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Procurement Department

ADDENDUM # 6

To: File 1805-909-23-4796
RFP for: Victoria Plaza Rehabilitation and Modernization

Please make the following changes:

Closing date and time are changed to July 24, 2018 at 2:00 p.m.

Replace pages in Sections 21, 22 and 23 of the specifications with the attached revisions.

Replace the following drawings with the attached revisions: P1-0, P1-1, M1-1, M1-2

See attached notes from H2MG titled Addendum 1 dated 7/3/18

See attached notes (2 sets 1 for Mechanical Drawings and 1 for Electrical Drawings) from H2MG titled Project Memo both dated July 3, 2018

See attached notes from H2MG titled Addendum No. 6, dated July 18, 2018

The following questions are asked:

Question 1: With the clarification that the incoming service will be concrete encased in that basement, can we get a cut through the basement that shows the relationship of the exterior grade to the basement grade. Also does the basement have a concrete floor?
Answer 1: Yes. See attached As Built drawings.

Question 2: E1.1 – What is the meaning of general note #2?
Answer 2: See R1, R2, R3.

Question 3: E2.0 – The VFD's shown between column line A12 & A13 appear to need free standing racks. Is this correct?
Answer 3: May be wall mounted.

Question 4: E2.0 – Note 10: VFD's come with a disconnect, a separate disconnect is not required.
Answer 4: If VFD has a disconnect the disconnect shown may be deleted.

Question 5: E2.1 – Note 11: Since this is on a GFI circuit breaker this should be a standard receptacle**.**
Answer 5: If a GFI breaker is provided the GFCI receptacle may be deleted.

Question 6: E2.1.1 – Notes 2 & 8 call for a motor rated switch but the symbol calls for a manual motor starter with thermal overloads. Is every place where an $M is shown on the plans just a motor rated switch?
Answer 6: Motor rated switch is acceptable.

Question 7: E2.2 – Is there really no unit 15 on the 5th floor?
Answer 7: Not sure of the question, do you mean unit "D"?

Question 8: We understand that the SPF is part of an alternate. Which other equipment also comprise this alternate?
Answer 8: It is not an Alternate.

Question 9: E2.3 – Please verify that the elevator disconnects shown on this sheet are really Bussman modules.
Answer 9: See note 4.

Question 10: What is the E in a circle south of the elevators for?
Answer 10: Unknown.

Question 11: E3.2 – We understand that this sheet is for floor 2 through 9, though the detail tag only references level 2.
Answer 11: Levels 2 through 9.

Question 12: E6.1 – We assume that the difference in feeders to the units is based on voltage drop. We note that the feeders to units 05 & 06 are the same length but different sizing. Why is this?
Answer 12: All feeders are the same.

Question 13: E6.1 – Since the generator feeds a 3 pole ATS no ground should be used at the generator. (only when a 4 pole is used)
Answer 13: The Ground is required per NEC.

Question 14: E6.1 – Note 6 should be repositioned on the riser as it appears to apply to feeder L3000. Also note 6 should also reference note 1 on sheet E6.3 for clarity.
Answer 14: Acknowledged.

Question 15: E6.1 – Note 17 is used at the generator but the narrative is missing. We assume it may have to do with the control wiring from the generator to the ATS on the fire pump. Note that this control wiring must also be 2 hour fire rated!
Answer 15: We concur.

Question 16: E6.1 – We believe that the feeder to XFMR "TMSBL" should be H2000 not L2000.
Answer 16: We concur.

Question 17: E6.3 – The feeder from the existing transformer to the existing panel ELEP will be in excess of 25'. Should a fused disconnect be mounted on a rack above the transformer?
Answer 17: The feeder may not exceed 25 feet.

Question 18: E7.3 – Since a fused disconnect was added ahead of ELA we assume this is now an MLO panel.
Answer 18: It could be an MLO.

Question 19: Section 26 05 33: We do not find any requirement for the incoming service to be concrete encased except in the building. Correct?
Answer 19: CPS and City of San Antonio require concrete encasement.

Question 20: Section 26 05 33: It appears that EMT is allowable in the crawl space. Correct?
Answer 20: Only if not in a moisture area.

Question 21: Section 26 05 33: Will MC cable be allowed for wiring within the units?
Answer 21: Not specified, may be a value engineering option.

Question 22: E2.2 – Are any of the walls which will be penetrated by the horizontal feeders to the units concrete requiring coring?
Answer 22: See General Note #4.

Question 23: Sht P1.3 note 7 calls for solar panels typical. No specification is supplied for the solar panels or associated accessories. Please expand on solar panel requirements.
Answer 23: Refer to notes in the electrical drawings.

Question 24: Has the Housing Authority negotiated with the city/county for permit fees.
Answer 24: We are not aware of any permit fee negotiations or discounts.

By: Charles R Bode
Charles Bode Asst. Director of Procurement

Date: July 19, 2018

Victoria Plaza Renovation
San Antonio Housing Authority
Phase 1

INDEX

DIVISION 21 - 23
MECHANICAL SPECIFICATIONS

SECTION 21 10 00 - FIRE PROTECTION SYSTEM

PART 1 - GENERAL

1.1 SCOPE

A. This Section specifies a complete and working fire protection system consisting of an automatic wet pipe fire sprinkler system, an automatic dry pipe fire sprinkler system, a wet standpipe system and a fire protection pressure boosting system extending from a control pumping station to all fire main risers and fire hydrants.

1.2 APPLICABLE PROVISIONS

A. Refer to Section 23 00 00, Mechanical General Provisions.

1.3 STANDARDS

A. Make the installation in accordance with applicable statutes, ordinances, codes and regulations of National Fire Protection Association (NFPA), Underwriters Laboratories (UL), OSHA, Factory Mutual, Industrial Risk Insurers, the building insurance underwriter, the City of San Antonio Fire Department and any state, local or other governmental authorities having jurisdiction.

B. Resolve any code violation discovered in contract documents with the Engineer prior to award of the contract. After award of the contract, make any correction or addition necessary for compliance with applicable codes at no additional cost to Owner.

C. Furnish equipment and materials approved by NFPA, FM and UL. Fittings, valves, hoses and the like must bear a UL label.

D. Obtain and pay for all permits and inspections.

1.4 CONTRACTOR QUALIFICATIONS

A. Contractor for the work under this section shall be a specialist in this field and have the personal experience, training, skill and the organization to furnish a practical working system. If required, the Contractor shall furnish acceptable evidence of having contracted for and installed not less than three systems of comparable size and type to this one, that have served their Owners satisfactorily for not less than three years.

B. The foreman for this work shall have had experience in installing not less than three such systems that have been approved by the local Fire Marshal's office. Adequate and competent supervision shall be provided to ensure first class workmanship and installation.

C. The Contractor shall hold a Certificate of Registration from The State Fire Marshal per the Texas State Sprinkler Rules and Article 5.43-3 Insurance Code.

D. Work shall be executed and all materials installed in accordance with the best practice of the trades in a thorough, substantial, workmanlike manner by competent workmen, presenting a neat appearance when completed. Work shall be performed by mechanics skilled in the trade.

E. The Contractor shall be responsible for all construction techniques required for all fire protection systems specified and shown on the drawings.

1.5 AUTOMATIC SPRINKLER SYSTEM DESIGN CRITERIA

A. Requirements. Furnish a complete, working and approved automatic sprinkler system for the entire building, including all concealed spaces, attics, stairs and outside covered walkways as required by all authorities listed in this specification. Furnish a complete automatic wet pipe sprinkler system for all heated building areas and a complete dry pipe system for all unheated areas (areas subject to freezing). All portions of buildings shall be protected by automatic fire sprinkler systems. Reference floor plans for additional requirements. Drawings indicate a general arrangement of the system and are not to be considered as a complete or final design. If Contractor must deviate from general arrangement shown, such deviation shall be clearly indicated with Contractor's bid and shall submit a detailed description of the deviation with his bid. Contractor shall pay all costs incurred to change the sprinkler system design or arrangement after award of contract.

B. Flow Test. Prior to design, conduct a flow test with representatives of the Owner's Insurance Company, where applicable, and the local Fire Department present.

C. System Design. The sprinkler system contractor is required to develop, submit and install a complete and approved fire protection system design.

1. Prepare detailed drawings and submit them to Factory Mutual, the building insurance underwriter, the City of San Antonio Fire Marshal's Office, and any other state or local governing body having jurisdiction for approval. Contractor shall commence design work on submittal drawings immediately after award of contract and shall submit approved drawings to the Architect/Engineer in a reasonable amount of time (for Engineer's acknowledgement) prior to installation of any portion of the fire systems. Approved data shall bear seal of approval by the Factory Mutual, the City of San Antonio Fire Department and all other agencies having jurisdiction (insurance or otherwise). Submit approved drawings only. Do not submit drawings to Architect/Engineer without approval seal and signature. Drawings shall include all required information required by NFPA pamphlets for working plans, including all details, plans, calculations, etc. All fire sprinkler drawings shall include all information required by NFPA 13, Chapter 1.

2. Drawings shall be submitted to governmental authorities (listed in this specification), for approval immediately after award of contract to avoid delays on the construction project. Contractor shall be responsible for obtaining approvals before start of construction and shall assume all responsibilities for delays.

3. The Contractor shall be responsible for the complete design of the fire sprinkler system. All pressure losses through the distribution system and fluctuations in supply system pressures shall be adequately accounted for. Care shall be taken in making water tests to be used in designing or evaluating the capacity of sprinkler systems. Reference NFPA pamphlet No. 13 Appendix A. It shall be the sole responsibility of the Contractor to

replace or otherwise correct any portion of the fire sprinkler system that does not meet available pressures and flow rates. Future changes in water supplies shall be considered. It shall be the sole responsibility of the Contractor to determine available flow and pressures.

4. The automatic sprinkler system shall be hydraulically designed (by the Contractor).

5. All piping shall be installed above finished ceilings and below roof insulation (except for dry pipe systems). Do not route piping under lights.

6. Provisions for flushing systems. Sprinkler system shall be arranged for flushing. Readily removable fittings shall be furnished at the end of all cross mains. All cross mains shall terminate in 1-1/4-inches or larger pipe. All branch lines on sprinkler system shall be arranged to facilitate flushing. Route all drain lines to outside.

7. Contractor shall coordinate exact location of access doors with Architect/Engineer during design phase. Obtain location approval from Architect/Engineer for each and every access door.

8. All sprinkler heads shall be installed at the center of all ceiling tiles. Do not locate heads off center of tiles or near ceiling grids. Contractor shall include in his bid costs for additional pipe, sprinkler heads, etc. required to accomplish these spacing requirements.

