ADDENDUM NO. 5
Date: January 13th, 2025

PROJECT: Hays/Caldwell Water Treatment Plant Improvements – Phase 2; San Marcos, Texas

PROPOSAL NO.: HC Phase 2

BID DATE: **2:00 pm; Friday, January 24, 2025**

FROM: Yue Sun, P.E.
Project Director
Ardurra Group, Inc.
3115 Allen Parkway, Suite 300
Houston, TX 77019

To: **Prospective Offerors and Interested Parties**

01/13/2025

This addendum forms a part of the bidding documents and will be incorporated into the Contract Documents, as applicable. Insofar as the original Contract Documents, Specifications, and Drawings are inconsistent, this Addendum shall govern. Please acknowledge receipt of this Addendum on the Proposal form, Section 00 41 00 submitted to the Canyon Regional Water Authority. **FAILURE TO ACKNOWLEDGE RECEIPT OF ADDENDA ON THE PROPOSAL FORM MAY BE CAUSE FOR DISQUALIFICATION.**

CONTRACT DOCUMENTS:

1. Section 00 01 10 Table of Content: Remove Pages 3 through 6 and replace with the updated Pages 3 through 6.

SPECIFICATIONS:

1. Specification 23 05 00 HVAC – General Provisions: Remove Specification 23 05 00 and replace with the updated Specification 23 05 00.
2. Specification 23 05 48 HVAC – Vibration and Seismic Control: Add the attached new Specification 23 05 48.
3. Specification 23 05 53 HVAC – Identification: Remove Specification 23 05 53 and replace with the updated Specification 23 05 53.
4. Specification 23 05 93 HVAC – Testing, Adjusting, and Balancing: Remove Specification 23 05 93 and replace with the updated Specification 23 05 93.
5. Specification 23 07 13 HVAC – Duct and Pipe Insulation: Add the attached new Specification 23 07 13.
6. Specification 23 09 00 HVAC – Controls: Add the attached new Specification 23 09 00.
7. Specification 23 31 13 HVAC – Metal Ductwork and Accessories: Add the attached new

Specification 23 31 13.

8. Specification 23 34 23 HVAC – Metal Fans: Remove Specification 23 34 23 and replace with the updated Specification 23 34 23.
9. Specification 23 74 23 HVAC – Makeup Air Units: Add the attached new Specification 23 74 23.
10. Specification 23 81 26 HVAC – Standard DX Air-Conditioning Equipment: Add the attached new Specification 23 81 26.
11. Specification 40 62 63 Operator Interface Terminal: Add the attached new Specification 40 62 63.
12. Specification 40 75 00 Analytical Instruments: Remove Specification 40 75 00 and replace with the updated Specification 40 75 00.

CONSTRUCTION DRAWINGS:

1. Drawing S3: Delete this drawing in its entirety and replace with the updated Drawing S3.
2. Drawing S5: Delete this drawing in its entirety and replace with the updated Drawing S5.
3. Drawing S8: Delete this drawing in its entirety and replace with the updated Drawing S8.
4. Drawing S12: Delete this drawing in its entirety and replace with the updated Drawing S12.
5. Drawing MO-1: Delete this drawing in its entirety and replace with the updated Drawing MO-1.
6. Drawing MO-2: Delete this drawing in its entirety and replace with the updated Drawing MO-2.
7. Drawing MO-3: Delete this drawing in its entirety and replace with the updated Drawing MO-3.
8. Drawing MO-4: Delete this drawing in its entirety and replace with the updated Drawing MO-4.
9. Drawing MO-5: Delete this drawing in its entirety and replace with the updated Drawing MO-5.
10. Drawing MO-6: Delete this drawing in its entirety and replace with the updated Drawing MO-6.
11. Drawing MO-7: Delete this drawing in its entirety and replace with the updated Drawing MO-7.
12. Drawing MO-8: Delete this drawing in its entirety and replace with the updated Drawing MO-8.
13. Drawing MO-9: Delete this drawing in its entirety and replace with the updated Drawing MO-9.
14. Drawing H1: Delete this drawing in its entirety and replace with the updated Drawing H1.
15. Drawing H1: Delete this drawing in its entirety and replace with the updated Drawing H1.
16. Drawing H2: Insert this drawing in its entirety.
17. Drawing H3: Delete this drawing in its entirety and replace with the updated Drawing H3.
18. Drawing H4: Insert this drawing in its entirety.
19. Drawing H5: Insert this drawing in its entirety.

CLARIFICATIONS:

1. In spec section #40 67 00. you call out (1) GST Level Relay Panel. I do not see this panel anywhere on the drawings. If this panel is needed. Please provide info on it.

   Response: Delete the following from the PCSI-Furnished Control Panels Table in specification Section 40 67 00:

   - GST Level Relay Panel row
   - PLC-RWPS row

2. LIT-800 & LIT/LE-801. Are these instruments new or existing? If new is the LIT-800 a Pressing Sensing Level & the LIT-801 is an Ultrasonic?
   Response: The referenced instruments are existing.

3. Can you clarify the Q&A deadline, Thank you.

   Response: The deadline for Q and A will be 2pm on Thursday, January 16, 2025.

4. In spec section #40 75 00. in products. 2.1 & 2.2. It says the analyzers-To be added. Please add the specs for the Total Organic Carbon & Ozone Residual Analyzers.
   Response: Please see revised Specification 40 75 00.

5. Drawing I-4 per addendum 4 it shows you added (1) Ethernet Switch #ESW-3, (1) OIT-3 & UPS-3 I don't see a spec on these added components. Please add to specs. Can you also give a KVA for the different UPS's. (Rack Mounted) for Network Rack Enclosure & Tower style for PLC. Is there a Battery Backup time you want to add?

   Response: Refer to specification Section 40 66 00 for Ethernet switch requirements. Refer to specification Section 40 78 00 for UPS requirements. Refer to specification Section 40 62 63 included with Addendum No. 5 for OIT requirements.

6. On drawing I-3. You show (1) Network Equipment Rack #1 & (1) PLC Enclosure #PLC-RWPS. I'm assuming these items are future? The reason I ask, is they are in bold print. Future items are shown as dashed lines. Please advise if they are New or Future.

   Response: The Raw Water Pump Station Electrical Building itself is called out on I3 as future; hence, everything shown inside the building is also future.

7. Reference electrical sheets E22 and E24 Electrical sheet show cable tray for this project. Can you please tell us the width of cable tray on sheet E22 and E23? Please advise?

   Response: Drawings E22 and E23 are to scale. The width of the cable tray is as shown on the drawings.

END OF ADDENDUM NO. 5

Yue Sun, P.E.
Project Director

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SECTION 23 05 00
HVAC - GENERAL PROVISIONS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This Section specifies the general requirements of the HVAC work to be performed and described in other Division 23 – HVAC sections and shall not void any of the requirements specified under the General Conditions or General Requirements.

B. Furnish all labor, materials, equipment, services, and incidentals required and install and test a complete HVAC system as specified and shown on the Contract Drawings.

C. The requirements specified herein shall be modified only if specified otherwise for specific applications in other Divisions.

D. Work to be included under the "Scope of Work" of each HVAC Specification Section shall include all labor, material, equipment, tools and services necessary to furnish, deliver, unload, install, test and place in satisfactory operation the equipment, services and systems as called for under each HVAC Section including any incidental work not shown, or not specified but which can reasonably be inferred as belonging to the various systems and necessary in good practice to provide complete and fully operational systems.

E. This HVAC specification is incomplete without the information contained on the Drawings and in the Equipment Schedules.

F. Description of the work included in each Section is not intended to in any way limit the above broad statement but is intended as a more specific mention of the most important items included therein.

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G. Design Conditions:
   1. Outdoor Design Conditions
      a. The following outside design conditions will be used, based on climate data at City of San Marcos, as documented in the 2021 ASHRAE Fundamentals Handbook:
      b. Summer (0.4%): .....100.0ºF Dry-bulb, 74.3ºF Wet-bulb
      c. Winter (99.6%): .....27.5ºF Dry-bulb
      d. Elevation:.....597 ft. above Sea Level
   2. For air-cooled condensing unit selection, the summer design dry bulb temperature shall be plus 10 degrees F above ambient unless otherwise indicated on the drawing schedules.
   3. Indoor Design Conditions
      a. Refer to individual HVAC drawings and sequences of operation for indoor design conditions and setpoints.
   4. Capacity of equipment is indicated at actual operating conditions, unless otherwise noted. Size equipment to perform as indicated at site elevation and scheduled conditions.

H. Job Conditions
   1. Examine Contract Documents to determine how other work will affect execution of mechanical work.
   2. Determine and verify locations and arrangement of existing utilities, systems and equipment, and become familiar with existing conditions.

1.2 MEASUREMENTS AND PAYMENTS

A. No separate payment will be made for work performed under this Section. Include the cost for this work in the lump sum Base Bid.

1.3 RELATED WORK

A. The following work related to, but not covered under the HVAC work, will be done under other related Divisions as listed below.
   1. Cutting and patching, except for items specified herein.
   2. Temporary heating, electric power, and lighting.
   3. Trenching, excavation and backfill, except for items specified herein.
   4. Concrete work, except for furnishing of required anchor bolts, sleeves, and templates, which shall be furnished with equipment.
   5. Structural steel and miscellaneous metal, except for supplementary steel required for hangers, equipment supports, anchors and guides, which shall be furnished with equipment.
   6. Flashing and counterflashing, except for items specified herein.
   7. Painting, except for factory finished equipment, shop painting and identification labeling.
   8. Plumbing, except water and drain connections to HVAC equipment, is included in other Sections.
   9. Refer to other divisions for electrical requirements.
   10. Electrical field power, interlock wiring and conduit, except for field wiring and conduit for automatic temperature HVAC controls as specified and as shown on the HVAC Drawings.
   11. Motor starters and disconnects, except for those furnished as an integral part of equipment supplied under this Division, shall be provided under Electrical.

B. Related Documents:
   1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 – General Requirements Specification Sections, apply to this Section.

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1.4 SUBMITTALS

A. Shop Drawings - Submit to the Owner's Designated Representative, in accordance with Division 01 – General Requirements, all shop drawings and product data specified in this Section and in each individual HVAC Specification Section. All information should be provided at one time for each specification section. Incomplete submittals will be rejected. Submittals shall include the following minimum information:
   1. Equipment Schedules – Provide Equipment Schedules in a format equivalent to Equipment Schedules on Contract Drawings. Provide all data indicated on the Equipment Schedules.
   2. Catalog Cutsheets – Provide for each equipment unit and accessory. Indicate options from cutsheets with arrows, or equivalent. Indicating options with a highlighter marker is unacceptable, as it does not transmit during the copying process. Indicate specification number and equipment tag number on all cutsheets. As a minimum, provide information for the following:
      a. Catalog data for all motors to include operating efficiency.
      b. Catalog data on vibration isolators, including materials of construction, operating efficiency and layout diagrams that locate the isolators on the equipment by model number.
      c. Catalog data on bearings and confirmation of bearing life for the service specified.
      d. Information on coatings as specified in the coating section.
      e. Catalog data on selected filters: types and sizes, quantity of modules required for each filter type and efficiency ratings performance data.
      f. For belt drive equipment, provide drive data indicating sheave sizes, belt size, number and length.
   3. Drawings - Provide description of the proposed unit, general equipment arrangement, equipment dimensional data, materials of construction, location and

size of outside air, return air and supply air openings, clearance requirements for maintenance access and equipment operation and equipment operating weights, furnished specialties and accessories. Significant dimensional differences between the specified equipment verses the proposed equipment shall be noted on the equipment submitted. Indicate specification number and equipment tag number on all drawings.

4. Equipment Performance Curves for equipment with fans - Indicate fan size, type, arrangement, materials of construction, weight, motor horsepower, type, power supply and motor frame size. Each submittal shall include pertinent fan/pump performance (operating data) information and a performance curve showing the fan operating point or range, including operating efficiency, flow rate, pressure, and BHP. The minimum size of the actual fan curve shall be no less than 6-in by 8-in. The use of faxed copies of curves is not acceptable. Provide certified test data for all fans. For pumps show NPSHR. For fans show shutoff head.
5. Accessories – A list of all accessories and options to be furnished shall be included on each submittal.
6. Spare Parts List – Provide manufacturer's recommended spare parts list.
7. Certification that equipment capacities meet requirements on Equipment Schedules based on indicated design criteria as specified.
8. Detail mounting and securing structure.
9. Warranty Information
10. Wiring Diagrams - Provide power, signal, and control wiring for all equipment.
11. Provide nameplate data and arrangement for approval by Owner's Designated Representative.
12. Equipment and materials shall be in strict accordance with the Specification requirements. Fully explain and itemize any exceptions to, or deviations from the Contract Specifications with references to the individual specification sections.
13. Where corrosion resistance is required, provide conformation of material suitability for the specified service.
14. For units that will be shipped exposed, provide a description of the protective packaging that will be used during transit.
15. All submittals shall contain a statement that all specification Sections have been read and complied with. The certification statement shall be made by all the following applicable parties, the Contractor, subcontractor, and the vendor. The statement shall be an individual statement for each party involved and shall be included with every submittal and resubmittal.

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B. In the event the vendor and/or manufacturer starts procurement and/or fabrication prior to receipt of approved shop drawings, then vendor/manufacturer does so at their own risk.

C. Operation and Maintenance Manuals
   1. Submit to the Engineer as required herein and in Division 01 – General Requirements, a single, combined Operating and Maintenance Manual for the following major equipment.
      a. Make-Up Air Unit
      b. Air-Handling Units
      c. Split Systems
      d. Exhaust Fans
   2. Submit an electronic Preliminary O&M with all contents listed below. Provide forms with blanks to be filled out or placeholder pages for information to follow in the Final O&M submittal. The preliminary submittal shall be as complete as possible. Submittals with only O&M data from the equipment manufacturer, without edits and supplemental data from the contractor, will be rejected without review.

3. Submit an electronic Final O&M. This submittal shall have all information filled out, including but not limited to substantial completion date, warranty start/end dates, signatures, completed training log documentation, pictures of nameplates, etc.
4. Final hard copy and electronic binders shall be provided and submitted as required under Division 01 – General Requirements.
5. Personnel familiar with the operation and maintenance of specific information shall prepare manuals. Where applicable, provide information for the specific series, model, and size of the equipment.
6. Equipment shall be identified with the Engineer's Equipment Numbers and Identification as shown in the Schedules and on the Drawings.
7. Contents - Each volume shall contain the following minimum contents:
   a. Cover page with the following:
      "Installation, Operation and Maintenance Manual
      for
      Project Name
      Project No.: XXXXX
      Bid Date: XX/XX/XX
      Substantial Completion Date: XX/XX/XX
      Division 23 – HVAC"
   b. Table of Contents page with each of the following sections.
   c. Contacts page with Engineer(s), Contractor(s), Local Parts/Supplier(s)
   d. Contractor's Warranty
   e. XXXX (for each major type of equipment)
      (i) Approved Shop Drawing
      (ii) Installation, Operation and Maintenance
      (iii) Manufacturer's Warranty
      (iv) Equipment Nameplates
      (v) Spare Parts table with part number, quantity, and approximate price of each item.
   f. Equipment location drawings (11x17)
   g. Startup Reports
   h. Testing, Adjusting, and Balancing Reports
   i. Training Documentation
8. Bookmarks shall be provided in the electronic O&M with each of the above 'Content' sections.
9. The Manufacturer's O&M data shall include the following:
   a. Identify O&M data with equipment tags as scheduled and indicated on drawings. If multiple models are included in the O&M, identify which data is applicable. Indicate selections and options with arrows, outline rectangles, or equivalent. Do not use highlighter marker since it might make the data illegible or not transmit during copying.
   b. Installation including instructions for unpacking, installing, aligning, checking and testing.
   c. Operating Instructions to provide pre-operational checks, start-up and shutdown, and description of all control modes. Include emergency procedures for all fault conditions and actions to be taken for all alarms. Procedures for long term storage shall be included.
   d. Maintenance shall include preventive, and corrective. Items such as inspection, calibration, lubrication, tests, etc., shall be covered. A complete list of materials for preventative maintenance shall be included. Instructions for assembling, disassembling, repairing and reordering parts shall be included in the instruction manual for corrective maintenance. Schedules for test of other functions are to be included. Provide a list of tools required to service the equipment. Trouble shooting instructions to include a trouble-shooting guide shall be included. The instruction manual shall list all special materials, tools, and test equipment that are required to perform troubleshooting and all phases of maintenance. Provide exploded view

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drawings or other similar drawings of all assemblies showing all parts which are separately replaceable for maintenance.

10. Startup Reports shall indicate successful equipment installation and operations, signed, and dated by responsible supervising technician.
11. Testing, Adjusting, and Balancing Reports.
12. Training Documentation shall include date of training, equipment covered, and all names of personnel that attended.
    a. A representative of the manufacturer who has complete knowledge of proper operation and maintenance shall be provided for the number of days and/or hours as listed herein and other related sections to instruct representatives of the Owner and the Engineer on proper operation and maintenance. With the Owner's permission, this work may be conducted in conjunction with the inspection and the installation and test run as provided under PART 3. If there are difficulties in operation of the equipment due to the manufacturer's design or fabrication, additional service shall be provided at no additional cost to the Owner.
13. The contractor shall provide and supplement any O&M data requested above that is not provided by the manufacturer.

D. In general, corrections or comments or lack thereof made relative to submittals during review shall not relieve the Contractor from compliance with the requirements of the Drawings and Specifications. Submittals are for review of general conformance with the design concepts of the project and general compliance with the contract documents. The Contractor is responsible for the final design conforming and correlating all quantities and dimensions, selecting fabrication processes and techniques of construction, coordinating the work of all trades, and performing the work in a safe and satisfactory manner. Items resubmitted by Contractor shall specifically reference comments made on submittal review documents. Failure to do so may prolong submittal review process and cause additional incurred costs.

1.5 REFERENCE STANDARDS

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A. The latest published issue of Standards or Recommendations of the following listed Societies, Associations or Institutes are part of this Section. These shall be considered as minimum requirements. Specific requirements of this Section and/or Drawings shall have precedence. In case of conflict between published requirements, the Engineer shall determine which is to be followed.

B. Abbreviation and the title of Federal, State and industry standards, technical societies, associations and institutes and other organizations used are as follows:

1. AABC – Associated Air Balance Council
2. ACGIH – American Conference of Governmental Industrial Hygienists
3. ADC – Air Diffusion Council
4. ABMA – American Bearing Manufacturers Association
5. AMCA – Air Movement and Control Association
6. ANSI – American National Standards Institute
7. ARI – Air Conditioning and Refrigeration Institute
8. ASHRAE – American Society of Heating, Refrigerating and Air Conditioning Engineers
9. ASME – American Society of Mechanical Engineers
10. ASTM – American Society for Testing and Materials
11. CTI – Cooling Tower Institute
12. FM – Factory Mutual Engineering and Research Corp.
13. IBR – Institute of Boiler and Radiator Manufacturers
14. IEEE – Institute of Electrical and Electronics Engineers
15. NIST – National Institute of Standards and Technology
16. NEBB – National Environmental Balancing Bureau

17. NEC – National Electrical Code
18. NEMA – National Electrical Manufacturers Association
19. NFPA – National Fire Protection Association
20. OSHA – Occupational Safety and Health Administration
21. SMACNA – Sheet Metal and Air Conditioning Contractors National Association
22. UL – Underwriters Laboratories
23. State and city building, plumbing and mechanical codes.
24. American Gas Association.
25. Authorities having jurisdiction.

C. Where reference is made to one (1) of the above standards, the revision in effect at the time of bid opening shall apply.

1.6 QUALITY ASSURANCE

A. The Contractor shall be fully responsible for the proper execution and performance of the work described herein. It shall be their responsibility to inspect all installation conditions and bring to the attention of the Owner's Designated Representative any conditions which may affect their work adversely. They shall report to the Owner's Designated Representative prior to commencing any portion of this work, any conditions unsuitable for the installation of their portion of the work.

B. Mention herein or indication on the Drawings of equipment, materials, operation or methods shall require that each item mentioned or indicated be provided to make a complete system ready for continuous operation.

C. Attention is called to the necessity for elimination of transmission of excess and nuisance vibration and noise from mechanical equipment to building structures. All equipment, therefore, shall be carefully selected and installed to meet this condition and isolators, sound deadening material and/or water hammer arrestors shall be provided where required.

D. All equipment of a given type shall be furnished by or through a single manufacturer or as specified on the schedules. 5

E. Inspection by the Owner's Designated Representative or failure to inspect shall not relieve the Contractor of responsibility to provide materials and perform the work in accordance with the documents.

F. Use all new materials unless otherwise specified. Materials and equipment shall be free from all defects and imperfections that might affect the serviceability of the finished product. No used equipment or materials will be allowed.

G. The Owner's Designated Representative reserves the right to sample and test any materials after delivery and to reject all components represented by a sample that fails to comply with the specified requirements.

H. All equipment shall be UL listed and stamped with all testing agency seals.

I. Use of asbestos or material containing asbestos shall be strictly prohibited.

J. All rotating parts of equipment shall be statically and dynamically balanced at the factory.

K. Guarantee that all equipment meets the design and performance requirements specified, and alter and/or replace, at no cost to the Owner any piece of equipment which fails to meet these requirements.

L. If, during the performance of the work, the Contractor finds a conflict, error, or discrepancy between or among one (1) or more of the Sections, or between or among one or more Sections and the Drawings, furnish the higher performance requirements. The higher performance requirement shall be considered the equipment, material,

device, or installation method which represents the most stringent option, the highest quality, or the largest quantity.

M. Where Drawings and Specifications conflict with one another, the information on the Drawings shall take precedence.

1.7 DEFINITIONS

A. Terminology used under this Division is defined as follows:
   1. Readily Accessible – Shall mean that the unit shall be accessible without the need for ladders, harness, or another device. Basically, the unit shall be accessible at operator level. It shall also mean that no equipment, piping, or other systems shall need to be removed or dismantled to access the unit.
   2. Easily Accessible - Shall mean that the unit shall be accessible without the need for removing or dismantling any equipment, piping, or other systems; however, it may require the use of a ladder of harness to reach the unit.

1.8 DELIVERY, STORAGE AND HANDLING

A. Refer to general requirements under Division 01 – General Requirements and the following specific requirements.

B. All materials and equipment shall be inspected for size, quality, and quantity against approved shop drawings upon delivery.

C. Due to the corrosive nature at the plant, do not deliver new HVAC equipment until ready for installation. Extended storage at Project Site more than twenty (20) days shall not be acceptable. Particular attention shall be made to air-conditioning equipment and associated refrigerant piping which has more restrictive requirements; refer to other sections under Division 23 – Mechanical for specific requirements.

D. Deliver equipment and materials to the site in the manufacturer's original, unopened containers and packaging. Each package shall be labeled to indicate the project and the contents of each package. Where applicable, equipment numbers shall be marked on the container.

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E. All equipment and materials shipped that are exposed such as on a flatbed truck shall be protected during transit. The equipment and materials shall be protected from moisture, road salt, dirt and stones or other materials thrown up from other vehicles. Electrical components shall be protected as above, but with special attention to moisture. The method of shipment protection shall be defined in the submittals.

F. For any short-term storage at Project site, equipment and materials shall be stored in a covered, dry and temperature-controlled location off of the ground.

G. Provide covering and shielding for equipment and materials to protect from damage.

H. Repair, restore and replace damaged items.

I. Protect equipment and materials and finishes during handling and installation to prevent damage.

1.9 SYSTEM DESCRIPTION/DESIGN REQUIREMENTS

A. Drawings
   1. The Drawings are essentially diagrammatic, although all work shown on the Drawings is approximately shown to scale. Figured dimensions and detailed drawings shall be followed in every case. Size and routing of piping and ductwork are shown, but it is not intended to show every offset, crossover, transition or fitting nor every structural difficulty that may be encountered. To carry out the true intent and purpose of the Drawings, the Contractor shall provide all necessary parts for a final installed system which conforms to the structure, avoids obstructions, and provides required clearances and passageways. The

Contractor shall be responsible to coordinate the system installation and routing with the work of all other trades.

2. Do not change sizes indicated on the Drawings without written approval of the Engineer.
3. The Drawings indicate the extent and general arrangement of the systems. If any departures from the Drawings or specifications are deemed necessary, details of such departures and the reasons therefore shall be submitted as soon as practical for review. No such departures shall be made without the prior written concurrence of the Engineer.
4. The absence of duct and pipe supports and details on the Drawings shall not relieve the Contractor of the responsibility for providing them.
5. The location of all equipment, ductwork and piping shall be considered as approximate only and the right is reserved by the Engineer to change at any time, before the work is installed, the position of such equipment, ductwork and piping to meet structural conditions and to provide proper headroom clearance or for other sufficient causes and such changes shall be made without additional expense to the Owner.
6. For locations of building elements, refer to dimensioned architectural/structural drawings.
7. Field measurements take precedence over dimensioned drawings.

B. Codes, Local Code Amendments and Ordinances

1. Comply with all the laws, ordinances, codes, rules, and regulations of the State, local or other authorities having jurisdiction over any of the work specified herein. All such laws, ordinances, codes, rules, and regulations governing this work shall be a part of the Specifications. Where the requirements of the Specifications and Drawings are more stringent than the codes, ordinances, etc., the Contract Documents shall take precedence.
2. Obtain all required permits and pay all legal fees for the same and in general take complete charge and responsibility for all legal requirements pertaining to this Section of the work.
3. If any work is performed and subsequent changes are necessary to conform to the regulations, such change shall be made as part of this work at no additional cost to the Owner.

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C. Coordination

1. Equipment and HVAC units shall fit into the space available with adequate clearance for service as determined by the Engineer. Submitted equipment or units, which do not meet these criteria, shall be rejected. Do not assume that all the manufacturers listed as acceptable manufacturers will provide equipment or units that will fit in the space allocated. Selection of acceptable manufacturers is not based on whether the manufacturer's standard stock unit will fit into every space allocated. A custom or semi-custom HVAC unit may be required to meet project space and performance requirements.
2. Refer to the Structural and Architectural Drawings which indicate the type of construction in which the work shall be installed. Locations shown on the HVAC Drawings shall be checked against the general and detailed drawings of the construction proper. All measurements must be taken at the building.
3. The Contractor shall coordinate the location and placement of all concrete inserts and welding attachments with the structural engineer.
4. The Contractor shall assume full responsibility for coordination of the HVAC systems with the work of all trades, including scheduling, and verification that all structures, ducts, piping and the mounting of equipment are compatible.
5. It shall be the responsibility of the subcontractor to have employed a competent coordinator of mechanical systems and as such to provide all coordination of drawings or sketches as may be required or deemed necessary by the Engineer

to obtain the required ceiling heights and eliminate conflicts with all piping, ducts, electrical, process mechanical and installations of all other trades.

D. Engineering Services
   1. When engineering services are specified to be provided by the Contractor, the Contractor shall retain a licensed professional engineer to perform the services. The engineer shall be licensed at the time the work is done and in the State in which the project is located. If the State issues discipline specific licenses, the engineer shall be licensed in the applicable discipline. In addition, the engineer shall be experienced in the type of work being provided.
   2. All work is to be done according to the applicable regulations for professional engineers, to include signing, sealing, and dating documents. When submittals are required by a professional engineer, in addition to state required signing and sealing, a copy of the current wallet card or wall certificate indicating the date of expiration shall be included with the submittal.
   3. Provide one (1) original and three (3) copies of the licensed professional engineer's certification.

E. NOISE CRITERIA
   1. The selection of pumps, fans, air handling equipment, air conditioners, heating ventilating and air conditioning machinery and mechanical equipment and the installation of the system components such as duct work and piping shall be such as not to exceed to maximum permissible noise for non-equipment spaces as defined in Table 2, Design Guidelines for HVAC System Noise in Unoccupied Spaces contained in the 2015 edition of the ASHRAE Application Handbook. Under no conditions shall the noise created by equipment exceed the levels of permissible noise exposures of occupational areas as established by the OSHA and other Federal, State, and local safety and health standards, codes and ordinances.
   2. Preferential consideration shall be given to equipment that does not generate a noise level more than 80 dBA at a distance of (5) feet in any direction from the unit under operating conditions. 5
   3. Refer to Equipment Schedules for sound criteria. Provide sound data for fans, ventilating equipment and air-conditioning units as listed in the Equipment Datasheets for the following frequency bands: 63, 125, 250, 500, 1000, 2000, 4000 and 8000 Hz. Data shall be the sound power level (reference 10^12 watts per octave band) and to include the dBA at 5 feet. The equipment supplier shall provide actual data for the equipment submitted. If the space does not meet the required criteria, and the noise level of the equipment is found to be the cause, the equipment supplier shall be responsible for the modifications required to correct the condition.

F. Start-Up Supervision
   1. An authorized representative of the manufacturer shall perform the initial startup of the equipment. The Contractor shall provide personnel as required to assist with the startup of each piece of equipment and system and assist with making all adjustments as necessary so that the system is placed in proper operating condition.
   2. The Owner's Designated Representative shall witness startup. The use of local sales representatives to perform this work is not acceptable, unless the manufacturer provides documented evidence that the sales representative has been specifically trained for this work.

1.10 WARRANTY

A. Warrant all material and workmanship included herein. Warranty shall include parts & labor for a period of one (1) year from date of final acceptance by Owner unless a longer warranty is indicated in Division 01 – General Requirements. The Contractor

shall be responsible for all cost incurred in furnishing and installing the replacement equipment.

B. Refer to Division 01 – General Requirements for general warranty requirements.

1.11 SPARE PARTS

A. Spare parts shall include all special items on the manufacturer's standard list of spare parts.

B. In addition to special items, the following spare parts shall be provided:
   1. Furnish all special tools required for normal operation and proper servicing of the equipment.
   2. Spare parts shall include all items on the manufacturer's standard list of spare parts and the following for each unit:
      a. One (1) complete set of drive belts for each piece of belt driven equipment.
   3. Provide a minimum of 4 or 10 percent of the total units rounded to the next full unit whichever is greater for each size and rating of the following components.
      a. Panel light bulbs
      b. Fuses

C. Pack spare parts in containers suitable for extended storage without deterioration of the parts (minimum one (1) container per building). Containers shall be clearly labeled designating contents, pieces of equipment for which intended and equipment identification numbers.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Due to the corrosive nature at the plant and proximity to the ocean, special attention shall be made to materials of construction called out in each specification section and on the equipment schedules in the Drawings. Where not called out in each individual specification section or on the Drawings, all material for equipment, ductwork, dampers, linkages, supports, hardware, etc. specified under this Division shall be constructed of corrosion resistant materials – FRP, aluminum or type 316L stainless steel. Uncoated steel, galvanized steel or painted steel shall not be acceptable unless specifically indicated otherwise in the Drawings or equipment specifications.

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2.2 equipment supply manufacturers

A. The manufacturers listed in the individual equipment specifications under this Division are the only acceptable manufacturers, unless ‘or equal’ is specified to allow alternates. Alternate equipment manufacturers require comprehensive data for comparison to those specified.

B. The contractor shall bear the full burden of proof for the alternate manufacturer’s equivalency and is still not guaranteed approval which shall remain at the discretion of the owner and engineer.

C. The following list provides the minimum, but does not necessarily all the items, to be provided for comparison of equipment for approval. Refer to individual specification sections for additional general, product, and quality requirements.
   1. Manufacturer’s years of experience and relevant project experience.
   2. All materials, including grade and thickness.
   3. Supports and frames.
   4. Screens, guards, and grilles.
   5. Attachment methods, including welding, rivets, bolts, and screws.
   6. Motors, including efficiency, rpm, enclosure type, drive frame details, bearings, and manufacturer cutsheet.

7. Fans and full performance data, including but not limited to volume, total static pressure, fan rpm, elevation, and operating power.
8. Sound data, including sound power by octave band (e.g. 63, 125, 250, 500, 1000, 2000, 4000, 8000), weighted sound power level (LwA), weighted sound pressure level (dBA), and Sones per respective ANSI and AMCA methods.
9. Housing construction, including insulation, doors, hinges, handles, gaskets, inlet and discharge connections, etc.
10. Painting and coatings, including chemical compatibility with applicable environment and potential contaminants.
11. All internal components, including filters, media, coils, pans, etc.
12. Dampers, including blades, axles, linkages, seals, and performance.
13. All control components, including contacts, relays, DDC boards, communication cards, terminal strips, starters, VFDs, disconnects, gauges, damper actuators, etc.
14. Certifications and agency approvals.

2.3 ELECTRICAL EQUIPMENT

A. Certain items of electrical equipment which are furnished under this Section shall meet the requirements specified in the Electrical Divisions of the Contract Documents.

B. Electric Motors
1. Electric motors in NEMA frame sizes shall conform to the requirements in Division 01 – General Requirements, unless otherwise specified herein.
2. The motor manufacturer shall confirm that motors used to power equipment are provided with bearings that will provide a bearing life equal to the driven equipment or better. Confirmation shall be included with shop drawing submittal.
3. Motors will be selected to be non-overloading over the entire operating range of the equipment. A safety factor of 25 percent will be added to all motors up to and including 50 horsepower. A safety factor of 15 percent will be added to all motors over 50 horsepower. Motors indicated on the schedules are to be considered a minimum. This sizing is not to limit compliance with the above requirements.
4. Provide motors with equipment to be driven by variable frequency drive (VFD) machines compatible with VFD controllers. Locate disconnects on outside of equipment enclosures or guards.
5. Motors shall be premium efficiency type as rated by NEMA. Where premium efficiency motors are not available for the motor size specified, provide high-efficiency motors.

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C. Electrical enclosures and panels, including HVAC control panels and associated switches, lights, pushbuttons, and other controls components, shall be suitable for the environment and electrical classification for the space they are located in and shall meet NEC requirements and Division 26 – Electrical requirements. Refer to the electrical drawings for the space classifications and NEMA designations, and. Refer to Division 26 - Electrical specifications for specific additional requirements.

D. Where hazardous classifications and NEMA ratings are not shown on the HVAC Drawings refer to the Electrical Drawings.

E. Where a conflict with NEMA rating occurs between or within Drawings and Specifications, the more restrictive NEMA rating shall govern.

F. Final installation shall provide minimum clearance to electrical components including control panels as required by the manufacturer and by NEC. No ductwork/piping/etc. shall encroach on access clearance. Contractor shall re-install at no additional cost to owner if any component, system, or sub-system violates this clearance requirement.

2.4 BEARINGS

A. Grease lubricated bearings (except where driven by motors smaller than 1/2 Hp) shall be equipped with Zerk lubrication fittings and with provision for automatic relief of

lubricant pressure away from fan wheel or pump seal. The latter may be accomplished by either built in relief devices or automatic ball and spring relief fittings at the bottom of the bearing housing.

B. Pressure relieves shall be located outside of the units and shall be visible from maintenance locations. Lubrication fittings shall be located to be easily accessible from maintenance or operating levels. Where necessary, extension tubes shall be provided to bring the service fitting to an accessible location and the relief visible from the same location.

C. Bearings for all equipment in the schedule below shall have heavy-duty grease lubricated ball or roller bearings. Bearings shall have ample thrust provision to prevent end play during the normal life of the bearing. Unless specifically noted otherwise, all fans and pumps shall have bearings for both the equipment and motors with the following ABMA L-10 life.
   1. Fans over 3000 cfm – 40,000 hours.

D. For systems with bearings requiring L-10 lives of 100,000 hours or greater, the equipment supplier shall provide calculations for both the equipment bearings and the motor bearings to confirm the bearing selections. For belt drives, the calculations shall include the effect of the sheave size, number of belts, the sheave location on the shaft, and the location of the motor to the driven sheave.

E. The equipment manufacturer shall provide confirmation of the required life based on the actual drive components. For motors 50 horsepower and greater, the bearing life calculations for both the equipment bearings and the motor bearings shall be provided.

2.5 FLAME AND SMOKE RATINGS

A. All materials, including adhesives, surface coatings, sealers, assemblies of several materials, insulation, jacketing, finish, etc, shall have flame spread ratings not over 25 (fire resistive) and smoke development ratings not over 50 and fuel contributed rating not over 50, as established by tests conducted in accordance with ASTM E84, National Bureau of Standards Radiant Energy Fire Test and the National Fire Code of the NFPA.

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B. These requirements shall apply to all circumstances whether the materials are field applied or have been applied by a manufacturer in his/her shop, or elsewhere, prior to delivery to the project for installation.

2.6 V-BELT DRIVE

A. V-belt drives shall consist of the driver and driven sheaves and one (1) or multiple matched V-belts. Drives furnished to transmit less than 3/4 Hp may be a single groove, single belt type. Drives to transmit 3/4 Hp or more shall consist of at least two belts. Belts smaller than "A" cross section shall not be used.

B. Each sheave shall be grooved to match the belt selection, bored and keyed to fit the receiving shaft, and grooves shall be in parallel planes exactly perpendicular to the bore for the full 360 degrees. Sheaves shall have keys and setscrews. Sheave material may be cast iron.

C. The drive shall be sized 1.5 times the motor nameplate rating and also shall have ample strength to start the driven equipment by full voltage across the line motor starting.

D. Where variable speed drive is specified, the drive sheave shall be of the variable pitch type which will provide a 5 percent speed variation of the driven equipment at the nominal rated speed. However, the higher speed side shall not cause the driven equipment to draw more than full nameplate rating horsepower from the driver.

2.7 IDENTIFICATION

A. Each piece of equipment shall be provided with a manufacturer's permanent nameplate and label with the equipment tag number as used in the contract documents.

B. Each duct shall be labeled with its service type, corresponding equipment tag number, and airflow direction.

C. Refer to Section 23 05 53 – HVAC Identification.

2.8 EQUIPMENT VIBRATION ISOLATORS AND MOUNTINGS

A. General

1. Unless internally isolated, or otherwise specified in this Division, all machinery or vibrating mechanical equipment shall be isolated from the building structure by vibration isolators. Operating equipment that can transmit objectionable vibration and noise must be installed with special types of vibration isolators such as flexible connectors to ductwork, piping and wiring.
2. All equipment shall be provided with attachment points for floor or suspended mounting that will safely transmit all loads including seismic to the supports.
3. The vibration isolator manufacturer shall be responsible for the proper selection of vibration isolators suitable for the particular application. Selection of the vibration isolator shall include the following factors:
   a. Equipment Weight and weight distribution
   b. Operating thrust and wind loading
   c. Equipment operating frequencies
   d. Type of building support structure
   e. Seismic forces as required by the applicable building codes to include shear, tension and compression due to the code specified loads
4. Except for the Owner Furnished equipment, vibration isolators shall be furnished with the equipment.
5. All floor mounted vibration isolators shall be bolted to the floor, pad or framing on which they rest. Bolts shall be arranged to prevent transmission of vibration through the bolts.
6. All isolation devices for a single piece of equipment shall be selected for a uniform static deflection according to distribution of weight in the equipment.
7. Isolators exposed to the weather, in rooms classified on electrical drawings as damp, wet, or corrosive or where called for on the Drawings shall be provided with corrosion protection. Steel parts other than springs shall be stainless steel. Parts subject to wear, rubbing, shall be non-corrosive material such as rubber or stainless steel. Springs and hardware shall be material of equal or greater corrosion resistance than the associated ductwork.
8. After installation of equipment, isolators shall be adjusted for proper loading and distribution of weight.

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2.9 SEISMIC RESTRAINTS

A. Refer to Section 23 05 48 – HVAC Vibration and Seismic Control.

2.10 EQUIPMENT PADS

A. Equipment pads are furnished and installed under Structural and Civil.

B. Refer to Structural Drawings for details.

C. Contractor shall coordinate pad dimensions with Structural and Civil for the furnished equipment Coordinate with General Work for installation of housekeeping pads required for mechanical equipment.

2.11 PAINTINGS AND COATINGS

A. Outdoor Equipment

1. Special corrosion resistant/protective coatings shall be provided for equipment located outside.
2. Application shall be by certified applicators from the equipment manufacturer.
3. All components exposed to the outdoor environment, except stainless and aluminum, shall be coated.
4. Unless otherwise specified or scheduled the following shall be provided.
   a. Coils shall be coated by immersion or flow coating, oven cured, thermoset phenolic epoxy coating, 1.0mil dry thickness, Heresite P-413, or approved equal from the equipment manufacturer.
   b. Equipment and components not able to be oven cured shall have a spray-applied high-performance epoxy-silane coating, 1.5mil dry thickness, Heresite ED-600, or approved equal from the manufacturer.
5. Field touch-up shall be spray-applied, 2mil thickness on coils and 6mil thickness for all other, Heresite VR-554T (Brown), VR-514T (Red), or approved equal.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine work area and conditions under which work is to be performed and identify conditions that may be detrimental to proper and timely completion.

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

3.2 INSTALLATION

A. All products shall be installed according to the applicable manufacturer's recommendations, the details shown on the Drawings and as specified herein and in other related Sections in this Division.

B. The Contractor shall start up each piece of equipment and system and shall make all adjustments so that the system is placed in proper operating condition. 5

C. Install all equipment, ductwork, piping and trim in accordance with the manufacturer's printed instructions and install rigid, plumb and true to line, with all parts in perfect working order.

D. The Contractor shall not install any equipment or materials until the Owner and Owner’s Designated Representative(s) have approved all submittals. If any equipment or materials are installed prior to approval of the submittals, it shall be at the Contractor's risk.

E. Provide necessary anchoring devices and supports.
   1. Use structural supports suitable for equipment, or as indicated.
   2. Check loadings and dimensions of equipment with shop drawings.
   3. Do not cut, or weld to, building structural members.
   4. Provide equipment supports even though not detailed on mechanical, architectural and structural drawings.

F. Verify that equipment will fit support layouts indicated. Where substitute equipment is used, revise indicated supports to fit.

G. Arrange for necessary openings to allow entry of equipment. Where equipment cannot be installed as structure is being erected, provide and arrange for building in of boxes, sleeves or other devices to allow later installation or purchase equipment in manufactured sections to allow move-in and reassembly.

H. Provide all penetrations through roofs prior to installation of roofing.

I. For penetrations required after installation of roofing:

1. Arrange and pay for repairs and flashing work by authorized roofer; provide counterflashing.

J. Install rain hoods and metal counter flashings as indicated, and to make penetrations of mechanical work through walls and roofs water and weathertight.
   1. Furnish clamps, waterproofing material and labor.
   2. Where metal flashings are applied over concrete, paint concrete with 1/8 IN of mastic cement first.
   3. Set flashing in mastic cement, watertight.

K. Arrange and pay for repairs and replace roof construction which is damaged by this work by the owner's designated roofer in a manner which will not nullify roof warranty.

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

M. Install equipment, piping and ductwork to permit easy access for normal maintenance.
   1. Maintain easy access to filters, motors, drives, compressors, and arrange piping, conduit, ducts and related work to facilitate maintenance and to meet or exceed NEC required clearances.
   2. Relocate items which interfere with access or NEC required clearances.

N. Completely encase entire length of buried copper piping as well as all copper piping passing through and cast in concrete in minimum 25-mil polyethylene sleeve. Extend sleeve material minimum 6-inches above concrete, overlap any joints minimum 12" and secure with tape.

O. Contractor shall apply two-part epoxy paint where polyethylene sleeve stops and pipe penetrates mechanical seals at subsurface concrete walls. Extend sleeves to minimum 3-inches from mechanical seals. Paint pipe minimum 6-inches inside sleeve, allow paint to dry and seal ends of sleeves with waterproof tape. 5

3.3 INSTALLATION OF EQUIPMENT FURNISHED BY OWNER OR OTHER DIVISIONS

A. Receive, uncrate and set in place mechanical equipment furnished by Owner or other Divisions as called out on the contract drawings or specifications to be installed by mechanical contractor.

B. Remove, relocate and reinstall existing mechanical equipment to be reused.

C. Provide rough-in and final connections to equipment requiring mechanical services.
   1. For equipment furnished by Owner or other divisions:
      a. Obtain rough-in data from final shop drawings and coordinate with installation of utilities.

D. Install fittings, valves, and other items furnished as integral part of equipment, but shipped loose.

3.4 CUTTING AND PATCHING

A. Avoid cutting, where possible, by setting sleeves or frames, and by requesting openings in advance. Coordinate locations with work of other sections.

B. Locate openings and sleeves to permit neat installation of ductwork, piping and equipment.

C. Do not remove or damage fireproofing materials.
   1. Install hangers, inserts, supports, and anchors prior to installation of fireproofing.
   2. Repair or replace damaged fireproofing.

D. In existing areas remove and replace existing ceilings and finishes for plumbing Work if not shown to be removed on architectural drawings and schedules.

3.5 FIELD QUALITY CONTROL

A. Materials, ductwork, and equipment shall be properly protected at all times and all duct and pipe openings shall be temporarily covered, capped or plugged so as to keep dirt and debris out. Keep covers, plugs, or caps in place until final connections are made.

B. Protect nameplates on all equipment from damage and paint.

C. Test and inspect all systems and put into satisfactory operation prior to final acceptance by Owner. Test the work as required by the Owner's Designated Representative during the progress of the work to demonstrate the strength, durability and fitness of the installation. Furnish all instruments, ladders, lubricants, test equipment and personnel required for the tests; including manufacturer's representatives for testing and start up of all supplied equipment. Balancing and testing shall be performed as specified herein and by related Sections in this Division. All testing shall be performed, witnessed, and signed off in the presence of the Owner's Designated Representative.

D. Perform final tests of all systems shall be carried out as required by the Owner's Designated Representative prior to final acceptance of the systems for the purpose of demonstrating satisfactory functional and operating efficiency as well as adjustment. All failure modes, safeties, alarms, and interlocks shall be included in the functional testing. During this period, the setting of all automatic controls shall be checked, and sufficient measurements taken to ensure that conditions are correct and that capacities are adequate to meet the specified requirements. Provide competent personnel to conduct all tests. Systems will not be considered complete until all tests have been concluded to the satisfaction of the Owner's Designated Representative and all other parties having jurisdiction. In event of leakage or defects, tests must be repeated until all faults are corrected. All tests shall be performed in the presence of the Owner's Designated Representative. The general operating tests shall be performed under as near design conditions as possible. Four (4) signed and witnessed copies of records of all tests, measurements, settings of throttling devices and nameplate data shall be submitted to the Owner's Designated Representative.

E. Start-up and run equipment and verify for excess and nuisance vibration and noise transmission to the building structure, including all occupied areas. Notify the Owner and Engineer if excess and nuisance vibration and noise is detected. Provide isolators, sound deadening material, water hammer arrestors and other required material to reduce unwanted vibration and noise. Failure to remedy during startup shall not relieve the Contractor of addressing noise and vibration problems reported by the Engineer or Owner during inspection or occupancy by Owner.

F. Contractor shall demonstrate satisfactory performance of all equipment and systems for a minimum period of five (5) working days prior to final acceptable by Owner.

G. Test and Inspection Reports – Contractor shall submit certified and witnessed test reports, verifying that equipment is operating per the contract documents and design conditions. Where the individual specification sections require factory-trained representatives to make inspections and/or assist with testing. The name and contact information of said individuals shall be in the test and inspection reports. Four (4) copies of records of all tests, measurements, settings of throttling devices and nameplate data shall be submitted to the Owner's Designated Representative.

3.6 TRAINING

A. Provide the Owner with training instruction for the proper operation maintenance, inspection, troubleshooting, etc. of equipment and systems installed under this Section. Refer to individual specification sections and Division 01 – General Requirements for additional requirements.

3.7 IDENTIFICATION

A. All equipment, ductwork and piping shall be provided with a label. The labels shall be placed in a location that will be visible by personnel. The label shall be in addition to the manufacturer's standard equipment label. Labeling is included in related Sections in this Division.

3.8 TEMPORARY OPERATION

A. Properly maintain and service all equipment and systems until the particular equipment or the system has been accepted by the Owner. Contractor shall follow manufacturer's recommended maintenance schedule during this period.

