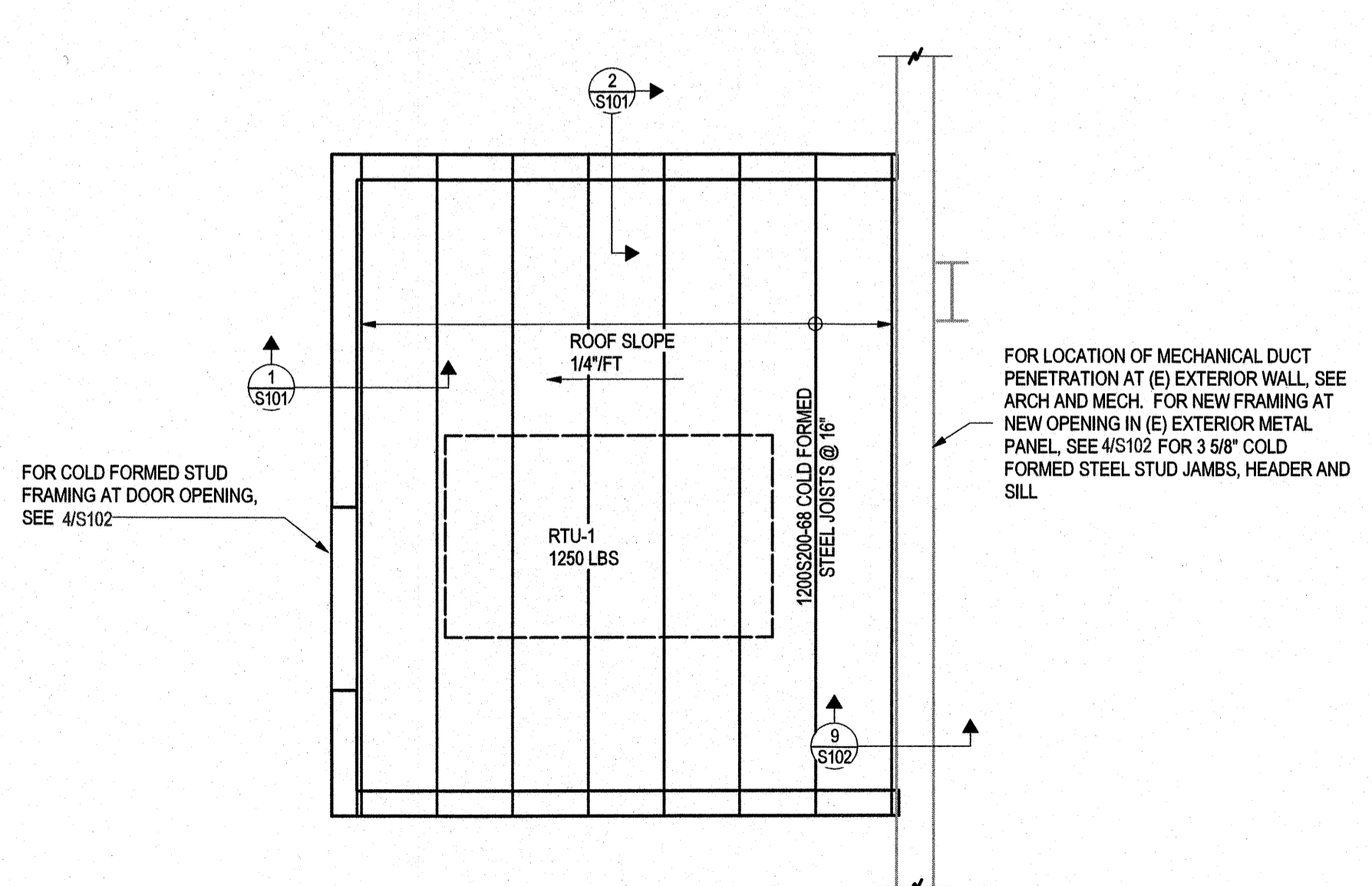
**2 SECTION**  
 S101 3/4" = 1'-0"



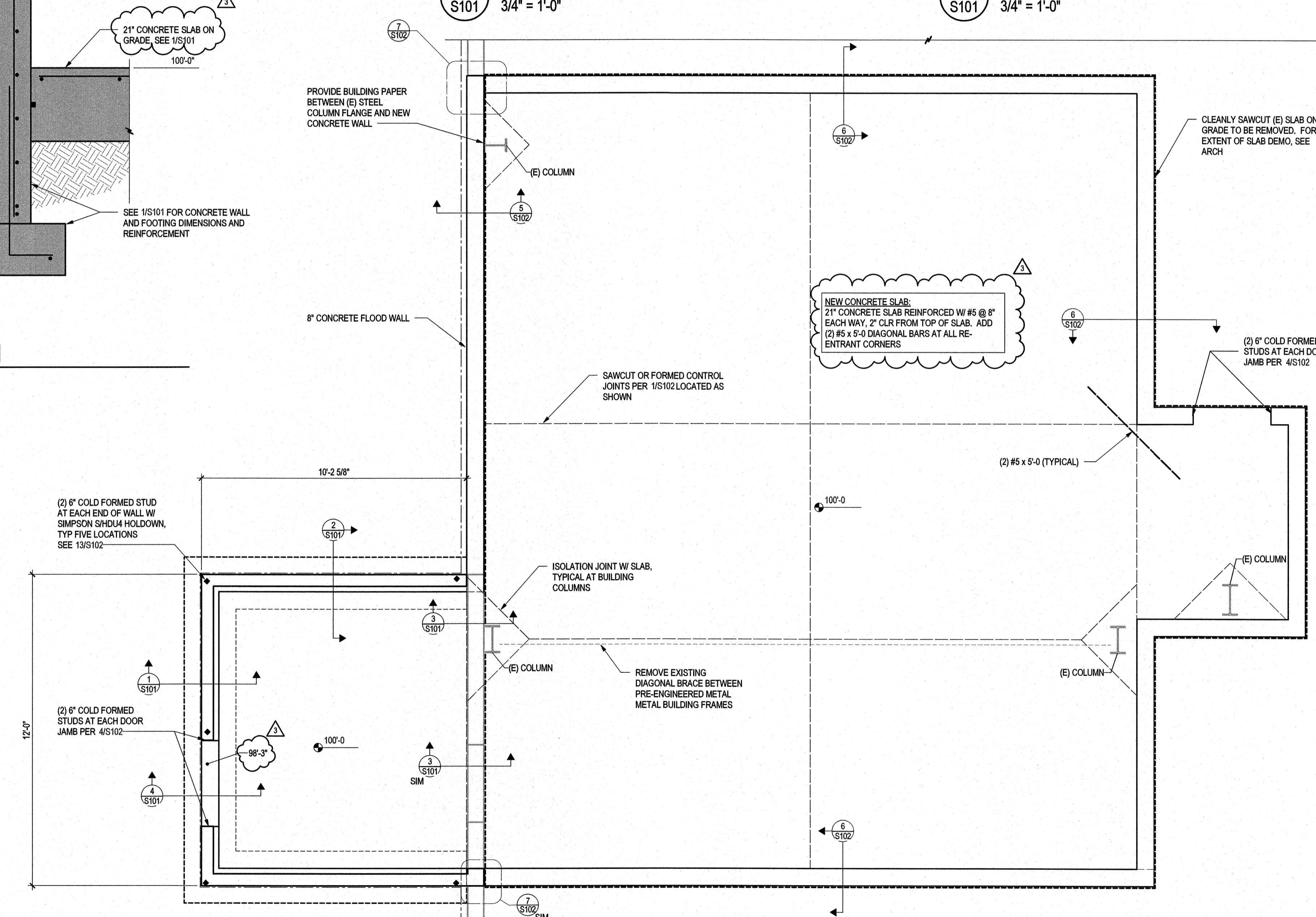
**3 SECTION**  
 S101 3/4" = 1'-0"