9. Prior to installation, furnish a minimum of seven (7) copies of approved drawings to the Architect/Engineer. Do not start installation work until all required approvals have been obtained.

10. Design the system in accordance with statutes, ordinances, codes and regulations of Factory Mutual, Industrial Risk Insurers, National Fire Protection Association (NFPA), Underwriters Laboratories (UL), OSHA, International Building Code, City of San Antonio Fire Department, the building insurance underwriter, and any state, local or other governmental authorities having jurisdiction.

11. Test Procedures. Upon completion and prior to acceptance of installation, test the system as required in NFPA Pamphlet No. 13.

12. Material and Equipment. Use new and unused materials and equipment, approved by NFPA and as listed in the UL list of "Inspected Fire Protection Equipment and Materials."

1.6 GUARANTEE

A. Guarantee work for 1-year from the date of final acceptance of the project and during that period make good any faults or imperfections that may arise due to defects or omissions in materials, workmanship or design.

2.0 PRODUCTS

2.1 PIPING AND FITTINGS

A. Furnish pipe and pipe fittings of domestic manufacturers only.

1. Above Slab. Furnish Schedule 40, black steel pipe conforming to ASTM A 135 with Class-150 standard Malleable Iron screwed fittings. For piping 4-inch and larger diameter pipe, weld the joints. Style 77, Victaulic couplings with grade "E" molded synthetic rubber gaskets (rated at 300 PSI) are acceptable alternatives to welded connections. Thin wall pipe shall not be used.

    a. Pipe Hangers. Furnish U.L. listed and FM approved, adjustable, pregalvanized carbon steel with zinc electroplated insert equivalent to Michigan Hanger Co., Inc. Model #115 and #130.

2. Underground. Furnish Class 50 ductile iron pipe meeting requirements of AWWA C-104, C-151 and ASTM A-339, wrapped with at least 8-mils of polyethylene wrap. Furnish concrete thrust blocks at all changes in direction, according to the pipe manufacturer's recommendations (minimum 4-sack mix with a compressive strength at 28 days of 2000 PSI).

2.2 FIRE MAIN VALVES

A. Furnish valves for use on fire mains as specified. Valves 2-1/2 inches and above shall be stamped with UL approval.

1. Above Ground Gate Valves. Furnish Class 175, WWP, OS & Y, bronze mounted, solid wedge, ASTM A-126 Class B cast body and bonnet, flanged end, UL stamped gate valves. Stockham G-634, Kennedy 68, Mueller A-2073-6 or Nibco F-607-O.

2. Gate Valves for Wall Indicator Post. Furnish Class 175, bronze mounted, solid wedge, ASTM A-126 Class B cast body and bonnet, non rising stem, flanged end, UL stamped gate valves with mounting plate for indicator post. Stockham G-632-O, Kennedy 70X, Mueller A-2052-6 or Nibco F-609.

3. Globe Valves. Furnish Class 125, WOG, rising stem, brass swivel disc holder, screwed end, UL listed for fire sprinkler service all bronze globe valves. United 125S or Kennedy 97W/182.

4. Check Valves. Furnish Class 175, WWP, Bolted cap, ASTM A-126 Class B cast body and cap, flanged end, UL stamped check valves with composition swing-type disc. Stockham G-940, Kennedy 126A or Nibco F-908-W.

5. Dry Pipe Valve. Furnish Reliable Automatic Sprinkler Company Inc. Model "D" dry pipe valve complete with trim and model A-2 or B-1 Automatic air maintenance device.

6. Alarm Check Valves. Furnish Reliable Automatic Sprinkler Company Inc. Model "E" alarm valve complete with trim.

7. Water Motor Gong. Furnish Reliable Automatic Sprinkler Company Inc. Model "C" mechanical sprinkler alarm, complete.

8. Ball Drip Valves. Furnish Potter Roemer No. 5982 3/4-inch ball drip valve or approved equal.

2.3 SPRINKLER HEADS

A. Install upright, pendent or sidewall sprinkler heads in exposed piping areas and flush type sprinkler heads in areas with ceilings. Furnish dry pendent type where applicable. Prior to submitting on sprinkler heads, obtain approval of specified heads from authorities listed above in this section. All heads shall be UL listed.

1. Upright or pendant. Use a brass sprinkler head, such as Reliable Automatic Sprinkler Company Inc. Model "G" "Automatic Sprinklers Spray Upright, Spray Pendant and Conventional", with polished chrome finish for upright or pendant installation.
2. Sidewall. Use a brass sprinkler head, such as Reliable Automatic Sprinkler Company Inc. Model "G" "Sidewall Sprinklers", with polished chrome finish for sidewall installation. Furnish extended coverage heads where required.

3. Flush. Use a brass sprinkler head, such as Reliable Automatic Sprinkler Company Inc. Model "G4", concealed head with flat white finish cover plate, for flush installation.

4. Dry Pendant. Use a brass sprinkler head, such as Reliable Automatic Sprinkler Company Inc. Model "G3", dry sprinkler. Furnish concealed type with flat white finish cover plate for areas with lay in ceilings and recessed pendant type with polished chrome plated cup assembly in all other areas.

B. Spare Sprinkler Head Box. Furnish a red baked enamel fire sprinkler head cabinet complete with replacement sprinkler heads (quantity as required by NFPA) and one sprinkler wrench for each type of sprinkler head. Locate and install on wall as close as possible to fire main riser.

2.4 FIRE DEPARTMENT INLET CONNECTIONS:

A. Freestanding Fire Department Connection:

1. Furnish and install cast brass angle body, 18” long polished brass cover sleeve, cast brass identification base plate, cast brass plugs and chains on each pin lug swivel. Potter Roemer No. 5785 or approved equal.

B. Freestanding Fire Pump Test Header:

1. Furnish and install cast brass angle inlet body, brass NRS hose gate valves with loose bonnets, 3” female N.P.T. inlet x 2-1/2” male hose thread outlet, 2-1/2” male hose threaded outlet, 2-1/2” caps and chains, 18” long polished brass cover sleeve and brass identification plate letters “Pump Test Header Connection”, Potter Roemer No. 5868 or approved equivalent.

C. Roof Mounted:

1. Furnish and install cast brass body with female N.P.T. inlet and male N.P.T. 3-way outlets with 2-1/2" fire hose valve connections. Potter Roemer No. 5882.

2.5 FLOW INDICATOR SWITCHES

A. Furnish a U.L. Listed and FM approved water flow indicator with a minimum of two sets of normally open contacts and 20-second delay such as a McDonnell Miller FS-4-3D-20. A contact on the indicator will be connected to building fire alarm system. Install where shown on drawings and furnish all wire and conduit required from flow switch to the alarm panel.

2.6 SUPERVISORY SWITCHES

A. Furnish U.L Listed and FM approved, Notifier Series NIP supervisory switch for indicator post and Series NGV supervisory switch for OS&Y valve installation with two single pole, double throw microswitches. The mechanism shall be contained in a red baked enamel, weatherproof housing and shall incorporate the necessary facilities for attachment to the valve. The switch mechanism shall have a minimum capacity of 1 ampere, 125 volts a-c. The entire installed assembly shall be tamperproof and arranged to cause switch operation if the housing cover is removed or if the unit is removed from its mounting. Install supervisory switches where shown on drawings and furnish all wire and conduit required from supervisory switch to the alarm panel. Furnish a set of additional alarm contacts for additional supervisory capability.

2.7 AUTOMATIC DRY PIPE FIRE SPRINKLER SYSTEM

A. System. Include all necessary pipe, pipe fittings and accessories as required to furnish a complete, working and approved system.

B. Dry Pipe Valve. Equip, connect and install dry pipe valve and system as required by NFPA. Furnish valve and standard system appurtenances, including priming chambers, water and air pressure gauges, priming water level indicator, alarm testing by-pass, air maintenance device, etc.

C. Air Compressor. Furnish a UL listed, completely automatic, electric motor driven air compressor unit built, sized and equipped as required by NFPA. Install where shown and connect to dry pipe system with air maintenance device. Furnish an air pressure switch wired to operate the compressor. Size the compressor as required to recover and maintain system at normal pressure plus 25 percent in less than 30 minutes minimum and as required by all authorities having jurisdiction. Contractor shall size compressor and coordinate adequate electrical power service to compressor prior to submittal of product.

1. Motor. Furnish a high efficiency, drip-proof motor suitable for use and of sufficient size to handle full load starting torque.

2. Air Receiver. Furnish a cylindrical steel tank, constructed in accordance with ASME Code for unfired pressure vessels. Furnish receiver with inlet and outlet fittings located above tank centerline and a drain on bottom. Equip outlet and drain with shut-off valves.

Size air receiver as required by NFPA for dry pipe sprinkler system installation.

3. Moisture Traps. Use ball float moisture traps with case body 250 psi. Wilkerson Model 5101-8. Install where shown and at low points of the system.

4. Controls. Furnish all motor starters, control panels, pressure switches, conduit, wiring and all other appurtenances required for a complete and working automatic system.

2.8 FIRE PUMP SYSTEM

A. System. Assemble the system on the job and include the fire pump, fire pump controller, jockey pump, jockey pump controller magnetic across-the-line starters and all valves, gauges, accessories and interconnecting piping to furnish a complete and working pumping system.

B. Fire Pump. Furnish UL and FM approved horizontal, split case fire pump with an electric drive motor and shall fully conform to NFPA Pamphlet No. 20. Capacities and characteristics are scheduled on the drawings.

1. Furnish pump designed to deliver not less than 150 percent to the rated capacity at the pressure of not less than 65 percent of the rated head.

2. Furnish that shut-off pressure not exceed 120 percent of the rated pressure.

3. Hydrostatically test the pump to twice the working pressure but not less than 250 PSIG. In addition, pump shall be given a complete performance test. The certified characteristic curves obtained from the test shall be properly prepared and submitted to the Architect/Engineer. Furnish factory certified pump curves.

4. Mount the pump and driver on a common base plate of fabricated steel.

5. Connect the pump and driver directly through a flexible coupling.

6. As driver, furnish a horizontal induction electric motor of open, drip-proof type.

7. Fire pump shall be equipped with eccentric suction reducer, discharge tee, blind flange, overflow cone, hose valve header, casing pressure relief valve (not smaller than 3/4-inch). Suction and discharge pressure gauges, automatic air release valve, concentric discharge increaser fitting and engraved or permanently etched operating instructions and capacities.