B. This maintenance shall include compliance with the manufacturer's operating and maintenance instructions as well as periodic checking, cleaning, and/or replacement of belts, strainers and filters and the lubrication of moving parts and all required adjustments.

C. Contractor shall repair any equipment and systems that fail, leak or get damaged. Any systems that cannot be repaired to the satisfaction of the Owner's Designated Representative shall be replaced in kind, without additional cost to the Owner

D. Records of all maintenance and lubrication work performed on Owner or Contractor furnished equipment shall be maintained at the construction or installation site and be available at all times for a review by the Owner or Owner's Designated Representative. At the request of the Owner or Owner's Designated Representative copies of these records shall be submitted for information and/or review.

3.9 OPPOSITE SEASON STARTUP

A. At first heating or cooling season following final acceptance, start up systems not started due to lack of seasonal design load. The Contractor shall make any necessary modifications to the initial adjustments to produce optimum system operation.

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3.10 PAINTING AND COATINGS

A. Indoor equipment such as fans, air handling units, air conditioning units, and other items of manufacture shall be hot dipped galvanized, aluminum, or stainless steel and will have factory applied paint finish, color as standard with the manufacturer. Components fabricated from stainless steel do not require a coating finish unless otherwise specified.

B. All items not factory or shop primed prior to installation shall be suitably cleaned of rust and mill scale by wire brushing, sanding, or other means and prime painted, immediately after installation.

C. All outdoor copper piping and fittings not insulated or jacketed, such as connections to outdoor equipment , shall be coated.

D. The Contractor shall be responsible for the repair of all defects, blemishes, holidays and the like apparent in manufactured coatings and shall ensure that the materials used for such repair shall match and be compatible with the manufacturer's standard color, coatings, and practices. Surfaces to be repaired or recoated are to be prepared as recommended by the paint or coating supplier. Care shall be taken not to paint over nameplates.

E. Furnish touch up paint for the various types of equipment furnished and deliver unopened paint to the Owner at completion of the project. The amount of touch-up paint supplied shall be sufficient to cover 15 percent of the applicable painted surfaces or one (1) pint, whichever is greater.

3.11 CLEANING AND DISINFECTION

A. All equipment, coils, fan wheels, motors, ductwork and piping shall be left in a thoroughly cleaned condition. Refer to related specification sections and Division 01 – General Requirements for additional information.

B. Clean specialties such as traps and strainers.

C. All piping shall be thoroughly flushed to remove all foreign materials prior to any cleaning procedure. All strainer baskets shall be removed, cleaned, and reinstalled at the completion of the cleaning operation and also at the completion of all system and equipment final tests. All flushing and cleaning shall be to the satisfaction of the Owner's Designated Representative. Furnish, install and remove all temporary piping and equipment used in the cleaning and flushing operations. Cleaning and flushing shall be performed as specified in other Sections.

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END OF SECTION

SECTION 23 05 48
HVAC - VIBRATION AND SEISMIC CONTROL 5

PART 1 - GENERAL

1.1 SCOPE OF WORK

1.2 MEASUREMENTS AND PAYMENTS

A. No separate payment will be made for work performed under this Section. Include the cost for this work in the lump sum Base Bid.

1.3 RELATED WORK

A. Comply with the General Requirements and referenced documents.

B. Comply with all other Division 23 – Mechanical Sections, as applicable. Refer to other Divisions for coordination of work with other portions of work.

1.4 SUBMITTALS

A. Shop Drawings: Submit in general accordance with Division 01 – General Requirements and Section 23 05 00 – HVAC General Provisions. Submit manufacturer's descriptive literature and installation instructions for all vibration isolation equipment.

1.5 QUALITY ASSURANCE

A. All equipment and materials shall be new and of the best quality and have been manufactured by a firm with a minimum of five (5) years of experience in this field.

B. All equipment and materials shall be installed in a workmanlike manner by experienced mechanics and as recommended by the equipment and vibration isolation manufacturers.

1.6 SYSTEM DESCRIPTION/DESIGN REQUIREMENTS

A. Unless otherwise specified in this Division all machinery or vibrating mechanical equipment shall be isolated from the building structure by vibration isolators with a minimum deflection as specified. Operating equipment that can transmit objectionable vibration and noise must be installed with special types of vibration isolators such as flexible connectors to ductwork, piping and wiring. In more critical areas and under particular conditions, additional vibration isolators shall be installed as specified in other related Sections in this Division, or in specific equipment schedules.

B. All equipment shall be provided with attachment points for floor or suspended mounting that will safely transmit all loads including seismic to the supports.

C. The vibration isolator manufacturer shall be responsible for the proper selection of vibration isolators suitable for the particular application. Selection of the vibration isolator shall include the following factors:
   1. Equipment Weight and weight distribution.
   2. Operating thrust and wind loading.
   3. Equipment operating frequencies.
   4. Type of building support structure.
   5. Seismic and wind forces as required by the applicable building codes to include shear, tension and compression due to the code specified loads.

1.7 DELIVERY, HANDLING AND STORAGE

A. Cover and protect material in transit and at site. Material not properly protected and stored and which is damaged or defaced during construction shall be rejected.

B. Storage and protection of materials shall be in accordance with Division 23 – HVAC.

1.8 WARRANTY/EXTENDED WARRANTY

A. Refer to Division 01 – General Requirements and Section 23 05 00 – HVAC General Provisions.

PART 2 - PRODUCTS

2.1 GENERAL

A. Objectionable vibration or noise created in any part of the building by the operation of any equipment furnished and/or installed under Division 23 – Mechanical will not be permissible.

B. Contractor shall take all precautions against the same by isolating the various items of equipment, pipes, and ducts from the building structure and by such other means as may be necessary to eliminate the transmission of excessive vibration and objectionable noise produced by any equipment installed thereby.

C. Design all foundations, supports, etc., for equipment, piping and ductwork with this end in view.

D. Contractor shall supervise and instruct the construction of all foundations and supports, in order that they may be constructed in such manner as to prevent the transmission of noise and vibration.

2.2 APPLICATIONS

A. Isolating material shall be selected in each case in accordance with the manufacturer's recommendations and the latter shall be prepared to demonstrate, upon request of the Engineer, the isolation effectiveness of the material which has been installed upon his recommendation.

B. Isolators shall be so selected that when all the items in each of the mechanical rooms are in simultaneous operation, the vibration transmission to the building at the lowest disturbing frequency shall be limited to a maximum of 10% for a mechanical equipment room floor that is on the ground and 5% for all other building surfaces, including those in fan rooms, from all the equipment when the various items are in harmony.

C. Isolators exposed to the outdoors or located in un-air-conditioned rooms shall be provided with corrosion protection or shall be non-corrosive material such as rubber or 316 stainless steel. Springs and hardware shall be material of equal or greater corrosion resistance than the associated ductwork.

D. Isolator Types for Floor/Base Mounted Equipment

1. Isolators for supporting floor or base mounted equipment (where not internally isolated) shall be of the free-standing, open spring type, laterally stable, with ribbed pads bonded to the underside of the base plate, leveling bolts and bolt holes for anchoring to floor slab or concrete pad. Isolators shall be similar to Amber Booth type SW-2 with a minimum two inch (2") deflection. All floor mounted vibration isolators shall be bolted to the floor, pad or framing on which they rest. Bolts shall be arranged to prevent transmission of vibration through the bolts.
2. For all mechanical equipment that is not internally isolated, condensing units and tanks, provide vibration isolation pads to be placed under the entire unit, tank, and accessories so that there is no direct metal-to-concrete or tank-to-concrete contact. Pads may be either elastomeric, rubber-like, or neoprene type with water resistant outer wrapping. Pads may be ribbed or waffled, and may vary in thickness from 1/4" to 1-1/2" depending on the equipment load. Alternating layers of pads and steel shims will be allowed where an increased thickness or deflection is needed. Pads shall be sized to operate within the loading range of the manufacturer in pounds per square inch, and be loaded in the upper half of this range. Air handling unit and other mechanical equipment to be installed on housekeeping pads shall be mounted on ribbed neoprene pads equal to Amber Booth Ampad Type NR or NRC, Style B isolators.

E. Isolator Types for Suspended Equipment
   1. Isolators for supporting Fans A/C Units and other equipment suspended from the structure above on rod hangers shall be of the open spring type with housings and noise washers, lock washers, nuts, etc. Isolators shall be similar to Amber Booth type BSW-1 or 2 or KDXW-1 or 2 with a minimum 1 inch deflection for fans and fan coil units and 2 inch deflection for air handling units. For fans and fan coil units less than 1000 CFM in capacity they may be isolated with rubber-in-shear isolating grommets in lieu of spring isolators.

2.3 MANUFACTURER

A. Isolating material used shall be equivalent to Amber/Booth, Kinetics Noise Control, Korfund Vibration Mountings, or Mason.

2.4 SEISMIC RESTRAINTS

A. Seismic restraints shall be provided for all life safety systems including but not limited to all ductwork, piping, scrubber ductwork, free standing, suspended, or wall mounted HVAC equipment and panels installed under related Sections in this Division. Seismic restraints shall be as evaluated by an evaluation service member of ICC-ES or other agency acceptable to authorities having jurisdiction.

B. Seismic restraints shall be provided for all piping and HVAC systems and equipment as required by IBC/ASCE 7. Refer to Structural documents for Site class, Seismic design category, assigned seismic use group or building category as defined in the IBC, Design Spectral Response Acceleration at Short Periods (0.2 Second) (SDS), and Design Spectral Response Acceleration at 1-Second Period (SD1).
   1. Component Importance Factor: systems not required for life safety and not containing hazardous materials 1.0.
   2. Component Importance Factor: systems required for life safety (fire sprinklers) and containing hazardous materials 1.5.
   3. Component Response Modification Factor: Reference ASCE 7-10.
   4. Component Amplification Factor: Reference ASCE 7-10.

C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

D. Materials of construction for seismic supports shall be the same as those specified for equipment supports and hangers, and duct and pipe supports and hangers.

E. Wind-restraint and Seismic-restraint loadings shall be as determined by a Structural Engineer in accordance with IBC/ASCE 7.

F. The Contractor shall retain a professional engineer to provide seismic loadings, analysis data, and designs of seismic restraints and vibration isolation signed and sealed by a qualified professional engineer responsible for their preparation and licensed in the state of Oklahoma. This will include but not be limited to the following:
   1. Provide seismic loadings to the vibration isolation supplier based on actual equipment being used to allow the proper selection of vibration isolators.
   2. Provide sizing of bolts for attachment of non-vibrating equipment to the structure based on the actual equipment being used.
   3. Provide design of required additional bracing for equipment when vibration isolators or bolts are not adequate to withstand seismic forces.
   4. Provide design of bracing for all suspending equipment.
   5. Provide design of wind bracing for all exterior components.

6. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
   a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service member of ICC-ES or other agency acceptable to authorities having jurisdiction.
   b. Annotate to indicate application of each product submitted and compliance with requirements.

G. Provide design of bracing for all piping and ductwork that exceeds the limitations of the SMACNA Seismic Restraint Manual.
   1. Provide design of bracing for all piping and ductwork.
   2. Where piping or ductwork is subject to thermal expansion, the loads caused by the thermal expansion and contraction shall be included in the design of the restraint bracing.

H. Signed and sealed calculations and details shall be submitted for record purposes.

I. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer

PART 3 - EXECUTION

3.1 PERFORMANCE OF ISOLATORS

A. Comply with recommendations set forth by the American Society of Heating, Refrigerating and Air Conditioning Engineers for the selection and application of vibration isolation materials and units.

B. Comply with manufacturer's recommendations for selection and application of vibration isolation materials and units.

C. Place isolators where indicated and where specified herein. Coordinate all isolator selections with approved equipment and other pertinent shop drawings of exact equipment to be isolated. Verify to ensure accuracy of load points and take into account any accessory devices adding to equipment loads to be supported by isolators.

D. After installation of equipment, isolators shall be adjusted for proper loading and distribution of weight.

END OF SECTION

SECTION 23 05 53
HVAC - IDENTIFICATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Summary description of work:
   1. This section describes piping, valve, duct and equipment identification and the associated color code system to be used.

1.2 MEASUREMENTS AND PAYMENTS

A. No separate payment will be made for work performed under this Section. Include the cost for this work in the lump sum Base Bid.

1.3 Related work:

A. General requirements: Division 01.

B. Pipe painting: Division 09.

C. General provisions: Section 23 05 00.

1.4 REFERENCE STANDARDS

A. Piping system identification:
   1. ANSI / ASME -A13.1, "Scheme for the Identification of Piping Systems".
   2. ANSI Z535.1 2007: "Safety Color Code"

1.5 SUBMITTALS

A. Shop drawings: Provide list of wording, symbols, letter size, and color coding for mechanical identification per Division 01 and Section 23 05 00 to the Engineer for review. Submit also the following additional information for Engineer review:

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B. Provide manufacturers catalog literature for each product required.

C. Samples of each type of label and marker.

D. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

E. Valve chart and schedule showing valve tag numbers, type, location, function, and valve manufacturer’s name and model number.

F. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.

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 GENERAL

A. Acceptable manufacturers:
   1. Pipe, valve and equipment markers:
      a. Seton Identification Products.

b. Brady Corporation.
c. Craftmark Pipe markers.
d. Or equal

2. Underground marking tape:
a. Seton Identification Products.
b. Brady Corporation.
c. Craftmark Pipe markers.
d. Or equal.

B. Color
1. Prior to ordering materials, obtain list of Owners Standard colors for identification of mechanical equipment, piping and devices and conform to this listing. Unless specified otherwise or identified in the Owners Standards, conform to ANSI/ASME A13.1.

C. Application
1. Identification shall be suitable for indoor or outdoor application, for area temperature and other ambient conditions, as required per use. Outdoor identification systems shall be UV rated.

2.2 PIPE MARKERS

A. Pipe markers: Provide color-coded pipe markers conforming to ANSI-A13.1. Pipe markers shall be semi-rigid plastic pipe markers performed to fit around pipe or pipe covering which snap into place around pipe. Marker shall be of color (Legend and Background) per Table at the end of this specification, and of the approved Legend Letter Size and Marker Length as listed below.

B. Strap on markers are not acceptable.
1. Each color-coded marker shall contain:.....
a. Identify contents of piping system by fluid contained
b. Nominal Pipe Size of the identified pipe
c. Direction of Flow Arrows

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2. Size of letters legend:

Outside Diameter of Pipe or Pipe Covering	Length of Color Field	Size of Letters and Arrows
3/4 -to 1-1/4 IN	8 IN	1/2 IN
1-1/2 to 2 IN	8 IN	3/4 IN
2-1/2 to 6 IN	12 IN	1-1/4 IN
8 to 10 IN	24 IN	2-1/2 IN
Over 10 IN	32 IN	3-1/2 IN

2.3 VALVE TAGS

A. Brass: Seton, or an approved equal, Style 250 BL 19 gauge polished brass, 1 1/2 in. diameter. Each tag shall designate appropriate service with 1/4 in. stamped black filled letters and valve number with 1/2 in. stamped black filled numbers. Identifying letters for various systems shall be, for example: LPS, PA, etc. Provide each valve tag with approved metal seals with 4 ply .018 copper smooth wire; brass "S" nooks, or No. 16 brass jack chain.

B. Aluminum: Seton, or an approved equal, Style 250 BL 0.032 in. thick polished aluminum, 2 in. diameter. Each tag shall designate appropriate service with 1/4 in. engraved letters and valve

number with 1/2 in. engraved letters. Identifying letters for various systems shall be, for example: LPS, PA, etc.

2.4 VALVE CHARTS

A. Provide charts of all valves in duplicate. Charts shall include the following:
   1. Valve Identification Number
   2. Service
   3. Location
   4. Purpose

B. Provide one (1) chart mounted in aluminum with plexiglass frame mounted on wall where directed by Engineer.

2.5 EQUIPMENT IDENTIFICATION

A. Equipment Data Plate:
   1. Provide manufacturer's standard permanent nameplate constructed of stainless steel, with data engraved or stamped, permanently attached to the equipment.
   2. Data shall include, as a minimum, Engineer's equipment tag number as shown on Drawings; Manufacturer name, product name, model number, and serial number; equipment capacity, operating and power characteristics; and labels of testing agencies.

B. Equipment Tag Nameplate:
   1. Provide 1/16 inch thick, engraved laminated phenolic markers for each piece of equipment equal to Setonply.
   2. Nameplates shall have black exterior and white core, neatly beveled edges, and shall show white letters or numbers (letter/number height minimum 1/2 inches) on a black background.
   3. Unit numbers indicated in equipment schedules shall be provided as specified above on all equipment using 1-in high Optima Bold, upper case, Grid 2 spacing, white or black in color as approved depending on substrate. Unit numbers shall be mounted at eye level on machines where possible or at the upper most broad vertical surface of low equipment.
   4. Inscribe on the nameplate the Engineer equipment tag number as used on the Drawings. (Example: P-02 or AHU-01)

C. Where specific equipment is described elsewhere herein, it shall take precedence over this paragraph.

2.6 HVAC DUCT MARKERS

A. Provide pressure sensitive vinyl (self-adhesive), color-coded marker for make-up air unit supply ductwork.

B. For plastic or FRP duct where self-adhesive markers may not perform satisfactorily, provide semi-rigid plastic markers to fit on or around duct, and which snaps into place around duct.

C. Each color-coded marker shall contain:
   1. Legend indicating service type (i.e., Make-Up Air)
   2. Corresponding Equipment Tag Number (i.e., MAU-01, etc.)
   3. Air Flow Direction
      a. Border (background) color determined by component function per Duct Marker Legend Table-2 below.

D. Size of Legend Lettering
   1. Block style lettering, 2 inches height minimum.

2.7 ACCESS PANEL MARKERS

A. Access panel markers:
   1. Metal tack style: Use on acoustical tile ceilings.

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a. Seton style BCM or ECM.
2. Engraved plastic style.
a. 3/4 IN square with center hole for small screw.
b. Seton style CM75.

2.8 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags; of plasticized card stock with matte finish suitable for writing.
1. Size: 3 by 5-1/4 inches (75 by 133 mm) minimum
2. Fasteners: Brass grommet and wire
3. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.
4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 GENERAL

A. Plan the locations of markers, tags, and nameplates to insure good visibility of such markers, tags, and nameplates in conformance with ANSI A13.1.

B. Clean the area to which said markers, tags, and nameplates shall be applied.

C. Where adhesive markers are used, degrease and clean surface prior to applying marker.

D. Install markers, tags, and nameplates in accordance with manufacturer's instructions.

3.2 VALVE IDENTIFICATION

A. Identify all valves, with appropriate service designation and valve number designation on valve tags. Tagging of valves within factory-fabricated equipment and valves, at unit heaters, fan coil units, air terminal unit reheat coils and plumbing fixture stops are not required. Install tags on valves using valve tag fasteners in manner for easy reading.

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B. Furnish 4 charts including valve identification number, location, (I.e. room number, column number, above ceiling, etc.) service, and purpose.
1. Mount 1 chart in frame and secure on wall in location directed by Owner.
2. Include remaining 3 sets in "Operation and Maintenance Manuals".

3.3 PIPE IDENTIFICATION

A. Pipe markers of the colors indicated in the Tables below; locate and size per ANSI A13.1. Comply with manufacturer's directions.

B. Markers shall be in clear view aligned with axis of piping, readable from access panels (where applicable), and shall not be obscured by other work. Label should be clearly visible from operating positions especially those adjacent to control valves. Markers shall be applied to exposed and concealed piping. Locate pipe markers as follows:
1. Next to each valve and fitting, except on plumbing fixtures and equipment.
2. At each branch or riser take off.
3. At each passage through walls, floors and ceilings (both sides).
4. At each pipe passage to underground.
5. On horizontal pipe runs every 20 FT, at least once in each room and each story traversed by piping system.
6. All access doors, manholes, or equivalents that permit view of concealed piping.
7. Near major equipment and other points of origin and termination.

C. Install markers with tape color bands over each end of marker, extending around pipe and overlapping a minimum of 30 degrees.

D. Install flow direction arrow tape to extend full circumference of pipe.

E. See Drawings for symbols, legends, and abbreviations. Markers shall include line size, service designation, area code and line number, where applicable; see Table-1 below for pipe service designations and abbreviations.

3.4 DUCTWORK IDENTIFICATION

A. Locate duct markers at each branch or riser take-off next to equipment, at each side of penetration walls, floors, and ceilings and at each obstruction and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system. Align markers with axis of duct. Seal markers with clear lacquer.

B. Identify ductwork access doors serving fire dampers, smoke dampers, and combination smoke/fire dampers.

C. Stenciled Duct Marker Option: Stenciled markers, showing service and direction of flow, may be provided instead of laminated-plastic duct markers at Contractor's option, if lettering larger than 1 inch (25 mm) high is needed for proper identification because of distance from normal location of required identification. Stencil markers shall be permanent following legend and color schemes same as plastic markers.

3.5 EQUIPMENT IDENTIFICATION

A. Permanently attach equipment nameplates in conspicuous, accessible, and visible location, directly on equipment. Provide for all mechanical equipment including but not limited to starters, pumps, fans, unit heaters, duct heaters, VAV boxes, condensing units, air-handling units, boilers, chillers, HVAC equipment, tanks, heat transfer equipment, water treatment equipment, and control panels. Secure nameplates with adhesive. Small devices, such as in-line pumps, may be identified with metal tags.

B. For unsuitable surfaces, such as high temperature or lack of space, use 316 stainless steel copper or brass rings or chains to attach tags.

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C. Identify devices located above ceilings with additional identification.
   1. Use access panel markers (metal tack style) for acoustical tile ceilings, or engraved plastic style, 3/4 IN square, for mounting on panel door, or equipment nameplates.
   2. Coordinate with Owner on identification method and color codes.
   3. Provide markers on all removable ceilings and ceiling access panels to indicate locations of valves, dampers, smoke detectors, etc., and other mechanical items that may need servicing or adjustment. Glue marking tacks in place to prevent their falling out.
   4. Where fire protection devices are located inside ductwork, provide an additional tag on the duct access door identifying device inside.
      a. Identification letter size: 1-1/2 IN high minimum.
   5. Color code access panel markers as follows:
      a. Red: Fire dampers and smoke detectors.
         (i) Notation:
            (a) D-Damper
            (b) S-Smoke Detector
            (c) H-Heat Detector
      b. Gold: Automatic and balancing dampers:
         (i) Notation:
            (a) V-Valve
            (b) D-Damper

3.6 INSTALLATION OF UNDERGROUND MARKING TAPE

A. Install underground marking tape above metallic outside utility lines as indicated in accord with manufacturer's instructions.

B. Install underground detectable marking tape above non-metallic outside utility lines as indicated in accord with manufacturer's instructions.

C. Allow minimum 12 IN between tape and line and install 12 to 18 IN below finished grade level (6 IN below finished grade for detectable marking tape).

D. When lines are buried 30 IN or greater in depth, install 6 IN minimum width tape.

3.7 CONTROL DIAGRAMS AND INSTRUCTIONS

A. Provide HVAC control and systems instructions and diagrams in wall mounted frames.
   1. Mount framed diagrams in conspicuous, easily accessible places in equipment rooms housing appropriate HVAC system.

B. Diagrams and instructions may be reduced in size provided they are easily readable, and lettering is not smaller than 1/16” tall.

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3.8 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

3.9 ADJUSTING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.10 CLEANING

A. Clean faces of mechanical identification devices.

Table-1

PIPE MARKER LEGEND

CODING COLORS		
G - Green		
B - Blue		
O - Orange		
R - Red		
Y - Yellow		
W - White		

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LEGEND	PIPE LABEL WORDING
COND	Condensate

Note: Refer to Drawings for service descriptions, designations, and abbreviations, use above legends where not indicated on drawings. Service descriptions, designations, and abbreviations on Drawings take precedence over the table.

Table-2

BACKGROUND COLOR / LETTER COLOR	SERVICE TAG LEGEND	SERVICE IDENTIFICATION
AIR		
Blue/White	MA	Make-Up Air Supply
Blue/White	SA	Air Supply
Blue/White	OA	Outside Air
Blue/White	EA	Exhaust Air
DRAINS & WASTES		
Green/White	COND	Condensate Drain (Condensate from Cooling Coils)
REFRIGERATION		
Yellow/Black	RL	Refrigerant Liquid
Yellow/Black	RS	Refrigerant Suction

Note: Refer to Drawings for service descriptions, designations, and abbreviations, use above legends where not indicated on drawings. Service descriptions, designations, and abbreviations on Drawings take precedence over the table.

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END OF SECTION

SECTION 23 05 93
HVAC - TESTING, ADJUSTING AND BALANCING

PART 1. GENERAL

1.1 SCOPE OF WORK

A. Furnish the necessary labor, materials, instruments, transportation and devices required to test, adjust and balance all HVAC systems, including variable refrigerant flow systems, as detailed herein and as shown on the HVAC Drawings. Each system shall be tested, adjusted and balanced as required to cause the systems to perform in accordance with the intent of the Drawings, the Control Sequences and this Section.

B. Work Description - Refer to Section 23 05 00 – HVAC General Provisions for a general description of work and to the following additional specific descriptions:
   1. Packaged DX Rooftop Units and their supply/return ductwork.
   2. Ductless split systems, including outdoor condensing unit and indoor AC units.
   3. Exhaust systems.
   4. Make-up air units and supply ductwork.
   5. Instrumentation and controls systems.

C. The TAB Contractor shall be responsible for reviewing all the HVAC Drawings and associated Sequences of Operation and accompanying specification information on the HVAC systems and the intended operation for every system.

D. Test and balance air and water system and submit testing and balancing reports to the Engineer for review and approval. Re-balance when required by the Engineer, incorporating all changes and certify the systems have been tested and balanced to meet specified requirements. The tests shall demonstrate the specified capacities and operation of equipment and materials comprising the systems. Such tests other than as described herein, which are deemed necessary by the Engineer to indicate the fulfillment of the Contract, shall be made. 5

E. The test and balance work shall comply with the requirements of this specification and all data required by this Section shall receive complete final approval by the Engineer before final payment is made.

F. If, in the opinion of the Engineer, the TAB Contractor has not, will not, or cannot comply with the testing, balancing and adjusting requirements of this Section, he may advise the Owner to employ a qualified firm to perform such work at Contractor's sole expense.

G. Related Sections – The following documents shall also govern the work under this Section.
   1. Division 01 – General Requirements.
   2. Section 23 05 00 – HVAC General Provisions.

1.2 MEASUREMENTS AND PAYMENTS

A. No separate payment will be made for work performed under this Section. Include the cost for this work in the lump sum Base Bid.

1.3 RELATED WORK

A. The Mechanical Contractor shall:
   1. Install, startup, operate and check all HVAC systems prior to balancing work.
   2. Replace filters at all HVAC equipment with clean filters prior to TAB procedures.
   3. Provide the necessary personnel to assist the TAB Subcontractor during the balancing work and shall make all necessary adjustments and corrections to equipment and systems (i.e. add dampers, add pulleys and belts, etc.) as directed by the TAB Contractor.
   4. Provide the necessary equipment to the TAB Contractor for making readily accessible all HVAC equipment and other devices requiring adjustment.

1.4 QUALITY ASSURANCE

A. TAB Contractor Qualifications
   1. Testing, balancing and operation of the systems shall be performed by competent and experienced technicians, having formerly done similar work in this field and whose qualifications and performance shall be subject to the approval of the Engineer.
   2. TAB work shall be performed by an AABC or NEBB certified agency, which is independent of all suppliers and installers on the particular job.
   3. All TAB work shall be done under the supervision of registered mechanical engineers or AABC or NEBB certified test and balance engineers employed directly by the TAB Contractor. Supervisory personnel shall have at least five (5) years experience in TAB work.
   4. Show five (5) successfully completed projects of similar size and scope.
   5. The TAB Contractor shall furnish all necessary calibrated instrumentation to adequately perform the specified services. An inventory of all instruments and devices in possession of the TAB Contractor may be required by the Engineer to determine the TAB Contractor's performance capability.
   6. The TAB contractor shall be prepared to submit credentials and other evidence of qualifications, and work experience, following receipt of, but prior to award of filed subbids. Submit qualifications within sixty (60) days after Contract award.

B. Test and Balancing Standards
   1. AABC or NEBB requirements and recommendations.
   2. Report forms for TAB work shall be as recommended by the AABC or the NEBB.

1.5 SUBMITTALS

A. Submit Pre-Qualifications, in accordance with Division 01 – General Requirements and Section 23 05 00 – HVAC General Provisions, with the following information:
   1. Qualifications and experience information and data as detailed below. Include only qualifications and experience related to type of work described herein and as indicated on the drawings and other sections of the specifications.
   2. Evidence of registration as certified AABC or NEEB TAB contractor where work is to be performed in the State of Texas.
   3. Proposed testing schedules and procedures.
   4. Preliminary draft "system" balancing reports.

B. Testing and Balance Reports - Submit final Test Reports after completion of testing, adjusting and balancing work. Refer to Part 3 of this Section for testing procedures.
   1. Cover Sheet - Provide the following general data in a format selected by the TAB Contractor:
      a. Project Name
      b. Project Location: address including City and State
      c. Owner Contract Number
      d. Building name
      e. Project Engineer(s) Name
      f. General Contractor Name
      g. Mechanical Contractor Name
      h. TAB Contractor Name, address and phone number
      i. Printed Name, signature and seal/certification of responsible-in-charge TAB engineer/technician.
      j. Dates tests were performed
   2. Preface - A general discussion of the systems, any abnormalities and problems encountered.
   3. Instrument List - The list of instruments including type, manufacturer, model #, serial number, range and calibration dates.

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4. Test Forms - Furnish test report data on 8-1/2-in by 11-in bond AABC or NEBB form paper in accordance with Division 01 – General Requirements and Section 23 05 00 – HVAC General Provisions. Submit format for recording data and receive approval prior to use.
   a. Each test form header/footer shall include the following general information:
      (i) Name of TAB Contractor.
      (ii) Project Name and Address.
      (iii) Dates tests were performed.
      (iv) Building Name or Room Number or Zone Number.
      (v) Instruments used to perform the test.
      (vi) Name of test technician or test engineer.

5. Furnish, as a minimum, the following test data on the test forms for all HVAC equipment.
6. HVAC Makeup Air Units
   a. Tag Number (as used in the HVAC Drawings)
   b. Location
   c. Manufacturers, model number and serial number.
   d. All design and manufacturer's rated data.
   e. Total supply air, cfm, design and actual.
   f. Heating Type, electric or gas
   g. Heating Capacity, kW or MBH Input/Output
   h. Pressure, inches w.g., at inlet of each fan .
   i. Pressure, inches w.g., at discharge of each fan.
   j. External static pressure, inches w.g., design and actual.
   k. Pressure drops across system components such as louvers, filters, and coils.
   l. Total static pressure, inches w.g., design and actual.
   m. Outlet velocity - fpm.
   n. Fan RPM.
   o. Maximum tip speed - fpm.
   p. Submit the actual fan operating point on a copy of the fan shop drawing showing operating curve.
   q. Supply air temperature (dry bulb and wet bulb), deg. F.
   r. Outside air temperature (dry bulb and wet bulb), deg. F.
   s. List the following data from all fan motors installed.
      (i) Manufacturer model and size.
      (ii) Motor horsepower, service factor and rpm.
      (iii) Volts, phases, cycles and full load amps (one (1) reading for each phase leg on 3 phase motors).
      (iv) Efficiency.
7. HVAC Systems – Indoor Ductless AC Unit
   a. Tag Number (as used in the HVAC Drawings)
   b. Location
   c. Manufacturers, model number and serial number.
   d. All design and manufacturer's rated data.
   e. Total outside air, cfm, design and actual (if applicable).
   f. Outlet velocity - fpm.
   g. Supply air temperature (dry bulb and wet bulb), deg. F.
   h. Return air temperature (dry bulb and wet bulb), deg. F.
   i. Outside air temperature (dry bulb and wet bulb), deg. F.
   j. Refrigerant Type
   k. Refrigerant Capacity, pounds
8. HVAC Systems – Outdoor Condensing Units
   a. Tag Number (as shown on the HVAC Drawings)
   b. Location
   c. Manufacturer and model number of all units.
   d. All design and manufacturers rated data.
   e. Liquid and suction pressures in psi.

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f. Outside air temperature (dry bulb and wet bulb), deg. F.
g. Capacity of system, BTUH.
h. Voltage and ampere input of motors under full load (one (1) for each phase leg).
i. Sound data, dba, at 5 ft. from unit.

9. Fans
   a. Tag Number (as used in the HVAC Drawings)
   b. Location
   c. Manufacturers, model number and serial number.
   d. All design and manufacturer's rated data.
   e. Total air flow, cfm, design and actual.
   f. Pressure, inches w.g., at inlet of each fan.
   g. Pressure, inches w.g., at discharge of each fan.
   h. External static pressure, inches w.g., design and actual.
   i. Total static pressure, inches w.g., design and actual.
   j. Outlet velocity - fpm.
   k. Fan RPM.
   l. Maximum tip speed - fpm.
   m. Submit the actual fan operating point on a copy of the fan shop drawing showing operating curve.
   n. List the following data from all fan motors installed.
      (i) Manufacturer model and size.
      (ii) Motor horsepower, service factor and rpm.
      (iii) Volts, phases, cycles and full load amps (one (1) reading for each phase leg on 3 phase motors).
      (iv) Efficiency.
10. Electric Heating Coils
    a. Tag Number (as used in the HVAC Drawings)
    b. Location
    c. Manufacturer and model number.
    d. All design and manufacturer's rated data.
    e. Flow rate of air through coil, cfm, design and actual.
    f. Face velocity, fpm.
    g. Entering air temperature (dry bulb and wet bulb), deg. F., design and actual.
    h. Leaving air temperature (dry bulb and wet bulb), deg. F., design and actual.
    i. Air pressure drop through coil, inches w.g.
    j. Actual operating current and voltage for all legs.
    k. Capacity of coil in KW.
11. Diagrams - Prepare 11-in by 17-in single line diagrams or 12-in by 18-in half size drawings showing all duct systems indicating all terminal air outlets including diffusers, grilles and registers, perforated plates, nozzles and other types of air supply, exhaust or return outlets. The minimum scale for diagrams showing the measurement points shall be 1/8-in=1-ft-0-in in the final form as submitted. The use of faxed copies of diagrams is not acceptable. Location of test points shown on the diagrams shall be clear and easy to locate on the diagram. The identification mark of the test points shall be the same as is shown on the test report showing the test data. The identification for test points shall include indication of the units served, and shall not have a duplicate in the project. All supply outlets shall be adjusted so that there are no drafts. Grille and register readings may be made by a vane anemometer, but diffuser readings shall be made by a flow hood or a velometer, using the tip recommended by the diffuser manufacturer. Each diagram sheet shall include the following information:
    a. Project Name and address.
    b. Project Location: address including City and State
    c. Owner Contract Number
    d. Building name
    e. TAB Contractor Name, address and phone number

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f. Dates tests were performed.
g. Size of outlet.
h. Type outlet.
i. Manufacturer of outlet.
j. The cfm at each outlet on system and corresponding cfm at each outlet as noted on the plans.
k. Percent deviation of the measured flow versus the design flow.
l. Indication of the branch and terminal that are the open/low that are the basis for balancing the remainder of the system.

C. All submittals shall contain a statement that Sections 23 05 00 – HVAC General Provisions, 15990 – HVAC Testing, Adjusting, and Balancing and all other referenced Sections have been read and complied with. The certification statement shall be made by all of the following that are applicable; the Contractor, sub-contractor and the vendor. The statement shall be an individual statement for each party involved, and shall be included with every submittal and resubmittal.

D. In general, corrections or comments or lack there of, made relative to submittals during review shall not relieve the Contractor from compliance with the requirements of the drawings and specifications. Submittals are for review of general conformance with the design concepts of the project and general compliance with the contract documents. The Contractor is responsible for the final design conforming and correlating all quantities and dimensions, selecting fabrication processes and techniques of construction, coordinating the work of all trades, and performing the work in a safe and satisfactory manner.

1.6 SCHEDULE AND PROCEDURES

A. A complete schedule of balancing procedures for each of the buildings or systems shall be submitted in sufficient time in advance so that the Engineer, at his option, might arrange to observe these procedures as they progress. Before commencing with the balancing of the systems submit the methods and instruments proposed to be used to adjust and balance the air and water systems.

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B. Submit proposed testing programs at least two (2) weeks prior to the scheduled test to assure agreement as to personnel and instrumentation required and scope of each testing program.

1.7 DRAWING REVIEW

A. The TAB Contractor shall thoroughly review the location of all fresh air dampers, return dampers, spill dampers, quadrant dampers, splitter dampers, bypass dampers, face dampers, fire dampers, registers, grilles, diffusers, VAV boxes, troffers, etc. The purpose of the review is to finalize the optimum locations for dampers, test ports and balancing valves shown on the Drawings.

1.8 EQUIPMENT CURVES

A. Fan Characteristics Charts: The HVAC and General Contractors shall provide to the TAB Contractor any required characteristic curve charts for all fans to include air conditioning units and air handling units. Characteristic curve charts shall be not less than 8-1/2-in by 11-in and shall show the static pressure, capacity horsepower and overall efficiency for operating conditions from no load to 130 percent of specified load. The minimum size of the actual fan curve shall be no less than 6-in by 8-in. The use of faxed copies of curves is not acceptable.

B. Pump Characteristic Charts: The Mechanical Contractor shall provide to the TAB Contractor any required characteristic curve charts for each water or water/glycol system pump. Charts shall be not less than 8-1/2-in by 11-in showing head developed, efficiency and power required for varying capacities at the operating speeds of the equipment. The minimum size of the actual pump curve shall be no less than 6-in by 8-in. The use of faxed copies of curves is not acceptable

1.9 GUARANTEE/WARRANTY

A. The balancing work shall be guaranteed to be accurate and factual data, based on readings in the field. All typewritten data shall be submitted within fourteen (14) working days of the performance of the test. Test data shall not be held until final completion, but shall be submitted on an interim basis as soon as the test or appropriate group of tests are finished.

B. Provide extended warranty of ninety (90) days after completion of test and balancing work, during which time Owner/Engineer/Owner's Representative may request a recheck or resetting of equipment or systems which may not be performing satisfactorily. Provide technicians as required to perform additional testing and balancing.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Furnish gaskets, lubricants and other expendable materials required to be replaced during the execution of this work.

B. Fixed-pitched pulleys required for fan adjustments shall be furnished on an exchange basis by the party responsible for the fan installation.

C. Where test results indicate that air quantities at any system fan are below or in excess of the specified amount, the HVAC and General Contractors, at their own expense, shall change driving pulley ratio or shall make approved changes to obtain the specified or scheduled air quantities.

D. Testing apparatus: Furnish plugs, caps, stops, valves, pumps, compressors, blowers and similar devices required to perform this work.

1. Furnish anemometers, thermometers, gauges, voltmeters, ammeters, tachometers and similar instruments, not part of the permanent installation, but required to record the performance of the equipment and systems.
2. Testing apparatus, not part of the permanent installation, shall remain the property of the Contractor, but made available to the Engineer.
3. Instruments used for testing shall be certified accurate to within plus or minus 0.10 degrees F for temperature or plus or minus 0.10-in wc for pressure. Calibration of the instruments shall be done within seven (7) days of testing for this project and henceforth every thirty (30) days thereafter for the duration of the testing period. Certification of calibration shall be submitted to the engineer prior to starting the work.

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PART 3 - EXECUTION

3.1 INSPECTIONS

A. During construction, the TAB Contractor shall inspect the installation of pipe systems, sheet metal work, temperature controls, and other component parts of the HVAC systems. The inspections shall be performed periodically as the work progresses. A minimum of two inspections are required as follows: (1) when 60 percent of the duct work is installed: (2) when 90 percent of the equipment is installed. The TAB Contractor shall submit a brief written report of each inspection to the Engineer.

3.2 START OF BALANCING

A. The General Contractor shall notify the TAB Contractor and Engineer when systems become operational and ready for preliminary and final testing, adjusting and balancing.

B. Final balancing shall not begin until system has been installed complete and is capable of normal operation. Provide personnel to assist in rough balance and calibration.

C. If requested by Owner, testing, adjusting and balancing work shall be done in the presence of the Owner's Representative. Notify Owner's Representative at least two (2) weeks prior to commencing balancing work.

D. All grilles, dampers, fans, coils, pumps, valves and linkages shall be verified to be installed and operating.

E. System shall be capable of operating under control as specified on Drawings and/or contained herein.

F. TAB work shall be done under normal operating conditions of equipment. For example, if HVAC sequences of control indicate that fans shall run with associated motorized dampers at intake louver open, then fan shall be tested with intake damper open.

G. Visually inspect all fire dampers to ensure that they are fully open.

H. Verify with straight edge that fan/pump and motor shafts are parallel and that sheaves are in proper alignment.

I. Verify that belts are properly tensioned when unit is operating with no excessive squeal at startup. If not correct, adjust sheaves or motor base accordingly.

J. Check dampers on system are open, where required, prior to starting fans.

K. Check air filters and other filter media and start TAB procedures only with clean filters in the HVAC equipment. For HVAC equipment with inlet and discharge screens, verify screens are clean and free of debris prior to starting TAB procedures. The Mechanical Contractor shall install new, clean filters and clean inlet and discharge screens prior to TAB work.

L. Start fans and pumps, verify that rotation is correct. If rotation is incorrect coordinate with electrical contractor to switch power leads such that the motor rotates correctly. 5

M. Check nameplate voltage on motor, compare to scheduled voltage. Notify the Engineer immediately of any discrepancies. Measure and record actual voltage across all power leads. Notify the Engineer of discrepancies immediately.

N. Check motor nameplates full load amps, measure and record amperage across all power leads. If there are marked discrepancies in amperage draws between legs, notify the Engineer immediately.

O. Measure and record fan/pump and motor rpm. Check that motor rpm agrees with nameplate and scheduled rpm. Where a speed adjustment is required, the Mechanical Contractor shall make any required changes.

P. If, upon commencing the work, the TAB Contractor finds that the systems are not ready, or if a dispute occurs as to the readiness of the systems, the TAB Contractor shall request an inspection to be made by the Engineer. This inspection shall establish to the satisfaction of the represented parties whether or not the systems meet the basic requirements for testing and balancing. Should the inspection reveal the notification to have been premature, all costs for the inspection and work previously accomplished by the TAB Contractor shall be paid for by the General Contractor. Furthermore, such items that are not ready for testing and balancing shall be completed and placed in operational readiness before testing and balancing services shall be recommenced.

Q. Leaks, damage and defects discovered or resulting from startup, testing and balancing shall be repaired or replaced to like-new condition with acceptable materials. Tests shall be continued until system operates without adjustments or repairs.

3.3 REQUIRED ACCURACY

A. Air and Water systems shall be balanced to be within the following limits of the capacity shown on the Drawings. Limits shall be applied to both individual components and to the system totals.

1. General Systems (plus/minus 10 percent)
2. HVAC Air Systems (plus/minus 10 percent)
3. Makeup Air Systems (plus 10 percent)
4. Exhaust Systems (plus/minus 10 percent)

3.4 TESTING PROCEDURES

A. HVAC Air Systems Balance
   1. Test and balance all HVAC air systems supply air, return air, outside air and exhaust air systems in accordance with AABC or NEBB Standards by the use of direct reading instruments such as an "anemotherm" or velometer which has been properly calibrated, and record the results.
   2. Temporarily add static pressure to the system, to simulate the effect of dirty filters, by blanking off portions of the filter section, covering filter section with cheesecloth, sheet metal or other suitable means. Confirm static has been added with new static pressure reading across fan. Remove cheesecloth, etc, after traverses are complete.
   3. If so instructed by the Engineer, further balancing of temperature shall be made either by thermometer or by temperature recorder.
   4. The sequence of air balancing shall be as follows:
      a. First, establish air flow quantity at supply fan by main duct traverse.
      b. Next, establish air flow quantities in main ducts and branches.
      c. Finally, establish air flow quantities at outlets, using proportional balancing among branch outlets. All multiple opening systems shall be left with at least one (1) "open low" inlet or outlet, to which all other system openings shall be proportionally balanced. The "open low(s)" on each system shall be indicated in the report.
      d. After all outlets are adjusted to within the tolerances specified elsewhere in this Section, remeasure all system outlets, and retraverse all branch and main ducts to establish final "as balanced" flows.
      e. All main air ducts shall be traversed, using a Pitot tube and manometer. The manometer shall be calibrated to read two significant figures in all velocity pressure ranges. The static pressure reading at the traverse point shall be recorded for each successive traverse.
         (i) A main duct is defined as any of the following:
            (a) A duct serving five (5) or more outlets.
            (b) A duct serving two (2) or more branch ducts.
            (c) A duct emanating from a fan or plenum.
      f. All other ducts are branch ducts.
      g. The intent of this operation is to measure by traverse, the total air quantity handled by the fan and to verify the distribution of air to zones and to adjust system pressure to minimum level required to satisfy the farthest air outlet.
   5. Adjust fan speeds if results of system capacity tests are not within tolerances specified and repeat Paragraphs 3.04A4c, d and e above, as required.
   6. Mark all final balancing damper positions with a permanent marker and lock in place.
   7. For systems which modulate between different flow modes (e.g. minimum outside air to 100 percent outdoor air or 100 percent return air to 100 percent exhaust) measure and report system flow under both extremes of modulation and check for excessive system flow deviation above design, when system is modulating between its end points.
   8. Adjust automatic dampers to required settings as described in Sequence of Operation. Coordinate work with HVAC Controls Contractor to obtain required adjustment of HVAC controls for proper operation of HVAC systems.

B. Adjust belts, sheaves and the alignment of air handling equipment.

C. Where various combinations of sheaves must be installed on fan systems to achieve the correct air delivery, change the sheaves and continue to take successive readings until the correct combinations are installed.

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3.5 REPORT FORMS

A. General
   a. Project Name and address.
   b. Project Location: address including City and State
   c. Owner Contract Number
   d. Building name
   e. TAB Contractor Name, address and phone number
   f. Dates tests were performed.
   g. Size of outlet.
   h. Type of outlet (supply, exhaust, etc.).
   i. Manufacturer of outlet.
   j. The cfm at each outlet on system and corresponding cfm at each outlet as noted on the plans.
   k. Percent deviation of the measured flow versus the design flow.
   l. Indication of the branch and terminal that are the open/low that are the basis for balancing the remainder of the system.

B. HVAC Air Systems
   1. Furnish typewritten data tabulating the following:
      a. System Identification. In each report, the zones, supply, return and exhaust openings and traverse points shall be numbered and/or lettered to correspond to the numbers and letters used on the report data sheets and on the report diagrams.
      b. Opening number, type, size and design flow rate. Indicate design flow rate and actual flow rate.
      c. Quantity of air in cfm at each air outlet and inlet. Indicate design flow rate and actual flow rate.
      d. Dry bulb temperature in each room.
      e. Dewpoint in each room.
      f. Dry bulb temperature of the supply air.
      g. Dewpoint of the supply air.
      h. Outdoor dry and wet bulb temperature at the time the above tests are conducted. (Wet bulb temperature only required for AC systems)
      i. Provide data in schematic format, indicating design and actual air flow rates at each inlet and outlet.

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3.6 STANDBY EQUIPMENT

A. Where systems are provided with standby equipment, the system shall be balanced for operation in standby as well as normal operation.

3.7 FINAL ACCEPTANCE

A. At the time of final inspection, the TAB Contractor shall recheck, in the presence of the Engineer, specific and random selections of data recorded in the certified test-and-balance report.

B. Points and areas for recheck shall be selected by the Engineer.

C. Measurements and test procedures shall be the same as the original test and balance.

D. Selections for recheck, specific plus random, shall not normally exceed 15 percent of the total number tabulated in the report, except where special air systems require a complete recheck for safety reasons.