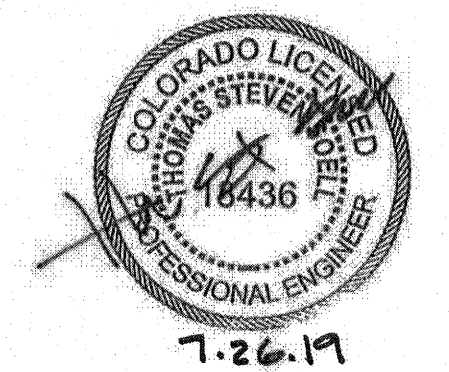
**4 SECTION**  
 S101 3/4" = 1'-0"

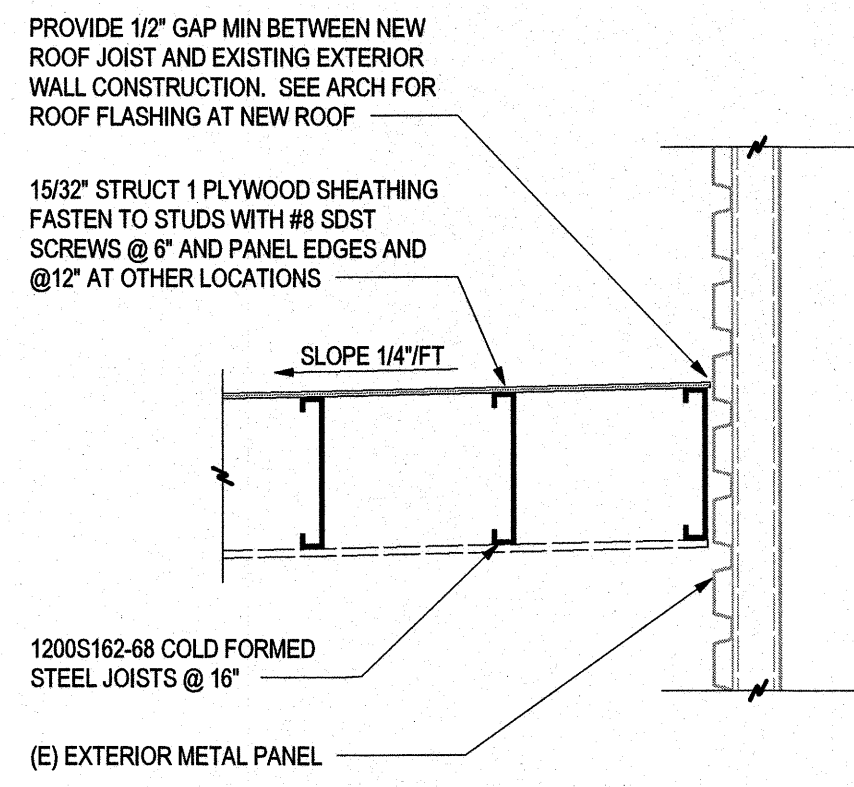


**VESTIBULE ROOF FRAMING PLAN**  
 3/8" = 1'-0"  
 0 1' 2' 4' 6'

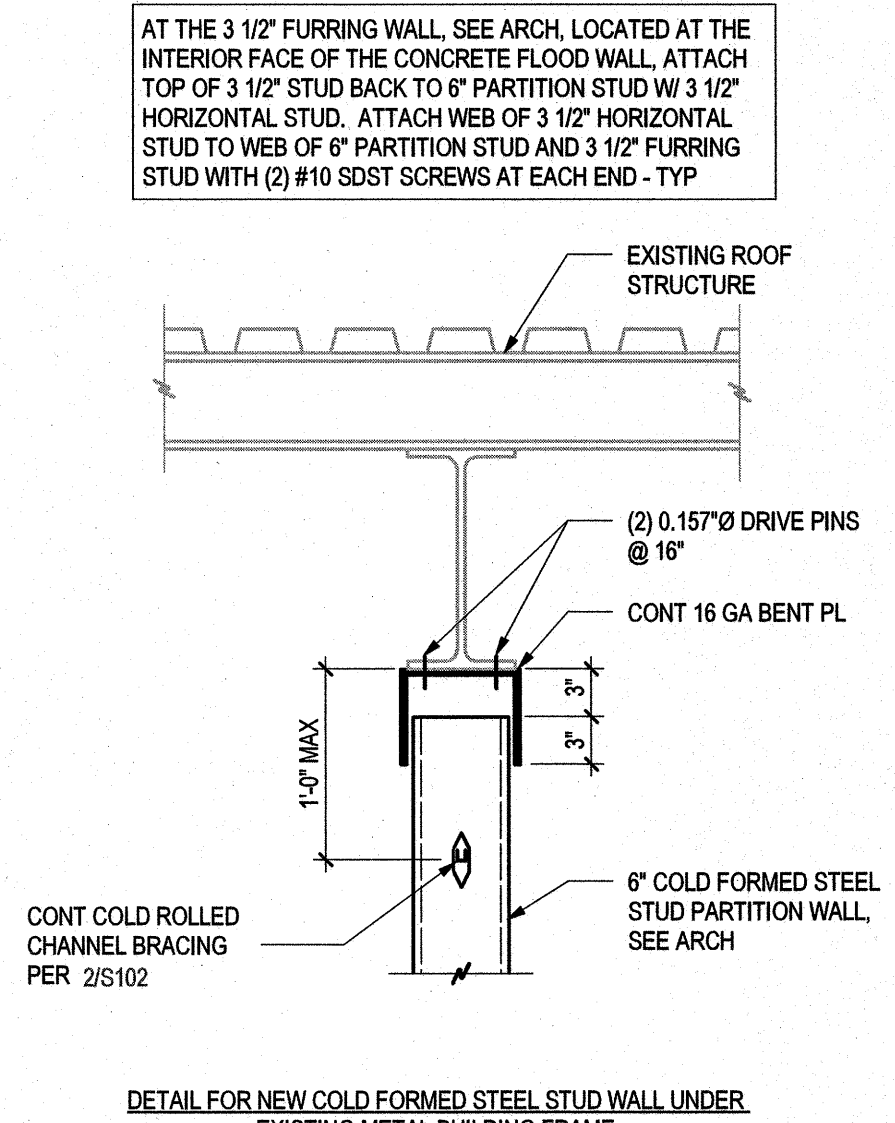


**FOUNDATION AND FLOOD WALL PLAN**  
 3/8" = 1'-0"  
 0 1' 2' 4' 6'  
 USGS BASE FLOOD ELEVATION, BFE = 5127.30'  
 USGS DESIGN FLOOD ELEVATION, DFE = 5129.30'  
 USGS FLOOD ELEVATION SLAB = 99'-6" TOP OF INTERIOR FLOOR SLAB  
 TOP OF INTERIOR FLOOR SLAB ELEVATION = 100'-0" UNLESS NOTED THIS XXXX  
 TOP OF PERIMETER EXTERIOR FLOORING = 99'-9" UNLESS NOTED THIS XXXX  
 TOP OF 8\"/>