8. Pump motors and related appurtenances shall be equipped for Wye-Delta starter operation.

C. Fire Pump Controller. Furnish a motor control specifically approved for fire pump use and marked "Fire Pump Controller." Furnish fire control equipment completely assembled, wired and tested at the factory. Select Joslyn Clark Controls or approved equal. Enclose all equipment in one or more approved, drip-tight enclosures. Employ combined manual and automatic, across-the-line controllers incorporating the following:

1. An externally operable, quick-break disconnect switch.

2. A time delay circuit breaker with trips on all phases for 300 percent of full load motor current.

3. A "Wye-Delta" reduced current motor starter capable of being energized automatically through the pressure switch or manually by an externally operable handle.

4. A running period timer set to keep the motor in operation after automatic start-up for at least 1 minute for each 10 horsepower of motor rating, but not to exceed 7 minutes.

5. An integral adjustable pressure switch.

6. A pilot lamp to indicate that circuit breaker is closed and power is available.

7. An alarm relay to energize an audible and visible alarm through an independent source of power to indicate phase reversal on line side of motor starter and that the circuit breaker is open or that power has failed. Furnish 4-inch vibrating bell and dual-lamp visual alarm.

8. Furnish an ammeter test link and voltmeter test studs.

9. Mount a two-position selector station on the enclosure marked "Automatic" and "Non-Automatic".

10. Furnish means on the controller to operate an alarm signal continuously while the pump is running.

11. One set of auxiliary contacts for connections to the data gathering system, one normally open one normally closed.

12. Equip controller with a "Wye-Delta" closed transition reduced current connection for starting current of 33.3 percent across-the-line starting in-rush and starting torque.

13. Furnish NEMA 2 enclosure with top drip head for controller.

D. Jockey Pump and Controller. Furnish turbine or vertical shaft centrifugal multi-stage type jockey pump with capacity and characteristics as scheduled on drawings. Equip with two pressure gauges (suction and discharge), field adjustable pressure switch initially set to maintain pressure as scheduled on drawings and a 3/4-inch relief valve set at 150 percent of the design head. Furnish a combined manual and automatic jockey pump control panel with fused disconnect switch, magnetic starter, minimum run timer and manual-off-automatic selector switch. (Furnish NEMA 1 enclosure, with top drip hood).

E. Fire Pump Test Connection. Furnish a Potter Roemer No. 5864, 4-outlet, 1000 GPM, polished chrome-plated brass, UL listed, fire pump test connection with six rising stem fire department outlet valves. Install complete with plugs, chains and cast brass plate lettered PUMP TEST CONNECTION all with polished chrome finish. Test threads on 2-1/2-inch valves, using a coupling from the local fire department hose. Make the test in presence of the Architect/Engineer, or Owner.

2.10 APPURTENANCES

A. Furnish all equipment, accessories, fittings, drains, valves, switches, controls, conduit, wire, etc. and all other appurtenances required to make a complete, working and approved system.

B. Furnish wall, polished chrome plated brass pipe escutcheons for pipe penetrations through building floors, walls and ceilings. Reference the section on Pipe and Pipe Fittings - General.

C. Valve Signs. Furnish all required lettered metal sign conforming to NFPA 13 or NFPA 14 attached to each control valve.

D. Drains. Main drains shall be piped to discharge at safe points outside building or to sight cones attached to drains to size to readily care for full flow from each sprinkler drain under maximum pressure. All drain piping located outside shall be polished chrome plated brass.

E. Sleeves

1. Furnish schedule 40 galvanized steel pipe sleeves for pipes passing through masonry walls, floors and ceilings.

2. Extend sleeve completely through construction.

3. Reference the section on Pipe and Pipe Fittings - General.

F. Pipe Escutcheons. Each exterior wall pipe penetration shall be sealed on both sides with a polished chrome plated cast brass pipe escutcheon with set screw.

2.11 PRODUCT DATA

A. Fire system installer shall furnish instruction manual describing all components and functions, complete installation instructions, procedures for placing system in operation, maintenance procedures and instructions, catalog cuts, drawings, and electrical circuit wiring diagrams.

B. Submittals. Reference the section on Mechanical General Provisions.

2.12 TEST PROCEDURES

A. Upon completion and prior to acceptance of installation, test all systems per local requirements and NFPA Pamphlets.

2.13 THREAD TEST

A. Test threads on all 2-1/2-inch valves, using a coupling from the local fire department hose. Make the test in presence of the Architect/Engineer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Contractor shall make installation according to approved drawings.

B. All sprinkler heads shall be installed within the center of all ceiling tiles. Do not locate heads off center of tiles or near ceiling grids. Contractor shall install sprinkler heads in finished areas such that symmetry is maintained throughout the building. The aesthetic integrity of the interior finished areas shall be maintained. Prior to installing any sprinkler piping, the Sprinkler Contractor shall coordinate proposed location of piping with all trades including the General Contractor. In all cases, sprinkler piping shall be installed above finished ceilings and lights (do not route piping under lights). Contractor shall include in his bid, any additional pipe, sprinkler heads, etc., required to accomplish spacing requirements listed above.

C. Route all mains and branches as close as possible to the roof structure. Support all sprinkler piping independently from the structure; do not support from ducts, pipe, conduits, or other supports.

D. All sprinkler piping shall be routed concealed and hidden from view in walls, above ceilings or in chases in all finished areas. Do not expose piping in finished areas.

E. Supervisory switches shall be mounted so that they will not interfere with the normal operation of the valve and shall be adjusted to operate within two revolutions of the valve control or when the stem has moved no more than one-fifth of the distance from its normal position.

F. All underground piping within 5-feet of building shall be embedded in sand in accordance with section VIA-1.13a of the "Standard Construction Specifications of the Water and Wastewater Department.

G. Contractor shall comply with Chapter 1, NFPA-13, for approval, acceptance Tests and Material and Test Certificate.

H. Make the installation according to approved drawings. Give the entire system a complete performance test.

3.2 COORDINATION

A. Making adjustments to field conditions is considered a part of the work required. Do not use contract drawings accompanying these specifications for rough-in locations but only for pipe sizing and general routing.

B. Contractor shall examine and familiarize himself with the Architectural, Structural, Electrical and Mechanical drawings to be knowledgeable of all connections required and space limitations.

C. The drawings are diagrammatic and are not intended to show all the fittings required. Contractor shall include in his bid, costs for items of material and labor which are not specifically called for in drawings or specifications, but which are required to make fire protection system installation. Contractor shall make any necessary changes to avoid beams, footings, columns, piers, vents, ducts, equipment or other obstructions.

D. All ductwork, lights, structural members and main runs of all other piping shall take precedence over sprinkler piping; coordinate with all other trades.

E. In any case where a pipe shown on a plan sheet differs from that shown on a riser, schematic or detail, use the larger of the two sizes shown.

END OF SECTION 21 10 00

SECTION 22 11 16 - DOMESTIC WATER PIPING AND APPURTENANCES

PART 1 - GENERAL

1.1 SCOPE

A. This Section provides requirements for furnishing and installing domestic hot and cold water piping.

1.2 RELATED WORK

A. Division 02, Site Work. Excavation, Trenching and Backfilling for Utilities.

B. Division 23, Mechanical.

1. Earthwork.
2. Access Doors.
3. Valves, Strainers and Vents.
4. Low Temperature Piping Insulation.
5. High Temperature Piping Insulation.
6. Pipe and Pipe Fittings - General.

1.3 STANDARDS

A. Perform work in accordance with applicable statutes, ordinances, codes, and regulations of governmental authorities having jurisdiction.

B. Resolve any code violation discovered in contract documents with the Engineer prior to award of the Contract. After award of the Contract, make any correction or additions necessary for compliance with applicable codes at no additional cost to Owner.

C. Obtain and pay for all permits and inspections.

PART 2 - PRODUCTS

2.1 PIPING AND FITTINGS

A. Provide pipe and pipe fittings of domestic manufacturers only and with labeling to comply with NSF 61.

B. Above Ground Piping.

1. 4-inches and smaller. Provide seamless ASTM B 88 harddrawn Type L or CDA alloy 194 heavy copper water tube with wrought copper fittings, ANSI B 16.22. Tape all bare copper piping located in CMU block walls with polyvinyl tape.

2. 6-inches and larger. Provide Schedule 40, galvanized steel pipe and pipe fittings conforming to ASTM A 120 and Style 77, Victaulic couplings molded rubber gaskets (rated at 300 PSI minimum).

C. Solder. Use Harris "Stay-Safe-Bridgit", lead free, UPC and NSF approved, silver bearing solder with Harris "Stay-Clean" liquid solder flux. Apply per manufacturer's recommendations.

D. Unions. Provide Class-150, standard, 300-pound water-oil-gas service galvanized, malleable iron unions with ground joint and bronze seat. Flange joints larger than 2-inch. Provide dielectric isolating unions at all junctions or connections between metallic piping of dissimilar metal.

2.2 VALVES

A. Provide valves of one manufacturer only. Do not provide valves of more than one manufacturer throughout project.

B. Below Ground Gate Valves. Provide Class 200, WWP, AWWA, non-rising stem, IBBM, double disk with parallel seat, ASTM A-126 Class B cast body and bonnet, flanged end gate valves with 1-1/4-inch shaft and 2-inch operating nut. Stockham G-745-O, Kennedy 561X or Mueller A-2380-6.

1. Provide an adjustable, extension type cast iron valve box with screw or locking slide adjustment, flared base and locking lid with 3/16-inch minimum wall thickness. Provide valve box for each valve. Use covers with appropriate identification marking cast on cover of type service. Western Iron Works Fig. 6-1.

C. Check Valves.

1. 2-1/2-inches and smaller. Provide Class 125, ASTM B-62 cast bronze composition body and cap, screwed end all bronze check valves with brass or bronze swing type disc. Stockham B-319, Jenkins 4092, Walworth 3406 or Powell 578.

2. 3-inches and larger. Provide Class 125, bronze mounted, bolted cap, ASTM A-126 Class B cast body and cap, flanged end check valves with bronze swing-type disc. Stockham G-931, Jenkins 624C, Walworth 8928F, Powell 559 or Nibco F-918-B.

D. Ball Valves. (3-inches and smaller only) Provide 600 PSI, cast brass body, replaceable reinforced Teflon seats, conventional port, blowout proof stems, chrome plated brass ball and screwed ends. Stockham S-216-BR-RT, Apollo 70-100, Jenkins 901-A or Nibco T-580-BR.

E. Balancing Valves. Provide Bell & Gossett "CB" series "CIRCUIT-SETTER" balancing valves with NPT connections. Size, install and balance set in accordance with manufacturer's recommendations.

