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3793
2/28/2025
Jackson, MS
STATE OF MISSISSIPPI

ADDENDUM NUMBER TWO (2)

Date: **February 27, 2025**

Project Name: **Renovation of the**
Matt Thomas Jr. Garden Apartments
Alcorn State University
134 Research Drive, Lorman, Mississippi 39096

CCD Project: **24010**

Copies To: All bid document holders of record

The following changes, additions, deletions, and/or clarifications to the Drawings dated September 10, 2024 and Project Manual (Specifications) revised January 28, 2025, are hereby made part of the Contract Documents. Receipt of this addendum shall be acknowledged by inserting its number and date in the Bid Proposal Form where indicated. Failure to acknowledge this Addendum will result in rejection of your bid proposal.

REQUESTS FOR INFORMATION

2.1 **RFI #1**: *Referencing Handrail Elevations 3 & 5 (for buildings B & D respectively), please clarify if the existing stair landing should be re-poured due to obvious sagging from washout beneath the landing. This sagging has caused a trip hazard.*

CCD Response: Remove and replace the concrete stairs and upper and lower landings at Building B and two locations at Building D. Landings shall have a maximum slope of 2% in any direction and shall be flush with existing conditions to remain. See revised drawing A101 R1. This work is part of the Base Bid.

2.2 **RFI #2**: *Is fleece baking required on the Adhered TPO Roofing?*

CCD Response: Provide fleece baked TPO membrane as specified.

2.3 **RFI #3**: *The exterior elevation shows 13' floors but the detail for walls shows 7'10" to concrete deck (or 7'8") with new ceilings tight to the deck. The reality from photos seems to be 8' and if so, how are circuits to be installed under those conditions?*

CCD Response: Overhead conduit and junction boxes are to be concealed within the new furred down ceiling. Provide metal furring of depth required. Maintain the maximum ceiling heights possible. Coordinate final ceiling heights with Architect prior to furring installation.

2.4 **RFI #4**: *Mechanical drawings indicate that we are supposed to reuse the existing line sets but the person I sent on the bid walk said that many were open ended and looked like they would not be able to be reused. We would recommend replacing all of the line sets for the project.*

ERG Response: Provide all new pre-molded, pre-insulated line sets routed to the exterior above the new bathroom ceilings. All new line sets exposed on the exterior wall shall be concealed behind sheet metal enclosures with Kynar 500 factory finish–color to be selected by Architect from full range of standard colors.

REQUESTS TO THE SPECIFICATIONS

2.5 **Table of Contents:** Replace with the attached revised Table of Contents R1.

2.6 **007200 Modified General Conditions**: Add paragraph 9.11 Liquidated Damages as follows:

9.11 **Liquidated Damages** – Time being of the essence of this Contract and a matter of material consideration thereof, a reasonable estimate in advance is established to cover losses incurred by the Owner if the Project is not substantially complete on the date set forth in the Contract Documents. The Contractor and his Surety will be liable for and will pay the Owner the sums hereinafter stipulated as fixed and agreed as liquidated damages for each calendar day for delay until the Work is substantially complete. The Contractor and his Surety acknowledge that the Owner's losses caused by the Contractor's delay are not readily ascertainable and that the amount estimated per day for liquidated damages is reasonable and is not a penalty.

The amount established per calendar day for liquidated damages is Five Hundred dollars ($500.00). Liquidated Damages will be deducted by the Owner from the Contract Sum.

2.7 **012100 Allowances**: Add paragraph 3.4.D to the Schedule of Allowances as follows:

D. Include in the bid for inclusion in the contract sum the amount of Fifteen Thousand dollars ($15,000) for the replacement of rusted exterior door frames. Coordinate with the Architect during construction to determine the quantity and selection of door frames for replacement.

2.8 **004200 Proposal Form**: Replace with the attached revised Proposal Form R1 which includes the following changes:

- Delete "(Professional must specify number of days)". The number of consecutive calendar days is to be bid as part of the Contractor's proposal.
- Delete reference to Alternates #4 and #5.
- Add the Description for Alternates #1, #2, and #3.

2.9 **005200 Standard Form of Agreement Between the Owner and the Contractor**: Replace agreement with the attached revised Standard Form of Agreement Between the Owner and the Contractor which includes the following changes:

2.2.1 The stipulated liquidated damages described in Paragraph 9.11 of the modified General Conditions are in the amount of Five-Hundred Dollars ($ 500.00) for each calendar day.

2.10 **092910 Gypsum Drywall**: Replace with the attached revised section 092910 R1.

2.11 **093013 R1 Ceramic Tile**: Replace with the attached revised section 093013 R1.

2.12 **220000 Plumbing**: Issue attached Division 220000 in its entirety.

2.13 **230000 HVAC**: Issue attached Division 230000 in its entirety.

REFER TO THE DRAWINGS

2.14 **A101 – Architectural Site Plan & Handrail Elevations**: Replace with attached drawing A101 R1 revised February 27, 2025.

2.15 **A103 – Demolition Floor Plans**: Add note 9 as follows:

9. Remove CMU walls to extent required for new electrical panels.

2.16 **A120 – First Floor Plan and Second Floor Plans**: Add note 4 as follows:

4. Patch and replace CMU walls to match existing, as required around new electrical panels.

2.17 A560 – Millwork Sections/ Details & Finish Schedules: Revise ceiling heights for all spaces to be “MAX”. Coordinate final ceiling heights with Architect prior to furring installation.

REFER TO ADDENDUM 1

2.18 **Project Name**: Delete reference to “Phase 1.”

END OF ADDENDUM NUMBER TWO (2)

September 10, 2024

R1: **February 27, 2025**

Project Manual
RENOVATION OF THE
MATT THOMAS JR. GARDEN APARTMENTS
ALCORN STATE UNIVERSITY
134 RESEARCH DRIVE, LORMAN, MISSISSIPPI 39096

CCD Project No. 24010

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PROPOSAL FORM R1
SECTION 00 4200 R1

To: Bureau of Building, Grounds and Real Property Management
501 North West Street, Suite 1401B [Woolfolk Building]
Jackson, Mississippi 39201

Re: Project # 24010
Project Title Renovation of the Matt Thomas Jr. Garden Apartments, ASU Campus
Location Lorman, Mississippi

I propose to complete all work in accordance with the Project Manual and Drawings within _____ consecutive calendar days for the sum of:

BASE BID: **(**Write in the amount of the base bid in words and numbers. In case of conflict, the written word governs.)

Words:_____ Dollars ($_____

ALTERNATES: **(**Write in the amount of all of the alternates in words and numbers. In case of conflict, the written word governs.)

Alternate #1 ☐ Adds ☐ Deducts
Words:_____ Dollars
($_____)
Description Remove and replace all existing window units with those specified for buildings B C, and D

Alternate #2 ☐ Adds ☐ Deducts
Words: _____ Dollars
($_____) _____
Description Add the interior build out of Building D

Alternate #3 ☐ Adds ☐ Deducts
Words: _____ Dollars
($_____)
Description See Section 012300 R1 - Alternates

ADDENDA ACKNOWLEDGMENT: (modified dates August 2016)

No. _____ No. _____ No. _____

No. _____ No. _____ No. _____

ACCEPTANCE:

I certify that I am authorized to enter into a binding contract, if this Proposal is accepted.

Signature _____ Date _____
Name and Title _____
Name of Business _____

Complete spelling of bidder's name and address - exact as recorded at the Secretary of State [http://www.sos.state.ms.us/busserv/corp/soskb/csearch.asp] which should be the same as you applied for at the Mississippi State Board of Contractors [http://www.msboc.us/Search2.CFM] (see 2.07, 3.01, 5.01) **PLEASE LOOK IT UP at SoS. SoS rules when the 2 are different.**

Address _____(mailing)
Address _____(physical)
City/State/Zip Code_____County _____
Phone _____ Fax _____ Email _____

■ **BIDDER'S CERTIFICATE OF RESPONSIBILITY NUMBER(S):** _____

■ **MINORITY BUSINESS ENTERPRISE? Yes** _____ **No** _____ (to assist with Code 57-1-57)

■ Attach copy of Non-Resident Bidder's Preference Law (5.04 of Bidder's Checklist)

■ **Mechanical / Plumbing / Electrical Contractors:** (modified Dec 2013 SoS per 10/17/12 Addendum 1 & Feb 2014; 021219 sub over $50,000.00; modified 04/06/2020)

Regarding said Divisions of the Specifications of the BoB Standard Form of Agreement Between The Owner and The Contractor: List any Mechanical/Plumbing and/or Electrical Sub-Contractors that will perform work of this contract; regardless of cost even for under $50,000.00. COR must be included where sub-contract exceeds $50,000.00. If no sub-contractor is listed, and such work is within scope of contract and over $50,000.00, bidder's own COR classification(s) must be sufficient to self-perform any such work. If no sub-contractor is listed, then use of sub-contractor to perform such scope will not be permitted. This is in accordance with 5.05 and 5.06 of the Bidder's Checklist.

Mechanical Contractor: _____ Certificate of Responsibility No. _____
Plumbing Contractor: _____ Certificate of Responsibility No. _____
Electrical Contractor: _____ Certificate of Responsibility No. _____

■

STANDARD FORM OF AGREEMENT BETWEEN THE OWNER AND THE CONTRACTOR
SECTION 00 5200 R1

This Agreement made the _____ day of _____, 20_____ between the Owner,

Bureau of Building, Grounds and Real Property Management
501 North West Street, Suite 1401B [Woolfolk Building]
Jackson, Mississippi 39201

created by Section 7-1-451 et seq., and Section 31-11-1, et seq., **Mississippi Code of 1972, Annotated**, and acting for the State of Mississippi;

and between the Contractor:

Business Name _____
Address _____
City/State/Zip _____ Phone: _____Fax:_____Email:_____

The Contractor is a (check and complete one of the following):

_____ ☐ CORPORATION or ☐ LLC solely organized and existing under the laws of the State of _____ and having its principal office in _____, _____, _____
(City) (County) (State

_____ PARTNERSHIP of the following (list all partners):
_____
_____
_____

_____ SOLE PROPRIETORSHIP

For the following Project:

GS#

This Agreement entered into as of the day and year first written above:

OWNER: BUREAU OF BUILDING, GROUNDS AND REAL PROPERTY MANAGEMENT

By:_____
(Signature)

Adrian Massey, Director _____
(Name and Title)

CONTRACTOR:

By:_____
(Signature)

_____
(Name and Title)

APPROVED AS TO FORM:

By: _____
(Signature of Attorney)

THE OWNER AND THE CONTRACTOR AGREE AS SET FORTH IN PAGES ONE THROUGH THREE, ARTICLES ONE THROUGH FIVE, AS FOLLOWS:

ARTICLE 1: THE WORK AND CONTRACT DOCUMENTS

THE WORK

1.1.1 The Contractor will perform all the work required by the Contract Documents for the Project indicated above.

1.2 **THE CONTRACT DOCUMENTS**

1.2.1 The Contract Documents which constitute the entire Agreement between the Owner and the Contractor, are enumerated as follows:

1.2.2 Project Manual dated _____

BIDDING REQUIREMENTS
- Advertisement for Bids
- Instructions to Bidders
- Proposal Form

STANDARD FORM OF AGREEMENT BETWEEN THE OWNER AND THE CONTRACTOR
CONTRACT BOND
POWER OF ATTORNEY
CERTIFICATE OF INSURANCE
CONDITIONS OF THE CONTRACT
- General Conditions
- Supplementary Conditions
- Labor Requirements
- Addenda

SPECIFICATIONS (check the specs listed on the contents and included in the manual)

- [x] Division 1: General Requirements
- [x] Division 2: Existing Conditions
- [ ] Division 3 Concrete
- [ ] Division 4: Masonry
- [ ] Division 5: Metals
- [x] Division 6: Wood, Plastics and Composites
- [x] Division 7: Thermal and Moisture Protection
- [x] Division 8: Openings
- [ ] Division 9: Finishes
- [ ] Division 10: Specialties
- [ ] Division 11: Equipment
- [ ] Division 12: Furnishings
- [ ] Division 13: Special Construction
- [ ] Division 14: Conveying Equipment
- [ ] Division 21: Fire Suppression
- [ ] Division 22: Plumbing
- [ ] Division 23: HVAC
- [ ] Division 25: Integrated Automation
- [ ] Division 26: Electrical
- [ ] Division 27: Communications
- [ ] Division 28: Electronic Safety and Security
- [ ] Division 31: Earthwork
- [ ] Division 32: Exterior Improvements
- [ ] Division 33: Utilities
- [ ] Division 34: Transportation
- [ ] Division 35: Waterway and Marine Construction
- [ ] Division 40: Process Interconnections
- [ ] Division 41: Material Processing and Handling Equipment
- [ ] Division 42: Process Heating, Cooling, and Drying Equipment
- [ ] Division 43: Process Gas and Liquid Handling, Purification, and Storage Equipment
- [ ] Division 44: Pollution and Waste Control Equipment
- [ ] Division 45: Industry-Specific Manufacturing Equipment
- [ ] Division 46: Water and Wastewater Equipment
- [ ] Division 48: Electrical Power Generation

1.2.3 Addenda

Addendum No. 1, dated _____
Addendum No. 2, dated _____
Addendum No. 3, dated _____
Addendum No. 4, dated _____
Addendum No. 5, dated_____

1.2.4 Drawings dated _____

Sheets No. _____ through _____
Sheets No. _____ through _____
Sheets No. _____ through _____
Sheets No. _____ through _____
Sheets No. _____ through _____
Sheets No. _____ through _____

Sheets No. _____ through _____
Sheets No. _____ through _____
Sheets No. _____ through _____
Sheets No. _____ through _____
Sheets No. _____ through _____
Sheets No. _____ through _____

1.2.5.1 Other documents, dated _____
_____

ARTICLE 2: CONTRACT SUM

2.1 **CONTRACT SUM**

2.1.1 The Owner will pay the Contractor in current funds for the performance of the work, subject to additions and deductions by Change Order as provided in the Contract Documents, the Contract sum of

_____Dollars
($ _____). The Contract sum is determined as follows:

Base Bid		$_____
Modifications	☐ Adds ☐ Deducts	$_____
Negotiations		$_____
Alternate No. _____	☐ Adds ☐ Deducts	$_____
Alternate No. _____	☐ Adds ☐ Deducts	$_____
Alternate No. _____	☐ Adds ☐ Deducts	$_____
Alternate No. _____	☐ Adds ☐ Deducts	$_____
Alternate No. _____	☐ Adds ☐ Deducts	$_____
Total Contract Sum		$_____

2.2 **LIQUIDATED DAMAGES**

2.2.1 The stipulated liquidated damages described in Paragraph 9.11 of the m*odified General Conditions* are in the amount of five-hundred Dollars ($ 500.00) for each calendar day.

ARTICLE 3: CONTRACT TIME

3.1 **TIME**

3.1.1 The work to be performed under this Contract shall be commenced upon the date stated in the *Notice to Proceed*. The work is to be substantially complete, subject to approved Change Orders, no later than _____ calendar days from the date stated in the *Notice to Proceed*.

ARTICLE 4: PAYMENTS AND FINAL PAYMENTS

4.1 **PROGRESS PAYMENTS**

4.1.1 Based upon applications for payment submitted to the Professional by the Contractor and *Certificates for Payment* issued by the Professional, the Owner will make progress payments on account of the Contract sum to the Contractor as provided in the Contract Documents.

4.2 **FINAL PAYMENT**

4.2.1 Final payment constituting the entire balance of the Contract sum will be paid by the Owner to the Contractor when the work has been completed, the Contract fully performed and a final Certificate for Payment has been issued by the Professional and approved by the Owner.

ARTICLE 5: MISCELLANEOUS PROVISION

5.1 **DEFINITION OF TERMS**

5.1.1 Terms used in this Agreement which are defined in the General, Supplementary, and Special Conditions of the Contract will have the meanings designated in those Conditions.

5.2 **CONTRACTOR'S INTEREST IN AGREEMENT**

5.2.1 The Contractor will not assign, sublet, or transfer the interest in this Contract agreement without the written consent of the Owner. The Owner and Contractor hereby agree to the full performance of the covenants contained herein.

5.3 **PROFESSIONAL**

5.3.1 The Professional assigned to this Project is as follows:

Name_____
Address_____
Telephone _____ Fax Number _____ E-Mail Address_____

***** END OF SECTION *****

SECTION 092910 R1 - GYPSUM DRYWALL

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes requirements for gypsum board, gypsum board sheathing, cement board, metal framing and related accessories. The extent of the gypsum drywall work is shown on the drawings and in schedules and is hereby defined to include gypsum board work with a tape-and-compound joint treatment system known as drywall finishing work. The types of work required include the following:

1. Gypsum drywall metal support system including studs, tracks, furring and related materials.

2. Gypsum drywall including interior gypsum board, trims, and related accessories.

3. Drywall finishing including joint tape-and-compound treatment and sanding.

1.2 SUBMITTALS

A. Submit product data for each product specified.

B. Submit qualifications of gypsum board installer and finisher including references.

1.3 QUALITY ASSURANCE

A. Comply with applicable requirements of the latest editions of:

1. ASTM C1396/1396M, Standard Specification for Gypsum Board

2. ASTM C754, Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products”

3. ASTM C840, Standard Specification for Application and Finishing of Gypsum Board

4. ASTM C 645 requirements for metal.

B. Comply with requirements and recommendations of the latest editions of:

1. Steel Stud Manufacturer’s Association

2. The Gypsum Construction Handbook as published by USG.

C. Comply with applicable requirements of the latest editions of Gypsum Association publications including but not limited to the following, except where more detailed or more stringent requirements are indicated including the recommendations of the manufacturer.

1. GA-216 - Application and Finishing of Gypsum Board

2. GA-214 - Recommended Levels of Gypsum Board Finish

3. GA-238 - Guidelines for Prevention of Mold Growth on Gypsum Board

4. GA-253 - Application of Gypsum Board Sheathing

5. GA-254 - Fire-Resistant Gypsum Sheathing

6. GA-801 - Handling and Storage of Gypsum Panel Products

D. Where work is indicated for fire resistance ratings, including fire resistant ratings required to comply with governing regulations. Provide materials and installations identical with applicable assemblies which have been tested and listed by recognized authorities, including UL, ASTM and FM.

E. Allowable Tolerances: Less than 1/16 inch offsets between planes of board faces, and 1/4 inch in 8'-0" for plumb, level, warp and bow.

F. Obtain gypsum boards, framing and fasteners, trim accessories, adhesives and joint treatment products from a single manufacturer, or from manufacturers recommended by the prime manufacturer of gypsum boards.

G. Gypsum board finisher/installer shall have a minimum of five (5) years experience in the installation and finishing of gypsum board systems similar in size and scope to the work of this project.

1.4 PRODUCT HANDLING

A. Deliver gypsum drywall materials in sealed containers and bundles, fully identified with manufacturer's name, brand, type and grade.

B. Store gypsum drywall materials in a dry, well ventilated space, protected from the weather, under cover and off the ground.

1.5 JOB CONDITIONS

A. Installer must examine the substrates and the spaces to receive gypsum drywall, and the conditions under which gypsum drywall is to be installed and shall notify the Contractor, in writing, of conditions detrimental to the proper and timely completion of the work. Do not proceed with the installation until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

B. Building shall be completely enclosed and weather-tight prior to installing gypsum board. Gypsum board and related materials shall be allowed to acclimate to building temperature and humidity levels before installation. Temperature shall be maintained between 55 and 85 degrees Fahrenheit with relative humidity between 20 percent and 85 percent prior to, during, and after installation.

C. Maintain ambient temperatures as indicated above for a period of 24 hours before drywall finishing, during finishing installation, and until compounds are completely dry.

PART 2 - PRODUCTS

2.1 METAL SUPPORT MATERIALS

A. Interior Studs: ASTM C 645, 25 gage (0.0209 inch) x 2-1/2 inches deep for wall furring. Provide stud manufacturer's standard accessories such as clips, shoes, ties, reinforcements, fasteners and other accessories as needed for a complete stud system. Runners shall match studs and shall be type recommended by stud manufacturer for floor and ceiling support of studs, and for vertical abutment of drywall work at other work. Studs, around showers and other wet areas, shall be G-40 hot dipped galvanized in accordance with ASTM 653/A653M.

1. "EQ" (Equivalent Gauge Thickness) Steel Studs and Runners that can show certified third party testing with gypsum board in accordance with ICC ES AC86 need not meet the minimum thickness limitation or minimum section properties set forth in ASTM C 645-09. The submission of a

recognized evaluation report is acceptable to show conformance to this requirement.

2. Gauge equivalent drywall framing shall meet the minimum performance requirements of conventional drywall framing as defined by the Steel Framing Industry Association (SFIA) and the Steel Stud Manufacturers Association (SSMA).

3. Gauge equivalent calculated design properties shall be based on AISI S100-07, North American Specification for Design of Cold-Formed Steel Structural Members.

B. Ceiling Furring Members: ASTM C 645, 25 gage, hat-shaped. Where shown as resilient provide manufacturer's special type designed to reduce sound transmission.

C. Backing Plate: 0.0312 inch (20 gauge) steel, unless noted otherwise.

D. Fasteners and Accessories: Type and size recommended by furring manufacturer for the substrate and application indicated.

2.2 GYPSUM BOARD PRODUCTS

A. To the extent not otherwise indicated, comply with GA-216, as specified and recommended. Exposed gypsum board shall be equal to Type X, fire rated type with tapered long edges as manufactured by United States Gypsum Company and as follows:

1. Edge Profile: Special rounded or beveled edge.

2. Sheet Size: 4'-0" width by maximum length available which will minimize end joints.

3. Thickness: 5/8 inch thick except where otherwise indicated.

4.

2.3 GYPSUM BOARD TRIM ACCESSORIES

A. Manufacturer's standard galvanized steel bead and trim units with flanges for concealment in joint compound including corner beads and casing beads (L and J trim).

2.4 GYPSUM BOARD JOINT TREATMENT MATERIALS

A. General: ASTM C 475, type recommended by the manufacturer for the application indicated, except as otherwise indicated.

1. Joint Tape: Perforated type

2. Joint Compound: On interior work provide chemical-hardening-type for bedding and filling, ready-mixed vinyl-type or non-casein-type for topping. On exterior work provide water resistant type.

3. Gypsum Board Sheathing Joint Tape: 2 inch wide 10 x 10 glass mesh as recommended by sheathing manufacturer.

2.5 MISCELLANEOUS MATERIALS

A. Provide auxiliary materials for gypsum drywall work of the type and grade recommended by the manufacturer of the gypsum board. Gypsum board fasteners shall comply with GA-216.

B. Provide type S-12, bugle head, self-tapping, fine thread, rust resistant screws at exterior gypsum sheathing applications.

PART 3 - EXECUTION

3.1 COORDINATION

A. Meet at the project site with the installers of related work and review the coordination and sequencing of work to ensure that everything to be concealed by gypsum drywall has been accomplished, and that chases, access panels, openings, supplementary framing and blocking and similar provisions have been completed.

3.2 METAL SUPPORT SYSTEM INSTALLATION

A. To the extent not otherwise indicated, comply with ASTM C754 “Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products” and manufacturer's instructions. Furnish concrete inserts, steel deck hanger clips, and similar devices to other trades for installation well in advance of time needed for coordination with other work. Isolate stud system from transfer to structural loading, both horizontally and vertically. Provide slip or cushioned type joints to attain lateral support and avoid axial loading. Install runner tracks at floors, ceiling and structural walls and columns where gypsum drywall system abuts other work. Terminate partition stud systems as shown, braced each side at 45 degrees at 4'-0" on center except where indicated to be extended to structural support or substrate above, or indicated otherwise on drawings. Space studs 16 inches on center except as otherwise indicated.

B. Install supplementary framing, runners, furring, blocking, backing plates and bracing where indicated on drawings and at locations required to support fixtures, equipment, grab bars, shower seats, handrails, heavy trim, furnishings, and similar work.

3.3 GYPSUM BOARD INSTALLATION

A. Install wall/partition boards vertically to avoid end-butt joints wherever possible.

B. Floating construction: Where feasible, including where recommended by manufacturer, install gypsum board with "floating" internal corner construction, unless isolation of the intersecting boards is indicated or unless control or expansion joints are indicated.

3.4 GYPSUM BOARD SHEATHING INSTALLATION

A. Install gypsum board sheathing in accordance with manufacturer’s specifications and recommendations and applicable portions of GA-253 and ASTM C 1280.

B. Attach gypsum board sheathing to metal studs with corrosion resistant screws at 8 inches on center along entire length of stud and at 8 inches on center along perimeter framing.

C. Seal and tape all joints and penetrations.

3.5 DRYWALL TRIM ACCESSORY INSTALLATION

A. Where feasible, use the same fasteners to anchor trim accessory flanges as required to fasten gypsum board to the supports. Otherwise, fasten flanges by nailing or stapling in accordance with manufacturer's instructions and recommendations.

B. Install metal corner beads at external corners of drywall work.

C. Install metal edge trim whenever edge of gypsum board would otherwise be exposed or semi-exposed. Provide type with face flange to receive joint compound except where semi-finishing type is indicated. Install L-type trim where work is tightly abutted to other work and install special kerf-type where other work is kerfed to receive long leg of L-type trim. Install U-type trim where edge is exposed, revealed, gasketed, or sealant-filled (including expansion joints.) Install metal control joint (beaded type) where indicated or required for proper installation.

3.6 DRYWALL FINISHING

A. Where finishing is required, apply treatment at gypsum board joints (both directions), flanges of trim accessories, penetrations, fasteners heads, surface defects and elsewhere as required to prepare work for decoration. Prefill open joints and rounded or beveled edges, using type of compound specified herein and recommended by manufacturer.

B. Apply joint tape at joints between gypsum boards, except where a trim accessory is indicated.

C. Apply joint compound in 3 coats (not including prefill of openings in base), and sand between last 2 coats and after last coat.

D. Unless otherwise indicated, install drywall finishing at all gypsum board exposed to view and to receive finishes.

E. Install gypsum board finishing in accordance with the latest editions of ASTM C 840, GA-214 "Recommended Levels of Gypsum Board Finish", and in accordance with the following schedule:

1. Taping, finishing, and corner beads are not required. Locate at concealed areas and ceiling plenum areas, except where a higher level of finish is required for fire-resistance rated assemblies and sound rated assemblies. Generally described as Level 0 finish in GA-214.

2. At joints and angles, embed tape in joint compound. Panel surfaces must be free of excess joint compound, but tool marks and ridges are acceptable. Locate at concealed areas and ceiling plenum areas, except where a higher level of finish is required for fire-resistance rated assemblies and sound rated assemblies. Generally described as Level 1 finish in GA-214.

3. At joints and angles, embed tape in joint compound and apply one separate coat of joint compound over tape, fastener heads, and flanges of trim accessories. Joint compound applied on the face of the tape when the tape is embedded is considered a separate coat. Panel surfaces must be free of excess joint compound, but tool marks and ridges are acceptable. Locate where panels are a substrate for tile or where indicated. Generally described as Level 2 in GA-214.

4. All joints and interior angles have tape embedded in joint compound and one additional coat of joint compound applied over all joints and interior angles. Fastener heads and accessories shall be covered with two separate

coats of joint compound. All joint compound shall be smooth and free from tool marks and ridges. Locate in areas to be decorated with a medium or heavy texture or where heavy-grade wall coverings will become the final decoration. Generally described as Level 3 in GA-214.

5. At joints and angles, embed tape in joint compound and apply three separate coats of joint compound over joints, angles, fastener heads, and flanges of trim accessories. Panel surfaces and joint compound must be smooth and free of tool marks and ridges. Locate at all panels where exposed to view or where painting or wall covering is the finish. Generally described as Level 4 in GA-214.

3.7 PROTECTION OF WORK

A. Protect gypsum drywall work from damage and deterioration during the remainder of the construction period.

B. Replace and refinish damaged board prior to substantial completion of project.

END OF SECTION 092910

SECTION 093013 R1 - CERAMIC TILE

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes requirements for ceramic tile and related setting and bonding materials.

1.2 REFERENCE STANDARDS

A. American National Standards Institute (ANSI-current edition)

B. Tile Council of North America (TCNA-current edition)

C. American Society for Testing and Materials (ASTM - current edition)

1.3 SUBMITTALS

A. Submit manufacturers product data, technical information and installation recommendations for each product specified.

B. Submit color charts consisting of actual tiles or sections of tiles showing full range of colors available for each type of tile specified. Include samples of grout and accessories requiring color selection.

C. Submit three (3) samples of each type and color of tile and grout required, mounted on not less than 12 inch square plywood or hardboard and grouted as required.

D. Submit shop drawings indicating scaled floor plan layout of the entire tiled area including all details, transitions, joint widths, base conditions, locations of thresholds, equipment, patterns and expansion joints.

E. Submit one full size sample of each tile accessory and marble threshold. Submit samples of trim and other units if requested by the Architect.

F. Submit certified test reports from a qualified independent testing laboratory showing evidence of compliance of the tile and tile setting products with requirements specified based on comprehensive testing of current products. Include laboratory's interpretation of test results relative to specified requirements.

G. Submit maintenance data and manufacturer's recommendations for cleaning.

H. Submit installer/subcontractor experience record including list of similar projects.

1.4 PERFORMANCE

A. Coefficient of Friction: Slip resistant in accordance with the Ceramic Tile Institute, a static coefficient of friction of not less than 0.60 when tested in accordance with ASTM C 1028 as modified by the Ceramic Tile Institute.

B. Water Absorption: Impervious when tested in accordance with ASTM C 373.

C. Bond Strength: 50 psi or greater when tested in accordance with ASTM C 482.

D. Breaking Strength: Average of 250 lbs. or greater when tested in accordance with ASTM C 648.

E. Abrasive Hardness: Index of 100 or greater when tested in accordance with ASTM 501.

1.5 QUALITY ASSURANCE

A. Furnish tile conforming with the Standard Grade Requirements of ANSI A137.1. When using setting and grouting materials manufactured under TCA license, include identification and formula number on each container. Provide materials obtained from only one source for each type of tile, grout and color to minimize variations in appearance and quality.

B. Installation contractor installer shall have a minimum of 5 years experience and shall have successfully completed projects of similar size and scope to the work of this project. Installation contractor shall provide certification from adhesives and grout manufacturer that installation training courses have been successfully completed.

C. A representative of the membrane, adhesive and grout manufacturer shall visit the site periodically to determine if products are installed in accordance with manufacturer's recommendations. The representative shall also be available to visit the site to address specific problems and concern that may arise during construction.

D. Conform to the requirements of the "TCNA" Tile Council of North America " Handbook of Ceramic Tile Installation and "ANSI" American National Standards Institute, Specifications for the Installation of Ceramic Tile - ANSI A108, A118, and A136 Material and Installation Standards.

E. Tile shall be certified by the Porcelain Tile Certification Agency (PTCA) and shall bear the PTCA certification mark on all tile product packaging.

F. Pre installation Meeting: Approximately two weeks prior to scheduled commencement of installation and associated work, meet at project site with installer of each component of associated work, Architect, manufacturer's representative, Owner. Discuss conformance with requirements of specification and job site conditions. Review locations where tile is to be installed, specific concerns related to site, installation methods, installation conditions, substrate acceptance, patterns, jointing, submittals, requirements of warranty, scheduled deliveries, and other related work affected by the installation of the tile and/or as determined by the Architect.

G. Coordination: Coordinate the work of this Section with work required by other sections including but not limited to subfloor, wall substrate, electrical, plumbing, and mechanical work.

H. Mock-up:

1. Within two weeks of approval of material submittals install a fully finished mock-up for each type, style, finish, size, and color of ceramic tile installation, including a threshold and respective installation adhesives, mortars, grouts and other installation materials. Mock-up shall be a minimum of 10 feet x 10 feet and will be reviewed for joint quality, color range, pattern and workmanship.

2. Provide special features as directed for caulking and contiguous work.

3. Obtain Architect's acceptance of the mock-up before start of ceramic tile work. Retain mock-up during construction as a standard for judging completed work. Do not alter, move or destroy mock-up until ceramic tile work is completed.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver packaged materials and store in original containers with seals unbroken and labels intact until time of use, in accordance with manufacturer's directions. Comply with requirements in ANSI A137.1 for labeling tile packages.

B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.

C. Store aggregates where grading and other required characteristics can be maintained, and contamination can be avoided.

D. Store liquid materials in unopened containers and protected from freezing.

1.7 JOB CONDITIONS

A. Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in Reference Standards and manufacturer's written instructions.

1.8 MAINTENANCE

A. Provide maintenance data to owner including cleaning methods, cleaning solutions recommended, stain removal methods, and polishes and waxes recommended.

1.9 EXTRA MATERIALS STOCK

A. Upon completion of the work of this Section, deliver to the Owner 2 percent minimum additional tile and trim shape of each type, color, pattern and size used in the Work, as well as extra stock of installation mortar, grouts, adhesives and accessories for the Owner's use in replacement and maintenance. Extra stock to be from same production run or batch as original tile and installation materials.

PART 2 - PRODUCTS

2.1 TILE MANUFACTURER MANUFACTURERS

A. Provide ceramic tile as manufactured by American Olean Tile Company:

B. Tile colors/textures shall be as selected in Section 090500 - Color Design

C. Other manufacturer’s providing products of same material, quality, size, thickness, texture, color and sheen will be acceptable. Upon submittal of substantiating data and approval by Architect

2.2 THRESHOLDS

A. Provide solid surface thresholds as specified in Section 064000 - Architectural Woodwork. Provide thickness as required to comply with ADA requirements and to match adjacent finish depth.

2.3 SETTING AND GROUTING MATERIALS

A. Manufacturer: Laticrete International, Inc., 1 Laticrete Park North, Bethany, CT 06524-3423. Tel:203-393-0010. Web: laticrete.com

1. Products of other manufacturers producing materials of same quality, color, and physical characteristics may be acceptable upon compliance with the requirements of this Section and approval by architect.

B. Mortar: Laticrete 254 Platinum multipurpose thin set mortar or approved equal.

C. Grout: Laticrete Spectralock Pro Grout or approved equal. Color of grout shall be as indicated in section 090500 Color Design.

D. Mix mortars, grouts, and waterproof membrane to comply with requirements of the manufacturer for accurately proportioning of materials, water or additive content, mixing equipment and mixer speeds, mixing containers, mixing time, and other procedures needed to produce mortars and grouts of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 INSPECTION

A. Installer must examine the substrate and the conditions under which ceramic tile is to be installed and notify the contractor in writing of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.2 INSTALLATION

A. Comply with the applicable parts of ANSI 108 Series of tile installation standards included under "American National Standard Specifications for the Installation of Ceramic Tile", and the tile and grout manufacturer's printed instructions, and applicable installation specifications of the Tile Council of America's "Handbook for Ceramic Tile Installation", latest edition.

B. Handle, store, mix and apply setting and grouting materials in compliance with the manufacturer's instructions.

C. Extend tile work into recesses and under equipment and fixtures, to form a complete covering without interruptions, except as otherwise shown. Terminate work neatly at obstructions, edges and corners without disruption of pattern or joint alignment.

D. Base and floor tile shall be installed with the Flush Method so the lip of the cove base is flush with the floor tile.

E. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight, aligned joints. Fit tile closely to electrical outlets, piping, and fixtures so that plates, collars, or covers overlap tile

F. Unless otherwise shown, lay tile in grid pattern. Align joints with adjoining tiles on floor, base and walls. Layout tile work and center tile fields in both directions in each space or on each wall area. Adjust to minimize tile cutting. Provide uniform joint widths as allowable by applicable TCA standards and as recommended by manufacturer.

G. Lippage, the difference in tile elevation between edges of adjacent tile modules, shall be no more than 1/32 inch.

H. Grout tile to comply with the requirements and installation standards of ANSI A108.10, ANSI A108.6 as applicable, and to provide an even, uniform grout surface between units. Grout shall be uniform and consistent in color and appearance.

3.3 INSTALLATION METHODS

A. Install tile to comply with requirements of the latest edition of “Handbook for Ceramic, Glass, and Stone Tile Installation” as published by “Tile Council of North America, Inc.

3.4 CLEANING AND PROTECTION

A. Tile surfaces shall be cleaned in strict accordance with tile and grout manufacturer's printed instructions and Reference Standards. Upon completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter. Clean grout and setting materials from face of tile while materials are workable. Leave tile face clean and free of all foreign matter. Flush the surface with clean water before and after cleaning.

B. Finished Tile Work: Leave finished installation clean and free of cracked, chipped, broken, unbonded, or otherwise defective tile work.

C. Protection

1. When recommended by tile manufacturer, apply a protective coat of neutral protective cleaner to completed tile walls and floors.

2. Protect installed tile work with Kraft paper or other heavy covering during the construction period to prevent damage and wear.

3. Prohibit all foot and wheel traffic from using tiled floors for a minimum of 7 days after installation.

4. Before final inspection, remove protective coverings and rinse neutral cleaner from all tile surfaces.

END OF SECTION 093013 R1

SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Under-building-slab and aboveground domestic water pipes, tubes, and fittings inside buildings.
2. Encasement for piping.

B. Related Requirements:

1. Section 230010 – Mechanical General Provisions.
2. Section 230500 – Basic Mechanical Materials and Methods.
3. Section 230523 – Valves.
4. Section 230553 – Mechanical Identification.

1.3 FIELD CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

1. Notify Architect no fewer than two days in advance of proposed interruption of water service.
2. Do not interrupt water service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

B. Potable-water piping and components shall comply with NSF 14 and NSF 61 Annex G. Plastic piping components shall be marked with "NSF-pw."

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.

B. Soft Copper Tube: ASTM B 88, Type K water tube, annealed temper.

C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.

D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

F. Copper Unions:

1. MSS SP-123.
2. Cast-copper-alloy, hexagonal-stock body.
3. Ball-and-socket, metal-to-metal seating surfaces.
4. Solder-joint or threaded ends.

G. Other fittings types not allowed.

2.3 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys.

D. Flux: ASTM B 813, water flushable.

E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.4 TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.

3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type Transition Coupling: AWWA C219.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Cascade Waterworks Mfg. Co.
b. Dresser, Inc.
c. Jay R. Smith Mfg. Co.
d. Viking Johnson.
e. Or equal.

PART 3 - EXECUTION

3.1 GENERAL

A. Install new bronze ball valves at water heaters.

B. Install new quarter turn ball stops on water supplies at new plumbing fixtures.

C. Install new stainless steel sheathed flexible connectors at sink, lavatories, water closets, and water heater connections.

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Modify and attach to existing copper water piping to install or relocate existing plumbing appliances and fixtures.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping to permit valve servicing.

F. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

G. Install fittings for changes in direction and branch connections. Other piping connection types not allowed.

H. Install unions, or flexible connectors in copper tubing at final connection to each piece of equipment, appliance, fixture, machine, and specialty.

3.3 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

3.4 CONNECTIONS

A. Drawing and details indicate general arrangement of piping, fittings, and specialties. Verify existing conditions.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to existing water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with new shutoff valve; extend and connect to the following:

1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.

E.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Piping Inspections:

a. Do not enclose, cover, or put new piping into operation until it has been inspected and approved by authorities having jurisdiction.
b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities and General Contractor having jurisdiction:

1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.

c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections, and arrange for reinspection.
d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests: (Required for all new and existing potable water piping inside building).

a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
d. Cap and subject piping to static water pressure of 20 psig above operating pressure, without exceeding pressure rating of piping system materials (minimum of 100 psig). Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
f. Prepare reports for tests and for corrective action required.
g. Rebuild/refurbish hose bibbs.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports. General Contractor to witness and log all water pressure tests.

3.6 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
4. Remove and clean strainer screens. Close drain valves and replace drain plugs.
5. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.7 CLEANING

A. Clean and disinfect new and existing potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

    a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    b. Fill and isolate system according to either of the following:

        1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
        2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

    c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
    d. Repeat procedures if biological examination shows contamination.
    e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction, and with closeouts.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.8 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

Service	Type of Pipe	Fittings	Joints
Above slab	Hard copper, Type L	Cast or wrought copper	Soldered

3.9 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use ball valves for piping 2-1/2 inch and smaller. Use gate valves with flanged ends for piping 3 inch and larger.
2. Drain Duty: Hose-end drain valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

3.10 INSULATION

A. Insulate new and existing water piping, and valve bodies and fittings in mechanical closet with ¾" fiberglass or Armaflex insulation.

Domestic Water Piping Test Log						
Date	Building or Apartment #	Description of Piping Section Tested	Test Press. (psig)	Test Duration (hours)	Results Pass/ Fail	Witness (Contractor) Initials
This form stall be completed and submitted with the project closeout documents. Contractor shall copy this form if more sheets are required. Piping pressure test log shall be kept at project site and shall be made available to the Architect upon request.						

END OF SECTION 221116

SECTION 221316 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Pipe, tube, and fittings.
2. Specialty pipe fittings.

1.3 FIELD CONDITIONS/GENERAL SCOPE

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Architect no fewer than two days in advance of proposed interruption of sanitary waste service.
2. Do not proceed with interruption of sanitary waste service without Architect's written permission.

B. The Contractor shall modify and repair the existing sanitary drainage system to newly connect new appliances and fixtures. Verify existing conditions.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10-foot head of water.

2.2 PIPING MATERIALS – (CONTRACTOR MAY CHOOSE PIPING TO MATCH SPECIFIC APPLICATIONS AND SITE CONDITIONS FROM THE FOLLOWING LIST)

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service class(es).

B. Gaskets: ASTM C 564, rubber.

C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.4 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. Heavy-Duty, Hub-less-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. ANACO-Husky.
    b. Charlotte Pipe and Foundry Company.
    c. Or equal.

2. Standards: ASTM C 1277 and ASTM C 1540.
3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe, stop.

2.5 COPPER TUBE AND FITTINGS

A. Copper Type DWV Tube: ASTM B 306, drainage tube, drawn temper.

B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

C. Hard Copper Tube: ASTM B 88, Type L and Type M, water tube, drawn temper.

D. Copper Pressure Fittings:

1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

E. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.

1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

F. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.6 PVC PIPE AND FITTINGS

A. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

B. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

D. Adhesive Primer: ASTM F 656.

E. Solvent Cement: ASTM D 2564.

2.7 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
2. Unshielded, Non-pressure Transition Couplings:

    a. Manufacturers: Subject to compliance with requirements, provide products by the following:

        1) Fernco Inc.
        2) Or equal.

    b. Standard: ASTM C 1173.
    c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
    d. End Connections: Same size as and compatible with pipes to be joined.
    e. Sleeve Materials:

        1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
        2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
        3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

3. Pressure Transition Couplings:

    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

        1) Cascade Waterworks Mfg. Co.
        2) Dresser, Inc.
        3) Jay R. Smith Mfg. Co.
        4) Or equal.

    b. Standard: AWWA C219.
    c. Description: Metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
    d. Center-Sleeve Material: Manufacturer's standard.
    e. Gasket Material: Natural or synthetic rubber.
    f. Metal Component Finish: Corrosion-resistant coating or material.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Drawing plans, notes, and details indicate general requirements, and arrangement of piping systems.

    1. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install new piping, and fittings as needed, or indicated to install new replacement appliances and fixtures.

C. Install fittings for changes in direction and branch connections.

D. Install piping to allow application of insulation.

E. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.

    1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
    2. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.

        a. Straight tees, elbows, and crosses may be used on vent lines.

    3. Do not change direction of flow more than 90 degrees.
    4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.

        a. Reducing size of waste piping in direction of flow is prohibited.

F. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.

G. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."

H. Install aboveground PVC piping according to ASTM D 2665.

I. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.2 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Join hub-less, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hub-less-piping coupling joints.

C. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

D. Plastic, Non-Pressure Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 appendixes.

3.3 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in ODs.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Section 230529 – Hangers and Supports.

1. Install galvanized-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install galvanized-steel pipe support clamps for vertical piping in noncorrosive environments.
3. Vertical Piping: MSS Type 8 or Type 42, clamps.

B. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.

C. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

D. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.
6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 72 inches with 3/8-inch rod.
2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
3. NPS 2-1/2: 108 inches with 1/2-inch rod.
4. NPS 3 and NPS 5: 10 feet with 1/2-inch rod.
5. NPS 6: 10 feet with 5/8-inch rod.
6. NPS 8: 10 feet with 3/4-inch rod.

F. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
2. NPS 3: 48 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 48 inches with 3/4-inch rod.
5. NPS 10 and NPS 12: 48 inches with 7/8-inch rod.

3.5 CONNECTIONS

A. Verify and provide general arrangements of piping, fittings, and specialties to suit field conditions.

B. Connect soil and waste piping to new fixtures and appliances and drain pans. Use transition fitting to join dissimilar piping materials.

C. Connect waste and vent piping to the following:

1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Water heater drain pans and HVAC evaporators.

3.6 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction of unusual conditions of leaking, deteriorated, or damage systems.

B. Reports: Prepare inspection reports of unusual conditions promptly to Architect.

C. Test sanitary waste and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new and existing piping and parts of existing piping that have been altered, extended, or repaired.

    a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.

    a. Expose work that was covered or concealed before it was tested.

3. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.

    a. Inspect plumbing fixture connections for gas and water leaks.

4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

3.7 CLEANING AND PROTECTION

A. Clean interior of new piping and piping near where new connections are made. Remove dirt and debris as work progresses.

B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

D. Repair damage to adjacent materials caused by waste and vent piping installation.

3.8 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

Description	Pipe	Fittings	Joints
Below grade, Soil, Waste, and Vent Piping	Solid-wall PVC	PVC socket fittings, DWV pattern	Solvent-cemented
Above grade, Soil, Waste, Vent Piping, and Condensate Dains	Solid-wall PVC	PVC socket fittings, DWV pattern	Solvent-cemented
Above grade, Soil, Waste, and Vent Piping	Cast-iron, hubless	Hubless, DWV pattern	Heavy-duty, couplings
Condensate drains		Copper, DWV pattern	Soldered
Water-heater drain pans and tap relief drains	Solid wall CPVC	CPVC socket fittings	Solvent-cemented

3.9 SANITARY DRAIN INSULATION

A. The sanitary waste piping system, including floor drain body, piping, fittings, and appurtenances, from the second-floor mechanical equipment closet floor drain extending to the vertical in closet riser and down thru the first-floor slab below, shall be neatly insulated for condensation control.

B. The insulation system shall be neatly installed and may be:

1. ½" Armaflex.
2. ½" Fiberglass with ASJ.
3. 1½" Duct-wrap fiberglass with FSK jacket

END OF SECTION 221316

SECTION 223400 - FUEL-FIRED, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Residential, gas-fired, domestic-water heaters.
2. Domestic-water heater accessories.

1.3 SUBMITTALS

A. See Section 230010 – Mechanical General Provisions.

B. Submit product data, O&M data, and samples and show item on shop drawings (where shop drawings are required) according to the following table.

1. “R” means required.
2. “R2” means required only for products and equipment differing for the specified manufacturer and model and for “or equals” where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawing
Water heaters	R	R		R
Accessories	R	R		R
Controls	R	R		R

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE/IESNA Compliance: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IESNA 90.1.

C. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects."

1.5 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired, domestic-water heaters that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including storage tank and supports.
b. Faulty operation of controls.
c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Periods: From date of overall project substantial completion.

a. Residential, Gas-Fired, Storage, Domestic-Water Heaters:

1) Storage Tank: Five years, parts only, non-prorated extended warranty.
2) Complete Unit: One year, parts and labor.

PART 2 - PRODUCTS

2.1 RESIDENTIAL, GAS-FIRED, STORAGE, DOMESTIC-WATER HEATERS

A. Residential, Atmospheric, Gas-Fired, Storage, Domestic-Water Heaters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Lochinvar, LLC.
b. Rheem Manufacturing Company.
c. Smith, A. O. Corporation.
d. Or equal.

2. Standard: ANSI Z21.10.3/CSA 4.3.
3. Minimum 80% thermal efficiency.
4. Storage-Tank Construction: Steel with 150-psig working-pressure rating.

a. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.

1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.

b. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
c. Lining: Glass complying with NSF 61 Annex G barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.

5. Factory-Installed Storage-Tank Appurtenances:

a. Anode Rod: Replaceable magnesium.
b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
c. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
d. Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
e. Jacket: Steel with enameled finish.
f. Burner: Single stage gas burner.
g. Automatic Ignition: ANSI Z21.20/CSA C22.2 No. 199, electric, automatic, gas-ignition system.
h. Temperature Control: Adjustable temperature control.
i. Combination Temperature-and-Pressure Relief Valves: ANSI Z21.22/CSA 4.4-M. Include one or more relief valves with total relieving capacity at least as great as heat input and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

6. Draft Hood: Draft diverter, complying with ANSI Z21.12.

2.2 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Compression Tanks:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. AMTROL, Inc.
b. Smith, A. O. Corporation.
c. Taco, Inc.
d. Or equal.

2. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air pre-charge to minimum system-operating pressure at tank.

3. Construction:

a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
b. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
c. Air-Charging Valve: Factory installed.

B. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC 3. Include dimensions not less than base of domestic-water heater and include drain outlet not less than NPS 3/4 with ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.

C. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1.

D. Heat-Trap Fittings: ASHRAE 90.2.

E. Comply with requirements for ball valves specified in Section 230523 – Valves.

F. Gas Shutoff Valves: ANSI Z21.15/CSA 9.1-M, manually operated. Furnish for installation in piping.

G. Combination Temperature-and-Pressure Relief Valves: Include relieving capacity at least as great as heat input and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.

1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.

H. Vent System: Provide complete new separate combustion air intake and type ‘B’ flue exhaust vent piping system including but not limited to the following: vertical and horizontal discharge flue piping, vent pipe clamps, fittings, roof flashing assembly, roof discharge terminal and fittings, Snap-Lok duct combustion air vertical and horizontal ductwork, factory fittings, roof intake cap with insect screen.

2.3 SOURCE QUALITY CONTROL

A. Hydrostatically test domestic-water heaters and storage tanks to minimum of one and one-half times pressure rating before shipment.

B. Domestic-water heaters will be considered defective if they do not pass tests and inspections.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

A. Domestic-Water Heater Mounting: Install domestic-water heaters on metal drip pan.

1. Maintain manufacturer's recommended clearances.
2. Arrange units so controls and devices that require servicing are accessible.

B. Install domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

1. Install new ball shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 230523 Valves.

C. Install gas-fired, domestic-water heaters according to NFPA 54.

1. Install new ball type gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters.

D. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

E. Install thermometer on outlet piping of domestic-water heaters.

F. Install piping-type heat traps on inlet and outlet piping of domestic-water heater storage tanks without integral or fitting-type heat traps.

G. Fill domestic-water heaters with water.

H. Charge domestic-water compression tanks with air in accordance with manufacturer’s instructions. Support tanks separately from piping.

I. Route 1" drain piping from drip pan to nearby floor drain.

3.2 CONNECTIONS

A. Comply with requirements for domestic-water piping specified in Section 221116 Domestic Water Piping.

B. Comply with requirements for gas piping specified in Section 231123 Facility Natural-Gas Piping.

C. Drawings indicate general arrangement of piping, fittings, and specialties.

D. Where installing piping adjacent to fuel-fired, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 230553 Mechanical Identification.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Set water heater controls initially to maintain 115°F.

B. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 01 for retesting and re-inspecting.

END OF SECTION 223400

SECTION 224000 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Plumbing fixtures and trim.
2. Accessories.

1.3 REFERENCE STANDARDS

A. As specified in Section 230010 “Mechanical General Provisions.”

1.4 SUBMITTALS

A. See Section 230010 – Mechanical General Provisions.

B. Submit product data, O&M data, and samples and show item on shop drawings (where shop drawings are required) according to the following table.

1. “R” means required.
2. “R2” means required only for products and equipment differing for the specified manufacturer and model and for “or equals” where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawing
Plumbing fixtures	R			R
Trim	R			
Supports	R			R
Accessories	R			

1.5 QUALITY ASSURANCE

A. As specified in Section 230010 “Mechanical General Provisions.”

B. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.

1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

C. 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.

D. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act".

E. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

F. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

G. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

H. Comply with the following applicable standards and other requirements specified for plumbing fixtures:

1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
2. Hand Sinks: NSF 2 construction.
3. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
4. Stainless-Steel Fixtures Other Than Service Sinks: ASME A112.19.3M.
5. Vitreous-China Fixtures: ASME A112.19.2M.
6. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.
7. Water-Closet, Flushometer Tank Trim: ASSE 1037.

I. Comply with the following applicable standards and other requirements specified for sink faucets:

1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
3. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
4. Faucet Hose: ASTM D 3901.
5. Faucets: ASME A112.18.1M.
6. Hose-Connection Vacuum Breakers: ASSE 1011.
7. Hose-Coupling Threads: ASME B1.20.7.
8. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
9. NSF Materials: NSF 61.
10. Pipe Threads: ASME B1.20.1.
11. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
12. Supply and Drain Fittings: ASME A112.18.1M.

J. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:

1. Atmospheric Vacuum Breakers: ASSE 1001.
2. Brass and Copper Supplies: ASME A112.18.1M.
3. Manual-Operation Flushometers: ASSE 1037.
4. Plastic Tubular Fittings and Piping: ASTM F 409.
5. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.
6. Tubular Brass Drainage Fittings and Piping: ASME A112.18.1M.

K. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Disposers: ASSE 1008 and UL 430.
2. Floor Drains: ASME A112.21.1M.
3. Grab Bars: ASTM F 446.
4. Hose-Coupling Threads: ASME B1.20.7.
5. Hot-Water Dispensers: ASSE 1023 and UL 499.
6. Off-Floor Fixture Supports: ASME A112.6.1M.
7. Pipe Threads: ASME B1.20.1.
8. Plastic Toilet Seats: ANSI Z124.5.
9. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.6 COORDINATION

A. Coordinate roughing-in and final plumbing fixture locations and verify that fixtures can be installed to comply with original design and referenced standards.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Provide two service kits for each type of faucet, flush valve, shower/tub valve and all other trim/accessories having serviceable parts.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General:

1. Provide fixtures and trim complete for proper installation as described in the manufacturer’s catalog with the modifications as shown on Plumbing Fixture Schedule in the plans or specifications.
2. All fixtures, specified to be of vitreous ware, shall be of a quality known commercially as “twice fired” vitreous chinaware of the best quality, nonabsorbent, burned so that the whole mass is thoroughly fused and vitrified producing a material white in color, which when fractured will show a homogeneous mass, close-grained and free from pores. The glazed and vitreous

china fixtures shall be white, thoroughly fused and united to the body, without discoloration, chips, or flaws and shall be free from cracks. Warped or otherwise imperfect fixtures will not be acceptable.

3. Factory grind back and bases of fixtures smooth.
4. Enamelware to be white cast iron with acid-resisting enamel.
5. Unless otherwise specified, water closets to have a waste passage to pass a 2-1/2-inch ball minimum. Bolt water closets to flanges with a 1-inch thick rubber foam gasket.
6. Fixture trim and exposed metal items shall be polished chrome-plated unless otherwise noted, and pipes passing through walls shall have polished chrome-plated escutcheon plates. All stainless steel shall be satin brushed (US32D) finish unless noted otherwise.
7. Fixtures shall be free from imperfections, true as to line, angles, curves, and color; smooth, watertight and practically noiseless in operation.
8. Exposed Pipe, Trim Including Fittings, Traps, Escutcheons, Valves, Valve Handles, and Accessories: Above and Below Fixtures:

    a. Polished chrome plated CP brass.
    b. Set-screw cast brass escutcheons for piping.
    c. Covering tubes not permitted.
    d. Provide Hudee stainless steel rims, as applicable, for non-self-rimming counter mounted fixtures.

9. Supply Fixtures With:

    a. Renewable seats or replaceable internal units.
    b. Compositional washers.

2.2 MANUFACTURERS

A. Named manufacturer model numbers used as example of item and establish minimum level of quality and minimum standard options. Equivalent models are acceptable.

1. Vitreous china fixtures:

    a. American Standard.
    b. Toto.
    c. Zurn.
    d. Kohler.
    e. Or equal.

2. Stainless steel sinks:

    a. American Standard.
    b. Just.
    c. Elkay.
    d. Kohler.
    e. Or equal.

3. Sink and lavatory trim:

a. Zurn.
b. Kohler.
c. Delta.
d. Or equal.

4. Showers/Tub Fittings:

a. Zurn.
b. Lawler.
c. Leonard.
d. Kohler
e. Or equal.

2.3 FLOOR-MOUNTED, BOTTOM-OUTLET WATER CLOSETS

A. Water Closets (WC-1): Floor mounted, bottom outlet, tank type, standard height.

1. Bowl and Tank: White vitreous china, pressure assisted, elongated bowl, floor mounted floor outlet, 2-1/4-inch passageway, tank, tank lid, chrome trip lever, white bolt caps, 1.6 gallons per flush.
2. Seat: White closed front with lid, plastic seat, self-sustaining with check hinge.
3. Stop and supply: Chrome plated, solid brass angle stops with one quarter turn handle and cast brass escutcheon with setscrew. Flexible stainless steel reinforced PEX closet risers, with chrome plated, cast brass, flange.

B. Water Closets (WC-2): Floor mounted, bottom outlet, tank type, ADA compliant.

1. Bowl and Tank: White vitreous china, pressure assisted, elongated bowl, floor mounted floor outlet, 2-1/4-inch passageway, tank, tank lid, chrome trip lever, white bolt caps, 1.6 gallons per flush.
2. Seat: White open front, plastic seat, self-sustaining with check hinge.
3. Stop and supply: Chrome plated, solid brass angle stops with one quarter turn handle and cast brass escutcheon with setscrew. Flexible chrome plated copper closet risers, with chrome plated, cast brass, flange with setscrew.

2.4 LAVATORIES

A. Lavatories (L-1): Wall mounted, vitreous china with back.

1. Lavatory: Wall mounted, vitreous china with overflow, Standard mounting height.
2. Faucet: Manually operated as noted, solid-brass, polished chrome finish, 0.5 gpm.
3. Pop-Up Drain Assembly: Drain and tailpiece brass, 1-1/4-inch.
4. Stops and supplies: Two chrome plated, solid brass angle stops with one quarter turn handle and cast brass escutcheon two flexible Stainless steel reinforced PEX lavatory risers, with chrome plated, cast brass, flange.
5. Trap: 1-1/4-inch, chrome plated, cast brass, P-trap with cleanout with cast brass escutcheon and brass nuts.
6. Accessories:

a. Adjustable floor mounted chair carrier, Zurn or equal. Carriers shall be fully compatible with each fixture.

B. Lavatories (L-2): Wall mounted, vitreous china with back, ADA compliant.

1. Lavatory: Wall mounted, vitreous china with overflow, ADA mounting height.
2. Faucet: Manually operated, solid-brass, 8-inch widespread, polished chrome finish, 0.5 gpm.
3. Strainer: 6-inch offset drain and tailpiece, brass, 1-1/4-inch.
4. Stops and supplies: Two chrome plated, solid brass angle stops with one quarter turn handle and cast brass escutcheon with setscrew, two flexible chrome plated copper lavatory risers, with chrome plated, cast brass, flange with setscrew.
5. Trap: 1-1/4-inch, chrome plated, cast brass, P-trap with cleanout with cast brass escutcheon with setscrew and brass nuts.
6. Accessories:

a. Adjustable floor mounted chair carrier, Zurn or equal. Carriers shall be fully compatible with each fixture.

C. Trap, supply and stop insulation kit Truebro Handi Lav-Guard or equal

2.5 SINKS

A. Sinks (S-1): Double compartment, stainless steel, counter mounted, self-rimming.

1. Sink: 18-gauge, type 302 stainless steel.
2. Faucet: Manually operated, polished chrome plated, brass deck faucet, swing spout, 6-inch, color coded metal wrist blade handles, 2.2 gpm.
3. Strainers: Type 304 stainless steel body and removable conical basket strainer with metal stem and rubber stopper. Chrome plated brass tailpiece, 1-1/2 x 4-inch.
4. Stops and supplies: Two chrome plated, solid brass angle stops with one quarter turn handle and cast brass escutcheon two flexible stainless steel reinforced PEX lavatory risers, with chrome plated, cast brass, flange (length of supply tubes determined by Contractor) to suit field conditions. The stop on the cold side shall have an extra 3/8" outlet for connection to ice maker valve box.
5. Trap: 1-1/2-inch, chrome plated, cast brass, P-trap with cleanout with cast brass escutcheon with setscrew.
6. Accessories: Hose and sprayer.

B. Sinks (S-2): Double compartment, stainless steel, counter mounted, self-rimming.

1. Sink: 18-gauge, type 302 stainless steel.
2. Faucet: Manually operated, polished chrome plated, brass deck faucet, 5-3/8-inch centerline swing gooseneck spout, 4-inch, color coded metal wrist blade handles, 2.2 gpm.
3. Strainer: Type 304 stainless steel body and removable conical basket strainer with metal stem and rubber stopper. Chrome plated brass tailpiece, 1-1/2 x 4-inch.

4. Stops and supplies: Two chrome plated, solid brass angle stops with one quarter turn handle and cast brass escutcheon with setscrew, two flexible chrome plated copper lavatory risers, with chrome plated, cast brass, flange with setscrew (length of supply tubes determined by Contractor).
5. Trap: 1-1/2-inch, chrome plated, cast brass, P-trap with cleanout with cast brass escutcheon with setscrew.
6. Accessories: Hose and sprayer.

2.6 SHOWERS

A. Shower Fittings (SH-1): Single-handle, pressure-balance mixing valve.

1. Shower fitting: Mixing valve with hot and cold water, indicators, integral stop/check valves, and fixed spray shower head. Shower head maximum flow shall be 2.5 gpm. Unit shall be pressure activated, non-scald type.
2. Verify shower valve and shower head mounting height with Architect. (Typical 7' AFF)
3. Drain: Floor drain with duco-coated cast iron body with polished bronze 6-inch diameter strainer and clamping collar.
4. Accessories:

    a. High-temperature shut-off device.

B. Shower Fittings (SH-2): Single-handle, pressure-balance mixing valve, ADA compliant.

1. Shower fitting: Mixing valve with hot and cold water, indicators, and integral stops. Diverter valve, 2.5 gpm hand/wall shower head, 60-inch flexible metal hose, 24-inch mounting slide bar wall connection.
2. Verify shower valve and shower head mounting height with Architect.
3. Drain: Floor drain with duco-coated cast iron body with polished bronze 6-inch diameter strainer and clamping collar.
4. Accessories:

    a. High-temperature shut-off device.

2.7 MISCELLANEOUS PLUMBING REQUIREMENTS

A. Provide new washers and seats at existing hose bibbs.

B. Provide new valved ice maker box for refrigerator icemaker with 6' stainless steel PEX flexible connector hose. Install inside of base cabinet.

C. Provide new washer box with one quarter turn shutoff valves to replace existing unit. Verify installation requirements

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water, soil and for waste piping systems and supports to verify actual locations and sizes of piping connections and that locations and types of supports match those indicated, before plumbing fixture installation. Use manufacturer's roughing-in data if roughing-in data are not indicated.

B. Examine walls and floors for suitable conditions where water closets will be installed.

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

3.2 APPLICATIONS

A. Include supports for plumbing fixtures according to the following:

1. Heavy-Duty, Floor Mounted Chair Carriers: For all wall mounted plumbing fixtures.

3.3 FIXTURE INSTALLATION

A. Assemble fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. For wall-hanging fixtures, install off-floor supports/carriers affixed to building substrate. See Architectural Drawings for fixture heights. If no fixture height is included consult Architect.

C. Install back-outlet, wall-hanging fixtures onto waste fitting seals and attach to supports.

D. Install floor-mounting fixtures on new closet flanges or other attachments to piping or building substrate. Closet flanges shall be anchored to the floor per manufacturer’s recommendations.

E. Install lavatory and sink fixtures with new chrome plated tubular waste piping.

F. Install counter-mounting fixtures in and attached to casework.

G. Install fixtures level and plumb according to manufacturers' written instructions and roughing-in drawings.

H. Install water-supply piping with new stops on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

I. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system. Rod and unstop any blockage on existing waste piping system.

J. Install toilet seats on water closets.

K. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

L. Install traps on fixture outlets.

M. Install new escutcheons at piping wall, floor, and ceiling penetrations in exposed, finished locations and within cabinets and millwork. Heavy-duty type escutcheons, shall be utilized in exposed applications under wall mounted lavatories and sinks and on exposed piping applications on tank type water closet stops, etc. Light duty slip-on type may be utilized in concealed installations within cabinets. Use deep-pattern escutcheons if required to conceal protruding fittings and cover wall penetrations.

N. Seal joints between fixtures and walls, floors, and counters using sanitary-type, one-part, mildew-resistant, silicone sealant. Grout excessive gaps as required. Match sealant and grout color to fixture color.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 and Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect water supplies from water distribution piping to fixtures.

C. Connect drain piping from fixtures to drainage piping.

D. Supply and Waste Connections to Plumbing Fixtures: Connect fixtures with water supplies, stops, risers, traps, and waste piping. Use size fittings required to match fixtures. Connect to plumbing piping.

E. Supply and Waste Connections to Fixtures and Equipment Specified in Other Sections: Connect fixtures and equipment with water supplies, stops, risers, traps, and waste piping specified. Use size fittings required to match fixtures and equipment. Connect to plumbing piping.

F. Ground equipment.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

G. Arrange for electric-power connections to fixtures and devices that require power. Electric power is specified under Division 26.

3.5 FIELD QUALITY CONTROL

A. Verify that installed fixtures are categories and types specified for locations where installed.

B. Check that fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

3.6 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Adjust water pressure at faucets, and flushometer valves to produce proper flow and stream.

C. Replace washers and seals of leaking and dripping faucets and stops.

3.7 CLEANING

A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:

1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
2. Remove sediment and debris from drains.

3.8 PROTECTION

A. Provide protective covering for installed fixtures and fittings throughout construction.

B. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

C. Replace any fixtures or equipment broken, cracked, discolored, pitted, or otherwise imperfect.

3.9 OPERATIONAL TESTS

A. Pour at least five (5) gallons of water into every floor drain and fill tub and drain to test for pipe stoppage. Remedy all stoppage.

END OF SECTION 224000

SECTION 230010 - MECHANICAL GENERAL PROVISIONS

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 DIVISION OF WORK

A. This section delineates the division of work between Divisions.

B. Consult all other Sections, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete and operable installation. This section is provided to assist the Contractor in coordination of work scope but shall not be construed to limit Contractor's scope of work encompassed by the contract documents.

C. Coordination with other Trades: The following table is intended to assist the Contractors in coordinating the scope of work between Division 23 (Indicated as 23 in table), and other Divisions as indicated. However, the General Contractor is ultimately responsible for coordination among his subcontractors regardless of what is listed in this Section.

INTERFACE/RESPONSIBILITY MATRIX						
System		Division under which the following is specified				Remarks
		Equipment	Installation	Power Wiring [1]	Control & Interlock Wiring [1]	
FIRE SPRINKLER SYSTEM						
	Flow switches	21	21	26	26	
	Valve monitors	21	21	26	26	
	Sprinkler system specialties (alarm bell, tamper switches, pressure switches, etc.)	21	21	26	26	
	Post indicating valves	21	21	26	26	
MECHANICAL EQUIPMENT						
	Mechanical equipment	23	23	26	23	
	Bipolar Ionization	23	23	26	23	
	Fans	23	23	26	23C	

INTERFACE/RESPONSIBILITY MATRIX						
System		Division under which the following is specified				Remarks
		Equipment	Installation	Power Wiring [1]	Control & Interlock Wiring [1]	
	Motor starters	23	23	26	23	
	Disconnects	26	26	26	26	
PLUMBING SYSTEMS						
	DHW heater venting and combustion air	23	23	-	-	
	Condensate drains including traps, primers	22	22	-	-	[3]
	Natural gas connections	22	22	-	-	[4]
MISCELLANEOUS						
	Trenching, backfilling, boring, soil compaction, saw-cutting, patching and paving for underground piping	31	31	-	-	
	Roofing, including cant strips and counterflashing at all penetrations	7	7	-	-	
	Thermal and acoustical insulation in and on partitions and ceilings	7	7	-	-	
	Roof and wall caps	23	23	-	-	
	Louvers	23	8	-	-	
	Concrete pads, etc. for equipment	23	23	-	-	
	Equipment, ductwork, and piping steel supports and frames, penetrations	23	23	-	-	
	Rooftop curbs for pipe/flues	23	23	-	-	
	Painting of exposed piping, HVAC ductwork, etc.	23	23	-	-	
	Fire-stopping around pipe and duct penetrations in floor and walls	23	23	-	-	
	Framing and CMU cutting of walls and floor/ceilings to accept air outlets, piping flues, ducts, etc.	23	23	-	-	
	Ceiling and wall access doors	23	8	-	-	

NUMBERED REMARKS:

[1] Wiring includes raceway, fittings, wire, boxes and related items, all voltages

[2] Wiring of interlock of duct smoke detectors to shut off supply fans upon detection of smoke is specified under Section 230900 Energy Management & Control System. All other smoke control/fire alarm related control wiring is specified under Division 26 Electrical.

[3] Coordinate piping from condensate pans to the sewer system including trap and

INTERFACE/RESPONSIBILITY MATRIX					
System	Division under the following is specified				Remarks
	Equipment	Installation	Power Wiring [1]	Control & Interlock Wiring [1]	
final connections is specified under Division 22 Plumbing. Piping from auxiliary drain pans, where provided at air handling equipment in furred spaces is specified under Division 23 HVAC. [4] Piping and modifications to deliver gas at the pressure required by mechanical and plumbing equipment, including final connections and shut-off cock, is specified under Division 22 Plumbing. Venting of gas appliances and other equipment where required is specified under Division 22 Plumbing and Division 23 Mechanical.					

D. HVAC/Electrical Design Coordination

1. The power ratings of motors and other HVAC equipment and the electrical characteristics of electrical systems serving them, as specified herein and indicated on the Drawings, have been established as minimums which will allow that equipment to satisfactorily function while producing the required capacities. These power ratings include a safety factor deemed appropriate to accommodate common differences between design parameters and field construction practices. Under no circumstances shall equipment with power ratings less than those indicated on the Drawings or specified herein be provided.
2. Reasonable efforts have been made to coordinate the electrical requirements of the HVAC equipment with the electrical systems serving that equipment. Differences among manufacturers of HVAC equipment make it impossible to produce a single electrical design which will satisfy the varying electrical requirements of those manufacturers. Consequently, the Contractor shall coordinate the electrical requirements of the HVAC equipment actually furnished on this Project and provide the electrical systems required by that equipment. This coordination effort shall be completed prior to the installation of either the HVAC equipment or the electrical systems serving that equipment. Electrical system revisions required to coordinate with the HVAC equipment actually furnished shall be provided at no additional cost to the Owner.

1.3 REFERENCE STANDARDS

A. Reference to codes, standards, specifications and recommendation of technical societies, trade organizations and governmental agencies shall mean that latest edition of such publications adopted and published prior to submittal of the bid. Such codes or standards shall be considered a part of this Specification as though fully repeated herein.

B. Work shall be performed in accordance with all applicable requirements of the latest edition of all governing codes, rules and regulations including but not limited to the following minimum standards, whether statutory or not.

C. Requirements of Regulatory Agencies

1. In accordance with the requirement of Division 1 General Requirements.
2. Nothing in contract documents shall be construed to permit work not conforming to current and applicable laws, ordinances, rules and regulations.
3. Where contract documents exceed requirements of applicable laws, ordinances, rules and regulations, comply with documents establishing the more stringent requirement.
4. It is not the intent of contract documents to repeat requirements of codes except where necessary for completeness or clarity.
5. Comply with the Safety Orders issued by OSHA and any other safety, State health or environmental regulations and any districts having jurisdictional authority. Where an omission or conflict appears between OSHA requirements and the Drawings and Specifications, OSHA requirements shall take precedence.
6. Applicable codes as listed below, in addition to others specified in individual sections.

    a. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) – Standard 90.1-2010 “Energy Standard for Buildings Except Low-Rise Residential Buildings”.
    b. International Building Code (IBC) – 2018.
    c. International Mechanical Code (IMC) – 2018.
    d. International Plumbing Code (IPC) - 2018.
    e. NFPA 1 – 2015, Fire Code
    f. NFPA 70 - 2014, National Electric Code
    g. NFPA 90A - 2015, Installation of Air Conditioning and Ventilating Systems
    h. International Residential Code (IRC) - 2018

D. Published specifications, standards, tests or recommended method of trade, industry or governmental organizations as listed below apply to all work in Division 23 HVAC, in addition to other standards which may be specified in individual sections.

E. All base material shall meet ASTM and ANSI standards.

F. All Gas Fired Devices: Comply with standards and bear label of AGA.

G. All Pressure Vessels, Relief Valves, Safety Relief Valves and Safety Valves: Comply with standards, ASME stamped.

H. All Electrical Devices and Wiring

1. Conform to standards of NEC
2. All devices UL or ETL listed and identified

I. Guidelines and Standards: The latest edition of guidelines and standards published by the following govern the Mechanical Systems and associated support system design. The systems shall be designed to meet or exceed these guidelines and standards.

AABC	Associated Air Balance Council

ADC	Air Diffuser Balance Council
AGA	American Gas Association
AMCA	Air Movement and Control Association, Inc.
ANSI	American National Standards Institute
ARI	Air Conditioning and Refrigeration Institute
ASC	Adhesive and Sealant Council
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASSE	American Society of Sanitary Engineers
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
AWS	American Welding Society
ETL	Interlek Semko (Formerly Electrical Testing Laboratories)
GISO	General Industry Safety Orders
HI	Hydraulic Institute
ICBO	International Conference of Building Officials
IEEE	Institute of Electrical and Electronic Engineers
NBS	National Bureau of Standards
NEBB	National Environmental Balancing Bureau
NEC	National Electrical Code
NEMA	National Electrical Manufacturer's Association
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Act
PDI	Plumbing and Drainage Institute
SMACNA	Sheet Metal and Air Conditioning Contractors National Association, Inc.
UL	Underwriter's Laboratories, Inc.

1.4 QUALITY ASSURANCE

A. Supply all equipment and accessories in compliance with the applicable standards listed herein and with all applicable national, state and local codes.

B. All equipment and accessories shall be new, and the product of a manufacturer regularly engaged in its manufacture.

C. All items of a given type shall be the products of same manufacturer.

D. Workmanship, material, and equipment shall be in accordance with Specifications and Drawings and in some instances the requirements exceed those required by codes and standards. Where not exceeded, the codes and standards shall be considered as absolute minimum requirements.

1.5 SUBMITTALS

A. No work may begin on any segment of this Project until the related submittals have been reviewed for conformance with the design intent and the Contractor has responded to all comments to the satisfaction of the Owner.

B. Submit drawings, product data, samples and certificates of compliance required as hereinafter specified. See also Division 01 – General Requirements.

C. Submit no later than 20-days after signing of Contract, or as otherwise indicated by Architect. Submit a schedule indicating the proposed submission date of each submittal division specified herein. Schedule shall anticipate the submittal review time, the possible need for resubmittals, and the time required for fabrication, shipping and integration into the construction sequence. Architect will advise of any conflicts in reviewing submittals that the proposed schedule presents.

1. Complete schedule of submittals for equipment and layout shop drawings. Allow 15-working days for review, unless Architect agrees to accelerated schedule.
2. List of all proposed substitutions: See requirements herein.
3. Designate in schedule dates for submission and dates that reviewed shop drawings, product data and samples will be needed.
4. Provide submittals promptly in accordance with schedule and in such sequence as to cause no delay in work or in work of any other division.

D. Submit drawings, product data, samples and certificates of compliance required hereinafter specified.

1. See also Division 01 General Requirements.
2. Provide comprehensive submittals of each division all at one time promptly in accordance with schedule and in such sequence as to cause no delay in work or in work of any other division.
3. Submittals for each specification section and each division shall be submitted in a single package. However, it is not required (nor desired) for all divisions to be submitted concurrently. Rather, submittal for divisionss may be staggered based on schedule and required equipment release dates.
4. Allow 15-working days for review, unless the Architect agrees to accelerated schedule.
5. For substitutions, list any features or characteristics that are not strictly in compliance with specifications. If none are listed with the submittal, Contractor is guaranteeing that substituted product is functionally equivalent to the specified product in accordance with requirements herein.
6. Submittal reviews by the Architect are intended to assist the Contractor in complying with the design intent and requirements of the drawings and specifications. Reviews do not relieve the Contractor from compliance with these requirements and comments or lack thereof does not constitute approval of changes in these requirements.

E. Submission and Resubmission Procedure.

1. Each submittal cover sheet shall contain the Contractor’s review statement. The statement shall be worded as follows:

a. It is hereby certified that the information included in this submittal and approved/proposed to be incorporated into this project (include official project name on Contract Drawings), is in compliance with the Contract Drawings and specifications, the electrical requirements have been coordinated with the Electrical Sub-Contractor, can be installed in the allocated spaces with adequate service space, and is approved for use and is submitted for Architect's review.

Authorized Reviewer: _____ Date: _____

2. Each submittal shall have a unique serial number that includes the associated specification section followed by a number for each sub-part of the submittal for that specification section, such as "SUBMITTAL 23 xx xx-01".
3. Each resubmittal shall have the original unique serial number plus revision number such as "SUBMITTAL 23 xx xx-01 REVISION 1".
4. Submit in format specified below. Submissions made in wrong format will be returned without action.

    a. Product Submittals: One copy in word-searchable electronic format per requirements herein. Submit each specification section in a separate file named with unique name and number described above.
    b. Shop Drawings:

        1) One copy in electronic format .dwg, .dwf, or .pdf

    c. Samples: As indicated in each specification section.

5. Architect will return a memo or mark-up of submittal with comments and corrections noted where required.
6. Make corrections

    a. Revise initial submittal to resolve review comments and corrections.
    b. Indicate any changes that have been made other than those requested.
    c. Clearly identify resubmittal by original submittal number and revision number.

7. Resubmit revised submittals until "No Exceptions" or "Furnish as Corrected" is provided by the Professional.
8. Once submittals are accepted and stamped with "No Exceptions" or "Furnish as Corrected" is provided by the Professional, provide:

    a. Complete submittal of all accepted products in a single electronic file for each specification section.
    b. Photocopies for coordination with other trades, if and as required by the Contractor or Architect. Photocopies will serve as submittal for record and coordination.
9. The stipulations included with the Professional remarks with "Furnish as Corrected" indicate provisional acceptance.

F. Product Data Submittals

1. Contents.

    a. Manufacturer's name and model number.
    b. All information required to completely describe materials and equipment and to indicate compliance with drawings and specifications, including, but not limited to:

        1) Schedule when more than one of each item is covered by submittal.
        2) Physical data, as applicable.

            a) Dimensions.
            b) Weights.
            c) Finishes and colors.
            d) Dimensional shop drawings.

        3) Performance data, as applicable.

            a) Rated capacities.
            b) Performance curve.
            c) Operating temperature and pressure.
            d) Efficiency.

        4) Flow and wiring diagrams as applicable.
        5) Description of system operation.

    c. All other pertinent information requested in individual sections.

2. Format.

    a. See Division 01 – General Requirements.
    b. Identify clearly if submittal is substitution: See requirements herein.
    c. Reference specification Division, Section, Title, Paragraph and Page number or drawing number as applicable
    d. Use same nomenclature, legend, symbols and abbreviations on submittal material as used in contract documents.

G. Samples.

1. Submit as required in each specification section.

1.6 COMPLETION REQUIREMENTS

A. Procedure.

1. Until the documents required in this section are submitted and approved, the system will not be considered "accepted".
2. Before requesting acceptance of work, submit one set of Completion Documents for review and approval of Architect.
3. After review, furnish quantity of sets indicated below to Owner.
4. Format:

    a. See herein for required format of Completion Documents.

b. Paper Copies: Assemble in chronological order following alpha-numeric system used in specification, in heavy three-ring binder.
c. Where electronic copies are called for herein, comply with the following:

1) Provide in word-searchable electronic format; acceptable formats are MS Word, Adobe Acrobat (pdf) and HTML; submit other formats for review and approval prior to submission; scanned paper documents not acceptable.
2) For submittals, provide separate file for each type of equipment.
3) For Test & Balance report, provide separate files for each air handling system.
4) Record drawings shall be in original format.

B. Operating and Maintenance (O&M) Manual.

1. See O&M Manual requirement herein

C. Record Drawings.

1. Keep up-to-date during progress of job one set of Mechanical Drawings indicating the Record installation. In addition to changes made during course of Work, show following by dimension from readily obtained base lines.

a. Fully illustrate all revisions made by all crafts in course of work.
b. Include all field changes, adjustments, variances, substitutions and deletions, including all Change Orders.
c. Exact location, type and function of concealed valves, dampers, controllers, piping, air vents and piping drains.
d. Exact size, invert elevations and location of underground and under floor piping and ducts.

1) Progress drawing set shall be available for inspection by Architect weekly.
2) Update engineering design drawings and shop drawings to reflect revisions and additional data listed above at completion of Project.

e. Original engineering design drawings will be provided to Contactor in electronic format compatible with AutoCAD version 2010 or later.
f. Both shop and engineering design drawings shall be in format compatible with AutoCAD version 2010 or later.
g. Drawings required to be updated if revisions were made.

1) Floor plans.
2) Shop drawings required herein.
3) Sections.
4) Riser diagrams.

D. Test and Balance Reports.

1. See Section 230593 – Testing, Adjusting, and Balancing for HVAC.

E. Training Materials.

1. See Training Materials requirements herein.

F. Miscellaneous Certificates.

1. Pressure and Leakage Test documentation/certificates.
2. Training/Instruction completion certificates.
3. Fire Marshal and Fire Department approvals of system, as required.
4. Final inspection certificate signed by governing authorities.
5. Warranty period, including start and end period.
6. Field test report, including as applicable.
7. Start-up documents with date and name of technician.
8. Piping pressure tests.
9. Certificates of sterilization/chlorination of plumbing systems.
10. Others as specified herein and in other Division 23 – Mechanical sections.

G. Format of Completion Documents.

1. Provide the type and quantity of media listed in table below.
2. Optical media shall be readable on a personal computer.

Document	Paper (Binder or bound)	Electronic
		USB Flash Drive
O&M Manuals	2	2
Record Drawings	2 Full size	2
	2 Half size	
Test and Balance Report	2	2
Miscellaneous Certificates	2	2
Warranty documents	2	2
Training materials	1 per trainee	1

1.7 SUBSTITUTIONS AND PRODUCT OPTIONS

A. For specific substitution requirements, See Division 00 and Division 01.

B. Where equipment and materials are shown on the drawings and/or specified hereinafter by a manufacturer's name and/or model number, it is the intent of these specifications to set minimum definite standards for equipment and materials to be used on the project. It is not the intent of these specifications to preclude the use of materials and equipment of similar design and quality to manufacturer's name specified. If the Contractor desires to substitute materials and equipment, he shall obtain written approval through the materials submittals process of all such substitutions before such substitutions are made. Unauthorized substitutions of materials and equipment may be ordered removed from the project without further grounds. The Architect will not approve any substitutions for specified materials and equipment unless such substitutions are requested by the Contractor.

C. The products of particular manufacturers have been used as the basis of design in preparation of these documents. It shall be the responsibility of this Contractor to determine if the submitted materials and equipment will fit into the space allotted with all required clearances as the materials and equipment utilized as the basis of design. Furthermore, the

Contractor shall verify and maintain adequate access to equipment, valves, filters, lubrication outlets, etc. Any changes to the building or system design necessary shall be arranged for in writing before the materials and equipment is ordered. All costs involved in making such changes shall be borne by the Contractor. If such changes are deemed inadvisable by the Architect, the Contractor shall install items specified even though materials and equipment had been previously approved. Architect's approval of materials and equipment other than the basis of design is for performance only.

D. Contractor shall consider the following parameters (at a minimum) when considering materials and equipment substitutions:

1. Capacities: The capacities included in the Contract Documents are absolute minimum and the substitution shall have equal or greater capacities.
2. Physical size limitations: Substitutes shall fit in the allotted space and shall have the manufacturer's minimum clearances.
3. Installation and operating weights.
4. Structural properties.
5. Noise levels.
6. Vibration.
7. Interchangeability.
8. Accessibility for maintenance, operation, and replacement.
9. Compatibility with other materials and assemblies.
10. Equal quality and style.

1.8 DESCRIPTION OF BID DOCUMENTS

A. The Contractor shall be responsible for becoming thoroughly acquainted with all Contract Document contents that affect his work under this contract. Work required under this section includes, but is not limited to, all material, equipment transportation, services and labor required to complete the entire mechanical system as required by the Contract Documents.

B. The Specifications and the associated Drawings are complimentary, and any portion of the work described in one shall be provided as if described in both.

C. Specifications.

1. Specifications, in general, describe quality and character of materials and equipment.
2. Specifications are of simplified form and include incomplete sentences.
3. Words or phrases such as "The Contractor shall," "shall be," "furnish," "provide," "a," "an," "the," and "all" have often been omitted from specifications for brevity.

D. Drawings.

1. Drawings are diagrammatic in nature and, unless explicitly dimensioned, indicate approximate locations of apparatus, equipment, ductwork and piping. Changes in the location, and offsets, of same which are not shown on the Drawings but are necessary in order to accommodate building conditions and coordination with the work of other trades, shall be made during the preparation of coordination drawings and prior to initial installation, without additional cost to the Owner. Contractor shall install all system components in such a manner as to conform to the structure, avoid obstructions,

preserve headroom, keep openings and passageways clear and maintain required servicing clearances without further instructions or additional cost to the Owner.

2. Scaled and figured dimensions are approximate and are for estimating purposes only. Indicated dimensions are limiting dimensions where noted. Duct and piping elevations are indicated for initial coordination; final requirements shall be determined by the Contractor after final coordination with other trades.
3. Before proceeding with work, check and verify all dimensions in field.
4. Assume all responsibility for fitting of materials and equipment to other parts of equipment and structure.
5. Make adjustments that may be necessary or requested in order to resolve space problems, preserve headroom and avoid architectural openings, structural members and work of other trades.
6. It is intended that all mechanical, plumbing and fire protection devices, piping, etc. be located symmetrically with all architectural elements. Refer to Architectural, Structural, Plumbing, Fire Protection, Mechanical and Electrical Specifications and Drawings in completing the required coordination.
7. The Contractor shall fully inform himself regarding any and all peculiarities and limitations of the spaces available for the installation of all work and materials furnished and installed under this Contract. He shall exercise due and particular caution to determine that all parts of his work are made readily accessible.
8. The Contractor shall study all drawings and specifications to determine any conflict with all applicable ordinances and statutes. Any discrepancies shall be reported to the Owner and any changes shall be shown on the as-built drawings with the additional work performed at no cost to the Owner.
9. The submittal of his bid shall indicate the Contractor has examined the site, drawings and specifications and has included all required allowances in his bid. No allowance shall be made for any error or omission resulting from the Contractor's failure to visit job site and to review drawings and specifications. The Contractor's bid shall include costs for all required drawings and changes as outlined above at no cost to the Owner.
10. Provide access to equipment and apparatus requiring operation, service or maintenance throughout the life of the system.

E. Do not use equipment exceeding dimensions indicated on drawings or equipment or arrangements that reduce required clearances or exceed specified maximum dimensions.

F. If any part of Specifications or Drawings appears unclear or contradictory, apply to Architect for an interpretation and decision prior to bid and as early as possible.

1. Do not proceed with work without the decision of the Architect.

1.9 ALTERNATES

A. Refer to Division 01 – General Requirements.

1.10 DEFINITIONS

A. In addition to those defined in Division 01 – General Requirements, the following additional definitions shall apply. Definitions of term used in Division 23 HVAC may differ from those given in general and supplementary conditions.

B. “Provide”: to furnish, supply, install and connect up complete and ready safe and regular operation of particular work referred to unless specifically noted.

C. “Supply”: to purchase, procure, acquire and deliver complete with related accessories.

D. “Work”: includes labor, materials, apparatus, controls, equipment services and all related accessories necessary for the proper and complete installation of complete systems.

E. “Piping”: includes pipe, tube, fittings, flanges, valves, controls, strainers, hangers, supports, unions, traps, drains, insulation and all related accessories.

F. “Wiring”: includes raceway, fittings, wire, boxes and all related accessories.

G. “Concealed”: not in view, installed in masonry or other construction, within furred spaces, double partitions, hung ceiling, trenches, crawl spaces, or enclosures.

H. “Exposed”: in view, not installed underground or “concealed” as defined above. Exposed piping, conduit, or ductwork is that which can be seen when the building is complete without opening or removing access doors or panels or accessible ceiling components.

I. “Control or Actuated Devices”: includes automatic sensing and switching devices such as thermostats, pressure, float, flow, electro-pneumatic switches and electrodes controlling operation of equipment.

J. “Indicated,” “shown” or “noted”: as indicated, shown or noted on drawings or specifications.

K. “Reviewed,” “approved,” or “directed”, as reviewed, approved or directed by or to Owner.

L. “Motor Controllers”: starter, variable speed drives and other devices controlling the operation of motors.

1.11 PROJECT CONDITIONS

A. Examine site related work and surfaces before starting work of any Section.

1. In case of conflict, the most stringent takes precedence.
2. For purposes of clarity and legibility, Drawings are essentially diagrammatic to extent that many offsets, bends, unions, special fittings, exact locations of items are not indicated, unless specifically dimensioned. Especially note a number of required duct and pipe offsets to coordinate with structure and not shown. Coordinate dimensioned conditions, including invert elevations, with other trades prior to installation by any trade.
3. Exact routing of piping, ductwork, etc. shall be governed by structural conditions and other obstructions. Not all offsets in ductwork or piping are shown on the Drawings. Determine which item to offset or relocate. Maintain required slope in piping. Make use of data in Contract Documents. In addition, Architect reserves right, at no additional cost to the Owner, to make any reasonable change in location of mechanical items, exposed at ceiling or on walls, to group them into orderly relationships or increase their utility. Verify Owner’s requirements in this regard prior to rough-in.
4. Take dimensions, location of doors, partitions, similar physical features from Architectural Drawings. Verify at Site under this Division. Consult Architectural

Drawings for exact location of outlets to center with Architectural features, panels, etc., at the appropriate location shown on Mechanical Drawings.

5. Mounting heights of brackets, outlets, etc., as required.
6. Report to Architect, in writing, conditions which will prevent proper provision of this work.
7. Beginning work of any Section without reporting unsuitable conditions to Architect constitutes acceptance of conditions by Contractor.
8. Perform any required removal, repair or replacement of this work caused by unsuitable conditions at no additional cost to the Owner.

B. Coordination.

1. Work out all “tight” conditions involving Work specified under this Division and work in other Divisions in advance of installation, if necessary, and before Work proceeds in these areas, prepare supplementary Drawings under this Division for review showing all Work in congested area. Provide supplementary Drawings, additional Work necessary to overcome congested conditions, at no additional cost to the Owner.
2. Conflicts: Difference or disputes concerning coordination, interference or extent of Work between sections shall be decided as follows:

    a. Install mechanical and electrical systems in the following order of preference (those trades listed below another must reroute to resolve the conflict):

        1) Drain piping required by code to be sloped.
        2) Supply air and exhaust air ductwork connected to fans.
        3) Electrical conduit 4 inches and larger.
        4) Domestic water piping.
        5) Fire sprinkler piping.
        6) Electrical conduit smaller than 4 inches.
        7) Control system piping and wiring.

    b. Continued disputes shall be decided by Contractor and Contractor’s decision, if consistent with Contract Document requirements, shall be final.

3. Supervision: Personally, or through an authorized and competent representative, constantly supervise the work from beginning to completion and, within reason, keep the same foreman and workmen on the Project throughout the Project duration.
4. Provide templates, information and instructions to other Divisions to properly locate hides and openings to be cut or provided.
5. The drawings govern in matters of quantity, and the specifications govern in matters of quality. In the event of conflict within the drawings involving quantities, or within the specifications involving quantities, or within the specifications involving quality, the greater quantity and higher quality shall apply. Such discrepancies shall be noted and clarified in the Bid. No additional allowances will be made because of errors, ambiguities, or omissions that reasonably should have been discovered during the preparation of the Bid.

C. Equipment Rough-in.

1. Rough-in locations shown on Mechanical Drawings for equipment furnished by the Owner and for equipment furnished under other Divisions are approximate only. Obtain exact rough-in locations from following sources.

a. From Shop Drawings for equipment provided under this contract.
b. From Architect for Owner Furnished-Contractor installed equipment.
c. From existing equipment where such equipment is relocated or reinstalled in same location under this Contract.

2. Verify mechanical characteristics of equipment before starting rough-in. Where conflict exists between equipment and rough-in shown on Drawings obtain clarification from Architect and provide as directed by the Architect at no additional cost to the Owner.
3. Make final connections.

1.12 PRODUCT DELIVERY, HANDLING AND STORAGE

A. See Division 01 – General Requirements (Product Requirements).

B. Deliver equipment in its original package to prevent damage or entrance of foreign matter. Provide materials on factory provided shipping skids and lifting lugs if required for handling. Provide protective coverings during construction.

C. Handle and ship in accordance with manufacturer's recommendations.

D. Identify materials and equipment delivered to Site to permit check against approved materials list, reviewed with no exceptions taken Shop Drawings.

E. Protect from loss or damage. Replace lost or damaged materials and equipment with new at no additional cost to Owner.

F. Where necessary, ship in crated sections of size to permit passing through available space.

1.13 PROJECT MANAGEMENT AND COORDINATION SERVICES

A. See Division 01 – General Requirements.

B. Overview: Provide a project manager/engineer for the duration of the Project to coordinate the Division 23 HVAC work with all other trades. Coordination services, procedures and documentation responsibility shall include, but shall not be limited to the items listed in this section.