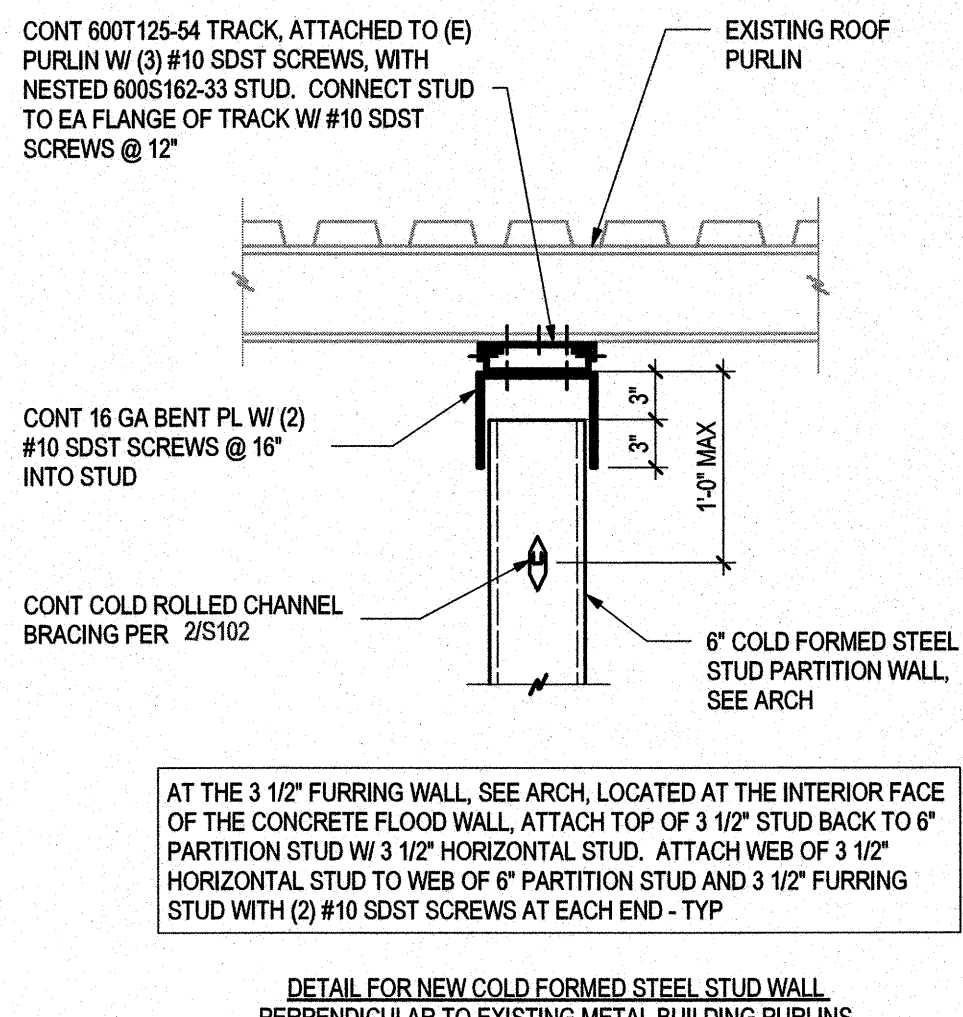




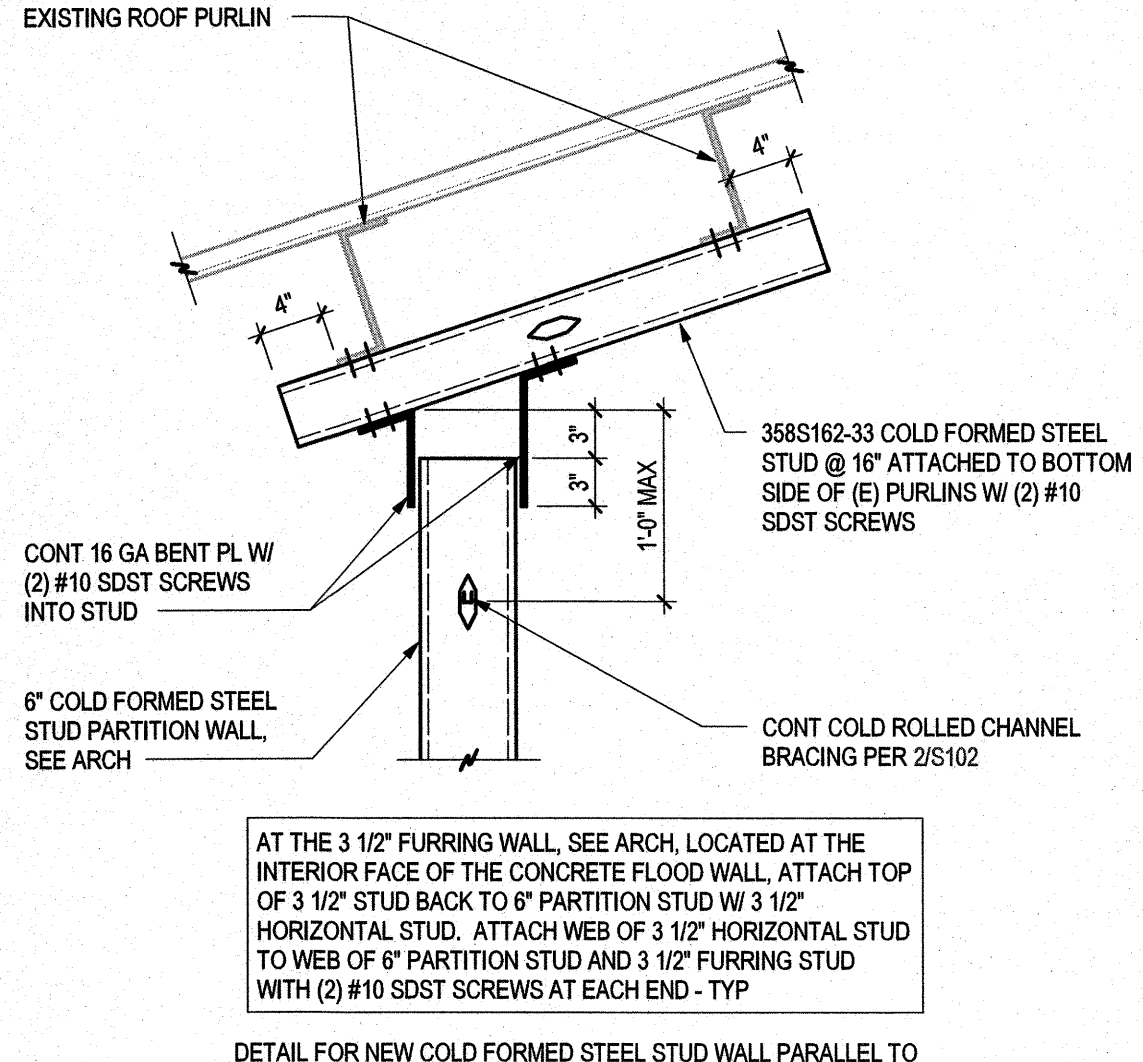
9 SECTION  