F. Pressure Reducing Valve. Provide a spring-loaded valve, with bronze body, threaded end with adjustable spring of corrosion-resistant steel and neoprene coated nylon diaphragm. 200 psi maximum inlet pressure and adjustable from 25 to 75 psi outlet pressure as required by Code. Fisher type 75A or Watts U5B series.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Make entire installation per local code requirements.

B. Keep the inside of the piping free from foreign matter.

C. Cut all piping neatly, using approved type mechanical cutters without damaging pipe. Use wheel cutters when applicable.

D. Ream all pipe connections and remove all burrs.

E. Properly flush all water lines adequately to remove all foreign matter from within plumbing systems prior to installation of fixtures.

F. For sets of fixtures installed on 4-inch walls or in concrete masonry unit (CMU) walls, provide a separate hot and cold water supply line for each fixture (do not interconnect in wall). Connect the water supply lines above the ceiling. Maintain structural and aesthetic integrity of walls.

G. Provide all valves, unions and appurtenances shown on floor plans, details, schematics and risers. Provide line-size shut-off valves for all groups of fixtures, each major equipment connection, each floor level and at all main branch connections to mains.

H. Provide access doors to provide access to all valves and to all appurtenances requiring service or maintenance.

I. Balancing valves shall be installed where shown on the drawings and where required to properly balance the hot water return system. Reference water heater specifications for other balancing requirements.

J. Provide all fittings and appurtenances required for a complete and working system.

3.3 MINIMUM COVER

A. For piping located below floors or finished grade, install piping in trench to the required depth to insure two feet minimum cover over pipe.

B. All underground piping shall be embedded in sand in accordance with Section VIA-1.13a of the "Standard Construction Specifications of the Water and Wastewater Department.

3.4 DRAINAGE

A. Install water piping systems with uniform horizontal grade of 1/8-inch per 10 feet, to low points to provide complete drainage of the system. Where constant pitch cannot be maintained for long runs, establish intermediate low points and rise to new level.

B. Grade branches to drain to mains or risers. Unless otherwise indicated, terminate low points of risers with drain valve piped to nearest hub or floor drain. Install a 2-inch drain for pipes 2-inches in diameter and larger. Install line size drain valves for pipes smaller than 2-inches. As drain valves, use gate valves as specified in this section. Route drains to floor drains with adequate air gap for cross connection protection.

3.5 STERILIZATION

A. Sterilize the main water system with solution containing not less than 50 parts per million available chlorine. Allow chlorinating solution to remain in system for period of 8 hours. Have valves and faucets opened and closed several times during the period. After sterilization, flush the solution from the system with clean water until residual chlorine content is less than 0.2 parts per million.

3.6 ROUGH-IN AND FINAL CONNECTIONS

A. Make rough-in and final connection of all services to all fixtures requiring plumbing connections. Contractor shall be responsible for installing fixtures at locations shown on the Architectural drawings and providing all service connections at required locations.

B. Provide service connections to all plumbing fixtures specified and to all equipment furnished by others. Reference Section 23 21 00 for rough-in requirements of equipment furnished by others.

3.7 COORDINATION

A. Making adjustments to field conditions is considered a part of the work required. Do not use contract drawings accompanying these specifications for rough-in locations but only for pipe sizing and general routing.

B. Contractor shall examine and familiarize himself with the Architectural, Structural, Electrical and Mechanical drawings to be knowledgeable of all plumbing connections required and space limitations.

C. The drawings are diagrammatic and are not intended to show all the fittings required. Contractor shall include in his bid, costs for items of material and labor which are not specifically called for in drawings or specifications, but which are required to make plumbing installation. Contractor shall make any necessary changes to avoid beams, footings, columns, piers, vents, ducts, equipment or other obstructions.

D. In any case where a pipe shown on a plan sheet differs from that shown on a riser, schematic or detail, use the larger of the two sizes shown.

E. Do not route any piping above electrical control panels and related electrical equipment. Prior to installation of any piping, determine the actual space requirements and the location of all electrical panels and related electrical equipment. Make all offsets and adjustments as required.

3.8 MAXIMUM PRESSURE

A. Provide pressure reducing valves on domestic water systems where pressures exceed 70 psi. Provide a minimum downstream pressure of 60 psi. Contractor shall obtain pressure readings at building cold water supply connection and forward pressure test findings to the Architect in written letter form prior to start of construction of interior water supply piping.

B. Pressure reducing valves shall be located exposed in mechanical rooms or (where space permits) above ceilings or in walls, with access doors of adequate size.

C. Equip all pressure reducing valves with two gate valves (for shut-off), a strainer, a 1-1/2-inch diameter by-pass with throttling valve (globe valve), a pressure relief valve and two pressure gauges. Relief valve discharge shall be routed to a safe point of discharge outside of building.

3.9 PIPE EXPANSION AND CONTRACTION

A. Provide expansion joints for all hot water piping having straight lengths of 100 feet and greater. Pipe anchors, guides and supports are specified in the section on pipe and pipe fittings general.

B. Provide swing joints to all branch connections and individual pipe connections from mains. Provide a minimum of 2-elbows from main connection for each branch or individual connection. Provide all offsets, changes in direction and swing joints required to compensate for expansion of pipe whether shown or not on the drawings.

C. Contractor shall install pipe with adequate spacing between the water lines and the building construction such that the expansion of the pipe (in length) is less than the space available. Protect all pipe from rupture or damage due to expansion.

3.10 TESTING

A. Test under a cold water hydrostatic pressure of 1-1/2 times operating pressure (150 psig minimum) and carefully check for leaks. Repair all leaks and retest system until system holds for at least 24 hours and proven watertight.

B. Testing shall be verified by Architect/Engineer or appointed Owner’s representative. At Architect's/Engineer's discretion, the General Contractor shall verify and document the test results. Test findings shall be documented and forwarded to the Architect.

END OF SECTION 22 11 16

SECTION 22 11 19 - VALVES, STRAINERS AND VENTS - GENERAL

PART 1 - GENERAL

A. This Section gives general requirements which apply to all Division 23, Mechanical, sections. Valve types for specific services are specified in the Section on that service.

PART 2 - PRODUCTS

2.1 VALVE DESIGN

A. Furnish valves designed for repacking under pressure when fully opened, equipped with packing suitable for intended service, equipped with gland followers, and having pressure/temperature rating not less than design criteria applicable to components of system. Perform shell and seat tests and stamp valve to show that tests have been successfully completed. Furnish valves conforming to following specifications:

Material	Specifications
Bronze - 150 psi maximum	ASTM B 62

2.2 VALVE OPERATORS

A. Furnish single lever operator for ball valves and butterfly valves.

2.3 VALVE BOXES

A. Employ cast iron boxes, extension type with screw or locking slide adjustment, and flared base. Minimum thickness of metal shall be 3/16-inch. Install boxes over each underground valve. Use covers with appropriate cast-in identification of service.

2.4 VALVE TAGS

A. Furnish valves with 1-1/2-inch diameter brass valve tag with stamped and red-filled numbers. Service designations shall be 1/2-inch letters, and valve numbers shall be 1/2-inch letters. Service designations shall be approved by Engineer. Secure tags to valves by use of brass "S" hooks and brass chain. Secure chain to valve by use of copper or monel meter seals. Mount charts and drawings listing functions of each valve and its location in a metal frame and behind glass places as directed. In addition on the record drawings, mark the symbols and furnish a valve schedule properly identifying the valve number and service with the exact location, the material being piped, and the room number of area that the valve services. This schedule shall be furnished on reproducible drafting paper or film suitable for reproduction on an Ozalid machine. The size of drafting paper shall be approved by the Owner.

2.5 STRAINERS

A. Unless specified or shown otherwise, furnish strainers ahead of tanks, traps, pumps, solenoid and control valves and other equipment indicated on drawings. Furnish "Y" or "T" pattern strainers. Arrange cap for easy removal of screen and provide with opening for blowout. Furnish strainer with blow-out nipple and plug valve of same size as blow-out connection, and pipe to nearest floor or hub drain.

2.6 WATER SYSTEM AIR VENTS

A. Use Armstrong No. AR-21 or approved equal venting traps at high points and at any other air pockets of closed circulating pipe systems. Extend 1/2-inch discharge drains to nearest floor or hub drain, or air handling unit condensate drain pan. Place a ball valve between air vent and piping system.

PART 3 - EXECUTION

A. Install valves and stops in accessible locations; furnish and install where shown or as required to make systems complete and readily maintained. Install shutoff valves to each group of plumbing fixtures and in branch chilled and heating water piping systems, whether shown or not.

B. Install valves located behind access doors so the doors can be closed with the valve in either the open or closed position.

C. Install valves so their bonnets can be removed.

D. Install horizontally-mounted valves so the valve stem is inclined 30 degrees above horizontal.

END OF SECTION 22 11 19

SECTION 22 11 23.13 - DOMESTIC WATER PRESSURE BOOSTING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes variable speed, packaged pump station for domestic water applications.

B. Sequence of operation

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Grundfos Hydro Multi-E

B. Quantum Flow – Proligy EZ Triplex

C. TIGERFLOW Systems, LLC (“TIGERFLOW”)

2.2 STATION

A. The station shall provide varying water flow rate at a constant pressure or ASHRAE 90.1 compliant pressure profile through the use of a PID PLC controller and variable speed drives.

B. The packaged pump station shall consist of:

1. Three pumps.

2. Check valves located on the discharge branch of each pump.

3. Ball valve or lug or grooved butterfly isolation valves for each set of pumps and check valves.

4. Common suction and discharge manifolds.

5. 4-20 mA transducer(s) located on the station discharge manifold.

6. A 4-20 mA transducer shall be provided on the suction manifold for applications where the water source is pressured city water.

7. Controls consisting of a dedicated variable frequency drives for each pump.

8. A common base or frame for components listed above.

2.3 COMPONENTS

A. Pumps shall be ANSI / NSF Standard 61 and ANSI / NSF 372 approved.

B. Valve, check, wafer type, 2” and larger

1. The Check Valve shall be of the silent operating type that begins to close as the forward flow diminishes and fully closes at zero velocity preventing flow reversal and resultant water hammer.

2. The valves used in potable water service shall be certified to NSF/ANSI 61, Drinking Water System Components – Health Effects, and certified to be Lead-Free in accordance with NSF/ANSI 372.

3. Manufacturer shall have a quality management system that is certified to ISO 9001 by an accredited, certifying body.

4. The valve design shall incorporate a center guided, spring loaded disc and having a short linear stroke that generates a flow area equal to the nominal valve size.

5. The operation of the valve shall not be affected by the position of installation. The valve shall be capable of operating in the horizontal or vertical positions with the flow up or down. Heavy duty springs for vertical flow down installations shall be provided when specified on 14 in. and larger valves.