C. Review of shop drawings prepared by other subcontractors

1. Obtain copies of all shop drawings for equipment provided by others that require electrical service connections or interface with Division 23 HVAC work.
2. Perform a thorough review of the shop drawings to confirm compliance with the service requirements contained in the Division 23 HVAC contract documents. Document and discrepancy or deviation as follows:

a. Prepare memo summarizing the discrepancy.
b. Provide a copy of the specific shop drawing, indicating via cloud, the discrepancy.

3. Prepare and maintain a shop drawing review log indicating the following information.

a. Shop drawing number and brief description of the system/material.
b. Date of review.
c. Indication if follow-up coordination is required.

D. Request for Information (RFI)

1. See Division 1 Request for Information

1.14 REVIEW OF CONSTRUCTION

A. Work may be reviewed at any time by representatives of the Owner and/or Architect.

B. Advise Owner that work is ready for review at the following times.

1. Prior to backfilling buried work.
2. Prior to concealment of work in walls and above ceilings.
3. When all requirements of Contract have been completed.
4. When testing will be performed.

C. Do not backfill or conceal work without Architect's consent.

D. Maintain on site, one set of Specifications and Drawings for use by Owner and/or Architect.

1. Include all change orders.

E. Contractor is responsible for construction methods, sequences and safety precautions.

1.15 SCHEDULE OF WORK

A. In accordance with Division 01 – General Requirements and as follows:

1. Arrange work to conform to schedule of construction established or required to comply with Contract Documents.
2. In scheduling, anticipate means of installing equipment through available openings in structure.

B. Confirm in writing to Architect, within 35-days of signing of contract, anticipated number of days required to perform test, balance, acceptance testing and commissioning of mechanical systems. Schedule test balance and acceptance testing of mechanical systems as follows:

1. Submit for review at this time, names and qualifications of test and balancing agencies to be used.
2. Test, Adjusting and Balancing and commissioning must occur after completion of mechanical systems, including all control calibration and adjustment, and requires substantial completion of the building, including closure, ceilings, lighting, partitioning, etc.
3. Allow 21-days after test and balance for system commissioning and life safety testing (where applicable).

1.16 CUTTING AND PATCHING

A. See Division 01 – General Requirements.

1.17 UTILITY CONNECTIONS

A. Utilities include but are not limited to, water, sanitary sewer, natural gas, fire protection water, etc.

B. Connect to utility company mains as required. Include all ancillary components required by serving utility company/school authorities.

C. Connect to on-site piping mains.

D. Contractor shall be responsible for payment of all service charges.

E. Contractor shall be responsible for provisions for temporary utilities.

1.18 WARRANTY

A. In accordance with Division 1 Guarantees, Warranties, Bonds, Service & Maintenance Contracts and as follows.

B. All extended warranties specified herein shall be non-prorated.

C. Warranty all materials, equipment, apparatus and workmanship to be free of defective materials and faulty workmanship for a period of one year from and after date of acceptance of completed contract.

D. Provide new materials, equipment, apparatus and labor to replace that determined by Architect to be defective or faulty.

E. This guarantee also applies to services including instructions, adjusting, testing, noise, balancing, etc.

F. Nothing herein intends or implies that guarantee shall apply to work which has been abused or neglected by the Owner or the Owner’s successor in interest.

1.19 PERMITS

A. Obtain all permits, certificates of inspections, patent rights and licenses that are required for the performing of this work by all laws, ordinances, rules and regulations or orders of any officer and/or body. Provide all notices necessary in connection therewith and pay all fees relating thereto and all costs and expenses incurred on account thereof. No work shall be covered before inspection by the jurisdiction authorities and observation by the Architect.

1.20 CONTINUITY OF EXISTING SERVICE AND SYSTEMS

A. Schedule work so existing systems will not be interrupted. Obtain approval from the Owner and Architect at least 14 days prior to any utility interruption or connection.

B. Perform work at such time and in such a manner as to cause minimum inconvenience to the Owner and as approved by the Architect. No allowance will be made for lack of knowledge of existing conditions.

C. Existing utility service and systems:

1. Protect existing active utilities.
2. Relocate as indicated on Construction Drawings.
3. Existing inactive utilities shall be capped or plugged (below grade).

D. Connections to existing work:

1. Install new work and connect to existing work with minimum interference to existing facilities.
2. Connect new work to existing work in neat and acceptable manner. Restore existing disturbed work to original condition.

E. Removal and relocation of existing work.

1. Disconnect, remove or relocate piping, ductwork, conduit, and other work noted or required by alterations, modifications or changes in existing construction.
2. Plug or cap affected active lines behind or below finished walls and/or floors.
3. Dispose of removed piping and material.

F. Special Traffic Requirements:

1. Maintain emergency and service entrances so they are usable for pedestrian, truck and emergency vehicles at all times.
2. Where trenches are cut, provide adequate bridging for above-mentioned traffic.

1.21 PROVISIONS FOR FUTURE WORK

A. The design contemplates future work. Provisions for this work are indicated on the Drawings. All work conducted as part of this contract shall be completed with the future work accounted for. Rework associated with system components installed in locations that will disrupt the future work shall be performed at no cost to the Owner.

1.22 PROCEDURE OF WORK

A. The Contractor is hereby cautioned that although he will be permitted to conduct his work during regular working hours (see exceptions below), his work shall be performed in such a manner so as not to interfere with the conduct of regular business unless approval for such interference has been obtained from the Owner and Architect. No reimbursement shall be made to the Contractor for losses sustained due to delays and interruptions of his work to accommodate the operation and business of the Owner.

B. Regular working hours exceptions: Extended utilities shutdowns and/or major equipment changeouts.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Listed “Acceptable Manufacturers” are those considered capable of manufacturing products or equipment conforming to detailed Specifications and Schedules, and as such, are invited to compete provided the offering is comparable in every respect to scheduled or specified products and actually conforms to the detailed Specifications and Schedule requirements. Listing herein as “Acceptable Manufacturers” does not imply “Accepted”, “Approved”, “Prior Approval” or any other connotation. All product offerings must be submitted for approval after Contract Award.

B. Alternate manufacturers as identified in each section will be considered under conditions specified herein.

C. Identify materials, equipment by manufacturer's name, nameplate data. Remove unidentified materials, equipment from Site.

D. Equipment specified by manufacturer's number shall include all accessories, controls, etc., listed in catalog as standard with equipment. Furnish optional or additional accessories as specified.

E. Where no specific make of material or equipment is mentioned, any first-class product of reputable manufacturer may be used, provided it conforms to requirements of system and meets with acceptance.

F. Provide an authorized representative to constantly supervise work of this Division, check all materials prior to installation for conformance with Drawings, Specifications, reviewed Submittals and reviewed Shop Drawings.

G. Conform to conditions shown and specified. Coordinate with other trades for best possible assembly of combined Work. Relocate equipment when necessitated by failures to coordinate Work or to advise Architect of conflicts in writing.

H. Material and Equipment-General Requirements

1. New.
2. Approved for use by State Fire Marshal and local building inspection department when applicable.
3. Testing agency labeled or with other identification wherever standards have been established.
4. Architect reserves right to reject items not in accordance with Specification either before or after installation.
5. Comprised to render complete and operable systems; provide additional items needed to complete installation to realized design.
6. Compatible with space allocated; modifications necessary to adjust items to space limitations at Contractor's expense.

7. Installed fully operating and without objectionable noise or vibration.
8. Design of mechanical systems is generally based on product of the first named manufacturers cited. Where systems for product installed necessitate modification of systems shown on drawings, Contractor is responsible for installation of systems appropriate to product installed.

I. Electrical Requirements

1. Electrical Work performed under Division 23 – Mechanical shall conform to requirements of Division 26 Electrical.
2. Provide weatherproof devices and installation for out-of-doors work.

2.2 PAINTING

A. Finish painting (other than factory applied) of mechanical equipment and associated piping and ductwork shall be as specified in Division 09 “Painting” Section(s). Provide touch up painting of prefinished mechanical products.

1. All equipment, ductwork, piping, conduit and associated supports, attachments, hardware, and connectors exposed indoors or to the weather shall be properly coated, painted, or otherwise protected from corrosion caused by the elements (sun, wind, rain, snow, ice, etc.).

B. Surfaces shall be left clean, debris shall be removed, and equipment shall be furnished in prime coat finish ready for finish coats.

1. Piping, Ductwork and Equipment: Clean exterior of piping, ductwork and equipment removing rust, plaster, and dirt by wire brushing. Remove grease, oil and similar materials by wiping with clean rags and suitable solvents.
2. Motors, Pumps and Other Items with Factory Finish: Remove grease and oil and leave surfaces clean and polished.

C. Cleaning operations may be supplemented by more detailed instructions in various other Sections of this Specification.

D. Paint for high temperature piping and equipment shall be high temperature resistant, designed for the temperatures at which the system will operate.

PART 3 - EXECUTION

3.1 INSPECTION

A. Verify that conditions are satisfactory for the installation of materials and equipment. Notify Architect if conditions are not satisfactory and do not commence work until conditions have been corrected.

3.2 INSTALLATION

A. Install materials and equipment in compliance with governing codes.

B. Use printed descriptions, specifications and recommendations of manufacturers as a guide for installation of Work. Follow in all cases where manufacturers of articles used furnish directions covering points not specified or shown.

C. Equipment.

1. Assemble equipment which is required to be field assembled under the direct supervision of the manufacturers' agent.
2. Prior to the final acceptance submit letters from the manufacturers that equipment has been assembled under the direct supervision of the manufacturers' agent.
3. Accurately set and level equipment with supports neatly placed and properly fastened.
4. Properly fasten equipment in place with bolts to prevent movement.
5. Coordinate the installation of equipment with openings in structure.
6. Coordinate and fully dimension steel supports for mechanical equipment where shown on drawings with installing contractor.
7. Provide all roof curbs for roof mounted fans, flues, piping and duct penetrations, etc.
8. Concrete.

    a. Concrete work, include forming, steel bar reinforcing, cast-in-place concrete, finishing and grouting is specified under Division 03 Concrete.
    b. Coordinate and fully dimension concrete housekeeping pads and curbs with installing contractor; dimensions shall be as required for structural requirements.
    c. Coordinate inertia base fill with installing contractor

D. Electrical.

1. See Division 26 Electrical.
2. Install electrical devices with code required clearances and access.
3. Assist the electrical contractor in the proper connecting of all electrical wiring and equipment required for mechanical equipment.

E. Sleeves, Chases and Concrete Inserts.

1. Provide all required sleeves, chases, concrete inserts, anchor bolts, etc.
2. Sleeves, chases are prohibited in structural members, except where shown or as directed by Architect in writing.
3. Embed no piping in concrete or masonry.

F. Waterproof Construction.

1. Comply with Division 07 – Thermal and Moisture Protection.
2. Include membrane clamps, sheet metal flashing, counter flashing, caulking and sealant as required for waterproofing of mechanical penetrations and sealing penetrations in or through fire walls, floors, ceiling slabs and foundation walls.
3. All penetrations through vapor barriers at slabs on grade shall be taped and made vapor tight.

4. Provide galvanized sheet metal weather protection canopies, hoods or enclosures over all out-of-doors equipment, the operation or maintenance of which would be impaired by rainwater; this requirement applies to damper operators and bearings, damper motors, controls and instruments. See other Sections in this Division for application of this requirement to motors, drives, ducts and fans.

G. Restoration of Damage.

1. Repair or replace, as directed by Architect, materials and parts of premises which become damaged.
2. Remove replaced parts from premises at no additional cost to the Owner.

H. Review architectural drawings and coordinate with Architect and other contractors to be sure that all architectural shafts, plenums, rated duct enclosures etc. required for mechanical systems are properly located and dimensioned.

I. Access Panels and Doors.

1. Coordinate size requirements and exact location with Contractor who will install access doors.
2. Minimum Sizes: 18 inches by 18 inches unless otherwise shown on Drawings or approved by Architect.
3. Provide where shown, or required by Regulatory Agencies, for access of all concealed equipment such as terminal units, valves, fire/smoke dampers, etc., for Mechanical Work:

    a. Equipment shall be located wherever practical over accessible ceilings or rooms to avoid access doors.
    b. Access doors shall not be used solely for access to balancing dampers; use instead, remote control devices specified under Section 233300 – Air Duct Accessories.

J. Openings.

1. Coordinate and fully dimension all openings in walls, floors, roofs, and structural elements required for mechanical work.
2. Provide all required fire-stopping around pipe, duct and other penetrations required for mechanical work in rated partitions where required by code. All penetrations of floors and ceilings, and between apartments, shall be fire-stopped.
3. Air outlet openings.

    a. Contractor shall coordinate exact locations of air outlets in floors, walls and ceilings with contractor installing partition, and existing CMU construction.

3.3 PROTECTION OF EQUIPMENT AND MATERIALS DURING CONSTRUCTION

A. See Division 01 – General Requirements.

B. Provide protective covers, skids, plugs or caps to protect equipment and materials from damage or deterioration during construction.

C. Store equipment and material under cover, and off the ground or floors exposed to rain.

D. For outdoor storage, protective covers of 10 mil thick black sheet plastic shall be fitted over equipment and materials. Covers shall be reinforced to withstand wind and precipitation. Set equipment and material on skids or platforms of height to avoid damage or deterioration from spattering and ground water.

E. Protect coils against damage by installing temporary closure panels over exposed coil faces. Panels shall be minimum 24 gauge sheet metal or 0.375" plywood.

F. Completely cover motors and other moving machinery to protect from dirt and water during construction.

G. Close open ends of fans, air valves, terminal units, energy recovery units, air handling units, and ductwork with temporary closures of sheet plastic taped in place.

H. Plug ends of pipes when work is stopped to prevent debris from entering the pipes.

I. Provide dust and debris protection for ductwork, coils, fans, equipment, motors, and bearings operated during construction up to date of substantial completion.

J. Cover open ends of exhaust and return ducts with temporary filter media while fan systems are operating.

K. Material, equipment or apparatus damaged because of improper storage or protection will be rejected.

1. Remove from site and provide new, duplicate, material, equipment or apparatus in replacement of that rejected.
2. Any porous materials, such as duct liner, insulation or flexible ductwork that becomes wet; for example, due to rain shall be replaced; drying is not sufficient (due to possible microbial contamination).

L. Perform Work in manner precluding unnecessary fire hazard.

3.4 ADJUSTMENT

A. Preliminary Operation.

1. Operate any portion of installation for Owner’s convenience if so requested by Architect. Such operation does not constitute acceptance of Work as complete but does constitute beneficial use. Cost of utilities, such as gas and electrical power, will be borne by the Owner if operation is requested by Owner.

B. Noise.

1. Cooperate in reducing any objectionable noise or vibration caused by mechanical systems to the extent of adjustments to specified and installed equipment and appurtenances.

2. Completely correct noise problems caused by failure to make installation in accordance with Contract Documents, including labor and materials required as a result of such failure, at no additional cost to the Owner.

3.5 SPECIAL TOOLS

A. Furnish to Owner at completion of work.

1. One set of any special tools required to operate, adjust, dismantle, or repair equipment furnished under any section of this Division.

3.6 CLEANING

A. Cleaning.

1. See Division 01 – General Requirements.

B. Thoroughly clean equipment, fans, pumps, motors, piping and other materials under this Division free from all rust, scale and all other dirt before any covering or painting is done, or the systems put in operation; leave in condition satisfactory to Architect.

C. At all times keep the premises free from accumulation of waste material and debris caused by his employees. At the completion of the Project, and at other times as Architect may direct, remove refuse from within and around the building. All tools, scaffolding and surplus materials shall also be removed, leaving the Site of his Work clean.

D. Completely cover all plumbing fixtures and all motors and other moving machinery to prevent entry of dirt and water during construction.

E. Effectively cap all openings into ducts and pipes to keep moisture and foreign matter out during construction.

F. Clean and polish identification plates.

G. Clean equipment, ductwork, insulation, piping, conduit, and room surfaces of dust and dirt and maintain in a clean condition from date of substantial completion until final completion of work and corrective work.

3.7 PAINTING

A. Painting.

1. Piping exposed to outdoors and, where indicated elsewhere.

a. One coat primer.
b. Two coat alkyd oil paint, UV resistant for PVC piping, color as indicated.
c. Not required for copper, galvanized steel, or insulated piping.
d. New and existing gas piping outdoors shall be cleaned, primed, and painted.

2. Steel hangers and supports exposed to outdoors.

    a. One coat primer.
    b. Not required for galvanized steel.

3. Interior of ductwork and duct accessories, including insulation stick pins, at air outlets as far back as visible from occupied spaces.

    a. Flat black.

4. Marred surfaces of factory painted equipment.

    a. Spot coat to match adjacent coat.

5. Insulation exposed to sunlight:
6. Piping and ductwork exposed to view indoors and not in equipment closet.

B. Execution.

1. Protect flooring and equipment with drop cloths.
2. Paint and materials stored in location where directed.
3. Oily rags and waste removed from building every night.
4. Wire brush and clean off all oil, dirt and grease areas to be painted before paint is applied.
5. Workmanship.

    a. No painting or finishing shall be done with:

        1) Dust laden air.
        2) Unsuitable weather conditions.
        3) Space temperature below 60 deg. F.

    b. Pipes painted containing no heat and remain cold until paint is dried.
    c. Paint spread with uniform and proper film thickness showing no runs, sags, crawls or other defects.
    d. Finished surfaces shall be uniform in sheen, color and texture.
    e. All coats thoroughly dry before succeeding coats are applied, minimum 24 hours between coats.
    f. Priming undercoat of slightly different color for inspection purposes.

6. Piping continuously painted in all exposed areas.

C. Paint.

1. High gloss medium or long alkyd paint.
2. Best grade for its purpose.
3. Deliver in original sealed containers.
4. Apply in accordance with manufacturer’s instructions.

D. Colors.

1. Colors as directed by Architect unless specified herein.
2. Interior of ductwork as far back as visible from outside: flat black.
3. Uncoated hangers, supports, rods and insets: dip in zinc chromate primer.

E. Factory Finish.

1. Ceiling and wall mounted air outlets in acoustical tile ceilings: Baked white enamel.
2. Aluminum air outlets that are not to be painted: anodized.
3. Exposed fan coil units: baked enamel.
4. Unit ventilators and unit heaters: baked enamel.
5. Fans, pumps, compressors, tanks and like items.
6. Air handlers, pumps, water heaters and like items where exposed.

F. Marred surfaces of prime coated equipment and piping: spot prime coat to match adjacent coat.

G. Properly prepare Work under this Division to be finish painted under Division 09 – Painting.

H. Provide moisture resistant paint for exterior painting and heat resisting paint for hot piping, equipment and materials.

I. For the following, provide factory prime coat. Also, provide factory finish painting on each if not specified in Painting Division.

1. Other air outlets.

J. Paint all equipment out-of-doors and equipment supports with two coats of weather resistant enamel.

K. Protect all finished surfaces of fixtures with heavy paper pasted thereon, or by other means, throughout the period of construction.

L. Refinish Work supplied with final finish under this Division if damaged under this Division to satisfaction of Architect.

3.8 FIELD QUALITY CONTROL

A. See Division 01 – General Requirements (Quality Control).

B. Tests.

1. Perform as specified in individual sections and as required by authorities having jurisdiction.
2. Duration as noted.

C. Provide required labor, material, equipment and connections.

D. Furnish written report and certification that tests have been satisfactorily completed.

E. Repair or replace defective work, as directed by Architect in writing, at no additional cost to the Owner.

F. Restore or replace damaged work due to tests as directed by Architect in writing, at no additional cost to the Owner.

G. Restore or replace damaged work of others, due to tests, as directed by Architect in writing, at no additional cost to the Owner.

H. Remedial work shall be performed to the satisfaction of the Architect, at no additional cost to the Owner, including:

1. Work related to all Division 23 – Mechanical tests.
2. Division 23 – Mechanical work related to Section 230593 – Testing, Adjusting and Balancing for HVAC.

I. Remedial work shall include performing any tests related to remedial work and additional time at no additional cost to the Owner.

3.9 EXISTING EQUIPMENT AND SYSTEMS

A. Owner has first right of refusal of all existing equipment and components indicated to be removed.

B. Material and equipment which has been removed and not accepted by the Owner shall become the property of the Contractor and shall be removed from the site.

C. Material and equipment which has been removed shall not be used in the new work, except as specified herein.

D. Where existing piping, ductwork and equipment is indicated on the Drawings, its size and location shall be verified.

3.10 EQUIPMENT AND INSTALLATION REQUIREMENTS

A. Air systems shall operate without aerodynamic noise generated from the faulty installation of ductwork or any component of the air distribution system.

B. Equipment shall be installed and connected as specified herein or indicated on the Drawings in accordance with the manufacturers' instructions and recommendations for this Project. Furnish and install auxiliary piping, water seals, valves, and electrical connections recommended by the manufacturer for operation.

C. Provide roughing, fittings, accessories, and connecting piping, and make final connections to all equipment. Coordinate carefully with equipment vendor prior to starting rough-in work.

D. In unfinished areas designated for future build-out, install piping, ductwork, conduit and equipment tight against the structure to maximize future ceiling height.

E. Motor quantities, sizes and equipment wattage ratings specified herein or indicated on the Drawings are the minimum requirements, unless noted otherwise. Motor quantities, sizes and equipment wattage ratings less than those specified herein or indicated on the Drawings are not acceptable. Larger motor sizes and equipment wattage ratings may only be provided if

necessary, to meet the prescriptive requirements specified herein or indicated on the Drawings. Where multiple motors or motor sizes or equipment wattage ratings larger than specified herein or indicated on the Drawings are furnished, provide and coordinate the corresponding increased number or capacity of feeders and other electrical equipment serving them, at no additional cost to the Owner.

F. Field-installed equipment controls, or sensor wiring shall be installed in conduit. Low voltage control and sensor wiring shall be installed in conduits separate from line voltage control wiring and power wiring.

G. Where water connection sizes at equipment vary from the pipe size indicated on the Drawings, provide appropriate reducers/increasers directly adjacent to the pipe-equipment unions. Unless otherwise specified herein or indicated on the Drawings, the size of the valves and accessories dedicated to the equipment shall not be less than the pipe size to which they are connected.

H. Install all work so that parts requiring periodic inspection, operation, maintenance and repair are readily accessible and with the manufacturer's minimum required clearances provided. Minor deviations from the drawings may be made to accomplish this, but changes of substantial magnitude shall not be made without written approval.

1. Group concealed valves, controls and equipment requiring access, so as to be freely accessible through access doors.

3.11 EXCAVATION AND BACKFILLING

A. In accordance with the requirements of Division 31 – Earthwork for excavating, trenching, and backfilling.

B. Provide barricades, signs, lanterns, shoring, sheeting and pumping as part of Work in this Division as required to ensure safe conditions. Comply with OSHA requirements.

C. Dig trenches straight, true to line and grade with sides and bottoms smoothed of any rock points.

1. Excavate 6 inches below grade of pipe.
2. Fill with sand properly packed.
3. Support pipe for entire length on packed sand.
4. Shape or pack bottom of trenches for pipe, duct fittings, hubs, couplings, etc., using templates to fit outside periphery of lower third of piping and ductwork.
5. Provide piping outside building with 36-inch minimum cover from top of pipe to finished grade.
6. Minimum width 16 inches.

D. Dispose of all surplus excavation material and seepage water as directed by the Architect.

E. Backfill.

1. After piping has been installed, tested and approved, backfill all excavation, tamp and compact by motor powered or compressed air tampers.

2. Backfill to 6-inches above crown of pipe with unwashed sand, with remainder of trench back-filled and mechanically tamped in 6-inch maximum layers of selected excavated materials, free from organic matter, rocks, etc. Provide 90-percent compaction in accordance with ASTM D 1557-58T; 95-percent compaction for trenches below building slabs.

F. In any asphalt or concrete paved areas, backfill only to subgrade level.

G. When piping is installed, prior to backfilling, advise Architect; do not backfill without acceptances of Architect.

H. Replace to original condition all paving, curbs, gutters, walks, etc., which become disturbed by trenching.

I. Compact finished soil at trenching and install new sod to match adjacent grass. Water fill SOD takes hold.

3.12 MAINTENANCE

A. Equipment operated prior to the date of substantial completion shall be maintained in accordance with manufacturer's recommendations. In addition, provide complete water treatment for hydronic and steam systems operated prior to date of substantial completion.

END OF SECTION 230010

SECTION 230020 - MECHANICAL CLOSE-OUT 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. Summary Includes

1. As-Built Drawings.
2. Maintenance manuals for the care and maintenance of systems and equipment.
3. Closeout Documentation Checklists.

B. Related Sections:

1. Section 230010 – Mechanical General Provisions.
2. Section 230030 – Demonstration and Training for Mechanical Systems.

1.3 SUBMITTALS

A. See Section 230010 – Mechanical General Provisions.

B. Initial Submittal: Submit draft copy of each manual a minimum of 60 days prior to requesting Substantial Completion inspection. Include a complete operations and maintenance directory. Architect will return draft copy and mark whether general scope and content of manuals are acceptable.

C. Submit manuals according to the following table.

1. “R” means required.

Item	Product Data	O&M Manual	Samples	Shop Drawing
As-Built drawings		R		
Operation and Maintenance Manuals		R		
Closeout Documentation Checklists		R		

PART 2 - PRODUCTS

2.1 AS-BUILT DRAWINGS

A. Maintain at job site a set of contract record documents kept current by indicating thereon all changes, substitutions, etc., between work as specified and as installed.

B. Show on record documents actual air quantities, water flow rates, valve or damper positions after balancing, etc.; also show, by actual dimension, location of all new and known existing underground work.

C. At the completion of the project, furnish the Owner three sets of drawings and three complete, clean sets of specifications showing installed location, size, etc., of all work and material as taken from record documents. All as-built (on record) drawings shall be labeled “As-Built Drawings,” dated and certified accurate by Contractor with his signature, on front page of all Drawing sets and Specifications.

2.2 OPERATION AND MAINTENANCE MANUALS

A. These operation and maintenance manual requirements supplement operation and maintenance manual documentation requirements of other Sections of these specifications.

B. Operation and maintenance documentation, in hardback 3-ring loose-leaf binders except full size drawings and CDs, shall cover the HVAC and building automation systems. Documentation shall include an operations and maintenance documentation directory, emergency information, operating manual, maintenance manual, test reports, and construction documents.

C. Initial Submittal: The operation and maintenance documentation package shall be submitted as one comprehensive package to the Owner 1 month before systems start-up, and shall be updated, revised and completed at completion of construction.

D. Final Submittal: Provide four (4) complete manuals.

1. Correct or modify each manual to comply with Architect’s comments. Submit Final manuals shall be submitted 15 working days prior to demonstration and training of Owner’s personnel. Manuals are to be used in training sessions by Owner’s personnel.

E. Compile and coordinate the documentation for equipment and systems installed. Unless otherwise indicated, organize each manual into a separate section for each system and subsystem and a separate section for each piece of equipment not part of a system. Documentation shall be typewritten and shall contain, at a minimum, the following information.

1. Introduction:

a. Project name, contractors' and subcontractors' names, addresses, telephone numbers, email addresses and facsimile numbers. Indicate the portion of the work for which each subcontractor was responsible.
b. List of Documents.
c. List of systems.
d. List of equipment.

e. Table of Contents.

2. Operations and Maintenance Documentation Directory:

   a. Explanation of the identification system used, including lists of systems, equipment, and component identifiers and names. Use the same system, subsystem and equipment designation as used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, “Preparation of Operating and Maintenance Documentation for Building Systems.”

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

   a. Title page.
   b. Warranty Page
   c. Table of contents.
   d. Manual contents.

4. Manual Title Page: Enclose title page in transparent plastic sleeve. Include the following information:

   a. Project name, contractors' and subcontractors' names, addresses, telephone numbers, email addresses and facsimile numbers. Indicate the portion of the work for which each subcontractor was responsible.
   b. Subject matter included in manual.
   c. Name and address of Project.
   d. Name and address of Owner.
   e. Date of submittal.
   f. Name, address, telephone number, fax number and email address of Contractor.
   g. Name and address of Architect and other Architects.
   h. Cross-reference to related systems in other operation and maintenance manuals.

5. Warranty Page

   a. Provide table as shown at end of section. Table to be on separate page in O&M. Three copies of table to be laminated and turned over to owner. All products to be listed in table.

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

   a. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table for all volumes in each volume of the set.

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

a. Binders: Heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2 x 11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.

    1) If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary, to provide essential information for proper operation or maintenance of equipment or system.
    2) Identify each binder on front and spine, with printed title “OPERATION AND MAINTNANCE MANUAL,” Project title or name, project number and subject matter contents. Indicate volume number for multiple-volume sets and six-digit Section number on bottom of spine.

b. Dividers: Heavy-paper dividers with plastic-covered tabs for each section. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the system on each divider, cross-referenced to Specification Section number and title of Project Manual.
c. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software diskettes for computerized electronic equipment.
d. Supplementary Text: Prepared on 8-1/2 x 11-inch, “20-lb” white bond paper.
e. Drawings: Attached reinforced, punched binder tabs on drawings and bind with text.

    1) If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
    2) If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual or reduced drawings. DO NOT USE BINDER POCKETS. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents and drawing locations.

f. Provide color photographs instead of drawings where necessary to demonstrate unusual or complex installations.

8. Emergency Information:

    a. Information for technical and nontechnical personnel about actions recommended during emergency situations to protect life and property and to minimize disruption to the building occupants. Emergencies shall, at a minimum, include:

        1) Fire.
        2) Security breach.
        3) Water outage.
        4) Power failure.
        5) Refrigerant release.
        6) Heating failure.
        7) Cooling failure.

2.3 SYSTEMS AND EQUIPMENT MAINTENANCE MANUAL

A. Content: For each system, subsystem and piece of equipment not part of a system, include source information, product information, maintenance procedures, repair materials, warranty information and bond information as described below.

B. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address and telephone number of Installer or supplier and maintenance service agent. Cross-reference Specification Section number and title in Project Manual.

C. Manufacturer's Maintenance Documentation: Manufacturer's maintenance documentation including the following information for each component part or piece of equipment:

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

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

1. Test and inspection instructions.
2. Troubleshooting guide.
3. Precautions against improper maintenance.
4. Disassembly: component removal, repair and replacement and reassembly Instructions.
5. Aligning, adjusting and checking instructions.
6. Manufacturer's demonstration and training videotape or DVD, if available.

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

1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual and annual frequencies.
2. Maintenance and Service Record: Include manufacturer's forms for recording maintenance.

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

G. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.

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

1. Include procedures to follow and required notifications for warranty claims.
2. Include all model, serial numbers and information required on table at end of section. Table is available in Excel upon request from Professional.

NOTE: Where manuals contain manufacturer's standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data includes more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.

2.4 CLOSEOUT DOCUMENTATION

A. Seven days prior to requesting a final inspection, the Contractor shall submit all O&M and closeout documentation to the Architect, to be submitted to the Owner at the end of the project.

B. The checklist herein shall be utilized for compiling documentation and shall be included behind front cover of O&M manuals.

C. Contractor shall initial and date each line item once completed and shall email a copy of the completed checklist to the Architect prior to final inspection request.

PART 3 - EXECUTION

3.1 MANUAL PREPARATION

A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals.

B. Assemble a complete set of the following manuals indicating procedures for each.

1. Operations and maintenance manual.

C. Manufacturer's Data: When manuals contain manufacturer's standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data includes more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.

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

D. Drawings: Prepare drawings supplementing manufacturer's printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequences and flow diagrams. Coordinate these drawings with information contained in Record Drawings to ensure correct illustration of completed installation. Do not use original Project Record Drawings.

1. Do not use original Project Record Drawings as part of operation and maintenance manuals.

3.2 CLOSEOUT DOCUMENTATION CHECKLIST

A. Closeout Documentation Checklists included:

1. Division 21 – Fire Protection.
2. Division 22 – Plumbing.
3. Division 23 – HVAC.

B. Warranty Documentation Format:

1. See Example

CLOSEOUT DOCUMENTATION CHECKLIST DIVISION 21 – FIRE PROTECTION		
Project Name:		
Initials of person completing task	Date task completed	Description of Contractor's Submittal
		Signed Letter Record of Owners Personnel O & M Training.
		DVD Record of Owners Personnel O & M Training (3 each).
		Pipe pressure test log. Pipe pressure tests per NFPA 13.
		Provide copy of Installation and Material Certificate per NFPA 13.
		As-Built Drawings with Contractor's Stamp

CLOSEOUT DOCUMENTATION CHECKLIST DIVISION 22 – PLUMBING		
Project Name:		
Initials of person completing task	Date task completed	Description of Contractor's Submittal
		Signed Letter Record of Owners Personnel O & M Training.
		DVD Record of Owners Personnel O & M Training (3 each).
		Operation & Maintenance Manuals.
		As-Built Drawings with Contractor's Stamp.
		Warranty Information.
		Potable Water Sanitation Report and Certification.
		Pipe pressure test log. (Gas)

CLOSEOUT DOCUMENTATION CHECKLIST DIVISION 23 – HVAC		
Project Name:		
Initials of person completing task	Date task completed	Description of Contractor's Submittal
		Final TAB Report
		Signed Letter Record of Owners Personnel O & M Training.
		DVD Record of Owners Personnel O & M Training (3 each).
		Operation & Maintenance Manuals.
		As-Built Drawings with Contractor's Stamp.
		Warranty Information.
		Provide list of all spare air filter sets. List number, size, type and location/equipment match-up.

PROJECT NAME									
Equipment Tag	Manufacturer	Model Number	Serial Number	Maufacturer Warranty Description	Start Date	End Date	Contact Information		Remarks
							Name	Phone Number	
RTU-1	NAME OF MANUFACTUER	ABC1234	ABC1234	1-year Parts Only	1/1/2020	1/1/2021	John Doe (Company)	(xxx) xxx-xxxx	
				5-year Compressor Parts Only	1/1/2020	1/1/2021	John Doe (Company)	(xxx) xxx-xxxx	
VAV Terminal Units	NAME OF MANUFACTUER	ABC1234	ABC1234	1-year Parts Only	1/1/2020	1/1/2021	John Doe (Company)	(xxx) xxx-xxxx	
EF-1	NAME OF MANUFACTUER	ABC1234	ABC1234	1-year Parts Only	1/1/2020	1/1/2021	John Doe (Company)	(xxx) xxx-xxxx	
EWH-1	NAME OF MANUFACTUER	ABC1234	ABC1234	5-year Heating Element	1/1/2020	1/1/2025	John Doe (Company)	(xxx) xxx-xxxx	
				10-year Tank	1/1/2020	1/1/2030	John Doe (Company)	(xxx) xxx-xxxx	
ODU-1	NAME OF MANUFACTUER	ABC1234	ABC1234	10-year Parts Only	1/1/2020	1/1/2030	John Doe (Company)	(xxx) xxx-xxxx	
IDU-1.01	NAME OF MANUFACTUER	ABC1234	ABC1234	10-year Parts Only	1/1/2020	1/1/2021	John Doe (Company)	(xxx) xxx-xxxx	
VRF Equipment	NAME OF MANUFACTUER	N/A	N/A	10-year Parts Only	1/1/2020	1/1/2030	John Doe (Company)	(xxx) xxx-xxxx	Includes central controller and thermostats
				2-year Labor	1/1/2020	1/1/2022	John Doe (Company)	(xxx) xxx-xxxx	Includes refrigerant and programming
HVAC Controls Actuators	NAME OF MANUFACTUER	N/A	N/A	5-year Parts Only	1/1/2020	1/1/2025	John Doe (Company)	(xxx) xxx-xxxx	

<CONTRACTOR NAME HERE> warranties and guarantees all materials, equipment and workmanship provided by our company relating to the HVAC system and Plumbing for the above referenced project.

If any parts or materials supplied by our company prove defective, we will repair or replace such items as necessary without expense to the Owner, including costs of services, materials, transportation, parts and labor.

This warranty period begins on <INSERT SUBSTANTIAL SUBMITTAL DATE> and shall run for one year from that date.

Any questions relating to warranty should be directed to our home office at <INSERT PHONE NUMBER>.

END OF SECTION 230020

SECTION 230500 - BASIC MECHANICAL MATERIALS AND METHODS

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. Administrative and Procedural requirements for preparing operation and maintenance manuals, including the following:

1. Temporary operation of mechanical equipment.
2. Wall and ceiling access panels.
3. Roof penetrations.
4. Fire, smoke, and sound stopping.
5. Pipe Sleeves.
6. Escutcheons.
7. Dielectric Fittings.
8. Protective drip pans.

B. Related Sections:

1. Section 230010 – Mechanical General Provisions.

1.3 SUBMITTALS

A. See Section 230010 – Mechanical General Provisions.

B. Submit product data, O&M data, and samples and show item on shop drawings (where shop drawings are required) according to the following table.

1. “R” means required.
2. “R2” means required only for products and equipment differing for the specified manufacturer and model and for “or equals” where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawings
Wall and ceiling access panels	R			R
Roof penetration provisions/flashing	R			R
Fire-stopping	R			R
Pipe sleeves	R			R
Escutcheons	R			

1.4 QUALITY ASSURANCE

A. Equipment Selection: Equipment of higher electrical characteristics, physical dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing and connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are increased. Additional costs shall be paid by this Contractor for these increases. If minimum energy ratings or efficiencies of equipment are specified, equipment must minimum requirements.

1.5 TEMPORARY ENVIRONMENTAL CONDITIONING

A. If the Contractor requires temporary heating, cooling, and dehumidification capability prior to the permanent building HVAC system being ready for operation, it shall be the Contractor's responsibly to provide and maintain in working condition the HVAC equipment and system components necessary to meet the recommended indoor environmental conditions. All cost associated with these temporary HVAC systems shall be the Contractor's responsibility and included in their bid.

B. Additionally, if the contractor requires temporary heating, cooling, and dehumidification capability prior to the Architect approving the use of the building mechanical systems, the Contractor shall be responsible for providing and maintaining temporary HVAC systems. All cost associated with these temporary HVAC systems shall be the Contractor's responsibility and included in their bid.

1. See minimum building condition requirements herein for operation of building mechanical equipment and systems.
2. Temporary HVAC systems and controls shall be capable of providing the recommended indoor environmental conditions.

1.6 OPERATION OF BUILDING MECHANICAL EQUIPMENT AND SYSTEMS

A. Temporary operation of the building mechanical equipment and systems shall be provided for this project beginning a minimum of 30 days (or as approved by Architect) prior to the scheduled substantial completion date and maintained until the Owner's final acceptance of the project, or any phase thereof. The beginning of this temporary HVAC period is intended to align with general industry standard construction practice of providing a minimum suitable indoor environment for the installation and curing of millwork, adhesives, finishes, wall covering(s), tile ceiling/floors, etc. This interior space conditioning includes all areas of the project where the space will be similarly conditioned with heating, cooling, and/or dehumidification capability after the project or any portion/phase thereof is completed.

B. Temporary Operation of Building Mechanical Equipment and Systems Procedure:

1. The Contractor shall notify the Architect in writing fourteen (14) days in advance to request temporary operation of the building permanent HVAC systems.
2. The Architect will schedule a site-visit to observe the site conditions to ensure all the items described below have been met prior to temporary operation.
3. The Contractor shall submit in writing an operation and maintenance plan for temporary use of the building HVAC systems. At a minimum the O&M plan shall address:

a. Equipment, system, and air filter maintenance.
b. Temporary filter efficiency and installation locations.
c. Daily, weekly, monthly, etc. cleaning procedures to ensure indoor cleanliness.
d. Describe in detail how the system will be controlled, and indoor conditions monitored. Procedures for shutting down equipment or isolation of areas where dust, dirt, or particulate producing activities occur.

4. At a minimum the following building components and activities shall be completed prior to operation of the building HVAC systems:

a. Dust or particulate generating construction activities completed.
b. All dirt, dust, and debris have been removed from the building areas being served.
c. Duct and cooling water piping insulation is fully completed and all seams, openings, etc. have been sealed.
d. All HVAC system equipment utilized for temporary heating and cooling shall have been started up per specifications. All manufacturer's authorized representative startup and warranty information (including checklists) shall be completed and submitted to the Architect.
e. All temporary air filters in place of types and installed in locations specified in 234000 "Air Cleaning Devices." All return air and exhaust air distribution devices and openings shall be covered and protected with filter material specified in 234000 "Air Cleaning Devices." All temporary filters shall be continually monitored and replaced periodically when required.

5. Upon completion of the Architect's site visit, review of site conditions and temporary operation plan, the Architect reserves the right to refuse temporary startup and operation if site conditions and plan do not meet specifications. No additional time will be given to the Contractor due to unapproved startup and temporary operation conditions.
6. Additionally, the Architect reserves the right to order the building HVAC systems shut down if the building condition or indoor environmental conditions are not maintained and found to be unacceptable.

C. Contractor shall have either specified or temporary controls in place and fully operational to maintain the specified equipment availability above. Contractor shall provide all required temporary building services for temporary operation at no additional cost to the Owner. The cost of utilities to provide this availability and use shall be by this Contractor.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work includes but are not limited to the following listed in this specification.

B. Wall and ceiling access doors.

1. Acudor.

2. Williams Brothers.
3. J.R. Smith.
4. Or equal.

C. Roof penetrations.

1. Custom Curb, Inc.
2. Plenums.
3. Thybar.
4. Or equal.

2.2 WALL AND CEILING ACCESS DOORS

A. Access panels shall be provided for all concealed valves, controls, dampers, and other mechanical equipment and devices where occasional access for adjustment or repairs will be necessary. Panels shall have cam and cylinder lock with two keys. All locks shall be keyed alike. Label panels as in accordance with Section 230553 – Mechanical Identification.

B. Size of panels to be large enough to permit servicing or replacement of devices, controls, valves, etc.; minimum size to be 18"x18". Submit schedule with submittal package indicating location and size.

C. General.

1. Fabricate units of all welded steel construction.
2. The frame and panel assembly for fire rated access panels shall be manufactured under the Factory Inspection Service of Underwriters Laboratories, Inc., and shall bear a label reading: "Frame and Fire Door Assembly, Rating 1-1/2 Hr. (B), Temperature Rise 30 Minutes, 250ºF, Maximum".
3. Access panels used in toilets, kitchens, and other areas expected to experience high relative humidity are to be constructed of stainless steel.

D. Flush Panel Access Panels: Model WB-GP.

1. Frame and door shall be of one-piece unit body construction and 14-gauge steel. Body shall be 18-gauge steel with a return edge around door opening.
2. Flange shall be 1-3/4” wide.
3. Hinges shall be concealed, piano type, opening to 175 degrees. Number of hinges will vary with size of door.
4. Locks shall be flush, key operated cylinder lock. Number of locks will vary with size of door.
5. Finishes shall be factory applied with a rust inhibiting phosphated undercoat; finish to be chemically bonded oven baked white enamel.
6. For installation in masonry openings, units shall be furnished with flexible metal anchor straps welded to the body.

E. Flush Access Panel for Drywall or Plaster: Model WB-DW and WB-PL.

1. Body and flange shall be 16-gauge steel. Door shall be 14-gauge steel.

2. Hinges shall be concealed, piano type, opening to 175 degrees. Number of hinges will vary with size of door.
3. Locks shall be flush, key operated cylinder lock. Number of locks will vary with size of door.
4. Finish shall be factory applied oven baked grey enamel with rust inhibiting phosphated undercoat.
5. Plaster models shall have 2-1/2” of 24 gauge galvanized expanded wing casting surrounding door.
6. Drywall models shall have a 1-1/8” perforated drywall bead on all four sides.

F. Fire Rated “B” Label Access Panel: Model WB-FR.

1. Frame and door shall be of one-piece unit body construction and 14-gauge steel. Door shall be sandwich type filled with 2" thick thermafiber felt insulation and back enclosure of 22-gauge steel. Body shall be 16-gauge steel.
2. Flange shall be 1-3/4” wide.
3. Hinge shall be continuous steel piano type mounted on long side of doors, opening to 180 degrees and equipped with a spring mechanism for automatic closure.
4. Lock assembly shall be self-latching with key operated cylinder lock and shall have a mechanism to release the latch bolt from the inside.
5. Finish shall be factory applied oven baked grey enamel with rust inhibiting phosphated undercoat.
6. For installation in masonry openings, units may be furnished with flexible metal anchor straps welded to the body.

2.3 ROOF PENETRATIONS

A. Contractor shall provide all thru roof boots and supports required for roof penetrations and equipment installation; the Contractor shall install and flash. These penetrations shall be approved by the roofing manufacturer.

B. Flashing collars and caps shall be minimum of 18-gauge galvalume steel construction. Equipment supports shall span a minimum of two joists. No load shall be applied to a cantilever section exceeding 1'-0" in length.

C. All Flues shall extend a minimum of 36" high (shall be higher if required such that top of curbs are minimum 8" above highest nearby roof surface). It shall be the Contractor’s responsibility to coordinate the opening and/or support height with roof construction and provide minimum 15' spacing between combustion air intake and exhaust/flue outlets.

D. All exposed roof metal and plastic penetrations, equipment supports, and flashing shall be field painted to match roof color. Coordinate color with Architect.

E. Installation shall be in strict accordance with manufacturer’s printed instructions and as detailed on drawings and applicable codes.

2.4 FIRE, SMOKE, AND SOUND STOPPING

A. All fire, and sound stopping to be done by Contractor as approved by Architect.

B. All pipe, duct, and flue penetrations between apartments and attic, horizontally or vertically, shall be neatly fire-stopped and be neatly flashed with metal or escutcheons

2.5 PIPE SLEEVES

A. Pipe Sleeves.

1. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
2. PVC Pipe Sleeves: Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
3. Galvanized-Steel Sheet Metal Sleeves: Galvanized sheet metal sleeves with lock seam joints and comply with the following minimum thickness:

    a. 24 gauge for 3 inches and smaller.
    b. 22 gauge for 4 inches to 6 inches inclusive.
    c. 20 gauge for sizes over 6 inches.

2.6 ESCUTCHEONS (WALL, FLOOR, AND CEILING PLATES)

A. Description.

1. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener in exposed applications.
2. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
3. Split-Casting Brass Type: With polished, chrome-plated rough-brass finish and with concealed hinge and setscrew in exposed applications.
4. Escutcheon thickness: For wall and ceiling plates, not less than 0.025-inches for up to 3-inch pipe and 0.035-inches for larger pipe.
5. Escutcheon thickness: For floor plates, not less than 0.094-inches.

2.7 DIELECTRIC FITTINGS

A. Provide where copper and ferrous metal are joined.

1. 2 inch and less: Threaded dielectric union.
2. 2-1/2 inch and larger: Flange union with dielectric gasket and bolt sleeves.
3. Temperature Rating: 210 ˚F for water systems.

2.8 PROTECTIVE DRAIN PANS/CONDENSATE OVERFLOW PROVISIONS

A. Required at following locations:

1. Furnace-coil units with cooling located in closets in up-flow configuration, provide upper evaporator coil drain pan sensor to detect and automatically deenergize equipment if main drain outlet failed.

    a. Size to capture any overflow from unit condensate drain pan.

b. Size to capture any overflow from unit and extended to capture drips from valves, strainers, and unions. Pipe drain to nearby floor receptor.