S102 3/4" = 1'-0"



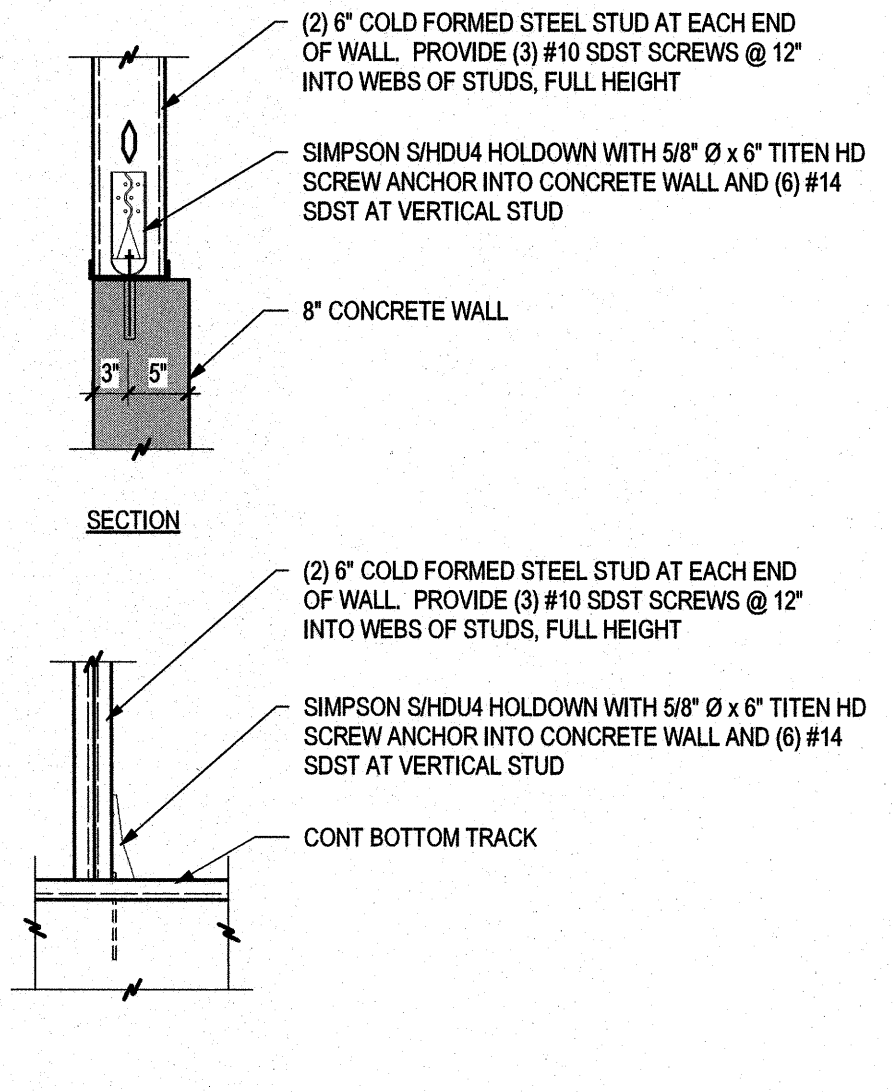
10 SECTION  
S102 1" = 1'-0"