6. All component parts shall be field replaceable without the need of special tools. Wafer and Globe styles shall be provided with a replaceable guide bushing held in position by the spring. The spring shall be designed to withstand 100,000 cycles without failure and provide a cracking pressure of 0.5 psi.

7. The wafer and globe disc shall be concave to the flow direction providing for disc stabilization, maximum strength, and a minimum flow velocity to open the valve.

8. The valve disc and seat shall have a seating surface finish of 16 micro-inch or better to ensure positive seating at all pressures. The leakage rate shall not exceed the allowable rate for metal seated valves allowed by AWWA Standard C508 or 1 oz. (30 ml) per hour per inch (mm) of valve diameter.

9. Wafer-style valve seats shall be fully retained with full size threads, and sealed with an O-ring.

C. Valve, butterfly, lug-type

1. Body shall be one-piece lug design with extended neck to allow for 2" of piping insulation. A non-corrosive bushing and a self-adjusting stem seal shall be provided. No field adjustment shall be necessary to maintain optimum field performance.

2. Disc edge and hub on metal discs shall be spherically machined and hand polished for minimum torque and maximum sealing capability.

3. Stem shall be one-piece design. Disc to stem connection shall be and internal double "D" design with no possible leak paths in the disc-to-stem connection. External disc-to- stem connections such as disc screws or pins are not allowed. Stem shall be mechanically retained in the body neck and no part of the stem shall be exposed to the line media.

4. Seat shall be tongue-and-groove bonded seat with a primary hub seal and a molded flange O-ring suitable for weld-neck and slip-on flanges. The seat shall totally encapsulate the body isolating it from the line media and no flange gaskets shall be required.

5. Valve shall have a maximum working pressure of 250 psig. Valve shall be tested to 110% of the rated pressure.

D. Valve, ball, 1-1/4" and smaller

1. Ball valves shall be 2-piece full port design constructed of forged copper silicon alloy brass body and end adapter.

2. Seats and stem packing shall be virgin PTFE. Stem shall be bottom loaded, blowout proof design with fluorocarbon elastomer O-ring to prevent stem leaks.

3. Ball valve shall have chrome plated brass ball and adjustable packing gland.

4. Valve sizes 1⁄4" – 2" shall be rated to 600psig (41 bar) WOG non-shock. Valves shall be certified to NSF/ ANSI standard 61/8.

5. Valve shall have a weighted average lead content of <=0.25% with respect to wetted area.

E. Piping

1. Manifolds shall be constructed of either 304 or 316 stainless steel. Manifolds shall have a maximum working pressure of 300 psig.

2. Manifolds shall be grooved at both ends to allow change of suction and discharge connection geometry in the field.

3. Main and branch piping shall be sized for a maximum velocity of 10 ft./s.

F. Controls

1. The control panel shall consist of:

a. Single point power connection

b. Through door control power disconnect with safety interlock to prevent door from being opened while in ON position

c. A solid-state programmable logic controller (PLC) with non-volatile memory (battery backup not required)

d. Fused 120 V AC control voltage transformer

e. Fused 24 V DC power supply, 1 Watt

f. Operator interface: 6-inch color scale touch screen Human Machine Interface (HMI, Tier I) including but not limited to the following:

(1) Main Screen with the following features:

(a) Individual pump HOA (Hand – Off – Auto) virtual switches

(b) Pump run indication, including current % speed

(c) Pump Failure indication

(d) current pressures readings in psig (suction and system)

(e) Current flow in GPM (if flowmeter specified)

(f) Adjustable manual (hand) speed setting

(g) Direct access to menu screen

(2) Menu screen providing direct access to all system settings and status screens

(a) Pump settings screen displays current settings and allows user changes

(b) Lead and lag pump start and stop pressures, psig.

(c) Lead and lag pump ON and OFF delay times, seconds

(3) Alarm settings screen displays current settings for all alarms and allows user changes.

(a) Low suction alarm settings

[1] Low suction pressure, psig

[2] ON and OFF delays, seconds

[3] Manual or automatic reset

(b) Low system alarm settings

[1] Low system pressure, psig

[2] ON and OFF delays, seconds

[3] Manual or automatic reset

(4) High system alarm settings

(a) High system pressure, psig

(b) ON and OFF delays, seconds

(c) Manual or automatic reset

(5) High suction economy mode

(a) Economy mode suction pressure, psig

(b) Economy mode enable / disable

(c) ON and OFF delays, seconds

(6) Separate Alarm Silence and Alarm Reset buttons

(7) Current system status screen displays:

(a) Pump(s) currently running

(b) Active alarms and warning messages

(8) System event history screen displays a minimum of the last 100 system events, including pump start /stops, alarm conditions and alarm acknowledgements.

(9) Pump run time screen displays the total operating time for each pump. Provide individual resets for each pump run time

(10) Lead pump alternation options will include:

(a) Automatic alternation on lead pump shutdown

(b) Manual alternation when operator touches alternate button

(c) Timed alternation:

[1] Daily (user specified time of day)

[2] Weekly (user specified day of week and time of day)

[3] Monthly (first week of month on user specified day of week and time of day)

(11) Multi-Level Security

(a) 5-8 Password protected security levels (field changeable passwords)

(12) An alarm horn with a minimum sound level of 85 db, annunciating all alarm conditions

g. The control panel shall be listed under UL/C-UL 508 and meet NEC (NFPA 70) requirements.

h. The control algorithm shall allow for varying discharge pressure with varying flow rates in order to compensate for varying friction losses in the system as described in ASHRAE 90.1. The control algorithm shall meet the requirements of ASHRAE 90.1.

i. The system control algorithm shall use a speed adjust curve calculation proportional response. Step response algorithms shall not be considered equal.

j. The Building Automation System communication through Modbus or BACnet protocol. Communication shall be provided via an RS-485 port.

k. The following event reporting shall be provided via BAS communication:

(1) Individual VFD status

(2) Remote System Disable

(3) Phase Loss Alarm

(4) Flow Switch or Level Switch option enabled

(5) Individual Pump Run

(6) Individual Pump Fault

(7) Individual Pump Hand/Auto status

(8) Low System Alarm

(9) Low Suction alarm

(10) High System Alarm

(11) General Alarm

(12) Alarm Horn Silenced

(13) System Sensor Failure

(14) Suction Sensor Failure

(15) Economy Mode engaged

(16) Fatal alarm

l. The following events initiation shall be available via BAS communication:

(1) BAS System Disable

(2) Enable BAS Set Point

(3) BAS Set Point (psi)

m. If VFD's are mounted inside the control panel, drive keypads shall me door mounted and accessible without opening the control panel or disengaging power.

n. The control panel shall have a minimum short circuit current rating of 1200 kVa.

o. The PLC controller shall communicate with the variable frequency drives using Modbus protocol via RS-485 cables.

G. Variable Frequency Drives (VFD)

1. Each drive will have individual disconnects and short circuit protection. Drive manufacturer must provide a two year minimum warranty.

2. Drives will be configured to provide the following operating features:

a. Drive keypad will have manual, off and automatic mode selection and will accessible to operators without opening an enclosure.

b. When in automatic, drive will run upon closure of the respective run permissive contact.

c. When in automatic and with a run permissive signal, drive speed will responded to a 0-10 V DC speed reference signal from pump controller.

d. Drive will provide a limited number of automatic resets for fault conditions and will maintain a history of faults.

H. Suction and system pressure transducers

1. Transducer wetted parts shall be a 300 series stainless steel.

2. Transducer shall output a 4-20 mA signal with a minimum accuracy of +1%.

PART 3 – EXECUTION

3.1 SUBMITTALS

A. Pumps curves with condition point and pump operating capacities shall be supplied.

B. Drawings

1. System outline drawing(s) including elevation, plan and detail views shall be provided.

2. Drawings shall include system connection and bolt-down sizes and locations as well as recommended NEC clearances.

3. Wiring diagrams in .pdf format shall be provided.

4. Installation, Operation and Maintenance manuals (IO&M's) shall be provided for the pump station.

3.2 QUALITY ASSURANCE

A. Manufacturers seeking authorization to furnish their product shall be a registered ISO9001:2008 manufacturer, and shall hold a current Quality Management Certificate for the assembly of custom packaged pumping systems and controls for use in commercial, irrigation, municipal, industrial, and fire applications.

B. The pump station shall be listed UL/cUL under category QCZJ for Packaged Pump Stations.

C. The manufacturer shall be listed under UL508 for the manufacturer of control panels.

D. The manufacturer shall have a minimum of 30 years' experience in the fabrication of packaged pump station.

E. The station shall be certified under NSF/ANSI Standard 61, Drinking Water System Components and NSF/ANSI 372 Lead Content Compliance.

F. The pump station shall be hydrostatically tested to maximum working pressure (MWP) the station is rated at for a minimum of 1 hour. Maximum working pressure is rated 125psig, 175psig, 230psig or 300psig based on the pump selected.

G. The pump station shall be factory run tested to insure condition point is maintained at the expected power draw.

H. The pump station test facility instrumentation shall be NIST traceable and have current calibration certificates.

I. Piping shall be built in compliance with ASME B31.1. Piping shall be fabricated by ASME Section IX certified welders.

J. Structural steel weldments shall we fabricated by AWS D1.1 certified welders.

K. Welder's certifications shall be available upon request.

3.3 INSTALLATION

A. Installation of the system shall be per the manufacture's recommendations and shall meet applicable federal, state and local codes.

B. Coordination of building trades and subcontractors and compliance with federal, state, and local codes shall be performed by the contractor with unit responsibility.

C. Unless otherwise negotiated, remote mounted instrumentation, control wiring and mapping of BAS communication points shall be the responsibility of the controls engineer/contractor.

D. Unless otherwise negotiated, interfacing of the Tier II HMI to the building's network to allow for web-enabled access shall be coordinated of the contractor having unit responsibility and the buildings IT professionals.

3.4 START-UP

A. Four (4) hours of start-up service and field training will be provided by the manufacturer's representative unless otherwise negotiated.

B. Prior to start-up, the station will be installed per manufacturer's instruction with power and water connected, communication lines connected, data point mapped and electrical inspection performed and approved. Sufficient water flow supply and demand shall be available to emulate full station designed performance.

C. The manufacturer's representative shall be given a minimum two (2) weeks of notice for start-up.

D. During start-up, the station shall be tested for start and stop conditions, pump condition point and full station flow. *Note if no flowmeter is purchased, it is the responsibility of the site to provide an accurate method for measuring or inferring flow.