2. Water heaters:

a. Tank or tankless type

B. Construction/drains:

1. Fabricate pans for tank type water heaters of 20-gauge galvanized sheet metal or aluminum, minimum two inches deep with rolled top edges.
2. Solder all seams watertight, and cross brace pans to prevent sagging and warping.
3. Provide dielectric union at copper pipe/galvanized pan connection point. Water heater and smaller drain pans shall have minimum one inch (1 inch) drain outlet routed to an approved location.
4. Drip pans under tankless water heaters shall be 20-gauge metal or 16-gauge PVC.
5. Provide 1" outlet drain and route to nearby suitable receptor.

PART 3 - EXECUTION

3.1 WALL AND CEILING ACCESS PANEL

A. Coordinate size requirements and exact location with Contractor who will install access doors.

B. Minimum Sizes: 18 inches by 18 inches unless otherwise shown on Drawings or approved by Architect.

C. Provide where shown or required for access of all concealed equipment such as terminal units, valves, fire/smoke dampers, etc., for Mechanical Work. Where ceiling is constructed with removable tiles or sections, access panels are not required.

1. Equipment shall be located wherever practical over accessible ceilings or rooms to avoid access doors.
2. Access doors shall not be used solely for access to balancing dampers; use instead remote control, devices specified under Section 233300 – Air Duct Accessories.

D. Contractor shall provide substantial metal angle frame and support at all ceiling access panels.

3.2 ROOF PENETRATIONS

A. All roof penetrations shall be furnished with a roof boot compatible with both the duct/pipe/flue configuration and roofing system. Plumbing vents shall extend minimum 8" above roof. Combustion air inlets shall extend minimum 18" above finished roof with gooseneck duct arrangement with neat ¼" opening galvanized hardware cloth.

B. Provide auxiliary steel support under all roof penetrations and at all ductwork penetrations as approved by Architect.

3.3 FIRE, SMOKE, AND SOUND STOPPING

A. Fire and smoke stopping shall be provided and installed at all locations where new and existing mechanical work passes through rated assemblies. This includes all ductwork, piping, and controls related conduit.

3.4 PIPE SLEEVES AND SLEEVE SEALS

A. Install sleeves for pipes passing through exterior walls, concrete beams, foundations, footings, floors and roof decks.

1. Cut sleeves to length for mounting flush with both surfaces.

    a. Exceptions:

        1) In areas where pipes are exposed, extend sleeves 1/4-inch above finished floor.
        2) Extend sleeves installed in floors of mechanical equipment areas or other wet areas (kitchens, toilets, etc.) 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Build sleeves into new walls, beams, foundations, footings, floors, roof decks and slabs as work progresses.
3. Install sleeves large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Pipe shall be capable of free movement within the sleeve.
4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using elastomeric joint sealants. Contractor shall coordinate specific sealing requirements to ensure fire, smoke or sound ratings are maintained through pipe penetration/sleeve assembly.

    a. Use Type S, Grade NS, Class 25, Use O, neutral-curing silicone sealant, unless otherwise indicated.

B. Interior wall pipe penetrations.

1. Galvanized-steel sheet metal sleeves.
2. Interior openings shall be caulked tight with fire, smoke or sound stopping material and sealant to prevent the spread of fire, smoke, and sound. Contractor shall coordinate specific requirements to ensure fire, smoke or sound ratings are maintained.

C. Above grade exterior wall, concrete beams, foundations, footings, waterproofed floors and where sleeve is extended above finished floor pipe penetrations: Seal penetrations using silicone sealant specified above.

1. Install galvanized steel or Schedule 40 PVC pipe sleeve.

D. Below grade exterior wall pipe penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeve for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Install galvanized steel or Schedule 40 PVC pipe sleeve.
2. Assemble and install mechanical sleeve seals according to manufacturer's written instructions. Tighten bolts that cause rubber sealing elements to expand and make watertight seal.

E. Sleeves that extend into return air plenums shall be of non-combustible material, either galvanized steel or Schedule 40 steel pipe sleeves.

F. For drilled penetrations in existing floors provide one-inch angle ring flange set in silicone sealant and bolted to the floor in lieu of pipe sleeves with one-inch extension above floor.

3.5 ESCUTCHEONS

A. Install pipe escutcheons for exposed pipe penetrations of concrete and masonry walls, wall board partitions, suspended ceilings, etc.

B. Inside diameter shall fit around insulation or around pipe when not insulated; outside diameter shall cover sleeve and penetration.

C. Use plates that fit tight around insulation or pipes when not insulated.

D. Plates shall cover openings around pipes/insulation and cover the entire pipe sleeve projection. Use deep pattern escutcheons where required to completely conceal protruding fittings and sleeves.

3.6 DIELECTRIC FITTINGS

A. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.

B. Wet Piping Systems: Install dielectric coupling, unions, and nipple fittings to connect piping materials of dissimilar metals.

3.7 PROTECTIVE DRAIN PANS

A. Route drain 1-inch or larger copper or CPVC piping to the nearest available open drain or outside as directed by Professional. Separate unit drain and drain pan unless otherwise indicated.

3.8 GROUTING

A. Provide neat fixture color coordinated grout at base of all floor mounted water closets after shims have been installed to stabilize fixtures.

3.9 CUTTING AND PATCHING

A. Do not cut into any major structural element without written approval of the Architect.

B. Cut required openings through existing masonry or reinforced concrete with diamond core drills. Use of pneumatic hammer type drills, impact type electric drills, and hand or manual hammer type drills, will be permitted only with approval of the Architect. Locate openings that will least affect structural slabs, columns, ribs or beams. Refer to the Architect for determination of proper design for openings through structural sections and opening layouts for approval prior to cutting or drilling into structure. After Architect's approval, carefully cut openings through construction no larger than absolutely necessary for the required installation.

C. Patching:

1. Shall be of quality and appearance matching the existing construction.
2. Contractor shall restore all services and construction that remains in use, to its condition prior to Work performed as part of this contract.

END OF SECTION 230500

SECTION 230523 - VALVES

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. Work Included in This Section: Materials, equipment, fabrication, installation and tests in conformity with applicable codes and authorities having jurisdiction for the following:

1. Service valves and plumbing systems (other than gas and fire sprinkler).
2. Check valves.
3. Safety and relief valves.
4. Vent and gas cocks.
5. Miscellaneous valves.

B. Related Sections:

1. Section 211300 – Fire Suppression Systems.
2. Section 221116 – Domestic Water Piping.

1.3 QUALITY ASSURANCE

A. Provide valves with manufacturer's name and pressure rating clearly marked on outside of body.

1.4 SUBMITTALS

A. See Section 230010 Mechanical General Provisions.

B. Submit product data, O&M data, and samples and show item on shop and coordination drawings according to the following table.

1. “R” means required.
2. “R2” means required only for products and equipment differing for the specified manufacturer and model and for “or equals” where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawing

Valves, all types	R	R		R
Valve accessories (handle extensions, operators, etc.)	R			

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Named manufacturer model numbers used as example of item and establish minimum level of quality and minimum standard options. Equivalent models of listed manufacturers are acceptable.

B. Ball, gate, and check valves.

1. Nibco Inc.
2. Crane Company.
3. De Zurik Corporation.
4. Or equal.

C. Gate valves – buried.

1. Mueller Company.
2. Kennedy Valve Mfg. Company.
3. Clow Corporation.
4. Or equal.

2.2 GENERAL

A. Where possible, provide valves of same manufacturer for all Mechanical Sections per products in this Section.

B. For copper tubing provide solder-joint valves, or IPS-to-copper adaptor, sized for use with tubing and respective valve.

C. For flanged valves, provide streamline companion flanges, ANSI B16.5, 1988 150 class pounds per square inch.

1. 255 pounds per square inch water on gage (WOG) at 150-degree Fahrenheit.
2. 225 pounds per square inch water on gage (WOG) at 250-degree Fahrenheit unless indicated otherwise.

D. Provide valves rated not less than 125 pounds per square inch steam working pressure, unless indicated otherwise.

E. Provide valve materials suitable for service and temperature of respective systems, especially with respect to discs, plugs, balls, linings, gaskets, and lubricants of globe valves, plug cocks, ball valves, etc.

F. Valves in Insulated Piping: With 2-inch (minimum, greater if insulation thickness is greater than 1 inches) stem extensions and the following features:

1. Ball Valves: With extended operating handle of non-thermal-conductive material and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation and memory stops that are fully adjustable after insulation is applied. Nibco Nib-seal handle extension or equal.

2.3 BALL VALVES

A. 2-1/2 inches and smaller.

1. Two-piece body, bronze ASTM B584 C84400.
2. 316 stainless steel stem and ball.
3. PTFE Seat.
4. Full Port 1/2 to 1 inch; Standard Port 1-1/4 and larger.
5. 600 pounds per square inch at 100-degree F, 125 pounds per square inch saturated steam.
6. Infinite throttling handle with memory stop.
7. Nibco 585-70-66 or equal. Nibco 580-70-66 or equal may be used for 1-1/4 inch and larger.

2.4 GATE VALVES (NOT ALLOWED ABOVE GROUND)

A. Gate Valves – Direct Buried.

1. AWWA C500.
2. Federal Specification WW-V-586, Type II, Class1.
3. Cast iron.
4. Pressure ratings: 2-12 inches - 200 pounds per square inch working, 400 pounds per square inch test; 14 inch and larger - 150 pounds per square inch working, 300 pounds per square inch test.
5. Double disc, parallel seat.
6. Non-rising stem.
7. Joint ends to match piping.
8. Equal to Clow Series F-5062 through F-5085.

B. Valve Indicator Posts.

1. U.L. listed.
2. Two-piece.
3. Non-rising stem.
4. Equal to Nibco NIP-1AJ.

2.5 CHECK VALVES

A. Check Valves, General Service.

1. 2 inches and smaller.

    a. Brass body.
    b. Swing check.
    c. Class 125 (125 psi steam, 200 psi water).
    d. Bronze disc.
    e. Screw-in cap.
    f. Soldered ends.
    g. Equal to Nibco S-413-W.

2.6 SAFETY AND RELIEF VALVES

A. General.

1. Constructed, rated and stamped in accordance with Section IV of the ASME Boiler and Pressure Vessel Code.
2. Direct spring-loaded type.
3. Adjustable discharge pressure setting.
4. Bronze body and all wetted parts shall be non-ferrous.
5. Suitable and rated for system pressure and temperature.

B. Set pressures.

1. Set pressure as indicated on Drawings: Not to exceed pressure rating of protected equipment.
2. Valves to open, under test, at set pressure with following tolerance:

    a. Set pressure up to 70 pounds per square inch gage: plus, or minus 2 pounds per square inch.
    b. Set pressure, above 70 pounds per square inch gage: plus, or minus 3 percent.

C. Capacities.

1. Valves shall have capacity to relieve maximum possible generated energy while maintaining pressure in protected equipment at no more than 10 percent above vessel working pressure.
2. Greater than make-up pressure reducing valve capacity.
3. Equipment relief valve capacity to exceed rating of connected equipment.
4. For boiler relief valves, the valve shall have a BTU/h rating in excess of the BTU/h rating of the boiler’s heating output.
5. Provide multiple valves if required for capacity even though only one valve may be shown on Drawings.

D. Maintain pressure in protected equipment at not more than the following:

1. Low pressure Boilers: 5 pounds per square inch above boiler working pressure.
2. High pressure Boilers: 6 percent above boiler working pressure.
3. Unfired Pressure Vessels: 10 percent above vessel working pressure.

E. Safety and Relief Valves: Equal to Consolidated.

F. Relief Valves, Water: Equal to Watts.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordinate with work of other trades.

B. Install valves in accordance with manufacturer's written installation instructions.

C. Provide valves as shown on drawings and provide shutoff valves around all equipment whether shown with valves on drawings or not.

D. Provide all valves (except control valves), strainers, and check valves of same size as the pipes in which they are installed unless otherwise indicated.

E. Pressure rating of valves same as piping in which installed.

F. Install valves with stems upright or horizontal, not inverted.

G. Install valves with cast directional arrows in direction of flow.

H. Check valves:

1. Install swing checks and gravity closing lift checks in horizontal position.

I. Install indoor valves only in accessible locations.

J. Locate equipment shut-off valves to be accessible without climbing over equipment.

K. Provide operating handles for all valves and cocks without integral operators, unless otherwise noted. Provide adequate clearance for easy operation.

L. Provide discharge pipe to atmosphere from all relief and safety valves, sized with area equal to sum of outlet areas of all valves connected thereto, unless indicated larger. Extend to over code compliant drain receptacle with airgap.

3.2 VALVE APPLICATIONS

A. Valves shall be limited to the applications listed below. Where this section disagrees with drawings, obtain clarification from Architect, and provide as directed by the Architect at no additional cost to the Owner.

B. Ball valves:

1. Throttling and shut-off: water.
2. Use in domestic water, and general fire protection piping 2-1/2 inches and smaller.

C. Gate Valves:

1. Direct buried.
2. Not used for general shut-off (ball only for general shut-off).

3.3 FIELD QUALITY CONTROL

A. Test operate valves from closed-to-open-to-closed position while valve is under test pressure.

3.4 INSPECTION & COMPLETION

A. Verify that adequate clearance between valves and adjacent walls or equipment is available to permit maintenance and repairs.

END OF SECTION 230523

SECTION 230529 - HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. HVAC stands.
3. Equipment supports.

B. Related Sections:

1. Division 22 – Plumbing Work.

1.3 REFERENCE STANDARDS

A. American Society of Mechanical Engineers: ASME Section VIII – Boiler and Pressure Vessel Code – Pressure Vessels.

B. Pipe Supports: ANSI B31.1, Power Piping.

C. Duct Hangers: SMACNA Duct Manuals.

1.4 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

B. Terminology: As defined in MSS SP-90, “Guidelines on Terminology for Pipe Hangers and Supports”.

1.5 SUBMITTALS

A. See Section 230010 – Mechanical General Provisions.

B. Submit product data, O&M data, and samples and show item on shop drawings (where shop drawings are required) according to the following table.

1. “R” means required.
2. “R2” means required only for products and equipment differing for the specified manufacturer and model and for “or equals” where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawing
Pipe hangers and supports	R	R		R
Structural attachments	R			R
Equipment supports/stands	R			R

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Named manufacturer model numbers used as example of item and establish minimum level of quality and minimum standard options. Equivalent models of listed manufacturers are acceptable.

B. Hangers, Inserts and Supports.

1. Unistrut.
2. Superstrut.
3. B-Line Systems.
4. Or equal.

2.2 PIPE HANGERS AND SUPPORTS

A. Model numbers are Superstrut, unless otherwise indicated.

B. Provide electro-chromate, galvanized or factory painted finish; no plain, "black" hangers allowed.

C. Dielectric Isolators: All uninsulated copper tubing systems; Superstrut isolators or equal, Cush-A-Strip or Cush-A-Clamp on all pipe clamps; for individual hangers, use felt lined hangers.

D. Individual Pipe Hangers.

1. Cold and hot pipe all sizes: Clevis hanger, No. C710.

E. Multiple or Trapeze Hangers.

1. Factory channel.

a. 12 gauge thick steel.
b. Single or double section.
c. Electro-chromate finish.
d. Strutnuts: Series A-100 or CM-100.

e. Straps: Series 702.
f. No. A-1200 or A-1202.

F. Wall Supports.

1. Pipe sizes up to 3 in: Steel bracket No. C738.
2. Pipe sizes 4 in and larger: Welded steel bracket C-735.
3. Hot pipe sizes 6 inches and larger.

a. Welded steel bracket No. C739.
b. Adjustable steel yoke and cast iron, roller No.C729.

G. Insulated Pipe Strap.

1. 1/2 in to 1 in plumbing piping in wood frame construction.
2. Felt insulated.
3. Kopty or equal.

H. Escutcheons: See Section 230500 – Basic Mechanical Materials and Methods.

I. Flashing and Sleeves.

1. Flashings.

a. See Division 7 – Thermal and Moisture Protection.
b. Flash and counter flash watertight all pipe and duct penetrations of roofs and exterior walls.
c. Flash pipes through roofs with ITWBuildex Dektite or equal.
d. Flash vents through roofs with.

1) Minimum 24-gauge soldered roof jack for flat surface roofs.
2) Minimum 4-pound lead soldered roof jack for roofs other than flat surface roofs.
3) Vandal caps.
4) Provide counter-flashing sleeves and storm collars.
5) Caulk counterflashing and storm collar weather tight.
6) Other flashings shall be minimum 24-gauge galvanized sheet metal.

2. Sleeves.

a. See 230500 – Basic Mechanical Materials and Methods.

b. For insulated piping, sleeve diameter shall not be less than diameter of insulation.

c. Terminate sleeves flush with walls, and ceiling.

d. For exposed vertical pipe, extend sleeves 1 inch above finished floor except where escutcheons are required.

e. Packing through fire rated partitions one of following.

1) 3M Penetration Sealing Systems (PSS 7909) and 3M Fire Barrier Caulk and Putty.
2) Dow-Corning LTV Silicone foam.
3) Or equal.

3. Separate piping through walls, other than concrete walls, from contact with wall construction materials; use non-hardening caulking.

4. Install insulation on piping in walls which require insulation at time of installation.

2.3 DUCT HANGERS AND SUPPORTS

A. See Section 233113 – Metal Ducts.

2.4 STRUCTURAL ATTACHMENTS

A. Model Numbers are Superstrut, unless otherwise indicated.

B. All components shall have galvanized or equal finish.

C. Anchor Bolts: Size as specified for hanger rods.

D. Concrete Inserts.

1. Malleable iron.
2. Place reinforcing steel through insert as recommended by manufacturer for recommended loads.
3. No. 452 or equal.

E. Beam Clamps.

1. All with U-568 safety strap.
2. All with locknuts on.

a. Set Screw.
b. Hanger rod.

3. Bottom flange attachment.

a. Loading 150-pound and less: U-563.
b. Loading 150-pound to 300-pound: U-562.
c. Loading more than 300-pound: U-560.

4. Top flange attachment.

a. Permitted only when bottom flange attachment cannot be used.
b. Loading 400-pound and less: M-777.
c. Loading more than 400-pound: M-778.

F. Welded Beam Attachments: No. C-780 or equal.

G. Side Beam Attachments: No. 542 or equal.

H. Hanger Rods.

1. ASTM A575 Hot rolled steel, galvanized.
2. ANSI B1.1 Unified Inch Screw Treads.
3. Threaded both ends, threaded one end, or continuous threaded.

I. Hanger Rod Fixtures.

1. Turnbuckles: No. F-112 or equal.
2. Linked Eye Rod.

    a. Rod swivel.
    b. No. E-131 or equal.

3. Clevis: No. F-111 or equal.

J. Powder or Gas Actuated Anchors.

1. Not allowed on initial building construction; allowed only for revisions made after initial construction and with approval of Owner.
2. Hardened steel stud with threaded shank; size of shank to match hanger rod size.
3. Use only with non-shock loads.
4. Maximum load safety factors:

    a. Maximum anchor load: 100 pounds.
    b. Static loads – 5.
    c. Vibratory loads - 8-10.

5. For concrete and steel; not to be used for light weight concrete, brick or concrete block.
6. 10% testing rate required, testing by contractor.
7. Omark Drivit or equal.

K. Expansion Shields.

1. Carbon-steel anchors, zinc coated.
2. Stainless steel for corrosive atmospheres.
3. For normal concrete use.

    a. Self-drilling anchor.
    b. Sleeve anchor.
    c. Stud anchor.

4. For thin concrete use: wedge anchor.
5. For brick or concrete block use: sleeve anchor.
6. Maximum load safety factors.

    a. Static loads – 4.

b. Vibratory loads - 8 – 10.
c. Shock loads - 8 – 10.

7. Size to suit hanger rods.
8. ITT Phillips Red Head or equal.

L. Steel Deck Inserts.

1. Factory stud with.

a. Clip.
b. Spring.
c. Coupling.

2. ITT Phillips Red-Head or equal.

M. Miscellaneous Metal.

1. Steel plate, shapes and bars: ASTM A36.
2. Steel pipe columns: ASTM A53, Schedule 40, black.
3. Bolts and nuts: regular hexagon-head type, ASTM A307, Grade A.
4. Lag bolts: square head type, Fed. Spec. FF-B-561.
5. Plain washers: round, carbon steel, Fed. Spec. FF-W.92.

2.5 MISCELLANEOUS MATERIALS

A. Powder-Actuated Drive-Pin Fasteners: Powder-actuated-type, drive-pin attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.

C. Structural Steel: ASTM A36/A36M, steel plates, shapes, and bars, black and galvanized.

D. Concrete: Normal weight concrete (145 pcf) using Type I Portland Cement, 1" maximum size coarse aggregate to provide a minimum 28-day compressive strength of 3000 psi.

E. Grout: ASTM C1107, Grade B, factory-mixed and -packaged, non-shrink and nonmetallic, dry, hydraulic-cement grout.

1. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.
2. Properties: Non-staining, noncorrosive, and nongaseous.
3. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 PIPE HANGERS, SUPPORTS AND GUIDES

A. General.

1. Assure adequate support for pipe and contents.
2. Provide adjustable hangers for all pipes complete with inserts, adjusters, bolts, nuts, swivels, all-thread rods, etc., except where specified otherwise.
3. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Where piping of various sizes is to be 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.
4. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.
5. Install all cast iron piping in accordance with Cast Iron Soil Pipe Industry (CISPI) Standards.
6. Support all piping within 2 feet of each change of direction on both sides of fitting.
7. Thermal hanger shields shall be provided at hangers and supports where piping is insulated.
8. Prevent vibration or swaying.
9. Provide for expansion and contraction.
10. Supports of wire, rope, wood, chain, strap perforated bar or any other makeshift device not permitted.
11. Comply with applicable requirements at ANSI B31.1 and B31.2 for piping.
12. Support piping independently so that equipment is not stressed by piping weight or expansion.
13. Hangers and supports shall have minimum safety factor of five (5), based on ultimate tensile or compressive strength, as applicable, of material used; base calculations on equipment’s heaviest operating weight and pipes full of water.
14. Install additional supports or braces if, during normal operation, piping should sway, crawl or vibrate. Piping shall be immobile.
15. Install thrust blocks as required to prevent sway.

B. Horizontal piping, except as noted.

1. Adjustable clevis type and rod; all services at or below 250 degrees F.
2. Rollers or slide bases: not required.
3. Trapeze hangers; guide individual pipes on trapezes with 1/4-inch U-bolt or Superstrut 702 pipe clamp.

    a. Install thermal hanger shield at each support point.

4. Galvanized sheet metal shields between hangers and PVC piping.
5. Threaded steel rods.

    a. 2-inch vertical adjustment with 2 nuts each end for positioning and locking.
    b. Size to 12-inch inside pipe size (IPS).

Pipe, IPS	Rod
to 2 inch	3/8 inch
2-1/2 inch and 3 inch	1/2 inch
4 inch	5/8 inch
6 inch and 8 inch	3/4 inch
10 inch and 12 inch	7/8 inch
14 inch and 18 inch	1 inch
20 inch and 30 inch	1-1/4 inch

c. Size above 12-inch IPS and multiple pipe standards: safety factor of 5 on ultimate strength on area.
d. For double rod hangers: 1 size smaller than above.

C. Vertical piping.

1. Base support.

a. Base elbow or welded equivalent.
b. Bearing plate on structural support.

2. Guides.

a. At every third floor but not to exceed.

1) 25 feet for piping to 2-inch.
2) 36 feet for piping 2-1/2 inch to 12-inch.
3) 50 feet for piping 14 inch and larger.

b. Or as otherwise designed by the Vibration Isolation vendor.

3. Top support.

a. Special hanger or saddle in horizontal connection.
b. Provisions for expansion.

4. Intermediate supports: steel pipe clamp at floor.

a. Bolted and welded to pipe.
b. Extension ends bearing on structural steel or bearing plates.

5. For multiple pipes: coordinate guides, bearing plates and accessory steel.

D. Horizontal insulated piping.

1. Install saddles for rollers or slide bases.
2. Install thermal hanger shields for all other types of supports.
3. See Section 230719 Piping and Equipment Insulation for insulation connection to shields.

E. Vertical insulated piping.

1. Install thermal hanger shields at guides.
2. See Section 230719 Piping and Equipment Insulation for insulation connection to shields.

F. Install Pipe Isolators between hangers and piping for all uninsulated copper tubing.

G. Miscellaneous Steel.

1. Provide miscellaneous steel members, beams, brackets, etc., for support of work in this division unless specifically included in other divisions.

H. Fire-stopping.

1. At pipe penetrations through rated assemblies.
2. Commercial pipe sleeve assemblies that are UL listed and that have been approved by the fire marshal for this purpose.

I. Roof pipe supports shall be installed per manufacturer's recommendations in coordination with the roofing system and company holding the roof warranty.

3.2 PIPE SUPPORT SPACING

A. Maximum spacing for horizontal piping.

Type of Pipe	Size	MAXIMUM SPACING
Steel	1-1/2 inch and smaller	7 feet
	2 inch and larger	10 feet
Copper	3/4 inch and smaller	5 feet
	1- 1-1/4 inch	6 feet
	1-1/2 - 3 inch	8 feet
	4 inch and larger	10 feet
Plastic	3/4 inch and smaller	3 feet
	1" – 1-1/2"	6 feet
	1-1-1/4 inches	6 feet
	1½″-3″	8 feet
	4 inch and larger	10 feet

B. Spacing Notes: Additional supports at:

1. Changes in direction.
2. Branch piping and runouts over 5 feet.
3. Concentrated loads due to valves, strainers, and other similar items.
4. At valves 4 inch and larger in horizontal piping, support piping on each side of valve.

C. Parallel piping on trapezes.

1. Maximum spacing to be that of pipe requiring closest spacing.

3.3 ATTACHMENT TO STRUCTURE

A. Concrete.

1. Use inserts for suspending hangers from reinforced concrete slabs, walls, and sides of reinforced concrete beams wherever practicable.
2. Set inserts in position in advance of concrete work.
3. Provide reinforcement rod in concrete for inserts carrying.

    a. Pipe over 4-inch.
    b. Ducts over 60 inches wide.

4. Where concrete slabs form finished ceiling, finish inserts flush with slab surface.
5. Where inserts are omitted, install hangers with expansion shields.
6. Through-deck support.

    a. Drill through concrete slab from below.
    b. Provide rod with recessed square steel plate and nut above slab.

7. Where permitted by Owner and only for revisions made after initial construction, powder actuated anchors or expansion shields may be used in lieu of inserts.

    a. In bottom of thick slabs.
    b. In thin slab construction, only in sides of beams.

8. Pre-Cast Concrete.

    a. Use pre-set inserts.
    b. Where inserts are not available, field drill through beam or joists at locations as directed by Architect.
    c. Through bolt side beam bracket to beam or joist.

9. Poured-In-Place Concrete.

    a. With metal form or underdeck.
    b. Before concrete is poured.

        1) Field drill hole through metal deck.
        2) Provide bearing plate, nut, and locknut on rod; or install factory-made steel deck inserts specified hereinbefore.

    c. After concrete is poured.

        1) Install hangers with expansion shields.

B. Steel Beam Anchors.

1. Beam or channel clamps.

2. Do not cut or weld to structural steel without permission of structural engineer.

C. Steel Deck Anchors.

1. Concrete filled: as specified above.
2. Decking without concrete.

a. Through rod Support.

1) Weld to square plate, 1/4 in thick.
2) Plate to distribute load over minimum of two full cells.
3) Coordinate with floor layouts to clear cells with wiring.

D. Side Wall Supports.

1. Concrete walls: As specified for hangers.
2. Stud Walls.

a. Toggle bolts.
b. Stud welded to structural studs.

E. Support Spreaders.

1. Install spreaders spanning between structural members when hangers fall between them, and hanger load is too great for slab or deck attachment.
2. Spreaders may be one of methods listed below, or combination of both as required.

a. Fabricated from structural channel.

1) End fittings bolted or welded.
2) Secure to structural members.

a) As required by construction.
b) As reviewed by Structural Engineer.

b. Formed channels with fittings, Superstrut or equal.

1) Submit manufacturer's calculations for installation.

3.4 DUCT HANGERS AND SUPPORTS

1. See Section 233113 Metal Ducts.

3.5 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure above or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and floor pipe supports. Finish shall provide a smooth bearing surface.

3.6 METAL FABRICATION

A. Cut, drill, and fit miscellaneous metal fabrications for heavy-duty steel trapezes and equipment supports.

B. Fit exposed connections together to form hairline joints. Field-weld connections that cannot be shop-welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedure's for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.7 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.8 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. 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 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. Equipment nameplates.
2. Pipe markers.

1.3 REFERENCE STANDARDS

A. Pipe marker shall comply with ANSI A13-1.

1.4 SUBMITTALS

A. See Section 230010 – Mechanical General Provisions.

B. Submit product data, O&M data, and samples and show item on shop drawings (where shop drawings are required) according to the following table.

1. “R” means required.
2. “R2” means required only for products and equipment differing for the specified manufacturer and model and for “or equals” where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawing
Pipe markers	R		R	
Equipment tags	R		R	

1.5 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.6 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with location of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Named manufacturer model numbers used as example of item and establish minimum level of quality and minimum standard options. Equivalent models of listed manufacturers are acceptable.

1. Brimar Industries, Inc.
2. Seton Identification Products.
3. Marking Services, Inc.

2.2 EQUIPMENT IDENTIFICATION DEVICES

A. Equipment Labels:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: Principal lettering shall be 1/2 inch. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
9. Label Content: Include equipment's Drawing designation or unique equipment number, serial number, drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

B. Warranty Label:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.

4. Maximum Temperature: Able to withstand temperatures up to 160 deg. F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: Principal lettering shall be 1/2 inch. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
9. Label Content: Include warranty information including start date, end of parts and labor warranty date, contact name and contact number. Coordinate information with professional and end user before making labels.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.3 ACCESS PANEL AND DOOR MARKERS

A. Access panel and access door markers:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Red.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: Principal lettering shall be 1/2 inch. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label access panels and access doors identifying “Fire Damper, Fire/Smoke Damper”, etc.

2.4 WARNING SIGNS AND LABELS

A. Warning signs and labels:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Red.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

6. Minimum Letter Size: Principal lettering shall be 1/2 inch. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include caution and warning information plus emergency notification instructions.

2.5 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.

1. Colors: Comply with ASME A13.1, unless otherwise indicated.
2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
3. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.
4. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or shaped pipe markers at least three times letter height and of length required for label.

B. Pretensioned Pipe Labels: Pre-coiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Shaped Pipe Markers: Preformed semirigid plastic formed to partially cover circumference of pipe and to attach to pipe with mechanical fasteners that do not penetrate insulation vapor barrier.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces, of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment (including motor starters, VFDs, control panels, etc.)

B. Locate equipment labels where accessible and visible.

C. Install access panel markers with screws on equipment access panels.

3.4 PIPE LABEL INSTALLATION

A. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Within 18” of each valve, valve assembly and control device.
2. Within 3’ of each 90-degree elbow, connection to equipment or vessel and where pipe enters shafts and penetrates outside walls, floors, ceilings and non-accessible enclosures.
3. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
4. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
5. At access doors, manholes, and similar access points that permit view of concealed piping.
6. Near major equipment items and other points of origination and termination.
7. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
8. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

B. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

C. Pipe Label Color Schedule:

Service	Pipe marker	Background color	Lettering
Natural gas	Natural gas	Yellow	Black

3.5 ADJUSTING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.6 CLEANING

A. Clean faces of mechanical identification devices and glass frames of valve schedules.

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. The Testing, Adjusting, and Balancing (TAB) Agency shall be hired by the Mechanical Contractor directly. This Section is provided to establish the TAB scope of work and provide information to enable the Contractor to schedule TAB activities with all other trades.

B. Section Includes:

1. Balancing Air Systems:

a. Operational testing and adjusting of air handling equipment.
b. Balancing of air distribution systems.
c. Testing and adjustment of air terminal devices.

2. Control system verification.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. BAS: Building automation systems.

C. NEBB: National Environmental Balancing Bureau.

D. TAB: Testing, adjusting, and balancing.

E. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

1.4 SUBMITTALS

A. See Section 230010 – Mechanical General Provisions.

B. Submit product data, O&M data, and samples and show item on shop drawings (where shop drawings are required) according to the following table.

1. “R” means required.
2. “R2” means required only for products and equipment differing for the specified manufacturer and model and for “or equals” where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawing
Final air balancing report		R		

C. Final Test & Balance Report.

1. At least 15 days prior to Contractor’s request for final inspection, submit electronic copy of final reports on approved reporting forms, and certifications for review and approval by Architect. Once approved, provide required quantity of paper and electronic copies per 230010 “Mechanical General Provisions.”
2. Form of final reports.

    a. Fully completed report forms for all systems specified to be tested and balanced including at a minimum all data specified herein to be recorded.
    b. Each individual final reporting form must bear:
    c. Identify instruments of all types that were used and last date of calibration of each.
    d. Certifications.

        i. Controls verifications

1.5 QUALITY ASSURANCE

A. TAB Specialists Qualifications: Certified by AABC or NEBB.

1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC or NEBB.

B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

C. Prior to start of testing, adjusting, and balancing, verify that required Project conditions are met:

1. System and control system installation is complete and in full operation.
2. All pre-functional tests have been performed.
3. Equipment has been started and tested in accordance with manufacturer’s installation instructions.
4. Doors and windows are in place and closed or under normal traffic conditions.
5. Proper mostly clean air filters are in place.

D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

E. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.6 PROJECT REVIEW

A. Construction Review.

1. Make on-site visits during progress of construction: Number and timing of visits to be as required to perform the functions specified below.
2. Purpose of review.

a. Identify potential problem for performing total system balance.
b. Identify modifications that will affect air total system balance.
c. Schedule and coordinate total system balance with other work.
d. Identify conditions that could create hazardous environment for building occupants.

3. Typical activities.

a. Check that necessary balancing and measuring hardware is:

1) In place.
2) Located properly and accessibly.
3) Installed correctly.

b. Identify and evaluate variations from system design.
c. Record data from equipment nameplates.
d. Identify and report possible restrictions in systems; such as:

1) Poorly designed duct fittings.
2) Others as may arise or based on Agency's experience.

e. Verify that construction progress will not delay total and/or phased project system balance.
f. Identify best location for duct Pitot tube traverses.
g. Identify scaffolding and other access needs.

1.7 FIELD CONDITIONS

A. Verify and coordinate TAB activities on projects with phased sequences requirements.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified herein. If not otherwise noted, the following minimum requirements apply.

1. Volt-meter: plus or minus 1 percent scale.
2. Ammeter: plus or minus 1 percent scale.

3. Ohmmeter: plus or minus 0.1 percent scale for calibrating plus or minus 0.4 degrees Fahrenheit resistance temperature sensors, plus or minus 0.25 percent scale for calibrating plus or minus 1 degrees Fahrenheit temperature sensors, plus or minus 1 percent scale for measuring motor current.
4. Ultrasonic time-of-travel strap-on flow sensor: plus or minus 5 percent of reading.
5. Other flow sensors: plus or minus 2 percent of reading.
6. Water pressure gauge: plus or minus1/2 percent scale, ASME Grade 2A.
7. Watt meter, plus or minus1/2 percent scale: 3 phase split core current transducers.
8. Temperature: plus or minus 0.4 degrees Fahrenheit.

B. All equipment shall be calibrated within 6 months of use, or according to the manufacturer's recommended interval, whichever is shorter, and when dropped or damaged. Calibration tags shall be affixed or certificates readily available and proof of calibration shall be included reports.

PART 3 - EXECUTION

3.1 GENERAL

A. Coordinate with work of other trades.

B. Coordinate all work with ongoing work.

1. Coordinate TAB with project phasing.

C. Report to Professional any discrepancies or items not installed in accordance with the Contract Drawings pertaining to proper balance and operation of air and water distribution systems.

D. Perform testing, adjusting and balancing in accordance with AABC or NEBB standards.

E. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to Section 230713 "Duct Insulation" and Section 230719 "Piping and Equipment Insulation.".

F. Mark equipment settings with paint or other suitable, permanent identification material, including damper control positions, valve indicators, and similar controls and devices, to show final settings.

3.2 CONTROL SYSTEM COORDINATION/VERIFICATION

A. See Section 230900.

B. Test and balance is responsible for ensuring all thermostats are programmed and systems operate properly

3.3 AIR SYSTEMS BALANCING

A. General.

1. Do not operate fan systems for test or balance until spaces served have been cleaned of dust and debris, to avoid contamination of supply air or return air paths and equipment.
2. Filters.

a. Check that proper specified filters are installed, oriented in the proper airflow direction, free of bypass, and clean.
b. Make no adjustment for dirty filters, fans were selected for clean filters at design airflow.
c. Adjust airflows to within 5% of scheduled quantities for total system CFM.

B. Air Outlets.

1. Adjust diffusers' throw pattern, grilles and registers to pattern indicated on the Drawings. Review manufacturer's instructions for proper diffuser blade or weir gate positions to provide this throw pattern as it is not always intuitive. It is TAB agency's responsibility to adjust throw patterns for all adjustable throw diffusers. If diffuser has a fixed throw pattern and is incorrectly installed, HVAC contractor shall correct pattern prior to balance.

a. Sidewall Registers: As indicated on the Drawings.

2. Test and adjust each diffuser, grille and register to within plus or minus 10 percent of design requirements.

a. Start with all dampers wide open.
b. Adjust dampers, starting with nearest to terminal unit or fan. Make adjustments using duct mounted volume dampers rather than dampers at diffuser face (if any) unless absolutely required.
c. At least one damper shall remain wide open at end of balance.

3. Return air filter grilles: No balance required.
4. Report.

a. Tag each diffuser and register and mark tag on copy of floor plan.
b. For each grille, diffuser, and register, indicate tag, size, type, and effective area (where applicable).
c. Required velocity/cubic feet per minute.
d. Initially tested velocity/cubic feet per minute.
e. Finally tested cubic feet per minute after adjustments.

C. Air Handling Units, Blower Coil Units, Fan Coil Units, Packaged Equipment Air Flow Rate Readings.

1. Total supply air quantities shall be determined at all of the following where applicable:

a. Pitot traverse in the supply duct downstream, positive pressure side of the fan.
b. Pitot traverse at coil or filter bank.
c. Totaling the readings of individual air outlets.
d. Totaling the readings of individual terminals as read through the EMCS.

2. Total return air quantities shall be determined at all of the following where applicable:

a. Pitot traverse in the return air duct or damper entering air handler.
b. Totaling the readings of individual air outlets, if ducted return system.
c. Totaling reading of each return air shaft inlet, if multi-story plenum return system.

D. Constant Volume Air Handling Units, Fan Coil Units, and Furnaces.

1. Total air quantities shall be obtained within 5 percent of design by adjustment of fan speed.

a. Adjust speed potentiometer for EC motors.
b. Adjust SCR for direct drive PSC motors.

E. Constant Volume Exhaust Fans.

1. See herein for air outlet balancing.
2. Total air quantities for fan shall be determined by:

a. Totaling the readings of individual air outlets (or inlets).

3. Total air quantities shall be obtained within 10 percent of design by adjustment of fan speed.

a. Constant speed fans:

1) Adjust speed potentiometer for EC motors.

4. Report.

a. Tag.
b. Manufacturer and model of fan and motor.
c. Sheave data at motor and fan; belt data.
d. Motor horsepower, rpm, volts, phase, full load amps.
e. Fan airflow rate at all locations measured, as listed above.
f. Final measured amps.
g. Inlet and outlet static pressure.

END OF SECTION 230593

SECTION 230596 – AIR SYSTEM CLEANING

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. Work Included in This Section: Methods, materials, equipment, installation, and tests in conformity with applicable codes and authorities having jurisdiction for the following:

1. Air system cleaning.

B. Related Sections:

1. Section 230010 "Mechanical General Provisions."

1.3 SUBMITTALS

A. See Section 230010 – Mechanical General Provisions.

B. Submit product data, O&M data, and samples and show item on shop drawings (where shop drawings are required) according to the following table.

1. “R” means required.
2. “R2” means required only for products and equipment differing for the specified manufacturer and model and for “or equals” where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawings
HVAC system cleaning contractor license certificate(s)	R			

1.4 REFERENCE STANDARDS

A. NADCA Standards: The HVAC system cleaning contractor shall perform the services specified here in accordance with the current published standards of the National Air Duct Cleaners Association (NADCA).

1. All terms in this specification shall have their meaning defined as stated in the NADCA Standards.
2. NADCA Standards shall be followed with no modifications or deviations being allowed.

B. Applicable Standards and Publications: The following current standards and publications of the issues currently in effect form a part of this specification to the extent indicated by any reference thereto:

1. National Air Duct Cleaners Association (NADCA): Standard 05 - Requirements for the Installation of Service Openings in HVAC Systems.
2. Underwriters' Laboratories (UL): UL Standard 181.
3. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE): Standard 62.1, Ventilation for Acceptable Indoor Air Quality.
4. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA): HVAC Duct Construction Standards - Metal and Flexible.
5. North American Insulation Manufacturers Association (NAIMA): Cleaning Fibrous Glass Insulated Air Duct Systems.

1.5 QUALITY ASSURANCE

A. Certification: The HVAC system cleaning contractor shall have a minimum of one (1) Air System Cleaning Specialist (ASCS) certified by NADCA on a full-time basis or shall have staff certified by a nationally recognized certification program and organization dedicated to the cleaning of HVAC systems.

B. Supervisor Qualifications: A person certified as an ASCS by NADCA or maintaining an equivalent certification by a nationally recognized program and organization, shall be responsible for the total work herein specified.

C. Experience: The HVAC system cleaning contractor shall submit records of experience in the field of HVAC system cleaning as requested by the owner. Bids shall only be considered from firms which are regularly engaged in HVAC system maintenance with an emphasis on HVAC system cleaning and decontamination.

D. Equipment, Materials and Labor: The HVAC system cleaning contractor shall possess and furnish all necessary equipment, materials, and labor to adequately perform the specified services.

1. The contractor shall assure that its employees have received safety equipment training, medical surveillance programs, individual health protection measures, and manufacturer's product and material safety data sheets (MSDS) as required for the work by the U.S. Occupational Safety and Health Administration, and as described by this specification. For work performed in countries outside of the U.S.A., contractors should comply with applicable national safety codes and standards.
2. The contractor shall maintain a copy of all current MSDS documentation and safety certifications at the site at all times, as well as comply with all other site documentation requirements of applicable OSHA programs and this specification.
3. Contractor shall submit to the owner all Material Safety Data Sheets (MSDS) for all chemical products proposed to be used in the cleaning process.

E. Licensing: The HVAC system cleaning contractor shall provide proof of maintaining the proper license(s), if any, as required to do work in this state. Contractor shall comply with all Federal, state, and local rules, regulations, and licensing requirements.

PART 2 - PRODUCTS

2.1 NOT USED

PART 3 - EXECUTION

3.1 HVAC SYSTEM COMPONENT INSPECTIONS AND SITE PREPARATIONS

A. HVAC System Component Inspections: Prior to the commencement of any cleaning work, the HVAC system cleaning contractor shall perform a visual inspection of the HVAC system to determine appropriate methods, tools, and equipment required to satisfactorily complete this project. The cleanliness inspection should include air handling units and representative areas of the HVAC system components and ductwork. In HVAC systems that include multiple air handling units, a representative sample of the units should be inspected.

B. The cleanliness inspection shall be conducted without negatively impacting the indoor environment through excessive disruption of settled dust, microbial amplification, or other debris. In cases where contamination is suspected, and/or in sensitive environments where even small amounts of contaminant may be of concern, environmental engineering control measures should be implemented.

1. Damaged system components found during the inspection shall be documented and brought to the attention of the Owner.

C. Site Evaluation and Preparations: Contractor shall conduct a site evaluation, and establish a specific, coordinated plan which details how each area of the building will be protected during the various phases of the project.

D. Inspector Qualifications: Qualified personnel should perform the HVAC cleanliness inspection to determine the need for cleaning. At minimum, such personnel should have an understanding of HVAC system design, and experience in utilizing accepted indoor environmental sampling practices, current industry HVAC cleaning procedures, and applicable industry standards.

3.2 GENERAL HVAC SYSTEM CLEANING REQUIREMENTS

A. Containment: Debris removed during cleaning shall be collected and precautions shall be taken to ensure that Debris is not otherwise dispersed outside the HVAC system during the cleaning process.

B. Particulate Collection: Where the Particulate Collection Equipment is exhausting inside the building, HEPA filtration with 99.97% collection efficiency for 0.3-micron size (or greater) particles shall be used. When the Particulate Collection Equipment is exhausting outside the building, Mechanical Cleaning operations shall be undertaken only with Particulate Collection Equipment in place, including adequate filtration to contain Debris removed from the HVAC system.

C. Controlling Odors: Measures shall be employed to control odors and/or mist vapors during the cleaning process.

D. Component Cleaning: Cleaning methods shall be employed such that all HVAC system components shall be Visibly Clean as defined in applicable standards (see NADCA Standards). Upon completion, all components shall be returned to those settings recorded just prior to cleaning operations.

E. Service Openings: The contractor shall utilize service openings, as required for proper cleaning, at various points of the HVAC system for physical and mechanical entry, and inspection.

1. Contractor shall utilize the existing service openings already installed in the HVAC system where possible.
2. Other openings shall be created where needed and they shall be created so they can be sealed in accordance with industry codes and standards.
3. Closures shall not significantly hinder, restrict, or alter the airflow within the system.
4. Closures shall be properly insulated to prevent heat loss/gain or condensation on surfaces within the system.
5. Openings shall not compromise the structural integrity of the system.
6. Construction techniques used in the creation of openings should conform to requirements of applicable building and fire codes, and applicable NFPA, SMACNA and NADCA Standards.
7. Cutting service openings into flexible duct is not permitted. Flexible duct shall be disconnected at the ends as needed for proper cleaning and inspection.
8. Rigid fiber glass duct systems shall be resealed in accordance with NAIMA recommended practices. Only closure techniques that comply with UL Standard 181 or UL Standard 181a are suitable for fiber glass duct system closures.
9. All service openings capable of being re-opened for future inspection or remediation shall be clearly marked and shall have their location reported to the owner in project report documents.

F. Air handling units and terminal units.

1. Interior surfaces of the unit casing.
2. Coil surfaces compartment.
3. Condensate drain pans.
4. Fans, fan blades, and fan housings.

G. Duct Systems.

1. Create service openings in the system as necessary in order to accommodate cleaning of otherwise inaccessible areas.
2. Mechanically clean all duct systems to remove all visible contaminants, such that the systems are capable of passing Cleaning Verification Tests (see NADCA Standards).

3.3 HEALTH AND SAFETY

A. Safety Standards: Cleaning contractors shall comply with applicable federal, state, and local requirements for protecting the safety of the contractor's employees, building occupants, and the environment. In particular, all applicable standards of the Occupational Safety and Health Administration (OSHA) shall be followed when working in accordance with this specification.