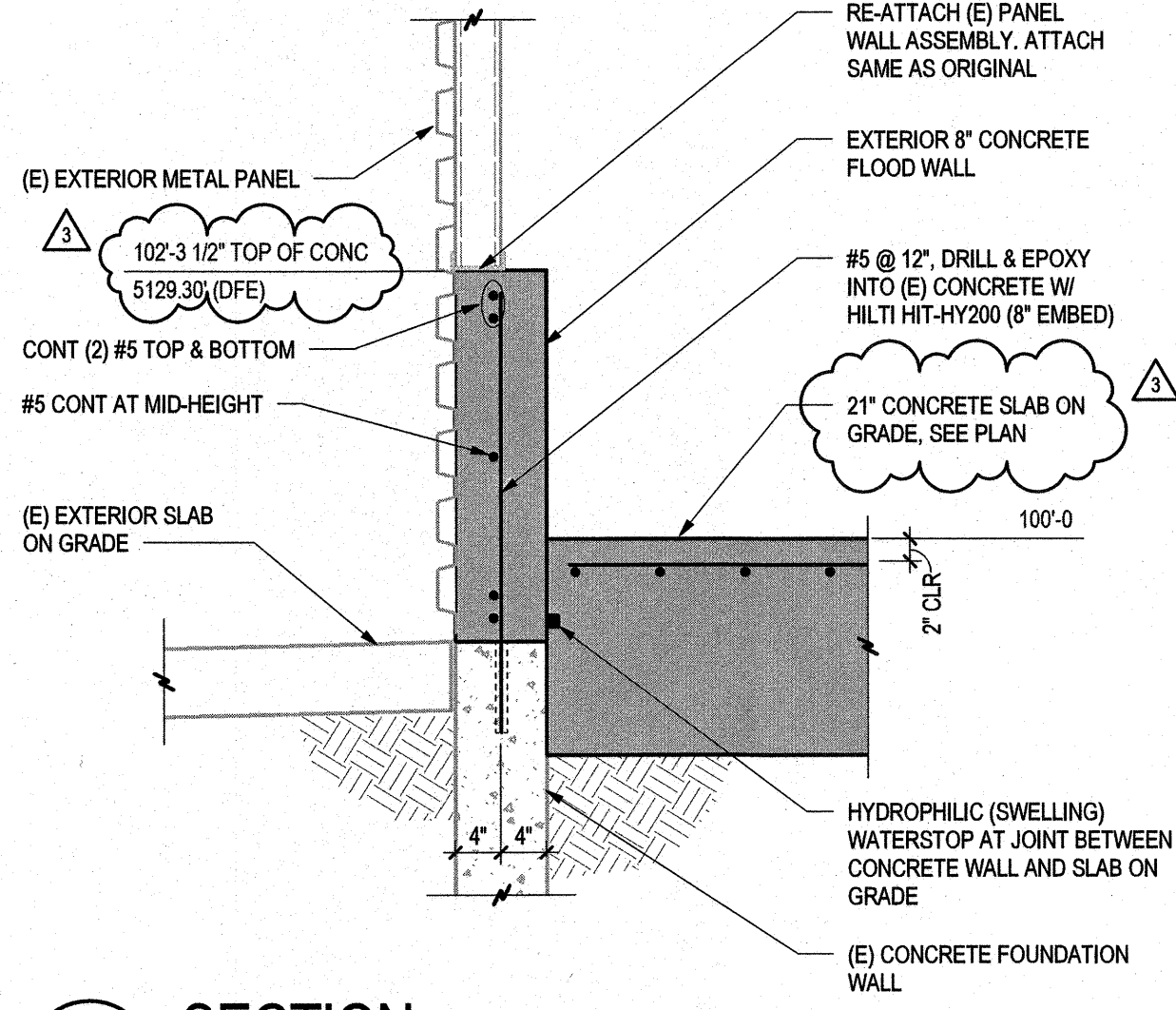
11 SECTION  
S102 1" = 1'-0"



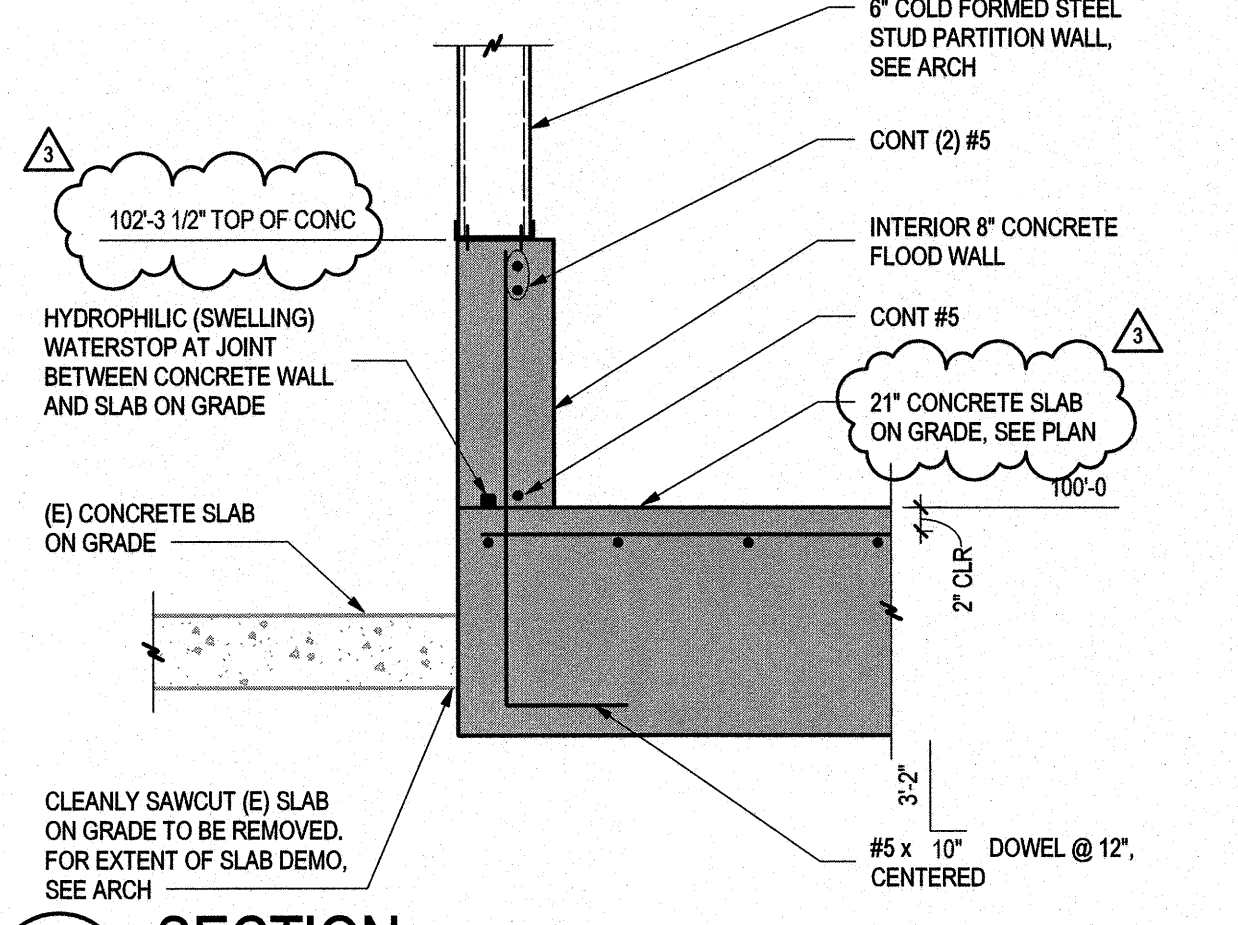
12 SECTION  
S102 1" = 1'-0"