END OF SECTION 22 11 23.13

SECTION 22 13 00 - DRAINS, HYDRANTS, CLEANOUTS AND APPURTENANCES

PART 1 - GENERAL

1.1 SCOPE

A. This Section provides requirements for furnishing and installing floor drains, hose bibbs, cleanouts and water hammer arresters.

1.2 RELATED WORK

A. Division 23 - Mechanical.

1. Access Doors.

2. Pipe and Pipe Fittings – General.

3. Domestic Water Piping.

4. Soil, Waste and Sanitary Drain Piping, Vent Piping

1.3 JOB REQUIREMENTS

A. Furnish drains, hydrants and cleanouts shown or specified with all necessary trimmings. Provide drains, drain bodies, hydrants, cleanouts and similar devices of one manufacturer.

B. Provide that all porcelain enameled surfaces be acid resistant.

1.4 STANDARDS

A. Perform work in accordance with applicable statutes, ordinances, codes, and regulations of governmental authorities having jurisdiction.

B. Resolve any code violation discovered in contract documents with the Engineer prior to award of the contract. After award of the contract, make any correction or additions necessary for compliance with applicable codes at no additional cost to Owner.

PART 2 - PRODUCTS

2.1 DRAINS

A. Floor Drains, Finished Areas, Square Top (FD-1). Furnish a primer coated cast iron floor drain with flashing flange, bottom outlet, seepage openings and 6-inch square, adjustable, heavy duty stainless steel strainer, Mifab F1000-5; Watts Drainage; Wade or approved equivalent.

B. Floor Drains, Mechanical Rooms, Shallow Type (FD-2). Furnish a primer coated cast iron floor drain with flashing flange, bottom outlet, seepage openings, secured/vandal proof, 9-inch diameter, satin finished nickel bronze or stainless steel, heavy duty/tractor grate and secondary strainer. Mifab F1320-Y-14-3-5, Watts Drainage FD-320-Y-1-5-6; Wade W-1310-1-5-8-13 or approved equivalent.

2.2 CLEANOUTS

A. Finished Floors and Concrete Floors, square top (FCO). Furnish a primer coated cast iron floor cleanout with combination cover and plug, threaded adjustable housing and ferrule, membrane flange, secured/vandal proof, square, heavy duty, satin finished nickel bronze or stainless steel scoriated top that adjusts to finished floor after concrete has set. Mifab C1100 C-5-3, Watts Drainage CO-200-S-6; Wade W-6030-XS-1-5-26-75 or approved equivalent.

B. Outside Areas, square top (EXTERIOR FCO). Furnish a primer coated cast iron, heavy traffic duty floor cleanout with combination cover and plug, threaded adjustable housing with flanged ferrule, secured/vandal proof, square, extra heavy duty, satin finished nickel bronze or stainless steel scoriated top (adjustable to finished grade level). Cast cleanouts flush in a 18-in. by 18-in. by 6-in. thick concrete pad. Concrete pad and cleanout shall be installed such that the top of pad and cleanout top are both set flush with finished grade. Mifab C1100-C-XR-3, Watts Drainage CO200-RX; Wade W-6010-XS-1-5-75 or approved equivalent.

C. Finished Walls (WCO). Furnish a primer coated cast iron cleanout tee with countersunk, taper thread bronze plug, No-Hub connections and round, smooth, stainless steel secured access cover with secured/vandal proof screw. Mifab C1460-RD-3, Watts Drainage CO-460-RD; Wade W-8460-NH-R6-5 (No-Hub connections) or approved equivalent.

D. Unfinished Areas (WCO). Furnish a primer coated cast iron cleanout tee with countersunk head, taper thread bronze plug and No-Hub connections. Mifab C1460, Wade W-8560NH-D; Watts Drainage CO-460; (No-Hub connections) or approved equivalent.

2.3 HYDRANTS

A. Hose Bibb, Finished Areas, Polished Chrome Finish (HB-1). Provide a polished chrome plated, short-pattern single sink faucet/hose bibb with self-contained and interchangeable operating nut (quarter turn), 3/4-inch flanged female inlet, ¾-inch hose thread outlet and polished chrome plated lever handle. Equip complete with non-removable, spout end vacuum breaker ASSE 1011 and ASSE 1019 listed with ¾-inch female hose thread inlet and 3/4-inch male hose thread outlet. Mifab HY-9241, Chicago Faucet No. 15-E27 or approved equivalent.

B. Hose Bibbs, Unfinished Area, Rough Brass Finish (HB-2). Provide a rough brass, short pattern single sink faucet/hose bibb with self-contained and interchangeable operating nut (quarter turn), 3/4-inch male inlet, 3/4-inch hose thread outlet and chrome plated tee handle. Equip complete with non-removable, spout end vacuum breaker ASSE 1011and ASSE 1019 listed with 3/4-inch female hose thread inlet and 3/4-inch male hose thread outlet. Mifab HY-9041, Chicago Faucet No. 7T-E27 or approved equivalent.

2.4 WATER HAMMER ARRESTERS

A. Type. Provide 250 psig, heavy-duty, balanced expansion, nesting bellows type hydraulic water hammer arresters contained in a permanently factory charged and sealed pressurized

compression chamber. Chamber shall consist of a stabilized 18-8 stainless steel casing having sufficient displacement volume to dissipate the calculated kinetic energy generated in the piping system and sealed with fusion weld under an argon gas shield. Provide bellows precharged with clinically pure air or nitrogen, completely sealed and operating free of casing. Water hammer arresters shall be tested and certified in accordance with the Plumbing and Drainage Institute (PDI) "Standard P.D.I. WH-201" and the American Society of Sanitary Engineering Standard ASSE-1010. Mifab CLB series, Watts Drainage SS Series; Wade W-Shockstop series or approved equivalent. O-ring type water hammer arresters are not considered equals. Do not submit or install water hammer arresters that depend on O-rings for seals.

B. Size. Provide all arresters size and quantity as required and recommended by both the Plumbing and Drainage Institute Standard PDI-WH-201 and the manufacturer's sizing and placement recommendation data sheets.

1. Contractor shall be responsible for obtaining and installing the proper number and size of water hammer arresters, including all arresters where special requirements occur. Where fixture unit counts/totals exceed the scheduled ratings, provide factory engineered, rechargeable water hammer arresters complete with pressure gauge and air valve.

2. Water Hammer Arrester sizes shown on drawings are <u>minimum size</u> requirements only (quantities are <u>partial</u> requirements only). Water hammer arresters shall be of sufficient size and shall be installed throughout the water systems such that there will be no noise, movement in the piping system or damage to equipment due to water hammer. Adequately protect all equipment and fixtures requiring water hammer protection to all washing machines, kitchen sinks, dishwashers, tub and showers, and waterclosets.

3. Access Doors. Provide a 10-inch (minimum) square access door for single arrester installations and a 14-inch square (minimum) door for two arrester installations in walls. Provide minimum 14-inch square access door for all arresters located above ceilings except for arresters located directly above lay-in-place acoustic tile ceilings.

2.5 WATERPROOFING MEMBRANE

A. When a membrane is not provided in floor or roof construction, provide a membrane of size that extends a minimum of 12-inches on either side of floor drain, roof drain or cleanout.

B. Membrane shall be 4-pound per square foot sheet lead, Number 24 B & S gauge sheet copper or three layers of standard grade 15-pound asphalt impregnated roofing felt with each layer thoroughly hot mopped to ensure a completely watertight installation.

C. Coordinate waterproofing with appropriate trades.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General.

1. Install in accordance with manufacturer's recommendations and as shown on the drawings.

B. Floor Drains and Hub Drains.

1. Coordinate flashing work with work of other trades. Coordinate with floor slab work to interface drains with concrete.

2. Install floor drains at the low points of the surface areas to be drained. Set top of drains 1/2-inch below finished floor elevation unless otherwise shown on mechanical or structural drawings. Set floor drain grates such that top of grate is installed flush with surrounding floor elevation.

3. Adequately grout around all floor drain tops. Fill in gaps between floor drain and floor with grout (or other rigid concrete based material) that matches the surrounding finished flooring in both color and texture.
4. Install drain flashing collar of flange such that no leakage occurs between drain and adjoining flooring. Maintain watertight integrity of penetrated waterproof membranes.

5. Position drains such that installed drains are accessible and easy to maintain.

6. All floor drains and hub drains shall be individually vented to outside or nearest vent of adequate size. Provide a vent line for each floor drain and hub drain whether or not shown on drawings. Provide a 2-inch diameter (minimum) individual vent line.

C. Cleanouts.

1. Location.

a. Cleanouts shown on drawings are partial requirements only. Contractor shall provide and install all cleanouts shown on drawings, specified in this specification section as well as any additional cleanouts required by code authorities having jurisdiction.

b. Provide cleanouts wherever necessary to make accessible all parts of the drainage soil or waste systems.

c. Provide a line size cleanout on each horizontal drain line 5-feet or greater in length.

d. Locate cleanouts in runs not more than 50-feet apart and provide all additional cleanouts required by local authority having jurisdiction. 50-foot spacing between cleanouts shall include length of vertical risers at cleanouts. All portions of the drain system shall be accessible to a 50-foot drain and sewer cleaning/rodding machine through cleanouts.

e. Provide cleanouts where soil or waste lines change in direction of more than 90□ as well as any other cleanouts required by local authority having jurisdiction.

f. Provide cleanouts at the end of each continuous waste line and at the end or each battery of fixtures.

g. Provide a line size wall cleanout at each sink and each urinal.

h. Provide cleanouts at the base of each soil or waste stack.

i. Provide a full size upper terminal cleanout at each run of piping which is more than 50-feet in total developed length or fraction thereof, except on horizontal drain lines less than five feet in length unless such line is serving sinks or urinals (cleanouts are required at all sinks and at all urinals).

j. Provide a full size, cast iron, double, two-way cleanout with two exterior floor cleanouts extended to grade and casted into a 18-inch by 24-inch by 6-inch concrete pad for each drain line extending from building. Risers from double two way cleanout fitting to cleanouts shall be standard weight, cast iron, DWV, bell and spigot soil pipe and pipe fittings.

2. Size. Install cleanouts the same size as the soil waste lines in which the cleanouts are placed; however, no cleanout should be larger than 4-inches in diameter.