B. Occupant Safety: No processes or materials shall be employed in such a manner that they will introduce additional hazards into occupied spaces.

C. Disposal of Debris: All Debris removed from the HVAC System shall be disposed of in accordance with applicable federal, state, and local requirements.

3.4 MECHANICAL CLEANING METHODOLOGY

A. Source Removal Cleaning Methods: The HVAC system shall be cleaned using Source Removal mechanical cleaning methods designed to extract contaminants from within the HVAC system and safely remove contaminants from the facility. It is the contractor's responsibility to select Source Removal methods that will render the HVAC system Visibly Clean and capable of passing cleaning verification methods (See applicable NADCA Standards) and other specified tests, in accordance with all general requirements. No cleaning method, or combination of methods, shall be used which could potentially damage components of the HVAC system or negatively alter the integrity of the system.

1. All methods used shall incorporate the use of vacuum collection devices that are operated continuously during cleaning. A vacuum device shall be connected to the downstream end of the section being cleaned through a predetermined opening. The vacuum collection device shall be of sufficient power to render all areas being cleaned under negative pressure, such that containment of debris and the protection of the indoor environment are assured.
2. All vacuum devices exhausting air inside the building shall be equipped with HEPA filters (minimum efficiency), including hand-held vacuums and wet vacuums.
3. All vacuum devices exhausting air outside the facility shall be equipped with Particulate Collection including adequate filtration to contain Debris removed from the HVAC system. Such devices shall exhaust in a manner that will not allow contaminants to re-enter the facility. Release of debris outdoors shall not violate any outdoor environmental standards, codes, or regulations.
4. All methods require mechanical agitation devices to dislodge debris adhered to interior HVAC system surfaces, such that debris may be safely conveyed to vacuum collection devices. Acceptable methods will include those, which will not potentially damage the integrity of the ductwork, nor damage porous surface materials such as liners inside the ductwork or system components.

B. Methods of Cleaning Fibrous Glass Insulated Components.

1. Fibrous glass thermal or acoustical insulation elements present in any equipment or ductwork shall be thoroughly cleaned with HEPA vacuuming equipment, while the HVAC system is under constant negative pressure, and not permitted to get wet in accordance with applicable NADCA and NAIMA standards and recommendations.
2. Cleaning methods used shall not cause damage to fibrous glass components and will render the system capable of passing Cleaning Verification Tests (see NADCA Standards).
3. If there is any evidence of damage, deterioration, delaminating, friable material, mold or fungus growth, or moisture such that fibrous glass materials cannot be restored by cleaning or resurfacing with an acceptable insulation repair coating, they shall be identified to the Owner for replacement. Replacement of damaged insulation is not specified under this Section.

C. Cleaning of coils.

1. Measure differential pressure across each coil.

2. See NADCA ACR 2006, “Coil Surface Cleaning” Section. Type 1 or Type 1 and Type 2, cleaning methods shall be used to render the coil visibly clean and capable of passing Coil Cleaning Verification (see applicable NADCA ACR 2006).
3. Coil drain pans shall be subject to NADCA ACR 2006, “Non-Porous Surfaces Cleaning Verification”. Ensure that condensate drain pans are operational.
4. Electric-resistance coils shall be de-energized, locked out, and tagged before cleaning.
5. Cleaning methods shall not cause any appreciable damage to, cause displacement of, inhibit heat transfer, or cause erosion of the coil surface or fins, and shall comply with coil manufacturer’s written recommendations when available.
6. Rinse thoroughly with clean water to remove any latent residues.

D. Antimicrobial Agents and Coatings.

1. Apply antimicrobial agents and coatings if active fungal growth is reasonably suspected or where unacceptable levels of fungal contamination have been verified. Apply antimicrobial agents and coatings according to manufacturer’s written recommendations and EPA registration listing after the removal of surface deposits and debris.
2. When used, antimicrobial treatments and coatings shall be applied after the system is rendered clean.
3. Apply antimicrobial agents and coatings directly onto surfaces of interior ductwork.
4. Sanitizing agent products shall be registered by the EPA as specifically intended for use in HVAC systems and ductwork.

3.5 CLEANLINESS VERIFICATION

A. General: Verification of HVAC System cleanliness will be determined after mechanical cleaning and before the application of any treatment or introduction of any treatment-related substance to the HVAC system, including biocidal agents and coatings.

B. Visual Inspection: The HVAC system shall be inspected visually to ensure that no visible contaminants are present.

1. If no contaminants are evident through visual inspection, the HVAC system shall be considered clean; however, the owner reserves the right to further verify system cleanliness through Surface Comparison Testing or the NADCA vacuum test specified in the NADCA standards.
2. If visible contaminants are evident through visual inspection, those portions of the system where contaminants are visible shall be re- cleaned and subjected to re-inspection for cleanliness.
3. NADCA vacuum test analysis should be performed by a qualified third party experienced in testing of this nature.

C. Additional Verification:

1. Perform surface comparison testing or NADCA vacuum test.
2. Conduct NADCA vacuum gravimetric test analysis for nonporous surfaces.

D. Verification of Coil Cleaning:

1. Measure differential pressure across each coil.
2. Coil will be considered clean if cleaning restored the coil differential pressure drop to within 10% of the measured when the coil was first installed.

3. Coil will be considered clean if the coil is free of foreign matter and chemical residue, based on a thorough visual inspection.

E. Prepare a written cleanliness verification report. At a minimum, include the following:

1. Written documentation of the success of the cleaning.
2. Site inspection reports, initiated by supervisor, including notation on areas of inspection, as verified through visual inspection.
3. Surface comparison test results if required.
4. Gravimetric analysis (nonporous surfaces only).
5. System areas found to be damaged.

F. Photographic Documentation: Submit photographic documentation as required.

3.6 RESTORATION

A. Restore and repair HVAC air distribution equipment, ducts, plenums, and components according to NADCA ACR 2006, “Restoration and Repair of Mechanical Systems” Section.

B. Restore service openings capable of future reopening. Comply with requirements in Section 233113 – Metal Ducts. Include location of service openings in Project closeout report.

C. Replace fibrous-glass materials that cannot be restored by cleaning or resurfacing.

D. Replace damaged insulation.

E. Ensure that closures do not hinder or alter airflow.

F. New closure materials, including insulation, shall match opened materials and shall have removable closure panels fitted with gaskets and fasteners.

3.7 POST PROJECT REPORT

A. At the conclusion of the project, the Contractor shall provide a report to the owner indicating the following:

1. Success of the cleaning project, as verified through visual inspection and/or gravimetric analysis.
2. Areas of the system found to be damaged and/or in need of repair.

END OF SECTION 230589

SECTION 230713 - DUCT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes insulating the following duct services:

1. Ducts and plenums, thermal insulation.
2. Ducts and plenums, acoustic insulation. (Liner)

B. Related Sections:

1. Section 230719 Piping and Equipment Insulation.

1.3 REFERENCE STANDARDS

A. ASTM B209 – Aluminum and Aluminum-Alloy Sheet and Plate.

B. ASTM C177 – Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.

C. ASTM C335 – Steady-State Heat Transfer Properties of Horizontal Pipe Insulation.

D. ASTM C585 – Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe.

E. ASTM C921 – Properties of Jacketing Materials for Thermal Insulation.

F. ASTM E84 – Surface Burning Characteristics of Building Materials.

G. ASTM E96 – Water Vapor Transmission of Materials.

H. NFPA 255 – Surface Burning Characteristics of Building Materials.

I. SMACNA – HVAC Duct Construction Standards - Metal and Flexible.

J. UL 723 – Surface Burning Characteristics of Building Materials.

K. ASTM E 814 – Standard Test Method for Fire Tests of Through-Penetration Fire Stops.

1.4 DEFINITIONS

A. Duct Dimensions.

1. Duct sizes indicated on Drawings shall be clear inside dimensions unless duct size is specifically indicated as outside dimensions (OD).

1.5 QUALITY ASSURANCE

A. Source Quality Control.

1. Service: Use insulation specifically manufactured for service specified.
2. Labeling: Insulation labeled or stamped with brand name and number.

B. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

1.6 SUBMITTALS (NOT REQUIRED UNLESS CONTRACTOR SUBSTITUTES)

A. See Section 230010 – Mechanical General Provisions.

B. Submit product data, O&M data, and show item on shop drawings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Named manufacturer model numbers used as example of item and establish minimum level of quality and minimum standard options. Equivalent models of listed manufacturers are acceptable.

B. Insulation: fiberglass.

1. Owens-Corning Fiberglass Corporation.
2. Johns Manville.
3. Certainteed Corporation.
4. Knauf.
5. Or equal.

C. Adhesives.

1. Childers Brand; H. B. Fuller Construction Products.
2. Foster Brand; H. B. Fuller Construction Products.
3. Mon-Eco Industries, Inc.
4. Or equal.

D. Mechanical Fasteners.

1. AGM Industries, Inc.
2. Miracle Adhesives Corporation.
3. Grip-Nail.
4. Or equal.

2.2 GENERAL

A. Energy Codes: The current versions of ASHRAE 90.1 shall govern where requirements for thickness exceeds thickness specified.

B. All insulation materials, including jackets, facings, adhesives, coatings, and accessories are to be fire hazard rated and listed by Underwriters' Laboratories, Inc., using Standard UL 723 (ASTM E-84), (NFPA-255), (ASA A2.5-1963).

1. Flamespread: maximum 25.
2. Fuel contributed, and smoke developed: maximum 50.
3. Flameproofing treatments subject to deterioration from moisture or humidity are not acceptable.

C. Insulation and accessories shall not provide any nutritional or bodily use to fungi, bacteria, insects, rats, mice, or other vermin, shall not react corrosively with equipment, piping or ductwork, and shall be asbestos free: Duct lining shall meet ASTM C1136 and ASTM C665 for biological growth in insulation

2.3 MATERIALS

A. Duct Wrap with Vapor Barrier, Type DW-V.

1. Insulation: ASTM C553 and C612; flexible, noncombustible blanket.

a. Installed 'K' ('Ksi') value: ASTM C518, 0.27 at 75 degrees Fahrenheit.
b. Maximum service temperature: ASTM C411, 250 degrees Fahrenheit.
c. Maximum moisture absorption: 0.20 percent by volume.

2. Vapor Barrier Jacket - factory installed. (FSK).

a. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
b. Moisture vapor transmission: ASTM E96 Procedure E; 0.02 perm.
c. Secure with pressure sensitive tape.

3. Vapor Barrier Tape: Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based, adhesive.

a. Flexible fiberglass wrap

1) Supply Air: 2.2” Nominal Thickness with Installed R-Value 6.0 (0.75 pcf)
2) Return/Outside/Exhaust Air: 1.5” Nominal Thickness with Installed R-Value 4.2 (0.75 pcf)

b. Installed conductance: 0.27 BTU-inch/hr/square foot/degree Fahrenheit.
c. Factory applied jacket.

1) Foil-scrim-kraft laminate: Aluminum foil facing.
2) Glass scrim reinforcing.
3) Kraft paper backing.

d. Maximum vapor permeance: 0.02 perms,

4. Owens-Corning All Service Faced Duct-Wrap or equal.

B. Duct Board with Vapor Barrier, Type DB-V

1. Insulation: ASTM C612; rigid, noncombustible board.

a. 'K' ('Ksi') value: ASTM C518, 0.23 at 75 degrees Fahrenheit.
b. Maximum service temperature: 350 degrees Fahrenheit.
c. Maximum moisture absorption: 0.20 percent by volume.

2. Vapor Barrier Jacket - factory installed (FSK).

a. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
b. Moisture vapor transmission: ASTM E96 Procedure E; 0.02 perm.
c. Secure with pressure sensitive tape.

3. Vapor Barrier Tape: Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based, adhesive.
4. Installed conductance: 0.23 BTU-inch/hr/square foot/degree Fahrenheit.
5. Thickness per Duct Insulation Type and Thickness Schedule.
6. Factory applied jacket.

a. Foil-scrim-kraft laminate.

1) Aluminum foil facing.
2) Glass scrim reinforcing.

C. Rectangular Duct Liner, Type AL.

1. Material.

a. Insulation: ASTM C423.
b. 'K': ASTM C518, 0.23 at 75 degrees Fahrenheit.
c. Maximum service temperature: 350 degrees Fahrenheit.
d. Maximum moisture absorption: 0.20 percent by volume.
e. Thickness per Duct Insulation Type and Thickness Schedule.
f. 1-1/2 pounds per cubic foot unless shown otherwise to be 3 pounds per cubic foot.
g. Installed conductance: 0.25 BTU-inch/hr/square foot/degree Fahrenheit.

2. Interior air side surface.

a. Smooth black neoprene or matte facing overlay on air side. Coating shall conform to NFPA 90A, ASTM C665, ASTM G21.
b. Suitable for velocity up to 4000 feet per minute.
c. Meet erosion test method described in UL publication No. 181.
d. Durable and mechanically cleanable.
e. EPA registered anti-microbial agent.
f. Certainteed Toughgard Duct Liner or equal.
g. Adhesives.

1) Duct Insulation, Internal: Foster 85-60 or equal.
2) Weld Pins: Duro-Dyne CP or equal.

D. Round Duct Liner, Type RAL.

1. Same material as Type AL.
2. Interior air-side surfaces same as Type AL.
3. Self-supporting, slide-in installation.
4. Schuller Permacote Spiracoustic or equal.
5. Small diameter ducts which cannot be insulated internally using duct lining materials shall be pre-fabricated. Insulation material shall be fixed between outer duct metal and a perforated metal liner. United McGill k27 series or equal. Fittings shall be insulated to same standard and shall be by same manufacturer.

E. Plenum Liner, Type PL

1. Material.

a. Heavy-density mat-faced Plenum Liner: Comply with ASTM C 1071.
b. 'K': ASTM C518, 0.23 at 75 degrees Fahrenheit.
c. Maximum service temperature: 350 degrees Fahrenheit.
d. Maximum moisture absorption: 0.20 percent by volume.
e. Thickness per Duct Insulation Type and Thickness Schedule.
f. 1-1/2 pounds per cubic foot unless shown otherwise to be 3 pounds per cubic foot.
g. Installed conductance: 0.25 BTU-inch/hr./square foot/degree Fahrenheit.

2. Interior air side surface.

a. Smooth black neoprene or matte facing overlay on air side. Coating shall conform to NFPA 90A, ASTM C665, ASTM G21.
b. Suitable for velocity up to 4000 feet per minute.
c. Meet erosion test method described in UL publication No. 181.
d. Durable and mechanically cleanable.
e. EPA registered anti-microbial agent.
f. Knauf Insulation Rigid Plenum Liner or equal.
g. Adhesives.

1) Duct Insulation, Internal: Foster 85-60 or equal.
2) Weld Pins: Duro-Dyne CP or equal.

PART 3 - EXECUTION

3.1 DUCT & PLENUM INSULATION

A. Duct Insulation Type and Thickness Schedule.

Location	Cooling or Heat/Cool Supply	Re-turn/Outdoor Air	Exhaust
Concealed in ceiling or chases	2.2 inches DW-V	1-1/2 inches DW-V	1-1/2 inches DW-V
Concealed in unconditioned spaces	2.2 inches DW-V	1-1/2 inches DW-V	-
Lined duct where duct is exposed within mechanical closets or within conditioned spaces.	1 inch 1.5 pounds per Cubic foot AL or AL	1 inch 1.5 pounds per Cubic foot AL or AL	-
Return air plenums	-	1 inch 1.5 pounds per cubic foot PLORAL	-
Flex duct	By manufacturer	By manufacturer	-
Air distribution devices, not factory insulated (backpans of grilles, regis-ters, and diffusers), and sidewall boots	1½ inches DW-V Or ½ inch AL	-	-

3.2 NON-INSULATED DUCTWORK

A. No insulation required for ducts so indicated in Duct Insulation Type and Thickness Schedule, and the following:

1. Factory-insulated flexible ducts.
2. Factory-insulated plenums and boots.
3. Flexible connectors.

B. Do not line ducts:

1. Where prohibited by codes.
2. Food service exhaust.

3.3 DUCT INSULATION INSTALLATION

A. General.

1. Ensure that insulation is continuous through all walls.
2. Finish insulation neatly at hangers, supports and other protrusions.
3. Locate insulation joints or cover seams in least visible locations.
4. Where ducts run in groups too close to be individually insulated and finished.

    a. Completely fill all spaces between ducts with rigid or flexible insulating material.
    b. Insulate and finish exterior surfaces of group as specified for particular service.

5. Where ducts cannot be insulated after erection, insulate prior to installation.
6. Where specified thickness of insulation and/or lining exceeds available thickness in single layer, provide insulation and/or lining in 2 or more layers with joints staggered.
7. Preparation:

    a. Do not install covering before ductwork and equipment has been tested and reviewed.
    b. Ensure surface is clean and dry prior to installation.
    c. Ensure insulation is dry before and during application.

8. Mechanical fasteners:

    a. Use spot weld anchors in all shop fabricated internally lined ducts.
    b. Adhered anchors.
    c. Clip off pin penetrations flush with insulation surface or facing.
    d. Seal pins and washers where pins penetrate vapor barriers.

        1) With 4 inch square pieces of vapor barrier material to match facing.
        2) Adhere with vapor-seal adhesive.

    e. Spacing on rectangular ducts.

        1) Typical of horizontal and vertical, unless otherwise specified.
        2) Duct board.

            a) 3 inches in from edges.
            b) Intermediate fasteners: 12 inches on center maximum spacing all directions.
            c) Not less than four pins per surface.

        3) Duct Wrap.

Side Dimension	Maximum Spacing
24 inches and under	None required.

Side Dimension	Maximum Spacing
25 to 32 inches	Horizontal - none. Vertical: 1 row centered, 12 inches on center
33 to 48 inches	2 rows, 12 inches on center.
49 to 60 inches	3 rows, 12 inches on center.
61 inches and over	16 inches on center, all directions.

4) Duct wrap spacing applicable to flat surfaces of flat oval ducts.

9. Provide 24 gauge sheet metal Z section frames over edges of duct and plenum lining.

   a. At access openings and doors.
   b. Along edges exposed to air flow.

B. Rectangular Duct Wrap.

1. Vapor barrier and sealing continuous without breaks. Vapor proof seal around supports and bracing.
2. 2 inches lap strip at one end.
3. Peel insulation for 2 inch lap strip along longitudinal joints.
4. Seal lap strips with vapor-seal adhesive; Foster's 85-60 or equal.

C. Round Duct Wrap.

1. Adhere flexible insulation to ductwork with adhesive applied in 6 inch wide strips on 16 inch centers.
2. Provide 16 gauge annealed tie wire tied, spiral wound or half hitched at 16 inch centers.
3. Overlap insulation 2 inches and seal joints and breaks with 2 inch lap of foil adhered over joint.
4. Apply duct wrap with vapor barrier as specified above for rectangular ducts.

D. Duct Board.

1. Comply with published recommendations of manufacturer.
2. Secure on top, sides and bottom of duct with mechanical fasteners, spacing as scheduled.
3. Secure with 4-inch strips of adhesive, 8 inch on center.

E. Rectangular Duct and Plenum Lining.

1. Comply with SMACNA Duct Liner Application Standard, published recommendations of manufacturer, and following:
2. Apply adhesive over 100 percent of surfaces to be lined.
3. The coated surface shall face air stream.
4. Surface adjacent to air flow, including at joints, to be uniformly flat.

5. Insulation on floors of plenums and large ducts where access is required shall be protected by wire mesh so that lining is not damaged when walked or crawled on.
6. Blank-Off Panels: Insulation, enclosed with sheet metal on all sides; all joints with vapor barrier mastic and taped.
7. Volume Dampers: Where volume dampers do not allow for continuous insulation, terminate insulation clear of handle sweep and finish edges to maintain vapor barrier and to prevent damage to the insulation.
8. Seal butt joints and exposed edges of liner to prevent erosion.
9. Edges at terminal points shall be provided with metal beading and heavily coated with adhesive.
10. Damaged areas replaced or heavily coated with adhesive.
11. Mechanical fasteners.

    a. Use weld pins.
    b. Install mechanical fasteners.

        1) Weld pins flush with liner surface. Weld pins spaced maximum of 12-inch on center in both directions and within 2 inches of all corners and joints, except where SMACNA Standard requires closer spacing.
        2) Within 2 inches of all edges.
        3) Minimum 4 pins per side.
        4) For field alterations of lined ducts, install adhesive and glued pins with washers. Clip-off pins after washers installed. Field installed pins shall be used for unusual conditions only and shall not exceed 1 percent of total pins.

3.4 PENETRATION THROUGH RATED WALLS

A. Refer to drawings for penetrations of rated assemblies.

B. Install per manufacturer’s installation and listing requirements.

3.5 FIELD QUALITY CONTROL

A. Repair separation of joints or cracking of insulation due to thermal movement or poor workmanship.

B. All vapor barriers shall be continuous; tears, holes, staples, etc. shall be coated with vapor barrier mastic and patch with facing or tape.

C. See Section 233113 – Metal Ducts for protection of lined duct during construction.

END OF SECTION 230713

SECTION 230719 - PIPING AND EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Work Included in This Section: Materials, equipment, fabrication, installation and tests in conformity with applicable codes and authorities having jurisdiction for the following:

1. Piping insulation.
2. Pipe insulation jacket.
3. Equipment insulation.

1.3 REFERENCE STANDARDS

A. ASTM B209 – Aluminum and Aluminum-Alloy Sheet and Plate.

B. ASTM C177 – Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.

C. ASTM C335 – Steady-State Heat Transfer Properties of Horizontal Pipe Insulation.

D. ASTM C585 – Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe.

E. ASTM C921 – Properties of Jacketing Materials for Thermal Insulation.

F. ASTM E84 – Surface Burning Characteristics of Building Materials.

G. ASTM E96 – Water Vapor Transmission of Materials.

H. NFPA 255 – Surface Burning Characteristics of Building Materials.

I. SMACNA – HVAC Duct Construction Standards - Metal and Flexible.

J. UL 723 – Surface Burning Characteristics of Building Materials.

K. ASTM E 814 – Standard Test Method for Fire Tests of Through-Penetration Fire Stops.

1.4 QUALITY ASSURANCE

A. Source Quality Control.

1. Service: Use insulation specifically manufactured for service specified.
2. Labeling: Insulation labeled or stamped with brand name and number.

B. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

1.5 SUBMITTALS

A. See Section 230010 – Mechanical General Provisions.

B. Submit product data, O&M data, and samples and show item on shop drawings (where shop drawings are required) according to the following table.

1. "R" means required.
2. "R2" means required only for products and equipment differing for the specified manufacturer and model and for "or equals" where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawing
Piping insulation	R			
Jackets	R			

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Named manufacturer model numbers used as example of item and establish minimum level of quality and minimum standard options. Equivalent models of listed manufacturers are acceptable.

B. Insulation: Cellular glass.

1. Pittsburg-Corning
2. Or equal.

C. Insulation: fiberglass.

1. Owens-Corning Fiberglass Corporation.
2. Manville.
3. Certainteed Corporation.
4. Knauf.
5. Or equal.

D. Insulation: Elastomeric Closed Cell.

1. Armstrong World Industries, Inc.
2. Rubatex Corporation.
3. Or equal.

E. Weatherproof Aluminum Jacket.

1. Childers Products Company.
2. Insul-Coustic/Birma Corporation.
3. Or equal.

F. Pre-molded pipe fitting covers and Jacketing.

1. Manville: Zeston.
2. Childers Products Company.
3. Proto Corporation.
4. Insul-Coustic/Birma Corporation.
5. Or equal.

G. Adhesives.

1. Foster Div. Amchem Products Inc.
2. Childers Products Company.
3. Epolux Mfg. Corporation.
4. Insul-Coustic/Birma Corporation.
5. Armstrong 520 Adhesive.
6. Or equal.

H. Mechanical Fasteners.

1. AGM Industries, Inc.
2. Miracle Adhesives Corporation.
3. Grip-Nail.
4. Or equal.

2.2 GENERAL

A. Energy Codes: The current versions of ASHRAE 90.1 shall govern where requirements for thickness exceeds thickness specified.

B. All insulation materials, including jackets, facings, adhesives, coatings, and accessories are to be fire hazard rated and listed by Underwriters' Laboratories, Inc., using Standard UL 723 (ASTM E-84), (NFPA-255), (ASA A2.5-1963).

1. Flamespread: maximum 25.
2. Fuel contributed, and smoke developed: maximum 50.
3. Flameproofing treatments subject to deterioration from moisture or humidity are not acceptable.

C. Insulation and accessories shall not provide any nutritional or bodily use to fungi, bacteria, insects, rats, mice, or other vermin, shall not react corrosively with equipment, piping or ductwork, and shall be asbestos free: Duct lining shall meet ASTM C1136 and ASTM C665 for biological growth in insulation.

D. Provide a continuous vapor seal for any service piping that carries liquid below 60 degrees Fahrenheit.

2.3 PIPE INSULATION

A. Cellular Glass.

1. Insulation (without jacket) ASTM C 552, Type II, Class 1.
2. Insulation (with jacket) ASTM C552, Class 2.
3. Sectional.
4. 0.32 maximum K-factor at 75 degrees Fahrenheit mean temperature.
5. Pittsburg-Corning or equal.

B. Fiberglass.

1. Molded: one piece, with factory-applied, all purpose, vapor retarder jacket, maximum 0.26 K factor at 75 degrees Fahrenheit mean temperature: Owens-Corning ASJ/SSL-II Pipe Insulation or equal.

C. Flexible, closed cell elastomeric thermal insulation.

1. Insulation ASTM C534.
2. Service rating of 220 degrees Fahrenheit.
3. Density 6.0 pounds per cubic foot.
4. Closed cell foam: Vapor permeability ASTM E96 0.2 perm.
5. Max moisture absorption: 1.0 percent by volume, 10 percent by weight.
6. Molded pipe insulation.

    a. Maximum 0.27 K factor at 75 degrees Fahrenheit mean temperature
    b. Maximum water vapor transmission rating of 0.17 perm-inches,

7. Sheet insulation.

    a. Maximum 0.28 K factor at 75 degrees Fahrenheit mean temperature.
    b. Maximum water vapor transmission rating of 0.17 perm-inches.

8. Seal with Rubatex adhesive or equal: Armstrong Armaflex II or equal.

D. Underground pipe insulation: See Section 232112 – Hydronic Piping.

2.4 EQUIPMENT INSULATION

A. Flexible, closed cell elastomeric thermal insulation.

1. Insulation ASTM C534, Type II sheet material.
2. Service rating of 220 degrees Fahrenheit.
3. Density 6.0 pounds per cubic foot.
4. Closed cell foam: Vapor permeability ASTM E96 0.2 perm.
5. Max moisture absorption: 1.0 percent by volume, 10 percent by weight.
6. Sheet insulation.

    a. Maximum 0.28 K factor at 75 degrees Fahrenheit mean temperature.
    b. Maximum water vapor transmission rating of 0.17 perm-inches.

7. Seal with Rubatex adhesive or equal: Armstrong Armaflex II or equal.

2.5 JACKETS

A. Factory Applied Vapor Barrier All Service Jacket (ASJ).

1. ASTM C921, White kraft paper bonded to aluminum foil and reinforced with glass fiber yarn.
2. Moisture Vapor Transmission: ASTM E96; 0.02 perm inches.
3. Secure with self-sealing longitudinal laps and butt strips.
4. Secure vapor barrier mastic.
5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum or 0.010 inch thick stainless steel.
6. Vapor Barrier Lap Adhesive: Compatible with insulation.

B. Aluminum Jacket: ASTM B209.

1. Use for weatherproof jacket.
2. Thickness: 0.016 inch sheet.
3. Finish: Embossed.
4. Joining: Longitudinal slip joints and 2 inch laps.
5. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
6. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum or 0.010 inch thick stainless steel.

C. Preformed PVC.

1. Polyvinylchloride covers similar to Manville Zeston.
2. Colors:

    a. Chilled Water: Blue.
    b. Condenser Water: Light blue.
    c. Heating Water: Red.
    d. Domestic Cold Water: Green.
    e. Domestic Hot Water: Orange.

D. Equipment insulation facings: Foil-scrim-kraft laminate of aluminum foil facing, glass scrim reinforcing, kraft paper backing.

E. Preformed Pipe Fitting Covers:

1. Aluminum.

a. Factory fabricated formed covers.
b. General Aluminum Supply Corporation GASCO or equal.

2. PVC.

a. Factory fabricated formed covers.
b. Manville Zeston or equal.

2.6 ADHESIVES AND COATINGS

A. Foster product names and figure numbers or equal.

1. Lagging adhesive: 30-36.
2. Fiberglass: Zeston Z-Glu.
3. Vapor barrier coating: Tite-fit 30-80, UP Label, comply with MIL-C-19565C, Type II; fire and water resistant.
4. Vaporseal adhesive: 85-60.
5. Cellular glass bedding and sealing compound adhesive: Foamseal 30-45.
6. Outdoor mastic: 30-90.
7. Asphalt mastic: C.I. Mastic 60-25.
8. For elastomeric insulation: 520 contact, adhesive.

2.7 WIRE, BANDING AND FASTENING DEVICES

A. Wire: minimum 16 gauge copper clad annealed steel wire

B. Bands: 3/4 inches nominal width with wing seals, of minimum thickness as follows:

1. Aluminum: 0.007 inches. Except where exposed to weather, 0.020 inches.
2. Stainless steel: 0.010 inches.

C. Staples: outward clinching type of corrosion resistant steel.

2.8 MECHANICAL FASTENERS

A. Mild steel, copper plated.

B. AGM Industries Power Base insulation pins or equal.

C. Insulation washers:

1. Galvanized steel.
2. 1-1/2 inch diameter.
3. AGM Industries SLW-1 or equal.

2.9 PRE-INSULATED PIPE SUPPORT AND SHIELDS

A. Provide insulated pipe supports for all insulated pipe and tubing. Insulated pipe supports shall be Pipe Shields, Inc. or equal.

B. All insulated pipe supports shall be load rated. Load ratings shall be established by pipe support manufacturer based upon testing and analysis in conformance with the latest edition of the following codes: ASME B31.1, MSS SP-58, MSS SP-69 and MSS SP-89.

C. All insulated pipe supports shall have cellular glass insulation and galvanized steel jackets. Pipe supports for use on flat surfaces shall have integral load distribution plates coated with zinc primer minimum 3 mils thick.

D. See Section 230529 – Hangers and Supports.

E. Hangers and supports shall fit outside of all pipe insulation and insulation inserts. Provide pre-insulated pipe supports as specified and install per manufacturer's installation instructions. Shield lengths and gauges shall also be per manufacturer's recommendations.

F. Tape all butt joints where pipe insulation butts up against hanger shield.

1. On hot pipe, apply three inch wide vapor barrier tape or band over the butt joint.
2. On chilled water piping, apply a wet coat vapor barrier lap cement on all butt joints and seal the joints with a minimum of three inch wide vapor tape or band.

2.10 FIRE-STOPPING

A. At pipe penetrations through rated assemblies.

B. Commercial pipe sleeve assemblies that are UL listed and that have been approved by the fire marshal for this purpose.

C. Insulation shall be continuous through penetration.

2.11 ACCESSORIES

A. Insulation Protection Saddles: 12-inch long, 16 gauge steel.

B. Paint: Ultraviolet resistant latex paint with special adherence capabilities to the fitting covers, elastomeric, aluminum facing, Kraft paper, tapes and adhesives.

PART 3 - EXECUTION

3.1 PIPE & EQUIPMENT INSULATION SCHEDULE

A. Type P-1.

1. Molded fiberglass.
2. All-service jacket (ASJ).
3. Vapor sealed.

B. Type P-1A.

1. Molded fiberglass.
2. All-service jacket (ASJ).
3. Vapor sealed.
4. PVC jacket.

C. Type P-1B.

1. Molded fiberglass.
2. All-service jacket (ASJ).
3. Vapor sealed.
4. Metal jacket.

D. Type P-1C

1. Molded fiberglass
2. All-service jacket with a polymer film exterior surface (ASJ-MAX)
3. Vapor sealed
4. Temperature Rating 0-1000°F
5. ASTM E84 tested as an assembly

E. Type P-2.

1. Flexible elastomeric insulation.

F. Type P-3.

1. Cellular glass insulation.
2. All service jacket (ASJ).
3. Vapor sealed.

G. Type P-3A.

1. Cellular glass insulation.
2. All service jacket (ASJ).
3. Vapor sealed.
4. PVC jacket.

H. Type P-3B.

1. Cellular glass insulation.
2. All service jacket (ASJ).
3. Vapor sealed.
4. Metal jacket.

I. Type E-1.

1. Flexible elastomeric insulation.

J. Application Schedule.

Piping Systems	Location	Type	Pipe Size	Insulation Thickness	Freeze Protection
Cold Condensate Drain Lines	Interior	P-2	All Sizes	1/2"	-
Condensate, and sanitary sewer waste/vent piping receiving condensate (horizontal piping and first three feet of vertical piping, Underside of floor drain bodies receiving condensate)	Interior	P-1 P-2	All Sizes	3/4"	
Combustible piping (PVC, PEX, etc.) installed in return air plenum	Return Air Plenum	P-1C	All Sizes	3/4"	
Domestic cold water	Interior concealed	P-1	1-1/2” and smaller	1/2"	-
			2” and larger	3/4"	-
	Interior exposed	P-1A	1-1/2” and smaller	1/2"	-
			2” and larger	3/4"	-
	Exterior exposed	P-1B	All Sizes	3/4"	Yes
Domestic hot water (includes recirculation piping)	Interior concealed	P-1	1-1/2” and smaller	3/4"	-
			2” and larger	1"	-
	Interior exposed	P-1A	1-1/2” and smaller	3/4"	-
			2” and larger	1"	-
	Exterior exposed	P-1B	All Sizes	1”	Yes
Roof drains (horizontal and vertical piping)	All	P-1	All Sizes	3/4"	-
		P-2	All Sizes	1”	-
Roof drains (underside of roof drain bodies/bowl)	All	E-1	All Sizes	3/4"	-
Refrigerant suction	All	P-2	All Sizes	3/4"	-
Refrigerant hot gas (VRF systems)	All	P-2	All Sizes	3/4"	-

K. Non-insulated piping and equipment.

1. Hot water expansion tanks and piping to them other than the first 3 feet from the point of connection at piping mains.
2. Vent, overflow, drain and relief, except as noted otherwise.

3.2 INSTALLATION

A. Install materials in accordance with manufacturer’s instructions.

B. Coordinate with work of other trades.

C. Deliver material to job site in original non-broken factory packaging, labeled with manufacturer's density and thickness.

D. Install insulation where it cannot become wet. If insulation becomes wet, remove and dispose of properly and replace with new, dry insulation. Wetted insulation is not acceptable. Ensure insulation is dry before and during installation.

E. Insulate all piping, valves, fittings, flanges and accessories.

F. On piping exposed to public view, locate insulation and cover seams in least visible locations.

G. Insulate fittings, joints and valves with insulation of same material and thickness as adjoining pipe. Use pre-molded fiberglass fittings. For strainers, expansion joints, fittings and accessories requiring servicing or inspection insulation shall be removable and replaceable without damage. Enclose within two-piece no. 15 gauge aluminum covers fastened with cadmium-plated bolts and nuts.

H. Insulate flanges with insulation sleeve of same material as pipe insulation to cover flange and overlap insulation on adjacent piping.

I. Continue insulation through walls, sleeves, pipe hangers and other pipe penetrations.

J. Finish insulation at supports, protrusions and interruptions. No hangers or supports shall be embedded in insulation. Do not insulate expansion bellows.

K. Fiberglass insulation.

1. Provide insulation with factory applied vapor barrier jackets.
2. Butt edges neatly. ASJ with 3 inch minimum butt strips.
3. Longitudinal overlaps: Minimum 2 inch self-sealing, double adhesive.
4. Apply additional jacket as specified.
5. For insulation with factory-applied jackets, secure laps with aluminum or stainless steel, bands at 18 inches o.c.
6. For piping conveying fluids below, ambient temperature finish with vapor barrier adhesive.

L. Elastomeric Tubing.

1. Butt edges neatly. Seal longitudinal and transverse joints with adhesive to maintain minimum vapor permeance. Adhesive shall be selected and applied in accordance with insulation manufacturer's recommendations.
2. Apply additional jacket as specified.

M. For all pipe systems exposed in the mechanical equipment rooms, finish with an all service PVC jacket.

N. For exterior applications, provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with

glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

O. For buried piping, provide factory fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with one mil thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with a polyester film.

P. Perform work at ambient and equipment temperatures as recommended by adhesive manufacturer.

Q. Protection: Protect against dirt, water, chemical, or mechanical damage before, during, and after installation. Repair or replace damaged insulation at no additional cost.

R. Paint all insulation exposed to ultraviolet light (sunlight). (Generous two coats)

S. All vapor barriers shall be continuous. Tears, holes, staples, etc. shall be coated with vapor barrier mastic and patch with facing or tape.

T. Joints between insulation and access shall be sealed with vapor barrier mastic.

3.3 PIPE INSULATION APPLICATION

A. General.

1. Before applying insulation.

    a. Test piping for tightness and obtain approval.
    b. Dry pipe thoroughly.
    c. Clean surfaces to be insulated of dust, grease and foreign matter.

2. Butt edges neatly.
3. Fill voids with insulating cement.
4. Longitudinal overlaps.

    a. 2 inches minimum.
    b. For exposed work: toward ceiling or wall.
    c. For weatherproof aluminum jackets: on side to shed water.

5. Circumferential overlaps on weatherproof aluminum jackets: 2 inches minimum.
6. Continuous insulation passing through sleeves or other openings.
7. Oversize insulation to accommodate heat tracing on piping.

B. Valves, fittings, flanges and accessory insulation.

1. Unless otherwise noted, insulate:

    a. Valves including bonnets.
    b. Flanges.
    c. Fittings.

d. Strainers.
e. Expansion joints.
f. Specialties.

2. Insulation for strainers, expansion joints, fittings and accessories requiring servicing or inspection.

   a. Insulation removable and replaceable without damage.
   b. Enclosed within two piece, No. 18 gauge aluminum covers fastened with cadmium plated bolts and nuts.

3. Insulation of same thickness as adjacent piping insulation.
4. For piping systems insulated with fiberglass.

   a. Apply pre-molded insulation sections of the same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
   b. Cover fittings with heavy PVC fitting covers. Overlap PVC covers on pipe insulation jackets at least 1 inch at each end. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.

5. For piping systems insulated with cellular glass.

   a. Apply pre-molded insulation sections of the same material as straight segments of pipe when available. Secure according to manufacturer’s written instructions.
   b. When pre-molded insulation elbows and fittings are not available, apply mitered sections of pipe insulation (blanket insulation is not acceptable) to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire, tape, or bands.
   c. Cover fittings with heavy PVC fitting covers. Overlap PVC covers on pipe insulation jackets at least 1 inch at each end. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.

6. For piping systems insulated with elastomeric thermal insulation.

   a. Apply mitered sections of pipe insulation.
   b. Secure insulation materials and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

7. Flanges.

   a. Apply preformed pipe insulation to outer diameter of pipe flange.
   b. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
   c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with the same insulation material as adjacent piping insulation.

d. Apply canvas jacket material with manufacturer's recommended adhesive, overlapping seams at least 1 inch, and seal joints with vapor-retarder mastic.

8. Finish for outdoor locations only: weatherproof aluminum jacket compatible with weatherproof jacket on adjoining pipe insulation.

C. At pipe hangers.

1. Insulation protection shields specified in Section 230529 – Hangers and Supports.
2. Butt insulation to shields.
3. Cold piping: Wet coat of vapor barrier lap cement on all butt joints.

D. Jackets and facings.

1. Vapor-sealed types: continuous; staples not permitted.
2. Adhere longitudinal laps: Adhere 3 inches wide joint strip, of same material as facing, at center of each butt joint.
3. Adhesives.

a. Vapor-sealed insulation: vapor-seal adhesive.
b. Heating service insulation: vapor-seal adhesive.
c. Weatherproof aluminum jacket: sealing compound.
d. PVC jacket: welding compound.
e. Underground asphalt felt jacket: asphalt mastic

E. Wiring, banding and fastening devices: Secure insulation to piping and equipment in accordance with following minimum requirements.

1. Piping insulation section 3 foot long.

a. Concealed vapor-sealed insulation banded at ends and center.
b. Other concealed insulation banded at ends and center.

2. Pipe fitting insulation.

a. Loops of wire to secure mitered segments of insulation.
b. Wire spiraled on from end to end on blanket insulation

3. Outdoor piping weatherproof aluminum jackets banded at circumferential joints and center of each section: Lap joint at bottom.

4. Provide aluminum banding near ends of unicellular piping valve and accessory insulation where unicellular is allowed by Professional.

3.4 EQUIPMENT INSULATION

A. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Secure insulation to equipment with bands, welded-on anchors, ties or adhesive.

Where access to equipment is required for testing or maintenance the insulation shall be installed so that it is removable and so that the vapor barrier can be remade after access.

B. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor barrier cement.

C. For cold equipment or equipment containing fluids below ambient temperature.

1. Insulate entire system.
2. Provide vapor barrier jackets, factory applied, or field applied.
3. Finish with glass cloth and vapor barrier adhesive.
4. Cover with aluminum jacket where specified.

D. For equipment containing fluids above ambient temperature.

1. Insulate entire system.
2. Provide standard jackets, with or without vapor barrier, factory applied, or field applied.
3. Finish with glass cloth and adhesive.
4. Cover with aluminum jacket where specified.
5. For hot equipment containing fluids 140 degrees Fahrenheit or less, do not insulate flanges and unions, but bevel and seal ends of insulation.
6. For hot equipment containing fluids over 140 degrees Fahrenheit, insulate flanges and unions with removable sections and jackets.

E. Finish insulation at supports, protrusions, and interruptions.

F. For equipment in mechanical equipment rooms or in finished spaces, finish with aluminum jacket.

G. Do not insulate over nameplate or ASME stamps; bevel and seal insulation around such.

H. General.

1. Apply insulation with edges tightly butted.

a. Joints staggered and secured in place by steel bands.
b. Where necessary weld on suitable anchors.

2. Seal with 520, adhesive.

I. Special considerations.

1. Chiller heads: removable and replaceable covers to allow tube removal.
2. Strainers and suction diffusers: removable and replaceable covers to allow strainer removal.
3. Pumps: removable and replaceable covers to allow impeller replacement.
4. Provide sufficient clearance around openings for normal operation of equipment.

3.5 PENETRATION THROUGH RATED WALLS

A. Refer to drawings for penetrations of rated assemblies.

B. Install per manufacturer’s installation and listing requirements.

3.6 FIELD QUALITY CONTROL

A. Repair separation of joints or cracking of insulation due to thermal movement or poor workmanship.

B. All vapor barriers shall be continuous; tears, holes, staples, etc. shall be coated with vapor barrier mastic and patch with facing or tape.

END OF SECTION 230719

SECTION 230886 - AIR PURIFICATION SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Work included in this section: materials, equipment, fabrication, installation and tests in conformity with applicable codes and authorities having jurisdiction for the following:

1. Bi-Polar Ionization.

1.3 REFERENCE STANDARDS

A. ASHRAE Standard 62 & 52

B. NFPA 70.

1.4 QUALITY ASSURANCE

A. The Air Purification System shall be a product of an established manufacturer in the USA and shall be manufactured and assembled in the USA.

B. A qualified representative from the manufacturer shall be available to inspect the installation of the air purification system to ensure installation in accordance with manufacturer's recommendation.

C. Projects designed using ASHRAE Standard 62.1 IAQ Procedure shall require the manufacturer to provide Indoor Air Quality calculations using the formulas within ASHRAE Standard 62.1 to validate acceptable indoor air quality at the outside air quantity scheduled. The manufacturer shall provide independent test data on a previous installation in a similar application that proves compliance to ASHRAE 62.1 and the accuracy of the calculations.

D. The Air Purification Technology shall have been tested by UL or Intertek/ETL to prove conformance to UL 867-2007 including the ozone chamber testing and peak ozone test for electronic devices. All manufacturers shall submit their independent UL 867 test data with ozone results to the engineer during the submittal process. All manufacturers shall submit a copy with their quotation. Contractors shall not accept any proposal without the proper ozone testing documentation.

1.5 SUBMITTALS

A. See Section 230010 – Mechanical General Provisions

B. Submit product data, O&M data, and samples and show item on shop drawings (where shop drawings are required) according to the following table.

1. "R" means required.
2. "R2" means required only for products and equipment differing for the specified manufacturer and model and for "or equals" where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawing
Air Purification Systems	R	R		

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Named manufacturer model numbers used as example of item and establish minimum level of quality and minimum standard options. Equivalent models of listed manufacturers are acceptable.

B. Filter Media and Frames:

1. Global Plasma.
2. Bioclimatic.
3. Aerisa.

2.2 BI-POLAR IONIZATION DESIGN AND PERFORMANCE CRITERIA

A. Each piece of air handling equipment, so designated on the plans, details, equipment schedules and/or specifications shall contain a plasma ion generator with bipolar ionization output as described here within.

B. The Bi-polar Ionization system shall be capable of:

1. Effectively killing microorganisms downstream of the bipolar ionization equipment (mold, bacteria, virus, etc.).
2. Controlling gas phase contaminants generated from human occupants, building structure, furnishings and outside air contaminants.
3. Reducing space static charges.
4. Reducing space particle counts.
5. When mounted to the air entering side of a cooling coil, keep the cooling coil free from pathogen and mold growth.
6. All manufacturers shall provide documentation by an independent NELEC accredited laboratory that proves the product has minimum kill rates for the following pathogens given the allotted time and in a space condition:

a. MRSA: 99.5% in 60 minutes or less
b. E. Coli: 93.5% in 30 minutes or less
c. H1N1: 86.6% in 60 minutes or less
d. Aspergillus: 74.8% in 60 minutes or less

7. Manufacturers not providing the equivalent space kill rates shall not be acceptable. All manufactures requesting prior approval shall provide to the engineer independent test data from a NELEC accredited independent lab confirming kill rates and times meeting the minimum requirements stated in section 2.2 B, points 6a through 6d.

C. The bipolar ionization system shall operate in such a manner that equal amounts of positive and negative ions are produced. Single pole ion devices shall not be acceptable.

1. Airflow rates may vary through the full operating range of a VAV system. The quantity of air exchange shall not be increased due to the air purification system requirements.
2. Velocity Profile: The air purification device shall not have a maximum velocity profile.

D. Humidity: Plasma Generators shall not require preheat protection when the relative humidity of the entering air exceeds 85%. Relative humidity from 0 - 100%, condensing, shall not cause damage, deterioration or dangerous conditions to the air purification system.

E. Ionization Equipment Requirements:

1. Electrode Specifications (Bi-polar Ionization):

a. Each plasma generator with bipolar ionization output shall include the required number of electrodes and power generators sized to the air handling equipment capacity.
b. Electrodes shall be energized when the main unit disconnect is turned on and the fan is operating.
c. Ionization output when tested in the occupied space shall be between 500 and 800 ions/cm3.
d. Manufacturer shall demonstrate that no voltage potential exists due to exposed electrical components in the duct system or plenum. Exposed needles protruding into the air steam will not be accepted.