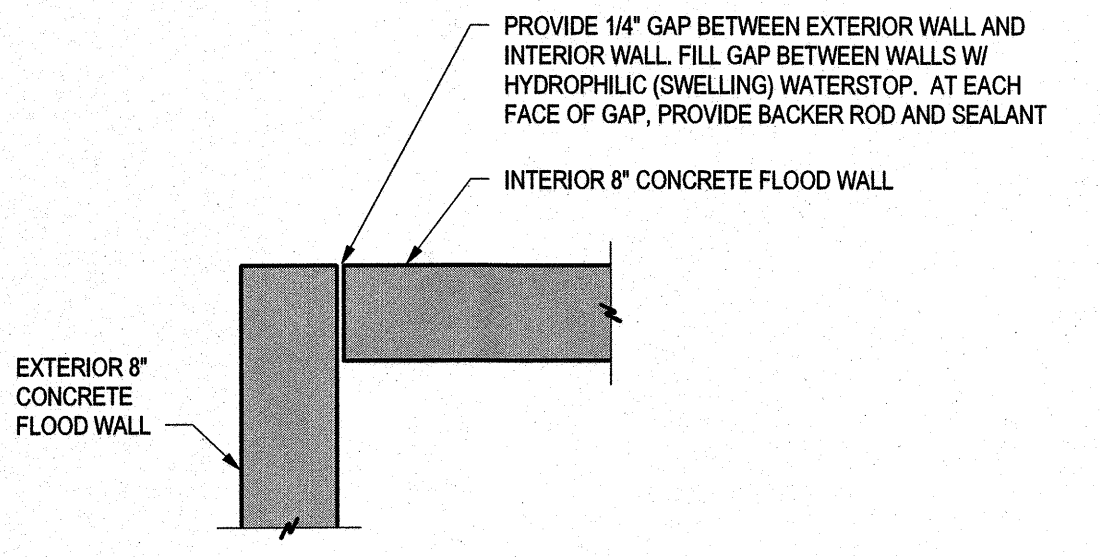
13 DETAIL  
S102 3/4" = 1'-0"



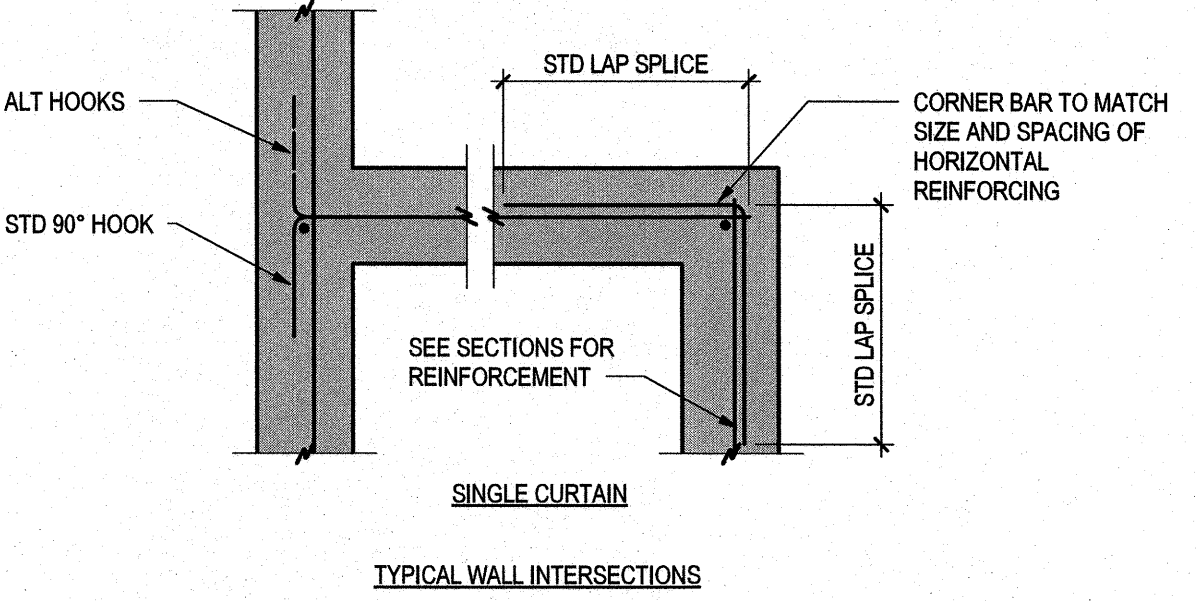
5 SECTION  
S102 3/4" = 1'-0"



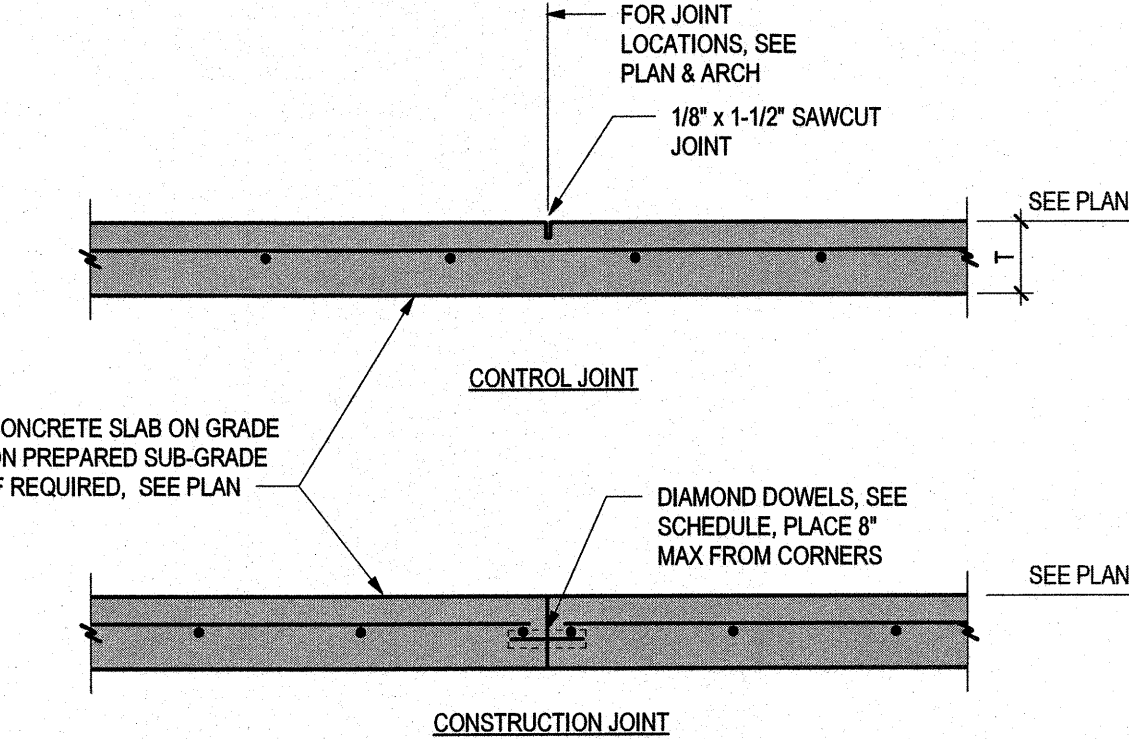
6 SECTION  
S102 3/4" = 1'-0"