E. If the specific rechecks are more than 5 percent deviation from the report or specified flows, all of the systems, that require specific recheck, shall be rebalanced. If 5 percent or 5 of the random checks, whichever is less, exceeds a 10 percent deviation from the specified flows, the report shall be rejected. In the event the report is rejected, all systems shall be readjusted and

tested, new data recorded, a new certified test-and-balance report submitted, and a new inspection test made, all at no additional cost to the Owner.

F. Each fan shall operate with no objectionable noise or vibration.

3.8 OPPOSITE SEASON TEST

A. The TAB Contractor shall perform an inspection of the HVAC system during the opposite season from that in which the initial adjustments were made. The TAB Contractor shall make any necessary modifications to the initial adjustments to produce optimum system operation.

3.9 SOUND MEASUREMENTS

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A. Record data at 4 points of property line with all equipment running.

3.10 COMMISSIONING

A. Each system shall undergo a complete functional acceptance test, and shall include all interrelated systems. Submit a Test Report documenting time of testing, results of testing and attendee names and contact information.

B. Commissioning shall be witnessed by Owner, Owner's Representative and Engineer.

C. For air-conditioned spaces, verify room temperatures are maintained in accordance with the Sequences of Operation.

END OF SECTION

SECTION 23 07 13
HVAC - DUCT AND PIPE INSULATION 

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This Section specifies the basic materials and methods of installation for insulation for ductwork systems. Specific uses and applications are specified in other Sections of Division 15 – HVAC and on the Drawings:

1.2 MEASUREMENTS AND PAYMENTS

A. No separate payment will be made for work performed under this Section. Include the cost for this work in the lump sum Base Bid.

1.3 RELATED WORK

A. System applications for insulation are specified in other Sections of Division 23 – HVAC.

B. Building insulation is included in Division 07 – Thermal and Moisture Protection.

1.4 SUBMITTALS

A. Submit to the Engineer, in accordance with Division 01 – General Requirements and Section 23 05 00 – HVAC General Provisions, the following for each insulation by System: manufacturer's product data showing conformance with this Section for all required insulation, jackets, covers, coatings, adhesives, fasteners, supports and appurtenances; complete manufacturer's instructions for installation of all required items. The submittal will be considered incomplete without all information provided.

B. All submittals shall contain a statement that Sections defining specific insulation types and thickness and all other referenced Sections have been read and complied with. The certification statement shall specify the specific Sections and be made by all of the following that are applicable; the Contractor, sub-contractor and the vendor. The statement shall be an individual statement for each party involved, and shall be included with every submittal and resubmittal.

C. All materials deliveries must have accompanying manufacturer's certifications attesting to satisfactory results of product testing showing conformance with this Section.

D. For material that will be shipped exposed, provide a description of the protective packaging that will be used during transit.

E. In general, corrections or comments or lack thereof, made relative to submittals during review shall not relieve the contractor from compliance with the requirements of the drawings and specifications. Submittals are for review of general conformance with the design concepts of the project and general compliance with the contract documents. The contractor is responsible for the final design conforming and correlating all quantities and dimensions, selecting fabrication processes and techniques of construction, coordinating the work of all trades, and performing the work in a safe and satisfactory manner.

1.5 REFERENCE STANDARDS

A. National Fire Protection Association (NFPA)

B. Occupational Safety and Health Administration (OSHA)

C. Where reference is made to one (1) of the above standards, the revision in effect at the time of bid opening shall apply.

1.6 QUALITY ASSURANCE

A. The insulation materials to be furnished under this section shall be essentially the standard products of manufacturers regularly engaged in the manufacture of insulation systems.

B. Several manufacturers are indicated as acceptable for each type of insulation in these specifications. The Insulation Sub-contractor shall be responsible for determining that all insulation supplied for the project is suitable for installation in the spaces indicated. The Insulation Sub-contractor shall also insure that all materials used are compatible and in compliance with applicable codes and standards.

C. The Owner and Engineer reserve the right to sample and test any materials after delivery and to reject all components represented by a sample that fails to comply with the specified requirements.

1.7 DELIVERY, STORAGE AND HANDLING

A. All materials shall be inspected for size, quality and quantity against approved shop drawings upon delivery.

B. Delivery schedule of all equipment and material shall be coordinated with the Contractor. Equipment and material ready for shipment prior to the agreed on shipping date shall be stored without cost to the Owner by the manufacturer.

C. All material shipped that is exposed such as on a flatbed truck shall be protected during transit. The equipment shall be protected from moisture, road salt, dirt and stones or other materials thrown up from other vehicles. Material shall be protected as above, but with special attention to moisture. The method of shipment protection shall be defined in the submittals.

D. All materials shall be suitably packed for shipment and long term storage. Each package shall be labeled to indicate the project and the contents of each package. Material identification and/or material name and part numbers shall be marked on the container.

E. All materials shall be stored in a covered dry location off of the ground. When required to protect the materials they shall be stored in a temperature-controlled location.

1.8 DEFINITIONS

A. Particular terminology used under this Section is defined as follows:
   1. Traffic Level and Personnel Level Areas, including process areas, equipment rooms, boiler rooms and other areas where insulation may be damaged by normal activity and local personnel traffic. Area extends to 8-ft above floor, walkways, platforms and stairs, and horizontally 3-ft beyond the edge of walkways, platforms, and stairs.
   2. Exposed Ductwork - All ductwork visible from the floor level and includes all ductwork in equipment rooms, boiler rooms, etc.
   3. Concealed Ductwork - Ductwork not visible from the floor level and includes ductwork above ceilings and in shaftways.
   4. Supply Air Ductwork - Ductwork carrying air from a fan or air handling unit to the space or spaces to which it will be introduced. This air may have been heated or cooled or in the case of ventilation system the air would be neither heated nor cooled. Supply air ductwork extends from the fan or air handing unit to the registers, grilles or diffusers at the end of the ductwork.
   5. Return Air Ductwork - Ductwork carrying air from the space it was supplied to back to a fan or air handing unit. Return air ductwork extends from the registers or grilles at the end of the ductwork to the air handling unit or connection with an outdoor air intake duct.
   6. Exhaust Air Ductwork - Ductwork carrying air from a space to a fan and then to be discharged to the outdoors. Exhaust air ductwork extends from the registers or grilles at the end of the ductwork to the fan. From the fan the exhaust ductwork extends to the discharge point, exhaust air damper, or exhaust air plenum, whichever comes first.

7. Relief Air Ductwork - Ductwork carrying air from a space without a fan to be discharged to the outdoors or adjacent space. Relief air ductwork extends from the registers or grilles at the end of the ductwork to the discharge point, relief air damper, or relief air plenum, whichever comes first.
8. Outdoor Air Ductwork - Ductwork carrying untreated air from the outside to a fan or air handling unit. Outdoor air ductwork starts at the intake point, outdoor air damper, or outdoor air plenum, whichever comes last. The outdoor air ductwork extends to the fan, air handing unit, or connection with a return air duct, whichever comes first.
9. Mixed Air Ductwork - Ductwork that can carry either return air or outdoor air or a combination of both. Mixed air ductwork starts at the connection of the return air and outdoor air ducts and extends to the fan or air handling unit.
10. Outdoor Air Plenum - A plenum that extends from the opening in the skin of the structure to the outdoor air duct. If the outdoor air damper is directly at the intake or there is no outdoor air damper, the plenum will extend to the first size reduction. If the outdoor air damper is not at the intake, the plenum will extend to the outdoor air damper.
11. Exhaust Air Plenum - A plenum that extends from the opening in the skin of the structure to the exhaust air duct. If the exhaust air damper is directly at the discharge or there is no exhaust air damper, the plenum will extend from the last size reduction. If the exhaust air damper is not at the discharge, the plenum will extend to the exhaust air damper.
12. Relief Air Plenum - A plenum that extends from the opening in the skin of the structure to the relief air duct. If the relief air damper is directly at the discharge or there is no relief air damper, the plenum will extend from the last size reduction. If the relief air damper is not at the discharge, the plenum will extend to the relief air damper.
13. Ventilated Spaces - Areas supplied with outdoor air on a continuous or intermittent basis. The outdoor air may be heated and/or cooled or untreated.
14. Heated Spaces - Areas where heat is supplied to maintain a minimum temperature during the heating season.
15. Unheated Spaces - Areas where heat is not applied and there is no minimum temperature requirement during the heating season.
16. Conditioned Spaces - Areas that are provided with heating and/or mechanical cooling.
17. Non-Conditioned Spaces - Areas that are not provided with mechanical heating or cooling.
18. Indoor Ductwork - Ductwork within a building that is not exposed to the weather.
19. Outdoor Ductwork - Ductwork that is not within a building and is exposed to the weather.
20. Flues/Stacks/Breeching - Ductwork carrying products of combustion to the atmosphere.
21. Hot Ductwork - Ductwork carrying air with a temperature above the surrounding space temperature.
22. Cold Ductwork - Ductwork carrying air with a temperature below the surrounding space temperature.
23. Hot/Cold Ductwork - Ductwork carrying air with a temperature that can be either above or below the surrounding space temperature.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials and integrated insulation assemblies furnished shall have flame spread ratings of not over 25 (fire resistive), smoke developed rating of not over 50 and fuel contributed rating of not over 50, as established by tests conducted in accordance with Interior Federal Standard No. 00136B, entitled 'Interior Federal Standard Flame-Spread Properties for Materials' and the National Fire Code of the NFPA. The treatment of jackets or facings to impart flame and smoke safety must be permanent. (The use of water-soluble treatment is prohibited.) Exception allowed for closed cell foam insulation and PVC fitting covers.

B. The toxicity of the solvents used shall not exceed a maximum allowable concentration of 200 ppm or the latest value published by the American Conference of Governmental Industrial Hygienists and OSHA.

C. Adhesives, coatings and vapor barrier materials shall be compatible with the insulation as recommended by the insulation manufacturer. Submit a certified statement attesting to the approval of the materials by the insulation manufacturer. Adhesives and coatings shall be manufactured by Foster Div.; H.B. Fuller Co.; Childers Products Co. or equal. H.P. Fuller and Childers Products Nos are listed below by adhesive/coating types.
   1. Lagging adhesive: .....30 36, CP50, AMV-1.
   2. Vapor barrier coating:.....30 35, CP30.
   3. Vapor seal adhesive:.....85 75, CP82.
   4. Duct adhesive.....85 20, CP82.
   5. Sealing compound adhesive: .....30 45, CP70.
   6. Weatherproof mastic: .....35 01, CP10 1.

2.2 INSULATION FOR REFFRIGERANT AND CONDENSATE PIPING (TYPE HI-1)

A. Insulation Material - Molded flexible closed cell sectional pipe insulation, ASTM E84 25/50 rated. The insulation shall have a maximum thermal conductivity "K" factor of 0.245 BTU-in/(hr-sq.ft.-deg.F) at 75 degrees F mean temperature up to 1-inch thickness. Provide insulation with reinforced lap seal along longitudinal joint.

B. Paint insulation located outdoors with manufacturer recommended WB finish according to manufacturer's instruction unless an alternative jacket is specified in Table 1 below.

C. Acceptable manufacturers shall be Armacell Corp. Black LapSeal; Johns Manville Corp. or equal.

2.3 INSULATION FOR DUCTWORK-FIBERGLASS BOARD TYPE (TYPE HI-2)

A. Insulation Material - Fibrous glass semi-rigid board rated to 250 degrees F. faced. The insulation shall have a minimum density of 3 lbs/cu ft and a maximum thermal conductivity "K" factor of 0.23 BTU-in/(hr-sq.ft.-deg.F) at 75 degrees F.

B. Facing shall be factory applied vapor barrier 0.02 perm, FSK facing.

C. Acceptable manufacturers shall be Certain-Teed CertaPro CB 300; Owens-Corning; Manville Corp.; or equal.

2.4 INSULATION FOR DUCTWORK CLOSE CELL FOAM TYPE (TYPE HI-3)

A. Insulation Material Flexible closed cell foam sheet, ASTM E84 25/50 rated, minimum density 5.5 lbs/cu ft, maximum thermal conductivity "K" factor of 0.28 BTU-in/(hr-sq.ft.-deg.F) at 75 degrees F mean temperature.

B. Paint insulation located outdoors with manufacturer recommended WB finish according to manufacturer's instruction unless an alternative jacket is specified in Table 2 below.

C. Acceptable manufacturers shall be Armacell Armaflex FS; Manville Corp. or equal.

2.5 FIELD APPLIED JACKETS AND FITTING COVERS

A. General – Fittings shall be provided with preformed covers of the material type as specified below.

B. PVC jackets shall be white, gloss finish, 20 mil thickness, 25/50 rated.

C. Aluminum (ALU) jackets shall be 0.016 -in. thickness minimum, Type 3003-H-14 aluminum covers with 3/16-in corrugations. Longitudinal joint shall be warranted to provide a positive

seal without screws, rivets, etc. and secured with 1/2-inch aluminum bands with wing seals. Aluminum covers shall be provided with a baked-on acrylic exterior finish and internal moisture barrier coating for resistance to water and corrosion. Finish shall be chalk and fade resistant. Fittings shall be pre-molded, same material and thickness as jacket. Aluminum jacket shall be as manufactured by ITW Insulation Systems..

D. Stainless steel (SSTL) jackets shall be 0.016 thickness, 304 316 stainless steel covers with 3/16-in corrugations. Longitudinal joint shall be warranted to provide a positive seal without screws, rivets, etc. and secured with 1/2-inch Type 316 stainless steel bands with wing seals. Fittings shall be pre-molded, same material and thickness as jacket.

E. Flexible weather proofing (FWP) jacket. Rubberized asphalt composite membrane, self adhesive, 55-60 mil thickness with multi-ply embossed UV-resistant aluminum foil/polymer laminate outer layer. Equal to Alumaguard by Polyguard.

PART 3 - EXECUTION

3.1 GENERAL

A. Do not apply insulation prior to testing and acceptance of ductwork and/or equipment. Insulation shall not be applied to damp or frosty surface. Clean dust, dirt, grease and moisture from surfaces of ducts before applying insulation or insulation adhesives. Nameplates and equipment certification and data tags affixed to any piece of apparatus shall not be covered. Where two (2) layers of insulation are used, stagger all joints both ways. Secure each layer independently. Continue insulation and jacketing through walls, partitions, floors and pipe sleeves.

B. The Contractor shall not install any equipment or materials until the Owner and Engineer have approved all submittals. If any equipment or materials are installed prior to approval of the submittals, it shall be at the Contractor's risk.

C. Internal duct liner is not allowed unless otherwise indicated on the drawings and approved by the engineer.

D. Insulation, adhesives, coatings and vapor barrier materials shall be applied in accordance with manufacturer’s recommendations. Do not apply these materials when ambient temperature is above or below the maximum and minimum ambient temperature respectively, specified as limits by the manufacturer.

E. The use of staples or other fasteners that penetrate the vapor barrier is not permitted.

F. **Provide hangers, supports, and anchors that do not penetrate insulation or jackets of insulated piping**

G. Insulation systems that require a vapor barrier shall be installed with an intact vapor barrier that covers the entire duct or piece of equipment to be insulated. All edges of insulation that do not abut another piece of insulation shall have the vapor barrier extended, and sealed to the item being insulated. All penetrations through the insulation such as for thermowells, test ports, dampers, nameplates, or other items shall have the vapor barrier extend over the edges of the insulation and sealed to the item being insulated. Where items are mounted on ductwork a standoff shall be provided to protect the vapor barrier. The vapor barrier shall be sealed to the standoff.

H. For insulated items exceeding 100 square feet, or 20 feet in length, extend the vapor barrier to the item being insulated to reduce the area or length within a single enclosed area to the dimensions listed above.

3.2 INSTALLATION OF DUCT INSULATION – GENERAL

A. For purposes of insulation, flexible metal ductwork shall be treated as sheet metal ductwork.

B. All cold ductwork shall be provided with a vapor barrier. Where the method of attachment causes penetrations of the vapor barrier such penetrations shall be sealed with vaporseal adhesive and vapor barrier tape.

C. All outside corners of ductwork in the traffic level shall be protected by sheet metal angles. Angles shall be 2x2x22 gauge galvanized steel. When the duct is constructed of materials other than galvanized steel, the protective angle shall be fabricated of the same material as the duct, or of equal corrosion resistance. If a different material of equal corrosion resistance is to be used, it must be approved by the Engineer. Angles shall be attached to the outside of the vapor barrier with adhesive. The entire inside surface of the corner angle shall be coated with adhesive before being installed.

D. Clips, pins, washers, staples and other metal components shall be of the same material as the duct to be insulated. Where items of the same material are not available, a material of equal corrosion resistance may be used. If a different material of equal corrosion resistance is to be used, it must be approved by the Engineer.

E. All joints in insulation shall be compressed 0.25-in. Corner insulation shall be lapped with the overlap extending over the full thickness of the insulation layers. Open spaces in joints are not acceptable. A minimum of two (2) layers of insulation shall be used when the required insulation thickness is greater than 2-in. Joints in adjacent layers shall be staggered a minimum of 3-in.

3.3 INSULATION FOR REFRIGERANT AND CONDENSATE PIPING (TYPE HI-1)

A. Outdoor Piping

1. Installation – Apply insulation in the thickness listed in Table-1 below. Laps and joints shall be sealed using self-sealing laps or vapor barrier tape. Insulation and vapor barrier shall completely encapsulate all flanges, valves, and fittings with the exception of valve handles.

3.4 INSULATION FOR DUCTWORK-FIBERGLASS BOARD TYPE (TYPE HI-2)

A. Hot Ductwork

1. Installation - Apply insulation in the thickness listed in Table-2 below. Impale the insulation over suitable mechanical fasteners, such as welded pins or approved adhered pins, applied to duct surface on 12-in to 18-in centers. Use a minimum of two rows of fasteners on each side of duct. Secure insulation in place with suitable self-locking caps pushed onto the pins. All joints and breaks in insulation and pin heads shall be sealed with vapor barrier tape. All insulation raw edges and butt joints are to be sealed off with either pressure sensitive duct tape or lagging adhesive. Groove insulation to cover standing seams or stiffeners or butt to the standing seams or stiffeners. Extend facing continuously over standing seams or stiffeners to provide a continuous finish.

B. Cold Ductwork

1. Installation - Apply insulation in the thickness listed in Table-2 below. Fasten insulation to sheet metal duct with weld pins or approved adhered pins and clip washers. Place pins on 12-in centers located near edge of insulation and with a minimum of two rows per side. Impale insulation on pins. Attach clip washers so that they rest on the surface of the insulation without indent. Cut off pins flush with surface of washers. Seal penetrations with aluminum vapor barrier coating. Groove insulation to cover standing seams or stiffeners. Extend vapor barrier facing continuously over standing seams or stiffeners to provide continuous seal. Seal joints and edges with 4-in wide strip of factory furnished vapor barrier facing adhered with vapor barrier adhesive or approved vapor barrier duct sealing tape to provide a continuous vapor barrier.

C. Outdoor ductwork - For rectangular ductwork, slope top surface of jacket to prevent ponding of rainwater.

3.5 INSULATION FOR DUCTWORK-CLOSED CELL FOAM TYPE (TYPE HI-3)

A. Installation - Apply insulation in the thickness listed in Table-2 below. Attach insulation to sheet metal duct work with a full coverage coat of adhesive. Joints shall be made to have compression fit with the joints sealed with adhesive. Insulation shall be cut at standing joints and seams in the ductwork with additional layers of insulation applied over the standing joint or seam to obtain an insulation thickness equal to that on the surface of the duct. Manufacturer's installation instructions shall be followed. Adhesives and coatings shall be provided by the insulation manufacturer and shall be compatible with the insulation. Insulation shall be provided with a protective finish for outdoor use in accordance with manufacturer's recommendations.

B. Outdoor ductwork – For rectangular ductwork, slope top surface of jacket to prevent ponding of rainwater.

3.6 INSTALLATION OF EQUIPMENT INSULATION – GENERAL

A. Equipment normally furnished with inspection splits shall be insulated in two (2) sections so that a removable section can be removed without damage to the stationary section.

B. Manhole covers and access door covers shall be formed of built-up insulation and reinforced with aluminum jacketing so that the entire piece covering the manhole, or door, can be easily removed and replaced us a unit.

3.7 LABELING

A. After application of insulation and jacketing (where applicable), label ductwork. Refer to other Sections of Division 23 - HVAC.

TABLE-1

PIPE INSULATION SCHEDULE

Service	Legend	Installation	Pipe Size (in.)	Insulation		Field-Applied Jacket Type (See Notes below)	Remarks
				Type	Thickness (in.)		
Refrigerant Lines		Indoors	All	HI-1	1	ALU	
Refrigerant Lines		Outdoors	All	HI-1	1	ALU	
Condensate (A/C)		Indoors	All	HI-1	3/4	ALU	

General Insulation Schedule Notes for all HVAC Piping:

1. Specific uses and requirements called out on the Drawings take precedence over those listed above.
2. Jacket material for interior piping and drain bodies in chemical rooms shall be 25/50 fire rated PVC with pre-molded fitting covers.
3. Where 'None' is specified in the schedule above under the field-applied jacket column, it shall mean that the insulation shall be provided with the insulation manufacturer's standard factory applied jacket (paper or foil) as called under Part 2 – Products of this specification.
4. Refer to Part 1 – Definitions of this specification for definition of 'Traffic Level'.
5. Field applied jackets are not required above ceilings, behind walls and in chases.
6. N/A = Not Applicable
7. ALU = Aluminum Jacket.
8. SSTL = Stainless Steel Jacket
9. FWP = Flexible Weather Proofing Jacket

TABLE-2

DUCT INSULATION SCHEDULE

Service	Legend	Installation	Size	Insulation		Jacket Type	Remarks
				Type	Thickness (in.)		
Supply Air	SA	Indoors – Exposed Areas	All	HI-2	2	**	
Return Air	RA	Indoors – Exposed Areas	All	HI-2	2	**	
Outside Air	OA	Indoors – Exposed Areas	All	HI-2	2	**	
Make-up Air	MA	Indoors – Exposed Areas	All	HI-2	2	**	
Exhaust Air	EA	Between EF and Isolation Damper	All	HI-2	2	**	This is to prevent condensation on ductwork when EF is off.
Exhaust Air	EA	Indoors – Exposed Areas	All	N/A	N/A	N/A	No Insulation Required.

** - No additional jacket required beyond what is specified with the insulation.

General Duct Insulation Schedule Notes:

1. Specific uses and requirements called out on the Drawings take precedence over those listed above.
2. Internal duct liner is not allowed unless otherwise indicated on the drawings and approved by the engineer.
3. N/A = Not Applicable
4. ALU = Aluminum Jacket.
5. SSTL = Stainless Steel Jacket
6. FWP = Flexible Weather Proofing Jacket

END OF SECTION

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SECTION 23 09 00
HVAC - CONTROLS

5

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Design, furnish, install, test, and calibrate all the HVAC control systems indicated on the Drawings for complete and operational systems to accomplish the sequences of operations, including but not limited to the following.
   1. General
      a. Devices to be furnished with equipment requiring field mounting.
      b. Conduit and wiring between HVAC field devices and HVAC equipment.
      c. All control wiring less than 110V.
      d. The HVAC Contractor is responsible for testing, witnessing, and reporting on the operation of all HVAC systems to ensure proper installation and function. See sequences of control on drawings for additional information.
      e. Refer to Section 23 05 00 for HVAC General Provisions.
   2. Ozone Building
      a. Rooftop Air-Handling Units, their remote temperature controllers, and contact/connection for shutdown signal from ozone/oxygen alarm system.
      b. Make-Up Air Units and their remote devices (e.g. supply duct discharge temperature sensor).
      c. Packaged Air-Handling Units (AHU) and Make-up Air Units (MAU) motor starters.
      d. Motorized Dampers and actuators. (120V power, on/off control, and interlocks by Division 26 - Electrical).
      e. Electrical Room Temperature Sensor (for SCADA monitoring and alarm).
      f. Ozone Room Temperature Sensor (for SCADA monitoring and alarm).

1.2 MEASUREMENT AND PAYMENT

A. No separate payment will be made for work performed under this Section. Include the cost for this work in the lump sum Base Bid.

1.3 RELATED WORK

A. The following shall be furnished and installed under Division 26 - Electrical:
   1. All power wiring and conduits (110V and above).
   2. Motorized dampers actuators power and on/off control.
   3. Exhaust fan power, on/off control, and interlocks with motorized dampers.
   4. Motor starters, unless noted otherwise (e.g. AHU and MAU starters are integral with the packaged units).
   5. Disconnects.
   6. Convenience power receptacles for servicing equipment.
   7. On starters, the necessary auxiliary contacts, with buttons and switches in the required configurations.

1.4 SUBMITTALS

A. Shop Drawings - Submit all shop drawings with all information required per Division 01 – General Requirements, Section 23 05 00 – HVAC General Provisions and the following additional specific requirements:
   1. HVAC Controls submittal shall be submitted as one (1) complete package with all items as required by Division 01 – General Requirements, Section 23 05 00 – HVAC General Provisions, and this section.
   2. Contractor shall submit all components requiring connection or communication with Division 26 – Electrical, and field devices requiring connection or communication with HVAC equipment.

a. MAU supply discharge temperature sensor.
b. AHU room temperature controllers, sensors, and/or thermostats.
c. Dampers and Actuators.

3. Include drawings with locations of equipment and field devices.
4. Include sequences of operation.
5. Catalog Cutsheets – Provide for each equipment unit and accessory. Indicate options from cutsheets with arrows, or equivalent. Indicating options with a highlighter marker is unacceptable, as it does not transmit during the copying process. As a minimum, provide information for the following:
   a. Thermostats and humidistats.
   b. Sensors, transmitters and controllers.
   c. Dampers – Include damper schedules showing size, configuration, materials of construction, required torque for positive close off vs. operating velocity, pressure drop across damper at installed velocity, and locations.
   d. Actuators – Provide actuator schedules showing size, configuration, associated damper or valve tag, materials of construction, NEMA rating, operating torque, voltage and amperages, and locations.
6. Technical specification data sheets of each system component and device with indication of its use.
7. Complete listing of deviations from the system as specified.
8. For units that will be shipped exposed, provide a description of the protective packaging that will be used during transit.

B. Operation and Maintenance Manuals
   1. Operation and maintenance will be included with the associated equipment O&Ms in accordance with Division 01 – General Provisions and 23 05 00 – HVAC General Provisions.

C. Owner Training Report – Submit report listing name and contact information of instructor, dates and times training was offered, agenda or curriculum of items covered in training class, and name list of all training attendees.

D. Successful System Startup and Operation Report – Submit report with name and contact information of supervising technician, and dates of testing procedure.

E. In general, corrections or comments or lack thereof, made relative to submittals during review shall not relieve the Contractor from compliance with the requirements of the drawings and specifications. Submittals are for review of general conformance with the design concepts of the project and general compliance with the contract documents. The Contractor is responsible for the final design conforming and correlating all quantities and dimensions, selecting fabrication processes and techniques of construction, coordinating the work of all trades, and performing the work in a safe and satisfactory manner.

1.5 REFERENCE STANDARDS

A. The HVAC Contractor shall provide a system to meet requirements of NFPA-72A, 72B, 72C and 72D, and shall be listed by Underwriters Laboratories. Each component of the system shall be, where applicable, UL listed for the intended service and meet the safety requirements.

1.6 QUALITY ASSURANCE

A. The HVAC Contractor and Manufacturer shall be fully licensed at the time of bid to do business in the job site area and have a minimum five (5) years of experience designing, installing, testing and calibrating the type of HVAC control systems described herein and on the Drawings. Wholesalers, contractors, franchisers, dealers, or any firm whose principal business is not that of manufacturing and installing HVAC as herein specified will not be acceptable.

B. The HVAC Contractor and controls Manufacturer must have a branch office facility within 25 miles of the project for at least five (5) years, with technical staff and complete spare parts

inventory and test and diagnostic equipment to keep systems in operation twenty-four (24) hours per day seven (7) days per week. They shall have emergency service available in the local area for temperature control systems for which he/she is currently performing on-call emergency service twenty-four (24) hours per day seven (7) days per week with a maximum response time of four (4) hours.

C. The HVAC Contractor shall have in their direct employ the personnel capable of detailed engineering, coordination, drafting, procurement, and expediting, scheduling construction, testing, inspection, installation, startup, calibration, and commissioning.

D. The equipment to be furnished under this Section shall be essentially the standard product of the Manufacturer. Where two (2) or more units of the same class of equipment are required, they shall be the product of a single Manufacturer; however, all the component parts of the system need not be the products of one (1) Manufacturer.

E. System components may be from multiple Manufacturers whose products meet the performance requirements of the Contact Documents. The HVAC Contractor shall be responsible for each system component and for determining that all equipment supplied for this project is suitable for installation and proper operation in the space provided with fully adequate operating and maintenance access space. The HVAC Contractor shall also be responsible for the overall integration of the system components and overall performance of the system in compliance with the Contract Documents.

F. The equipment furnished for installation under this Section shall be tested at the factory as standard with the Manufacturer of the equipment.

G. Inspection by the Engineer's representative or failure to inspect shall not relieve the Contractor of responsibility to provide materials and perform the work in accordance with the documents.

H. The Owner and Engineer reserve the right to sample and test any materials after delivery and to reject all components represented by a sample that fails to comply with the specified requirements.

1.7 SYSTEM DESCRIPTION/DESIGN REQUIREMENTS

A. Electrical and Control Rooms - Shall consist of simple room temperature control with the integral equipment controls from the manufacturer. Refer to drawings and sequences of operations for additional information.

B. The Ozone Room ventilation control system shall have the following systems. Provide all necessary components for a complete and functional system. Refer to drawings and sequences of operations for additional information.
   1. Make-Up Air Units shall run 24/7 and operate independently. Heating shall modulate based on discharge air temperature.
   2. 24/7 Exhaust Fan shall run continuously when energized by Division 1 - Electrical.
   3. Purge Exhaust Fan shall run when energized by Division 1 – Electrical upon ozone/oxygen detection and alarm system activation.
   4. Intake louver motorized dampers shall be opened by Division 1 – Electrical upon ozone/oxygen detection and alarm system activation.

C. The HVAC Contractor shall ensure the compatibility of all components of the HVAC control system and interconnections with other disciplines to provide a fully functional system in accordance with the sequence of operations, specifications and drawings.
   1. The HVAC control system shall be as specified herein and shall perform the functions specified and indicated on the Drawings.
   2. All materials and equipment used shall be standard, non-proprietary components, regularly manufactured for this and/or other systems, and not custom designed especially for this project. All systems and components shall have been thoroughly tested and proven in actual use.
   3. Refer to Section 23 05 00 – HVAC –General Provisions.

D. COORDINATION
1. The HVAC Contractor shall assume full responsibility for the coordination of the work of this Section with that of the HVAC sections to accomplish the requirements of space conditioning as indicated on the construction drawings and as specified. The HVAC Contractor shall furnish, install, supervise and test the field wiring associated with the work of this Section and shall be responsible for coordinating the installation of controls with the HVAC Contractor.
2. The HVAC Contractor shall coordinate the locations of desired items such as access doors, size of instrument holes, conduits/wiring, or other devices in the ductwork, piping and plenums.

1.8 DELIVERY, HANDLING AND STORAGE

A. Refer to Section 23 05 00 – HVAC General Provisions.

1.9 MAINTENANCE/SPARE PARTS

A. Refer to Section 23 05 00 – HVAC General Provisions.

1.10 WARRANTY/EXTENDED WARRANTY

A. Refer to Section 23 05 00 – HVAC General Provisions for warranty requirements and the following specific requirements related to this Section.

PART 2 - PRODUCTS

2.1 HVAC CONTROLS - GENERAL

A. NEMA enclosure ratings.
1. Components in the Ozone Room shall be NEMA 4X rated.

2.2 ROOM THERMOSTATS/TEMPERATURE SENSORS

A. General:
1. Room thermostat and temperature sensors mounted on exterior walls shall be provided with insulated mounting plates.
2. All room thermostats and sensors shall be mounted 48-in above finish floor except where otherwise indicated on the Drawings or specified herein.
3. Unless otherwise indicated, the controls shall maintain space temperatures within plus or minus 2 degrees F, and space relative humidity within plus or minus 5 percent of their set points.
4. Thermostat controls shall have 5 deg. F deadband minimum.
5. Thermostat controls shall have setback feature with 7-day clock, minimum 2-hour occupant override and 10-hour power backup.
6. Thermostats and temperature sensors shall cover their respective temperature ranges as called out on the Sequences of Operation or as specifically called out below.
7. Sensor setpoints shall be fully adjustable from the HVAC control panel and locally at each sensor where specifically called out below.
8. Label thermostats/temperature sensors with tag name of unit it serves.

B. Room Temperature Controllers – Air-Conditioning/Air-Handling Units
1. Shall be thermostat type for use in clean areas. Thermostat shall be single/multiple stage and/or variable capacity heating/cooling thermostat with 7-day programmable settings. Thermostat shall display room temperature and have battery backup for storage of settings in case of power failure, auto and manual switch, adjustable 3 to 10 degree dead band between heating and cooling set points, adjustable heating and cooling set points and daylight savings feature. Thermostat finish shall be white.
2. Provide from air-conditioning equipment Manufacturer.

3. Room Temperature Controllers – shall be fully compatible with the associated HVAC equipment furnished. Refer to Section 23 81 26 for additional information.

C. Room Temperature Sensor Transmitter with Indicator (to SCADA)
1. Shall be wall-mounted polycarbonate housing, field replaceable RTD temperature sensor, 2% accuracy, -40 deg.F. to 140 deg.F. temperature range, 24 VDC power supply, loop powered 4-20mA output, and backlit LCD temperature display. Model shall be Dwyer RHP-W or approved equal.

2.3 EQUIPMENT TAGGING

A. Control Panels - Provide laminated phenolic nameplates for each control panel. Nameplates shall have black exterior and white core, with beveled edges, and shall show white letters or numbers on a black background. The nameplate shall include the panel tag number used on the HVAC drawings and shall describe its function, i.e. HVAC Control Panel.

B. Control Devices Inside a Control Panel – Each control device inside a control panel, including but not limited to controllers and relays, shall be labeled with a unique identification tag number. The tag number shall match the tag number used in the control wiring schematics and other controls documentation for ease of identifying devices during diagnostic testing and troubleshooting. Refer to Division 26 – Electrical specifications for tagging requirements on the project.

C. Devices Mounted Outside of Control Panel - All HVAC control devices not mounted in a clearly labeled panel, including but not limited to room temperature sensors, room thermostats, and switches, shall be provided with an engraved plastic plate mechanically attached to the wall surface. The plastic label shall contain the name of the device, its function and system or system number for the device.

2.4 ELECTRICAL

A. All field wiring (other than power wiring) between control devices and control terminals in HVAC equipment shall be furnished and installed under this Section and shall conform to the requirements of Division 26 – Electrical.

B. All wiring between HVAC equipment and Electrical furnished equipment shall be done by Division 26 – Electrical.

C. Refer to the electrical drawings and Division 26 – Electrical specifications for NEMA enclosure types, other than NEMA 1, by room or location designation such as “Damp,” “Wet,” “Corrosive,” etc.

D. Installation and materials of construction of all conduit, wire, sleeves, outlet boxes, insulating bushings, system cabinets, terminal boxes, pull boxes, junction boxes, inserts, anchors, hangers and hardware, system devices, etc, shall be in accordance with the appropriate requirements of Division 26 – Electrical, and in accordance with sections of the current edition of the local codes for signal systems and electrical systems.

E. Conduit, boxes and fittings and their installation and testing shall be as specified in Division 26 – Electrical. Where not called out in Division 26 – Electrical, the following requirements shall apply. For installations in corrosive process and industrial type areas, wiring shall be run in rigid aluminum conduit. For installations in non-corrosive process and industrial type areas, wiring may be run in rigid steel conduit. EMT, aluminum construction, shall only be allowed in dry locations above ceilings and wood or metal stud framed partition walls for office type and commercial type work.

F. Wire with the exception of DDC cable and thermostat wire shall be stranded copper type THHN/THWN insulated for 600 Volts. Wire and its installation and testing shall be as specified in Division 26 – Electrical.

G. In the event of any conflict among referenced codes, current editions of the applicable local codes shall take precedence for interpretation of “Signal System” installation requirements.

H. Installation of sensor wiring in finished areas shall be concealed whenever possible. Where concealed wiring is not possible, written approval for exposed work must be obtained from the Engineer prior to installation.

I. Coordination Issues
   1. Shutdown signals from ozone/oxygen leak detection system and HVAC equipment will be wired under Division 26 – Electrical. HVAC shall assist and coordinate connection points at HVAC equipment.
   2. The following conduit and wiring is to be furnished and installed under this Section:
      a. Between HVAC equipment and HVAC field devices.

J. Refer to electrical drawings for details of wiring at motor control panels. All interconnecting wiring to start and stop motors by Electrical Contractor.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The Contractor shall not install any equipment or materials until the Owner and Engineer have approved all submittals. If any equipment or materials are installed prior to approval of the submittals, it shall be at the Contractor's risk.

B. The HVAC Contractor shall coordinate final locations of all control devices with other trades and actual conditions at the site to assure that all installed control devices shall be accessible after the project is complete so that the Owner can perform required maintenance, repair or troubleshooting work. Control devices requiring regular access, including but not limited to room thermostats, room humidistats, control panels and switches, shall be readily accessible without requiring ladders, temporary platforms, or removal of other equipment for accessing the device.

3.2 TESTING, ADJUSTING AND CALIBRATION

A. Upon completion of the project, completely test, adjust and calibrate all thermostats, temperature sensors, safety thermostats, duct sensors, flow switches/sensors, damper actuators, and all other components provided under this Section for a complete and functioning system.

B. Cycle damper, and damper actuator assembly where applicable, to assure proper operation.

C. Testing and calibration shall be done under the specific device Manufacturer’s testing and calibration procedures and requirements.

3.3 INSTRUCTION

A. The HVAC contractor shall provide complete system documentation at acceptance time, as specified herein. Documentation shall be provided in four (4) sets, unless otherwise noted elsewhere in this Section. Documentation shall include the following:
   1. All data specified in Paragraph 1.03 above, in its final as-built approved form.
   2. As-built interconnection wiring diagrams, or wire lists, or list of the complete field installed system with complete, properly identified, ordering number of each system component and device.

B. Training
   1. The HVAC Contractor shall provide training for the operation and maintenance of the HVAC control systems. The use of local sales representatives to perform the training work is not acceptable, unless the Manufacturer provides documented evidence that the sales representative has been specifically trained for this work.

2. Each trainee shall be provided with a full set of instructional materials and operating manuals for each of the various courses in which he is trained. In addition, three (3) complete additional sets of the training manuals are to be provided. Submit training material for review and comment by Owner at least two (2) weeks prior to scheduled training sessions.
3. All training sessions are to be scheduled with the Owner to maintain required plant operating coverage. If required to maintain coverage, the classes shall be split into multiple sessions. Any training cancellations or reschedules shall be immediately communicated to the Owner to allow plant personnel to reschedule.
4. The use of onsite facilities for training is to be approved by and scheduled with the Owner.
5. Man-hour requirements tabulated below are exclusive of travel time and do not relieve the Contractor of obligation to provide sufficient service to place equipment in satisfactory operation.

Training	No. of Sessions[(a)]	Minimum Time Per Session (hours)
Ozone Building	2	2

[(a)]Instruction may be given upon completion of all Items if acceptable to the Owner's Representative and provided that all tests were successful, and the O&M manuals have been submitted to and accepted by the Owner's Representative. Provide Owner with at least 2-week advance notice when scheduling training sessions. Number of training sessions indicated is required to cover all personnel plant shifts; verify number with Owner's Representative.

6. Provide to the Owner, at time of acceptance of the unit, a written 1-year Manufacturer's standard service contract for the complete controls system, commencing on the date of acceptance of the system by the Owner. Contract shall include one (1) preventive maintenance inspection of the installation prior to expiration of the warranty period to assure the safe and dependable operation of the system. This service contract does not supersede or replace the Manufacturer's standard 1 year equipment warranty.
7. The Owner shall be offered a yearly inspection contract for the complete controls system.
8. The HVAC Contractor shall provide all training material, instruction booklets and equipment for classroom type and hands-on laboratory type instruction. Training shall cover all plant shifts in multiple training sessions to minimize impact on plant operations.
   a. The HVAC Contractor shall provide training for personnel that will be operating the system. The material covered will include basic instruction in the system, changing system set points, changing and deleting access codes, basic maintenance and repair of the mechanical, electrical and digital portions of the system, trouble shooting and repair of the mechanical component, generation of data files and reports. The course shall be a combination of classroom and hands-on work.

3.4 FIELD TESTING AND ADJUSTMENT

A. A Manufacturer's factory representative shall conduct the field testing and adjustment of the system so that it is placed in proper operating condition. The Contractor shall provide personnel and equipment, as required, to assist Manufacturer's factory representative with testing and adjusting procedure.

B. Remove all temporary devices and equipment resulting from testing.

C. Test unit according to Manufacturer's written instructions and perform the following:
   1. Verify all ventilation fans run/fail alarms activate when fan is running or not.
   2. Verify scrubber duct dampers open and close and indicator lights activate appropriately whenever damper is open or closed.
   3. Operate motorized dampers over entire operating range and adjust damper linkages, motor operators, etc. for proper damper operation.
   4. Adjust time-delay relays for actuator run-time.

5. Assist balancing contractor and set damper operating limits when required for balancing.
6. Test and adjust controls. Replace damaged and malfunctioning controls equipment.
   a. Calibrate and adjust initial temperature set point on thermostats.
   b. Run unit in Auto and Manual mode, from thermostat, HVAC control panel or MCC, as applicable.
   c. Verify operation of control panel, including operation of pilot-lights, switches, and alarms. Simulate all alarms and test for proper operation and signals.
7. Check electrical devices
   a. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
   b. Inspect and record performance of interlocks and protective devices
8. Test all safety devices for functionality. Replace malfunctioning or damaged safety devices.
9. Measure acoustical performance to check compliance with acoustical criteria. The Contractor is responsible for bringing the unit into compliance with acoustical criteria.
   a. Take precautions to prevent damage to building or its contents during testing. At the Contractor's expense, the Contractor shall repair or make good any building components or contents damaged during testing. Any leaks, defects or deficiencies discovered during testing shall be immediately repaired and testing shall be repeated until the testing requirements are fully complied with and approved by the Engineer and local plumbing inspectors having jurisdiction. Caulking of pipe joints shall not be allowed as a remedy to pipe leaks.
   b. Refer to Section 23 05 93 – HVAC Testing, Adjusting, and Balancing.

3.5 ACCEPTANCE PROCEDURE

A. Upon successful completion of all HVAC controls and systems, the Engineer and Owner shall be requested, in writing, to inspect and approve the satisfactory operation of the HVAC controls system, sub-system(s) and accessories.

B. Upon receipt of a detailed punch list from the Engineer, an installation inspection report shall be prepared showing, by system, each outstanding item on the punch list. After all items appearing on the installation inspection report are completed, a second written request for system approval shall be made to the Engineer. As each or all items are approved, an appropriate notation shall be entered at the time of joint inspection on the system report, with counter signature of the Engineer and date. A copy of this report shall be made for the Owner and Engineer.

C. Problems, which occur within approved hardware, shall be corrected in an appropriate fashion under guarantee. Any such occurrence shall not void previous approval; however, the system contractor shall be responsible to attend to and remedy such items within a reasonable amount of time. Appropriate logs, schedules, and reports shall be maintained to reflect these items and their redress.

D. During the acceptance inspections, the HVAC Contractor shall provide the required personnel to operate the system and show complete functionality. The System Supplier will also provide the required communication devices to allow simultaneous observations at multiple points. In general, each system will be run through its complete operating sequence.

E. Functional acceptance testing will be halted for systems that are found to be operating incorrectly. Corrections will not be made during the inspection. If multiple systems are found to have operating deficiencies, the acceptance testing will be canceled and rescheduled at the System Supplier's expense.

F. Final payment to the Contractor shall be made until after the successful testing and acceptance by the Engineer and Owner of the complete controls system.

3.6 CONTROL SEQUENCES

A. The following information shall apply to all sequences. HVAC equipment will operate with the sequences of operation as indicated on the Drawings.
   1. All sequences are reversible unless otherwise noted.
   2. All setpoints given on the control sequences shown on the Drawings are indicative only and shall be fully adjustable above and below such set points. The stated setpoints are given as initial starting points to be adjusted as desired during startup and operation. If a set point is not stated, the control range of devices shall be suitable for the intended service. Range of devices shall be approximately 50 percent greater in both directions than span of variable, with a minimum of 25 degrees and a maximum of 100 degrees F for air systems.
   3. All alarms and indications shall be provided at the operator interface, and where called out on the Drawings, the panel face and to the plant's SCADA system.
   4. Manual reset of control functions with manual reset will be at the HVAC control panel, unless otherwise noted.
   5. Where required to prevent nuisance shutdowns of systems, provide time delay before the sensors are activated during system startup. This would include, but not be limited to low temperature freeze protection on 100 percent outdoor air units and flow switches/sensors on fan systems.
   6. Where control sequences refer to activation of an alarm indicator, it will be understood to mean activation of a labeled pilot light at the local HVAC control panel or activation of an alarm display at the operator interface.

3.7 OPPOSITE SEASON TEST

A. The HVAC Contractor shall perform an inspection of the HVAC system during the opposite season from that in which the initial adjustments and setup were made. The HVAC Contractor shall make any necessary modifications to the initial adjustments to produce optimum system operation.

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SECTION 23 31 13
HVAC – METAL DUCTWORK AND ACCESSORIES 5

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish, fabricate and install all ductwork, including fittings, accessories, dampers, hangers, diffusers, registers, grilles and any incidental work or components required to provide complete air supply, return and exhaust ductwork systems as shown on the Drawings and as specified herein.

B. Furnish and install all louvers and motorized dampers shown on the Drawings and as specified herein.

C. Wind and Seismic restraints shall be designed, furnished and installed for all ductwork, piping, and equipment as required by IBC/ASCE 7 and related sections herein. Refer to structural contract documents for site seismic and wind requirements.

D. In general, ductwork shall consist of any passageway made of sheet metal or other material substantially air-tight, used for the conveying of air, gas or materials. Included are fittings, transitions, bracing, fasteners, sealers, supports and accessories such as access panels, access doors, turning vanes and manual air balancing dampers. All ductwork shall be of size and material as specified herein and as shown on the Drawings. All duct sizes indicated on the Drawings are clear, inside dimensions.

E. All ductwork, piping, and equipment shown on the drawings is intended to be approximately correct to scale but figured dimensions and detailed drawings of the actual equipment furnished shall be followed in every case. The drawings shall be taken in a sense as diagrammatic. Size of ductwork and piping are shown, but it is not the intent to show every offset or fitting, nor every hanger or support, or structural difficulty that may be encountered. To carry out the intent and purpose of the drawings all necessary parts to make a complete working system ready for use shall be furnished without extra charge. The contractor shall be responsible to coordinate the system installation and routing with the work of all trades.

F. Refer to Section 23 05 00 for HVAC General Provisions related to the work of this Section.

1.2 MEASUREMENTS AND PAYMENTS

A. No separate payment will be made for work performed under this Section. Include the cost for this work in the lump sum Base Bid.

1.3 RELATED WORK

A. Trenching, excavation and backfill is included in Division 02 – Site Work except for items specified herein.

B. Concrete work is included in Division 03 – Concrete except for required HVAC anchor bolts, sleeves and templates, which shall be furnished under this Section.

C. Structural steel and miscellaneous metal is included in Division 05 – Metals except for supplementary steel required for HVAC hangers, equipment supports, anchors and guides, which shall be furnished under this Section.