F. See schedules for type required. Descriptions are below.

1. Air Handler mounted units

a. Ion generators for air handling units 25 tons and larger shall be Plasma Air's BAR (or approved equal) furnished in a linear or bar mounted configuration to minimize the space required for installation. Ionization BAR shall be no more than 3" deep in the direction of airflow.
b. The mechanical contractor shall mount the plasma ionization BAR and connect it to the remote mount power supply panel using only low voltage

wiring. Low voltage wiring shall be defined as 12V. The use of high voltage cabling (600V or higher) shall not be acceptable due to safety concerns.

c. The remote mount power supply panel shall be capable of directly accepting voltage of 12V DC or 24V AC. The panel shall have an on/off switch, ionizer indicator LED, and a set of dry contacts which will indicate ionizer functionality. Dry contacts that indicate power available only shall not be acceptable.
d. For systems that don't utilize a feedback functionality indicating ion production, provide a duct mounted ion sensor powered from 12V DC or 24V AC. Ion sensor to be user adjustable from 500 to 20,000 ions per cm3 and contain a dry contact BMS interface. To be clear, for systems that only indicate power available to the ionizer, vendor must provide duct mounted ion sensor described herein.
e. Needles on air handler mounted units shall be recessed for safety and to avoid fouling of any exposed needles.

2. Duct mounted units

a. For systems less than 25 tons and where indicated on the plans and/or schedules to be duct mounted, plasma ion generators to be Plasma Air 7000 series (or approved equal) shall be supplied and installed by the mechanical contractor. The contractor shall follow all manufacturer IOM instructions during installation.
b. Generators shall be furnished with a factory-equipped gasketed mounting flange to prevent air leakage and to provide a thermal break. Gasketed flange shall be a minimum of 1 1/8" wide around the perimeter of the ionizer.
c. Ion generators shall be field installed in a location that is convenient for visual inspection, removal, and servicing. They shall include an ion indicator light clearly visible from below the installed location.
d. Needles on duct mounted units shall be recessed for safety and to avoid fouling of any exposed needles.

3. Variable Refrigerant Flow (VRF) Ductless units

a. Ion generators for VRF ductless units shall be brush type needlepoint units, Plasma Air model PA600 (or approved equal) designed to be mounted at the fan inlet.
b. The unit shall be rated to treat up to 2,400 CFM or 6 tons nominal capacity. For airflows greater than 2,400 CFM, multiple units shall be utilized as shown on the plans/schedules.
c. The housing shall be made from ABS plastic, contain an LED ionization output indicating LED, and an in-line 1 Amp fuse.
d. The unit shall contain two (2) mounting feet and shall be configured so the needles are oriented perpendicular to the flow of air entering the fan wheel.

G. Electrical Requirements:

1. Ion generators shall contain a built-in power supply and operate on 24V AC and shall connect to the fan and common terminals of the air handling unit served. Ion generators requiring a loose 24V, 120V or 230V transformer or power supply shall not be accepted.

2. Wiring, conduit and junction boxes shall be furnished and installed by the electrical contractor within housing plenums and shall be UL, NEC and NFPA 70 approved.

H. Control Requirements:

1. All plasma ion generators shall include internal short circuit protection, overload protection, and automatic fault reset. Manual fuse replacement shall not be accepted.
2. All BAR and 7000 series plasma ion generators shall include an external BMS interface to indicate ion generator status and alarm.

PART 3 - EXECUTION

3.1 ASSEMBLY AND INSTALLATION

A. All equipment shall be assembled and installed with a high level of workmanship to the satisfaction of the owner, architect and engineer.

B. Any material damaged by handling, water or moisture shall be replaced by the mechanical contractor at no cost to the owner.

C. All equipment shall be protected from damage on a daily basis throughout construction.

3.2 COMMISSIONING AND TRAINING

A. A manufacturer's authorized representative shall provide start-up supervision and training of owner's personnel in the proper operation and maintenance of all equipment.

B. Provide to the owner a portable handheld, ion counter with a calibrated range of 0 to 20,000 ions/cm3 and an accuracy of +/- 25% within the specified range. Ion counter shall have automatic zeroing capability on 10-minute intervals.

3.3 TRAINING

A. See Section 230010 – Mechanical General Provisions.

END OF SECTION 230886

SECTION 230900 - CONTROLS AND INSTRUMENTATION

PART 1 – GENERAL

1.1 DESCRIPTION

A. Provide complete HVAC controls and instrumentation for the following items:

1. Split Dx heat pump and gas furnace systems.

2. Packaged heating/cooling equipment.

3. Potable H/W recirculating pump control

4. Exhaust systems.

B. Definitions:

1. Control Wiring: Includes conduit, wire and wiring devices to install complete HVAC control systems including motor control circuits, interlocks, thermostats, switches and like devices.

1.2 QUALITY ASSURANCE

A. Performance tests:

1. Demonstrate to the Owner that all controls are installed, adjusted, and can perform all functions required by the contract drawings and specifications.

1.3 SUBMITTALS

A. Manufacturer's Literature and Data for all components, including the following:

1. Controllers.

2. Relays and switches.

B. Control Drawings: Integrate with flow diagrams; show outlines of HVAC equipment with control devices, schematic one line control piping and wiring, and written sequence of operation and operation instructions. Equipment numbers shall correspond to those shown on the Contract Drawings. Provide three (3) complete sets of blue-line as-built drawings.

C. Operation and Maintenance Manuals:

1. Submit in accordance with Section *Mechanical Close-Out Requirements*.

2. Include the following documentation:

a. General description and specification for all components.

b. Detailed illustrations and complete calibration procedures.

c. Complete trouble-shooting procedures and guidelines.

d. Complete operating instructions for all systems.

1.4 INSTRUCTIONS

A. Instructions to OWNER Operations Personnel: Perform in accordance with Section *Mechanical Close-Out Requirements*.

1.5 GUARANTY

Any defects in workmanship or material during the guaranty period shall be corrected by the CONTRACTOR at no cost to the OWNER. Correction of defects shall be accomplished during regular working hours.

PART 2 – PRODUCTS

2.1 WIRING MATERIALS

A. Comply with applicable sections of *Division 16*. Provide wiring for control devices furnished under this Section, HVAC motor control conduits and interlocks. Color code and number all wires, whether individual or in cables, for identification.

B. A complete wiring system shall be provided for all direct digital control (DDC) and electric controlled apparatus. All wiring shall be installed in a neat, workmanlike manner, of sufficient size and tested to be continuous and without unnecessary "short".

Wiring shall be as follows:

1. Exposed Areas and Mechanical Equipment Rooms: Wiring shall be routed in metallic conduit per Div. 26 requirements. Provide flexible conduit connections to rotating equipment.

2. Concealed, Accessible Areas: Wiring may be routed outside in above ceiling accessible spaces conduit, however wiring outside conduit shall be sheathed with plenum rated jacket with maximum rating of 50/25 smoke developed/fire rated per NFPA 90A.

a. All wiring will be routed in the bar joists and/or roof structure space and supported with tie-straps at maximum 6'-0" on center.

b. All drops and risers to HVAC equipment, fans, sensors, etc., will have a tie-strap installed directly above each device to insure a vertical support to the device.

c. Any open wiring that enters a conduit in the walls or drop/rise to connect equipment will have a minimum of 12" of wire looped outside the conduit above the ceiling and will be attached utilizing a tie-strap within 12" of the conduit end or connection.

3. Inaccessible Areas: Same as #1 above - includes wiring in walls, above hard ceilings, in chases, etc.

4. Inside Panels or Unit Enclosures: Wiring may be run outside conduit and neatly tied in bundles for neatness and function.

5. Wiring in exterior and moist environments shall be routed in weatherproof liquid tite conduit with matching fittings and connections.

6. Minimum gauge for low voltage (24VAC or less) control wiring shall be 18 AWG copper solid conductor(s).

2.2 THERMOSTATS

A. Combination heating/cooling thermostat: This remote wall sensor/controller is to be utilized to control split HVAC equipment with heating and cooling capabilities. Thermostats shall be of the low voltage or electronic WIFI adjustable type and shall conform to requirements of UL 873. Thermostats for air conditioners shall be provided and shall be combination heating-cooling type with contacts hermetically sealed against moisture, corrosion, lint, dust and foreign materials. Thermostats shall be designed to operate on not more than 1.5 degrees Fahrenheit differential from setpoint to actual temperature, or as noted, and of suitable range calibrated in degrees Fahrenheit. Thermostats shall have adjustable heat anticipation and fixed cooling anticipation. Air conditioning heating/cooling thermostats shall contain two independent temperature sending elements electrically connected to control the heating and cooling operation(s), respectively. The electrical characteristics shall be 24V AC or less. The maximum differential between heating and cooling setpoints shall be 3 degrees Fahrenheit. Automatic switching for system changeover from heating to cooling or cooling to heating shall be accomplished through the use of a thermostat sub-base. Provide all thermostats with visible temperature space read out in degrees Fahrenheit, and adjustable separate setpoint control for heating and cooling functions.

Provide the number of stages of control, with a nominal 3 to 5 degrees Fahrenheit between stages, for heating and cooling functions to match the number of stages scheduled and/or specified. Provide a type thermostat with emergency/auxiliary heat control capability matched to heat pump applications.

Provide wiring such that the unit LED LIT readout does not require a battery.

2.3 CONTROL SEQUENCES

Control sequences shall be:

A. NEW SPLIT AND PACKAGED DX SYSTEMS WITH HEAT

1. NEW AUTOMATIC HEATING/COOLING CHANGEOVER LED LIT WIFI THERMOSTAT, AS HONEYWELL, OR VICONICS.

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PART 3 – EXECUTION

3.1 INSTALLATION AND ADJUSTMENT

A. Install and adjust required control components and systems in accordance with instructions of the manufacturer. Work shall be performed by employees of the manufacturer or an authorized representative.

B. All control wiring shall be routed in accordance with paragraph 2.05 herein. Install control wiring and connections in accordance with applicable Sections of *DIVISION 26*.

C. Except for short apparatus connections run conduit parallel to or at right angles to the building structure. Conceal conduit in finished spaces.

D. Do not run conduit concealed under insulation or inside ducts. Mount control devices and conduit located on ducts or apparatus with external insulation or stand-off support to avoid interference with insulation.

E. Provide minimum 6 conductor control wiring between indoor unit and thermostat, such that thermostat controller is system powered and includes battery backup.

END OF SECTION 230900

SECTION 231123 - FACILITY NATURAL GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes materials, equipment, fabrication, special-duty valves, specialties, and installation for the following:

1. Natural gas piping.

1.3 PROJECT CONDITIONS

A. Site Gas System Pressure: (CONTRACTOR SHALL VERIFY).

B. Building Gas System Pressure: Reduce site pressure to secondary pressure of 8 Inch of Water Column. (CONTRACTOR SHALL COORDINATE WITH SUBMITTED GAS-FIRED EQUIPMENT).

1.4 SUBMITTALS

A. See Section 230010 – Mechanical General Provisions.

B. Submit product data, O&M data, and samples and show item on shop drawings (where shop drawings are required) according to the following table.

1. “R” means required.
2. “R2” means required only for products and equipment differing for the specified manufacturer and model and for “or equals” where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawing
Piping (below ground and above ground	R			R
Valves, all types	R			R
Pressure regulators	R			R
Specialties	R	R		R

1.5 QUALITY ASSURANCE

A. FM Standard: Provide components listed in FM's Fire Protection Approval Guide if specified to be FM approved.

B. IAS Standard: Provide components listed in IAS's Directory of AGA and CGA Certified Appliances and Accessories if specified to be IAS listed.

C. UL Standard: Provide component listed in UL's Gas and Oil Equipment Directory if specified to be UL listed.

D. ANSI Standard: Comply with ANSI Z223.1 and NFPA 54 (2009 Edition), "National Fuel Gas Code."

1.6 COORDINATION

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Using Agency or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Owner not less than seven days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Appliance Connector Valves.

a. Conbraco Industries, Inc.: Apollo Div.
b. Mueller Co.: Mueller Gas Products Div.
c. Watts Industries, Inc.: Water Products Div.
d. Brass Craft Manufacturing Co.
e. American Valve.

2. Gas Valves, NPS 2 and smaller.

a. Nibco, Inc.
b. Flow Control Equipment, Inc.
c. Grinnell Corp.
d. Honeywell, Inc. Co.
e. Crane Valves.
f. McDonald: A.Y. McDonald Mfg. Co.

g. Milwaukee Valve Co., Inc.
h. Mueller Co.: Mueller Gas Products Div.
i. Watts Industries, Inc.: Water Products Div.

3. Plug Valves, NPS 2-1/2 and larger.

a. Walworth Co.
b. Olson Technologies, Inc.; Homestead Valve Div.
c. Milliken Valve Co., Inc.

4. Service Meters: As approved by the Utility Provider or Owner.
5. Line Pressure Regulators.

a. American Meter Co.
b. Equimeter, Inc.
c. Fisher Controls International, Inc.
d. Schlumberger Industries: Gas Div.

6. Appliance Pressure Regulators.

a. Eaton Corp.: Controls Div.
b. Harper Wyman Co.
c. Maxitrol Co.

2.2 PIPING MATERIALS

A. Above Ground/Steel Pipe: ASTM A 53; Type E or S; Grade B (Grade A for pipe 1-1/2 inch and smaller) Schedule 40; black.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern, with threaded ends according to ASME B1.20.1.
2. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends according to ASME B1.20.1.
3. Cast-Iron Flanges and Flanged Fittings: ASME B16.1, Class 125.
4. Steel Welding Fittings: ASME B16.9, wrought steel or ASME B16.11, forged steel.
5. Steel Threaded Fittings: ASME B16.11, forged steel with threaded ends according to ASME B1.20.1.
6. Joint Compound and Tape: Suitable for natural gas.
7. Steel Flanges and Flanged Fittings: ASME B16.5.
8. Gasket Material: Thickness, material, and type suitable for natural gas.

2.3 SPECIALTY VALVES

A. Valves, NPS 2 and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.

B. Valves, NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.

C. Appliance Connector Valves: ANSI Z21.15 and IAS listed.

D. Gas Stops: Bronze body with AGA stamp, plug type with bronze plug and flat or square head, ball type with chrome-plated brass ball and lever handle, or butterfly valve with stainless-steel disc and fluorocarbon elastomer seal and lever handle; 2-psig minimum pressure rating.

E. Gas Valves, NPS 2 and Smaller: ASME B16.33 and IAS-listed bronze body and 125-psig pressure rating.

1. Tamperproof Feature: Include design for locking.

F. Plug Valves, NPS 2-1/2 and Larger: ASME B16.38 and MSS SP-78 cast-iron, lubricated plug valves, with 125-psig pressure rating.

1. Tamperproof Feature: Include design for locking.

G. Automatic Gas Valves: ANSI Z21.21, with electrical operator for actuation by appliance automatic shutoff device.

2.4 PRESSURE REGULATORS

A. Description: Single stage and suitable for fuel gas service. Include steel jacket and corrosion-resistant components, elevation compensator, and atmospheric vent.

1. NPS 2 and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
2. NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.
3. Line Pressure Regulators: ANSI Z21.80.
4. Appliance Pressure Regulators: ANSI Z21.18. Regulator may include vent limiting device, instead of vent connection, if approved by Architect.

B. Pressure Regulator Vents: Factory- or field-installed, corrosion-resistant screen in opening if not connected to vent piping.

2.5 METERS

A. Natural gas meter: Provide outside adjacent to mechanical room entrance, a meter for the Owner's use in determining the gas usage for this building. Meter shall be pipe or pedestal mounted, rotary style, enamel coated steel case. Provide combined register totalizer, water escape hole in housing and means for sealing against tampering. Provide with a pulse sensor so the building meter reading system can connect to the gas meter.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Refer to Division 31.

3.2 INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping adjacent to machines to allow service and maintenance.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Select system components with pressure rating equal to or greater than system operating pressure.

I. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

J. Arrange piping to allow inspection and service of equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels if valves or equipment requiring maintenance is concealed behind finished surfaces.

K. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

L. Install sleeve seals for piping penetrations of concrete walls and slabs.

M. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.3 PREPARATION

A. Close equipment shutoff fuel gas to premises or section of piping. Perform leakage test as specified in Article entitled, Field Quality Control, to determine that all equipment is turned off in affected piping section.

B. Comply with ANSI Z223.1, paragraph entitled, Prevention of Accidental Ignition.

3.4 PIPING APPLICATIONS

A. Flanges, unions, transitions, and special fittings with pressure ratings same as or higher than system pressure rating may be used in applications below, provided compliance with the IFGC is maintained.

B. Fuel Gas Piping above ground: Use the following:

1. NPS 2 and Smaller: Steel pipe, malleable-iron threaded fittings, and threaded joints.
2. NPS 2-1/2 and Larger: Steel pipe, steel welding fittings, and welded joints.

C. Fuel-Gas Piping below ground: Use the following:

1. Thermoplastic gas pressure pipe, tubing and fittings, ASTM D2513 with transition riser.

3.5 VALVE APPLICATIONS

A. Appliance Shutoff Valves for Pressure 0.5 psig or less. Appliance connector valve or gas stop.

B. Appliance Shutoff Valves for Pressure 0.5 to 2 psig: Gas stop or gas valve.

C. Appliance Shutoff Valves for Pressure 2 to 5 psig: Gas valve.

D. Piping Line Valves, NPS 2 and Smaller: Gas valve.

E. Piping Line Valves, NPS 2-1/2 and Larger: Plug valve or general-duty valve.

3.6 PIPING INSTALLATION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.

3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

F. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

G. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.

H. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.

1. Plain-End Pipe and Fittings: Use butt fusion.
2. Plain-End Pipe and Socket Fittings: Use socket fusion.

I. PE Piping Install regulator assemblies aboveground. Include gas valve or plug valve for each assembly.

1. Install gas valve or plug valve and strainer upstream from each service pressure regulator.
2. Install service pressure regulators with vent outlet turned down and with corrosion-resistant-metal insect screen.

J. Service Entrance Piping: Extend fuel gas piping and connect to fuel gas distribution for service entrance to building.

1. Exterior service meter will be provided by gas utility.

K. Concealed Locations: Except as specified below, install concealed gas piping in airtight conduit constructed of Schedule 40, seamless, black steel pipe with welded joints. Vent conduit to outside and terminate with screened vent cap.

1. Above-Ceiling Locations: Gas piping may be installed in accessible spaces, subject to approval of authorities having jurisdiction, whether or not such spaces are used as plenums. Do not locate valves above ceilings.
2. In Partitions: Do not install concealed piping in solid partitions. Protect tubing from physical damage when installed inside partitions or hollow walls.
3. In Walls: Gas piping with welded joints and protective wrapping specified in "Protective Coating" Article in Part 2 may be installed in walls, subject to approval of authorities having jurisdiction.
4. Prohibited Locations: Do not install gas piping in or through circulating air ducts, chimneys or gas vents (flues), ventilating ducts, or elevator shafts.

    a. Exception: Accessible above-ceiling space specified above.

L. Drips and Sediment Traps: Install drips at points where condensate may collect. Include outlets of service meters. Locate where readily accessible for cleaning and emptying. Do not install where condensate would be subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use minimum-length nipple of 3 pipe diameters, but not less than 3 inches long, and same size as connected pipe. Install with space between bottom of drip and floor for removal of plug or cap.

M. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings and in floor channels, unless indicated to be exposed to view.

N. Install fuel gas piping at uniform grade of 0.1 percent slope upward toward risers.

O. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

P. Connect branch piping from top or side of horizontal piping.

Q. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.

R. Install strainer on inlet of each line pressure regulator and automatic and electrically operated valve.

S. Install pressure gage upstream and downstream from each line pressure regulator.

T. Install flanges on valves, specialties, and equipment having NPS 2-1/2 and larger connections.

U. Install vent piping for gas pressure regulators and gas trains, extend outside building, and vent to atmosphere. Terminate vents with turned-down, reducing-elbow fittings with corrosion-resistant insect screens in large end.

V. Purging Pipes and Fittings: A combustible gas indicator shall be used when purging mains and piping. When purging gas from abandoned lines, the air and the gas must be discharged aboveground and directed away from power lines or structures. When

purging air from new lines, installation of a 3/4 service saddle and non-corrodible riser is required four (4) feet from each dead-end on all new installations of pipe in order to purge air from all dead-ends simultaneously. Release gas into new lines at a rate that will prevent formation of a hazardous mixture of gas and air or precede natural gas with a slug of inert gas.

W. Pipe Placement and Backfill.

1. When installing polyethylene pipe, sufficient slack shall be provided to allow for possible contraction. The polyethylene pipe shall not have a bend that is less than 25 times the outside diameter of the pipe. If a bend is required that is less than 25 times the outside diameter of the pipe, then an approved polyethylene elbow fitting is required. A fusion joint shall not be placed at a bend. During extremely high temperature conditions it may be necessary to cool the pipe before the last connection.
2. No polyethylene gas line shall be installed above ground. During maintenance, repair, and tie-in work, temporary polyethylene gas lines may be used above ground.
3. The minimum clearance required between the distribution piping and other underground structures is twelve (12) inches. Trench width and minimum cover shall comply with another Section of specification, Excavation, Trenching and Backfilling for Utilities. Unless otherwise shown on plans, pipe embedment shall be select material and remainder of trench may be backfilled with spoil from trenching operation.

3.7 VALVES AND VALVE BOXES

A. Provide valves and valve boxes plumb. All boxes shall be installed flush with the finished grade. Support box with brick or other approved material. Adequate backfill shall be placed around the valve boxes and valve extension boxes to prevent any damage or settlement to the pipeline that may be transferred to the pipe through the valve box. Protective sleeves shall be installed over fusion joints and extend through the valve boxes on the polyethylene valve installations.

3.8 HANGERS AND SUPPORTS

A. Refer to Section 230529 – Hangers and Supports.

3.9 CONNECTIONS

A. Install piping adjacent to appliances to allow service and maintenance. Connect piping to appliances using gas with shutoff valves and unions. Install valve upstream from and within 72 inches of each appliance. Install union downstream from valve.

B. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance using gas.

C. Ground equipment.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
2. Do not use gas pipe as grounding electrode.

3.10 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each service meter, pressure regulator and specialty valve.

1. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each service meter, pressure regulator and specialty valve.
2. Refer to 230553 – Mechanical Identification.

B. Label piping per 230553 – Mechanical Identification.

3.11 PAINTING

A. Use materials and procedures in Division 09 – Painting.

B. Paint all new and existing exterior pipe and interior pipe exposed to view in finished spaces, fittings, pressure regulators, specialty valves, etc.

1. Pipe and Fittings, Color: Yellow (Confirm color with Architect prior to painting).
2. Pressure Regulators, Specialty valves, Etc., Color: Red (Confirm color with Architect prior to painting).

C. Paint exposed interior pipe, fittings, pressure regulators, specialty valves, etc.

1. Pipe and Fittings, Color: Yellow (Confirm color with Architect prior to painting).
2. Pressure Regulators, Specialty valves, Etc., Color: Red (Confirm color with Architect prior to painting).

3.12 FIELD QUALITY CONTROL

A. Inspect, test, and purge piping according to ANSI Z223.1, Part 4 "Inspection, Testing, and Purging" and requirements of authorities having jurisdiction. Isolate pressure reducing valves and equipment controls during testing. Test pressure to be 100 psi for a period of 24 hours with no drop in pressure.

B. Repair leaks and defects with new materials and retest system until satisfactory results are obtained.

C. Report test results promptly and in writing to Architect.

D. Verify capacities and pressure ratings of pressure regulators, valves and specialties.

E. Verify correct pressure settings for pressure regulators.

F. Verify that specified piping tests are complete.

3.13 ADJUSTING

A. Adjust controls and safety devices. Replace damaged and malfunctioning controls and safety devices.

Natural Gas Piping Test Log						
Date	System	Description of Piping Section Tested	Test Press. (psig)	Test Duration (hours)	Results Pass/ Fail	Witness (Contractor) Initials
This form stall be completed and submitted with the project closeout documents. Contractor shall copy this form if more sheets are required. Piping pressure test log shall be kept at project site and shall be made available to the Architect upon request.						

END OF SECTION 231123

SECTION 232300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes materials, equipment, fabrication, special-duty valves, specialties, and installation for the following:

1. Split system refrigerant piping

1.3 REFERENCE STANDARDS

A. ANSI/ARI 495 – Refrigerant Liquid Receivers.

B. ANSI/ARI 710 – Liquid Line Dryers.

C. ANSI/ASHRAE 34 – Number Designation of Refrigerants.

D. ANSI/ASTM B32 – Solder Metal.

E. ANSI/ASTM B88 – Seamless Copper Water Tube.

F. ASTM B280 – Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.

G. ANSI/AWS A5.8 – Brazing Filler Metal.

H. ANSI/AWS D1.1 – Structural Welding Code.

1.4 SUBMITTALS

A. See Section 230010 – Mechanical General Provisions.

B. Submit product data, O&M data, and samples and show item on shop drawings (where shop drawings are required) according to the following table.

1. “R” means required.
2. “R2” means required only for products and equipment differing for the specified manufacturer and model and for “or equals” where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawing
Piping and fitting materials	R			R

1.5 QUALITY ASSURANCE

A. Each length of pipe, fitting, trap, fixture, or device used in any piping system shall be stamped or indelibly marked with:

1. Weight or quality.
2. Maker's name or mark.

B. Examine piping layouts and determine requirements for piping offsets, loops or expansion joints to adequately protect systems.

1. Determine locations and design of anchors and pipe guides to maintain proper piping alignment.
2. Determine anchor reaction forces and coordinate locations of anchors with Architect.

C. Conform to ANSI/ASME B31.1.

1.6 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-410A.

1. Suction Lines for Air-Conditioning Applications: 300 psig.
2. Suction Lines for Heat-Pump Applications: 535 psig.
3. Hot-Gas and Liquid Lines: 535 psig.

1.7 REUTILIZE EXISTING REFRIGERANT PIPING

A. Clean piping per industry standards and new equipment manufacturer’s recommendations.

B. Pressure test and remedy all leaks.

C. Newly insulate.

D. Install with new liquid drier.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 280, Type ACR.

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

E. Brazing Filler Metals: AWS A5.8.

F. Flexible Connectors:

1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
2. End Connections: Socket ends.
3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch- long assembly.
4. Pressure Rating: Factory test at minimum 500 psig.
5. Maximum Operating Temperature: 250 ˚F.

2.2 VALVES AND SPECIALTIES

A. Service Valves:

1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psig.

B. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.

1. Body and Bonnet: Plated steel.
2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch (16-GRC) conduit adapter, and 24-V ac coil.
6. Working Pressure Rating: 400 psig.
7. Maximum Operating Temperature: 240 ˚F.
8. Manual operator.

C. Thermostatic Expansion Valves: Comply with ARI 750.

1. Body, Bonnet, and Seal Cap: Forged brass or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
5. Suction Temperature: See DX Coil (AHU) Schedule.
6. Superheat: Adjustable.
7. Reverse-flow option (for heat-pump applications).

8. End Connections: Socket, flare, or threaded union.
9. Working Pressure Rating: 700 psig.

D. Moisture/Liquid Indicators:

1. Body: Forged brass.
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in ppm.
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 240 ˚F.

E. Replaceable-Core Filter Dryers: Comply with ARI 730.

1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina.
4. End Connections: Socket.
5. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
6. Maximum Pressure Loss: 2 psig.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 240 ˚F.

2.3 REFRIGERANTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Atofina Chemicals, Inc.
2. DuPont Company; Fluorochemicals Div.
3. Honeywell, Inc.; Genetron Refrigerants.
4. Or equal.

B. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-410A.

A. Suction Lines NPS 3-1/2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.

B. Hot-Gas and Liquid Lines: Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered.

3.2 VALVE AND SPECIALTY APPLICATIONS.

A. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.

B. Install thermostatic expansion valves as close as possible to distributors on evaporators.

1. Install valve so diaphragm case is warmer than bulb.
2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

C. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary.

D. Install filter dryers in liquid line between compressor and thermostatic expansion valve.

E. Install flexible connectors at condensing units.

3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

B. Install refrigerant piping according to ASHRAE 15.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

K. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels if valves or equipment requiring maintenance is concealed behind finished surfaces.

L. Install refrigerant piping in protective conduit where installed belowground.

M. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

N. Slope refrigerant piping as follows:

1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Liquid lines may be installed level.

O. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

P. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

Q. Identify refrigerant piping and valves according to Section 230553 – Mechanical Identification.

R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230500 – Basic Mechanical Materials and Methods.

S. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230500 – Basic Mechanical Materials and Methods.

T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230500 – Basic Mechanical Materials and Methods.

3.4 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or soldering, to prevent scale formation.

D. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

3.5 HANGERS AND SUPPORTS

A. See Section 230529 “Hangers and Supports for HVAC Piping and Equipment.”

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
2. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:

1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.
4. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.
5. NPS 1-1/2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
6. NPS 2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
7. NPS 2-1/2: Maximum span, 108 inches; minimum rod size, 3/8 inch.

D. Support multi-floor vertical runs at least at each floor.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Comply with ASME B31.5, Chapter VI.

2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.

    a. Fill system with dry nitrogen to the required test pressure.
    b. System shall maintain test pressure at the manifold gage throughout duration of test.
    c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
    d. Remake leaking joints using new materials and retest until satisfactory results are achieved.

3.7 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:

1. Verify that compressor oil level is correct.
2. Open compressor suction and discharge valves.
3. Open refrigerant valves except bypass valves that are used for other purposes.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

Refrigerant Piping Test Log						
Date	System	Description of Piping Section Tested	Test Press. (psig)	Test Duration (hours)	Results Pass/ Fail	Witness (Contractor) Initials
This form stall be completed and submitted with the project closeout documents. Contractor shall copy this form if more sheets are required. Piping pressure test log shall be kept at project site and shall be made available to the Architect upon request.						

END OF SECTION 232300

SECTION 233113 - METAL DUCTS

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. Work included in this section: materials, equipment, fabrication, installation, and tests in conformity with applicable codes and authorities having jurisdiction for the following:

1. Ductwork.
2. Plenums.
3. Fasteners, sealants, and gaskets.
4. Hangers and supports.
5. Duct air leakage tests.

1.3 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. ASHRAE - Handbook of Fundamentals; Duct Design.
2. ASHRAE - Handbook of HVAC Systems and Equipment; Duct Construction.
3. ASTM A 90 - Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles.
4. ASTM E 96 - Standard Test Methods for Water Vapor Transmission of Materials.
5. ASTM A 167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
6. ASTM A 525 - General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
7. ASTM A 527 - Steel Sheet, Zinc-Coated (Galvanized) by Hot-Dip Process, Lock Forming Quality.
8. ASTM B209 - Aluminum and Aluminum Alloy Sheet and Plate.
9. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
10. NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems.
11. NFPA 96 - Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment.

12. NFPA 45 – Laboratory Ventilating Systems and Hood Requirements.
13. SMACNA – HVAC Duct Construction Standards.
14. SMACNA – Rectangular Industrial Duct Construction Standards.
15. SMACNA – Round Industrial Duct Construction Standards.
16. SMACNA – HVAC Air Duct Leakage Test Manual.
17. UL 181 - Factory-Made Air Ducts and Connectors.
18. Engineering Design Manual for Air Handling Systems, United McGill Corporation (UMC).
19. Assembly and Installation of Spiral Ducts and Fittings, UMC.
20. Engineering Report No. 132 (Spacing of Duct Hangers), UMC.
21. AWSD1.1 American Welding Society Structural Welding Code.

1.4 DEFINITIONS

A. Seam: locks or weld applied longitudinally to close section of duct, for example longitudinal seam, spiral seam.

B. Joint: abutting connection between duct sections for continuity of air passage, for example cross joint, transverse joint, coupling.

C. Reinforcement: hardware applied to strengthen duct, for example girth angles, tie rods, fasteners (not connectors), and the like.

D. Stiffening: folding, bending, beading, crossbreaking or corrugating of sheets to achieve strength through shape, for example pocket lock secures joint and is transverse stiffener, with girth angle and fasteners applied (not connectors), joint or stiffener is reinforced.

E. Duct Classification:

1. Pressure classification: except as indicated on the Drawings:

   a. Low Pressure: Ductwork systems up to 2 inch w.g. positive or negative static pressure with velocities less than or equal to 1500 fpm.
   b. Medium Pressure: Ductwork systems over 2 inch w.g. and up to 6 inch w.g. positive or negative static pressure with velocities less than or equal to 2500 fpm.
   c. High Pressure: Ductwork systems over 6 inch w.g. and up to 10 inch w.g. positive or negative static pressure with velocities greater than 2500 fpm.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements.

1. Entire ductwork system, including materials and installation, installed in accordance with NFPA 90A.
2. Ductwork and components shall be listed as U.L. 181, 181A and 181B, Class I air duct, flame rating not to exceed 25 and smoke rating not to exceed 50.
3. Flues shall conform to the requirements of NFPA-211. Products shall be listed to UL-103 and shall carry the appropriate UL listing mark or label.

1.6 SUBMITTALS

A. See Section 230010 Mechanical General Provisions.

B. Submit product data, O&M data, and samples and show item on shop and coordination drawings according to the following table.

1. “R” means required.
2. “R2” means required only for products and equipment differing for the specified manufacturer and model and for “or equals” where specified.

C. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.

Item	Product Data	O&M Manual	Samples	Shop Drawing
Flexible duct	R			R
Duct pressure testing reports		R		

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Named manufacturer model numbers used as example of item and establish minimum level of quality and minimum standard options. Equivalent models of listed manufacturers are acceptable.

B. Spiral oval and round ducts:

1. United Sheet Metal Division, United McGill.
2. Semco Manufacturing, Inc.
3. Eastern Sheetmetal.
4. Lindab, Inc.
5. Or equal.

C. Duct Connection Systems:

1. Ductmate Industries, Inc.
2. Fabriduct Transverse Duct Connection system.
3. Ward Industries, Inc.
4. Or equal.

D. Flexible Connections:

1. Ventfabrics.
2. Duro Dyne.
3. Or equal.

E. Flexible Ducts:

1. Thermaflex.
2. Hart & Cooley.
3. Flexmaster.
4. Or equal.

F. Duct Sealants:

1. Foster Products Corporation.
2. Hardcast Corporation.
3. 3M.
4. Or equal.

G. Flexible Duct Clamps:

1. Panduit.
2. Dura-Dyne.
3. Young Regulator Company.
4. Or equal.

H. Hi-efficiency & conical Tap Fittings:

1. Flexmaster.
2. Crown.
3. Die Stamp.
4. Or equal.

2.2 APPLICATIONS

A. Ductwork systems shall be constructed in accordance with the following Materials as a minimum standard. Refer to Drawings for any deviation from this Table.

AIR SYSTEM	MATERIAL	SMACNA DUCT PRESSURE CLASS (1)	SMACNA DUCT SEAL CLASS(3)
Supply and Return Systems:			
Single Zone FCU Supply	Galvanized Steel	0.75” w.g.	A
Return Air	Galvanized Steel	0.5” w.g.	A
Exhaust Air Distribution	Galvanized Steel	-0.5” w.g.	A

B. Table Notes:

1. Positive pressure unless noted otherwise in Table.
2. Air device connections may be made with insulated flexible duct as specified herein.

3. Seal Class A Sealing Requirements: Seal all transverse joints, longitudinal seams, and duct wall penetrations. Longitudinal seams are joints oriented in the direction of airflow. Transverse joints are connections of two duct sections oriented perpendicular to airflow. Duct wall penetrations are openings made by any screw fastener, pipe, rod or wire. Spiral lock seams in round and flat oval duct need not be sealed. All other connections are considered transverse joints, including but not limited to taps and other branch connections, access door frames and jambs, duct connections to equipment, etc.
4. Verify minimum pressure classification per NFPA 96 requirements.
5. Applies to exhaust system for general laboratory exhaust, fume hoods, and biosafety cabinets. Refer to Drawings for construction of any additional exhaust systems.
6. Where ductwork systems are subject to routine decontamination (HPV, Clidox, etc.), provide 316L stainless steel ductwork as indicated.

2.3 MATERIALS

A. General Material Requirements.

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. (Minimum duct thickness shall be 24 gauge). Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
2. All duct sizes shown on the Drawings are clear inside dimensions. Allowance shall be made for internal lining, where specified, to provide the required free area.
3. All holes in ducts for damper rods and other necessary devices shall be either drilled or machine punched (not pin punched) and shall not be any larger than necessary. All duct openings shall be provided with sheet metal caps if the openings are to be left unconnected for future connections/phases, otherwise plastic covers are acceptable.

B. Galvanized Steel Sheet Metal:

1. Prime, cold rolled soft galvanized steel sheets.
2. Each sheet shall be stenciled with manufacturer's name and gauge.
3. ASTM A653 and A924.
4. Galvanizing: 1-1/4 ounces per square foot, total both sides.

    a. General: G-90.
    b. Exposed to weather: G-90.
    c. Plenum walls and blank-offs where in contact with cooling coil: G-90.

5. Lock-forming quality.

C. Miscellaneous Products.

1. Screws and rivets:

    a. Same material as sheet, except as indicated on the Drawings.

b. On aluminum sheets, provide cadmium plated or stainless steel.
c. Zinc or cadmium plated, permitted on galvanized sheets.
d. Minimum screw size: No. 10.
e. Minimum rivet size: 4 pound.

2. Duct Sealants:

a. Sealing compound: UL-181 listed, water based:

1) Foster Safetee Duct Sealant 32-19.
2) Childers CP-146.
3) Hardcast Products Group Flex-Grip 550.
4) Or equal.

b. Rolled Elastomeric Duct Sealant: Hardcast Products Group Foil Grip 1403-181BFX, or equal, UL 181 listed.
c. Gaskets:

1) Continuous, reinforced, inert self-conforming type.
2) 1/8 inch thick.
3) Width: to match angle connection.
4) 3M Weatherban Ribbon Sealant PF5422 or equal.

d. Two-Part Hard-Setting Joint Tape:

1) Two-part process includes tape and hard setting sealant.
2) Mineral impregnated woven fiber tape.
3) Impregnated with activator/adhesive of polyvinyl acetate type.
4) UL Listed.
5) Flame spread: 10.
6) Smoke contributed: 0.
7) Equal to Hardcast RTA-50 sealant and DT-5400 4 inch tape.

3. Spring Fasteners:

a. Oval head stud and receptacle.
b. Screwdriver slot.
c. Self-ejecting.
d. Dzus or equal.

4. Angles, tie rod and shapes for reinforcing ducts: In accordance with SMACNA HVAC Duct Construction Standards, except as indicated on the Drawings.
5. Duct connection system:

a. Transverse bolted duct joints.
b. Flanges with permanent, non-hardening sealant.
c. Ductmate Industries Ductmate 25 and 35, Fabriduct TDC, or equal.

D. Flexible Connections:

1. Conforming to NFPA 701, UL Standard No. 214 and NFPA 90A.

2. SMACNA HVAC Duct Construction Standards, except as indicated on the Drawings.
3. With metal edges at each end: No. 24 USSG galvanized steel. Double lock joint.
4. Length of fabric connections.

    a. Minimum: 2-inch.
    b. Maximum: 4-inch.

5. Materials:

    a. Coated glass fabric.
    b. Flame spread rating: 25.
    c. Smoke development rating: 50.
    d. 30 ounces per square yard.
    e. Sewed and cemented seams.
    f. Indoors:

        1) Neoprene.
        2) Ventfabrics, Inc. Ventglas or equal.

    g. Outdoors:

        1) Weather-resistant.
        2) Fiberglass with Hypalon.
        3) UV, sunlight, and ozone resistant.
        4) Ventfabrics, Inc. Ventlon or equal.

    h. Fume or Exhaust Hood:

        1) Fabric coated with Teflon fluorocarbon resins.
        2) Heat resistant up to 500˚F.
        3) Meets UL Standard #214 for flammability and NFPA 102 requirements.
        4) Ventfabrics, Inc. Ventel or equal.

E. Turning Vanes:

1. Galvanized steel ductwork: galvanized steel or painted black steel, except as indicated on the Drawings.
2. Other ductwork: same material as ductwork.
3. Construction per SMACNA HVAC Duct Construction Standards for:

    a. Double wall vanes.
    b. Vane length: Provide separate equal size sections for vane length greater than those indicated in referenced Standards.
    c. Vane runners: Type 1 or 2 acceptable.

4. Vane radius:

    a. 2 inch radius: duct width up to 36 inches.
    b. 4-1/2 inch radius: duct with 36 inches or larger.

5. Vane shall be at the correct angle for airflow (leading edge in line with the entering duct section; leaving edge in line with existing duct section). If only 45° angles are available, turning vanes shall only be used in 90° elbows where the entering width equals the exiting width; all other elbows shall be full radius type unless otherwise indicated on the drawings.

F. Hi-Efficiency Branch Rectangular to Round Take-Off Fittings: Low-pressure round take-off fittings in rectangular duct:

1. Factory-fabricated hi-efficiency take-off fitting.
2. 26 gauge body, G90 galvanized steel.
3. 1” wide mounting flange with fully closed corners and pre-punched screw holes, adhesive coated gasket on flange.
4. Balancing damper:

    a. 20 gauge blade.
    b. G90 galvanized steel 3/8 inch square control shaft.
    c. Nylon shaft bearings/bushings.
    d. 2” high insulation stand-off.
    e. Duro Dyne KR-3 Locking hand quadrant or equal.

5. No scoop allowed for any application.
6. Flexmaster STOD or equal.

G. Conical Taps: Low-pressure round take-off fittings in rectangular duct:

1. Heavy 26-gauge G-90 Galvanized Steel Body
2. (1") 26-gauge G-90 Galvanized Steel Flange
3. Double Sided Adhesive Gasket on Flange
4. Extra Heavy 24-gauge G-90 Galvanized Steel Blade
5. 3/8" Square Axle Secured to Blade with U-bolts (2 U-bolts used for 8" diameter and larger)
6. Nylon bushings on thru and end (all sizes)
7. 2" Stool with Locking Quadrant and Handle (all sizes, wing nuts not acceptable)
8. Sealed on all Seams
9. BO3 (2") Build-out, 3/8" Square Shaft (solid rod), U-bolt, Locking Quadrant, Handle
10. Flexmaster CBD-SOG-BO3 UT 3000G, Crown 3210-DS2 or equal.

2.4 SINGLE WALL ROUND LOW PRESSURE (SNAP LOCK)

A. Duct Classification: Ducts shall be considered low pressure when design velocities are 1500 fpm or less and maximum static pressure is 1-inch W.G., positive or negative.

1. Construct the following ductwork in accordance with minimum reinforcement requirements for static pressure class of 3/4-inch W.G., positive or negative.

    a. Supply ductwork downstream from blower coil units.
    b. Supply, return, or exhaust ductwork serving fans scheduled to operate at less than 3/4-inch W.G.

c. Supply, return, or exhaust branch ductwork which serves one or two inlets/outlets.

2. Construct the following ductwork in accordance with minimum reinforcement requirements for static pressure class of 1-inch W.G. positive or negative. (DOAS)

a. Supply, return, or exhaust ductwork serving fans scheduled to operate at less than 1-inch W.G. On supply fans, pressure drops for louvers, coils, clean filters, and sound traps may be deleted from scheduled fan static.
b. Supply, return, or exhaust ductwork serving multiple duct branches where the Contractor can demonstrate that pressures will not exceed 1-inch W.G., positive or negative.

B. Longitudinal seams on rectangular duct shall be Pittsburgh or Button punch snap lock, or equal. Snap lock seams for round duct may be used only on ducts classified for 1/2-inch W.G. Longitudinal seams for round ducts using lap and rivet, spot weld, or fillet weld may be used only on ducts classified for statics 1-inch W.G. or less.

C. Snap-Lok shall only be acceptable on sizes 12" and smaller, and where longitudinal seams are screwed within 4" of ends and maximum 18" o.c. Circumferential seams/connections shall include minimum 4 screws.

D. Adjustable round elbows can only be used with pressures less than 1" w.g., other spiral fittings will be used.

E. Snap-lock not acceptable when duct is exposed to view.

2.5 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS (LOW PRESSURE)

A. Duct Classification: Ducts shall be considered low pressure when design velocities are 1500 fpm or less and maximum static pressure is 2-inch W.G., positive or negative.

B. General: Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction with galvanized sheet metal, according to SMACNA's "HVAC Duct Construction Standards – Metal and Flexible." Comply with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.

1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure classification.
2. Materials: free from visual imperfections such as pitting, seam marks, roller marks, stains, and discolorations.

C. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches and larger and 0.0359 inches thick or less, with more than 10 square feet of unbraced panel area, unless ducts are lined.

D. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved,

duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

E. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

F. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

G. Bullhead tees are not permitted.

2.6 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS (LOW PRESSURE)

A. Duct Classification: Spiral ducts shall be utilized when design velocities are 1500 fpm or less and maximum static pressure is 2-inch W.G., positive or negative.

B. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

C. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).

D. Factory-fabricated spiral lock seam duct:

1. Snap-lock is not acceptable for ductwork exceeding 12" diameter and where system pressures exceed 1" w.g.
2. Factory-fabricated longitudinal seam acceptable for ducts larger than standard factory sizes.
3. Round Duct Flanges: Prefabricated connection system consisting of double-lipped, EPDM rubber gasket. Manufacture ducts according to connection system manufacturer's tolerances. All flanges to be factory mounted.
4. Flat Oval Ducts: Prefabricated connection system consisting of two flanges and one synthetic rubber gasket.

E. Fittings:

1. Same material, gauge thickness and construction as duct in which installed.

2. Full body fittings are acceptable.

3. Elbows:

a. Seams:

1) 4 inch and higher pressure, class and all ducts exposed to occupant view: continuously welded seams.
2) 1 inch to 3 inch pressure: spot welded with bonded (sealed) seams.

b. Gores:

1) 2 gores - less than or equal to 30 degrees.
2) 3 gores - 31 degrees through 45 degrees.
3) 4 gores – 46 degrees through 60 degrees.
4) 5 gores - over 61 degrees

Type	Pressure	Location	Fittings	Traverse Joints	Branches	Couplings
Round	< 2”	Concealed	Factory Fabricated	Conical/ 45° Entry	Loose Saddle Tap Field Installed	Slip ≤ 20” Flanges > 20”
	< 2”	Exposed	Factory Fabricated	Conical/ 45° Entry	Factory Installed	Slip ≤ 20” Flanges > 20”
Oval	< 2”	Concealed	Factory Fabricated	Conical/ 45° Entry	Factory Installed	Slip ≤ 20” Flanges > 20”
	< 2”	Exposed	Factory Fabricated	Conical/ 45° Entry	Factory Installed	Slip ≤ 20” Flanges > 20”

2.7 FLEXIBLE DUCTS

A. General Requirements:

1. Flexible ducts shall be used for supply air ducts only (not acceptable for return, exhaust, relief, outdoor, etc. air ducts).
2. UL 181, Class I Air Duct.
3. Labeled for compliance with IMC.
4. Class 1 Air Duct, NFPA 90A and 90B, BOCA, SBBC, HUD/FHA, MIN Property Std.
5. Maximum flex duct length 5’-0” (six feet), installed with no more than 90 degrees of bend to diffusers and grilles. Where longer duct runs or more bends are necessary, provide rigid round ductwork.