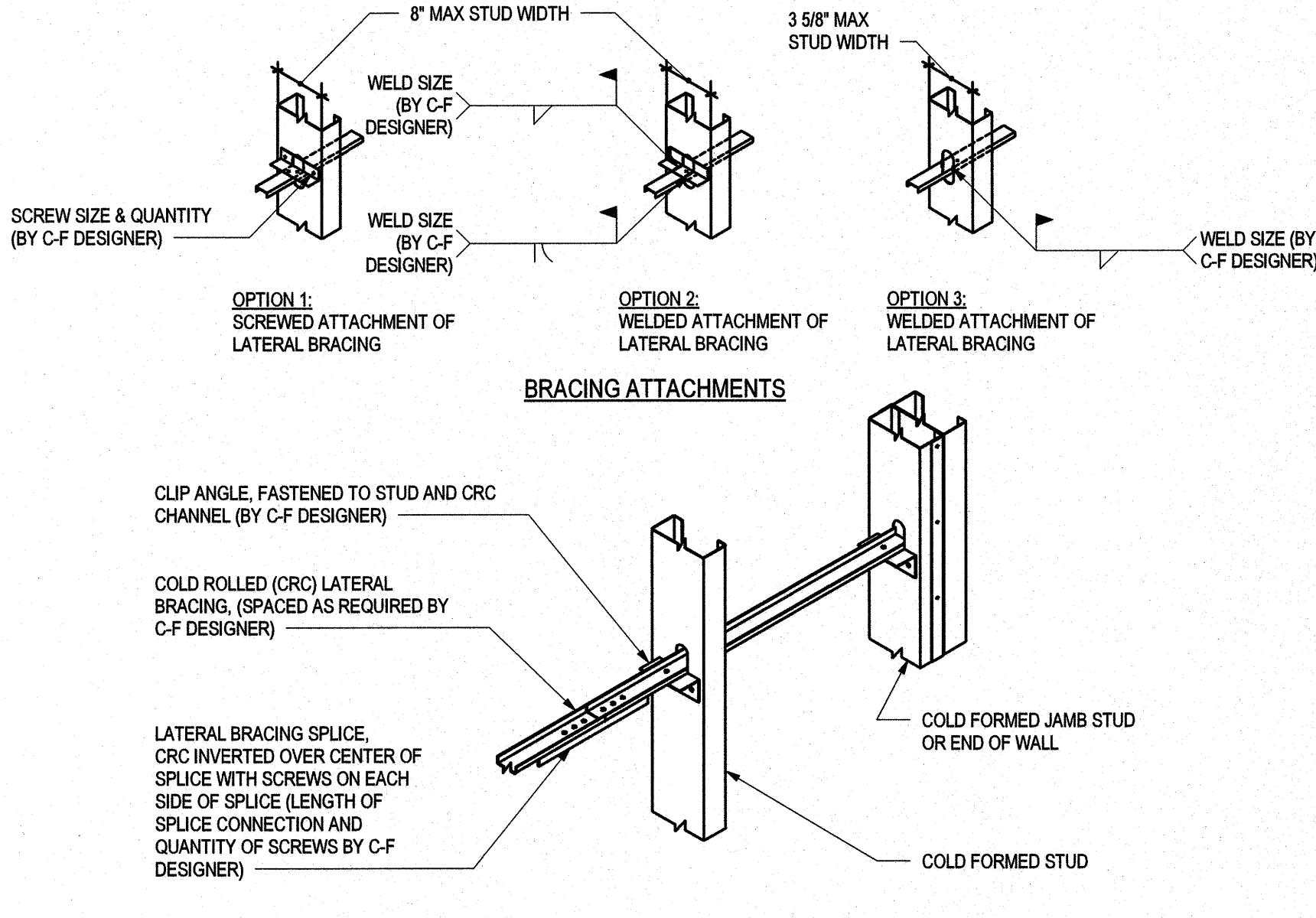
7 DETAIL  
S102 3/4" = 1'-0"



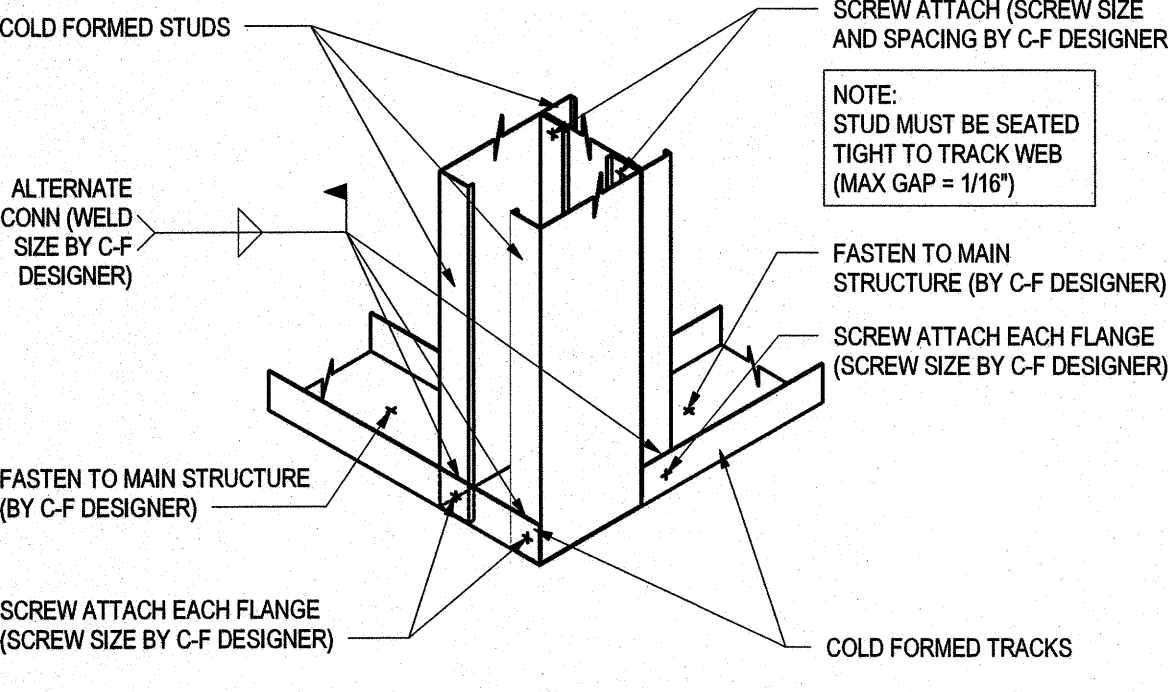
8 SECTION  
S102 3/4" = 1'-0"