D. Flashing and counterflashing is included in Division 07 – Thermal and Moisture Protection except for items specified herein.

E. Painting is included in Division 09 – Finishes except for factory finished HVAC equipment, HVAC shop painting and HVAC identification labeling and as required below in Part 2.

F. Thermal insulation is included in Section 23 07 13 – HVAC Duct and Pipe Insulation.

1.4 SUBMITTALS

A. Submit to the Engineer, in accordance with Division 01 – General Requirements, Section 23 05 00 – HVAC General Provisions, and the following Drawings and data.
   1. Detailed equipment and ductwork drawings at a minimum scale of 1/4 in = 1 ft 0 in. Site layout drawings and roof plans may be submitted at scales smaller than 1/4 in = 1 ft 0 in, subject to Engineer's prior approval. Drawings shall locate ductwork accessories including manual, automatic, fire and fire/smoke dampers and flex connectors. Ratings of fire dampers shall be shown. Drawings shall show location of all equipment, and equipment motors. Drawings shall also show required NEC clearances and dimension maintenance clear spaces for motors, drives, coils, filters and access doors or panels. Indicate ductwork pressure class and duct material used for fabrication. Include location of duct supports and details of each type of duct support.
   2. Standard shop and field installation details for transitions, elbows, takeoffs, discharge nozzles, turning vanes, access panels and doors, volume control and hangers. When SMACNA references are used, the specific methods for the project shall be clearly defined. Where SMACNA has more than one (1) option, the option to be used shall be indicated.
   3. Ductwork materials, joining methods, reinforcing and material gauges. Where options are allowed by SMACNA, the proposed option shall be clearly defined. Indicate proposed materials and methods for ductwork and equipment hangers. Indicate in the submittal where each type of duct material will be used by area or building name and system (i.e. supply, exhaust or return).
   4. For all associated air devices such as louvers, diffusers, grilles, volume dampers, fire dampers, gravity dampers, etc., provide device data in table format indicating ID tag, quantity, type, location used, size, etc. Provide each device type on separate sheets; for example all fire dampers with required data should be listed on one (1) sheet and volume dampers on a separate sheet. Include catalog cutsheets for each device type, clearly indicating type used and any options selected. Indicate options and any other selections from cutsheets by indicating arrow or other appropriate indicator. Use of highlighter is unacceptable since it does not copy. Indicate where each device will be used by building name or area and service type, i.e. supply, exhaust or return.
   5. Submit air device information with ductwork layout drawings in one (1) complete package.
   6. For insulation include proposed installation directions as recommended by manufacturer for each distinct system type.
   7. For items that will be shipped exposed, provide a description of the protective packaging that will be used during transit.
   8. All submittals shall contain a statement that all contract documents have been read and complied with. The certification statement shall be made by all of the following that are applicable; the Contractors, sub-contractors and the vendors. The statement shall be an individual statement for each party involved, and shall be included with every submittal and resubmittal.

B. In general, corrections or comments or lack thereof, made relative to submittals during review shall not relieve the Contractor from compliance with the requirements of the drawings and specifications. Submittals are for review of general conformance with the design concepts of the project and general compliance with the contract documents. The Contractor is responsible for the final design conforming and correlating all quantities and dimensions, selecting fabrication processes and techniques of construction, coordinating the work of all trades, and performing the work in a safe and satisfactory manner.

1.5 REFERENCE STANDARDS

A. These standards, including all applicable state and local codes, shall be considered as minimum requirements. This is a general list and not all standards listed are necessarily referenced elsewhere in this Section. Specific requirements of this Section and/or Drawings shall have precedence. The Engineer shall resolve conflicts between published requirements.

B. Titles and abbreviations of Federal, State and industry standards, technical societies, associations and institutes and other organizations which may be used are as follows:
   1. American Conference of Governmental Industrial Hygienists (ACGIH)
   2. Air Movement and Control Association (AMCA)
   3. American National Standards Institute (ANSI)
   4. Air conditioning and Refrigeration Institute (ARI)
   5. Air Diffusion Council (ADC)
      a. ADC 1062 R4 - Certification, Rating and Testing Manual.
   6. American Society of Heating, Refrigerating and Air conditioning Engineers (ASHRAE)
      a. ASHRAE 68 - Laboratory Method of Testing In Duct Sound Power Measurement Procedure for Fans.
   7. American Society of Mechanical Engineers (ASME)
   8. American Society for Testing and Materials (ASTM)
      a. ASTM A653 - Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron, Alloy-Coated (Galvannealed) by the Hot Dip Process.
      b. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
      c. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
   9. Factory Mutual (FM)
   10. National Institute of Standards and Technology (NBS)
   11. National Fire Protection Association (NFPA)
      a. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
      b. NFPA 102 - Standard for Grandstand, Folding and Telescopic Seating, Tents and Membrane Structures.
      c. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies.
      d. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.
   12. Occupational Safety and Health Administration (OSHA)
   13. Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
   14. Underwriters Laboratories (UL)
      a. UL 214 - UL Standard for Safety Tests for Flame Propagation of Fabrics and Films.
      b. UL 555 - UL Standard for Safety Fire Dampers.
      c. UL 723 - UL Standard for Safety Test for Surface Burning Characteristics of Building Materials.

C. Where reference is made to one (1) of the above standards, the revision in effect at the time of bid opening shall apply.

1.6 QUALITY ASSURANCE

A. Inspection by the Owner's and Engineer's representative or failure to inspect shall not relieve the Contractor of responsibility to provide materials and perform the work in accordance with the contract documents.

B. The Owner and Engineer reserve the right to sample and test any materials after delivery and to reject all components represented by a sample that fails to comply with the specified requirements.

1.7 PROJECT/SITE REQUIREMENTS

A. Environmental Requirements

B. Existing Conditions

C. Field Measurements

1.8 DEFINITIONS

A. Particular terminology used under this Section is defined as follows:
   1. Traffic Level and Personnel Level - Areas, including process areas, equipment rooms, boiler rooms and other areas where insulation may be damaged by normal activity and local personnel traffic. Area extends vertically to 8-ft above floor, walkways, platforms and stairs, and horizontally 3-ft beyond the edge of walkways, platforms, and stairs.
   2. Exposed Piping and Ductwork - Piping and ductwork visible from the floor level and includes all piping and ductwork in equipment rooms, boiler rooms, etc.
   3. Concealed Piping and Ductwork - Piping and ductwork not visible from the floor level and includes piping and ductwork above hung ceilings and in shaftways.

1.9 COORDINATION

A. The Drawings indicate the extent and general arrangement of the systems. If any departures from the drawings or specifications are deemed necessary, details of such departures and the reasons therefore shall be submitted as soon as practical for review. No such departures shall be made without the prior written concurrence of the Engineer.

B. The Contractor shall coordinate the location and placement of all concrete inserts and welding attachments with the structural engineer.

C. The Contractor shall assume full responsibility for coordination of the HVAC systems, including but not limited to; scheduling, and verification that all structures, ducts, piping and the mounting of equipment are compatible.

D. The Contractor shall not install any equipment or materials until the Owner and Engineer have approved all submittals. If any equipment or materials are installed prior to approval of the submittals, it shall be at the Contractor's risk.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATION FOR DUCTWORK

A. Flexible fabric connectors for galvanized ductwork shall be airtight, watertight, fire retardant, and weather-resistant, UL 214 approved, and a minimum of 3" of metal on each side of 3" of fabric crimped into metal edging strips. Fabric shall be 26 oz/sq yd glass fabric, 0.019-inch thickness, double-coated with duPont’s Hypalon. Rated temperature range shall be between –10 deg.F to 275 deg.F. Fabric shall have a flame spread rating of not over 25 and smoke developed rating of not higher than 50, complying with NFPA 90A. Fabric shall be equal to Ventlon as manufactured by Ventfabrics or approved equal. All flex connections exposed to weather shall be covered with a galvanized sheet metal rain shield.

B. Flexible fabric connectors for aluminum ductwork shall be airtight, watertight, fire retardant, and weather-resistant, UL 214 approved, and a minimum of 3" of metal on each side of 3" of fabric crimped into .032 gage aluminum metal edging strips. Fabric shall be 26 oz/sq yd glass fabric, 0.019-inch thickness, double-coated with duPont’s Hypalon. Rated temperature range shall be between –10 deg.F to 275 deg.F. Fabric shall have a flame spread rating of not over 25 and smoke developed rating of not higher than 50, complying with NFPA 90A. Fabric shall be equal to Ventlon as manufactured by Ventfabrics or approved equal.

C. Flexible fabric connectors for stainless steel shall be airtight, watertight, fire retardant, and weather-resistant, and UL 214 approved., Fabric shall be 14 oz/sq yd glass fabric, 0.014-inch thickness, coated with duPont’s Teflon. Rated temperature range shall be between –20 deg.F to 500 deg.F. Fabric shall have a flame spread rating of not over 25 and smoke developed rating of not higher than 50, complying with NFPA 102. Fabric shall be equal to Ventel as manufactured by Ventfabrics or approved equal. Fabric shall be double wrapped around ductwork and secured with two type 316 stainless steel, worm gear band clamps per side. Roll

bead onto ductwork and secure band clamps outboard of beads. Fabric shall overlap metal ductwork a minimum of 3” each side with a 3” gap between ducts.

D. Flexible duct connectors shall be installed at all inlet and outlet of air-handling units.

2.2 FLAME AND SMOKE RATINGS

A. All materials, including adhesives, surface coatings, sealers, assemblies of several materials, insulation, jacketing, finish, etc, shall have flame spread ratings not over 25 (fire resistive) and smoke development ratings not over 50 and fuel contributed rating not over 50, as established by tests conducted in accordance with ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials and the National Fire Code of the NFPA.

B. These requirements apply to all circumstances whether the materials are field applied or applied by a manufacturer in his/her shop, or elsewhere, prior to delivery to the project.

2.3 SOUND CONTROL

A. The selection of ductwork and accessories shall be such as not to create noise that will exceed the levels of permissible noise exposures for occupational areas as established by the OSHA and other Federal, State, and local safety and health standards, codes and ordinances.

2.4 HANGERS, SUPPORTS AND ANCHORS

A. Furnish supports, hangers and other devices necessary to support firmly and substantially the equipment and ductwork described in this Section. Ductwork support systems shall include restraints as required by the applicable building codes to withstand seismic loading. Design shall be provided by a professional engineer hired by the Contractor as specified in this section.

B. Rectangular, Round and Flat-Oval Ductwork - Spacing and size of hangers shall be as called for in the SMACNA standards, except as limited below.
   1. Rectangular ductwork 48-in wide and larger shall be supported by adjustable threaded rod hangers.
   2. Round ductwork 37-in and larger shall be supported by two adjustable threaded rods at each support.

C. All hangers shall be of same material as ductwork which they serve, e.g., galvanized, aluminum, black steel, etc.

D. All hanger hardware and fasteners shall be of the same material as the duct they serve or shall be of a material with equal or greater corrosion resistance. Where materials other than the duct material are used, they must be approved by the Engineer before installation.

E. Perforated band iron or wire for supporting ducts shall not be permitted.

F. Where C clamp type hangers are used, furnish with a retainer strap.

G. Support flexible duct with galvanized steel band hangers, 1 in wide minimum, attached so as not to crush the ductwork. The use of wire to hang flexible ductwork shall not be permitted.

H. The following methods of hanger attachment to the building structure are NOT allowed. The numbers and letters refer to hanger methods shown in Figure 4-1, 4-2, 4-3 and 4-4 of the 1985 edition of the HVAC Duct Construction Standards Metal and Flexible as published by SMACNA.

"T"- wrap around strap on open web joist.

"W" - bent over band on open web joist.

"14" - friction clamps.

"17" - bent wire in metal deck.

Hanger Straps

I. Design of hangers shall include the effect of all loads applied to the duct as well as the load of the insulation and any jacketing. These loads include, but are not limited to wind, snow, seismic and internal dirt or liquid buildup.

J. Hangers shall not be supported from roof decking or bulb tees. Where required, provide supplemental steel to span between the building's structural elements.

K. For large diameter duct, provide neoprene pad at contact point between duct and duct support.

2.5 SEISMIC RESTRAINTS

A. Seismic restraints shall be provided for all HVAC systems including but not limited to all tanks, piping, ductwork, free standing, suspended, or wall mounted HVAC equipment and panels installed under related Sections in this Division. Refer to Structural documents for Site class, Seismic design category, assigned seismic use group or building category as defined in the IBC, Design Spectral Response Acceleration at Short Periods (0.2 Second) (SDS), and Design Spectral Response Acceleration at 1-Second Period (SD1).
   1. Component Importance Factor: systems not required for life safety and not containing hazardous materials 1.0.
   2. Component Response Modification Factor: Reference ASCE 7-05.
   3. Component Amplification Factor: Reference ASCE 7-05.

B. Materials of construction for seismic supports shall be the same as those specified for equipment supports and hangers, and duct and pipe hangers.

C. Wind-restraint and Seismic-restraint loadings shall be as determined by the Structural Engineer in accordance with IBC/ASCE 7-05.

D. The Contractor shall retain a professional engineer to provide seismic loadings and designs of seismic restraints. This will include but not be limited to the following:
   1. Provide seismic loadings to the vibration isolation supplier based on actual equipment being used to allow the proper selection of vibration isolators.
   2. Provide sizing of bolts for attachment of non-vibrating equipment to the structure based on the actual equipment being used.
   3. Provide design of required additional bracing for equipment when vibration isolators or bolts are not adequate to withstand seismic forces.
   4. Provide design of bracing for all suspending equipment.
   5. Provide design of wind bracing for all exterior components.

E. Provide design of bracing for all piping and ductwork that exceeds the limitations of the SMACNA Seismic Restraint Manual.
   1. Provide design of bracing for all piping and ductwork.
   2. Where piping or ductwork are subject to thermal expansion, the loads caused by the thermal expansion and contraction shall be included in the design of the restraint bracing.

2.6 DUCTWORK MATERIAL

A. Ductwork shall be constructed of the materials specified using the gauges or thicknesses, reinforcing and construction methods in accordance with SMACNA standards. Unless otherwise specified, all components of the duct systems shall be constructed of the same material as the ductwork. Or shall be of a material with equal or greater corrosion resistance as the duct material specified. For example, if aluminum ductwork is called out and aluminum supports are not available then FRP or stainless steel supports shall be used. Or if aluminum dampers are not available then stainless steel dampers shall be used including braces and turning vanes.
   1. Galvanized steel ductwork shall be constructed of hot-dip galvanized sheet steel, per ASTM A653. Coating shall be minimum 0.90 oz per sq. ft. zinc coating on each side in conformance with coating designation G-90.
   2. Aluminum ductwork shall be constructed of 3003H-14 alloy B&S Gauges.

3. Stainless steel ductwork shall be constructed of Type 304 316 stainless steel.
4. Fiberglass ductboard shall not be allowed.

2.7 DUCTWORK CONSTRUCTION DETERMINANTS

A. Ductwork shall be constructed of the following materials and to the following standards:

Duct System	Location	Static Pressure in-wg	Construction Material	SMACNA Standard
SA, RA	Electrical Room	Pos-2	GS	M&F
SA, RA	Ozone Room	Pos-2	AL	M&F
EA	All	Neg-2	SSTL	M&F

Abbreviations

M&F - SMACNA HVAC Duct Construction Standards – 2nd Edition. - Metal & Flexible
IRD - SMACNA Round Industrial Duct Construction Standards
IRT - SMACNA Rectangular Industrial Duct Construction Standards
TP - SMACNA Thermoplastic Duct (PVC) Construction Manual - 1st Edition.
AL - Aluminum
GS - Galvanized Steel
SSTL - 316 Stainless Steel

B. Design of ductwork shall include all loads applied to the ductwork in addition to the load of the duct. These loads include but are not limited to insulation and any jacketing, wind, snow and internal dirt or liquid build up.

2.8 DUCTWORK CONSTRUCTION

A. All ductwork shall be substantially built with joints and seams smooth on the inside and given a neat appearance on the outside. Inside surfaces and joints shall be smooth and free from pockets, burrs and projections. All joints shall be substantially airtight with laps made in the direction of air flow and no flanges projecting into the air stream.

B. Pressure Classes
1. Pressure classes for determination of sheet metal gauge and reinforcing shall be as defined by the table above and the latest issue of the SMACNA HVAC Duct Construction Standards – Metal & Flexible - 2nd Edition, SMACNA Round Industrial Duct Construction Standards, and SMACNA Rectangular Industrial Duct Construction Standards.
2. All metal and flexible ductwork shall be constructed according to SMACNA 2 inch positive or 2-inch negative pressure class unless noted otherwise on the contract drawings.
3. The pressure class shall be the same for the entire length of ductwork, including branches, of the specific duct system.

C. Rectangular Ductwork (Sheet Metal)
1. Ductwork shall be constructed as shown on the Drawings and in accordance with the specified SMACNA - Construction Standard.
2. Cross breaking or beading shall conform to SMACNA standard. Cross breaking or beading shall be applied to the sheet metal between the standing seams or reinforcing angles. The center of the cross break shall be of the required height to assure rigidity for each panel.
3. Alternate Construction Factory fabricated joint systems may be offered as an alternate form of construction. The system offered shall meet all requirements of SMACNA. Alternate joint systems shall be "Ductmate System" as manufactured by Ductmate Industries, Inc., installed in accordance with the manufacturer's recommendations. The

system shall be sealed for zero leakage and angle attachment to the main duct section shall be by tack welding. The use of screws or nails is not allowed.

2.9 DAMPERS

A. General
1. Dampers shall be constructed of the same material as the ductwork or a material with greater corrosion resistance, including blades, housings, channels, shafts, linkages and fasteners.
2. Rectangular damper blades shall not exceed 6 inch in width. Maximum blade length in any section shall be 48 inches. Gang multiple dampers together for larger sizes. Additional stiffening and/or bracing shall be provided for multi-section dampers. Multi section dampers shall be provided with sufficient interconnecting hardware to provide unison operation of blades in the entire assembly.
3. Dampers shall be of size and type as indicated on the Drawings.
4. All dampers shall be selected for a rating that equals or exceeds the specified system pressure and velocity. Field fabricated dampers are not acceptable.
5. Manual dampers shall be supplied with locking quadrants. Quadrants in galvanized steel and black steel ductwork shall be galvanized steel. All other duct systems shall have stainless steel locking quadrants. Locking quadrants shall have an infinitely adjustable positive method of holding the damper in its selected position such as a bolt through both the slotted quadrant and the lever arm. Systems using springs or other devices that can vibrate loose are not acceptable.
6. Damper linkages and motors shall be face mounted where indicated on the contract drawings.

B. Isolation Motorized Dampers
1. MD-A: Rectangular dampers shall be low-leakage, insulated type. Dampers shall be heavy-duty, double wall, 304 stainless steel construction blades with thermal break. Blades shall be opposed-blade type with replaceable twin edge seals. Adhesive or clip-on type seals are not acceptable. Blades shall be gang operated by linkage located outside the airstream. Frames shall be 0.125” thick. Bearings shall be dual action polycarbonate. Linkages and axles shall be 316 stainless steel. The manufacturers shall be Greenheck model VSD-34, Ruskin, or Tamco.

C. Manual Balancing Dampers
1. BD-A (for stainless steel ductwork): Rectangular dampers frames shall be 316 stainless steel. Blades shall be heavy gage, opposed-blade type. Adhesive or clip-on type seals are not acceptable. Blades shall be gang operated by linkage located outside the airstream. Bearings shall be synthetic type. Shafts shall be hexagonal for positive locking attachment to blades and linkage. Provide with infinitely adjustable locking hand quadrant. Manufacturers be Greenheck, Ruskin, or Tamco.

2.10 ACCESS DOORS

A. Access doors shall be minimum 24-in by 24-in in ducts 26-in and larger. Where the duct size is less than 26-in, the largest door that can be accommodated shall be used. Access doors shall be of the same material as the duct, pan type construction for metal ductwork, with smooth edges and fitted seals, constructed and installed for air-tight fit with ease of opening and closing. Doors shall be substantially butt hinged, with heavy sash locks and substantial door pulls, provide access doors with key lock where located in public area. Door openings and door frames shall be reinforced with bar stock or angle. Where ductwork is installed with exterior duct insulation, the access door shall be of the double wall insulated type. Access doors shall be factory fabricated. Where ductwork is constructed of aluminum or stainless steel, access door and hardware shall be of material with equal or greater corrosion resistance.

B. Hand hole access panels shall be 12-in by 12-in, constructed of the same material as the ductwork, with peripheral gaskets and sash locks. Provide hinges or chain for attachment to duct.

C. Provide access doors for access to fire dampers, smoke dampers, and combination fire/smoke dampers.

2.11 FASTENERS

A. Sheet metal screws, drive cleats, cinch bands and other fasteners shall be fabricated from materials with an equal or greater corrosion resistance than the ductwork in which they are installed. Where a material other than the duct material is used, it shall be approved by the Engineer before installation.

2.12 LABELS

A. The service of each duct along with an arrow indicating direction of flow shall be provided on each duct system. Labels shall be located not more than 20 linear feet apart and shall also be provided at both sides of elbows or wall penetrations, at each damper, and each equipment connection.

B. Labels shall contain the service spelled out and the equipment number of the equipment served. Label locations shall have unobstructed view from normal viewing locations.

C. Numbers and letters shall be die-cut from 3.5 mil vinyl film and prespaced on carrier film. Adhesive and finish shall be protected with one piece removable liners. Colors shall be white letters on black backgrounds.

D. The system for preparation and application of letters shall be Type B a.s.i./2 by ASI Sign Systems; Architectural Graphics Inc. or equal. Letters shall be 3-in high Optima Bold, upper case using Grid 2 spacing. Direction arrows are to match. The instructions of the manufacturer shall be followed in respect to storage, surface preparation and application of letters.

2.13 DIFFUSERS, REGISTERS AND GRILLES

A. General
   1. All diffusers, registers and grilles shall be of the shape, sizes, capacity and type as shown on the Drawings.
   2. For seismic areas, provide air devices with earthquake tabs and suspend from structure independent of ceiling.

B. Wire Mesh Covers
   1. On all duct openings that do not have a specific diffuser, register, or grille or where called for on the drawings provide a removable wire mesh cover, the wire mesh and support frame shall be the same material as the duct where the cover is installed. Unless otherwise noted the wire mesh shall be 0.5-in mesh.
   2. The wire mesh shall be contained in a metal frame. The mesh shall be firmly attached to the frame to prevent it being pulled out of the frame by casual contact. The frame shall be a minimum of 16 gauge sheet metal, or the minimum gauge for a flange based on SMACNA, whichever is greater. The frame shall be on both sides of the mesh creating a sandwich with the mesh in the middle. Fastenings shall go through the frame on both sides of the cover.

2.14 SEALANT

A. Duct sealant shall be water based, asbestos free, mildew and mold resistant, crack and peel resistant, industrial grade synthetic latex sealant, suitable for indoor and outdoor applications, and for service temperature ranges between –20 deg. F to 200 deg. F, and rated for pressure classes of 1/2 to 10-in wg and SMACNA seal classes A, B, and C. Sealant shall have a

maximum flame spread of 25 and a maximum rate of fuel contributed and smoke developed of 50 when tested in accordance with ASTM E84, NFPA 255 and UL 723.

B. Sealant shall be LEED compliant, and bear the applicable LEED compliant stamp on the product literature and product packaging.

C. Sealant shall be Iron-Grip 601 as manufactured by Hardcast, Carlisle coating and waterproofing or approved equal.

2.15 LOUVERS

A. General

1. Louvers shall be fixed, drainable style, constructed of aluminum unless noted otherwise and sized to minimize water penetration for the airflow at each application. All louvers shall have 1/2-inch aluminum bird screen mounted in removable aluminum frame. Coordinate mounting/frame style for each location. Fasten louvers flush to adjacent structures with corrosion resistant fasteners to withstand wind loading. Provide aluminum angle/channel to reinforce multiple louver sections when single section size is exceeded. Coordinate reinforcement to avoid interference with dampers and fans located behind louvers. Seal around louvers water tight with colored silicone caulking. Provide aluminum drainage sills above and below louvers.
2. Louver performance shall resist water penetration to less than 0.01 oz of water at 1000 fpm free area velocity per AMCA Water Penetration Test. A 48”x48” louver shall have a minimum 50 percent free area.
3. Stationary louvers shall be 4-inch thick, drainable blade, 45 degree angle, 0.125 thickness extruded aluminum frames and blades. Coordinate mounting frame style for each location. Louvers shall be Greenheck ESD-403, Ruskin ELF445DXH, or approved equal.
4. Special order louvers for minimum wind load rating both positive and negative per IBC and ASCE. See structural drawings and specs for wind loading at the site. The louver manufacturer shall provide attachment and reinforcing details and instructions to achieve required wind ratings. Coordinate wall construction type and details for each louver location with louver manufacturer.
5. Submit color selection for approval by the architect.

PART 3 - EXECUTION

3.1 INSTALLATION OF DUCTWORK

A. Fabricate and erect all ductwork shown on the Drawings, as specified herein, and in accordance with SMACNA standards. Rigidly support and secure ductwork.

B. Install ductwork parallel to walls and/or roof and vertically plumb unless shown otherwise.

C. Any change in duct sizes, offsets, transitions and fittings required to accommodate job conditions shall be submitted to the Engineer for approval.

D. The Contractor shall not install any equipment or materials until the Owner and Engineer have approved all submittals. If any equipment or materials are installed prior to approval of the submittals, it shall be at the Contractor's risk.

E. During installation, temporarily close the open ends of ducts to prevent debris and dirt from entering. Install work in accordance with the overall approved progress schedule and in cooperation with all other trades so there will be no delay to other trades.

F. The Drawings of the air ducts and air risers show the general location for installation of the ducts and risers. Should additional offsets or changes in direction be made, these changes must be considered in the original bid and shall be installed at no additional cost to the Owner.

G. All necessary allowances and provisions shall be made in the installation of the ducts for the structural conditions of the building. Ducts shall be transformed or divided as may be required.

Wherever this is necessary, maintain the cross sectional area. All of these changes, however, must be approved and ducts installed as directed by the Engineer or as approved on shop or erection drawings.

H. The taper of all transformations shall be not more than 15 degrees.

I. Secure ducts to curbs according to SMACNA "Duct Construction Standards."

J. Where ducts are constructed of materials other than galvanized steel the reinforcing members shall be of the same material as the ductwork.

K. The use of button punching or snap locks on ductwork constructed of aluminum shall not be permitted.

L. Do not run any ductwork through elevator machine rooms, egress stairwells or electrical rooms, except for ductwork specifically serving the room (i.e. air-conditioning ductwork serving electrical room).

3.2 HANGERS

A. Rectangular, Round and Flat-Oval Ductwork - Spacing and size of hangers shall be as recommended in the SMACNA standards except as noted in PART 2.

B. Install hangers plumb and securely suspended from supplementary steel or inserts in concrete slabs. Sufficiently thread lower ends of hanger rods to allow adequate vertical adjustment. Do not use building siding or metal decking to hang ductwork.

C. Ducts shall not be supported from furring, hung ceilings or from another duct or pipe.

D. Ductwork shall not come in contact with any of the ceiling construction or any other equipment piping, conduit, etc. in the ceiling cavity.

E. Duct support at flexible connections shall be adjustable for ease of aligning the duct to the piece of equipment.

3.3 SEALING OF DUCTWORK

A. General - Unless otherwise indicated, seal all ductwork joints and seams using sealant in accordance with the instructions of the sealant manufacturer and this Section. All transverse seams, joints and fitting connections, both shop and field assembled, shall be sealed in accordance with this Section. Longitudinal seams shall be sealed on all duct systems with a design operating pressure greater than 2 in w.g.

B. Application of Sealant - Thoroughly clean all seams, joints, etc, of dirt, oil, grease, or other coatings which might interfere with the adhesion of the duct sealant before the sealant is applied. Do not apply to cold or wet ductwork or where subject to temperatures below 35 deg F. or above 110 deg F. and/or rain is expected within 36 hours of application. Follow manufacturer’s recommendations.

C. Uncured sealant may be forced into the slotted side of the seam or joint before shop or field assembly and the joint or seam completed while the sealant is still uncured. Excess sealant shall be removed from both the inside and outside of the duct before it sets.

D. Duct Tape - The use of duct tape is prohibited.

E. The following ductwork systems do not require sealing of joints and seams. Gaskets at flanged joints are still required.
   1. Ventilation supply air systems downstream of the supply fan or air handling unit and located in the area being served by the system.
   2. Return air systems upstream of the return fan or air handling unit and located in the area being served by the system.
   3. Return air systems upstream of the return fan or air handling unit and located in a return air plenum for the system being served.

3.4 DUCTWORK FITTINGS AND ACCESSORY ITEMS

A. Duct Elbows Changes in direction and offsets shall be made in a gradual manner to facilitate streamline flow of air. Unless indicated otherwise on the Drawings, all elbows shall be made with long-radius elbows. Long-radius elbows are considered to have a centerline radius of not less than 1 1/2 times the width of the duct in the plane of the elbow. Where long-radius elbows are not practical due to clearance issues, short-radius elbows may be used. Short-radius elbows are considered to have a centerline radius of not less than 1 times the width of the duct in the plane of the elbow. For rectangular ductwork where full radius elbows cannot be installed, provide abrupt elbows equipped with shop installed turning vanes unless noted otherwise on the Drawings.

B. Flexible Fabric Connectors
   1. Where the construction of the flexible connection or vibration isolator results in a cross sectional area of the connection which is less than 90 percent of the adjacent ductwork, the size of the connection shall be increased to provide a cross sectional area equal to or greater than 90 percent of the adjacent duct.
   2. Provide flexible duct connections at both the intake and discharge connections for all fans, fan units or blowers, air handling units and air conditioning units except as noted below.
      a. Wall and roof fans that have integral motor/fan wheel isolation.
      b. Air handling units where the fan is isolated from the intake and discharge connections by internal flexible connections or separations, and the unit is mounted without vibration isolators between the unit and the support structure.
   3. Ductwork spacing and alignment for flexible connections shall be aligned to the tolerances of the flexible connection manufacturer, or plus/minus 1/4-in whichever is less. Bolts shall be actuator
   4. d to the manufacturer's recommendations. Do not over tighten.

C. Dampers
   1. Install manual volume control dampers wherever it may be necessary to regulate air volume for system air balancing and where shown on the Drawings.
   2. Install motorized actuated dampers where shown on plans and when supplied by other trades.

D. Access Doors
   1. Hinged access doors shall be installed where listed below, wherever shown on the Drawings and wherever access may be required for service, maintenance and adjustment.
   2. Provide access doors at the following locations (minimum requirements):
      a. Coils in ducts both entering and leaving side.
      b. Motorized actuated dampers, linkage side.
      c. Plenums.
      d. Fire dampers.
      e. Smoke dampers.
      f. Electric duct heaters.
      g. Filter banks.
      h. As necessary or required.
      i. Inlet and outlet ducts to fans and air handlers.
   3. Where access doors are required in ductwork located above ceilings, coordinate the location of the access doors to clear the ceiling support system and to be accessible through the ceiling grid.
   4. 12 in by 12 in handhole access panels may be substituted for access doors when indicated on the Drawings.

3.5 GRILLES, REGISTERS AND DIFFUSERS

A. The location of grilles, registers, and diffusers (GRD's) shall be as shown on the Reflected Ceiling Plans and as shown on the ductwork drawings. If the location of a GRD needs to be

moved because of a conflict (I.e. sprinkler head) obtain approval for the new location from the Engineer.

B. Install all devices in an approved manner in accordance with the manufacturer's recommendation.

3.6 FILLING IN SPACE AROUND DUCTWORK

A. To prevent sound passing through the area between the duct and the framed or cut opening in the floors, walls or partitions, pack mineral wool to completely fill the space the full depth of the opening. Whenever a fire rated wall or floor is penetrated do not fill or caulk the space or around the fire damper sleeve.

B. At standard wall penetration, apply escutcheon plates on both faces of the wall to close the gap between the structure and the sides of the insulated or bare duct. Escutcheon plates shall be the same material as the duct. Seal gap between escutcheon plate and wall surface, air and water tight with clear, silicone caulk.

3.7 INSTALLATION OF WALL LOUVERS

A. For hoods and louver assemblies installed at exterior walls, gap between frames and wall surfaces shall be sealed air and watertight with silicone caulk.

3.8 DUCTWORK GENERATED NOISE

A. All ductwork shall be free from pulsation, chatter, “oil canning”, vibration or objectionable noise. After system is in operation, should these defects appear, correct by removing, replacing or reinforcing the work. No discreet tones will be allowed.

3.9 TEST PORTS

A. Where shown on the Drawings and where required for testing and balancing, provide instrument insertion ports. Size and location of ports shall be coordinated with the Contractor performing air balancing. Seal ports with plastic snap lock plugs. When the ductwork will be insulated, extend the port to the face of the insulation and seal the vapor barrier to the port.

B. In round ductwork provide two (2) ports 90 degrees on centers. In rectangular ductwork provide ports as required by AABC or NEBB for a full traverse measurement.

C. As a minimum, ports shall be provided in the following connections:
   1. All duct mains.
   2. All duct branches unless all connections are diffusers, registers, or grilles and the total can be calculated by summing the readings for all of the connections.
   3. All connections to tanks or hoods where there is no other access for taking a measurement.

D. A main duct is defined as one (1) of the following:
   1. A duct serving five (5) or more outlets.
   2. A duct serving two (2) or more branch ducts.
   3. A duct emanating from a fan or plenum.
   4. All remaining ducts are considered branch ducts.

3.10 ADJUSTMENT

A. Start-Up and Temporary Operation
   1. Properly maintain and service all equipment and systems until the particular equipment or system has been accepted by the Owner.

3.11 CLEANING OF DUCTWORK

A. Maintain all ductwork, fans, coils, air filters, outlets and other parts of the ductwork systems in a clean condition during installation.

B. Clean complete ductwork systems prior to testing and air balancing. Secure cheese cloth over all openings of the ductwork system for entrapment of dirt during the cleaning operation.

C. Thoroughly clean all parts of the installation at the completion of the work and prior to turning work over to Owner. All surface defects and scuff marks shall be removed or painted. Also remove any debris and construction material from inside ductwork.

3.12 INSTALLATION OF DUCTWORK INSULATION

A. Provide ductwork insulation as specified under Section 23 07 13 – HVAC Duct and Pipe Insulation and as called for on the drawings.

B. Duct liner is not allowed unless shown and called out on the contract drawings for sound reduction in the first ten (10) feet of duct leaving noise generating equipment.

C. All ductwork, except as noted below, shall be insulated unless approved in writing by the Engineer. Insulation specified in Section 23 07 13 – HVAC Duct and Pipe Insulation shall be installed regardless of notes below.
   1. Supply and return air ductwork.
   2. Exhaust ductwork, for fans with on/off control (e.g. purge exhaust) between outdoor equipment and indoor motorized isolation damper.

3.13 PAINTING

A. Paint the outside face of all louver blank off panels and the interiors of unlined plenums and ductwork where connected to louvers. Prime and paint with two coats of flat black exterior paint. Painting shall be performed under this Section and shall be as specified in Division 09 – Finishes.

B. Prepare surfaces to be painted by removing any stickers, glue, dirt, grease, and oil with cleaning solutions and methods according to paint manufacturer's instructions. Pickle galvanized metal if required by paint manufacturer according to paint manufacturer's instructions.

3.14 DUCT IDENTIFICATION

A. Duct identification shall be part of the work of this Section and shall be provided at all ducts. Refer to Part 2 of this specification for labeling requirements.

END OF SECTION

SECTION 23 34 23
HVAC – METAL FANS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish and install all fans and fan accessories as shown and scheduled on the Drawings, and as specified herein.

B. This HVAC specification is incomplete without the information contained on the Drawings and in the Equipment Schedules.

C. Refer to Section 23 05 00 – HVAC General Provisions for work related to this Section.

1.2 MEASUREMENTS AND PAYMENTS

A. No separate payment will be made for work performed under this Section. Include the cost for this work in the lump sum Base Bid.

1.3 RELATED WORK

A. Ductwork and accessories are included in Section 23 31 13 – HVAC Metal Ductwork and Accessories .

B. HVAC Controls and sequences of operation are in the HVAC Drawings.

C. Remote disconnects shall be provided under Division 26 – Electrical.

D. Refer to Division 26 – Electrical for electrical requirements.

1.4 EQUIPMENT SCHEDULES

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A. This Section is incomplete without the information contained in the drawings and schedules. All fans shall be of the type, capacity and arrangement as listed on the drawings and schedules. Units shall consist of the components shown, and listed on the drawings and schedules and those components obviously required for the type of unit. Particular attention must be paid to the remarks and notes in the schedules.

1.5 SUBMITTALS

A. Submit all shop drawings and Operating and Maintenance Manuals with all information required per Division 01 – General Requirements and Section 23 05 00 – HVAC General Provisions.

1.6 REFERENCE STANDARDS

A. These standards shall be considered as minimum requirements. This is a general list and not all standards listed are necessarily referenced elsewhere in this Section. Specific requirements of this Section and/or Drawings shall have precedence. The Owners Designated Representative shall resolve conflicts between published requirements.

B. Titles and abbreviation of Federal, State and industry standards, technical societies, associations and institutes and other organizations, which may be used, are as follows:
   1. Air Diffusion Council (ADC)
   2. American Bearing Manufacturers Association (ABMA)
   3. Air Movement and Control Association (AMCA)
   4. American National Standards Institute (ANSI)
   5. Air Conditioning and Refrigeration Institute (ARI)
   6. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
   7. American Society of Mechanical Engineers (ASME)
   8. American Society for Testing and Materials (ASTM)
   9. Factory Mutual (FM)
   10. Institute of Electrical and Electronic Engineers (IEEE)

11. National Institute of Standards and Technology (NIST)
12. National Electrical Code (NEC)
13. National Electrical Manufacturers Association (NEMA)
14. National Fire Protection Association (NFPA)
15. Occupational Safety and Health Administration (OSHA)
16. Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
17. Underwriters Laboratories (UL)

C. Where reference is made to one (1) of the above standards, the revision in effect at the time of bid opening shall apply.

1.7 COORDINATION

A. Coordinate installation of equipment with ceiling systems, lights, structural, and other components located in the ceiling plenum.

1.8 NOISE CRITERIA

A. Refer to Section 23 05 00 – HVAC General Provisions and individual Equipment Schedules.

1.9 WARRANTY - GUARANTEE

A. Refer to Division 01 and Section 23 05 00 – HVAC General Provisions for warranty requirements.

B. Guarantee that all equipment meets the design and performance requirements specified, and alter and/or replace, at no cost to the Owner any piece of equipment, which fails to meet these requirements. Include any work and factory trained supervision necessary.

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PART 2 - PRODUCTS

2.1 GENERAL

A. The use of a manufacturer's name and model number is for the purpose of establishing the standard quality, grade, type, size, physical arrangement, performance characteristics and availability.

B. Fans shall be factory assembled, complete with fan wheel, fan housing or cabinet, bearings, drives, OSHA approved guards, motor, motor base, unit base and vibration isolators, dampers, and bird screens unless otherwise specified. All fans shall be provided with lugs, brackets or field supplied devices to allow the fan to be firmly bolted to the structure or fastened to specified vibration isolators. The lugs, brackets or field supplied devices shall be sized to withstand the expected seismic and wind loads for the area and type of application. Location of the attachments shall be based on the equipment being hung or base mounted as shown on the Drawings and the schedules.

C. All fans shall be statically and dynamically balanced prior to shipment from factory.

D. Where belt drives are used, motors shall be provided with adjustable slide bases. Adjustable sheaves and slide bases shall be selected so that the midpoint of the adjustable range matches the fan schedule data. Drives selected shall have a safety factor of 1.5 times motor horsepower.

E. All fans shall be AMCA certified for air performance and sound ratings tested in accordance with AMCA 300.

F. Motor shall be selected to be non-overloading for the entire fan curve range and for the reasonable expected temperature and humidity. Schedule motor sizes are minimum. If a larger motor is required for the fan proposed, the larger motor shall be provided at no additional cost.

G. Fans shall be assembled with OSHA shaft, drive, and motor guards. Provide access for greasing bearings, tachometer readings of fan and motor speed without removing the cover. Cover shall be properly ventilated to prevent motor overheating.

H. Ductwork connections to units that require corrosion resistant coatings shall be made with flanges. Flanges shall be factory drilled before coating. Resilient washers suitable for the environment shall be used to protect the coating from the bolts in the flange. The use of self tapping screws or other fastening methods that will damage the coating are not acceptable.

I. The noise level of the equipment operating in the field shall not exceed 85 dBA overall sound pressure level (referenced to 20 micro pascals) at a distance of 3-ft from equipment surfaces. Provide octave band sound data if another noise level is specified in the schedule or if sound data submission is specified in the schedules.

J. Additional requirements are contained herein for specific fan types and in the schedules.

K. Section 23 05 00 – HVAC General Provisions contains general requirements for vibration isolators, bearings and motor drives. Adhere to those requirements and the specific requirements in this Section.

L. When bearings are not accessible, extended grease lines and fittings shall be supplied. Multiple bearing extended grease lines and fittings shall terminate in the same accessible location.

M. Provide inlet and outlet screens for fans that are not directly connected to ducts or walls.

N. Fans shall be UL listed and AMCA certified.

2.2 CENTRIFUGAL ROOF EXHAUST FANS

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A. Centrifugal upblast wall and roof exhaust fans shall be all aluminum housing, backward inclined aluminum wheel, direct drive, with stainless steel fasteners, and aluminum bird screen. Fan shall be statically and dynamically balanced in accordance with AMCA Standard 204-05. Motors shall be permanently lubricated, heavy duty, premium-efficiency type mounted on vibration isolators out of the airstream.

B. Motor type shall be TEFC with class F insulation unless otherwise indicated in the Equipment Schedules. The fan shaft shall be ground and polished steel with an anti-corrosive coating and first critical speed at least 25-percent over maximum load mounted in permanently sealed heavy duty, or pillow block bearings with extended lube lines, selected for a minimum L50 average life of 500,000 hours at maximum cataloged operating speeds. Drives shall be of the fully machined cast iron type, keyed and securely attached to the wheel and motor shafts.

C. The entire fan assembly shall be UL listed. The manufacturers shall be Greenheck CUE series, Loren Cook Co., or Aerovent.

D. Provide curbs 18-inch tall for insulated roofs, aluminum, welded curb with 45-degree cant and wood nailer, 2-inch thick insulation, and rubber seal between fan and curb. Provide curbs to match roof pitch for level fan mounting.

2.3 LABELING

A. Provide each piece of equipment with a factory-applied stainless steel nameplate permanently attached to the exterior of the equipment, in an accessible location, external to any insulated surface and observable while the equipment is in operation.

B. As a minimum, include the following information on the nameplate:

1. Manufacturer's name.
2. Equipment Model Number
3. Equipment tag number.
4. Purchasers order number.
5. Serial Number
6. Manufacturer's size and type
7. Air Flow Rate – CFM.
8. Design Pressure (inch W.G.).
9. Fan Horsepower and RPM.
10. Volts/Phase/Hertz
11. Date of manufacture.
12. Approving Agency Seals.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The fans shall be installed in accordance with the instructions of the manufacturer and as shown on the Drawings.

B. The Contractor shall not install any equipment or materials until the Owner and Owners Designated Representative have approved all submittals. If any equipment or materials are installed prior to approval of the submittals, it shall be at the Contractor's risk.

C. Ensure that lubricating fluids and greases have been applied according to manufacturer's recommendations. Contractor shall be responsible for all start-up checks and adjustments and shall perform them unless they are done by the manufacturer's representative. 5

D. Statically and dynamically balance each fan to assure vibration free operation.

E. Inspect fans and supervise start-up of all fans.

3.2 FIELD QUALITY CONTROL

A. Perform field quality-control inspections per any pre-startup checklists from the manufacturer. Fill out reports and submit to the Owners Designated Representative.

B. Replace any damaged or malfunctioning equipment with new equipment.

3.3 STARTUP SERVICE

A. The Contractor shall do the initial startup of the equipment so that each fan is placed in proper operating condition. The Owners Designated Representative shall witness startup.

B. Perform Field Quality Control checks and inspections specified above prior to start-up procedures.

C. Start unit according to manufacturer's written instructions and perform the startup checks per startup checklists from the manufacturer. Fill out reports and submit to the Owners Designated Representative.

3.4 EQUIPMENT IDENTIFICATION

A. Provide each equipment unit with an equipment tag label. Label shall be a plastic plate or self-adhesive tag. Lettering shall be 6-inches tall. Label shall be located in a visible location.

3.5 TEMPORARY OPERATION

A. Refer to Section 23 05 00 – HVAC General Provisions.

END OF SECTION

SECTION 23 74 23
HVAC – MAKEUP AIR UNITS | 5

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish and install all indoor mounted, packaged air handling units with heating section, fan section, filter section and other sections as shown on the Drawings, scheduled, and as specified herein.

B. Refer to Section 23 05 00 – HVAC General Provisions for work related to this Section.

1.2 MEASUREMENT AND PAYMENT

A. No separate payment will be made for work performed under this Section. Include the cost for this work in the lump sum Base Bid.

1.3 RELATED WORK

A. Remote disconnects shall be provided under Division 26.

B. Refer to Division 26 – Electrical for electrical requirements.

C. Refer to Drawing controls description prior to purchasing equipment. Contractor shall verify that equipment supplier provides equipment with all components, controls options, etc. to fulfill the intent of the HVAC control sequence as described in the drawings.

1.4 EQUIPMENT SCHEDULES

A. This Section is incomplete without the information contained in the schedules. All packaged, air handling units shall be of the type, capacity and arrangement as listed on the schedules. Units shall consist of the components listed in the schedule and those components obviously required for the type of unit. The order of component assembly will be as called for on the schedule. Particular attention must be paid to the remarks and notes in these schedules.

1.5 SUBMITTALS

A. Submit all shop drawings and Operating and Maintenance Manuals with all information required per Division 01 – General Requirements and Section 23 05 00 – HVAC General Requirements and the following additional specific requirements:
   1. Field quality-control test reports.

1.6 REFERENCE STANDARDS

A. Refer to Section 23 05 00 – HVAC General Provisions and the following specific standards.

B. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
   1. ASHRAE 52 - Method of Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.

C. Air Movement and Control Association (AMCA)

D. National Fire Protection Association (NFPA)
   1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems
   2. NFPA 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems.

E. Underwriters Laboratory
   1. Unit shall be certified in accordance with UL Standard 1995/CSA C22.2 No. 236, Safety Standard for Heating and Cooling Equipment

F. American Society for Testing and Materials (ASTM)

1. ASTM C1071 - Standard Specification for Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Materials).

G. Air-conditioning and Refrigeration Institute (ARI)

H. American Society of Mechanical Engineers (ASME)

I. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.7 QUALITY ASSURANCE

A. Refer to Section 23 05 00 – HVAC General Provisions and the following specific requirements related to this Section.

B. Unit shall be UL listed and stamped with all testing agency seals.

C. An authorized representative of the manufacturer who has complete knowledge of proper installation, startup, and operation and maintenance (O&M) shall be provided as noted below. The Owner and Engineer shall witness startup. The use of local sales representatives to perform this work is not acceptable, unless the manufacturer provides documented evidence that the sales representative has been specifically trained for this work. If there are difficulties in operation of the equipment due to the manufacturers' design or fabrication, additional service shall be provided at no cost to the Owner. Refer to Division 01 – General Requirements for startup requirements. Man-hour requirements tabulated below are exclusive of travel time and do not relieve the Contractor of obligation to provide sufficient service to place equipment in satisfactory operation.