3. Installation.

a. Set top of floor clean-outs such that top is flush with finished floor (including tile). Top of exterior floor cleanouts shall be installed flush with finished grade.

b. Where cleanouts occur in pipe chases, bring the cleanouts through the walls and install covers. Wall cleanout plugs shall be installed within 3-inches (in depth) from access door and shall be centered in respect to access door opening for easy access.

c. Install cleanout flashing collar of flange such that no leakage occur between cleanout and adjoining flooring. Maintain watertight integrity of penetrated waterproof membranes.

d. Cleanouts shall be readily accessible and shall be located at a minimum of 18-inches from any wall, fixture, equipment or other obstruction.

e. Adequately grout around all floor cleanout tops. Fill in gaps between cleanouts and floor with grout (or other rigid concrete based material) that matches the surrounding finished flooring in both color and texture.

4. Waterproofing. Coordinate flashing work with work of other trades.

D. Water Hammer Arresters.

1. Provide hydraulic water hammer arrestors in cold and hot water supply lines to each fixture, if single fixture, and to each battery of fixtures; and at each automatic,

solenoid-operated or quick-closing valve serving mechanical, kitchen or laundry equipment.

2. Hammer Arresters shown on drawings are partial requirements only. Water hammer arresters shall be installed throughout the water systems such that there will be no noise, movement in the piping system or damage to equipment due to water hammer. Adequately protect all equipment and fixtures requiring water hammer protection.

3. All water hammer arresters shall be installed directly behind such access doors and shall be readily accessible for easy replacement.

3.2 PROTECTION OF FINISH

A. All floor drains, cleanouts and wall hydrants shall be adequately protected from physical damage during construction. Grates, covers and tops that have been marred or damaged shall be replaced with new or equivalent design, material and finish at no cost to the Owner. Grates, covers and tops shall have a new and unmarred look at time of construction end.

3.3 COORDINATION

A. Making adjustments to field conditions is considered a part of the work required. Do not use

contract drawings accompanying these specifications for rough-in locations but only for pipe sizing and general routing.

B. Contractor shall examine and familiarize himself with the Architectural, Structural, Electrical and Mechanical drawings to be knowledgeable of all plumbing connections required and space limitations.

C. The drawings are diagrammatic and are not intended to show all the fittings required. Contractor shall include in his bid, costs for items of material and labor which are not specifically called for in drawings or specifications, but which are required to make plumbing installation. Contractor shall make any necessary changes to avoid beams, footings, columns, piers, vents, ducts, equipment or other obstructions.

END OF SECTION 22 13 00

SECTION 22 13 16 - SOIL, WASTE AND SANITARY CAST IRON DRAIN PIPING, VENT PIPING AND APPURTENANCES

PART 1 - GENERAL

1.1 SCOPE

A. This section provides requirements for furnishing and installing piping within buildings.

1.2 RELATED WORK

A. Division 23, Mechanical.

1. Pipe and Pipe Fittings.

2. Low Temperature Piping Insulation. For above ground drain piping receiving condensate.

3. Plumbing Fixtures and Fixture Carriers.

4. Drains, Hydrants and Cleanouts

1.3 STANDARDS

A. Perform work in accordance with applicable statutes, ordinances, codes, and regulations of governmental authorities having jurisdiction.

B. Resolve any code violation discovered in contract documents with the Engineer prior to award of the Contract. After award of the Contract, make any correction or additions necessary for compliance with applicable codes at no additional cost to Owner.

C. Obtain and pay for all permits and inspections.

D. All cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI) and be listed by NSF International.

E. All standard duty couplings for Hubless cast iron soil pipe and fittings shall conform to CISPI 310 and be certified by NSF International.

PART 2 - PRODUCTS

2.1 DRAIN PIPES AND FITTINGS

A. Provide piping within building and underground laterals extending from building and as otherwise noted.

B. Pipe and pipe fittings.

1. Above Ground Piping: Hot dipped coated, standard weight, cast iron DWV, no-hub soil pipe and pipe fittings with stainless steel couplings and neoprene gaskets.

a. Standards. No-hub piping shall meet testing requirements of ASTM A 74 and all requirements of CISPI 301 and 310. When requested by the engineer, the contractor shall furnish acceptable evidence if pipe tests.

b. Identification. No-Hub Pipe and pipe fittings shall bear the "CI NO-HUB" mark as evidence of adherence to CISPI standards.

c. Neoprene Gaskets. Gaskets shall conform to all requirements of ASTM C 564 standard and shall bear the mark "NEOPRENE" and "ASTM C 564".

d. Installation. Torque NO-Hub clamps.

C. For piping 2-inches and 3-inches in diameter, provide No-Hub pipe clamps manufactured by the No-Hub pipe and pipe fitting manufacturer. All pipe, pipe fittings, gaskets and clamps shall be of one domestic manufacturer. Do not interconnect pipe of one manufacturer with pipe fittings, gaskets and clamps of another. Purchase pipe, pipe fittings, gaskets and clamps as a system.

D. For piping 4-inches in diameter and larger, provide No-Hub pipe joints using Factory Mutual (F.M.) and Uniform Plumbing Code (UPC) approved and labeled No-Hub Pipe Clamps

1. Clamps shall be made of 24 gauge (.024-inch thick), Type 304 Stainless Steel shields. Each clamp shall consist of a neoprene gasket with a stainless steel outer band which effectively captures the gasket material and provides a 15-psi rated working pressure.

2. Each clamp shall bear the FM and UPC stamp and shall be approved to Class I of Factory Mutual Standard #1680.

3. Clamps shall have FM certification from a third party indicating clamp assemblies have been inspected and procedures have been verified to assure materials have been controlled to meet the FM #1680 requirements. Each clamp shall bear the FM and UPC stamp. Test shall include testing for blockage, bending moment, deflection angle, sealing sleeve, clamp strength, thrust as well as hydrostatic strength and salt spray.

4. Clamps shall be designed for 100 lbs. torque max. MiFab or approved equivalent. All elbows and tees shall be braced against thrust loads which might result in joint separation due to dynamic forces caused by sudden, heavy impulse loading (water hammer) conditions.

E. Install all clamps in accordance with the manufacturer’s recommendations, using tools recommended by the manufacturer of the pipe clamps. MiFab heavy duty couplings shall be made tight with a torque wrench and torqued to a minimum of 80 to 100-inch pounds, or as recommended by the manufacturer.

PART 3 - EXECUTION

3.1 NOTICE AND FEES

A. Give proper notice and pay all fees and other costs for complete sewer service.

3.2 GRADE AND COVER

A. Give horizontal pipe a uniform grade of 1/4-inch per foot where possible, but not less than 1/8-inch per foot, unless otherwise shown. Verify all flowline elevations and pipe grades with local authorities for approval of all sanitary piping with grades less than 1/4-inch per foot. Field verify all flow lines shown on drawings.

B. Prior to installation of any portion of piping, determine the actual space requirements including the space required for proper slope of pipe. Do not install any piping until such flow line elevations and offsets are determined to be acceptable within the limitations of these documents and local code requirements. Make all offsets and adjustments required for proper installation.

C. For piping located below floors or finished grade, install piping in trench to the required depth to ensure two feet minimum cover over the pipe.

3.3 DRAIN PIPE AND FITTINGS

A. Offsets and Fittings.

1. Use reduction fittings to connect two pipes of different diameter.

2. Change directions by appropriate use of 45-degree wyes, long-sweep quarter-bends, and sixth-, eighth-, and sixteenth-bends. Sanitary tees may be used on vertical stacks. Use long sweeps at the base of risers.

3. Do not route any piping above electrical control panels and related electrical equipment. Prior to installation of any piping, determine the actual space requirements and the location of all electrical panels and related electrical equipment. Make all offsets and adjustments as required.

B. Floor Drains. Provide all required floor drains complete with drain lines, vent lines and trap primers as required by the section on Drains, Hydrants and Cleanouts.

C. Cleanouts.

1. Provide drainage lines with properly specified cleanouts. Provide all as required by the section on drains, hydrants and cleanouts.

3.4 VENT PIPING

A. All vent and vent branch pipes shall be graded and connected to drip back to sanitary waste piping by gravity.

3.5 SANITARY DRAIN LINES RECEIVING CONDENSATE

A. Unless otherwise approved by local authority, all drains receiving condensate and located above ceilings or in rooms that are return air plenums shall be piped as follows;

1. Connect condensate drains to nearest sanitary drain line that is at least 3-inches in diameter.
2. Connect condensate drain through a 2-inch diameter deep seal P-trap.
3. Extend both 3-inch drain line and 2-inch P-trap inlet full size through roof and terminate at roof with a lead flashing as specified in this section for vent lines.
4. Connect condensate drain lines from equipment to side of 2-inch inlet drain line.
5. Insulate all above ground drain piping receiving condensate per Sections 23 07 00 and 23 07 19.53.

3.6 ROUGH-IN AND FINAL CONNECTIONS

A. Make rough-in and final connection of all services to all fixtures requiring plumbing connections. Contractor shall be responsible for installing fixtures at locations shown on the Architectural drawings and providing all service connections at required locations.

B. Rough-in and final connection of services to all equipment shall be installed in accordance with the latest edition of the manufacturer's rough-in measurements manual. Contractor shall obtain all such documents.

C. Use threaded sanitary tapped tee pipe fittings for p-trap connections at walls.

D. Provide service connections to all plumbing fixtures specified and to all equipment furnished by others. Reference Section 23 21 00 for rough-in requirements of equipment furnished by others.

E. Install all piping and associated equipment in accordance to manufacturer's recommendations using recommended tools.

F. Provide all fittings and appurtenances required for a complete and working system.

3.7 COORDINATION

A. Making adjustments to field conditions is considered a part of the work required. Do not use contract drawings accompanying these specifications for rough-in locations but only for pipe sizing and general routing.

B. Contractor shall examine and familiarize himself with the Architectural, Structural, Electrical and Mechanical drawings to be knowledgeable of all plumbing connections required and space limitations.

C. The drawings are diagrammatic and are not intended to show all the fittings required. Contractor shall include in his bid, costs for items of material and labor which are not specifically called for in drawings or specifications, but which are required to make plumbing installation. Contractor shall make any necessary changes to avoid beams, footings, columns, piers, vents, ducts, equipment or other obstructions.

D. In any case where a pipe shown on a plan sheet differs from that shown on a riser, schematic or detail, use the larger of the two sizes shown.

3.8 TESTING

A. Below Floors.

1. Test pipe below floors before backfilling and connecting to sewers.

2. Maintain not less than 15-feet of hydrostatic head.

3. Repair all leaks and repeat until system holds for 2-hours without a drop in water level.

B. System Test. After all the various sections of soil, waste and vent piping are installed, but before fixtures are connected, test the system by:

1. Plugging all outlets.

2. Filling the entire system with water and maintaining not less than 10-feet of hydrostatic head to any portion of the sanitary or vent piping system. Apply water tests to drainage, waste and vent systems either in its entirety or in sections. Provide extension pieces, wyes, supports, clamps, plugs and all other fittings and materials as required to facilitate plugging and testing.