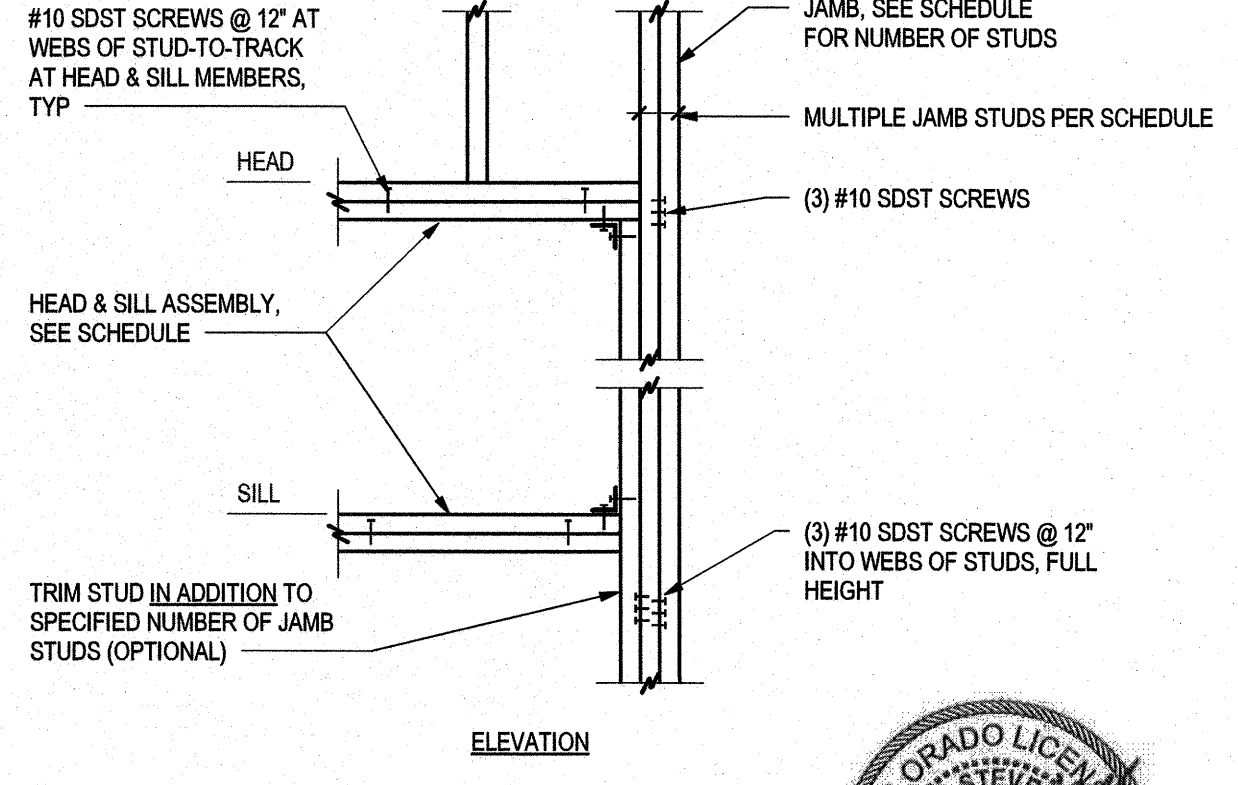
1 SCHEDULE  
S102 3/4" = 1'-0"



2 DETAIL  
S102 1/8" = 1'-0"



3 DETAIL  
S102 1/8" = 1'-0"



4 DETAIL  
S102 3/4" = 1'-0"

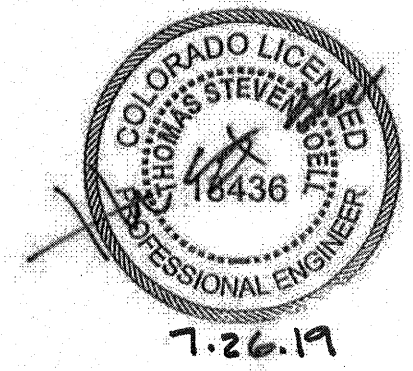
DOWEL SIZE & SPACING AT CONSTRUCTION JOINTS		
SLAB DEPTH (INCHES)	DOWEL DIMENSIONS (INCHES)	DOWEL SPACING (INCHES)
5 TO 6	1/4 x 4-1/2 x 4-1/2	18
7 TO 8	3/8 x 4-1/2 x 4-1/2	18
9 TO 11	3/4 x 4-1/2 x 4-1/2	20

EXTERIOR METAL STUD WALL OPENING ASSEMBLIES			
OPENING WIDTH	JAMBS (LINO)	HEAD AND SILL (LINO)	NUMBER OF #10 SDST SCREWS AT L-1-1/2 x 1-1/2 x 16 GA CLIP ANGLE CONNECTING HEAD TO JAMB
<4'-0" @ 6" STUDS	(2) 600S162-54	(1) 800T150-54 (FLAT) + (1) 600S162-54 (FLAT)	(2) EACH LEG (4 TOTAL)
<4'-0" @ 3 5/8" STUDS	(2) 362S162-43	(1) 362T150-54 (FLAT) + (1) 362S162-43 (FLAT)	(2) EACH LEG (4 TOTAL)

STUD SIZE	TYPE	SPACING	TOP & BOTTOM TRACKS
6"	600S162-54	@ 16"	CONT 600T150-54 TOP (NESTED) & BOTTOM

- CONNECT MULTIPLE STUDS AT HEAD AND JAMBS AS INDICATED
- HORIZONTAL BRIDGING BETWEEN STUDS: 150U50-54 @ 4'-0" W L1-1/2x1-1/2 x 16 GA CLIPS EACH STUD (2) #10 SCREWS EACH LEG) AS IN 2/S102



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BUILDING SERVICES DIVISION  
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BOULDER, CO 80302  
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3897 N. 75TH STREET  
WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL

PROJECT  
WALDEN TRANSPORTATION CREW ROOM AND OFFICE REMODEL  
LOCATION  
3897 N. 75TH STREET BOULDER, COLORADO 80301  
SHEET SCHEDULES AND DETAILS  
FILE NAME  
ACCT 19008  
DATE: 06/07/2019  
DRAWN BY: AJT/DSA  
CHECKED BY: TSS

REVISIONS  
PERMIT SET 3/28/2019  
RESUBMITTAL 6/7/2019  
F.P. REVIEW RESUBMITTAL 7/26/2019

SHEET  
**S102**