Services Provided by Factory Representative	Minimum[(a)] No. of Trips	Minimum Time On Site Per Trip (hours)
1. Inspect and approve installation[(b)]	1	4
2. Supervise initial adjustment and assist in testing[(c)]	1	4
3. Instruct Owner and Owner's Representative in proper start-up and O&M[(d)]	1	4

(a) The manufacturer's factory representative shall be present at frequent enough intervals to ensure proper installation, testing, and initial operation of the equipment.

(b) The manufacturer's factory representative shall provide to the Owner's Representative a written certification that the system has been installed in accordance with the manufacturer's recommendations.

(c) May be done upon completion of Item 1 if acceptable to the Owner's Representative.

(d) Instruction may be given upon completion of Item 2, provided that the test is successful and the O&M manuals have been submitted to and accepted by the Owner's Representative.

1.8 DELIVERY, STORAGE AND HANDLING

A. Refer to Section 23 05 00 – HVAC General Provisions.

1.9 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 – Concrete.

B. Coordinate installation of equipment supports/roof curbs with Division 07 – Thermal and Moisture Protection.

C. Units shall fit into the space available with adequate clearance for service as determined by the Engineer. Submitted units, which do not meet these criteria, shall be rejected. Do not assume that all of the manufacturers listed as acceptable manufacturers will provide a unit that will fit in the space allocated. Selection of acceptable manufacturers is not based on whether the manufacturer's standard stock unit will fit into every space allocated. A custom or semi-custom air-handling unit may be required to meet project space and performance requirements.

1.10 NOISE CRITERIA

A. Refer to Section 23 05 00 – HVAC General Provisions and individual Equipment Schedules.

1.11 WARRANTY - GUARANTEE

A. Warrant all material and workmanship included herein. Warranty shall include parts & labor for a period of twelve (12) months from date of arrival of equipment on site for the replacement of any parts found defective due to manufacture.

B. Guarantee that all equipment meets the design and performance requirements specified, and alter and/or replace, at no cost to the Owner any piece of equipment which fails to meet these requirements. Include any work and factory trained supervision necessary.

PART 2 - PRODUCTS

2.1 GENERAL

A. In general, units shall be factory assembled with supply fan, DX evaporator and condenser coils, and electric reheat coil as scheduled, filters, dampers, access sections with hinged access doors, motor, motor base, drive, drive guard and vibration isolators. Entire unit shall be factory painted.

B. Unit shall have a draw-through supply fan configuration and discharge air configuration as shown on the drawings.

C. Units shall be designed to provide an integrated assembly when all of the components are assembled. All transition sections and filler pieces required between sections are to be provided as part of the unit.

D. Support brackets or rails are to be provided with the unit. Type of support is to be as required by the schedules and as shown on the Drawings, e.g. hung, floor mounted, etc. All air handling units shall be provided with lugs, brackets or field supplied devices to allow the unit to be firmly bolted to the structure or fastened to specified vibration isolators. The lugs, brackets or field supplied devices shall be sized to withstand the expected seismic loads for the area and type of application. Location of the attachments shall be based on the equipment being hung or base mounted as shown on the Drawings and the schedules.

E. Units not mounted on vibration isolators shall have all rotating components internally isolated from the main unit with vibration isolators.

2.2 CASINGS

A. Unit construction shall be double wall aluminum on both sides with thermal breaks. Pressure class rating shall be for the total fan static pressure.

B. Unit insulation shall have a minimum thermal resistance R-value of 6.25. Foam insulation shall have a density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D-1929-11 for a minimum flash ignition temperature of 610°F.

C. Unit shall be designed to reduce air leakage and infiltration through the cabinet. Sealing shall be included between panels and between access doors and openings to reduce air leakage. Piping and electrical conduit through cabinet panels shall include sealing to reduce air leakage.

D. Ductwork connections to units that require corrosion resistant coatings shall be made with flanges. Flanges shall be factory drilled before coating. Resilient washers suitable for the environment shall be used to protect the coating from the bolts in the flange. The use of self-tapping screws or other fastening methods that will damage the coating are not acceptable.

E. Units for outdoor installation shall comply with the following:
   1. Materials of construction shall be corrosion resistant, or provided with a corrosion resistant coating system for weather protection.
   2. The casing shall enclose all components for weather protection, with gasketed access doors provided for all sections to facilitate maintenance. Doors shall be hinged with lever handles and have provision for key locking to prevent unauthorized tampering.
   3. Top of housing shall be constructed to prevent buckling and ponding of water.

2.3 FAN SECTION

A. Fan shall be belt drive unhoused, forward curved, with double width/double inlet.

B. Blower and motor assembly shall be dynamically balanced and be mounted on rubber isolators.

C. All fans shall be AMCA rated for sound and air performance.

D. Where called for on the schedules, fans shall be of spark-proof construction. On spark-proof fans, bearings shall not be placed in the air stream. Construction shall conform to AMCA and NFPA requirements.

2.4 Motor

A. Fan motor shall be premium efficiency and totally enclosed.

2.5 COOLING SECTION

A. Unit shall include a direct expansion (DX) cooling section with evaporator and condensing coils.

B. Refrigerant shall be R454B type.

C. Efficiencies shall meet the latest IECC energy code.

2.6 HEATING SECTION

A. Unit shall include an include electric heater consisting of electric heating coils, fuses, contactors, and a high temperature limit switch, with capacities as shown on the plans.

B. Electric heat shall have fully modulating capacity controlled by an SCR (Silicon Controlled Rectifier). A 0-10 VDC heating control signal shall be field provided to control the amount of heating.

2.7 FILTERS

A. Filter Box shall have tracks for the specified filter types to allow filter replacement from side. Sealing material shall be provided at tracks and ends to prevent air by-passing the filters.

B. Filters shall be aluminum washable type with a clean pressure drop of .060 inches water gage at 350 feet per minute.

C. For all types of filters, each filter section shall be provided with a differential static pressure gage across the filter. Each gage shall be provided with shut-off vent valves on each side of the gage to permit zeroing of the gage without disconnecting the gage. Tubing shall be

aluminum. Static pressure sensors, valves and fittings shall be aluminum. Pressure range of gages shall be three times the clean pressure loss of the filters provided.

D. Gages shall be Dwyer Magnehelic Series 2000 or approved equal.

2.8 UNIT CONTROL PANEL

A. For self-contained packaged units, factory wired UL listed microprocessor-based NEMA 4X control panel shall be furnished and mounted on the unit. Panels shall include all controls required in other sections, and all safety controls and interlocks, heavy duty fused visible break, control devices, motor starters, transformer for controls circuits and terminal strip for remote wired devices. Control type and sequence shall be as specified in other Sections and on the Drawings. Control voltage shall not exceed 120V. Control panel door shall be provided with a keyed lock. A complete wiring diagram shall be permanently attached to the inside of the panel door.

B. Where specific area classifications are called for or shown on the electrical drawings, all equipment and wiring shall be in conformance with the requirements for that classification.

C. Panel shall be readily accessible, and located no greater than 66 inches above finished floor.

D. The type of enclosure and all components shall be provided in accordance with Division 26 – Electrical requirements.

E. Panel shall be provided by factory and factory installed to match the makeup air handling unit.

2.9 ACCESSORY SECTIONS

A. Accessory sections shall be as called for on the Drawings and schedules and as required for the unit type.

B. Damper shall be integral with the unit, located on the supply discharge, opposed blade type with blades mounted on 1/2-in minimum 316 stainless steel rods. Dampers shall be provided with low friction bushings and edge gaskets to reduce air leakage. Blades shall be sectionalized to limit unsupported blade length and warping at full system fan static pressures. Maximum damper blade width shall not exceed 6-in. Provide factory mounted motors for modulating dampers. Blades and housing shall be aluminum construction.

C. Mixing boxes shall be of the configuration shown on the Drawings. Deflection plates shall be provided if required to maintain even air flow over coils and prevent stratification.

D. Spacer and access sections will be provided where specified or required. Access sections shall have hinged doors on each end except for filters.

E. Inlet louvers for outdoor mounted units shall be weather proof design mounted between outside and the control dampers.

F. Provide with stainless steel drip pan.

2.10 ELECTRICAL

A. Unit shall be single-point connection with integral step-down transformer for unit controls. Equipment that is shipped in components shall be assembled in the field and field wired by the Contractor per the manufacturer's requirements. All field wiring and conduit shall meet Division 26 – Electrical requirements.

2.11 MANUFACTURERS

A. Unit shall be manufactured by Engineered Air, Absolute Aire, or Seasons 4.

2.12 LABELING

A. Provide each piece of equipment with a factory-applied stainless steel nameplate permanently attached to the exterior of the equipment, in an accessible location, external to any insulated

surface and observable while the equipment is in operation. As a minimum, include the following applicable information on the nameplate:

1. Manufacturer's name.
2. Equipment Model Number
3. Equipment tag number.
4. Purchasers order number.
5. Serial Number
6. Manufacturer's size and type
7. Air Flow Rate – CFM.
8. Pressure – in. W.G.
9. Fan Horsepower and RPM.
10. Heating Capacity – MBH or KW.
11. Volts/Phase/Hertz
12. List of each individual component's electrical data: volts, amps or watts, phase
13. Date of manufacture.
14. Approving Agency Seals.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Equipment shall be installed in accordance with manufacturer's recommendation. Provide piping and ductwork connections in accordance with the requirements of the other related Sections.

B. The Contractor shall not install any equipment or materials until the Owner has approved all submittals. If any equipment or materials are installed prior to approval of the submittals, it shall be at the Contractor's risk.

C. When units are shipped disassembled, field connect all sections together as shown on the Drawings to form single air handling unit. Seal all joints with gaskets and/or sealants.

D. Do not operate equipment without filters. Do not run equipment with dirty filter pressure drop more than twice clean filter pressure drop. A total of three (3) complete sets of filters shall be provided. The first set is to be installed for start-up, test and balancing. The second set shall be installed after final cleanup and acceptance by the Owner. The third set shall be turned over to the Owner as a spare.

E. The Contractor shall start up each piece of equipment and system and shall make all adjustments so that the system is placed in proper operating condition.

3.2 FIELD TESTING / VIBRATION / LEAKAGE

A. Provide the services of a factory trained representative to inspect, test and supervise startup.

3.3 ADJUSTING

A. Adjust supply fan speeds and damper settings for normal operation with no fume hoods on, one (1) fume hood on, and two (2) fume hoods on.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.4 CLEANING

A. At the completion of the work, clean all piping, equipment and apparatus for same included in this Section and, where required.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field quality-control tests and inspections and prepare test reports:
   1. After installing air-handling units, and where applicable the associated condensing units, and after electrical circuitry has been energized, test units for compliance with requirements. Start units to confirm proper motor rotation and unit operation.
   2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove malfunctioning units, replace with new units, and retest as specified above.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and do the following:
   1. Inspect for visible damage to unit casing.
   2. Inspect for visible damage to heater.
   3. Inspect for visible damage to fans.
   4. Inspect internal insulation.
   5. Verify that labels are clearly visible.
   6. Verify that clearances have been provided for servicing.
   7. Verify that controls are connected and operable.
   8. Verify that filters are installed.
   9. Clean heating coil and inspect for construction debris.
   10. Adjust vibration isolators.
   11. Lubricate bearings on fan.
   12. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
   13. Adjust fan belts to proper alignment and tension.
   14. Start unit according to manufacturer's written instructions.
      a. Complete startup sheets and attach copy with Contractor's startup report.
      b. Inspect and record performance of interlocks and protective devices; verify sequences.
      c. Operate unit for an initial period as recommended or required by manufacturer.
      d. Calibrate thermostat.
      e. Inspect outside-air dampers settings.
      f. Inspect controls for correct sequencing of heating.
      g. Measure and record the supply airflows.
   15. Verify operation of control panel, including pilot-light operation and failure modes. Inspect all alarms and safety devices.
   16. After startup and performance testing, change filters, vacuum heat exchanger, lubricate bearings, and adjust belt tension.

3.7 TRAINING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain makeup air units and condensing units. Refer to Division 01 – General Requirements.

3.8 EQUIPMENT IDENTIFICATION

A. Provide each air-handling unit with an equipment tag label. Label shall be a plastic plate or self-adhesive tag. Lettering shall be 6-inches tall. Label shall be located in a visible location.

3.9 TEMPORARY OPERATION

A. Refer to Section 23 05 00 – HVAC General Provisions.

END OF SECTION

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SECTION 23 81 26
HVAC – STANDARD DX AIR-CONDITIONING EQUIPMENT 5

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish and install all indoor mounted air-handling units with filters as shown on the Drawings, scheduled and as specified herein

B. Furnish and install all self-contained air-handling units with filters as shown on the Drawings, scheduled and as specified herein.

C. Furnish and install all split system units, condensing units and filters as shown on the Drawings, scheduled and as specified herein.

D. Refer to Section 23 05 00 – HVAC General Provisions for work relating to this Section.

1.2 RELATED WORK

A. Remote disconnects shall be provided under Division 26 – Electrical.

B. Refer to Division 26 – Electrical for electrical requirements.

C. Refer to Section 15890 – HVAC Metal Ducts and Accessories for ductwork installation requirements.

D. Refer to Drawings and Section 23 09 00 – HVAC Controls prior to purchasing equipment. Equipment supplier shall verify that equipment is provided with all components, controls options, etc. to fulfill the intent of the HVAC control sequence.

1.3 EQUIPMENT SCHEDULES

A. This Section is incomplete without the information contained in the schedules. All air handling units, package units, split systems and through-the-wall units shall be of the type, capacity and arrangement as listed on the schedules. Units shall consist of the components listed in the schedule and those components obviously required for the type of unit. The order of component assembly will be as called for on the schedule. Particular attention must be paid to the remarks and notes in these schedules.

1.4 SUBMITTALS

A. Submit all shop drawings and Operating and Maintenance Manuals with all information required per Division 01 – General Requirements and Section 23 05 00 – HVAC General Provisions.

1.5 REFERENCE STANDARDS

A. Refer to Section 23 05 00 – HVAC General Provisions and the following specific standards.

B. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
   a. ASHRAE 52 - Method of Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.

C. National Fire Protection Association (NFPA)
   1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems
   2. NFPA 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems.

D. American Society for Testing and Materials (ASTM)
   1. ASTM C581 - Standard Practice for Determining Chemical Resistance of Thermosetting Resins Used in Glass- Fiber- Reinforced Structures Intended for Liquid Service.
   2. ASTM C1071 - Standard Specification for Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Materials).

E. Association of Home Appliance Manufacturers (AHAM)

F. Where reference is made to one (1) of the above standards, the revision in effect at the time of bid opening shall apply.

1.6 QUALITY ASSURANCE

A. Refer to Section 23 05 00 – HVAC General Provisions and the following specific requirements related to this Section.

B. Guarantee that refrigerant cooling equipment will provide indicated cooling capacities in Equipment Schedules.

C. An authorized representative of the manufacturer who has complete knowledge of proper installation, startup, and operation and maintenance (O&M) shall be provided as noted below. The Owner and Engineer shall witness startup. The use of local sales representatives to perform this work is not acceptable, unless the manufacturer provides documented evidence that the sales representative has been specifically trained for this work. If there are difficulties in operation of the equipment due to the manufacturers' design or fabrication, additional service shall be provided at no cost to the Owner. Refer to Division 01 – General Requirements for startup requirements. Man-hour requirements tabulated below are exclusive of travel time and do not relieve the Contractor of obligation to provide sufficient service to place equipment in satisfactory operation.

Services Provided by Factory Representative	Minimum[(a)] No. of Trips	Minimum Time On Site Per Trip (hours)
1. Inspect and approve installation[(b)]	1	4
2. Perform start-up		
2. Supervise initial adjustment and assist in testing[(c)]	1	4
3. Instruct Owner and Owner's Representative in proper start-up and O&M[(d)]	1	4

(a) The manufacturer's factory representative shall be present at frequent enough intervals to ensure proper installation, testing, and initial operation of the equipment.

(b) The manufacturer's factory representative shall provide to the Owner's Representative a written certification that the system has been installed in accordance with the manufacturer's recommendations.

(c) May be done upon completion of Item 1 if acceptable to the Owner's Representative.

(d) Instruction may be given upon completion of Item 2, provided that the test is successful and the O&M manuals have been submitted to and accepted by the Owner's Representative.

1.7 COORDINATION

A. Coordinate installation of equipment supports/roof curbs with Division 07 – Thermal and Moisture Protection.

B. Units shall fit into the space available with adequate clearance per NEC and for service as required by the manufacturer. Submitted units, which do not meet these criteria, shall be rejected. Do not assume that all of the manufacturers listed as acceptable manufacturers will provide a unit that will fit in the space allocated. Selection of acceptable manufacturers is not based on whether the manufacturer's standard stock unit will fit into every space allocated. A

custom or semi-custom air-handling unit may be required to meet project space and performance requirements.

1.8 WARRANTY - GUARANTEE

A. Refer to Division 01 – General Requirements and Section 23 05 00 – HVAC General Provisions for general warranty requirements and the following specific requirements related to this Section.

B. Compressor shall have five (5) year parts warranty. For split systems, warranty is five (5) year parts only, no labor.

PART 2 - PRODUCTS

2.1 GENERAL

A. In general, units shall be factory fabricated, completely factory-assembled, tested and shipped in one (1) piece with fan, coils, filters, access panels/doors, fan motor, motor base, drive, drive guard, dampers, condensate pans, complete controls, vibration isolators with seismic restraints and other components as specified herein, indicated on the Drawings and as required for safe and satisfactory operation of the equipment.

B. Units shall be designed to provide an integrated assembly when all of the components are assembled. All transition sections and filler pieces required between sections are to be provided as part of the unit.

C. Support brackets or rails are to be provided with the unit. Type of support is to be as required by the schedules and as shown on the Drawings, e.g. hung, floor mounted, etc. All air-handling units shall be provided with lugs, brackets or field supplied devices to allow the unit to be firmly bolted to the structure or fastened to specified vibration isolators. The lugs, brackets or field supplied devices shall be sized to withstand the required wind and seismic loads for the area and type of application. Location of the attachments shall be based on the equipment being hung or base mounted as shown on the Drawings and the schedules.

D. Units not mounted on vibration isolators shall have all rotating components internally isolated from the main unit with vibration isolators.

2.2 PACKAGED DX ROOFTOP UNITS (VARIABLE CAPACITY)

A. General
   1. Nominal Cooling Capacity from 3 to 10 tons shall be Trane Precedent eFlex or approved equal.
   2. Refer to drawings for model number and type as called out on the Equipment Schedules.
   3. Refer to drawings for downflow or horizontal duct configurations.

B. Construction
   1. Cabinet - Galvanized steel, phosphatized, and finished with a pre-applied baked polyurethane enamel. Structural members shall be 16 gauge with access doors and removable panels of minimum 20 gauge. Unit cabinet surface shall be tested 672 hours in salt spray test in compliance with ASTM B117. Cabinet top cover shall be one (1) piece construction. or where seams exist it shall be double-hemmed and gasket-sealed. Water- and air-tight panels with handles shall provide access to filters, supply air fan section, evaporator coil section, and unit control section. Provide ½ inch foil-faced, fire retardant permanent, odorless glass fiber material. All edges captured so that there is no insulation exposed in the airstream. The base of the unit shall have provisions for forklift and crane lifting.
   2. Provide Coatings on items exposed to the outdoor environment. Refer to 15500 – HVAC General Provisions for additional information.

C. Supply Air Fan - Evaporator fan section shall be forward curved, double width, double inlet, centrifugal type fan with self-aligning, grease lubricated, ball or sleeve bearings with permanent

lubrication fittings. Units shall have belt driven supply fans with adjustable motor sheaves. Fan shall be permanently lubricated and have internal thermal overload protection. Provide shafts constructed of solid hot rolled steel, ground and polished, with key-way, and protectively coated with lubricating oil.

D. Single Zone Variable Air Volume - Units shall be provided with VFD (Variable Frequency Drive) on Indoor fan motor. VFD shall change fan speed according to mode of operation. During cooling mode, fan shall modulate to maintain space temperature. The compressor(s) shall operate to control discharge air temperature. This operation shall be standard with SZVAV offering.

E. Evaporator Cooling Coils - Aluminum fin surface mechanically bonded to copper tubing coil. Provide an independent expansion device for each refrigeration circuit. Factory pressure test at 450 psig and leak test at 200 psig. Provide each unit refrigerant circuit(s) completely piped with liquid line filter-drier, suction and liquid line pressure ports.

F. Condensate Drain Pan – Unit shall have a drain pan for base of evaporator coil constructed of 304 stainless steel with external connections. Unit shall include a condensate overflow switch to shut the unit down in the event that a clogged condensate drain line prevents proper condensate removal from the unit.

G. Condenser Section - Provide Microchannel condenser with vertical discharge and direct drive fans with aluminum blades. Fans shall be statically balanced. Motors shall be permanently lubricated with integral thermal overload protection in a weather tight casing. Provide tool-less factory installed corrosion resistant louvered hail/vandalism guards to protect condenser coils from hail or physical damage. Wire mesh coil guards shall not be acceptable.

H. Compressors (Variable Capacity) - Shall be scroll compressor with direct drive operating at 3600 rpm. Integral centrifugal oil pump. Provide suction gas cooled motor with winding temperature limits and compressor overloads. Units shall have cooling capabilities down to 0 degree F as standard. Provide ultra-high efficiency unit with eFlex variable speed compressor technology. Variable speed compressor shall be capable of speed modulation from 15Hz to a maximum of 60Hz. The unit shall be capable of operating at or below 25% of full load cooling capacity. The compressor motor shall be a permanent magnet type. Each variable speed compressor shall be matched with a specially designed refrigerant cooled, variable frequency drive which modulates the speed of the compressor motor and provides several compressor protection functions.

I. Controls (Variable Capacity): Provide all necessary factory-wired controls to operate a rooftop unit based on maintaining two (2) temperature setpoints: discharge air and zone. During one (1) zone VAV cooling, the unit will maintain zone cooling setpoint by modulating the supply fan speed more or less to meet zone load demand; and the unit will maintain discharge temperature to the discharge cooling setpoint by modulating and staging DX cooling.

J. Zone Sensor: Provide Trane zone sensor, or approved equal, single zone VAV eFlex type control for full unit capabilities.

K. Air Filters - Filters shall mount integrally within unit and be accessible through hinged access panels. Filters shall be 2” MERV 8 pleated type.

L. Shutdown Contact: Provide dry type contact for signal from ozone/oxygen detection alarm system.

M. Electrical:
   1. Factory-made penetrations shall be provided for connection of all electrical wiring. These wiring provisions shall be through the base. Field penetrations of the unit base pan shall not be acceptable.
   2. Fan motors and compressors shall be provided with series rated circuit breakers that will provide the unit rated level of protection. The unit shall be marked with approved cULus markings and will adhere to cULus regulations.

3. A complete wiring diagram shall be permanently attached to the inside of the panel door.

2.3 EQUIPMENT NAMEPLATE

A. Provide each piece of equipment with a factory-applied stainless steel nameplate permanently attached to the exterior of the equipment, in an accessible location, external to any insulated surface and observable while the equipment is in operation. As a minimum, include the following applicable information on the nameplate:
   1. Manufacturer's name.
   2. Equipment Model Number
   3. Equipment tag number.
   4. Purchasers order number.
   5. Serial Number
   6. Manufacturer's size and type
   7. Air Flow Rate – CFM.
   8. Airside Design Pressure – in. W.G.
   9. Fan Horsepower and RPM.
   10. Cooling Capacity – Total and Sensible Cooling, MBH.
   11. Heating Capacity – MBH or KW.
   12. For gas-fired equipment, Type of Fuel Approved for use.
   13. Refrigerant Type.
   14. Volts/Phase/Hertz
   15. List of each individual component's electrical data: volts, amps or watts, phase
   16. Date of manufacture.
   17. Approving Agency Seals.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Equipment shall be installed in accordance with manufacturer's recommendation. Provide piping and ductwork connections in accordance with the requirements of the other related Sections.

B. Install units level and plumb, maintaining manufacturer's recommended clearances.

C. Where applicable, install units level on structural platform. Coordinate wall penetrations with wall construction. Secure units to structural support with anchor bolts.

D. The Contractor shall not install any equipment or materials until the Owner has approved all submittals. If any equipment or materials are installed prior to approval of the submittals, it shall be at the Contractor's risk.

E. When units are shipped disassembled, field connect all sections together as shown on the Drawings to form single air handling unit. Seal all joints with gaskets and/or sealants.

F. Use flexible duct connectors when attaching ductwork to air-handling units. Refer to Section 23 31 13 – HVAC Metal Ductwork and Accessories for type.

G. Ground equipment. Refer to Division 26 – Electrical for requirements.

H. Do not operate equipment without filters. Do not run equipment with dirty filter pressure drop more than twice clean filter pressure drop. A total of three (3) complete sets of filters shall be provided. The first set is to be installed for start-up, test and balancing. The second set shall be installed after final cleanup and acceptance by the Owner. The third set shall be turned over to the Owner as a spare.

I. The Contractor shall start up each piece of equipment and system and shall make all adjustments so that the system is placed in proper operating condition.

3.2 FIELD QUALITY CONTROL

A. For equipment over 5-ton cooling capacity, engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field quality-control tests and inspections and prepare test reports:
   1. After installing air-handling units, and where applicable the associated condensing units, and after electrical circuitry has been energized, test units for compliance with requirements. Start units to confirm proper motor rotation and unit operation.
   2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove malfunctioning units, replace with new units, and retest as specified above.

3.3 STARTUP SERVICE

A. For equipment over 5-ton cooling capacity, engage a factory-authorized service representative to perform startup service. Complete installation and startup checks according to manufacturer's written instructions and do the following:
   1. Inspect for visible damage to unit casing.
   2. Inspect for visible damage to coils.
   3. Inspect for visible damage to fans.
   4. Inspect internal insulation.
   5. Verify that labels are clearly visible.
   6. Verify that clearances have been provided for servicing.
   7. Verify that controls are connected and operable.
   8. Verify that filters are installed.
   9. Clean coils and inspect for construction debris.
   10. Adjust vibration isolators.
   11. Lubricate bearings on fan.
   12. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
   13. Adjust fan belts to proper alignment and tension.
   14. Start unit according to manufacturer's written instructions.
      a. Complete startup sheets and attach copy with Contractor's startup report.
      b. Inspect and record performance of interlocks and protective devices; verify sequences.
      c. Operate unit for an initial period as recommended or required by manufacturer.
      d. Calibrate thermostat.
      e. Inspect outside-air dampers and return-air damper settings.
      f. Inspect controls for correct sequencing of heating and emergency shutdown.
      g. Measure and record the supply, outside and return airflows.
   15. Verify operation of control panel, including pilot-light operation and failure modes. Inspect all alarms and safety devices.
   16. After startup and performance testing, change filters, vacuum coils, lubricate bearings, adjust belt tension, and inspect operation of power vents.

3.4 EQUIPMENT IDENTIFICATION

A. In addition to the manufacturer provided stainless steel nameplate data, provide each equipment unit with an equipment tag label in accordance with Section 15501 – HVAC Identification. Label shall be located in a visible location.

END OF SECTION

SECTION 40 62 63

OPERATOR INTERFACE TERMINAL

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This Section of the Specifications describes the requirements for Operator Interface Terminals (OITs) to be furnished under other Sections of the Specifications as listed in the Related Work paragraph of this Section.

B. All equipment described herein shall be submitted and furnished as an integral part of equipment specified elsewhere in these Specifications.

1.2 RELATED WORK

A. No references are made to any other section which may contain work related to any other section. The Contract Documents shall be taken as a whole with every section related to every other section as required to meet the requirements specified. The organization of the Contract Documents into specification divisions and sections is for organization of the documents themselves and does not relate to the division of suppliers or labor which the Contractor may choose to employ in the execution of the Contract. Where references are made to other Sections and other Divisions of the Specifications, the Contractor shall provide such information or additional work as may be required in those references and include such information or work as may be specified.

1.3 SUBMITTALS

A. Submittals for equipment specified herein shall be made as a part of equipment furnished under the applicable related work sections. Individual submittals for devices specified herein will not be accepted and will be returned un-reviewed.

B. Submit catalog data for all items supplied from this specification within the control panel submittal specified else ware as applicable. Submittal shall include catalog data, functions, ratings, inputs, outputs, displays, etc., enough to confirm that the equipment provides every specified requirement. Any options or exceptions shall be clearly indicated.

1.4 REFERENCE CODES AND STANDARDS

A. Instrumentation equipment, materials and installation shall comply with the National Electrical Code (NEC and with the latest edition of the following codes and standards:

1. National Electrical Safety Code (NESC)
2. Occupational Safety and Health Administration (OSHA)
3. NEMA ICS 1-101 Diagrams, Designations and Symbols
4. ANSI/ISA-5.06.01-2007 - Functional Requirements Documentation for Control Software Applications.
5. ISA-TR20.00.01-2001 - Specification Forms for Process Measurement and Control Instruments Part 1: General Considerations Updated with 27 New Specification Forms in 2004-2005.
6. ISA-5.4-1991 Instrument Loop Diagrams.
7. ISA-5.5-1985 Graphic Symbols for Process Displays.

8. ISA-5.1-1984 (R1992) Instrumentation Symbols and Identification.
9. ISA-5.3-1983 Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic, and Computer Systems.
10. ISA-20-1981 Specification Forms for Process Measurement and Control Instruments, Primary Elements, and Control Valves.
11. ISA-5.2-1976 (R1992) Binary Logic Diagrams for Process Operations.
12. NEMA ICS 6 Enclosures for Industrial Controls and Systems
13. National Fire Protection Association (NFPA)
14. National Electrical Manufacturers Association (NEMA)
15. American National Standards Institute (ANSI)
16. Insulated Cable Engineers Association (ICEA)
17. The International Society of Automation (ISA)
18. Underwriters Laboratories (UL)
19. UL 508, the Standard of Safety for Industrial Control Equipment
20. UL 508A, the Standard of Safety for Industrial Control Panels
21. UL 50, the Standard of Safety for Enclosures for Electrical Equipment.
22. NFPA 79, Electrical Standard for Industrial Machinery
23. Factory Mutual (FM)
24. NFPA 70 National Electrical Code (NEC)
25. NFPA 70E Standard for Electrical Safety in the Workplace
26. ANSI C37.90.2 Standard Withstand Capability of Relay Systems to Radiated Electromagnetic Interference From Transceivers.
27. NEMA ICS 4 Terminal Blocks for Industrial Use.
28. NEMA LS1 Low Voltage Surge Protection Devices.
29. UL 1283 Standard for Safety-Electromagnetic Interference Filters.
30. UL 1449 Third Edition Surge Protective Devices
31. City of San Antonio, TX Electrical Code
32. All equipment and installations shall conform to applicable Federal, State, and local codes.

B. All equipment shall comply with the requirements of the National Electric Code and Underwriters Laboratories (UL) where applicable.

C. Each specified device shall also conform to the standards and codes listed in the individual device paragraphs.

1.5 QUALITY ASSURANCE

A. The manufacturer of this equipment shall have produced similar equipment for a minimum period of five years. When requested by the Owner/Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

B. Equipment submitted shall fit within the space or location shown on the Drawings. Equipment which does not fit within the space or location is not acceptable.

C. For the equipment specified herein, the manufacturer shall be ISO 9001 2000 certified.

1.6 WARRANTY

A. The Manufacturer shall warrant the equipment to be free from defects in material and workmanship as per the requirements in the General Conditions from date of acceptance of the equipment containing the items specified in this Section. Within such period of warranty, the Manufacturer shall promptly furnish all material and labor necessary to return the equipment to new operating condition. Any warranty work requiring shipping or transporting of the equipment shall be performed by the Contractor at no expense to the Owner.

PART 2 - PRODUCTS

2.1 OPERATOR INTERFACE TERMINAL

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. Modicon
    a. Harmony GTU Series

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. Environmental

1. Operating Temperature 32 – 113 Degrees F
2. Relative Humidity 10% - 90% Non-condensing
3. Shock (Operating) 15G for 11ms.
4. NEMA 4

D. Physical

1. Size: 12”
2. ColorTFT LCD Touch screen
3. Cooling fans as required
4. Embedded Operating System
5. Two serial and USB ports
6. Minimum 64mb of battery backed memory
7. Programmable keys as required.
8. Power Supply 120VAC

E. Protocol Interfaces

1. Modbus TCP

F. Programming Capability

1. Provide Manufacturer’s software package for programming the OIT.

2. Alarm and event management.
3. Bar graphs.
4. Multi colored background and objects.
5. Multi-level password security.
6. Communicate with a minimum of 4 PLCs simultaneously.

G. Spare Assemblies

1. Provide 1 spare OIT of each size provided.

2.2 SPARE PARTS

A. Provide the following spare parts for each control panel in the quantities specified:

1. One box of replacement fuses, all types and sizes used.
2. One replacement interface cable of each type used.

B. Spare parts shall be boxed or packaged for long term storage. Identify each item with manufacturer's name, description and part number on the exterior of the package.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All equipment specified herein shall be factory installed, field adjusted, tested and cleaned as an integral part of equipment specified elsewhere in these Specifications.

END OF SECTION

SECTION 40 75 00

ANALYTICAL INSTRUMENTS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish, install and test all analytical measurement, analytical control devices and appurtenances, as shown on the Drawings, specified in the Related Work Sections and Divisions, and as specified herein.

B. Analytical equipment, specified in other Divisions, shall be manufactured in accordance with this Section, and submitted as a part of the equipment specified in other Divisions.

1.2 RELATED WORK

A. No references are made to any other section which may contain work related to any other section. The Contract Documents shall be taken as a whole with every section related to every other section as required to meet the requirements specified. The organization of the Contract Documents into specification divisions and sections is for organization of the documents themselves and does not relate to the division of suppliers or labor which the Contractor may choose to employ in the execution of the Contract. Where references are made to other Sections and other Divisions of the Specifications, the Contractor shall provide such information or additional work as may be required in those references and include such information or work as may be specified.

1.3 REFERENCE CODES AND STANDARDS

A. The equipment in this specification shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted):

1. ISO 2975/VII liquids and BS 5857-2.4 for gases. Transit Time Meters
2. American Society of Mechanical Engineers (ASME). 1971. Fluid meters: Their theory and application.
3. International Organization of Standards (ISO 5167-1). 1991. Measurement of fluid flow by means of pressure differential devices Venturi Tube w/ liquid
4. ASME PTC 19.2 Pressure Measurement
5. ANSI B88.1 Pressure Transducers Calibration
6. ISA S37.6 Strain Gage Transducers Potentiometer
7. Calibration AVS 6.2, 6.4, 6.5 Hazardous Areas
8. IEC 79-10 Intrinsically Safe Circuits
9. ANSI 913 Electrical Instruments in Hazardous Atmospheres
10. NFPA 496 Standard for Purged and Pressurized Enclosures for Electrical Equipment.
11. FM Class 3615 – Explosion Proof Electrical Equipment General.
12. FM Class 3611 Class I Division 2 Hazardous Locations.
13. FM Class 3610 Class I, II, III Division 2 Intrinsically Safe Apparatus & Associated Apparatus.
14. FM Class 6310 Combustible Gas Detectors.
15. FM Class 3810 Measuring and Process Control Equipment.
16. ANSI/NEMA 250 – Enclosures for Electrical Equipment.

17. UL 1950 Safety of Information Technology Equipment.

B. All meters, relays and associated equipment shall comply with the requirements of the National Electric Code and Underwriters Laboratories (UL) where applicable.

C. Each specified device shall also conform to the standards and codes listed in the individual device paragraphs.

1.4 QUALITY ASSURANCE

A. The manufacturer of this equipment shall have produced similar instrumentation equipment for a minimum period of five (5) years. When requested by the Owner/Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

B. Equipment submitted shall fit within the space or location shown on the Drawings. Equipment which does not fit within the space or location is not acceptable.

C. For the equipment specified herein, the manufacturer shall be ISO 9001 2000 certified.

1.5 WARRANTY

A. The Manufacturer shall warrant the equipment to be free from defects in material and workmanship for two (2) years from date of acceptance of the equipment containing the items specified in this Section. Within such period of warranty, the Manufacturer shall promptly furnish all material and labor necessary to return the equipment to new operating condition. Any warranty work requiring shipping or transporting of the equipment shall be performed by the Contractor at no expense to the Owner.

PART 2 - PRODUCTS

2.1 TOTAL ORGANIC CARBON ANALYZER

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Hach Biotector

B. The listing of specific Manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features, and functions. The Manufacturers listed above are not relieved from meeting these Specifications in their entirety.

C. General:
   1. Furnish the instrument as follows :
      a. Microprocessor-based, providing continuous measurement of the Total Organic Carbon (TOC) concentration in water;
      b. Capable of testing external samples and standards without removing the analyzer from the continuous sample stream;
      c. Enclosure rating of IP45 or better;
      d. Manufactured of materials as recommended by the Manufacturer to be compatible with both the environmental conditions and the process fluid; and
      e. Includes all required Federal and State certifications when used for State or Federal water quality compliance monitoring. Include written documentation demonstrating all said certifications in submittal materials for each analyzer provided under this Section.

D. Function/Performance:
   1. Furnish the instrument as follows:
      a. Remote analyzer controller
      b. Power requirement of 100 to 240 VAC at 50 or 60 Hz;

c. Accuracy of ±2 % or ±0.005 mg/L•C (whichever is greater) or better;
d. Precision of <1 % RSD;
e. Calibration that is typically stable for 12 months or greater;
f. Sample analysis time of two minutes or less;
g. Sample flow rate range of 50 mL/min or less;
h. Sample pressure capability up to 100 psig or greater;
i. Sample temperature range of +5 °C to +95 °C or better;
j. Operating temperature range of +4 °C to +40 °C or better;
k. Operating relative humidity of 0 % to 95 %, non-condensing;
l. Maximum operating altitude of 9,800 FTMSL or greater;
m. Minimum of four user-programmable 4-20 mA DC analog outputs;
n. Minimum of three user-programmable alarm outputs; and
o. CE and ETL safety certifications.

E. Required Options and Accessories:
1. Include a weather protection shield for all controllers mounted in outdoor locations
2. Include all sample conditioning kit/equipment and installation accessories as recommended by instrument manufacturer

2.2 DISSOLVED OZONE ANALYZER

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
1. Hach

B. The listing of specific Manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features, and functions. The Manufacturers listed above are not relieved from meeting these Specifications in their entirety.

C. General:
1. Furnish the instrument as follows:
a. Microprocessor-controlled process analyzer designed to employ the amperometric (reagentless) method to continuously monitor the ozone concentration in water;
b. Utilizes a two-electrode amperometric sensor with a pH-buffered potassium chloride reference electrolyte and an ozone-selective membrane separating it from the process fluid;
c. IP66/NEMA 4X enclosure rating;
d. Includes materials of construction as recommended by the Manufacturer to be compatible with the environmental conditions of the installation location and with the process fluid;
e. Supplied with a compatible separately-mounted controller
f. Includes all required Federal and State certifications when used for State or Federal water quality compliance monitoring. Include written documentation demonstrating all said certifications in submittal documents for each analyzer provided.
2. Furnish sufficient lengths of the manufacturer's specialty cables for installation of power and/or signal conductors as provided with each instrument.
3. Furnish the minimum length of cable required between to connect the analyzer to the controller as indicated on the Drawings and:
a. Field verify the length of each required cable is sufficient to connect the analyzer to the controller without excessive cable length as far as possible.
b. If required cabling lengths are field verified to be longer than indicated on the Drawings, furnish the required length(s) of cabling at no additional cost to the Owner.

c. All cabling between the analyzer and the controller shall be supplied by the instrument manufacturer. Splicing of the cabling between the analyzer and its associated controller shall not be permitted.

D. Function/Performance:

1. Furnish the instrument with the following configuration and characteristics:
   a. Accuracy of ±3% or 0.01 mg/L• O3 (whichever is greater) or better;
   b. Minimum detection limit of 0.005 mg/L• O3 or better;
   c. Response time of ~90 seconds for a 90% change;
   d. Receives power from its associated controller;
   e. Operating process fluid temperature range of +2 °C to +45 °C or better;
   f. Operating temperature range of 0 °C to +45 °C or better;
   g. Operating humidity range of 0 to 90% non-condensing or better;
   h. Operating pH range of pH 4.0 to pH 8.0 or better;
   i. Minimum sample flow rate of 14 L/hour or less;
   j. Sample pressure range of 0.1 to 2.0 bar or better;
   k. Includes an amperometric measuring cell with a gold cathode and a silver anode, a pH buffered potassium chloride reference electrolyte, and a membrane selective to ozone installed in a manufacturer-supplied flow cell; and
   l. Includes automatic temperature compensation utilizing an integral temperature sensor.

E. Required Options / Accessories:

1. Include a weather protection shield for all controllers mounted in outdoor locations
2. Include manufacturer-provided acidification units for all analyzers with sample fluids having a pH greater than pH 8.0.
3. Furnish manufacturer-recommended spare supplies of the following:
   a. Membranes
   b. Bottles of electrolyte
   c. Electrodes

2.3 ANALYZER CONTROLLER

5

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. Hach
   a. Model sc4500

B. The listing of specific Manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features, and functions. The Manufacturers listed above are not relieved from meeting these Specifications in their entirety.

C. General:

1. Furnish Analyzer Controller(s) as follows:

   a. Microprocessor-based;
   b. Enclosure rating of IP66 and NEMA 4X or better;
   c. Manufactured of materials as recommended by the manufacturer to be compatible with the environmental conditions at the installation location(s);
   d. Capability of simultaneously connecting to at least two compatible analyzers;
   e. Includes a local LCD-based user interface for programming/configuration;
   f. Includes field-configurable parameter configurations;
   g. Includes the capability to actively monitor the health of all components internal to the Controller;
   h. Includes the capability to display diagnostics as to the overall health of both the Controller and all connected compatible analyzers;

i. Includes the capability to show the time remaining to the next required maintenance for all connected compatible analyzers;
j. Includes the capability for connection to a Cellular Network (4G or better), Wi-Fi Network, or Local Area Network
k. Supports Profibus DP, Modbus TCP/IP, Profinet IO, and Ethernet/IP communications protocols; and
l. Designed for use in both indoor and outdoor locations.

D. Function/Performance:
1. Furnish the controller(s) with the following configuration and characteristics:
a. Includes a TFT color display with a capacitive touchpad of at least 3.5 inch diagonal size;
b. Ambient operating temperature range of -20 °C to +45 °C or better;
c. Operating relative humidity of 0 to 95 %, non-condensing;
d. Maximum operating altitude of 6,500 FTMSL or greater;
e. CE approved for EMC with all compatible analyzers;
f. Listed for use in general locations to UL and CSA safety standards by ETL with all compatible analyzers;
g. UL/CAS 61010-1 safety approved;
h. Provides menu-driven operation;
i. Equipped with a real-time clock;
j. Includes a USB reader for both data downloads and controller software uploads;
k. Capable of internal storage of at least 20,000 data points for USB downloads for each connected analyzer;
l. Includes a minimum of two user-programmable output relay contacts rated at 100 to 240 VAC, 5 A resistive / 1 A pilot duty and 42 VDC at 125 W resistive / 28 W pilot duty;
m. Includes a minimum of five user-selectable 0-20 mA DC or 4-20 mA DC user-programmable analog outputs, each with a maximum of 500 ohms impedance or better; and
n. Retains all user settings for a minimum of 10 years in internal flash memory.

E. Required Options/Accessories:
1. Include a weather protection shield for all controllers mounted in outdoor locations
2. Furnish a quantity of one or 10% of the total quantity of spare controllers furnished on this project, whichever is greater.

PART 3 - EXECUTION

3.1 INSTALLER'S QUALIFICATIONS

A. Installer shall be specialized in installing this type of equipment with minimum 5 years documented experience

3.2 EXAMINATION

A. Examine installation area to assure there is enough clearance to install the equipment.

B. Verify that the equipment is ready to install

C. Verify field measurements are as instructed by the manufacturer.

3.3 INSTALLATION

A. The Contractor shall install all equipment per the manufacturer's recommendations and Contract Drawings.

B. All process connections shall be 316 stainless steel tubing, 3/8” minimum, unless otherwise shown on the Drawings. Fittings shall be of the compression type, 316 stainless steel.

C. All conduit entries into the instruments shall use hubs of watertight, threaded aluminum, insulated throat, stainless steel grounding screw, as manufactured by T&B H150GRA Series, or equal.

D. Install stainless steel instrument labels with instrument ID, secured with safety wire.

E. All non-loop powered instrument transmitters shall have an approved disconnecting means for power mounted within reach of the transmitter.

3.4 RACEWAY SEALING

A. Where raceways enter terminal boxes, junction boxes, or instrumentation equipment, all entrances shall be sealed with 3M 1000NS Watertight Sealant or approved equal.

3.5 FIELD QUALITY CONTROL

A. Inspect installed equipment for anchoring, alignment, grounding and physical damage.

B. Check tightness of all accessible electrical connections. Minimum acceptable values shall be specified in the manufacturer's instructions.

3.6 FIELD ADJUSTING

A. Adjust all equipment for proper range and field conditions, as described in the manufacturer's instructions.

B. Any field adjustments required for proper system operation shall be included in the Final O&M.

3.7 FIELD TESTING

A. Perform all electrical field tests recommended by the manufacturer.

B. Test each interlock system for proper functioning.

C. Test all control logic for proper operation.

3.8 CLEANING

A. Remove all rubbish and debris from inside and around the equipment. Remove dirt, dust, or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner, or clean, lint free rags. Do not use compressed air.

3.9 EQUIPMENT PROTECTION AND RESTORATION

A. Touch-up and restore damaged surfaces to factory finish, as approved by the manufacturer. If the damaged surface cannot be returned to factory specification, the surface shall be replaced.

3.10 MANUFACTURER’S CERTIFICATION

A. A qualified factory-trained and certified representative shall certify in writing that the equipment has been installed, adjusted, including all settings as defined in the Contract Documents.

B. The Contractor shall provide three (3) copies of the representative’s certification.

3.11 TRAINING

A. Provide the representatives, services for training of Owner’s personnel in operation and maintenance of the equipment furnished under this Section.

B. The training for each type of equipment shall be for a period of not less than one (1) eight-hour day.

C. The cost of training program to be conducted with Owner's personnel shall be included in the Contract Price. The training and instruction, as far as practicable, shall be directly related to the system being supplied.

D. Provide detailed O&M manuals to supplement the training course. The manuals shall include specific details of equipment supplied and operations specific to the project.

E. The training session shall be conducted by a manufacturer's qualified representative. Training program shall include instructions on the assembly, motor starters, protective devices, metering, and other major components.