B. Type 1 Acoustical Insulated

1. Minimum working pressure:

a. 6” w.g. positive
b. 2” w.g. negative, 16” diameter or smaller
c. 1” w.g. negative, 18” & 20” diameter

2. Rated Velocity

a. 2,550 fpm

3. Acoustic Performance:

    a. Minimum insertion loss (dB) for 6’ of 8” diameter flexible duct for flow velocities less than 2,500 fpm.
    b. Acoustical testing to be performed in accordance with ASTM E477 and ADC Test Code FD 72-RI by ETL

	Sound Power Levels, dB re. 10^{-12} Watts, at Octave Band Center Frequency, Hz					
	125	*250*	*500*	*1000*	*2000*	*4000*
Insertion Loss	*5*	*16*	*17*	*18*	*16*	*11*

4. Duct Fabric:

    a. Polyethylene fabric. Fabric to be mechanically locked to the duct helix without the use of adhesives

5. Duct Helix

    a. Corrosive resistant galvanized steel. Helix is to be mechanically formed to attach the duct fabric without the use of adhesives.

6. Vapor Barrier

    a. Fire retardant, reinforced aluminum.
    b. (.05) perm A.S.T.M. E96, Procedure A

7. Insulation

    a. Factory insulation jacket, factory wrapped. R8 minimum.

8. Flexmaster Type 1M or equal.

C. Type 6 Acoustical Insulated (in locations as indicated on schedules/plans)

1. Minimum working pressure:

    a. 6” w.g. positive
    b. 5” w.g. negative, 16” diameter
    c. 1” w.g. negative, 18” & 20” diameter

2. Rated Velocity

    a. 5,550 fpm

3. Acoustic Performance:

    a. Minimum insertion loss (dB) for 6’ of 8” diameter flexible duct for flow velocities less than 2,500 fpm.

b. Acoustical testing to be performed in accordance with ASTM E477 and ADC Test Code FD 72-RI by ETL

	Sound Power Levels, dB re. 10^{-12} Watts, at Octave Band Center Frequency, Hz						
	63	*125*	*250*	*500*	*1000*	*2000*	*4000*
Insertion Loss	*5.7*	*14*	*13*	*15*	*16*	*18*	*16*

4. Duct Fabric:

   a. Spunbond Nylon fabric. Fabric to be mechanically locked to the duct helix without the use of adhesives

5. Duct Helix

   a. Corrosive resistant galvanized steel. Helix is to be mechanically formed to attach the duct fabric without the use of adhesives.

6. Vapor Barrier

   a. Fire retardant, reinforced aluminum.
   b. (.05) perm A.S.T.M. E96, Procedure A

7. Insulation

   a. Factory insulation jacket, factory wrapped. R8 minimum.

8. Flexmaster Type 6M or equal.

2.8 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

I. Round Duct Supports:

1. Minimum 2" wide 20 gauge galvanized metal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordinate with work of other trades.

B. Ductwork Installation – General:

1. Install ducts in accordance with manufacturer's written installation instructions.
2. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
3. Construct with gages, joints, bracing, reinforcing, and other details per latest IMC, ASHRAE, SMACNA and NFPA, unless specified otherwise.

    a. Comply with most stringent.
    b. Provide ducts with IMC gages or thicker when traversing rated corridors.
    c. Combustion air ducts: Minimum 24 gage.

4. Construct of galvanized sheet metal, except where otherwise indicated herein or on Drawings.
5. Provide for duct rigidity by either of these methods:

    a. Beading at 12 inches on center, maximum.
    b. Cross-break outward in ducts having positive internal pressure.
    c. Cross-break inward in ducts having negative internal pressure.

        1) Exception: All ducts exposed to rain shall outward cross-break on top of the duct.

6. Duct dimensions indicated are outside duct dimensions (OD) unless indicated on the Drawings as inside dimension (ID or net, clear dimension).

7. Alter duct sizes on basis of equal friction where required to facilitate installation. Reflect changes in shop drawings for review by Architect.
8. At duct penetrations of walls, floors and ceilings where exposed to occupant view, provide sheet metal angle type escutcheons with no sharp corners or edges.

    a. Clearance from duct to opening shall not exceed 2 inches.
    b. Escutcheons shall overlap wall, floor, or ceiling surface by ½ inch minimum.

9. Frame, trim, caulk and seal all duct penetrations through acoustical walls and partitions.
10. Tapers:

    a. Pitch sides of duct in diverging or converging airflow maximum of 1 to 4 taper.
    b. Abrupt, bushing type fitting not allowed.

11. Duct Openings:

    a. Provide openings where required to accommodate thermometers, smoke detectors, controllers, and the like. Insert through airtight rubber grommets.
    b. Where openings are provided in insulated ductwork for insertion of instruments, install insulation material inside metal ring for use as plug.
    c. At fire dampers allow adequate length of duct to install access door.

12. Avoid penetration of ducts; provide airtight seal at unavoidable penetrations of hanger rods.
13. No exposed sharp metal allowed.

    a. All exposed pins, screws and sharp objects shall be covered with hardening silicon.
    b. All exposed sheet metal edges shall be hemmed with exposed corners rounded smooth.
    c. Remove all sheet metal fish hooks.

14. Install lining in ducts and plenums as specified in Section 230713 – Duct Insulation.
15. Flexible Connections:

    a. Coated glass fabric.
    b. For indoor or outdoor use.
    c. Use diaphragm type at plug fan inlets.
    d. Install at connections to fans and air handling units and as indicated on Drawings.
    e. 2 inch slack in fabric; install to allow minimum movement of 1 inch in both tension and compression.
    f. Protect from direct solar and rain exposure with sheet metal shroud where outdoors.

16. Volume dampers: Install dampers as specified in Section 233300 – Duct Accessories

C. Elbows and Splits:

1. Use radius elbows in rectangular ducts unless otherwise indicated on the Drawings: Centerline radius dimension shall not be less than 1-1/2 duct width.
2. Where space does not permit duct radius specified above, install short radius splitter vanes per SMACNA HVAC Duct Construction Standard.

    a. Number of vanes determined by ratio of inner radius (R) to duct width in plane of radius (W).
    b. One vane: Radius to width ratio above 0.3.
    c. Two vanes: Radius to width ratio between 0.1 to 0.3
    d. Three vanes: Radius to width ratio 0.1 and smaller.

3. Use square turns with turning vanes in rectangular ductwork, unless otherwise indicated on the Drawings, at following locations.

    a. Use only where full radius elbow cannot fit.
    b. Use only in ducts with 2000 fpm or less design velocity.
    c. In high and medium pressure ductwork spot weld turning vane to duct.

D. Rectangular Duct Joints:

1. Transverse Joints:

    a. In medium pressure ductwork shall be Fabriduct TDC or Ductmate or equal.
    b. In low pressure ductwork shall be Fabriduct TDC or equal except that ducts under 19 inches longest side may be slip & drive (S&D)

2. Longitudinal seams shall be Pittsburgh. Snap lock not allowed.

E. Plenum walls, blank-offs, and casings:

1. Construct per SMACNA HVAC Duct Construction Standard, Casings and Plenums.
2. Static pressure class:

    a. Upstream of fan: -2 inches.
    b. Downstream of fan: fan static pressure or greater.

3. Seal all joints, edges, and penetrations as per HVAC ducts as specified herein.

F. Round and oval ductwork:

1. Joints between ducts:

    a. Made with beaded sleeve joints as scheduled.
    b. Duct sealer applied to male end.
    c. Mechanically fastened with sheet metal screws or pop rivets.
    d. Over joint and screw or rivet heads, apply coating of duct sealer.

        1) Duct where exposed to occupant view: Sealant shall be within joint only and not visible.

2. Joints, duct and fitting:

    a. Slip projecting collar of fittings into duct: Per SMACNA HVAC Duct Construction Standard.
    b. Apply duct sealer: Seal and tape as specified above.
    c. Mechanically fasten: Fastening schedule: Per SMACNA HVAC Duct Construction Standard.

3. Branch take-offs:

    a. Medium pressure: 45 degrees (fittings).
    b. Low pressure: straight 90 degrees (fittings).

4. Horizontal supports:

    a. One or two-piece clamp band strap.
    b. Minimum: one per section.
    c. Support fittings as required to prevent sagging.

5. Vertical Supports: one of the following:

    a. Clamp bands with extended ends supported by floor.
    b. Clamp bands with knee bracing.
    c. Pedestal at base of vertical.

G. Grille connections:

1. Provide at entry to diffuser collar either.

    a. Straight duct for 1 duct diameters or greater.
    b. Full radius elbow.
    c. Side inlet plenum.

        1) Height: 4 inches minimum taller than top of grille to provide room for uniform airflow to grille.
        2) Width/length: 2 inches wider than duct or round diffuser collar, whichever is larger.
        3) Internal surfaces lined with minimum 1/2 inch thick Type AL duct liner as specified under Section 230713 – Duct Insulation.
        4) At contractor's option, where plenum is required at round neck diffuser, square neck diffuser with length and width equal to diffuser diameter may be substituted.

    d. Thermaflex FlexFlow Elbow or equal.

2. Connections at grilles shall be insulated to the extent the duct is insulated including the final register box.
3. Seal connections at grilles per seal class of upstream ductwork.

H. Sound-rated duct packing:

1. Wherever possible avoid duct penetrations through sound-rated walls, floors and ceilings.
2. Provide packing for unavoidable duct penetrations.

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Ductwork exposed to occupant view shall be run straight and true, in line with building elements. No sagging or out-of-true straight runs shall be acceptable. Sidewall taps, and duct joints shall be clean and free of visual blemishes and all sealant shall be internal to joint and not visible. Ducts shall have no external markings or tags. All duct beads shall be parallel.

C. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

D. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

E. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

F. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

A. Ducts not exposed to weather: Seal using one of the following:

1. Duct sealer compound.
2. Gasketed TDC or Duct-Mate.
3. Two-Part Hard-Setting Joint Tape.
4. Flexible duct:

    a. Secure with straps or clamps as specified herein.
    b. Supplement with duct tape, both inner and outer liner.

5. Indoor duct where exposed to occupant view: Sealant shall be within joint only and not visible.
6. Fire and fire/smoke dampers: Sealant shall be listed as approved on manufacturer’s UL installation sheet.
7. Continuously welded ducts: Additional sealing not required.

B. Seal punched holes and corner cracks.

C. Seal all factory fabricated ducts, including transverse joints on gored elbows.

D. Seal end caps.

E. After installation and testing reseal joints found to be leaking at no additional cost to the Owner.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor, and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 233300 – Air Duct Accessories.

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer.

3.7 DUCT AIR LEAKAGE TESTING

A. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test. See the Duct Air Leakage Test Log at the end of this section.
2. Test the following systems:

    a. Supply, and Outdoor Air Ducts for DOAS Unit: Test 100% of installed duct sections.
    b. Field installed plenums. Test 100% of all field installed plenums.

3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Test for leaks before applying external insulation.
5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
6. Give seven days' advance notice for testing.

B. General:

1. Pretesting shall be conducted prior to conducting test in presence of TAB Agency and Architect. Once all required ductwork has passed the pretest duct pressure test, the TAB Agency and Architect shall be notified to visit the site for witness testing.
2. Use portable high pressure, blower and necessary instruments to indicate amount of leakage.
3. Conduct tests as prescribed in SMACNA HVAC Air Duct Leakage Test Manual and make test before duct sections are concealed.
4. Procedure:

    a. Seal openings in ducts and plenums to be tested.
    b. Connect test apparatus to test section using flexible duct connection or hose.
    c. Close damper on blower suction side, to prevent excessive buildup of pressure.
    d. Start blower and gradually open damper on suction side of blower.
    e. Build up pressure in test section equal to static pressure class.
    f. Noise generated from duct leakage not acceptable. Seal as required.
    g. Determine amount of air leakage by makeup air flow measurements:

        1) Maximum permitted leakage for HVAC ductwork shall be:

$$CFM_{max} = \left(\frac{A}{100}\right) C_L P^{0.65}$$

Where,

CFM_{max} = The maximum permitted leakage, cubic feet per minute (cfm).
A= Surface area of the tested duct sections, square feet.
C_L= Duct leakage class, cfm/100 square feet at 1 inch water column.
= 6 for rectangular sheet metal, rectangular fibrous ducts, and round flexible ducts
= 3 for round/flat oval sheet metal or fibrous glass ducts
P= Test pressure which shall be equal to the design duct pressure class rating, inches water column.

2) Allowable leakage can also be calculated as 1 percent of the design operating air volume for the entire system. If this method is used, the total system leakage must first be determined and then compared with the 1 percent (of system volume flow) allowable leakage. Acceptance is indicated if the actual measured leakage of the entire system is less than the calculated allowable leakage.
3) If leakage exceeds permitted limit, repair leaks and retest duct sections at no additional cost to the Owner until permitted leakage limits are obtained.

5. Visually mark tested sections with certification sticker and initials of field test inspector.

C. Documentation:

1. Submit certification of test results of compliance to Architect (must be initialed by TAB Agency representative prior to submitting to Architect).
2. Include Duct Air Leakage Test Log indicating compliance.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and test logs.

3.8 PROTECTION

A. Adhere to SMACNA Duct Cleanliness for New Construction Guidelines for Intermediate Level Duct Cleanliness unless more stringent requirements are indicated herein.

B. Storage: Porous materials, such as lined and flexible duct, shall be stored where they will not be exposed to rain or other moisture sources.

C. Temporary closure: Provide temporary closure of polyethylene film or other covering which will prevent entrance of dust and debris at the following conditions:

1. Exposed ends of unlined installed ducts at the end of each day.

2. Exposed ends of lined ducts or plenums whether in storage or installed.

D. Duct cleaning:

1. Using the connected fan(s) force air at high velocity through duct to remove accumulated dust.
2. Protect equipment and spaces, which may be harmed by excessive dirt with filters, or bypass during cleaning.
3. In areas, which must be kept dust free, seal all outlets duct tight. When closures are removed avoid spilling dust in room.

3.9 INSPECTION

A. Verify that adequate clearance between ducts and adjacent walls or equipment is available to permit proper sealing, maintenance and repairs.

3.10 PRE-OPERATING CHECKS

A. Before operating the duct systems: Set all manual dampers in full open position.

3.11 TESTING AND ADJUSTING

A. After starting the duct systems: Check for noise and leakage. Repair as required at no additional cost to the Owner.

B. See Section 230593 – Testing, Adjusting, and Balancing: Coordination with Balance Agency:

1. Provide services of a sheet metal installer familiar with the system ductwork to provide assistance to the balancing agency during the initial phases of air balancing in locating all sheet metal dampers.
2. Install missing dampers.

Duct Air Leakage Test Log					
Date	System	Description of Duct Section Tested	Test Press. (in w.g.)	Results Pass/ Fail	Witness (TAB Agency) Initials

END OF SECTION 233113

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Duct Access Doors.
2. Manual, Automatic and Backdraft Dampers.
3. Wall Louvers and Combination Louvers/Dampers.
4. Duct Accessory Hardware.

1.3 QUALITY ASSURANCE

A. Fire, smoke, and fire/smoke dampers shall be UL listed and constructed in accordance with UL Standard 555 Fire Dampers and UL Standard 555S.

B. Demonstrate operation of smoke dampers to authorities having jurisdiction and Architect as part of life safety testing.

C. Access doors shall be UL labeled.

D. Damper pressure drop and leakage ratings shall be based on tests and procedures performed in accordance with AMCA 500 - Test Methods for Louvers, Dampers and Shutters.

1.4 SUBMITTALS

A. See Section 230010 Mechanical General Provisions.

B. Submit product data, O&M data, and samples and show item on shop and coordination drawings according to the following table.

1. “R” means required.
2. “R2” means required only for products and equipment differing for the specified manufacturer and model and for “or equals” where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawing
Balancing dampers	R2			R
Automatic dampers	R	R		R
Backdraft dampers	R2			R
Wall louvers	R			R
Combination louvers/dampers	R	R		R
Drain pans	R2			

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Named manufacturer model numbers used as example of item and establish minimum level of quality and minimum standard options. Equivalent models of listed manufacturers are acceptable.

2.2 DUCT ACCESS DOORS

A. Manufacturers

1. Ventfabrics, Inc.
2. Duo Dyne, Corporation.
3. Ruskin Mfg. Company.
4. PCI Industries – Pottorff.
5. Ductmate.

B. In accordance with SMACNA Duct Construction Manuals, except as indicated in the Drawings.

C. Construction:

1. Galvanized steel.
2. Rating same as duct pressure class.
3. Where duct is insulated:

    a. Fiberglass insulation, thickness to match duct insulation installed R-value, see 230713 – Duct Insulation.
    b. Double wall.

4. Removable type with safety chain linking door permanently to frame.
5. Positive seal polyethylene gasket.
6. Paired progressive cam-locks, quantity as required for tight, low leakage fit.
7. No tools required for opening and closing.

D. Size:

1. 20 inches x 14 inches unless otherwise indicated in the Drawings.
2. Ducts less than 16 inches: one dimension 20 inches; other dimension 2 inch less than duct width.
3. Larger sizes where required for access.

E. Provide in the following locations:

1. Coils in ducts (including at VAV boxes).

    a. Entering and leaving side for cooling coils.
    b. Entering side for heating coils.

2. Automatic dampers: linkage side.
3. Smoke dampers.
4. Fire dampers.
5. Smoke detection heads.
6. At the top of each lined duct riser accessible from the fan room floor (for inspection of duct liner).
7. Fan bearings enclosed in ducts.
8. Sprinkler heads in ducts.
9. Motors, actuators or other accessories that require access or service inside ducts.
10. Outdoor air plenums as required to clean plenum from dirt and debris.
11. Where otherwise indicated on the Drawings.

2.3 MANUAL, AUTOMATIC AND BACKDRAFT DAMPERS

A. Manufacturers:

1. Ruskin Manufacturing Company.
2. Greenheck Fan Corp.
3. PCI Industries - Pottorff
4. Johnson Controls

B. Manual Dampers:

1. Conform to requirements of SMACNA HVAC Duct Construction Standards.
2. General:

    a. Blades of same material as duct where damper is located.
    b. Damper Hardware:

        1) Ventlok 400 and 4000 series or equal; for low pressure systems 2 inch SMACNA pressure class and less.
        2) Ventlok HiVel hardware or equal; for greater than 2 inch SMACNA pressure class.

c. Actuating quadrants typical for single and multi-blade dampers; provide closed bearing on opposite end from quadrant to prevent air leakage: Ventlok No. 609 or equal.
d. Bearing at one end of damper rod: Ventlok No. 609 or equal.
e. Sealed bushings installed at both ends to avoid duct leakage.
f. Accessible quadrant at other end of damper rod.

1) With lever and lock screw: Ventlok No. 635 or equal.
2) Insulated ducts.

a) Quadrants mounted on collar to clear insulation.
b) Ventlok Nos. 637, 638, or 639 or equal.
c) Selection based on insulation thickness.

g. For dampers above non-removable ceilings and without ceiling access panels provide Ventlok No. 677 or equal concealed damper regulator.

1) With paintable cover plate.
2) Required interconnecting hardware.

3. Round, Inline

a. Heavy 26-gauge G-90 Galvanized Steel Body (all sizes)
b. Extra Heavy 24-gauge G-90 Galvanized Steel Blade
c. 3/8" Square Axle Secured to Blade with U-bolts
d. Nylon bushings on thru and end (all sizes)
e. 2" Stool with Locking Quadrant and Handle (all sizes, wing nuts not acceptable)
f. Sealed on all Seams
g. BO3 (2") Build-out, 3/8" Square Shaft (solid rod), U-bolt, Locking Quadrant, Handle
h. Flexmaster Co. Connecting Sleeve (SL-BO3), Crown 175-XS2 or equal.

4. Rectangular

a. Single blade dampers:

1) Galvanized steel ductwork: galvanized steel, except as indicated in the Drawings.
2) Blade: Two gages heavier than duct gage, or 18 gage, whichever is lighter.

b. Multi-blade dampers.

1) Low Pressure/Low Velocity Systems (2-inch water column or less static pressure class and 1500 fpm or less face velocity).

a) Opposed blade damper.
b) Ruskin Model CD35 or equal.

5. High Pressure/High Velocity Systems (greater than 2-inch water column static pressure class or greater than 1500 fpm face velocity):

    1) Rectangular.

        a) Opposed blade damper.
        b) Ruskin Model CD60 or equal.

    2) Round and Oval.

        a) Oval: Ruskin Model CDR25 and DO25 or equal.
        b) Round: Up to 20-inch diameter: Ruskin Model MDRS25 or equal.
        c) Round: Larger than 20-inch diameter: Ruskin Model CDRS25 or equal.

C. Automatic Dampers:

1. Actuators: See Section 230913 – EMCS Basic Materials and Control System.
2. Construction:

    a. Return air dampers (AHUs):

        1) Class 2 smoke-rated Ruskin Model SD-36 or equal.
        2) End switches: Provide end switch to indicate fully-closed position.

    b. Blade Action:

        1) Throttling duty: opposed.
        2) Mixing duty: parallel.
        3) Two-position: parallel or opposed.

    c. Bearings: Molded synthetic sleeve, turning in extruded hole in frame.
    d. Seals:

        1) Blade: Inflatable PVC coated fiberglass material or neoprene mechanically attached to blade edge.
        2) Jamb: Flexible metal compression type.

    e. Linkage: concealed in frame. External linkage and jack-shafts will not be accepted.
    f. Axles: Minimum 1/2-inch diameter plated steel, hex-shaped, mechanically attached to blade. Side access for direct-coupled actuator.

3. Finish: Mill galvanized.
4. Damper area: See Drawings for sizes.
5. Low Pressure/Low Velocity Systems (2-inch water column or less static pressure class and 1500 fpm or less face velocity).

    a. Integral, heavy-duty factory-installed motorized damper acceptable for exhaust fans unless otherwise scheduled.

b. Ruskin Model CD36 or equal.

6. High Pressure/High Velocity Systems (greater than 2-inch water column static pressure class or greater than 1500 fpm face velocity):

a. Ruskin Model CD60 or equal.

D. Backdraft Dampers:

1. Required locations:

a. Where indicated on the Drawings.
b. In suction or discharge of all exhaust fans as listed in equipment schedule.

1) Integral, heavy-duty factory-installed type acceptable unless otherwise scheduled.

2. General Applications:

a. Construction:

1) Extruded aluminum construction.
2) Extruded vinyl locked into blade edge.
3) Blade ends overlapping frame.

b. Performance:

1) Start to open: .02 inches w.g. or less.
2) Fully open: .05 inches w.g. or less.
3) Leakage for 24 inch wide damper: 25 cfm per ft^2 or less.

c. Ruskin Series CBD4 or equal.

3. High Velocity Applications:

a. Applies to discharge of air handlers and where velocity exceeds 1500 fpm. Damper shall be specifically designed for location at turbulent fan discharge.
b. Frame:

1) Minimum 12 gage galvanized steel channel.
2) Bolt Holes: Both flanges.

c. Blades:

1) Airfoil-shaped with integral structural reinforcing tube running full length of each blade.
2) Material: 7 inches x minimum 0.080 inch Alloy 6063-T5 extruded aluminum.
3) For multiple section dampers, provide galvanized steel or aluminum bracket to link dampers so they operate together.

d. Axles: Minimum 3/4 inch diameter plated steel.
e. Bearings: Bolt-on bearings with re-lube ball bearings.
f. Linkage:

1) 3/16 inch thick x 3/4 inch plated steel tie bar with minimum 16 gage plated steel linkage arms; stainless steel pivot pins.
2) Located out of airstream (side or external linkage).

g. Counterbalance: Located out of airstream.
h. Seals:

1) Blade:

a) Mechanically attach blade seals to blade.
b) Silicone rubber rated for 300 degrees Fahrenheit.

2) Jamb: Vinyl

i. Ruskin CBS92 or equal.

2.4 FIRE DAMPERS

A. Manufacturers:

1. Ruskin Manufacturing Company.
2. Greenheck Fan Corp.
3. Air Balance Inc.
4. PCI Industries – Pottorff.

B. Ratings (test conditions and label) per UL Standard 555.

1. 250 degrees Fahrenheit minimum.
2. 1-1/2 hour fire rating, unless otherwise indicated in the Drawings.
3. Dynamic (closes against air flow).

C. Factory sleeve.

D. Damper.

1. Multi-bladed, equipped with fusible link, spring loaded type.
2. Style:

a. As indicated on the Drawings.
b. Ducted, rectangular duct: Style B (out of airstream).
c. Ducted, round duct: Style A (in airstream) with damper sleeve 2” in each dimension larger than duct; plus, cap and collar.
d. Un-ducted: Style A (in airstream).

E. Fusible Link.

1. UL listed.
2. Fusible links on fire dampers shall be constructed to UL Standard 33 – Fusible Links for Fire Protection Service.
3. Temperature rating: Per code.

F. Type:

1. Rectangular type up to 1000 feet per minute: Ruskin DIBD2 or DIBD10 Style A or equal.
2. Rectangular type 1000 feet per minute and higher: Ruskin DIBD2 or DIBD10 Style B or equal.
3. Circular and oval type: Ruskin DIBD2 Style CR and CO, or DIBD10 Style R and LO or equal.

G. Status end switches:

1. Where indicated on the Drawings.
2. Ruskin SP100 or equal Switch Package.

2.5 COMBINATION SMOKE AND FIRE DAMPERS

A. Manufacturers:

1. Ruskin Manufacturing Company.
2. Greenheck Fan Corp.
3. Air Balance Inc.
4. PCI Industries – Pottorff.

B. Fire ratings (test conditions and label) per UL Standard 555.

1. 250 degrees Fahrenheit minimum.
2. 1-1/2 hour fire rating, unless otherwise indicated in the Drawings.

C. Factory sleeve.

D. Damper.

1. Two-position duty: Either parallel blade or opposed blade.
2. Leakage class, as scheduled minimum Class 2, rated per UL 555S.
3. Locate damper in sleeve starting at approximately 3” from end of the sleeve opposite the damper actuator end. (Damper shall be installed with this end protruding 3 inches out from inside surface of wall.)

E. Actuator.

1. 120 volt.
2. Two-position unless otherwise indicated on drawings.
3. Spring return normally closed unless otherwise indicated on drawings.
4. Electronic cut-out at full-open so that actuator creates no noise holding open.
5. Permanently lubricated gears.

6. Direct coupled with steel clamp; aluminum clamp and external linkage not acceptable.

F. Controls.

1. Heat-actuated electric release.
2. Controlled closure to prevent duct and HVAC component damage.
3. Time to drive from full closed to open and or spring from full open to closed shall not exceed the following:

    a. FSD's: 15 seconds.
    b. All others: 75 seconds.

4. Damper to automatically reopen after a test, smoke detection or power failure condition. In the event of heat activated closure, the damper must be manually reset at the damper.
5. Release temperature: as scheduled on drawings or use the following: 165 ºF. This must be <286 ºF for life safety system or whatever design-fire temperature is for exhaust dampers. Should be about 50°F above normal temperature, not less than 160°F per IBC. In non-life safety buildings, use 165ºF. For life safety bldgs with smoke control, use 250ºF which is more than 50ºF above the design smoke temperature, typically 165ºF.
6. Ruskin EFL or equal.

G. Status end switches.

1. Where indicated on the Drawings.
2. Ruskin SP100 or equal Switch Package.

H. Type.

1. Ruskin Type FSDR25, or equal for round ducts. (UL R5531, CSFM #3230-245:108).
2. Ruskin Type FSD36, or equal for 1800 feet per minute and below. (UL R5531, CSFM #3235-0245:0124).
3. Ruskin Type FSD60 or equal for 1800 feet per minute and above. (UL R5531, CSFM #3235-0245:0126).
4. Alternative Ruskin Type FSD60FA or equal for 1800 feet per minute and above. (UL R5531, CSFM #3230-245:116 respectively).
5. Ruskin Type FSD60M, for short sleeve where needed. (UL R5531, CSFM #3230-245:110).

I. Smoke Detector.

1. Detects presence of smoke in the airstream of ductwork in HVAC systems without a minimum operating velocity including no flow operation.
2. UL Listed.
3. AHJ Required Listing.
4. Ruskin DSDN, or as provided by Div-26 or equal.

2.6 CONDENSATE PUMP

A. Manufacturer: Little Giant, Diversitech, or equal.

B. Provide where scheduled.

C. Contractor shall verify pumping head requirements.

D. Features:

1. Discharge check valve.
2. 115-volt with grounded plug connection.
3. High level alarm contact.

2.7 BELT GUARDS

A. Fabricated per OSHA and SMACNA Duct Construction Standards.

2.8 WALL LOUVERS & COMBINATION LOUVER/DAMPERS

A. Manufacturers:

1. Ruskin Manufacturing Company.
2. Greenheck Fan Corp.
3. PCI Industries – Pottorff.
4. United Enertech

B. Louvers licensed to bear AMCA Certified Ratings Seal. Ratings based on tests and procedures performed in accordance with AMCA 511 and comply with AMCA Certified Ratings Program. AMCA Certified Ratings Seal applies to air performance and water penetration ratings.

C. Materials.

1. Frame.

a. Extruded aluminum, Alloy 6063-T5.
b. Wall Thickness: 0.081 inch, nominal.
c. Depth: 6 inches minimum.
d. Downspouts and caulking surfaces.

2. Blades.

a. Horizontal rain resistant style.
b. Extruded aluminum, Alloy 6063-T5.
c. Wall Thickness: 0.081 inch, nominal.
d. 2 inch blade spacing.

D. Screen (¼" opening hardware cloth on intake, ½" opening on exhaust/relief).

1. Aluminum wire screen.
2. 14 gauge.
3. Frame: Removable, rewireable.
4. Mounted on inside of louver.

E. Gutters: Drain gutter in head frame.

F. Downspouts: Downspouts in jambs to drain water from louver for minimum water cascade from blade to blade.

G. Vertical Supports: Hidden vertical supports to allow continuous line appearance up to 120 inches.

H. Sill: Steeply angled integral sill eliminating areas of standing or trapped moisture where mold or mildew may thrive and effect indoor air quality.

I. Assembly: Factory assemble louver components; mechanically fastened.

J. Blank off panels for unused portions of louvers: 20 gage galvanized sheet metal.

K. Factory Finish:

1. Kynar 500 (70% Kynar Resin) 2-Coat Fluoropolymer Coating or equal, unless otherwise specified on Drawings.

    a. Conform to AAMA 2605-98.
    b. Apply coating following cleaning and pretreatment.
    c. Cleaning: AA-C12C42R1X.
    d. Dry louvers before final finish application.
    e. Total Dry Film Thickness: Approximately 1.2 mils, when baked at 450 degrees Fahrenheit for 10 minutes.
    f. Warranty: Limited 20 year warranty on standard colors.
    g. Color: Color as selected by Architect from manufacturer's standard colors.

L. Basis of Design Louvers:

1. Outside air intake: Greenheck EHH-601 or equal. 6-inch deep wind-driven rain louver.
2. Exhaust outlet: Greenheck EHH-601 or equal. 6-inch deep wind-driven rain louver.
3. Combination louver/damper: Greenheck EACA-601 or equal, 6” frame.

2.9 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Compliance with ASHRAE/IESNA 90.1-2010 includes Section 6.4.3.3.3 - "Shutoff Damper Controls," restricts the use of backdraft dampers, and requires control dampers for certain applications. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Volume dampers.

1. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

    a. Volume dampers shall be installed as far away from air outlets as functionally reasonable to avoid noise in the occupied space.
    b. Provide also in wyes and branch take-offs to outlets whether indicated on the Drawings or not, except.

        1) To sidewall outlets in exposed ducts (opposed blade dampers in outlets shall be provided).

2. For ductwork exposed to occupant view, volume damper handles shall be on top of duct or otherwise concealed from occupant view.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Fire and smoke dampers.

1. Provide in ducts and openings as indicated in the Drawings.
2. Provide access door in duct adjacent to each in location where damper may be inspected and internal fusible link or fire-stat may be replaced.
3. Install duct smoke detector provided by Division 26 if required; see Division 26 drawings.
4. Smoke and fire dampers installed in tunnel corridors shall have weight of damper supported from structure above.

H. Control dampers.

1. Field mounted control dampers installed with concealed linkage shaft accessible on side of damper with space for direct-coupled actuator.
2. Actuator installation: See Section 230913 – EMCS Basic Materials and Devices

I. Install belt guards at all exposed belts.

J. Drain pans.

1. See Section 221316 – Sanitary Waste and Vent Piping.
2. Condensate drain pans (including pans on fan-coils, packaged units, and air handlers).

    a. Slope to drain connection to allow complete draining of pan.
    b. Provide condensate pump where scheduled.
    c. Piping from intermediate drain pan to lowest pan.

        1) Pipe to within 1 inch of and discharge into lowest drain pan.

    d. Piping from lowest pan drain connection to sewer.

        1) Trap height and offset must allow water seal to remain and to allow complete drainage of pan both when fan is operating or not.

    e. Field test.

        1) Test all drain pans after installation to ensure proper slope and drainage and to prevent conditions of water stagnation that result in microbial growth.
        2) Drainage shall be considered acceptable if after covering the entire pan with 1/2 inch water, the pan drains within 3 minutes to leave puddles no more than 2 inch in diameter and no more than 1/8 inch deep.
        3) Test with the fan system in operation for pans on the suction side of the fan, and with the fan off for pans on the discharge side of the fan.
        4) Document tests: See Section 230010 – Mechanical General Provisions.

3. Auxiliary drain pans.

    a. See Section 221316 – Sanitary Waste and Vent Piping.
    b. Separate drain from main drain pan.
    c. Discharge where water flow is readily observed but not over any material or equipment that may be damaged by water.

K. Connect ducts to duct silencers rigidly.

L. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On both sides of duct coils.
2. Upstream from duct filters.

3. At outdoor-air intakes and mixed-air plenums.
4. At drain pans and seals.
5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
7. At each change in direction and at maximum 50-foot spacing.
8. Upstream from turning vanes.
9. Upstream or downstream from duct silencers.
10. Control devices requiring inspection.
11. Elsewhere as indicated.

M. Install access doors with swing against duct static pressure.

N. Label access doors according to Section 230553 Mechanical Identification to indicate the purpose of access door.

O. Install duct test holes where required for testing and balancing purposes.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

3.3 TESTING AND ADJUSTING

A. After starting duct accessories.

1. Check for noise and leakage; repair as required at no additional cost to the Owner.
2. Operation test: Test each piece of equipment to show that it will operate in accordance with requirements.

B. See Section 230593 – Testing, Adjusting, and Balancing for HVAC

END OF SECTION 233000

SECTION 233423 - HVAC POWER VENTILATORS

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. Ceiling Exhaust Fans.

1.3 REFERENCE STANDARDS

A. ANSI/AFBMA Standard 9 – Load Rating and Fatigue Life for Ball Bearings.

B. AMCA 99 – Standards Handbook.

C. AMCA 211 – Product Rating Manual for Fan Air Performance.

D. AMCA 300 – Reverberant Room Method for Sound Testing of Fans.

E. AMCA 311 – Fan Sound Performance.

F. ANSI/AFBMA 11 – Load Ratings and Fatigue Life for Roller Bearings.

G. UL 705 – Standard Power Ventilators.

1.4 QUALITY ASSURANCE

A. AMCA certified ratings per applicable AMCA standard based on the testing conducted in an independent laboratory.

B. Performance Ratings: Conform to AMCA 210 and bear the AMCA Certified Rating Seal.

C. Sound Ratings: AMCA 301; tested to AMCA 300 and bear the AMCA Certified Sound Rating Seal.

D. Fabrication: Conform to AMCA 99.

E. Conform to AMCA Bulletins regarding construction and testing.

1. Fans shall bear AMCA certified rating seal.

F. Scheduled equipment performance is minimum capacity required.

G. Scheduled electrical capacity shall be considered as maximum available.

1.5 SUBMITTALS

A. See Section 230010 – Mechanical General Provisions.

B. Submit product data, O&M data, and samples and show item on shop drawings (where shop drawings are required) according to the following table.

1. "R" means required.
2. "R2" means required only for products and equipment differing for the specified manufacturer and model and for "or equals" where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawing
Fans	R	R		R
Performance curves	R			
Sound Power ratings	R			
Motor ratings and electrical characteristics	R			
Dampers, housings, linkages, and operators	R			
Roof/wall outlet louvers	R			R
Fan speed controllers and other accessories	R	R		

C. Include:

1. Complete graph of fan curves, not just curve for design conditions.
2. Sound power levels:

a. Fans 1 horsepower and larger: dB by octave bands.
b. Fans less than 1 horsepower: sones.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Named manufacturer model numbers used as example of item and establish minimum level of quality and minimum standard options. Equivalent models of listed manufacturers are acceptable.

1. Loren Cook.
2. Greenheck.
3. PennBarry.
4. Or equal.

2.2 GENERAL

A. AMCA certification in accordance with ARI Standard 210 and 211, and AMCA Standard 2408 for centrifugal fans.

B. Fans used shall not increase motor size, increase noise level, or increase tip speed by more than 10 percent, or increase inlet air velocity by more than 20 percent, from specified criteria.

C. Performance.

1. See fan schedule on the Drawings.
2. Capacities: minimum as scheduled on the Drawings.
3. Brake horsepower rating: Maximum 10 percent above that scheduled on the Drawings.
4. Fans and drives shall be capable of accommodating static pressure variations of plus or minus 10 percent.
5. Motor horsepower: No larger than that scheduled on the Drawings or compensate Division 26 contractor for any associated cost to increasing motor size.
6. Sized for a critical speed of at least 125% of maximum RPM.

D. Painting.

1. Electrostatically applied, baked polyester powder coating, minimum 2 mil thick.
2. Paint must exceed 1,000 hour salt spray under ASTM B117 test method.

E. Discharge: As indicated on Drawings.

F. Unit shall bear an engraved aluminum nameplate. Nameplate shall indicate design CFM, static pressure, and maximum fan RPM. Unit shall be shipped in ISTA Certified Transit Tested Packaging

G. Wall Brick Vent Discharge Louvers

1. As shown on drawings

2.3 CEILING EXHAUST FANS

A. Description

1. Fan shall be ceiling mounted centrifugal exhaust fan.

B. Housing: Fan housing shall be galvanized steel and acoustically insulated. Galvanized steel shall be minimum as required by manufacturer model number on plans.

C. Fan Wheel: Wheel shall be centrifugal forward curved type

D. Motor:

1. Motor shall be totally enclosed type with permanently lubricated bearings and built-in thermal overload protection. Motor shall be furnished at the specified voltage and phase.

E. Grille: Painted aluminum, louvered grille with flange on intake and thumbscrew attachment to fan housing.

F. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

G. Sound Data: Maximum sound data allowed per schedules.

H. Accessories:

1. Isolation: Rubber-in-shear vibration isolators.
2. Fan Speed Controller and Disconnect: Pre-Wired.

2.4 DRYER BOOSTER FANS

A. Description

1. Fan shall be a backward incline dryer booster fan.

B. Construction

1. Inline booster fan to be airtight galvanized steel housing to ensure no leakage into structure. Plastic fans are not allowed.
2. Wall mounted booster fan to be galvanized steel housing with powder coat finish.

C. Inline fan to include integrated airflow sensing/pressure switch, temperature limit switch, quick connect/ disconnect fast clamp and wall mounted indicator panel. LED light on the panel shall show operation of fan.

D. Listed for dryer application.

E. Fan shall be installed per all manufacturer’s recommendations.

F. Totally enclosed motor for operation in high moisture, lint, and dust laden air. Fan to maintain 1,200 FPM velocity to suspend lint.

G. Motor features automatic reset thermal overload protection and sealed ball bearings.

H. Fan shall be HVI certified.

I. Fan shall be certified to the DEDPV supplement to the UL705 standard.

J. Accessories:

1. Galvanized metal lint trap with pull out white door with a view window. Lint trap to have attached removable lint filter and 1/2" flange for flush mount installation. (provide when booster fan is installed less than 15 feet from dryer).

2. DB10 Pressure Switch for use with wall mounted booster fan.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordinate with work of other trades.

B. Install fans in accordance with manufacturer's written installation instructions.

C. See Section 233113 – Metal Ducts for duct connections.

D. Backdraft Dampers.

1. Comply with ASHRAE 90.1 and IMC.
2. Provide backdraft dampers for discharge of every exhaust fan and as scheduled on the Drawings.

3.2 TESTING AND ADJUSTING

A. Start up and adjust fans to insure proper operation.

B. The submitted sound power level shall be verified through actual measurements and calculations in accordance with AMCA standards 300 and 301.

C. After starting fans: Check for objectionable noise or vibration. Correct as needed at no additional cost to the Owner.

D. Balancing: See Section 230593 – Testing, Adjusting and Balancing for HVAC.

3.3 TRAINING

A. See Section 230010 – Mechanical General Provisions.

END OF SECTION 233423

SECTION 233700 - AIR OUTLETS AND INLETS

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. Work included in this section: materials, equipment, fabrication, installation and tests in conformity with applicable codes and authorities having jurisdiction for the following: All air outlets, inlets, grilles, registers and diffusers except where integral with manufactured piece of equipment

1.3 REFERENCE STANDARDS

A. ARI Standard 650 – Air Outlets and Inlets.

B. ASHRAE Standard 70 – Methods of Testing for Rating the Airflow Performance of Outlets and Inlets.

C. AMCA Standard 500 – Laboratory Methods of Testing dampers for Rating.

D. NFPA Standard 90A – Installation of Air Conditioning and Ventilating Systems.

E. NFPA 90B – Standard for the Installation of Warm Air Heating and Air Conditioning Systems.

1.4 QUALITY ASSURANCE

A. Comply with ARI Standard 650, ASHRAE Standard 70, AMCA Standard 500, NFPA Standard 90A, and NFPA Standard 90B.

B. Provide outlets and inlets that have, as minimum, throw and noise criteria ratings for each size device as listed in manufacturer's current data, rated as required by the above standards.

1.5 SUBMITTALS

A. See Section 230010 – Mechanical General Provisions

B. Submit product data, O&M data, and samples and show item on shop drawings (where shop drawings are required) according to the following table.

1. “R” means required.
2. “R2” means required only for products and equipment differing for the specified manufacturer and model and for “or equals” where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawing
Grilles, registers, and diffusers	R			R
Accessories	R			

PART 2 - PRODUCTS

2.1 MANUFACTUERERS

A. Named manufacturer model numbers used as example of item and establish minimum level of quality and minimum standard options. Equivalent models of listed manufacturers are acceptable.

1. Titus.
2. Price.
3. Metal Aire.
4. Nailor.
5. Or equal.

2.2 AIR DISTRIBUTION DEVICES

A. Manufacturer shall examine and approve of application of each outlet.

B. Noise level at design capacities: no larger than diffuser selection indicated on the drawings.

C. Material:

1. All grilles are to be of steel construction unless otherwise indicated on schedules.

D. Volume dampers:

1. Do not provide dampers built into grille or directly attached to the grille unless specifically called out on drawings.
2. Opposed blade volume damper key-operated adjustable from face of diffuser on register except as noted.

E. Diffuser frame:

1. Frame type shall be coordinated with ceiling type. Refer to architectural reflected ceiling drawings.

a. At plaster or drywall ceilings:

1) Lay-in diffuser with drywall frame (Titus TRM to match diffuser material). Drywall frame to match diffuser color.

2. No visible screw allowed on diffusers or frames, unless otherwise indicated on the Drawings.
3. Linear and bar diffusers shown as one collinear piece on plans shall be constructed as one piece within manufacturing limitations and to appear as one section if manufacturing limitations require multiple pieces. Provide with Border Type shown on plans. Coordinate exact border type with design professional before ordering.

F. Color:

1. Face and frame: Factory-baked #26 white enamel unless otherwise indicated on the Drawings.
2. Internal parts of grille visible from occupied space, including all parts behind perforated face diffusers and visible parts of plenums: flat black.

G. Provide square to round adapters where required.

H. Provide one-, two-, three- or four-way discharge patterns as indicated on plans.

I. See mechanical schedules for type and sizes.

2.3 SCREENED OPENINGS

A. Mesh:

1. 3/4 in. square pattern.
2. No. 16 galvanized wire.
3. Interwoven.
4. Welded or secured to frame.

B. Frames:

1. 1 inch by 1 inch by 1/8-inch galvanized steel angles.
2. Continuous around perimeter of screen (welded at corners).

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordinate with work of other trades.

B. Install air outlets and inlets in accordance with manufacturer’s written installation instructions and Section 233113 – Metal Ducts.

C. Return and exhaust registers: Install with blades oriented to prevent sight through outlets.

D. Grille backs or plenums visible through grilles painted flat black.

E. Transfer grilles.

1. See indications on the Drawings.
2. Wall installations, unless otherwise indicated, provide two grilles.

a. One on each side of wall, except where open to return air plenum.
b. Connecting sheet metal collar with 18-inch elevation offset for sound and light attenuation.

F. Provide duct screens at termination ducts as indicated on the Drawings.

3.2 MOUNTING AND ALIGNMENT

A. All air outlets and inlets shall be secured to building.

1. Ceiling grilles shall be secured to prevent falling from ceiling during construction or service with minimum of two 16-gauge ceiling wires, two 22-gauge by 1-inch galvanized sheet metal strap or two #10 sheet metal screws.
2. Comply with IBC.

B. Mount directional grilles as indicated on the Drawings.

C. Adjust grille throw patterns.

1. As indicated on the Drawings.
2. For double-deflection grilles, adjust rear blades horizontal and front blades in 45-degree pattern at each end gradually rotating to be almost straight at blades in center of grille.
3. Adjust grille throw patterns prior to test and balance. See Section 230593 – Testing, Adjusting, and Balancing.

3.3 INSPECTION

A. Verify mounting, direction and adjustments are installed as indicated on the Drawings.

3.4 TESTING AND ADJUSTING

A. See Section 230593 – Testing, Adjusting, and Balancing for HVAC.

END OF SECTION 233700

SECTION 234000 - AIR CLEANING 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. Work included in this section: materials, equipment, fabrication, installation and tests in conformity with applicable codes and authorities having jurisdiction for the following:

1. Filter media.
2. Filter frames in built-up systems.

1.3 REFERENCE STANDARDS

A. ASHRAE Standard 52.2-1999 – Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.

B. ANSI/UL 900 – Test Performance of Air Filter Units.

1.4 QUALITY ASSURANCE

A. Filters shall have MERV ratings in accordance with ASHRAE Standard 52.2 with preconditioning as specified in Appendix J of that Standard.