F. The Owner reserves the right to videotape the training sessions for the Owner’s use.

END OF SECTION

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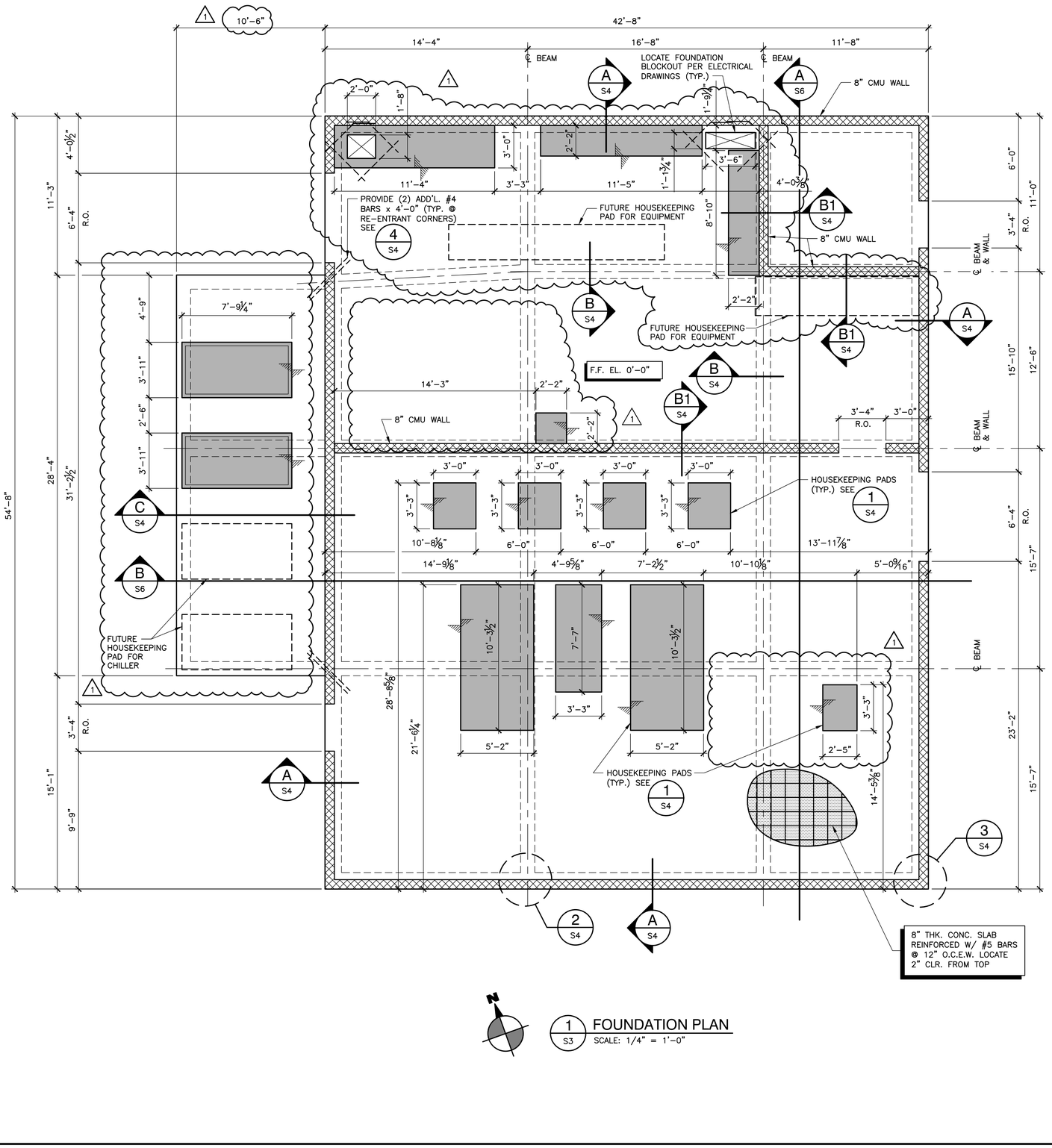

1 FOUNDATION PLAN
S3
SCALE: 1/4" = 1'-0"

LEGEND:

8" CMU WALL

RAISED HOUSEKEEPING PAD

NOTES:

1. FINISH FLOOR ELEV. OF 0'-0" IS FOR REFERENCE ONLY. SEE CIVIL DRAWINGS FOR ACTUAL FIN. FLR. ELEVATION.
2. CONTRACTOR SHALL CONSTRUCT THE FOUNDATION SO THAT THE FLOOR SHALL BE TRUE AND LEVEL TO A MAXIMUM TOLERANCE OF 1/8" IN 10 FEET.
3. OMIT CMU DOWELS AT ALL DOORWAYS.

4 3 2 1 0 4'
SCALE: 1/4" = 1'-0"

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REVISIONS

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CANYON REGIONAL WATER AUTHORITY
HAYS/CALDWELL WATER TREATMENT PLANT IMPROVEMENTS
PHASE 2

OZONE & ELECT. BLDG.
FOUNDATION PLAN

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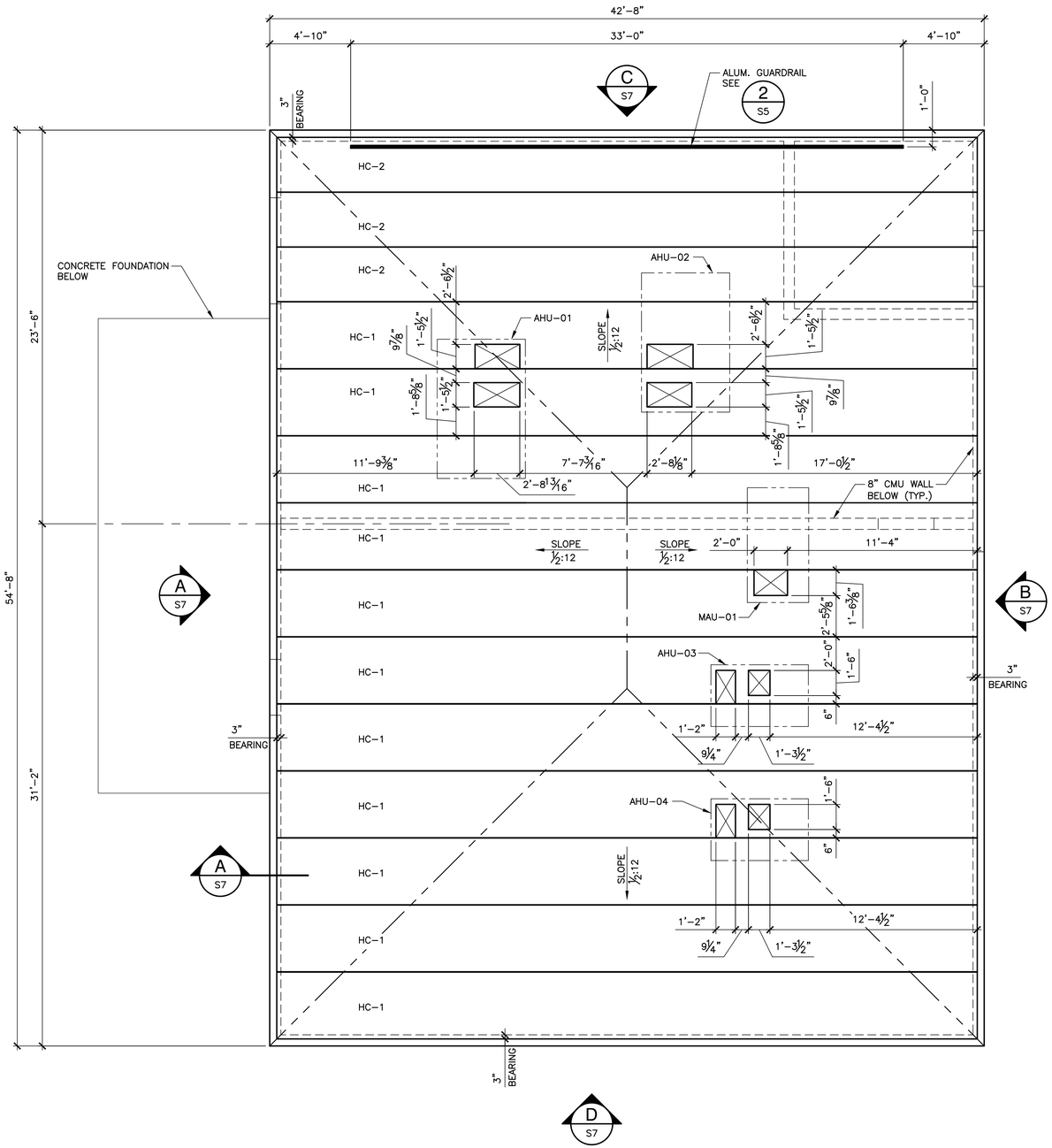
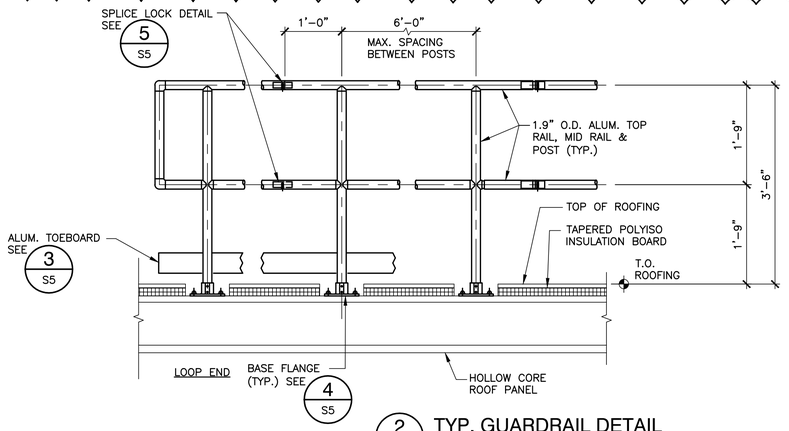


1 ROOF PANEL PLAN
S5
SCALE: 1/4" = 1'-0"



2 S5 TYP. GUARDRAIL DETAIL
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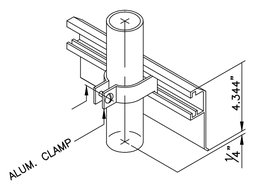

3 S5 TYP. TOE BOARD
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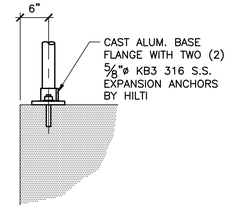

4 S5 TOP MOUNT CONNECTION DETAIL
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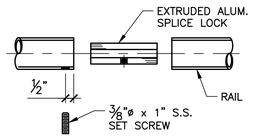

5 S5 SPLICE LOCK DETAIL
N.T.S.

PRESTRESSED HOLLOW CORE ROOF PANEL SCHEDULE					
MARK	LENGTH	WIDTH	DEPTH	TOPPING	CAMBER
HC-1	41'-10"	4'-0"	12"		
HC-2	41'-10"	3'-3¼"	12"		

HVAC EQUIPMENT SCHEDULE			
MARK	LENGTH	WIDTH	WEIGHT
AHU-01	5'-3"	8'-4"	1350 LBS
AHU-02	5'-3"	8'-4"	1350 LBS
AHU-03	5'-10"	3'-8"	950 LBS
AHU-04	5'-10"	3'-8"	950 LBS
MAU-01	3'-8"	6'-10"	1200 LBS

4 3 2 1 0 4'
SCALE: 1/4" = 1'-0"

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HAYS/CALDWELL WATER TREATMENT PLANT IMPROVEMENTS
PHASE 2

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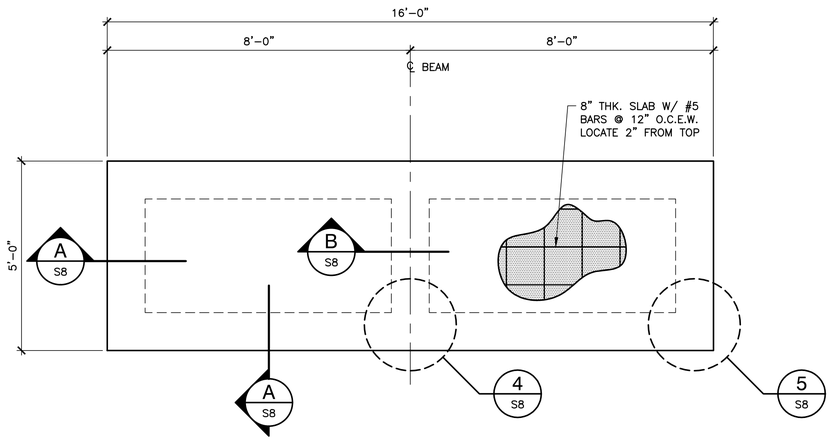
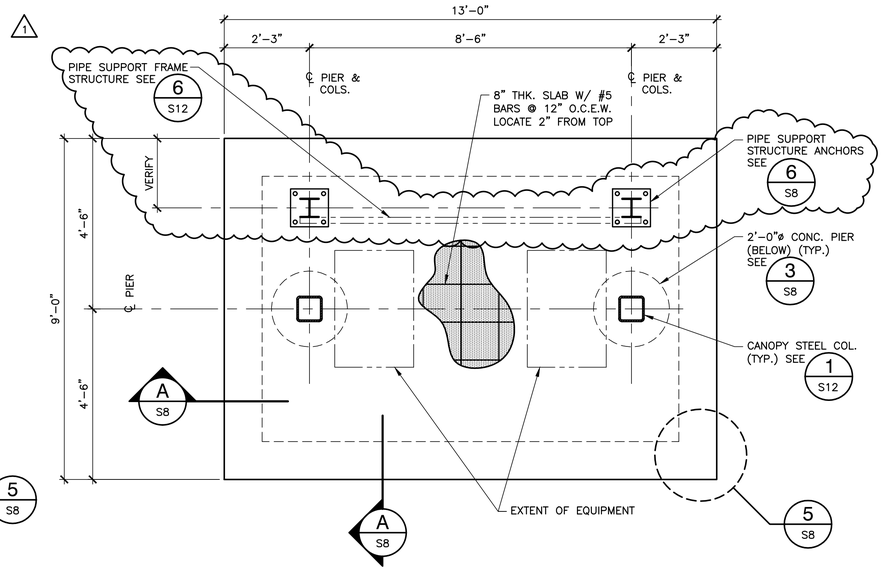
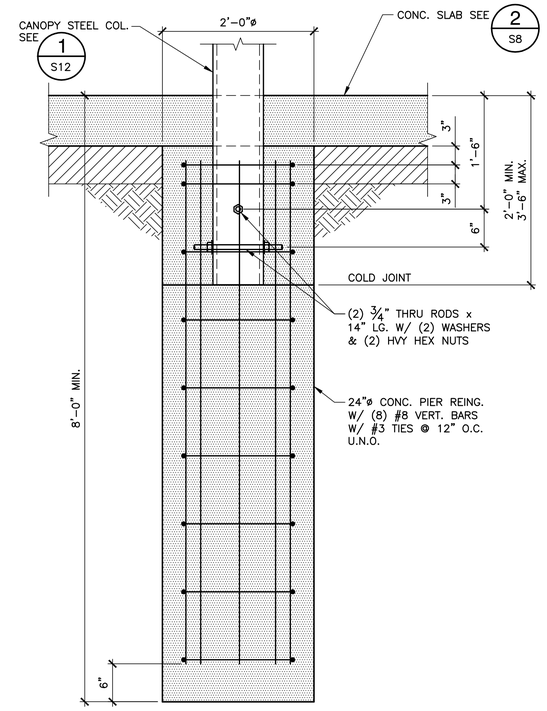


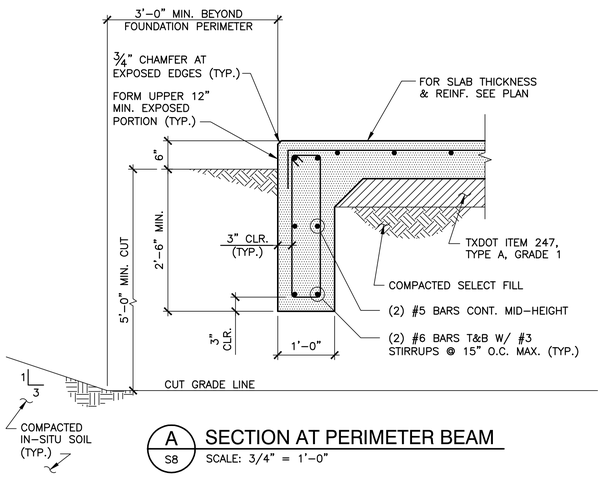




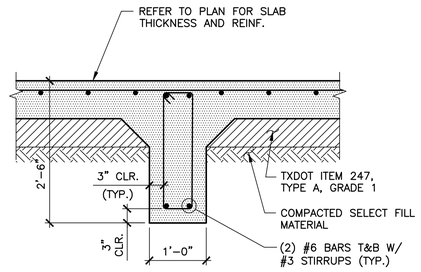
1 S8 CONTACT/OFF-GAS STRUCTURE FOUNDATION PLAN
SCALE: 1/2" = 1'-0"

2 S8 OZONE DESTRUCT FOUNDATION PLAN
SCALE: 1/2" = 1'-0"

3 S8 PIER DETAIL
SCALE: 1" = 1'-0"



A S8 SECTION AT PERIMETER BEAM
SCALE: 3/4" = 1'-0"



B S8 SECTION AT INTERIOR BEAM
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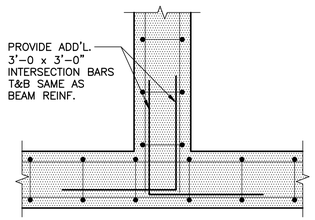
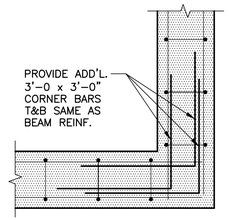


PLAN

4 S8 TYP. BEAM INTERSECTION DETAIL
N.T.S.



PLAN

5 S8 TYP. BEAM CORNER DETAIL
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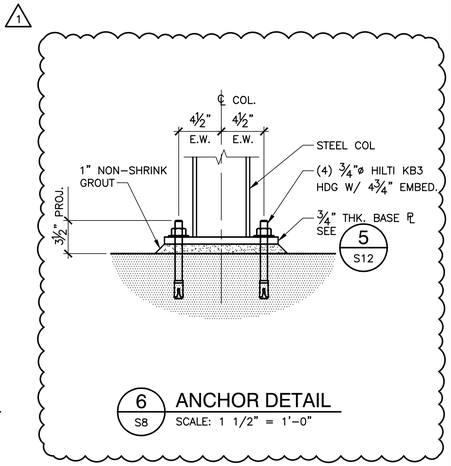

6 S8 ANCHOR DETAIL
SCALE: 1 1/2" = 1'-0"

SCALE: 1/2" = 1'-0"
SCALE: 3/4" = 1'-0"
SCALE: 1" = 1'-0"
SCALE: 1 1/2" = 1'-0"

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MISCELLANEOUS OZONE FOUNDATION PLANS, SECTIONS & DETAILS

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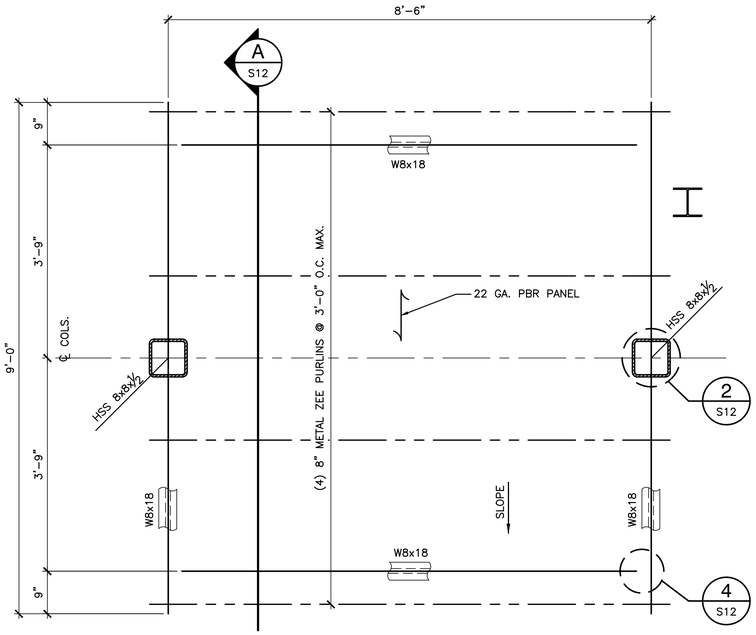
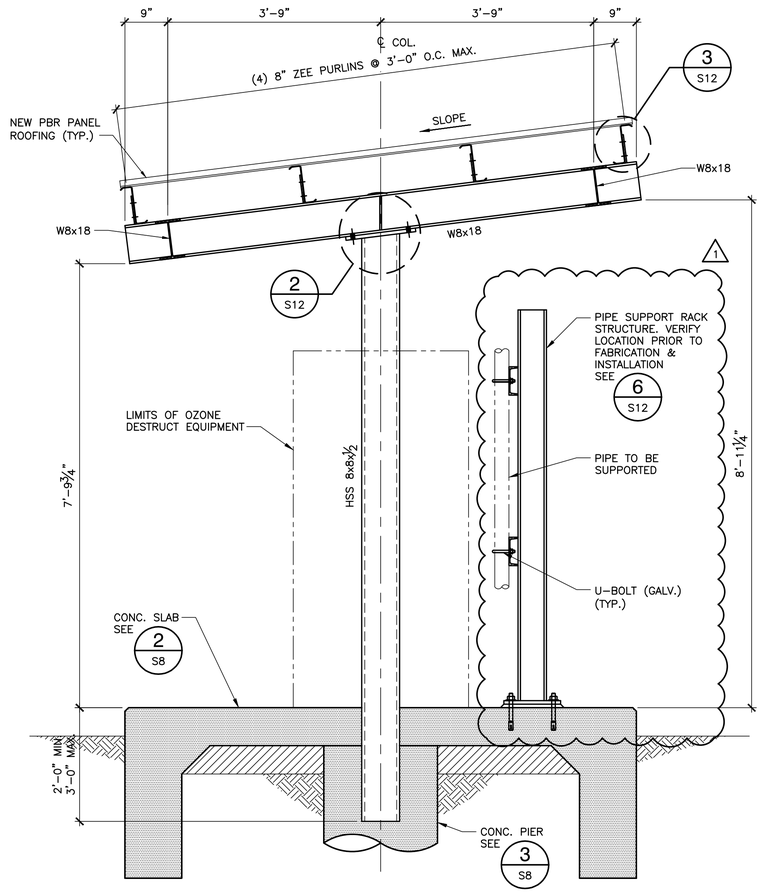
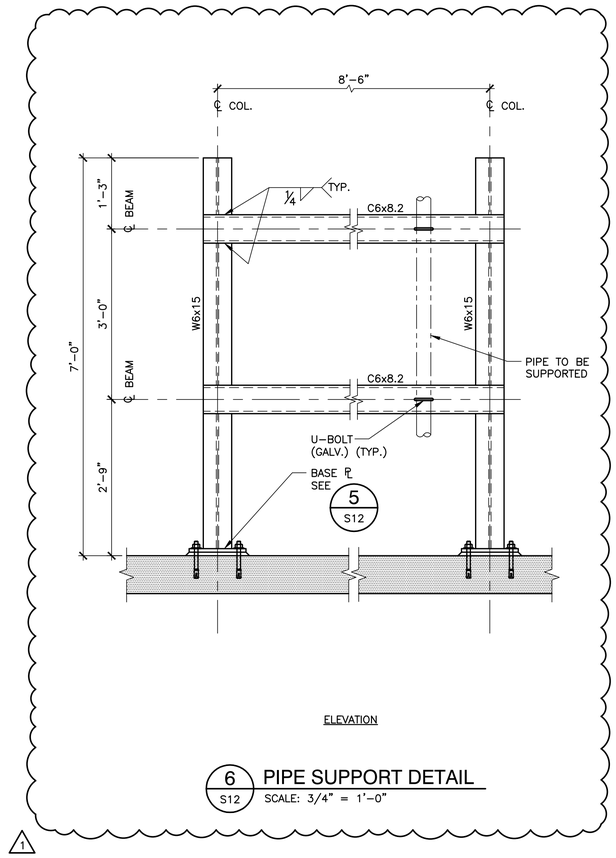


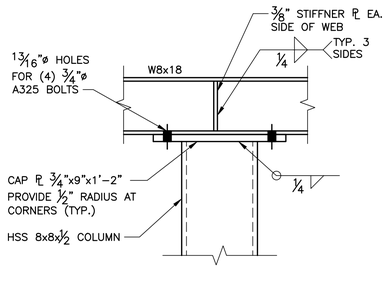
1 S12 CANOPY STEEL FRAMING PLAN
SCALE: 3/4" = 1'-0"



A S12 SECTION AT CANOPY
SCALE: 3/4" = 1'-0"



6 S12 PIPE SUPPORT DETAIL
SCALE: 3/4" = 1'-0"



2 S12 TYP. CAP PLATE DETAIL
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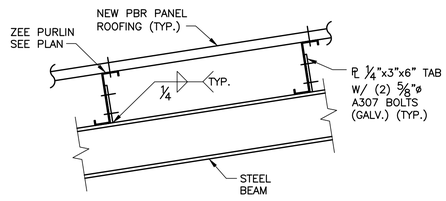

3 S12 TYP. PURLIN CONNECTION DETAIL
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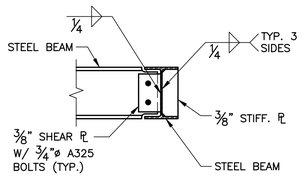

4 S12 BEAM TO BEAM CONNECTION
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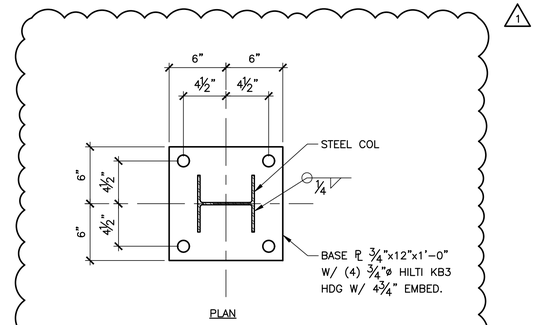

5 S12 BASE PLATE DETAIL
SCALE: 1 1/2" = 1'-0"

6" 0 1 2'
SCALE: 3/4" = 1'-0"

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OZONE DESTRUCT STEEL CANOPY PLAN, SECTION & DETAILS

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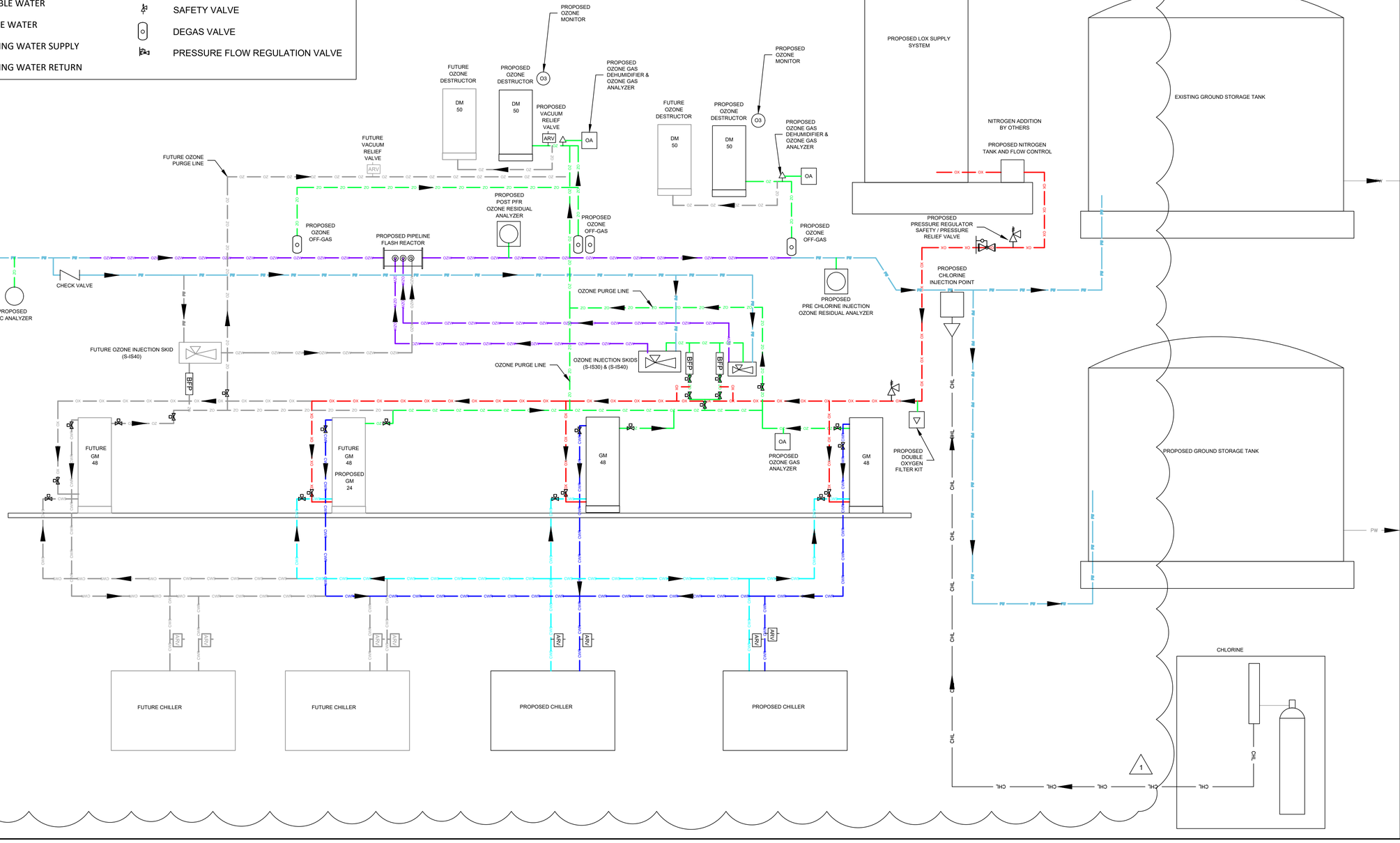
LEGEND

PW — EXISTING POTABLE WATER	INJECTOR
CHL — PROPOSED CHLORINE LINE	OZONE INJECTION SKID
OX — PROPOSED OXYGEN GAS	OZONE GENERATOR
OZ — PROPOSED OZONE GAS	TOC ANALYZER
PW — PROPOSED POTABLE WATER	OZONE RESIDUAL ANALYZER
OZW — PROPOSED OZONE WATER	DOUBLE OXYGEN FILTER KIT
CWS — PROPOSED COOLING WATER SUPPLY	BACKFLOW PROTECTOR
CWR — PROPOSED COOLING WATER RETURN	OZONE GAS ANALYZER
OX — FUTURE OXYGEN GAS	AIR RELEASE VALVE
OZ — FUTURE OZONE GAS	CONTROLLED VALVE
PW — FUTURE POTABLE WATER	SAFETY VALVE
OZW — FUTURE OZONE WATER	DEGAS VALVE
CWS — FUTURE COOLING WATER SUPPLY	PRESSURE FLOW REGULATION VALVE
CWR — FUTURE COOLING WATER RETURN	

NOTES:
CONTRACTOR TO SUBMIT FINAL PROCESS DIAGRAM FROM OZONE MANUFACTURER FOR REVIEW AND APPROVAL BY CRWA AND ENGINEER.



ISSUES / REVISIONS			
DESCRIPTION	NO	DATE	BY
NEW PIPE ROUTE AND NOTES	1	12/30/24	DAK

STATE OF TEXAS — DAVID A. KNEUPER — 98676 — LICENSED PROFESSIONAL ENGINEER

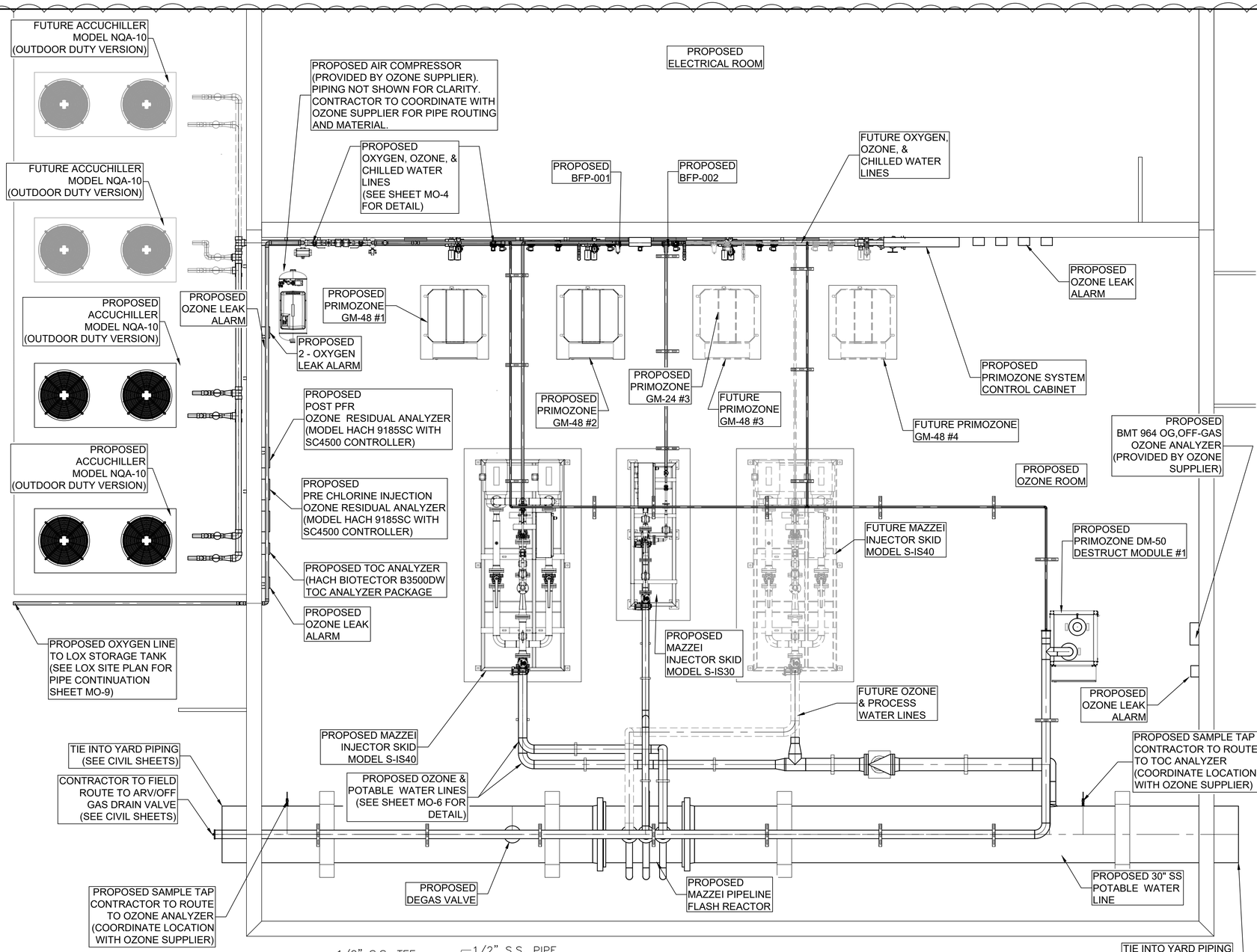
CANYON REGIONAL WATER AUTHORITY
HAYS/CALDWELL WATER TREATMENT PLANT IMPROVEMENTS
PHASE 2

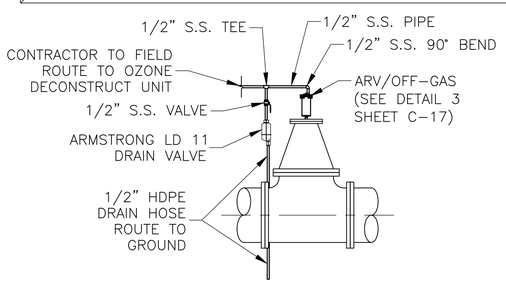
OZONE SYSTEM PROCESS DIAGRAM

UTILITY ENGINEERING GROUP PLLC
191 N. Union Ave NEW BRAUNFELS, TEXAS 78130 PH: (830) 214-0521
Texas Engineering Firm F-13712

DRAWING NO.: MO-1
10 of 141
DRAWN BY: TJC
CHECKED BY: DK
APPROVED BY: DK
JOB NO.: 170100

FILE: P:\Projects\A\6984 - CRWA\02 - Hays Caldwell Improvements Project\CAD\Sheets\PROCESS DIAGRAM.dwg TAB: MO-1 OZONE SYSTEM PROCESS DIAGRAM PLOTTED: 1/10/2025 8:59 AM BY: JONATHAN COMPTON





1 ARV/OFF-GAS DRAIN VALVE DETAIL
N.T.S.

Notes:

1. Ozone and Oxygen Leak Alarms provided by Ozone Equipment Supplier.
2. Contractor to locate ozone alarm indicators outside of ozone room doors.
3. Contractor to coordinate compressed air piping route to Ozone generators per Ozone supplier recommendations.
4. Contractor to verify all line sizes and materials with Ozone Equipment Supplier. Coordinate with Engineer for any changes prior to installation.

BILL OF MATERIALS

PIPE

ID	QTY	ND	SHORT DESCRIPTION	SERVICE
1	60'-2 1/4"	1/2"	316 SS PIPE	OZ3
2	4"	3/4"	COPPER PIPE	OX
3	7 3/16"	1"	316 SS PIPE	OZW
4	2'-11 9/16"	1"	COPPER PIPE	OX
5	6 3/4"	1"	SCH 80 PVC PIPE	CWS
6	56'-9"	1"	316 SS PIPE	OZ3
7	6 3/4"	1"	Sch 80 - PVC Pipe	CWR
8	25'-2 15/16"	1 1/4"	COPPER PIPE	OX
9	11'-0 1/4"	1 1/4"	316 SS PIPE	OZ3
10	8'-1 1/8"	1 1/2"	SCH 80 PVC PIPE	CWS
11	38'-9 1/4"	1 1/2"	COPPER PIPE	OX
12	5'-5 3/16"	1 1/2"	Sch 80 - PVC Pipe	CWR
13	42'-0 1/8"	2 1/2"	Sch 80 - PVC Pipe	CWR
14	54'-1 11/16"	2 1/2"	SCH 80 PVC PIPE	CWS
15	8'-11 1/8"	3"	316 SS PIPE	PW
16	14'-10 5/16"	3"	316 SS PIPE	OZW
17	5'-8 1/4"	4"	316 SS PIPE	AV
18	35'-10 1/16"	4"	316 SS PIPE	OZ3
19	13'-7 1/8"	4"	316 SS PIPE	PW
20	14'-10 3/4"	4"	316 SS PIPE	OZW
21	11'-11 11/16"	4"	316 SS PIPE	OZ3
22	10'-3 1/8"	6"	316 SS PIPE	PW
23	23'-11 7/8"	30"	316 SS PIPE	PW
24	16'-4 1/8"	30"	316 SS PIPE	OZW

FITTINGS

ID	QTY	ND	SHORT DESCRIPTION	SERVICE
25	1	1/2"	Tee	OZ3
26	13	1/2"	90 DEG BEND (316 SS)	OZ3
27	2	1"x1/2"	REDUCER	OZ3
28	11	1"	90 DEG BEND (316 SS)	OZ3
29	4	1"	90 DEG BEND (COPPER)	OX
30	9	1"	Tee	OZ3
31	3	1 1/4"	Tee	OZ3
32	9	1 1/4"	90 DEG BEND (COPPER)	OX
33	2	1 1/4"x1"	REDUCER (CONC)	OZ3
34	2	1 1/4"x1"	COUPLING, REDUCING	OX
35	5	1 1/4"x3/4"	TEE (RED)	OX
36	4	1 1/2"	90 DEG BEND	CWS
37	5	1 1/2"	90 DEG BEND (COPPER)	OX
38	4	1 1/2"	90 DEG BEND	CWR
39	2	2 1/2"x1 1/2"	REDUCER	CWR
40	2	2 1/2"	90 DEG BEND	CWR
41	2	2 1/2"	90 DEG BEND	CWS
42	2	2 1/2"x1 1/2"	REDUCER	CWS
43	7	2 1/2"	TEE	CWS
44	7	2 1/2"	TEE	CWR
45	2	3"	45 DEG BEND (316L SS)	PW
46	3	3"	90 DEG BEND (316L SS)	OZW
47	1	4"	Plug	OZ3
48	1	4"	CAP	PW
49	1	4"	90 DEG BEND (316L SS)	PW
50	2	4"	Tee	OZ3
51	4	4"	90 DEG BEND (316L SS)	OZW
52	1	4"	FLANGE BLIND	OZW
53	2	4"	90 DEG BEND (316 SS)	OZ3
54	1	4"x3"	Tee (red)	PW
55	2	6"	90 DEG BEND (316L SS)	PW
56	2	6"x4"	REDUCER (CONC)	PW
57	1	6"	Tee	PW

OLETS

ID	QTY	ND	SHORT DESCRIPTION	SERVICE
58	2	4"x1"	WELDOLET	OZ3
59	1	4"x1/2"	WELDOLET	OZ3
60	1	4"x1"	WELDOLET	OZW
61	1	30"x6"	WELDOLET	PW
62	1	30"x4"	WELDOLET	OZW

VALVES

ID	QTY	ND	SHORT DESCRIPTION	SERVICE
63	3	3/4"	BALL VALVE W/ AUTOMATIC ACTUATOR	OX
64	3	1"	BALL VALVE W/ AUTOMATIC ACTUATOR	CWS
65	12	1"	BALL VALVE W/ AUTOMATIC ACTUATOR	OZ3
66	3	1"	BALL VALVE W/ AUTOMATIC ACTUATOR	CWR
67	1	1"	Ball Valve	OZW
68	1	1 1/4"	PRESSURE VALVE	OX
69	1	1 1/4"	BALL VALVE W/ AUTOMATIC ACTUATOR	OZ3
70	2	1 1/2"	BALL VALVE	CWS
71	2	1 1/2"	BALL VALVE	CWR
72	1	2 1/2"	BACK PRESSURE CONTROL VAVLE	CWS
73	1	4"	BUTTERFLY VALVE (316L SS)	OZ3
74	1	4"	BUTTERFLY VALVE (316L SS)	AV
75	1	6"	Check Valve	PW

PIPE SUPPORTS

ID	QTY	SHORT DESCRIPTION	SERVICE
76	15	ADJUSTABLE PIPE SUPPORT	SUPPORT
77	55	WALL PIPE SUPPORT	WALL SUPPORT
78	12	WALL VALVE SUPPORT	WALL VALVE SUPPORT
79	1	ADJUSTABLE PIPE SUPPORT	SUPPORT

1

STATE OF TEXAS
DAVID A. KNEUPER
96676
LICENSED PROFESSIONAL ENGINEER

ISSUES / REVISIONS

DATE	NO	DESCRIPTION	BY
12/30/24	1	NEW PIPE ROUTE AND NOTES	DAK

CANYON REGIONAL WATER AUTHORITY
HAYS/CALDWELL WATER TREATMENT PLANT IMPROVEMENTS
PHASE 2

OZONE ROOM PLAN VIEW

UTILITY ENGINEERING GROUP PLLC
191 N. Union Ave NEW BRAUNFELS, TEXAS 78130 PH: (830) 214-0521
Texas Engineering Firm F-19712

DRAWING NO.: MO-2
10 of 141

DRAWN BY: TJC
CHECKED BY: DK
APPROVED BY: DK
JOB NO.: 170100

FUTURE ACCUCHILLER MODEL NQA-10 (OUTDOOR DUTY VERSION)

FUTURE ACCUCHILLER MODEL NQA-10 (OUTDOOR DUTY VERSION)

PROPOSED ACCUCHILLER MODEL NQA-10 (OUTDOOR DUTY VERSION)

PROPOSED ACCUCHILLER MODEL NQA-10 (OUTDOOR DUTY VERSION)

PROPOSED OXYGEN LINE TO LOX STORAGE TANK (SEE LOX SITE PLAN FOR PIPE CONTINUATION SHEET MO-9)

PROPOSED ELECTRICAL ROOM

PROPOSED OXYGEN, OZONE, & CHILLED WATER LINES (SEE SHEET MO-4 FOR DETAIL)

PROPOSED PRIMOZONE GM-24 #3

PROPOSED PRIMOZONE GM-48 #1

PROPOSED AIR COMPRESSOR (PROVIDED BY OZONE SUPPLIER)

PROPOSED PRIMOZONE GM-48 #2

FUTURE PRIMOZONE GM-48 #3

FUTURE PRIMOZONE GM-48 #4

PROPOSED OZONE ROOM

PROPOSED MAZZEI INJECTOR SKID MODEL S-IS30

PROPOSED MAZZEI INJECTOR SKID MODEL S-IS40

FUTURE MAZZEI INJECTOR SKID MODEL S-IS40

PROPOSED PRIMOZONE DM-50 DESTRUCT MODULE #1

PROPOSED BMT 964 OG,OFF-GAS OZONE ANALYZER (PROVIDED BY OZONE SUPPLIER)

TIE INTO YARD PIPING (SEE CIVIL SHEETS)

PROPOSED SAMPLE TAP CONTRACTOR TO ROUTE TO OZONE ANALYZER (COORDINATE LOCATION WITH OZONE SUPPLIER)

PROPOSED DEGAS VALVE

PROPOSED MAZZEI PIPELINE FLASH REACTOR

PROPOSED SAMPLE TAP CONTRACTOR TO ROUTE TO TOC ANALYZER (COORDINATE LOCATION WITH OZONE SUPPLIER)

TIE INTO YARD PIPING (SEE CIVIL SHEETS)

A O-2

B O-3

C O-4

1

STATE OF TEXAS
DAVID A. KNEUPER
96676
LICENSED PROFESSIONAL ENGINEER
12/30/24

ISSUES / REVISIONS

DATE	NO	DESCRIPTION	BY
12/30/24	1	NEW PIPE ROUTE AND NOTES	DAK

CANYON REGIONAL WATER AUTHORITY
HAYS/CALDWELL WATER TREATMENT PLANT IMPROVEMENTS
PHASE 2

OZONE ROOM DIMENSION AND CONTROL

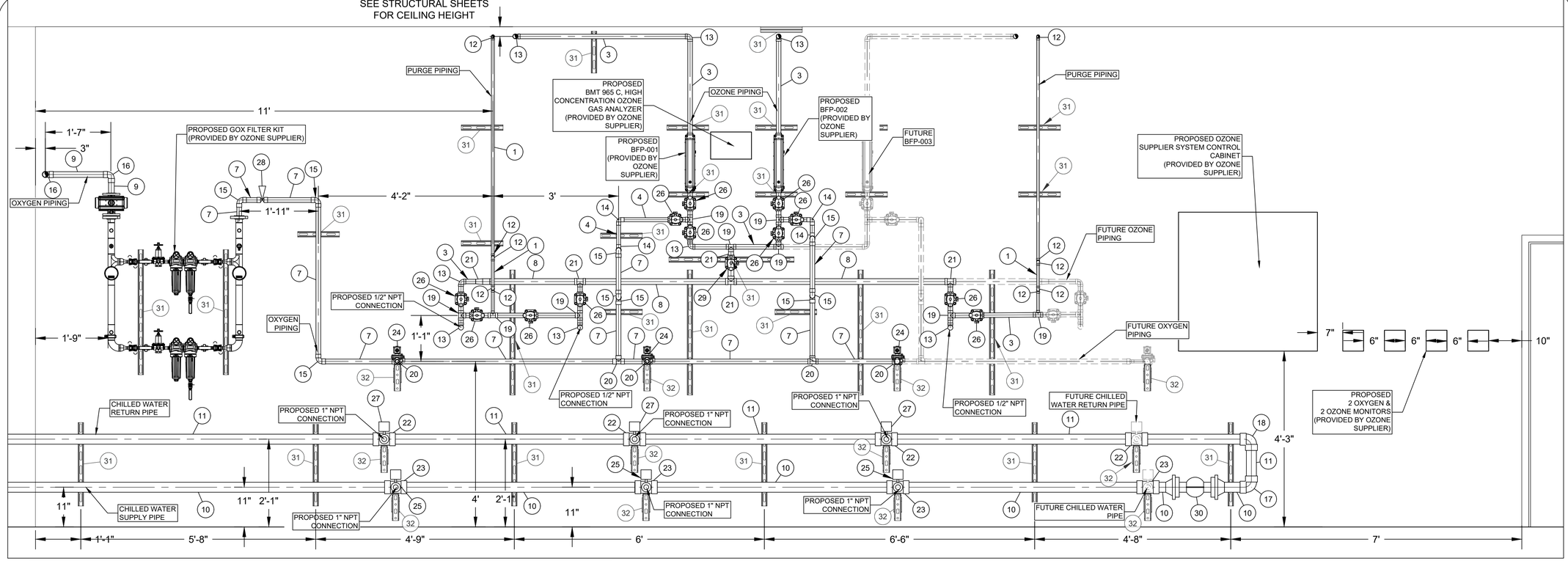
UTILITY ENGINEERING GROUP PLLC
191 N. Union Ave NEW BRAUNFELS, TEXAS 78130 PH: (830) 214-0521
Texas Engineering Firm F-23712

DRAWING NO.: MO-3

10 of 141

DRAWN BY: TJC
CHECKED BY: DK
APPROVED BY: DK
JOB NO.: 170100

FILE: P:\Projects\A\6084_CRWA\02 – Hays_Caldwell_Improvements_Project\CAD\Issued\HAYS_CALDWELL_PLANT\Ortho's\DWGs\PLAN_VIEW.dwg TAB: MO–3_OZONE_ROOM_DIMENSION_AND_CONTROL PLOTTED: 1/10/2025, 8:59 AM BY: JONATHAN_COMPTON



BILL OF MATERIALS				
PIPE				
ID	QTY	ND	SHORT DESCRIPTION	SERVICE
1	31'-3 1/8"	1/2"	316 SS PIPE	OZ3
2	4"	3/4"	COPPER PIPE	OX
3	38'-8 3/16"	1"	316 SS PIPE	OZ3
4	2'-11 9/16"	1"	COPPER PIPE	OX
5	6 3/4"	1"	Sch 80 - PVC Pipe	CWR
6	6 3/4"	1"	SCH 80 PVC PIPE	CWS
7	25'-2 15/16"	1 1/4"	COPPER PIPE	OX
8	11'-0 1/4"	1 1/4"	316 SS PIPE	OZ3
9	17'-4 15/16"	1 1/2"	COPPER PIPE	OX
10	40'-10 7/8"	2 1/2"	SCH 80 PVC PIPE	CWS
11	29'-8"	2 1/2"	Sch 80 - PVC Pipe	CWR
FITTINGS				
ID	QTY	ND	SHORT DESCRIPTION	SERVICE
12	10	1/2"	90 DEG BEND (316 SS)	OZ3
13	8	1"	90 DEG BEND (316 SS)	OZ3
14	4	1"	90 DEG BEND (COPPER)	OX
15	9	1 1/4"	90 DEG BEND (COPPER)	OX
16	2	1 1/2"	90 DEG BEND (COPPER)	OX
17	1	2 1/2"	90 DEG BEND	CWS
18	1	2 1/2"	90 DEG BEND	CWR
19	9	1"	TEE (316 SS)	OZ3
20	7	1 1/4"x3/4"	TEE (RED)	OX
21	5	1 1/4"	TEE (316 SS)	OZ3
22	4	2 1/2"x1"	TEE	CWR
23	4	2 1/2"x1"	TEE	CWS
VALVES				
ID	QTY	ND	SHORT DESCRIPTION	SERVICE
24	3	3/4"	BALL VALVE W/ AUTOMATIC ACTUATOR	OX
25	3	1"	BALL VALVE W/ AUTOMATIC ACTUATOR	CWS
26	12	1"	BALL VALVE W/ AUTOMATIC ACTUATOR	OZ3
27	3	1"	BALL VALVE W/ AUTOMATIC ACTUATOR	CWR
28	1	1 1/4"	PRESSURE VALVE	OX
29	1	1 1/4"	SLIDING GATE VALVE W/ AUTOMATIC ACTUATOR	OZ3
30	1	2 1/2"	BACK PRESSURE CONTROL VAVLE	CWS
PIPE SUPPORTS				
ID	QTY	SHORT DESCRIPTION		SERVICE
31	28	WALL PIPE SUPPORT		WALL SUPPORT
32	12	WALL VALVE SUPPORT		WALL VALVE SUPPORT

NOTES:

1. CONTRACTOR TO VERIFY EQUIPMENT PAD SIZING AND LOCATION WITH STRUCTURAL DRAWINGS.
2. CONTRACTOR TO VERIFY OZONE SUPPLIER PROVIDED EQUIPMENT AND MATERIALS PRIOR TO PIPING INSTALLATION.
3. FOR ALL OZONE PIPING, USE OZONE RATED GASKETS (PTFE-VIRGIN TEFLON)
4. CONTRACTOR TO PROVIDE PIPE SUPPORTS AS NEEDED FOR INSTALLATION. SOME PIPE SUPPORTS HAVE BEEN OMITTED FOR CLARITY.
5. OZONE SUPPLIER PROVIDED FLEXIBLE HOSING HAS BEEN OMITTED FOR CLARITY.
6. ALL STAINLESS STEEL PIPING TO BE WELDED
7. CONTRACTOR TO COORDINATE COMPRESSED AIR PIPING ROUTE TO OZONE GENERATORS DRYER PER OZONE SUPPLIER RECOMMENDATIONS.
8. CONTRACTOR TO COORDINATE ALL WALL AND ROOF PIPE PENETRATIONS WITH PROJECT STRUCTURAL ENGINEER.
9. CONTRACTOR TO ROUTE PIPING FROM BMT MESSTECHNIK OFF-GAS AND HIGH CONCENTRATION OZONE ANALYZERS AND DEHUMIDIFIER TO DESTRUCT UNIT AND OZONE LINE PER OZONE SUPPLIER RECOMMENDATIONS.
10. CONTRACTOR TO VERIFY ALL LINE SIZES AND MATERIALS WITH OZONE EQUIPMENT SUPPLIER. COORDINATE WITH ENGINEER FOR ANY CHANGES PRIOR TO INSTALLATION.

1

STATE OF TEXAS
DAVID A. KNEUPER
96676
LICENSED PROFESSIONAL ENGINEER
12/30/24

ISSUES / REVISIONS

DATE	NO	DESCRIPTION	BY
12/30/24	1	NEW PIPE ROUTE AND NOTES	DAK

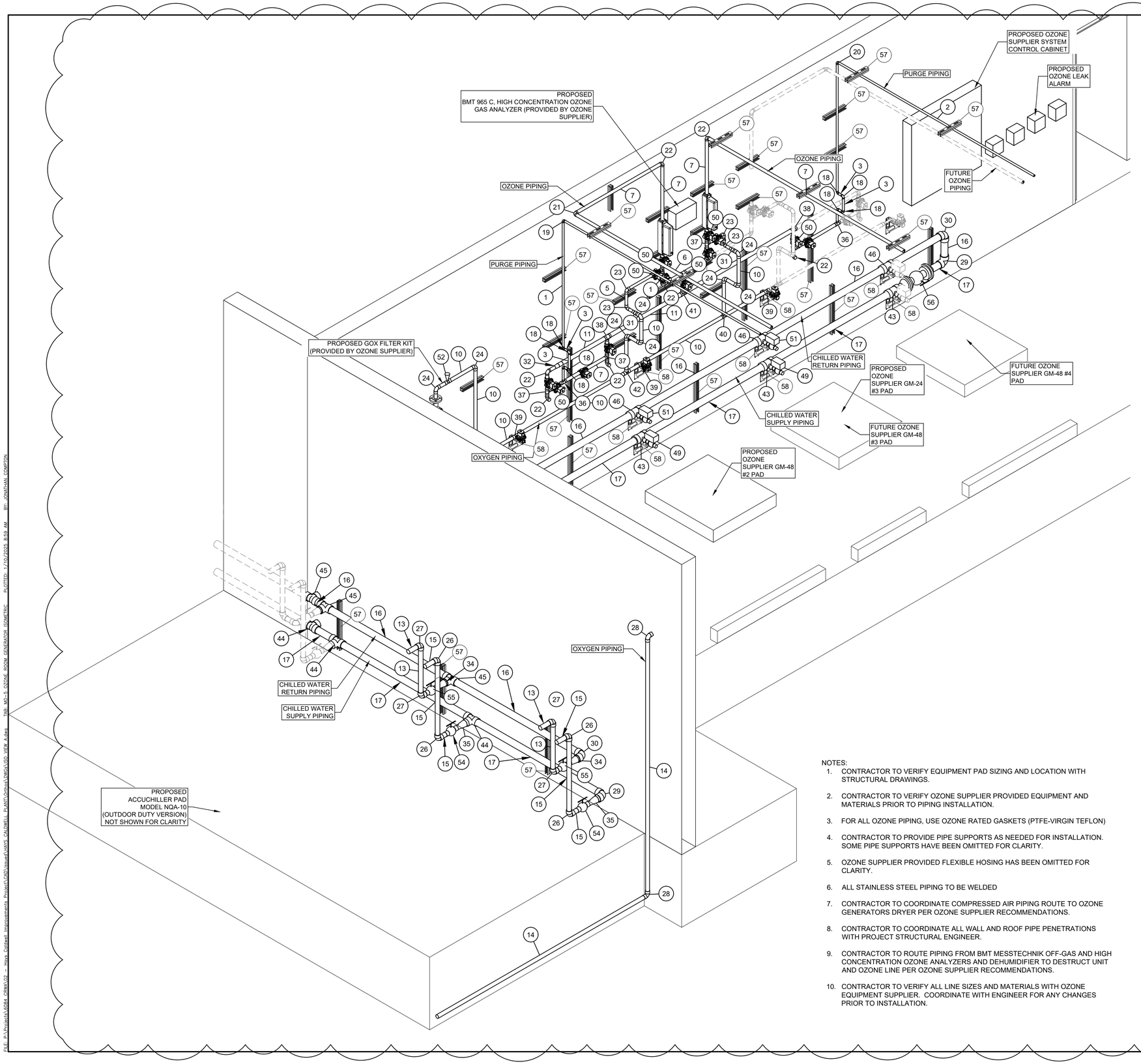
CANYON REGIONAL WATER AUTHORITY
HAYS/CALDWELL WATER TREATMENT PLANT IMPROVEMENTS
PHASE 2

OZONE ROOM SECTION A-A

UTILITY ENGINEERING GROUP PLLC
191 N. Union Ave NEW BRAUNFELS, TEXAS 78130 PH: (830) 214-0521
Texas Engineering Firm F-18722

DRAWING NO.: MO-4
10 of 141

DRAWN BY: TJC
CHECKED BY: DK
APPROVED BY: DK
JOB NO.: 170100



NOTES:

1. CONTRACTOR TO VERIFY EQUIPMENT PAD SIZING AND LOCATION WITH STRUCTURAL DRAWINGS.
2. CONTRACTOR TO VERIFY OZONE SUPPLIER PROVIDED EQUIPMENT AND MATERIALS PRIOR TO PIPING INSTALLATION.
3. FOR ALL OZONE PIPING, USE OZONE RATED GASKETS (PTFE-VIRGIN TEFLON)
4. CONTRACTOR TO PROVIDE PIPE SUPPORTS AS NEEDED FOR INSTALLATION. SOME PIPE SUPPORTS HAVE BEEN OMITTED FOR CLARITY.
5. OZONE SUPPLIER PROVIDED FLEXIBLE HOSING HAS BEEN OMITTED FOR CLARITY.
6. ALL STAINLESS STEEL PIPING TO BE WELDED
7. CONTRACTOR TO COORDINATE COMPRESSED AIR PIPING ROUTE TO OZONE GENERATORS DRYER PER OZONE SUPPLIER RECOMMENDATIONS.
8. CONTRACTOR TO COORDINATE ALL WALL AND ROOF PIPE PENETRATIONS WITH PROJECT STRUCTURAL ENGINEER.
9. CONTRACTOR TO ROUTE PIPING FROM BMT MESSTECHNIK OFF-GAS AND HIGH CONCENTRATION OZONE ANALYZERS AND DEHUMIDIFIER TO DESTRUCT UNIT AND OZONE LINE PER OZONE SUPPLIER RECOMMENDATIONS.
10. CONTRACTOR TO VERIFY ALL LINE SIZES AND MATERIALS WITH OZONE EQUIPMENT SUPPLIER. COORDINATE WITH ENGINEER FOR ANY CHANGES PRIOR TO INSTALLATION.

BILL OF MATERIALS			
PIPE			
ID	ND	SHORT DESCRIPTION	SERVICE
1	1/2"	316 SS PIPE	OZ3
2	1/2"	316 SS PIPE	OZ3
3	1/2"	316 SS PIPE	OZ3
4	3/4"	COPPER PIPE	OX
5	1"	COPPER PIPE	OX
6	1"	316 SS PIPE	OZ3
7	1"	316 SS PIPE	OZ3
8	1"	SCH 80 PVC PIPE	CWS
9	1"	Sch 80 - PVC Pipe	CWR
10	1 1/4"	COPPER PIPE	OX
11	1 1/4"	316 SS PIPE	OZ3
12	1 1/2"	COPPER PIPE	OX
13	1 1/2"	Sch 80 - PVC Pipe	CWR
14	1 1/2"	COPPER PIPE	OX
15	1 1/2"	SCH 80 PVC PIPE	CWS
16	2 1/2"	Sch 80 - PVC Pipe	CWR
17	2 1/2"	SCH 80 PVC PIPE	CWS
FITTINGS			
ID	ND	SHORT DESCRIPTION	SERVICE
18	1/2"	90 DEG BEND (316 SS)	OZ3
19	1/2"	90 DEG BEND (316 SS)	OZ3
20	1/2"	90 DEG BEND (316 SS)	OZ3
21	1"	90 DEG BEND (316 SS)	OZ3
22	1"	90 DEG BEND (316 SS)	OZ3
23	1"	90 DEG BEND (COPPER)	OX
24	1 1/4"	90 DEG BEND (COPPER)	OX
25	1 1/2"	90 DEG BEND (COPPER)	OX
26	1 1/2"	90 DEG BEND	CWS
27	1 1/2"	90 DEG BEND	CWR
28	1 1/2"	90 DEG BEND (COPPER)	OX
29	2 1/2"	90 DEG BEND	CWS
30	2 1/2"	90 DEG BEND	CWR
31	1 1/4"x1"	COUPLING, REDUCING	OX
32	1 1/4"x1"	REDUCER (CONC)	OZ3
33	1 1/4"x1"	REDUCER	OZ3
34	2 1/2"x1 1/2"	REDUCER	CWR
35	2 1/2"x1 1/2"	REDUCER	CWS
36	1"x1/2"	TEE (316 SS)	OZ3
37	1"	TEE (316 SS)	OZ3
38	1 1/4"x1"	TEE (316 SS)	OZ3
39	1 1/4"x3/4"	TEE (RED)	OX
40	1 1/4"	TEE (COPPER)	OX
41	1 1/4"	TEE (316 SS)	OZ3
42	1 1/4"	TEE (COPPER)	OX
43	2 1/2"x1"	TEE	CWS
44	2 1/2"	TEE	CWS
45	2 1/2"	TEE	CWR
46	2 1/2"x1"	TEE	CWR
VALVES			
ID	ND	SHORT DESCRIPTION	SERVICE
47	3/4"	BALL VALVE W/ AUTOMATIC ACTUATOR	OX
48	3/4"	BALL VALVE W/ AUTOMATIC ACTUATOR	OX
49	1"	BALL VALVE W/ AUTOMATIC ACTUATOR	CWS
50	1"	BALL VALVE W/ AUTOMATIC ACTUATOR	OZ3
51	1"	BALL VALVE W/ AUTOMATIC ACTUATOR	CWR
52	1 1/4"	PRESSURE VALVE	OX
53	1 1/4"	SLIDING GATE VALVE W/ AUTOMATIC ACTUATOR	OZ3
54	1 1/2"	BALL VALVE	CWS
55	1 1/2"	BALL VALVE	CWR
56	2 1/2"	BACK PRESSURE CONTROL VAVLE	CWS
PIPE SUPPORTS			
ID	SHORT DESCRIPTION		SERVICE
57	WALL VALVE SUPPORT		WALL VALVE SUPPORT
58	WALL PIPE SUPPORT		WALL SUPPORT

STATE OF TEXAS
DAVID A. KNEUPER
96676
LICENSED PROFESSIONAL ENGINEER

ISSUES / REVISIONS

DATE	NO	DESCRIPTION	BY
12/30/24	1	NEW PIPE ROUTE AND NOTES	DAK

CANYON REGIONAL WATER AUTHORITY
HAYS/CALDWELL WATER TREATMENT PLANT IMPROVEMENTS
PHASE 2

OZONE ROOM GENERATOR ISOMETRIC

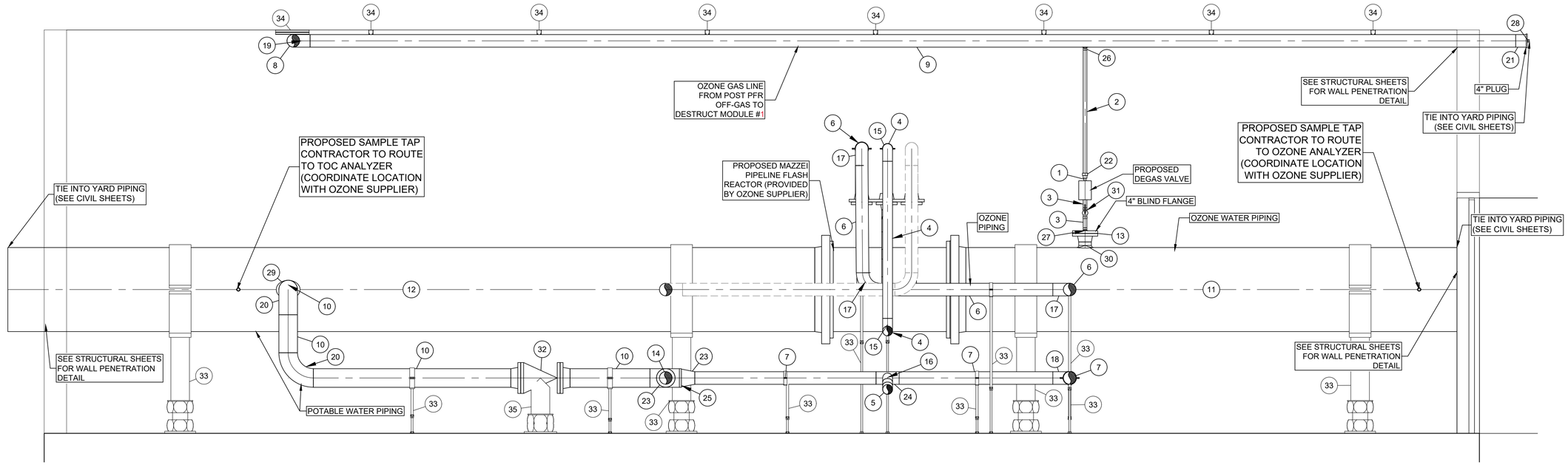
UTILITY ENGINEERING GROUP PLLC
191 N. Union Ave NEW BRAUNFELS, TEXAS 78130 PH: (830) 214-0521
Texas Engineering Firm F-19712

DRAWING NO.: MO-5
10 of 141

DRAWN BY: TJC
CHECKED BY: DK
APPROVED BY: DK
JOB NO.: 170100

1

FILE: P:\Projects\JG684_CRWA\02 – Hays Caldwell Improvements Project\CAD\Issued\HAYS CALDWELL PLANT\Ortho\XWG\ISO_VIEW_A.dwg TAB: MO–5 OZONE ROOM GENERATOR ISOMETRIC PLOTTED: 1/10/2025 8:59 AM BY: JONATHAN COMPTON



BILL OF MATERIALS				
PIPE				
ID	QTY	ND	SHORT DESCRIPTION	SERVICE
1	1 1/2"	1/2"	316 SS PIPE	OZ3
2	3'-8 7/16"	1"	316 SS PIPE	OZ3
3	7 3/16"	1"	316 SS PIPE	OZW
4	14'-10 5/16"	3"	316 SS PIPE	OZW
5	8'-11 1/8"	3"	316 SS PIPE	PW
6	14'-10 3/4"	4"	316 SS PIPE	OZW
7	13'-7 1/8"	4"	316 SS PIPE	PW
8	7'-2 5/8"	4"	316 SS PIPE	OZ3
9	35'-10 1/16"	4"	316 SS PIPE	OZ3
10	10'-3 1/8"	6"	316 SS PIPE	PW
11	16'-4 1/8"	30"	316 SS PIPE	OZW
12	23'-11 7/8"	30"	316 SS PIPE	PW
FITTINGS				
ID	QTY	ND	SHORT DESCRIPTION	SERVICE
13	1	4"	FLANGE BLIND	OZW
14	1	4"	CAP	PW
15	3	3"	90 DEG BEND (316L SS)	OZW
16	2	3"	45 DEG BEND (316L SS)	PW
17	4	4"	90 DEG BEND (316L SS)	OZW
18	1	4"	90 DEG BEND (316L SS)	PW
19	1	4"	90 DEG BEND (316 SS)	OZ3
20	2	6"	90 DEG BEND (316L SS)	PW
21	1	4"	Plug	OZ3
22	1	1"x1/2"	COUPLING, REDUCING	OZ3
23	2	6"x4"	REDUCER (CONC)	PW
24	1	4"x3"	Tee (red)	PW
25	1	6"	Tee	PW
OLETS				
ID	QTY	ND	SHORT DESCRIPTION	SERVICE
26	1	4"x1"	WELDOLET	OZ3
27	1	4"x1"	WELDOLET	OZW
28	1	4"x1/2"	WELDOLET	OZ3
29	1	30"x6"	WELDOLET	PW
30	1	30"x4"	WELDOLET	OZW
VALVES				
ID	QTY	ND	SHORT DESCRIPTION	SERVICE
31	1	1"	Ball Valve	OZW
32	1	6"	Check Valve	PW
PIPE SUPPORTS				
ID	QTY		SHORT DESCRIPTION	SERVICE
33	13		ADJUSTABLE PIPE SUPPORT	SUPPORT
34	8		WALL PIPE SUPPORT	WALL SUPPORT
35	1		ADJUSTABLE PIPE SUPPORT	SUPPORT

NOTES:

1. CONTRACTOR TO VERIFY EQUIPMENT PAD SIZING AND LOCATION WITH STRUCTURAL DRAWINGS.
2. CONTRACTOR TO VERIFY OZONE SUPPLIER PROVIDED EQUIPMENT AND MATERIALS PRIOR TO PIPING INSTALLATION.
3. FOR ALL OZONE PIPING, USE OZONE RATED GASKETS (PTFE-VIRGIN TEFLON)
4. CONTRACTOR TO PROVIDE PIPE SUPPORTS AS NEEDED FOR INSTALLATION. SOME PIPE SUPPORTS HAVE BEEN OMITTED FOR CLARITY.
5. OZONE SUPPLIER PROVIDED FLEXIBLE HOSING HAS BEEN OMITTED FOR CLARITY.
6. ALL STAINLESS STEEL PIPING TO BE WELDED
7. CONTRACTOR TO COORDINATE COMPRESSED AIR PIPING ROUTE TO OZONE GENERATORS DRYER PER OZONE SUPPLIER RECOMMENDATIONS.
8. CONTRACTOR TO COORDINATE ALL WALL AND ROOF PIPE PENETRATIONS WITH PROJECT STRUCTURAL ENGINEER.
9. CONTRACTOR TO ROUTE PIPING FROM BMT MESSTECHNIK OFF-GAS AND HIGH CONCENTRATION OZONE ANALYZERS AND DEHUMIDIFIER TO DESTRUCT UNIT AND OZONE LINE PER OZONE SUPPLIER RECOMMENDATIONS.
10. CONTRACTOR TO VERIFY ALL LINE SIZES AND MATERIALS WITH OZONE EQUIPMENT SUPPLIER. COORDINATE WITH ENGINEER FOR ANY CHANGES PRIOR TO INSTALLATION.

1

STATE OF TEXAS
DAVID A. KNEUPER
96676
LICENSED PROFESSIONAL ENGINEER
12/30/24

ISSUES / REVISIONS

DATE	NO	DESCRIPTION	BY
12/30/24	1	NEW PIPE ROUTE AND NOTES	DAK

CANYON REGIONAL WATER AUTHORITY
HAYS/CALDWELL WATER TREATMENT PLANT IMPROVEMENTS
PHASE 2

OZONE ROOM SECTION B-B

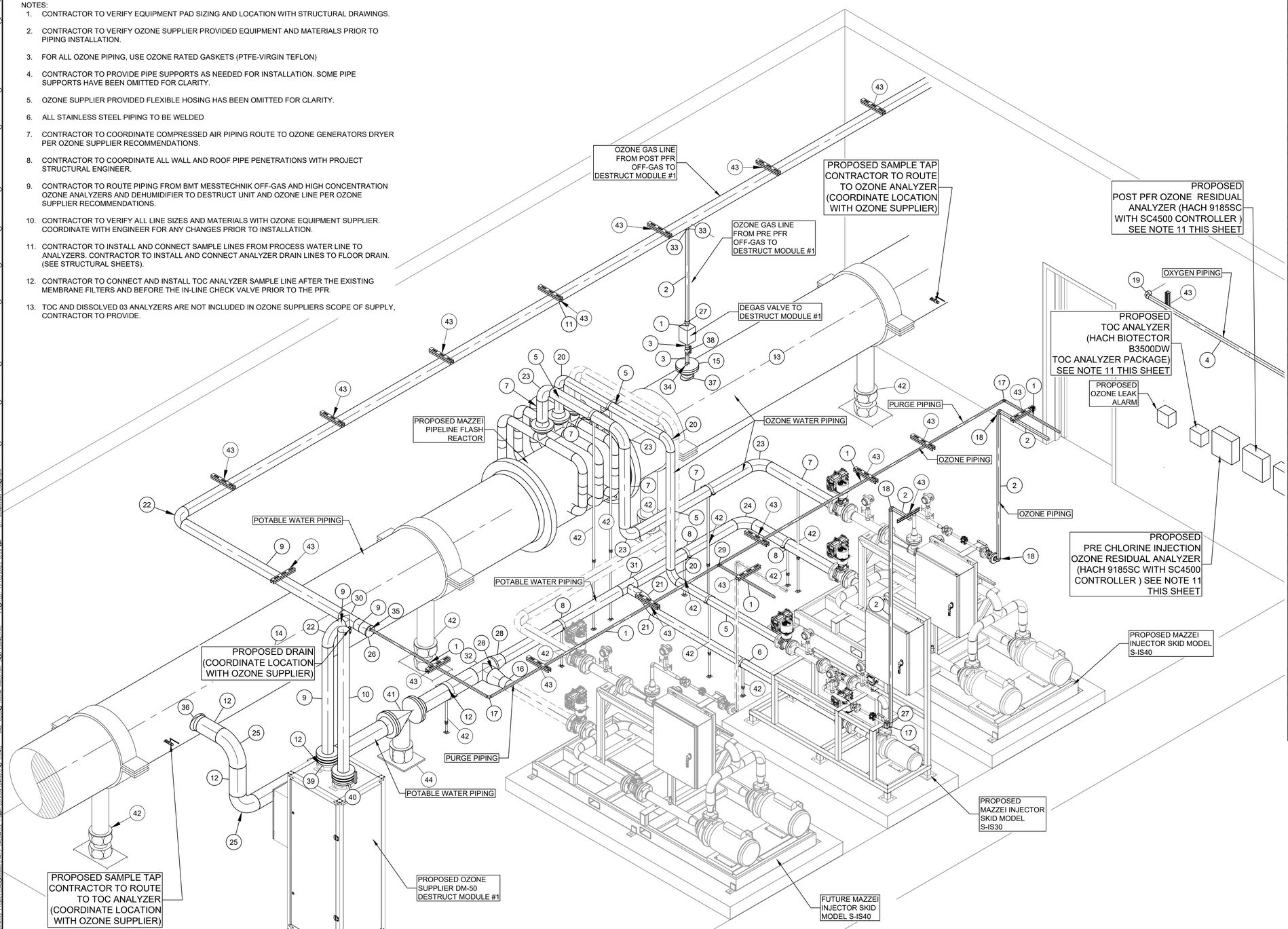
UTILITY ENGINEERING GROUP PLLC
191 N. Union Ave NEW BRAUNFELS, TEXAS 78130 PH: (830) 214-0521
Texas Engineering Firm F-18712

DRAWING NO.: MO-6
10 of 141
DRAWN BY: TJC
CHECKED BY: DK
APPROVED BY: DK
JOB NO.: 170100

FILE: P:\Projects\EGB4_CRWA\02 – Hays Caldwell Improvements Project\CAD\issued\HAYS_CALDWELL PLANT\Ortho\xrefs\DWGs\OZONE ROOM SECTION C.dwg TAB: OZONE ROOM SECTION B–B PLOTTED: 1/10/2025 8:59 AM BY: JONATHAN COMPTON

NOTES:

1. CONTRACTOR TO VERIFY EQUIPMENT PAD SIZING AND LOCATION WITH STRUCTURAL DRAWINGS.
2. CONTRACTOR TO VERIFY OZONE SUPPLIER PROVIDED EQUIPMENT AND MATERIALS PRIOR TO PIPING INSTALLATION.
3. FOR ALL OZONE PIPING, USE OZONE RATED GASKETS (PTFE-VIRGIN TEFLON)
4. CONTRACTOR TO PROVIDE PIPE SUPPORTS AS NEEDED FOR INSTALLATION. SOME PIPE SUPPORTS HAVE BEEN OMITTED FOR CLARITY.
5. OZONE SUPPLIER PROVIDED FLEXIBLE HOSING HAS BEEN OMITTED FOR CLARITY.
6. ALL STAINLESS STEEL PIPING TO BE WELDED
7. CONTRACTOR TO COORDINATE COMPRESSED AIR PIPING ROUTE TO OZONE GENERATORS DRYER PER OZONE SUPPLIER RECOMMENDATIONS.
8. CONTRACTOR TO COORDINATE ALL WALL AND ROOF PIPE PENETRATIONS WITH PROJECT STRUCTURAL ENGINEER.
9. CONTRACTOR TO ROUTE PIPING FROM BMT MESSTECHNIK OFF-GAS AND HIGH CONCENTRATION OZONE ANALYZERS AND DEHUMIDIFIER TO DESTRUCT UNIT AND OZONE LINE PER OZONE SUPPLIER RECOMMENDATIONS.
10. CONTRACTOR TO VERIFY ALL LINE SIZES AND MATERIALS WITH OZONE EQUIPMENT SUPPLIER. COORDINATE WITH ENGINEER FOR ANY CHANGES PRIOR TO INSTALLATION.
11. CONTRACTOR TO INSTALL AND CONNECT SAMPLE LINES FROM PROCESS WATER LINE TO ANALYZERS. CONTRACTOR TO INSTALL AND CONNECT ANALYZER DRAIN LINES TO FLOOR DRAIN. (SEE STRUCTURAL SHEETS).
12. CONTRACTOR TO CONNECT AND INSTALL TOC ANALYZER SAMPLE LINE AFTER THE EXISTING MEMBRANE FILTERS AND BEFORE THE IN-LINE CHECK VALVE PRIOR TO THE PFR.
13. TOC AND DISSOLVED 03 ANALYZERS ARE NOT INCLUDED IN OZONE SUPPLIERS SCOPE OF SUPPLY, CONTRACTOR TO PROVIDE.



BILL OF MATERIALS

PIPE

ID	QTY	ND	SHORT DESCRIPTION	SERVICE
1	52'-0 5/16"	1/2"	316 SS PIPE	OZ3
2	39'-1 5/8"	1"	316 SS PIPE	OZ3
3	7 3/16"	1"	316 SS PIPE	OZW
4	16'-7 1/2"	1 1/2"	COPPER PIPE	OX
5	14'-10 5/16"	3"	316 SS PIPE	OZW
6	8'-11 1/8"	3"	316 SS PIPE	PW
7	14'-10 3/4"	4"	316 SS PIPE	OZW
8	13'-7 1/8"	4"	316 SS PIPE	PW
9	11'-11 11/16"	4"	316 SS PIPE	OZ3
10	5'-8 1/4"	4"	316 SS PIPE	AV
11	35'-10 1/16"	4"	316 SS PIPE	OZ3
12	10'-3 1/8"	6"	316 SS PIPE	PW
13	16'-4 1/8"	30"	316 SS PIPE	OZW
14	23'-11 7/8"	30"	316 SS PIPE	PW

FITTINGS

ID	QTY	ND	SHORT DESCRIPTION	SERVICE
15	1	4"	FLANGE BLIND	OZW
16	1	4"	CAP	PW
17	3	1/2"	90 DEG BEND (316 SS)	OZ3
18	3	1"	90 DEG BEND (316 SS)	OZ3
19	2	1 1/2"	90 DEG BEND (COPPER)	OX
20	3	3"	90 DEG BEND (316L SS)	OZW
21	2	3"	45 DEG BEND (316L SS)	PW
22	2	4"	90 DEG BEND (316 SS)	OZ3
23	4	4"	90 DEG BEND (316L SS)	OZW
24	1	4"	90 DEG BEND (316L SS)	PW
25	2	6"	90 DEG BEND (316L SS)	PW
26	1	4"	PLUG	OZ3
27	2	1"x1/2"	REDUCER	OZ3
28	2	6"x4"	REDUCER (CONC)	PW
29	1	1/2"	Tee	OZ3
30	1	4"	Tee	OZ3
31	1	4"x3"	Tee (red)	PW
32	1	6"	Tee	PW

OLETS

ID	QTY	ND	SHORT DESCRIPTION	SERVICE
33	1	4"x1"	WELDOLET	OZ3
34	1	4"x1"	WELDOLET	OZW
35	1	4"x1/2"	WELDOLET	OZ3
36	1	30"x6"	WELDOLET	PW
37	1	30"x4"	WELDOLET	OZW

VALVES

ID	QTY	ND	SHORT DESCRIPTION	SERVICE
38	1	1"	Ball Valve	OZW
39	1	4"	BUTTERFLY VALVE (316L SS)	OZ3
40	1	4"	BUTTERFLY VALVE (316L SS)	AV
41	1	6"	Check Valve	PW

PIPE SUPPORTS

ID	QTY	SHORT DESCRIPTION	SERVICE
42	15	ADJUSTABLE PIPE SUPPORT	SUPPORT
43	20	WALL PIPE SUPPORT	WALL SUPPORT
44	1	ADJUSTABLE PIPE SUPPORT	SUPPORT

STATE OF TEXAS
DAVID A. KNEUPER
96676
LICENSED PROFESSIONAL ENGINEER

ISSUES / REVISIONS

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CANYON REGIONAL WATER AUTHORITY
HAYS/CALDWELL WATER TREATMENT PLANT IMPROVEMENTS
PHASE 2

OZONE ROOM INJECTOR SKID ISOMETRIC

UTILITY ENGINEERING GROUP PLLC
191 N. Union Ave NEW BRAUNFELS, TEXAS 78130 PH: (830) 214-0521
Texas Engineering Firm F-13712

DRAWING NO.: MO-7
10 of 141

DRAWN BY: TJC
CHECKED BY: DK
APPROVED BY: DK
JOB NO.: 170100

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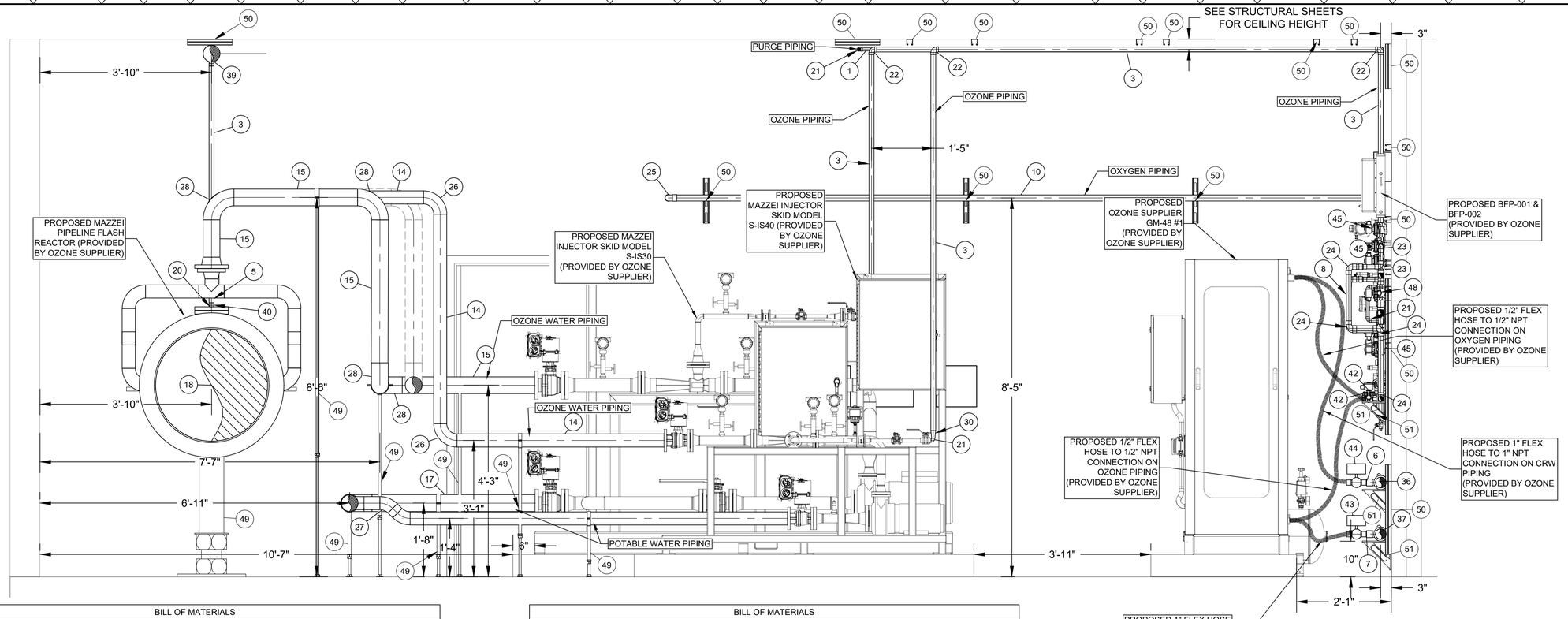

BILL OF MATERIALS				
PIPE				
ID	QTY	ND	SHORT DESCRIPTION	SERVICE
1	31'-4 3/4"	1/2"	316 SS PIPE	OZ3
2	2 11/16"	3/4"	COPPER PIPE	OX
3	54'-5 15/16"	1"	316 SS PIPE	OZ3
4	2'-11 9/16"	1"	COPPER PIPE	OX
5	7 3/16"	1"	316 SS PIPE	OZW
6	4 1/2"	1"	Sch 80 - PVC Pipe	CWR
7	4 1/2"	1"	SCH 80 PVC PIPE	CWS
8	25'-2 15/16"	1 1/4"	COPPER PIPE	OX
9	11'-0 1/4"	1 1/4"	316 SS PIPE	OZ3
10	18'-4 1/16"	1 1/2"	COPPER PIPE	OX
11	20'-5 3/16"	2 1/2"	Sch 80 - PVC Pipe	CWR
12	34'-6 1/16"	2 1/2"	SCH 80 PVC PIPE	CWS
13	8'-11 1/8"	3"	316 SS PIPE	PW
14	14'-10 5/16"	3"	316 SS PIPE	OZW
15	14'-10 3/4"	4"	316 SS PIPE	OZW
16	35'-10 1/16"	4"	316 SS PIPE	OZ3
17	13'-7 1/8"	4"	316 SS PIPE	PW
18	23'-11 7/8"	30"	316 SS PIPE	PW
19	16'-4 1/8"	30"	316 SS PIPE	OZW
FITTINGS				
ID	QTY	ND	SHORT DESCRIPTION	SERVICE
20	1	4"	FLANGE BLIND	OZW
21	7	1/2"	90 DEG BEND (316 SS)	OZ3
22	10	1"	90 DEG BEND (316 SS)	OZ3
23	4	1"	90 DEG BEND (COPPER)	OX
24	9	1 1/4"	90 DEG BEND (COPPER)	OX
25	3	1 1/2"	90 DEG BEND (COPPER)	OX
26	3	3"	90 DEG BEND (316L SS)	OZW
27	2	3"	45 DEG BEND (316L SS)	PW
28	4	4"	90 DEG BEND (316L SS)	OZW
29	1	4"	90 DEG BEND (316L SS)	PW
30	2	1"x1/2"	REDUCER	OZ3
31	2	1 1/4"x1"	COUPLING, REDUCING	OX
32	2	1 1/4"x1"	REDUCER (CONC)	OZ3
33	7	1"	Tee	OZ3
34	4	1 1/4"x3/4"	TEE (RED)	OX
35	2	1 1/4"	Tee	OZ3
36	2	2 1/2"x1"	TEE	CWR
37	2	2 1/2"x1"	TEE	CWS
38	1	4"x3"	Tee (red)	PW

BILL OF MATERIALS				
OLETS				
ID	QTY	ND	SHORT DESCRIPTION	SERVICE
39	1	4"x1"	WELDOLET	OZ3
40	1	4"x1"	WELDOLET	OZW
41	1	30"x4"	WELDOLET	OZW
VALVES				
ID	QTY	ND	SHORT DESCRIPTION	SERVICE
42	2	3/4"	BALL VALVE W/ AUTOMATIC ACTUATOR	OX
43	2	1"	BALL VALVE W/ AUTOMATIC ACTUATOR	CWS
44	2	1"	BALL VALVE W/ AUTOMATIC ACTUATOR	CWR
45	10	1"	BALL VALVE W/ AUTOMATIC ACTUATOR	OZ3
46	1	1"	Ball Valve	OZW
47	1	1 1/4"	PRESSURE VALVE	OX
48	1	1 1/4"	BALL VALVE W/ AUTOMATIC ACTUATOR	OZ3
PIPE SUPPORTS				
ID	QTY	SHORT DESCRIPTION		SERVICE
49	10	ADJUSTABLE PIPE SUPPORT		SUPPORT
50	38	WALL PIPE SUPPORT		WALL SUPPORT
51	6	WALL VALVE SUPPORT		WALL VALVE SUPPORT

NOTES:

1. CONTRACTOR TO VERIFY EQUIPMENT PAD SIZING AND LOCATION WITH STRUCTURAL DRAWINGS.
2. CONTRACTOR TO VERIFY OZONE SUPPLIER PROVIDED EQUIPMENT AND MATERIALS PRIOR TO PIPING INSTALLATION.
3. FOR ALL OZONE PIPING, USE OZONE RATED GASKETS (PTFE-VIRGIN TEFLON)
4. CONTRACTOR TO PROVIDE PIPE SUPPORTS AS NEEDED FOR INSTALLATION. SOME PIPE SUPPORTS HAVE BEEN OMITTED FOR CLARITY.
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STATE OF TEXAS
DAVID A. KNEUPER
96676
LICENSED PROFESSIONAL ENGINEER
12/30/24

ISSUES / REVISIONS

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1	12/30/24	NEW PIPE ROUTE AND NOTES	DAK

CANYON REGIONAL WATER AUTHORITY
HAYS/CALDWELL WATER TREATMENT PLANT IMPROVEMENTS
PHASE 2

OZONE ROOM SECTION C-C

UTILITY ENGINEERING GROUP PLLC
191 N. Union Ave NEW BRAUNFELS, TEXAS 78130 PH: (830) 214-0521
Texas Engineering Firm F-18712

DRAWING NO.: MO-8
10 of 141

DRAWN BY: TJC
CHECKED BY: DK
APPROVED BY: DK
JOB NO.: 170100

PROP. TANK

EX. TANK

TO PROPOSED CONTACT/OFF-GAS STRUCTURE, SEE SHEET C17

30" DUCTILE IRON (SEE YARD PIPING SHEETS)

CHLORINE LINE (SEE YARD PIPING SHEETS)

30" STAINLESS STEEL PIPE (SEE YARD PIPING SHEETS FOR CONTINUATION)

PRE CHLORINE INJECTION OZONE RESIDUAL ANALYZER SAMPLE LINE (CONTRACTOR TO COORDINATE WITH OWNER AND ENGINEER FOR ROUTING. COORDINATE WITH MANUFACTURER FOR LINE SIZE AND MATERIAL)

PROP. OZONE/ ELEC. BUILDING

FUTURE CHILLER

FUTURE CHILLER

PROPOSED CHILLER

EXISTING PROPOSED CHILLER

PROP. OZONE ROOM (SEE SHEET O-2 FOR ROOM PIPING)

PROPOSED OXYGEN LINE TO OZONE ROOM (SEE OZONE ROOM PLAN FOR PIPE CONTINUATION SHEET O-2)

1 1/2" OXYGEN PIPING

PROPOSED CONCRETE CONTAINMENT PAD 19'X26' (SEE STRUCTURAL SHEETS FOR DETAILS)

PROPOSED OXYGEN TANK 86" OD (PROVIDED BY OWNER)

PROPOSED VAPORIZERS (PROVIDED BY OWNER)

PROPOSED 1 1/2" EMERGENCY SHUT OFF VALVE & PRESSURE INDICATING TRANSMITTER

PROPOSED PROPOSED MATHESON LOX COMPRESSOR & BOOSTER

PROPOSED VAPORIZERS (PROVIDED BY OWNER)

PROPOSED FILL LINE

PROPOSED LIQUID NITROGEN TANK 4' OD (PROVIDED BY OWNER)

POST PFR OZONE RESIDUAL ANALYZER SAMPLE LINE - CONTRACTOR TO COORDINATE WITH OWNER AND ENGINEER FOR ROUTING

YARD PIPING (SEE CIVIL SHEETS)

OZONE ROOM PIPING (SEE SHEET O-2)

TOC ANALYZER SAMPLE LINE - CONTRACTOR TO COORDINATE WITH OWNER AND ENGINEER FOR ROUTING

30" DUCTILE IRON (SEE YARD PIPING SHEETS FOR CONTINUATION)

PROPOSED CONCRETE PAVEMENT (SEE CIVIL SHEETS)

PROPOSED PAVEMENT (SEE CIVIL SHEETS)

26'

19'

2171

2170

1 PROPOSED LOX SITE PLAN

SCALE: 1" = 5'

0 5' 10'

22"x34" SCALE: 1"=5'
11"x17" SCALE: 1"=10'

STATE OF TEXAS
DAVID A. KNEUPER
96676
LICENSED PROFESSIONAL ENGINEER
12/30/24

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NO	DATE	DESCRIPTION	BY
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CANYON REGIONAL WATER AUTHORITY
HAYS/CALDWELL WATER TREATMENT PLANT IMPROVEMENTS
PHASE 2

PROPOSED LOX SITE PLAN

UTILITY ENGINEERING GROUP PLLC
191 N. Union Ave NEW BRAUNFELS, TEXAS 78130 PH: (830) 214-0521
Texas Engineering Firm F-13122

DRAWING NO.: MO-9
10 of 141

DRAWN BY: TJC
CHECKED BY: DK
APPROVED BY: DK
JOB NO.: 170100

DUCTWORK SYMBOLS

- SUPPLY DIFFUSER/GRILLE
- RETURN GRILLE
- EXHAUST GRILLE
- 12" DIA. — ROUND DUCT. SIZE IN INCHES. SIZE INDICATED IS DUCT DIAMETER.
- 24x12 — RECTANGULAR DUCT. SIZE IN INCHES. FIRST NUMBER IS SIDE SHOWN.
- 20x12 — SUPPLY OR OUTSIDE AIR DUCT UP
- 20x12 — SUPPLY OR OUTSIDE AIR DUCT DOWN
- 20x12 — RETURN DUCT UP
- 20x12 — RETURN DUCT DOWN
- 20x12 — EXHAUST DUCT UP
- 20x12 — EXHAUST DUCT DOWN
- ROUND DUCT UP
- ROUND DUCT DOWN
- RECTANGULAR ELBOW WITH TURNING VANES
- 20x12 / 16x8 — TRANSITION - RECTANGULAR TO RECTANGULAR
- 20x12 / 10" — TRANSITION - RECTANGULAR TO ROUND
- UP — ELEVATION CHANGE (UP) RISE, (DN) DROP
- FLEXIBLE CONNECTION
- FLEXIBLE DUCT - SINGLE LINE
- DIFFUSER TAKEOFF WITH FLARED SPIN-IN TAP, MANUAL DAMPER AND FLEX DUCT
- RECTANGULAR DUCT BRANCH TAKEOFF WITH 45 DEG TAP
- ROUND DUCT BRANCH TAKEOFF WITH CONICAL TAP FROM RECT. OR ROUND MAIN