1.5 SUBMITTALS (NOT REQUIRED UNLESS CONTRACTOR CHOOSES TO SUBSTITUTE)

A. See Section 230010 – Mechanical General Provisions

B. Submit product data, O&M data, and samples and show item on shop drawings.

1. “R” means required.
2. “R2” means required only for products and equipment differing for the specified manufacturer and model and for “or equals” where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawing
Filters	R			

PART 2 - PRODUCTS

2.1 MANUFACTUERERS

A. Named manufacturer model numbers used as example of item and establish minimum level of quality and minimum standard options. Equivalent models of listed manufacturers are acceptable.

B. Filter Media and Frames:

1. Camfil/Farr Filtration Group.
2. Flanders/Precisionaire.
3. American Air Filter.
4. Or equal.

2.2 FILTERS

A. General.

1. UL 900 listed.
2. Disposable type.
3. Each filter shall consist of media, media support grid, and enclosing frame.
4. Each filter shall have flow direction and MERV rating permanently affixed to frame.

B. Type 1: Pleated Filter:

1. 2 inch or 4 inch pleated.
2. Media: Cotton & synthetic media (no polyester).
3. Minimum performance:

a. MERV 8 for use after construction period.
b. MERV 11 for use at startup and during construction period.

4. Maximum initial pressure drop at 500 feet per minute face velocity shall not to exceed 0.3 inches water column. Final pressure drop shall be no less than 1.0 inch water column.
5. Camfil/Farr 30/30 or equal.

C. Type 2: Bulk Media:

1. 1 inch fiberglass.
2. Filter media shall consist of a continuous filament fiberglass of graduated density. Media shall include a skin on the leaving air side. Furthermore, the media shall be treated with a non-toxic, non-flammable, odor free adhesive.
3. UL listed, Class 2.

2.3 FRAMES

A. For air handlers and fan-coils, see individual specifications Sections.

PART 3 - EXECUTION

3.1 FILTER MEDIA

A. Media as selected in equipment schedules on the Drawings.

B. Construction filters:

1. Type 1 for all equipment: roll media not acceptable.
2. Type 2 filter media is intended to be utilized over return/exhaust air grilles, registers and/or open ductwork during the construction period when the systems are being operated. This filter media is not to be utilized inside the housing of any HVAC systems.

C. Spare Filters:

1. Provide five (5) sets of spare filters for each piece of HVAC equipment and filter grille except the following (provide only one (1) spare set):

a. PTAC's (thru-wall units).
b. VRF system (indoor units, ductless type washable).

3.2 INSTALLATION

A. Factory installed in air handling equipment.

B. Coordinate with work of other trades.

C. Install Air Cleaning Devices in accordance with manufacturer's written installation instructions.

D. See Section 230593 – Testing, Adjusting, and Balancing for HVAC.

3.3 START-UP PROCEDURES

A. Do not operate air handling unit fan systems for any reason until spaces served have been cleaned of dust and debris, to avoid contamination of supply air or return air paths and equipment.

B. Supply fans shall not be operated unless filters are installed, including temporary filters for use during test and balance.

C. If the final pressure drop of the temporary filters is reached during test and balance, replace them with a spare set.

D. Before turning system over to the Owner, remove temporary construction filters and install clean final filters:

1. Remove prefilters in front of cartridge, bag, and HEPA filters after construction and do not replace. Prefilters shall not be used during normal operation.
2. See also Section 230593 – Testing, Adjusting, and Balancing for HVAC, Section 230010 – Mechanical General Provisions and Section 230500 – Basic Materials and Methods for media installation during temporary equipment operation and test and balance periods.

3.4 INSPECTION

A. Verify that adequate clearance between Air Cleaning Devices and adjacent walls or equipment is available to permit maintenance and replacement of filters.

B. Verify that filters are firmly seated in frame to minimize bypass.

3.5 TRAINING

A. See Section 230010 – Mechanical General Provisions.

END OF SECTION 234000

SECTION 235416.13 - GAS-FIRED FURNACES

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. Gas-fired furnaces and accessories complete with controls.
2. Air filters.
3. Air cleaners.
4. Refrigeration components.

1.3 SUBMITTALS

A. See Section 230010 – Mechanical General Provisions.

B. Submit product data, O&M data, and samples and show item on shop drawings (where shop drawings are required) according to the following table.

1. “R” means required.
2. “R2” means required only for products and equipment differing for the specified manufacturer and model and for “or equals” where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawing
Furnace	R	R		R
Furnace controls	R	R		
Furnace accessories	R	R		R
Condensing unit	R	R		R
Cooling coil	R	R		R
Specialties	R	R		
Accessories	R	R		

1.4 MAINTENANCE MATERIAL SUBMITTALS

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. Disposable Air Filters: Furnish two complete sets.

1.5 QUALITY ASSURANCE

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

B. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

C. Comply with NFPA 70.

1.6 WARRANTY

A. Special Warranty: Manufacturer shall provide parts only warranty coverage for the following components that fail in materials or workmanship within specified warranty period:

1. Warranty Period, Commencing on Date of Substantial Completion:

a. Furnace Heat Exchanger: 10 years.
b. Refrigeration Compressors: 5 years.
c. Parts, Entire Unit: 5 years.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a qualified testing agency, and marked for intended location and application.

B. General Requirements for Noncondensing Gas-Fired Furnaces: Factory assembled, piped, wired, and tested; complying with ANSI Z21.47/CSA 2.3 and NFPA 54.

2.2 GAS-FIRED FURNACES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Lennox Industries, Inc.; Lennox International.
2. Trane.
3. Tempstar.
4. Rheem.

B. Convertible from upflow, to horizontal with left or right airflow.

C. Single wire twinning.

D. Cabinet: Steel.

1. Cabinet interior around heat exchanger shall be factory-installed insulation.
2. Lift-out panels shall expose burners and all other items requiring access for maintenance.
3. Factory paint external cabinets in manufacturer's standard color.
4. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

E. Fan: Centrifugal, factory balanced, resilient mounted, direct drive.

1. Fan Motors: Comply with requirements in Section 230513 Motors and Controllers
2. Special Motor Features: Single speed, premium efficiency, as defined in Section 230513 "Common Motor Requirements for HVAC Equipment," and with internal thermal protection and permanent lubrication.

F. Type of Gas: Natural.

G. Heat Exchanger:

1. Primary: Aluminized steel.
2. Secondary: Stainless steel.

H. Burner:

1. Gas Valve: 100 percent safety two-stage main gas valve, main shutoff valve, pressure regulator, safety pilot with electronic flame sensor, limit control, transformer, and combination ignition/fan timer control board.
2. Ignition: Electric pilot ignition, with hot-surface igniter or electric spark ignition.

I. Gas-Burner Safety Controls:

1. Electronic Flame Sensor: Prevents gas valve from opening until pilot flame is proven; stops gas flow on ignition failure.
2. Flame Rollout Switch: Installed on burner box; prevents burner operation.
3. Limit Control: Fixed stop at maximum permissible setting; de-energizes burner on excessive bonnet temperature; automatic reset.

J. Combustion-Air Inducer: Centrifugal fan with thermally protected motor and sleeve bearings prepurges heat exchanger and vents combustion products; pressure switch prevents furnace operation if combustion-air inlet or flue outlet is blocked.

K. Furnace Controls: Solid-state board integrates ignition, heat, cooling, and fan speeds; adjustable fan-on and fan-off timing; terminals for connection to accessories; diagnostic light with viewport.

2.3 THERMOSTATS

A. Controls shall comply with requirements in ASHRAE/IES 90.1, "Controls."

B. WIFI Enable Programmable “Smart” Thermostat:

1. Thermostat Type: Communicating, Digital, Low Voltage, Programmable.
2. WiFi Specifications: 802.11b, 802.11g, 802.11n, 2.4GHz range
3. Display Type: Color Touchscreen.
4. Program Modes: 7-day programmable, Manual/Not Programmed.
5. Fan Function: Cycled, Continuous.
6. Power Supply: Hardwired
7. Stages: 2 Heat/2 Cool
8. Warranty: 5 years
9. Honeywell TH9320WF5003 or equal.

C. Solid-State Thermostat: Wall-mounted, programmable, microprocessor-based unit with automatic switching from heating to cooling, preferential rate control, seven-day programmability with minimum of four temperature presets per day, vacation mode, and battery backup protection against power failure for program settings.

D. Control Wiring: Unshielded twisted-pair cabling.

1. No. 24 AWG, 100 ohm, four pair.
2. Cable Jacket Color: Blue.

2.4 AIR FILTERS AND FILTER HOUSING,

A. Disposable Filters: 1-inch- thick fiberglass media with ASHRAE 52.2 MERV rating of 8 or higher, in sheet metal frame.

B. Description: Factory assembled, side or top service housings, constructed of 18 gage galvanized steel with integral track to receive 2-inch filters.

C. Access Door: Continuous gasket on perimeter and locking device which does not require use of any tools to open or close.

D. Sealing: Size of housing shall match the size of the inlet of the furnace being served. Incorporate positive-sealing gasket material between furnace and filter housing and filter housing and return air plenum to prevent bypass of unfiltered air.

2.5 REFRIGERATION COMPONENTS

A. General Refrigeration Component Requirements:

1. Refrigeration compressor, coils, and specialties shall be designed to operate with CFC-free refrigerants.
2. Energy Efficiency: Equal to or greater than prescribed by ASHRAE/IES 90.1.

B. Refrigerant Coil: Copper tubes mechanically expanded into aluminum fins. Comply with AHRI 210/240. Match size with furnace. Include condensate drain pan with accessible drain outlet complying with ASHRAE 62.1.

1. Refrigerant Coil Enclosure: Steel, matching furnace and evaporator coil, with access panel and flanges for integral mounting at or on furnace cabinet and galvanized sheet metal drain pan coated with black asphaltic base paint.

C. Refrigerant Piping: Comply with requirements in Section 232300 "Refrigerant Piping."

D. Air-Cooled Compressor-Condenser Unit:

1. Casing: Steel, finished with baked enamel, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Coil Guards: Coil guards shall be constructed of louvered steel panels or 16 gauge expanded galvanized steel as detailed on the drawings. Guard finish shall match that of the condensing unit.
3. Compressor: Hermetically sealed scroll type.

    a. Crankcase heater.
    b. Vibration isolation mounts for compressor.
    c. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
    d. Refrigerant Charge: R-410A.

4. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with AHRI 210/240, and with liquid sub-cooler.
5. Heat-Pump Components: Reversing valve and low-temperature air cut-off thermostat.
6. Fan: Aluminum-propeller type, directly connected to motor.
7. Motor: Permanently lubricated, with integral thermal-overload protection.
8. Low Ambient Kit: Permits operation down to 30 deg F.
9. Liquid line dryer.
10. Anti-short cycle timer.
11. Electro-mechanical high and low pressure, controls.
12. Evaporator defrost control.
13. Automatic reset timer to prevent compressor rapid cycle.
14. Hard start kit for single phase units.
15. Mounting Base: Concrete housekeeping pad unless otherwise specified.

E. Condenser Fan: Direct-drive, aluminum propeller fan; with permanently lubricated fan motor with thermal-overload protection.

F. Condenser: Aluminum-tube, aluminum-fin coil, with liquid sub-cooler.

1. Coil: 5/16 inch O.D. seamless aluminum.
2. Fin: aluminum continuous glued to coil.
3. Lab tested to withstand 2,000 psi.
4. Protected on all sides by louvered panels.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine factory-installed insulation before furnace installation. Reject units that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for gas and refrigerant piping systems to verify actual locations of piping connections before equipment installation.

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

3.2 INSTALLATION

A. Install gas-fired furnaces and associated fuel and vent features and systems according to NFPA 54.

B. Suspended Units: Suspend from structure using threaded rods, spring hangers, and building attachments. Secure rods to unit hanger attachments. Adjust hangers so unit is level and plumb.

C. Base-Mounted Units: Secure units to substrate. Provide optional bottom closure base if required by installation conditions.

D. Controls: Install thermostats and humidistats at mounting height of 60 inches above floor.

E. Wiring Method: Install control wiring in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal control wiring except in unfinished spaces.

F. Install ground-mounted, compressor-condenser components on 6-inch-thick, reinforced concrete base; 4 inches larger on each side than unit. Concrete, reinforcement, and formwork are specified in Division 03. Coordinate anchor installation with concrete base.

G. Install roof-mounted compressor-condenser components on equipment supports. Anchor units to supports with removable, cadmium-plated fasteners.

3.3 CONNECTIONS

A. Gas piping installation requirements are specified in Section 231123 Facility Natural-Gas Piping. Drawings indicate general arrangement of piping, fittings, and specialties. Connect gas piping with union or flange and appliance connector valve.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Vent Connection, Noncondensing, Gas-Fired Furnaces: Connect Type B vents to furnace vent connection and extend outdoors.

D. Connect ducts to furnace with flexible connector. Comply with requirements in Section 233300 "Air Duct Accessories."

E. Connect refrigerant tubing kits to refrigerant coil in furnace and to air-cooled compressor-condenser unit.

1. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.

F. Comply with requirements in Section 232300 "Refrigerant Piping" for installation and joint construction of refrigerant piping.

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Perform electrical test and visual and mechanical inspection.
2. Leak Test: After installation, charge systems with refrigerant and test for leaks. Repair leaks, replace lost refrigerant and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation, product capability, and compliance with requirements.
4. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.
5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

3.5 STARTUP SERVICE

A. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

1. Inspect for physical damage to unit casings.
2. Verify that access doors move freely and are weathertight.
3. Clean units and inspect for construction debris.
4. Verify that all bolts and screws are tight.
5. Adjust vibration isolation and flexible connections.
6. Verify that controls are connected and operational.

B. Start unit according to manufacturer's written instructions and complete manufacturer's operational checklist.

C. Measure and record airflows.

D. Verify proper operation of capacity control device.

E. After startup and performance test and lubricate bearings.

3.6 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Set controls, burner, and other adjustments for optimum heating performance and efficiency. Adjust heat-distribution features, including shutters, dampers, and relays, to provide optimum heating performance and system efficiency.

3.7 CLEANING

A. After completing installation, clean furnaces internally according to manufacturer's written instructions.

B. Install new filters in each furnace within 14 days after Substantial Completion.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain condensing units. Refer to Section 230010 – Mechanical General Provisions.

END OF SECTION 235416.13

SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

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. Work included in this section: materials, equipment, fabrication, installation, and tests in conformity with applicable codes and authorities having jurisdiction for the following:

1. Split-system heat pumps.
2. Split-system air conditioners

1.3 SUBMITTALS

A. See Section 230010 Mechanical General Provisions.

B. Submit product data, O&M data, and samples and show item on shop and coordination drawings (where shop and coordination drawings are required) according to the following table.

1. “R” means required.
2. “R2” means required only for products and equipment differing for the specified manufacturer and model and for “or equals” where specified.

Item	Product Data	O&M Manual	Samples	Shop Drawing
Split-system indoor unit and direct expansion coil	R	R		R
Outdoor heat pump or condensing unit	R	R		R
Controls	R	R		
Accessories	R	R		
Installation details				R

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Gaskets: One sets for each access door.

2. Fan Belts: One sets for each air-handling unit fan.

1.5 REFERENCE STANDARDS

A. ARI Standard 210/240 - Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment.

B. AMCA Standard 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating (ANSI).

C. UL 1995 – Heating and Cooling Equipment.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - " Procedures," and Section 7 - "Construction and System Start-up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.7 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.

B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:

a. For Compressor: Five years from date of Substantial Completion.
b. For Parts: One year from date of Substantial Completion.
c. For Labor: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Named manufacturer model numbers used as example of item and establish minimum level of quality and minimum standard options. Equivalent models are acceptable.

1. Lennox.
2. Trane.
3. York.
4. Or equal.

2.2 AIR SOURCE HEAT PUMP AIR HANDLING UNITS

A. Air Handler Casing: Casing shall be heavy gauge steel, phosphatized and finished with baked-on enamel. Evaporator and heat exchanger sections shall be insulated with one-inch (1") thick foil-faced glass fiber. Modular in design, multi-position up/down flow, horizontal left/right. Access panels with captive screws.

B. External Filter Rack:

1. Factory assembled, side or top service housings, constructed of 18 gage galvanized steel with integral track to receive 2-inch MERV 8 filters.
2. Access Door: Continuous gasket on perimeter and locking device which does not require use of any tools to open or close.
3. Sealing: Size of housing shall match the size of the inlet of the furnace being served. Incorporate positive-sealing gasket material between furnace and filter housing and return air plenum to prevent bypass of unfiltered air.

C. Condensate Drain Pans:

1. Fabricated with two percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.

    a. Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
    b. Depth: A minimum of 2 inches deep.

2. Single-wall, polymer or stainless-steel sheet.
3. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.

D. Evaporator coil shall be constructed of aluminum fins, mechanically bonded to copper tubes. Coil shall be tested at 400 psig. Coil shall be dual circuited on units larger than 6 tons, or as indicated on Construction Drawings. Electronic expansion valve with low ambient and low superheat protection.

E. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.

F. Supply fans.

1. Centrifugal, factory balanced, adjustable belt drive, permanently lubricated bearings.
2. Centrifugal, factory balanced, resilient mounted, direct drive.
3. Dual fans on air handling units 12.5 tons and greater.
4. See fan type indicated on Construction Drawings.

G. Fan motors.

1. Motor sheave on standard belt drive units shall be adjustable. Motor sheave on Single Zone VAV units shall be fixed. Motors shall have inherent overload protection.
2. Constant torque Electrically Commutated Motor (ECM).
3. Variable frequency drive (VFD) where indicated on Construction Drawings.
4. See motor type indicated on Construction Drawings.
5. See Section 230513 – Motor and Controllers.

H. Electrical.

1. Provide units with single point power connection and control box with circuit breakers for overload and short circuit protection. Factory wired and mounted on electric heat unit. Circuit breakers shall qualify as disconnect means at unit. Provide unit with circuit breaker cover kit to protect circuit breaker.

I. Controls.

1. Provide unit with low voltage electric controls.
2. Wall mounted programmable thermostat.

    a. LCD touchscreen display.
    b. Heating and cooling stages to match application specified.
    c. 7-day programmable.
    d. Proportional plus integral (PI) control.
    e. Touchscreen lockout.
    f. Setpoint adjustment.
    g. Override control.
    h. Fan speed control.
    i. Clock.

2.3 AIR SOURCE HEAT PUMP OUTDOOR UNITS

A. Air-Cooled, Compressor-Condenser Components:

1. Units shall be single or dual circuit type, as scheduled, and shall consist of scroll compressor(s) and, condenser coil(s), condenser fans, refrigerant receiver, charging valves, controls and holding charge.
2. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing. Casing shall have factory provided and installed condenser coil hail guards.
3. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

    a. Compressor Type: Scroll.
    b. Refrigerant Charge: R-410A.
    c. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.

4. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
5. Fan: Aluminum-propeller type, directly connected to motor.
6. Motor: Permanently lubricated, with integral thermal-overload protection.
7. Controls shall include contactors, high-pressure outlet with thermostatic reset, low-pressure cutout and reset relay to prevent unit cycling on overloads once the automatic resetting safety control trips. Where indicated or scheduled, provide units with low ambient controls with stable operation down to 0 ˚F including variable feed refrigerant head pressure controlled condenser fan operation. All wiring and devices shall be internal to cabinet. Exposed wiring is not acceptable.
8. Condenser coils shall be coated with a cathodic epoxy type electrodisposition coating formulated to uniformly cover all condenser-coil surfaces, including the edges of the fins, coils, heads, and frame, with a .8 –1.2 mil layer. The coating shall be selected to provide excellent resistance and durability to corrosive effects of alkalies, acids, alcohols, petroleum, seawater, salt air and corrosive environments. Coat shall be proven to withstand a 3,000-hour salt spray exposure test, with coil's heat transfer capacity reduced less than one percent.

B. Controls.

1. Provide single point unit power connection.
2. Provide unit with low voltage electric controls.
3. Unit control box shall be located within the unit and shall contain controls for compressor, reversing valve and fan motor operation and shall have a 50 VA 24-volt control circuit transformer and a terminal block for low voltage field wiring connections.
4. Safety Controls - High pressure, low temperature, and low pressure safety switches shall be wired through a latching lockout circuit to hold the conditioner off until it is reset electrically by interrupting the power supply to the conditioner. All safety switches shall be normally closed, opening upon fault detection.

2.4 ACCESSORIES

A. Automatic-reset timer to prevent rapid cycling of compressor.

B. Hard start kit.

C. Drain Hose: For condensate, where required.

2.5 AUXILLIARY DRAIN PAN

A. Provide auxiliary drain pan underneath indoor air handling units installed above ceilings.

B. Auxiliary drain pan shall extend six inches beyond the perimeter of the air handling unit in all directions.

C. Pipe drain pan discharge to sanitary sewer, See Section 221316 -Sanitary Waste and Vent Piping.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Equipment Mounting:

1. Install ground-mounted, compressor-condenser components on cast-in-place concrete housekeeping pad.

D. Install and connect refrigerant piping to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

C. Piping: Comply with requirements in Section 232300 – Refrigerant Piping.

D. Duct Connections: Duct installation requirements are specified in Section 233113 – Metal Ducts. Drawings indicate the general arrangement of ducts. Connect supply and

return ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Section 233300 – Air Duct Accessories.

3.3 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning units and retest as specified above.

C. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust initial temperature set points.

3.5 CLEANING

A. After completing installation, clean units externally and internally according to manufacturer's written instructions.

B. Install new filters in each indoor unit prior to performing Testing, Adjusting, and Balancing work.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 238126

NOTES:

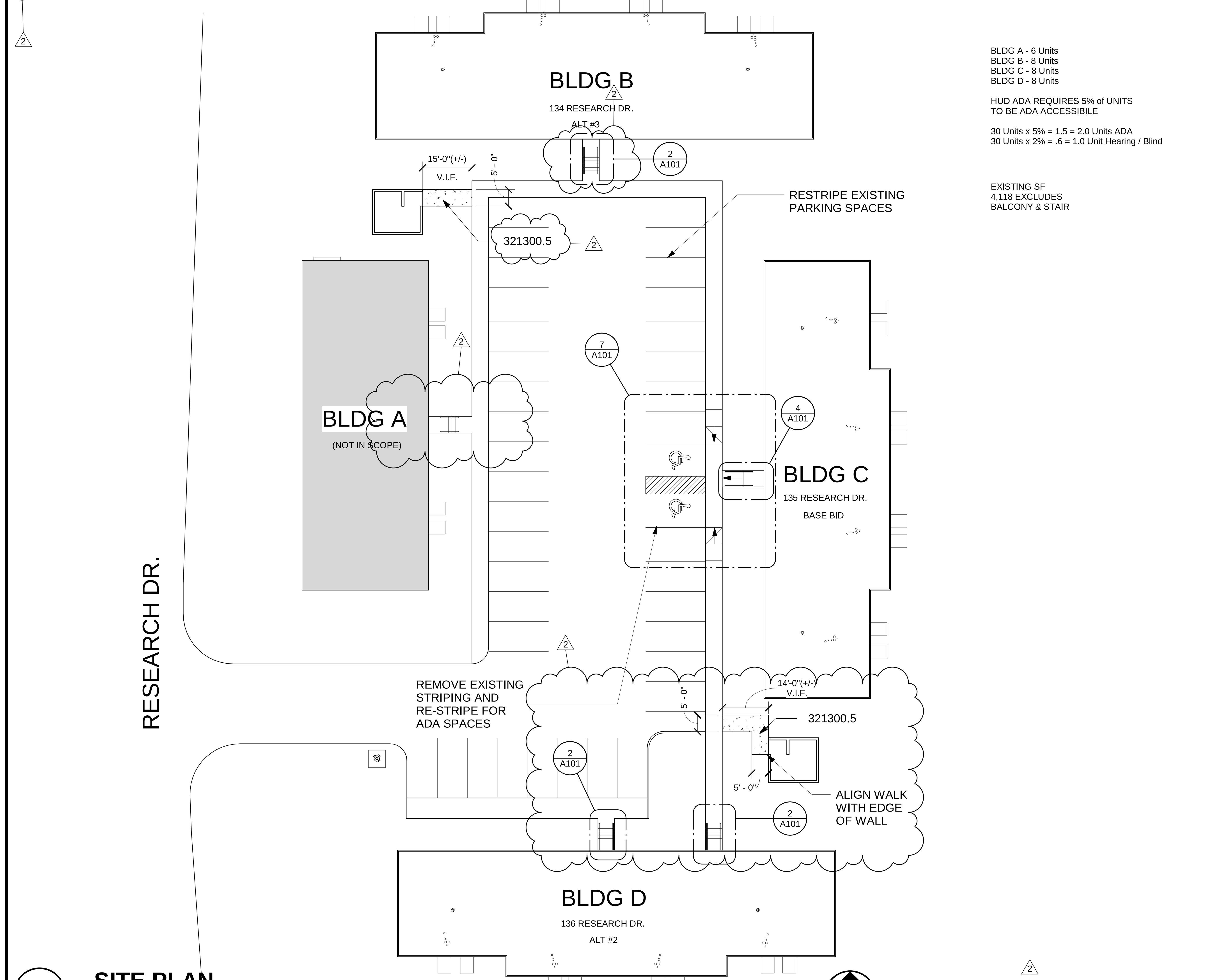
1. SIDEWALK CROSS SLOPES SHALL NOT EXCEED 2%.
2. RAMP SLOPES SHALL NOT EXCEED 8.33%.
3. SUB-GRADE FOR SIDEWALK SHALL BE PREPARED IN SAME MANNER AS REQUIRED FOR PAVEMENT CONSTRUCTION.
4. EXPANSION JOINT REQUIRED WHERE TYING SIDEWALK TO BUILDING OR BACK OF CURB WITH 1/2" PREMOLDED BITUMINOUS FIBER BOARD AND TOP FILLED WITH 1/2" SELF LEVELING ELASTOMERIC SEALER.
5. WELDED WIRE FABRIC SHALL BE SHEETS AND NOT ROLLS.
6. CONTRACTION JOINTS REQUIRED AT 5' O.C. & EXPANSION JOINTS REQUIRED AT 15' O.C. UNLESS OTHERWISE SHOWN ON THE DRAWINGS.
7. CONTRACTION/CONTROL JOINTS SHALL BE TOOLED OR SAWCUT IN STRAIGHT LINES TO THE DEPTHS SHOWN AT THE PROPER CURE TIME AND WITH THE PROPER MATERIALS/EQUIPMENT TO LEAVE THE FINISHED CONCRETE SURFACE ALONG THE JOINTS LOOKING SMOOTH AND FREE FROM CHIPPING OR OTHER DEFECTS. JOINTS WHERE CHIPPING OR OTHER IRREGULARITIES THAT COMPROMISE THE LOOK OF THE CONCRETE PER THE OWNER/ENGINEER SHALL BE REJECTED AND SUBSEQUENTLY REMOVED AND REPLACED BY THE CONTRACTOR AT NO ADDITIONAL COST TO THE OWNER.
8. CONTRACTOR SHALL SEE SPOT ELEVATIONS ON GRADING LAYOUT FOR SIDEWALK SLOPES.

BLDG A - 6 Units
BLDG B - 8 Units
BLDG C - 8 Units
BLDG D - 8 Units

HUD ADA REQUIRES 5% of UNITS TO BE ADA ACCESSIBLE

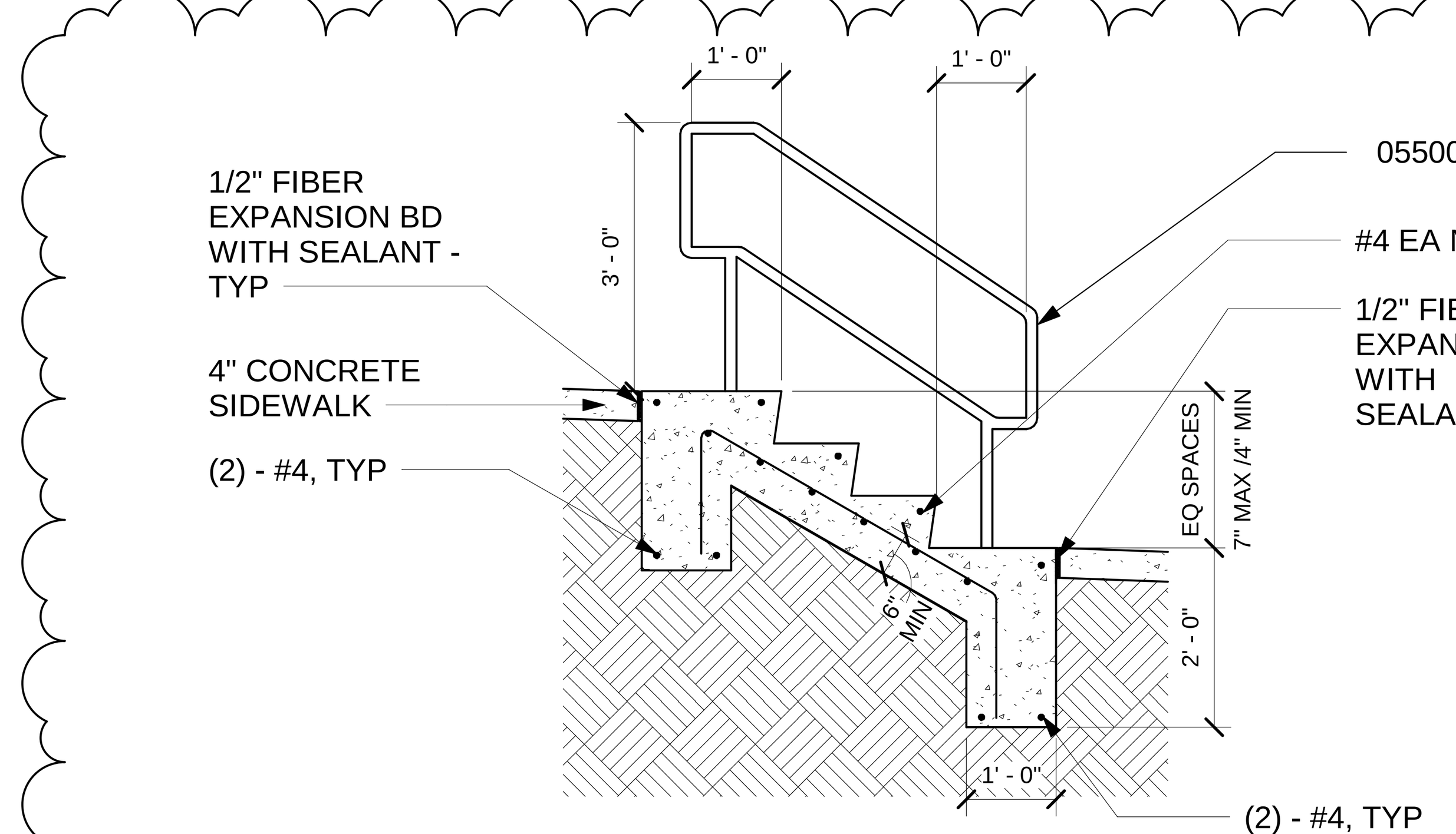
30 Units x 5% = 1.5 = 2.0 Units ADA
30 Units x 2% = .6 = 1.0 Unit Hearing / Blind

EXISTING SF
4,118 EXCLUDES
BALCONY & STAIR



1 SITE PLAN

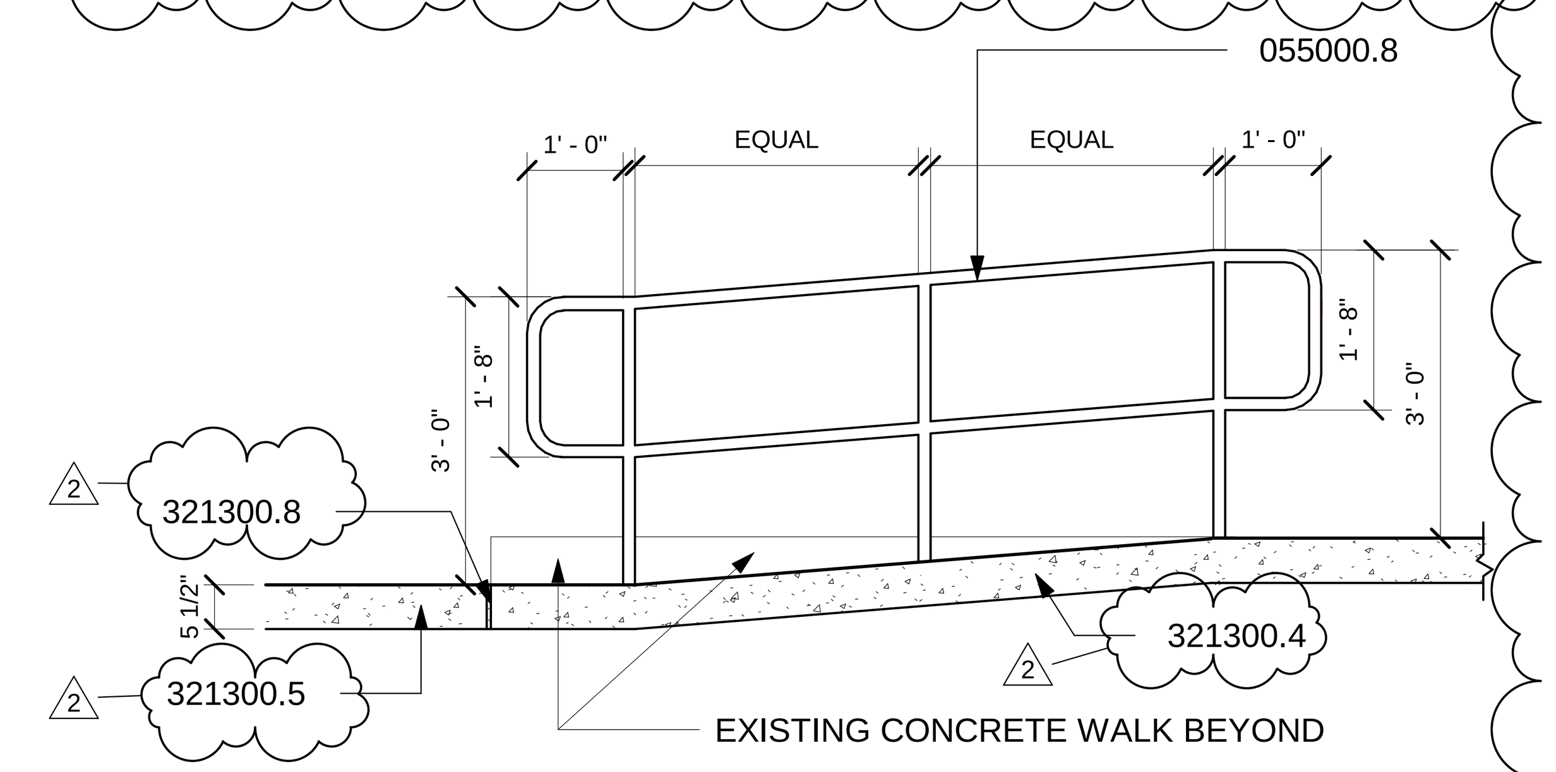
1" = 20'-0"



2 TYPICAL STAIR DETAIL

1/2" = 1'-0"

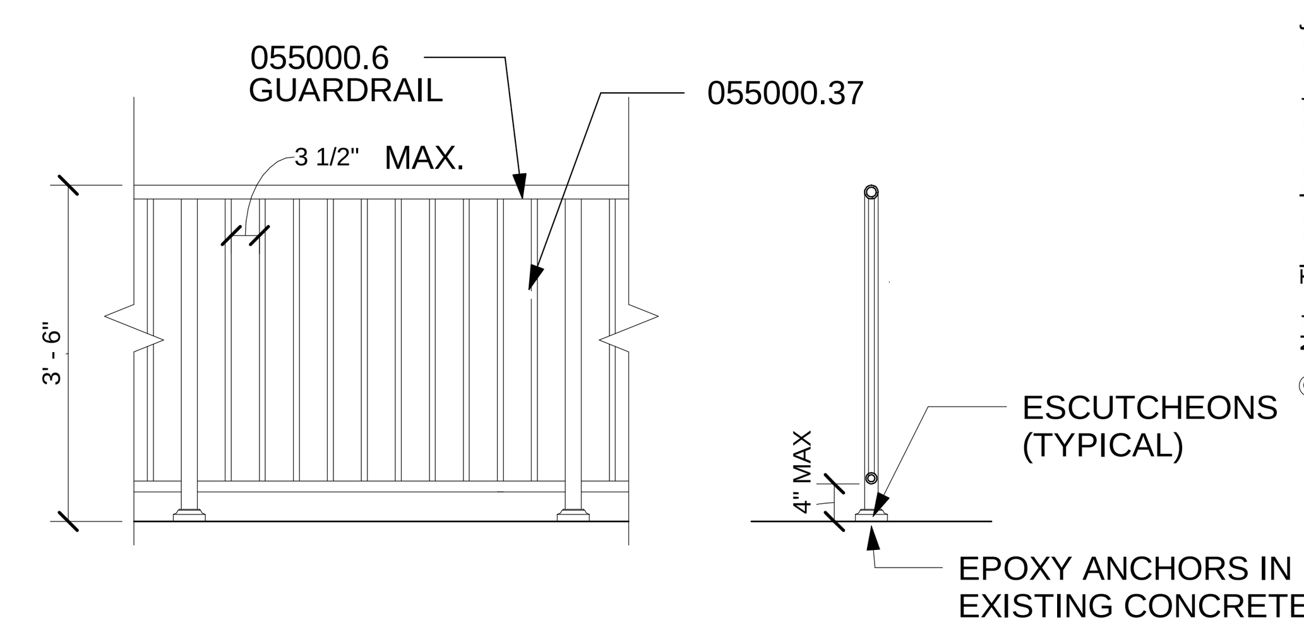
DETAIL REMOVED



4 BLDG C HANDRAIL ELEVATION

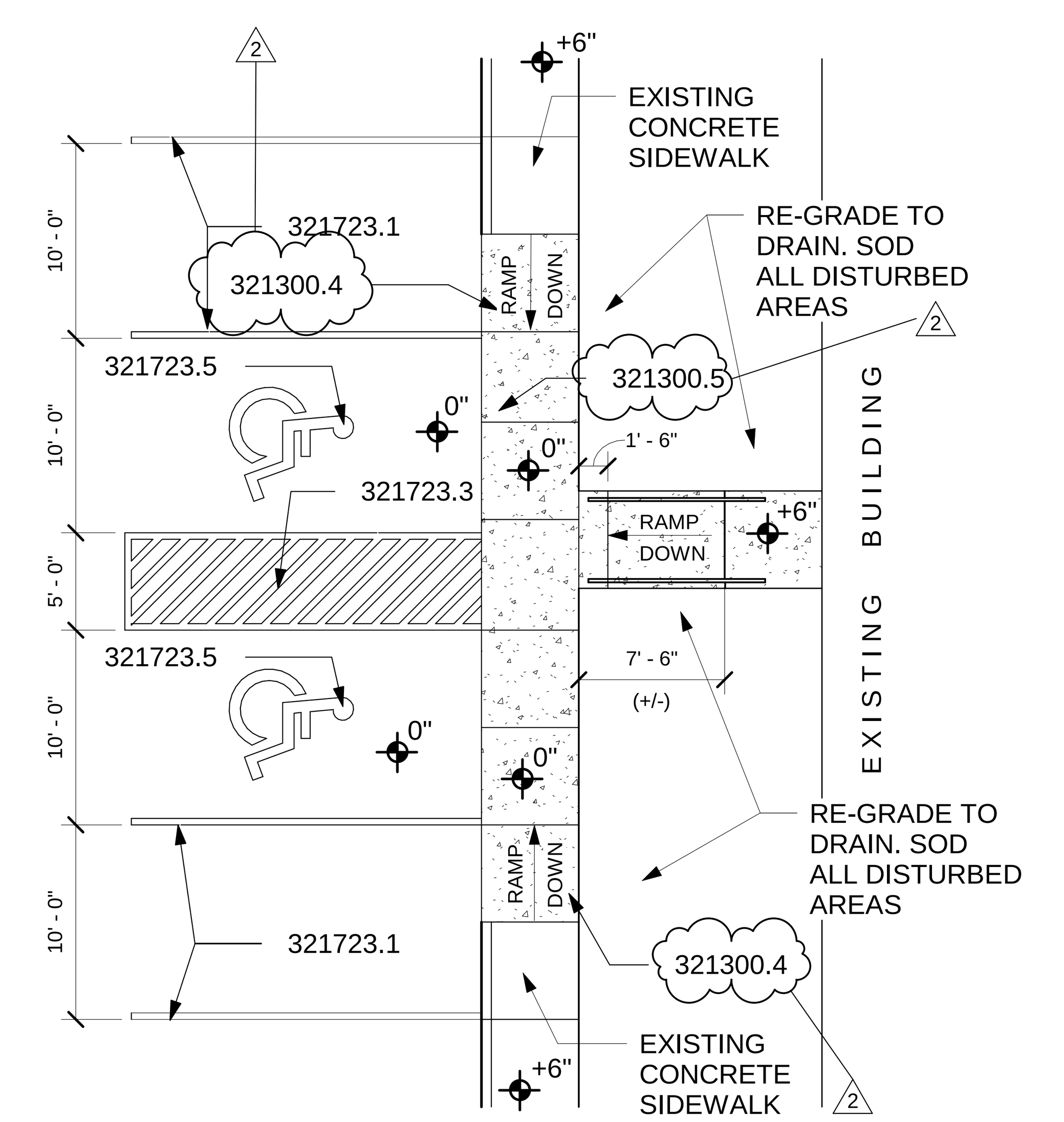
1/2" = 1'-0"

DETAIL REMOVED



6 GUARDRAIL DETAILS

1/2" = 1'-0"

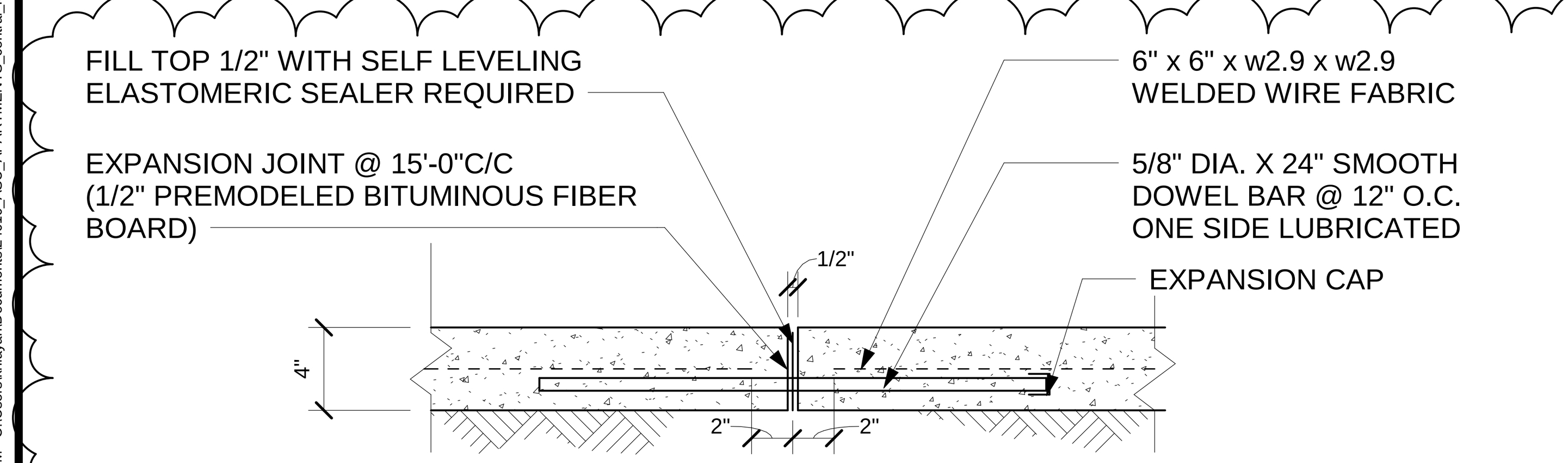


7 LARGE SCALE PLAN

1/8" = 1'-0"

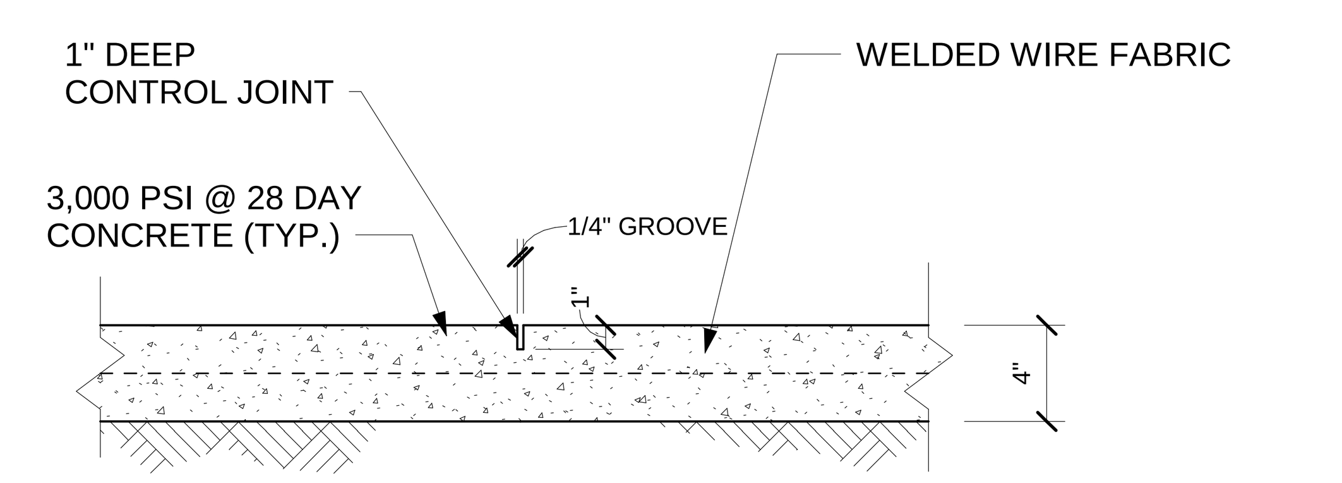
KEYNOTE LEGEND

055000.6	STEEL PIPE GUARDRAIL
055000.8	STEEL PIPE HANDRAIL
055000.37	STEEL BAR
321300.4	CONCRETE RAMP
321300.5	CONCRETE SIDEWALK
321300.8	EXPANSION JOINT
321723.1	PAVEMENT STRIPING
321723.3	HC PARKING AISLE
321723.5	HC SYMBOL



3 SIDEWALK EXPANSION JOINT DETAIL

1 1/2" = 1'-0"



5 SIDEWALK CONTRACTION JOINT DETAIL

1 1/2" = 1'-0"

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Renovation of the Matt Thomas Jr. Garden Apartments
Alcorn State University
134 Research Dr., Lorman, Mississippi

ARCHITECTURAL SITE PLAN & HANDRAIL ELEVATIONS

CCD PROJECT 24010
IHL PROJECT 201 264

DATE ISSUED
SEPTEMBER 10, 2024

DATE REVISED
FEBRUARY 28, 2025 2

DRAWING NO.

A101
R1