HVAC SYMBOLS

- DPT — DIFFERENTIAL PRESSURE TRANSMITTER
- DPI — DIFFERENTIAL PRESSURE INDICATOR
- DX — DIRECT EXPANSION (REFRIGERANT)
- ES — END SWITCH (DAMPER MOTOR)
- FS — FLOW SENSOR
- FS — FLOW SWITCH
- GUI — GRAPHICAL USER INTERFACE
- H — HUMIDISTAT
- H — HUMIDITY SENSOR
- HOA — HAND-OFF-AUTO SWITCH
- M — MOTORIZED OPPOSED BLADE DAMPER
- MCP — MANUFACTURER'S CONTROL PANEL
- PT — PRESSURE TRANSMITTER
- PRESSURE TEMPERATURE PORT
- SD — DUCT MOUNTED SMOKE DETECTOR
- S/D — COMBINATION STARTER/DISCONNECT
- SP — DUCT STATIC PRESSURE SENSOR
- TC — TEMPERATURE CONTROLLER
- TT — TEMPERATURE TRANSMITTER
- TIT — TEMPERATURE INDICATOR/TRANSMITTER
- T — THERMOSTAT
- C — CURRENT SWITCH
- VFD — VARIABLE FREQUENCY DRIVE
- CONNECTION POINT NEW TO EXISTING
- FORCED AIR TO SPACE
- INDIRECT AIR FROM SPACE
- $M — MOTOR RATED SWITCH
- C/C — COOLING COIL
- H/C — HEATING COIL
- H-O-A — HAND-OFF-AUTO SWITCH

GENERAL ABBREVIATIONS

A	@	AT
	AD	AIR DROP
	AFF	ABOVE FINISHED FLOOR
	ALT	ALTITUDE
	AP	ACCESS PANEL
	ASD	ADJUSTABLE SPEED DRIVE
	AUTO	AUTOMATIC
	AUX	AUXILIARY
	AVG	AVERAGE
B	BDD	BACKDRAFT DAMPER
	BHP	BRAKE HORSEPOWER
	BLDG	BUILDING
	BOD	BOTTOM OF DUCT
	BOP	BOTTOM OF PIPE
	BTM	BOTTOM
	BTU	BRITISH THERMAL UNIT
C	℄	CENTER LINE
	CCW	COUNTER CLOCKWISE
	CENT	CENTRIFUGAL
	CFM	CUBIC FEET PER MINUTE
	CLASS/DIV	NEC AREA CLASSIFICATION
	CLG	CEILING
	CLR	CLEAR
	COL	COLUMN
	CONT	CONTINUE, CONTINUOUS
	CTR	CENTER
	CU FT	CUBIC FEET
	CW	CLOCKWISE
D	DACS	DATA ACQUISITION AND CONTROL SYSTEM
	DB	DRY BULB
	DCVBP	DOUBLE CHECK VALVE BACKFLOW PREVENTER
	DEG	DEGREE
	DIA, Ø	DIAMETER
	DN	DOWN
	DWG	DRAWING
E	EA	EACH
	EL	ELEVATION
	EMERG	EMERGENCY
	ENT	ENTERING
	EQUIP	EQUIPMENT
	EWT	ENTERING WATER TEMPERATURE
F	F	FAHRENHEIT
	FLR	FLOOR
	FLG	FLANGE
	FL	FLOW LINE
	FOB	FLAT ON BOTTOM
	FPC	FIRE PROTECTION CONTRACTOR
	FPS	FEET PER SECOND
	FT	FEET
	FWE	FURNISHED WITH EQUIPMENT
G	GPM	GALLONS PER MINUTE
H	H-O-A	HAND-OFF-AUTO
	HP	HORSEPOWER
	HVAC	HEATING, VENTILATION AND AIR CONDITIONING
I		
	HZ	HERTZ
	ID	INSIDE DIAMETER
	IE	INVERT ELEVATION
	INV	INVERT
	IOS	INSTALLED BY OTHER SECTION
	IPS	IRON PIPE SIZE
K	KS	KITCHEN SINK
	KW	KILOWATT
L	LAB	LABORATORY
	LVG	LEAVING
	LWT	LEAVING WATER TEMPERATURE
M	M	MOTOR
	MATL	MATERIAL
	MAX	MAXIMUM
	MBH	THOUSAND BTU PER HOUR
	MCC	MOTOR CONTROL CENTER
	MECH	MECHANICAL
	MFR	MANUFACTURER
	MIN	MINIMUM
	MISC	MISCELLANEOUS
	MTD	MOUNTED
N	NA	NOT APPLICABLE
	NC	NORMALLY CLOSED
	NO	NORMALLY OPEN OR NUMBER
	NOM	NOMINAL
	NTS	NOT TO SCALE

ABBREVIATIONS - CONTINUED

O	OD	OUTSIDE DIAMETER
P	PD	PRESSURE DROP
	PG	PRESSURE GAUGE
	PLC	PROGRAMMABLE LOGIC CONTROLLER
	PNL	PANEL
	PSI	POUNDS PER SQUARE INCH
	PSIA	PSI ABSOLUTE
	PSIG	PSI GAUGE
	P&T	PRESSURE AND TEMPERATURE
R	RM	ROOM
	RPM	REVOLUTIONS PER MINUTE
S	SCADA	SUPERVISORY CONTROL AND DATA ACQUISITION
	SF	SQUARE FOOT (FEET)
	SHT	SHEET
	SPEC	SPECIFICATIONS
	SSTL	STAINLESS STEEL
	SQ	SQUARE
T	T&P	TEMPERATURE & PRESSURE RELIEF
	TEMP	TEMPERATURE
	THK	THICK(NESS)
	TOC	TOP OF CONCRETE
	TOP	TOP OF PIPE
	TOS	TOP OF STEEL
	TYP	TYPICAL
U	UL	UNDERWRITERS LABORATORY
	UNO	UNLESS NOTED OTHERWISE
W	W/	WITH
	W/O	WITHOUT
	WxH	WIDTH BY HEIGHT
	W&T	WASTE AND TRAP
	W&V	WASTE AND VENT

HVAC ABBREVIATIONS

AHU	AIR HANDLING UNIT
COND	CONDENSATE
EA	EXHAUST AIR
EF	EXHAUST FAN
RA	RETURN AIR
MAU	MAKE-UP AIR UNIT
SA	SUPPLY AIR

AACE Engineering License #F-10694

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STATE OF TEXAS — RICARDO J. AZCARATE — 81863 — LICENSED PROFESSIONAL ENGINEER — 2025-Jan-10

ISSUES / REVISIONS

NO	DATE	DESCRIPTION	BY
1	01/10/25	ADDENDUM 5	RA

CANYON REGIONAL WATER AUTHORITY
HAYS/CALDWELL WATER TREATMENT PLANT IMPROVEMENTS
PHASE 2

HVAC
SYMBOLS AND LEGENDS

7500 Rialto Blvd., Building 1, Suite 240
Austin, Texas 78735
Phone: 512.358.5353
www.Ardurra.com

Engineering License #F-10053
Ardurra Group, Inc.
Surveying Firm 10194688

ARDURRA
COLLABORATE. INNOVATE. CREATE.

DRAWING NO.: H1
of 190

DRAWN BY:	MKA
CHECKED BY:	JRI
APPROVED BY:	RJA
JOB NO.:	170100

AIR-HANDLING UNIT SCHEDULE

EQUIPMENT TAG NUMBER	AHU-01 & 02	AHU-03 & 04
BUILDING	OZONE BUILDING	OZONE BUILDING
SERVES	ELECTRICAL ROOM	OZONE ROOM
UNIT TYPE	PACKAGED DX/ELECT	PACKAGED DX/ELECT
UNIT CONFIGURATION	BOTTOM DISCHARGE	BOTTOM DISCHARGE
FAN CONFIGURATION	DRAW-THRU	DRAW-THRU
ECONOMIZER	NONE	NONE
ALTITUDE, FT. ABOVE SEA LEVEL	560	560
REDUNDANCY	N+1	EACH AT 65%
NOMINAL TONS	10	3
SUPPLY FANS:		
FAN TYPE	BC PLENUM FAN	BC PLENUM FAN
TOTAL AIRFLOW, CFM	4,000	1,200
OUTSIDE AIR, CFM	NONE	NONE
EXTERNAL SP., IN. WG	0.7	0.7
TOTAL SP., IN. WG (DIRTY FILTERS)	MFR STD + 0.2	MFR STD + 0.2
FAN RPM (EACH)	VARIABLE	VARIABLE
DRIVE TYPE	DIRECT	DIRECT
VFD	YES	YES
MOTOR HP	5	3
MOTOR RPM (EACH)	VARIABLE	VARIABLE
COOLING COIL:		
ENT. AIR TEMP. DB/WB, DEG F	80/67	75/63
CALCULATED SENSIBLE LOAD, MBH	83.8	38.4 (TOTAL) / 2 = 19.2 (EACH)
GROSS SENSIBLE CAPACITY, MBH	90.7	25.7
NET SENSIBLE CAPACITY, MBH	85.8	25.0
GROSS TOTAL CAPACITY, MBH	112.6	31.8
HEATER TYPE	ELECTRIC	ELECTRIC
CALCULATED HEAT LOAD, KW	12.4	9.2 (TOTAL) / 2 = 4.6 (EACH)
UNIT HEATING CAPACITY, KW	18	12
NUMBER OF STAGES	2	2
FILTERS:		
PRE-FILTER TYPE	FARR 30/30	FARR 30/30
FILTER RATING (MERV)	8	8
CONDENSING SECTION		
AMBIENT TEMP. RATING DEG F	115	115
COMPRESSOR (QTY) TYPE	(1) SCROLL	(1) SCROLL
COMPRESSOR CONTROL	VARIABLE	VARIABLE
REFRIGERANT TYPE	R454B	R454B
CONDENSER FANS	1	1
EER/SEER	12.5/20.0	14.3/19.6
UNIT VOLTS/PHASE/HERTZ	460/3/60	460/3/60
UNIT MIN. CIRCUIT AMPS.	36	26
UNIT MAX. OVER PROTECTION	50	30
MANUFACTURER	TRANE	TRANE
MODEL NUMBER	TZK120	TZK036
OPERATING WEIGHT, LBS	1,350	950

GENERAL NOTES: (APPLICABLE TO ALL UNITS)

1. SCHEDULE IS INCOMPLETE WITHOUT SPECIFICATION 23 81 26.
2. PROVIDE WITH HAIL GUARDS.
3. PROVIDE ANTI-SHORT CYCLE TIMER.
4. PROVIDE PREMIUM EFFICIENCY MOTORS.
5. PROVIDE 16" ALUMINUM CURB.
6. UNITS SHALL OPERATE INDEPENDENTLY BASED ON IT'S RESPECTIVE ROOM TEMPERATURE CONTROLLER.
7. DISCONNECT PROVIDED BY ELECTRICAL.
8. PROVIDE WITH DIRTY FILTER SWITCH.

MAKE-UP AIR UNIT SCHEDULE

EQUIPMENT TAG NUMBER	MAU-01
BUILDING	OZONE BUILDING
SERVES	OZONE ROOM
UNIT TYPE	PACKAGED DX/ELECT
UNIT CONFIGURATION	BOTTOM DISCHARGE
FAN CONFIGURATION	DRAW-THRU
ECONOMIZER	FULL TIME
ALTITUDE, FT. ABOVE SEA LEVEL	560
REDUNDANCY	NO
NOMINAL TONS	3
SUPPLY FANS:	
FAN TYPE	PLENUM
TOTAL AIRFLOW, CFM	600
OUTSIDE AIR, CFM	600
EXTERNAL SP., IN. WG	0.5
TOTAL SP., IN. WG (DIRTY FILTERS)	MFR STD + 0.2
FAN RPM (EACH)	VARIABLE
DRIVE TYPE	DIRECT
VFD	ECM
MOTOR HP	0.5
MOTOR RPM	941
COOLING COIL:	
ENT. AIR TEMP. DB/WB, DEG F	100.4/78.6
LVG. AIR TEMP. DB/WB, DEG.F.	56.5/56.4
GROSS SENSIBLE CAPACITY, MBH	26
GROSS TOTAL CAPACITY, MBH	45.1
HEATING TYPE 1	HOT GAS REHEAT
UNIT HEATING CAPACITY, MBH	24.9
NUMBER OF STAGES	VARIABLE (HGRH)
HEATER TYPE 2	ELECTRIC
UNIT HEATING CAPACITY, KW	11
NUMBER OF STAGES	VARIABLE (SCR)
FILTERS:	
PRE-FILTER TYPE	FARR 30/30
FILTER RATING (MERV)	8
CONDENSING SECTION	
AMBIENT TEMP. RATING DEG F	115
COMPRESSOR (QTY) TYPE	(1) SCROLL
COMPRESSOR CONTROL	VARIABLE
REFRIGERANT TYPE	R454B
CONDENSER FANS	1
ISMRE2 EFFICIENCY	7.7
UNIT VOLTS/PHASE/HERTZ	460/3/60
UNIT MIN. CIRCUIT AMPS.	18.3
UNIT MAX. OVER PROTECTION	20
MANUFACTURER	GREENHECK
MODEL NUMBER	RV-10-3I-1-E2
OPERATING WEIGHT, LBS	1,250

GENERAL NOTES: (APPLICABLE TO ALL UNITS)

1. SCHEDULE IS INCOMPLETE WITHOUT SPECIFICATION 23 74 23.
2. PROVIDE WITH HAIL GUARDS.
3. PROVIDE ANTI-SHORT CYCLE TIMER.
4. PROVIDE PREMIUM EFFICIENCY MOTORS.
5. PROVIDE 16" ALUMINUM CURB.
6. UNITS SHALL OPERATE INDEPENDENTLY BASED ON IT'S RESPECTIVE ROOM TEMPERATURE CONTROLLER.
7. DISCONNECT PROVIDED BY ELECTRICAL.
8. PROVIDE WITH DIRTY FILTER SWITCH.

METAL FAN SCHEDULE

EQUIPMENT TAG NUMBER	EF-01	EF-02
BUILDING	OZONE BUILDING	OZONE BUILDING
SERVICE	EXHAUST (24/7)	EXHAUST (PURGE)
UNIT CONFIGURATION	UPBLAST	UPBLAST
LOCATION	ROOF	ROOF
DISCHARGE	TOP	TOP
ALTITUDE, FT. ABOVE SEA LEVEL	560	560
FAN MATERIAL OF CONSTRUCTION	ALUMINUM	ALUMINUM
FAN TYPE	CENTRIFUGAL	CENTRIFUGAL
AIRFLOW, CFM	600	4,200
TOTAL STATIC PRESSURE, IN. WG	0.5	0.5
AIR STREAM TEMP RANGE, DEG F	50-110	50-110
FAN RPM	1,550	1,140
DRIVE TYPE	DIRECT	DIRECT
MOTOR HP	1/4	1-1/2
MOTOR RPM	1,550	1,140
MOTOR ENCLOSURE	TEAO	TEFC
FAN SPEED CONTROL	NO	NO
VOLTS/PHASE/HERTZ	230/1/60	460/3/60
EMERGENCY POWER	NO	NO
SPARK PROOF	NO	NO
SOUND DATA (DBA @ 5 FT. RADIUS)	56	70
VIBRATION ISOLATORS	MFR STD	MFR STD
STANDARD CURB CAP SIZE, IN x IN	19x19	30x30
CURB EXTENSION HEIGHT, IN	NONE	NONE
CURB ADAPTER SIZE, IN x IN	NONE	NONE
ROOF/WALL OPENING SIZE, IN x IN	15.5x15.5	26.5x26.5
OPERATING WEIGHT, LBS	50	250
MANUFACTURER	GREENHECK	GREENHECK
MODEL NUMBER	CUE-095-D	CUE-200HP-B
DAMPER	NONE	NONE
NOTES	1,2,3,4	1,2,3,4,5
CONTROLS	SEE SCHEMATICS	SEE SCHEMATICS

GENERAL NOTES: (APPLICABLE TO ALL UNITS)

1. SCHEDULE IS INCOMPLETE WITHOUT SPECIFICATION SECTION 23 34 00.

NOTES:

1. PROVIDE WITH ALUMINUM CONSTRUCTION, STAINLESS STEEL SHAFT AND FASTENERS, AND COATINGS ON FAN AND ACCESSORIES.
2. PROVIDE WITH COATINGS ON FAN AND ACCESSORIES.
3. PROVIDE WITH 50 DEGREE CELCIUS RATED PREMIUM EFFICIENCY MOTOR WHEN AVAILABLE.
4. PROVIDE WITH 16" ALUMINUM CURB, INSULATION, WOOD NAILER, AND FOAM CURB SEAL.
5. PROVIDE WITH DAMPER TRAY AND BACKDRAFT DAMPER.

AIR CONDITIONING UNIT SCHEDULE (VRF)

AIR CONDITIONER TAG NUMBER	AC-01
BUILDING	OZONE BUILDING
AREA SERVED	CONTROL ROOM
UNIT TYPE	SPLIT DX
UNIT CONFIGURATION	4-WAY
MOUNTING	CEILING-CASSETTE
FAN CONFIGURATION	MFR. STD.
ALTITUDE, FT. ABOVE SEA LEVEL	560
NOMINAL TONS	1.5
SUPPLY FAN:	
FAN TYPE	CENTRIFUGAL
TOTAL AIRFLOW, CFM (L/M/H)	460-490-570-600
MIN. OUTSIDE AIR, CFM	NONE
FAN CONTROL	4-SPEED
DRIVE TYPE	DIRECT
COOLING COIL:	
ENT. AIR TEMP. DB/WB, DEG F	80/67
APPROX. LVG. AIR TEMP. DB/WB, DEG F	55/54
TOTAL COOLING CAPACITY, MBH	14.5
SENSIBLE CAPACITY, MBH	12.9
CALCULATED SENSIBLE LOAD, MBH	10.9
EFFICIENCY, SEER2	25.0
HEATING:	
TYPE	HEAT PUMP
CALCULATED LOAD, BTUH	6.3
RATED CAPACITY, MBH	23.0
EFFICIENCY, HSPF2	9.2
FILTERS	MFR STD
REFRIGERANT LIQUID PIPE SIZE, IN	1/4
REFRIGERANT GAS PIPE SIZE, IN	1/2
DRAIN PIPE SIZE	1-1/4
ELECTRICAL:	NOTE 1
VOLTS/PHASE/HERTZ	230/1/60
MINIMUM CIRCUIT AMPACITY, MCA	1
OPERATING WEIGHT, LBS	50
MANUFACTURER	TRANE/MITSUBISHI
MODEL NUMBER	TPLA0A0181EA70A
ASSOCIATED CONDENSING UNITS	CU-01
NOTES	1

REMARKS: (APPLICABLE TO ALL UNITS)

A. SCHEDULE IS INCOMPLETE WITHOUT SPECIFICATION SECTION 23 81 26.
B. PROVIDE WIRED WALL MOUNTED CONTROLLER.
C. PROVIDE MANUFACTURER STANDARD CONDENSATE PUMP AND HIGH WATER CUTOFF.
D. PROVIDE WITH EEV KITS PER MANUFACTURER.

NOTES:

1. INDOOR UNIT IS POWERED BY OUTDOOR CONDENSING UNIT. FIELD WIRING/CONDUIT BY DIV. 26.

LOUVER SCHEDULE

EQUIPMENT TAG NUMBER	LV-01
BUILDING	OZONE BUIDLING
SERVES	PURGE EXHAUST
DIRECTION	SEE PLANS
APPROX. SIZE, WIDTH x HEIGHT	48x48
APPROX. AIRFLOW, CFM	4,200
FREE AREA, FT2	8.0
APPROX. FREE AREA VELOCITY, FPM	525
MATERIAL	ALUMINUM
MANUFACTURER	GREENHECK
MODEL	ESD-403
DAMPER	SEE SCHEDULE
NOTES	1

REMARKS: (APPLICABLE TO ALL UNITS)

A. REFER TO SPECIFICATION 23 31 13 FOR ADDITIONAL INFORMATION.
B. LOUVER PERFORMANCE AND CONSTRUCTION SHALL BE EQUAL TO THE MFR/MODEL SCHEDULED.
C. PROVIDE WITH ALUMINUM BIRDSCREEN ON BACK OF LOUVER.
D. FRAME AND BLADE WALL THICKNESS SHALL BE 0.125" THICKNESS.

NOTES:

1. COORDINATE LOCATION OF LOUVER WITH ARCHITECTURAL & & STRUCTURAL (BTM APPROX 8" AFF).

SUPPLY PLENUM SCHEDULE

EQUIPMENT TAG NUMBER	SP-A	SP-B	SP-C
SERVES	AHU-01 & 02	AHU-03 & 04	MAU-01
TYPE	SUPPLY	SUPPLY	SUPPLY
MATERIAL	ALUMINNUM	ALUMINNUM	ALUMINNUM
NOMINAL SIZE	30x30	24x24	24x24
DIFFUSER SIZE (EACH), INxIN	20x10	15x6	15x6
FRAME	SUSPENDED	SUSPENDED	SUSPENDED
FINISH	ALUMINUM	ALUMINUM	ALUMINUM
DISCHARGE PATTERN	4-WAY DRUM	4-WAY DRUM	4-WAY DRUM
DEFLECTION (DIRECTION)	30 DEGREES (DOWN)	30 DEGREES (DOWN)	30 DEGREES (DOWN)
AIRFLOW, CFM	4,000	1,200	600
MAXIMUM PRESSURE DROP, IN. WG	0.4	0.4	0.4
MAXIMUM NOISE CRITERIA	45	45	45
MANUFACTURER	RUSKIN	RUSKIN	RUSKIN
MODEL NUMBER	DLD-2010	DLD-1506	DLD-1506
NOTES	1, 2, 3	1, 2, 3	1, 2, 3

NOTES:

1. ALL HARDWARE AND FASTENERS SHALL BE 316 SS. GALVANIZED STEEL OR STEEL (COATED OR UNCOATED) MATERIAL SHALL NOT BE ACCEPTABLE.
2. PROVIDE WITH INTERNAL AIR DEFLECTOR AND BUILT-IN DUCT CAP WITH HANGING SUPPORT.
3. SUPPORT WITH ALL-THREAD ROD FROM ROOF STRUCTURE ABOVE.

MOTORIZED DAMPER SCHEDULE

EQUIPMENT TAG NUMBER	MD-01	MD-02
LOCATION	LV-01	DUCT
NOMINAL SIZE, WxH	48x48	24x24
FRAME MATERIAL	304 STAINLESS STEEL	304 STAINLESS STEEL
FRAME THICKNESS	12 GAGE	12 GAGE
BLADE MATERIAL	304 SSTL INSULATED	304 SSTL INSULATED
BLADE TYPE	AIRFOIL	AIRFOIL
BLADE ACTION	OPPOSED	OPPOSED
LINKAGES AND SHAFT MATERIAL	316 SSTL	316 SSTL
SEAL MATERIAL	SILICONE	SILICONE
LEAKAGE CLASS (MAX)	1A @ 1 IN.WG. (3 CFM/FT2)	1A @ 1 IN.WG. (3 CFM/FT2)
FINISH	MILL	MILL
MANUFACTURER	GREENHECK	GREENHECK
MODEL NUMBER	VSD-34	VSD-34
ACTUATOR		
MOUNTING	INTERNAL	EXTERNAL
NEMA RATING	4X	4X
OPERATION	TWO-POSITION	TWO-POSITION
TORQUE, IN-LB/FT2 (MINIMUM ACTUATOR)	10 (160)	10 (40)
VOLTAGE	120/1/60	120/1/60
MFR/MODEL (TORQUE)	BELIMO	BELIMO
NOTES	1	1

NOTES:

1. ALL HARDWARE AND FASTENERS SHALL BE 316 SS. GALVANIZED STEEL OR STEEL (COATED OR UNCOATED) MATERIAL SHALL NOT BE ACCEPTABLE.
2. SEE PLANS AND DETAIL FOR ADDITIONAL INFORMATION.

CONDENSING UNIT SCHEDULE (VRF)

CONDENSING UNIT TAG NUMBER	CU-01
BUILDING	OZONE BUILDING
AREA SERVED	CONTROL ROOM
UNIT TYPE	AIR-COOLED HEAT PUMP
UNIT CONFIGURATION	HORIZONTAL
MOUNTING	ROOF CURB
AMBIENT TEMP. RATING DEG F. MAX.	110
AMBIENT TEMP. RATING DEG F. MIN.	20
NOMINAL TONS	1.5
VOLTS/PHASE/HERTZ	230/1/60
ELECTRICAL MCA, AMPS	11
ELECTRICAL MOCP, AMPS	30
MANUFACTURER	TRANE/MITSUBISHI
MODEL NUMBER	TRUZA0181KA70NA
COMPRESSOR TYPE	SCROLL
REFRIGERANT TYPE	R410A
OPERATING WEIGHT, LBS	100
ASSOCIATED INDOOR UNIT	AC-I-1
NOTES:	1

REMARKS: (APPLICABLE TO ALL UNITS)

A. SCHEDULE IS INCOMPLETE WITHOUT SPECIFICATION SECTION 23 81 26.
B. PROVIDE LOW AMBIENT CONTROL WIND BAFFLE FOR OPERATION DOWN TO 0 DEG.F..

NOTES:

1. INDOOR UNIT IS POWERED BY OUTDOOR CONDENSING UNIT, FIELD WIRING/CONDUIT BY DIV. 16.

AACE Engineering License #F-10694

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STATE OF TEXAS — RICARDO J. AZCARATE — 81863 — LICENSED PROFESSIONAL ENGINEER — 1.10.25

ISSUES / REVISIONS

NO	DATE	DESCRIPTION	BY
1	01/10/25	ADDENDUM 5	RA

CANYON REGIONAL WATER AUTHORITY
HAYS/CALDWELL WATER TREATMENT PLANT IMPROVEMENTS
PHASE 2
HVAC SCHEDULES

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Phone: (512) 306-1333
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DRAWING NO.: H2 of 190

DRAWN BY:	MKA
CHECKED BY:	JRI
APPROVED BY:	RJA
JOB NO.:	170100

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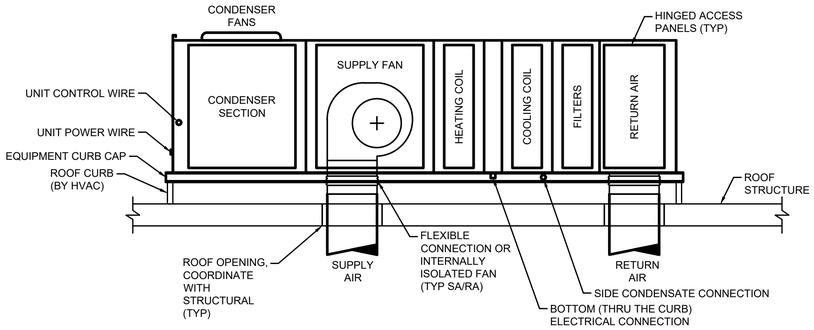
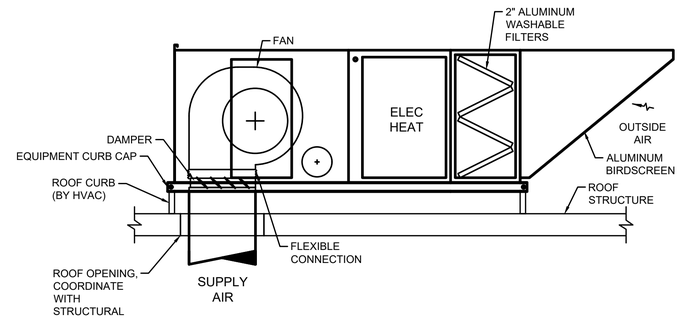
Friday January 10, 2025, 4:25pm



NOTES:

1. SEE ARCHITECTURAL FOR ROOF CURB FLASHING DETAILS.
2. FILL ROOF VOID SPACE BETWEEN SUPPLY AND RETURN DUCTS WITH 4" RIGID DUCTBOARD INSULATION. PROVIDE INSULATION SUPPORTS AS REQUIRED.

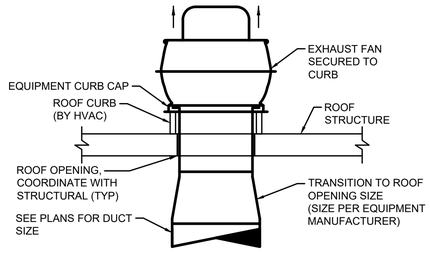
1 -- ROOFTOP AIR-HANDLING UNIT
NTS



NOTES:

1. SEE ARCHITECTURAL FOR ROOF CURB FLASHING DETAILS.

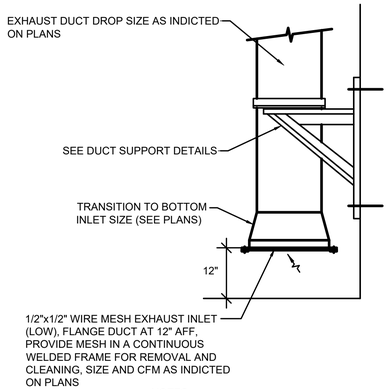
2 -- MAKE-UP AIR UNIT
NTS



NOTES:

1. SEE ARCHITECTURAL FOR ROOF CURB FLASHING DETAILS.

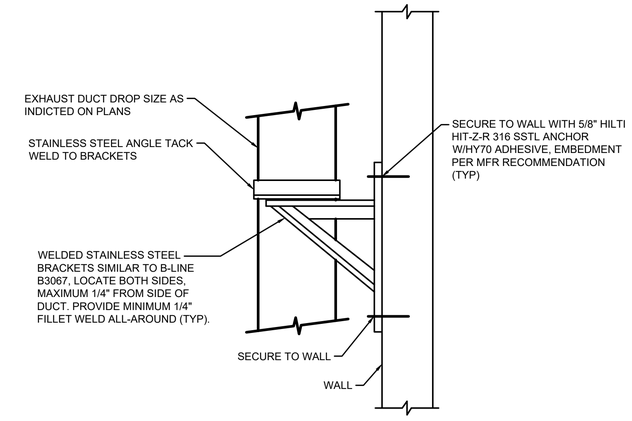
3 -- ROOF-MOUNTED EXHAUST FAN WITH HIGH INTAKE
NTS



NOTES:

1. MATERIALS SHALL BE 316 STAINLESS STEEL.

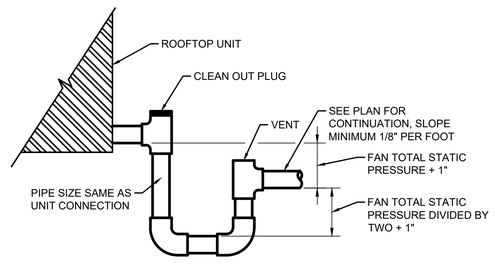
4 -- LOW POINT EXHAUST INLET
NTS



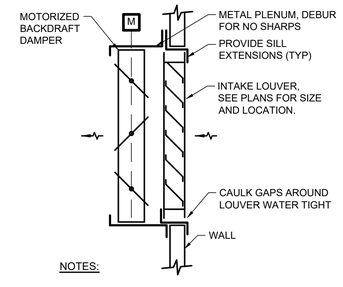
NOTES:

1. MATERIALS SHALL BE 316 STAINLESS STEEL.

5 -- DUCT SUPPORT
NTS



6 -- CONDENSATE TRAP FOR DRAW THRU UNIT
NTS



NOTES:

1. MATERIALS SHALL BE 316 STAINLESS STEEL.

7 -- WALL MOUNTED INTAKE ASSEMBLY
NTS

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ISSUES / REVISIONS

NO	DATE	DESCRIPTION	BY
1	01/10/25	ADDENDUM 5	RA

CANYON REGIONAL WATER AUTHORITY
HAYS/CALDWELL WATER TREATMENT PLANT IMPROVEMENTS
PHASE 2

HVAC DETAILS

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Austin, Texas 78735
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DRAWN BY:	MKA
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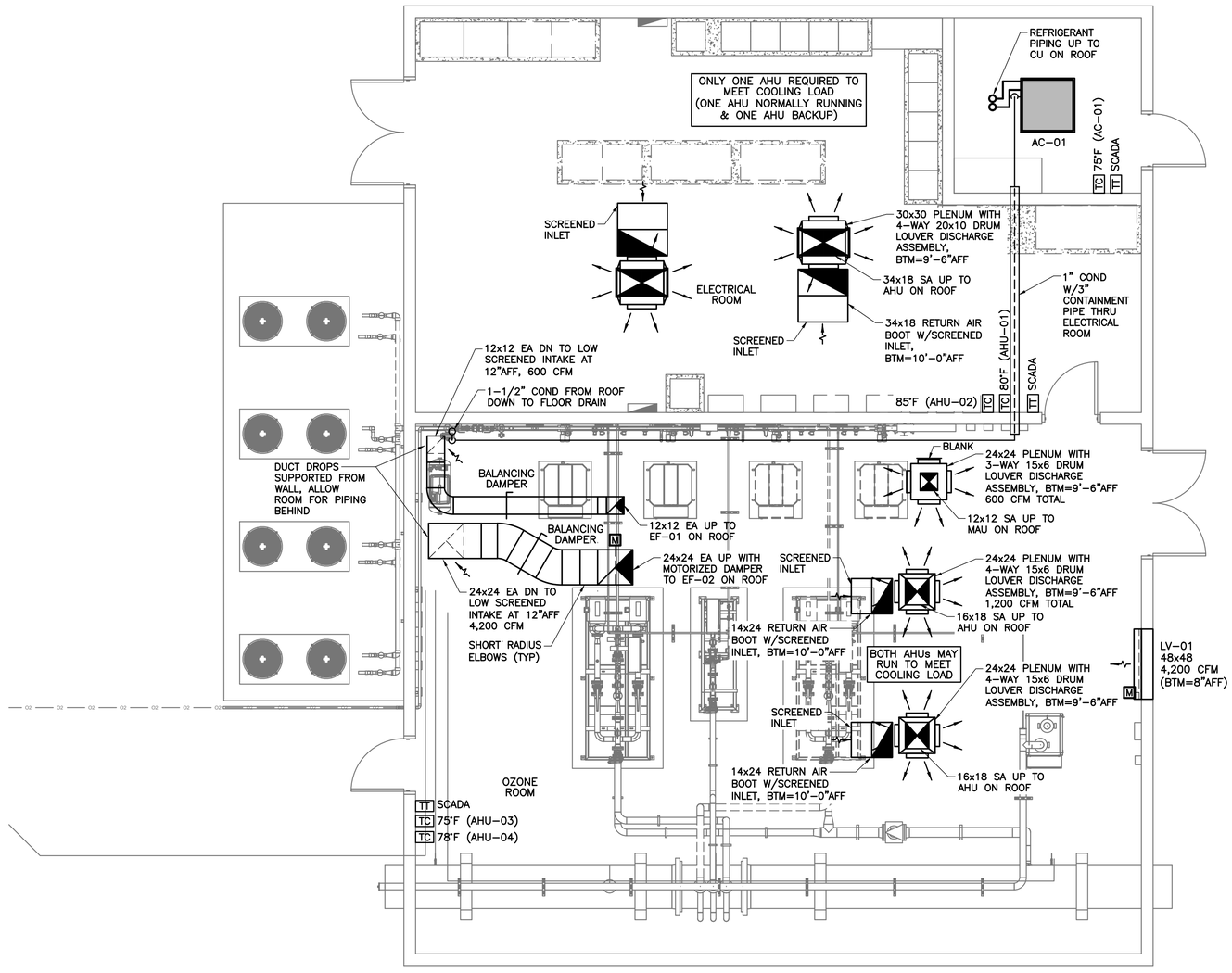
JOB NO.:	170100



1 PLAN
SCALE: 1/4" = 1'-0"
0 4' 8'
22"x34" SCALE:1"=4'
11"x17" SCALE:1"=8'

SEQUENCES OF OPERATION:

ELECTRICAL ROOM:
1. EACH ROOFTOP AIR-HANDLING UNIT IS SUFFICIENT TO MEET THE COOLING DEMAND OF THE ROOM. EACH UNIT WILL OPERATE INDEPENDENTLY BASED ON ITS REMOTE ROOM-MOUNTED TEMPERATURE CONTROLLER (TC). ONE TC WILL BE SET AT 80-DEG.F. AND THE OTHER AT 85-DEG.F. AS BACKUP. OCCASIONALLY, AT THE DISCRETION OF THE PLANT MAINTENANCE STAFF, THE SETTINGS SHALL BE MANUALLY SWITCHED TO EQUALIZE THEIR RUNTIME. THESE ARE VARIABLE CAPACITY UNITS THAT ARE BETTER ABLE TO MATCH THE ROOM COOLING LOADS AND SHALL FOLLOW THE MANUFACTURER'S SEQUENCES FOR INTERNAL CONTROL.
2. A ROOM-MOUNTED TEMPERATURE SENSOR SHALL BE PROVIDED BY HVAC FOR MONITORING AND ALARMING AT SCADA. CONDUIT/WIRING BY ELECTRICAL.

OZONE ROOM:
1. THE OZONE GENERATION EQUIPMENT AND PIPING IS A CLOSED SYSTEM, THEREFORE UNDER NORMAL CONDITIONS, HIGH LEVELS OF OZONE OR OXYGEN SHOULD NOT BE PRESENT. HOWEVER, A 24/7 EXHAUST AND MAKE-UP AIR UNIT IS PROVIDED FOR MINIMAL AIR CHANGE RATE TO EVACUATE ANY MINOR OFF-GASSING THAT MIGHT OCCUR. THIS SYSTEM (EF-01 AND MAU-01) IS INTERLOCKED BY ELECTRICAL. THE MAU WILL OPERATE TO MAINTAIN AN INITIAL NEUTRAL SUPPLY AIR TEMPERATURE SETTING OF 75 DEG.F. (ADJUSTABLE).
2. BOTH ROOFTOP AIR-HANDLING UNITS ARE NEEDED TO MEET THE PEAK COOLING DEMAND OF THE ROOM. EACH UNIT WILL OPERATE INDEPENDENTLY BASED ON ITS REMOTE ROOM-MOUNTED TEMPERATURE CONTROLLER (TC). ONE TO WILL BE SET AT 75-DEG.F. AND THE OTHER AT 78-DEG.F. TO STAGE THEIR COOLING. OCCASIONALLY, AT THE DISCRETION OF THE PLANT MAINTENANCE STAFF, THE SETTINGS SHALL BE MANUALLY SWITCHED TO EQUALIZE THEIR RUNTIME. THESE ARE VARIABLE CAPACITY UNITS THAT ARE BETTER ABLE TO MATCH THE ROOM COOLING LOADS AND SHALL FOLLOW THE MANUFACTURER'S SEQUENCES FOR INTERNAL CONTROL.
3. UPON OZONE/OXYGEN LEAK ALARM – THE PURGE EXHAUST SYSTEM (EF-02 & LV-01) SHALL RUN, THE EXTERIOR WALL LOUVER MOTORIZED DAMPER SHALL BE OPENED, THE MOTORIZED DAMPER FOR EF-02 SHALL BE OPENED, AND EXHAUST FAN EF-02 ENERGIZED. THE ROOFTOP AIR-HANDLING UNITS (AHU-02 & AHU-03) SHALL BE SHUTDOWN.
4. A ROOM-MOUNTED TEMPERATURE SENSOR SHALL BE PROVIDED BY HVAC FOR MONITORING AND ALARMING AT SCADA. CONDUIT/WIRING BY ELECTRICAL.

MATERIALS OF CONSTRUCTION:

ELECTRICAL ROOM:
1. SUPPLY & RETURN DUCTWORK AND SUPPORTS SHALL BE GALVANIZED STEEL.
2. GRILLES SHALL BE ALUMINUM WITH STAINLESS STEEL FASTENERS.
3. CONTROL DEVICES SHALL BE STANDARD NEMA1 RATING.

OZONE ROOM:
1. SUPPLY & RETURN DUCTWORK, INLET SCREEN, SHALL BE ALUMINUM WITH 316 STAINLESS STEEL SUPPORTS AND FASTENERS.
2. GRILLES SHALL BE ALUMINUM WITH 316 STAINLESS STEEL FASTENERS.
3. EXHAUST DUCTWORK, INLET SCREEN, SUPPORTS, AND FASTENERS SHALL BE 316 STAINLESS STEEL.
4. EXTERIOR WALL LOUVER SHALL BE ALUMINUM WITH COATINGS. DUCT/SLEEVE, FILTER HOUSING, AND DAMPER SHALL BE 316 STAINLESS STEEL. MOTORIZED DAMPER ACTUATOR SHALL BE NEMA4X RATING.
5. ROOM TEMPERATURE SENSOR FOR SCADA MONITORING SHALL BE NEMA4X RATING.

CONDENSATE PIPING:
1. CONDENSATE PIPING INDOORS SHALL BE CPVC, INSULATED, AND JACKETED.

NOTES:
1. HVAC CONTRACTOR SHALL PROVIDE THE ROOM TEMEPRATURE CONTROLLERS (TC) FROM THE AIR-HANDLING UNIT MANUFACTURER AND/OR COMPATIBLE WITH THEIR FULL INTENDED OPERATION PER AHU MANUFACTURER. DEVICE, CONDUIT, AND WIRING TO BE PROVIDED BY HVAC PER DIV 26 SPECIFICATIONS.
2. HVAC CONTRACTOR SHALL MAKE FINAL CONNECTION OF OZONE/OXYGEN LEAK ALARM SHUTDOWN SIGNAL FROM ELECTRICAL TO THE AIR-HANDLING UNITS (AHU-03 & 04) AND COORDINATE COMPLETE FUNCTIONALITY PER SEQUENCES OF OPERATION. CONDUIT AND WIRING PROVIDED BY ELECTRICAL.
3. DISCONNECTS, FAN STARTERS, POWER WIRING/CONDUIT, AND INTERLOCK OF EQUIPMENT SHALL BE BY ELECTRICAL.
4. MOTORIZED DAMPER AT EXTERIOR WALL LOUVER SHALL BE 120V AND POWERED/CONTROLLED BY ELECTRICAL.
5. HVAC CONTRACTOR SHALL BALANCE THE 24/7 SYSTEMS TO THE APPROXIMATE AIRFLOW SCHEDULED SO MAU-01 AND EF-01 ARE SIMILAR AIRFLOW (+/- 5%). UTILIZE THE BALANCING DAMPERS TO INDUCE ADDITIONAL STATIC PRESSURE LOSS AS NEEDED.
6. CONDENSATE PIPING SHALL BE SLOPED 1/8" PER FOOT MINIMUM.

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STATE OF TEXAS · RICARDO J. AZCARATE · 81863 · LICENSED PROFESSIONAL ENGINEER · 2025-Jan-10

ISSUES / REVISIONS

NO	DATE	DESCRIPTION	BY
3	01/10/25	ADDENDUM 5	RA

CANYON REGIONAL WATER AUTHORITY
HAYS/CALDWELL WATER TREATMENT PLANT IMPROVEMENTS
PHASE 2
HVAC
OZONE BUILDING FLOOR PLAN

7500 Rialto Blvd., Building 1, Suite 240
Austin, Texas 78735
Phone: (512) 536-5535
www.Ardurra.com

Engineering License #F-10053
Ardurra Group, Inc.
Surveying Firm 10194088

ARDURRA
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DRAWING NO.: H4 of 190

DRAWN BY:	MKA
CHECKED BY:	JRI
APPROVED BY:	RJA
JOB NO.:	170100

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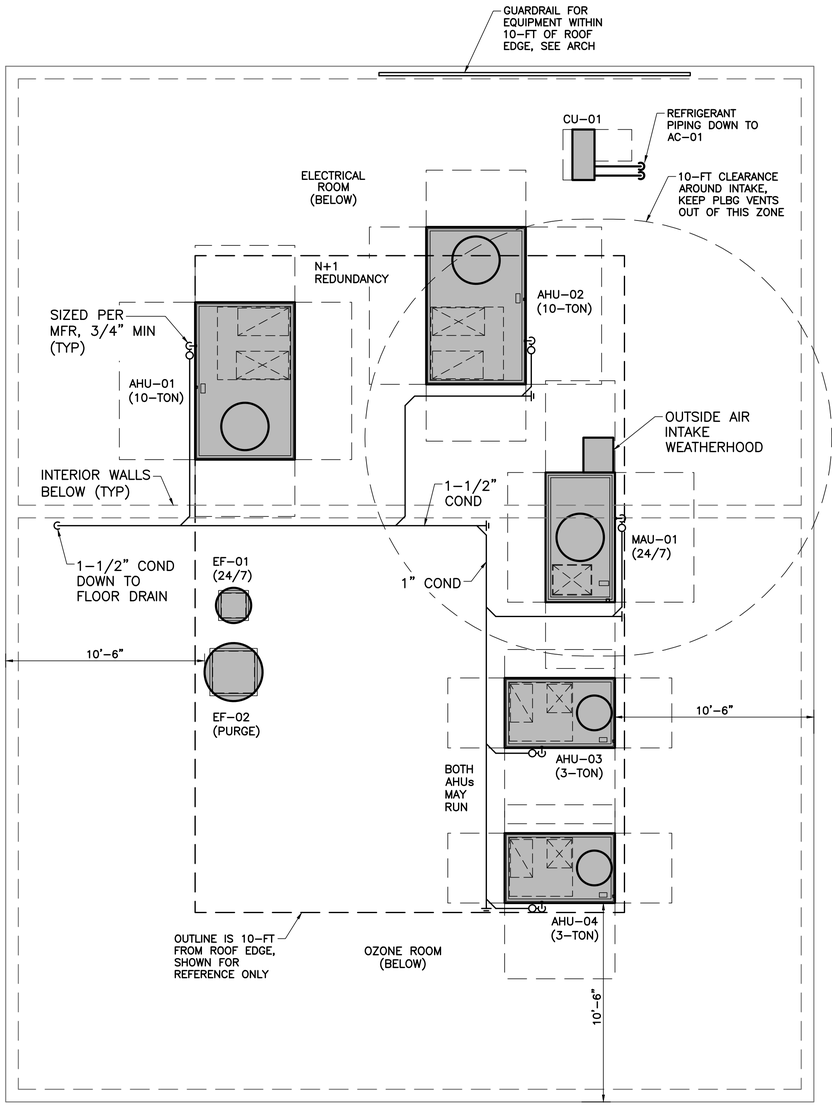
Friday, January 10, 2025, 4:26pm



MATERIALS OF CONSTRUCTION:

EXHAUST FANS:
1. ALUMINUM WITH SSTL AND COATINGS.

AIR HANDLING UNITS (AHU) AND MAKEUP AIR UNITS (MAU):
1. MANUFACTURER'S STANDARD, AND COATINGS.

CONDENSATE PIPING:
1. CONDENSATE PIPING OUTDOORS SHALL BE COPPER.

1 PLAN
SCALE: 1/4" = 1'-0"
0 4' 8'
22"x34" SCALE: 1"=4'
11"x17" SCALE: 1"=8'

AACE Engineering License #F-10694

THESE DOCUMENTS ARE RELEASED FOR PRELIMINARY REVIEW ONLY UNDER THE AUTHORITY OF RICARDO J. AZCARATE, P.E. NO. 81863 ON 01/10/25. IT IS NOT INTENDED FOR CONSTRUCTION, BIDDING, OR OTHER UNAUTHORIZED PURPOSES.

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81863
LICENSED PROFESSIONAL ENGINEER
2025-Jan-10

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