3. Repair all leaks and repeat until system holds for 6-hours without a drop in water level.

C. Furnish all equipment and labor required to conduct tests.

D. Testing shall be verified by Architect/Engineer or appointed owners representative. At Architect's/Engineer's discretion, the General Contractor shall verify and document the test results. Test findings shall be documented and forwarded to the Architect.

E. Prior to ceiling and wall cover-up, Contractor shall conduct smoke test of the entire waste and vent system to assure no leaks occur. Prior to test Contractor shall seal all vent through roofs, pump smoke in system. Once complete and accepted by the Architect/Engineer Team, Contractor shall unplug all vent through roofs. Contractor shall conduct a second smoke test when all plumbing fixtures are installed and introduce smoke in piping system as mentioned above. Both tests are to be witnessed and accepted by the Architect/Engineer Team prior to completion of the project.

END OF SECTION 22 13 16

SECTION 22 31 00 - AUTOMATIC WATER SOFTENERS

1.0 GENERAL

1.1 SCOPE

a. This Section provides requirements for furnishing and installing automatic water softeners.

1.2 APPLICABLE PROVISIONS

a. Refer to Section 23 00 00, Mechanical General Provisions.

2.0 PRODUCTS

2.1 AUTOMATIC WATER SOFTENERS

a. General. Furnish a fully automatic softening system, including the following:

(1) Two softening tank

(2) One salt storage tank

(3) Control valves, meter and pressure gauges

(4) Inter-connecting piping and control wiring

b. Resin Tank. Each softener resin tank shall be 30-inches in diameter. The sideshell height shall be 72-inches, sufficient to allow proper freeboard space above the resin bed depth for adequate expansion of the resin during backwashing. Tanks shall be designed for a working pressure of 100 psi. Each shall be equipped with a removable opening in the top head for media filling purposes. All tanks shall be fiberglass reinforced polyester.

c. Distribution System. Softener tank shall be equipped with a soft water collector and backwash distributor consisting of a plastic riser pipe with a fine-slotted plastic strainer attached to the bottom of the pipe, covered with a minimum of 3-inches of underbed sand to ensure even distribution of water. Softener tank shall be equipped with an upper distributor that distributes water laterally to ensure maximum water softening capacity.

d. Softener tank will be provided with 15 cubic feet of resin having a minimum exchange capacity of 30,000 grains per cubic foot when regenerated with 15 pounds of salt. The media shall be solid, of the proper particle size (not more than 4% through 40 mesh U.S. standard screens, wet screening) and shall contain no agglomerates, shells, plates, or shapes that might interfere with the normal function of the water softener. All resin shall be manufactured to comply with the food additive regulations, Paragraph 121-1148 of the Food and Drug Administration.

e. Brine System. A combination salt storage and brine tank, measuring 30-inches in diameter by 48-inches tall, with cover, will be provided. The tank shall be molded of corrosion-proof, high-density polyethylene.

(1) The brine tank shall be equipped with an elevated salt plate for brine collection, and a chamber to house a brine valve assembly. The brine valve shall automatically open to admit brine to the resin tank during education and close automatically to prevent introduction of air into the resin tank. During refill, the brine valve will regulate the flow of soft water into the brine tank, working with the timed refill feature of the softener control valve; together these components shall admit the correct volume of water to the brine tank in accordance with the salt dosage settings on the control valve. The brine valve shall include a float-operated safety shut-off valve, as a back-up to the time refill valve on the control, to prevent brine tank overflow.

f. Controls: Fully automatic; factory mounted on unit and factory wired.

(1) Adjustable duration of various regeneration steps.

(2) Push-button start and complete manual operation.

(3) Electric time clock and switch for fully automatic operation, adjustable to initiate regeneration at any hour of day and any day of week or at fixed intervals.

(4) Sequence of Operation: Program multiport pilot-control valve to automatically press-actuate main operating valve through steps of regeneration and return to service.

(5) Point on pilot-control valve shall indicate cycle of operation.

(6) Means of manual operation of pilot-control valve if power fails.

(7) Main Operating Valve: Industrial, automatic, multiport, diaphragm type with following features:

(a) Slow opening and closing, nonslam operation.

(b) Diaphragm guiding on full perimeter from fully open to fully closed.

(c) Isolated dissimilar metals with valve.

(d) Self-adjusting, internal, automatic brine injector that draws brine and rises at constant rate independent of pressure.

(e) Valve for single mineral-tank unit with internal automatic bypass of raw water during regeneration.

(f) Sampling cocks for soft water.

(g) Special tools are not required for service.

(8) Flow Control: Automatic, to control backwash and flush rates over wide variations in operating pressures, and that does not require field adjustments

(a) Demand-Initiated Control: Equip single mineral-tank units with automatic-rese-head water meter that electrically activates cycle controller to initiate regeneration at preset total in gallons. Design so head automatically resets to preset in total gallons for next service run.

3.0 EXECUTION

a. Instructions. Complete instructions for the installation and operation of the softening system shall be provided in booklet form. All component parts will be easily identified, in exploded views, by individual part numbers.

b. Service. Start-up and subsequent service such as maintenance, repair, and salt delivery shall be available as desired from a local authorized independently operated dealer or license.

c. Product Integrity. All major components, such as tanks, control valves and internals, shall be designed and assembled by a single source for optimum compatibility.

d. Control valve. Water softener control valve shall be a 7-day timer.

END OF SECTION 22 31 00

SECTION 22 40 00 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SCOPE

A. This section provides requirements for furnishing and installing water closets, lavatories, sinks, mop sinks, service sinks, showers, thermostatic mixing valves, emergency shower/eyewash and wall boxes.

1.2 APPLICABLE PROVISIONS

A. Refer to Section 23 00 00, Mechanical General Provisions.

1.3 JOB REQUIREMENTS

A. Furnish plumbing fixtures shown or specified with all necessary trimming. Furnish faucets, fittings, supply stops and similar devices of one manufacturer.

B. Unless otherwise specified, all sink faucets shall be washerless. Seats on faucets specified with renewable/replaceable seats shall be Monel.

C. Furnish chair carriers for all wall hung fixtures.

D. All porcelain enameled surfaces shall be acid resistant porcelain.

E. All plumbing fixtures shall be new and unused, free from imperfections, true as to line, angles, curves and color. Smooth, watertight and complete in every respect.

1.4 STANDARDS

A. Perform work in accordance with applicable statutes, ordinances, codes, and regulations of governmental authorities having jurisdiction.

B. Furnish and install required plumbing fixtures for use by handicapped as required by the latest edition of the Texas State Purchasing and General Services Commission Act or Elimination of Architectural Barriers and any other state or local code requirements.

C. Obtain and pay for all permits and inspections.

D. All fixtures shall comply with A112.19 and all subsections.

E. All faucets, valves, stops, etc. conveying water for human ingestion shall conform to NSF 61, Section 9.

F. EPC requirements:

Lavatories, private	1.0 gpm @ 60 psi
Shower heads	1.5 gpm @ 80 psi
Sink faucets	1.5 gpm @ 60 psi
Water closets	1.28 gallon per flush cycle

PART 2 - PRODUCTS

2.1 WATER CLOSETS

A. Floor Mounted Water Closets, Wheel Chair (WC1). (Adult ADA/TAS)

1. Fixture. Furnish and install a white vitreous china, siphon jet flushing action, elongated front, floor mounted measuring 16-1/2 inches high from finished floor to top of rim with 1-1/2 inch top spud. Water closet fixture shall be designed to flush efficiently with a maximum 1.28 gallons per flush and shall be equipped with two (2) white bolt covers/caps. American Standard No. 2857.128 with two American Standard No. 48310 100 bolt covers or approved equivalent.

2. Trim. Equip fixture with a diaphragm or piston operated, quiet flush, exposed water closet flush valve made of brass with metal oscillating non hold open type handle, 1 inch IPS screw driver operated back check angle stop with protective cap, renewable main valve seat, adjustable threaded union tailpiece, vacuum breaker, 1 1/2 inch by 11 1/2 inch flush tube and connection with spud coupling for 1 1/2 inch top spud, spud securing nut, wall and spud flanges, 1.28 gallon flush regulator, solid ring pipe support all with polished chrome finish. Flush control shall be mounted on wide side of handicapped toilet area or as directed by Architect. Sloan No. 111 – 1.28.

3. Seat. Furnish and install a white, extra heavy duty/extra heavy weight, injection molded solid plastic, institutional/industrial grade toilet seat. Seat shall be manufactured of high impact resistant, polystyrene or polypropylene plastic with open front, elongated toilet seat design, less cover. Toilet seat shall be equipped with series 300 stainless steel combination self sustaining/concealed check hinges. Self sustaining mechanisms and hinge posts in both hinges shall be series 300 stainless steel and shall be integrally molded into seat assembly. Hinge posts shall be fitted Sta-Tite Fastening System. Toilet seats shall have integral bumpers permanently molded into the seat and shall be of color matched molded plastic. Church "MOLTEX" No. 9500SSC or approved equivalent.

4. Heavy duty Torque set cast iron flange with integral compression seal to waste line and test cap. Jonespec No. CF2982 and closet flange Jonespec No. 2980.

5. Closet Bolt Assemblies. Furnish and install two solid brass water closet floor flange bolt assemblies (plated brass is not acceptable). Each bolt assembly shall consist of a solid

brass slotted head bolt, two solid brass nuts, two heavy solid brass washers and two resilient rubber washers.

2.2 LAVATORIES

A. Wall Hung Lavatories (LAV 1).

1. Fixture. Furnish and install a white vitreous china, wall hung, lavatory with back and side splash guards. Lavatory fixture shall measure 20 inches wide by 18 inches deep and shall be drilled for concealed arm carrier. Furnish fixture with faucet holes on 4 inch centers and front overflow ports. American Standard No. 0355.012 or approved equivalent.

2. Trim. Furnish and install solid brass all polished chrome center set and rigid copper tube inlets. Faucet shall be equipped with 1 gpm flow restricting aerator. Furnish complete with 1 1/4-inch polished chrome plated brass grid assembly and tail piece. American Standard No. 8123F.

3. Supplies. Furnish and install 1/2 inch IPS, all brass lavatory supply assembly with 1/2 inch x 3/8 inch loose key handle angle valve with 1/2 inch IPS female thread inlet, 3/8 inch O.D. by 12 inch long flexible tube riser and brass pipe escutcheon all with polished chrome finish. Entire assembly shall be made of brass. Supply stops with plastic internal parts are not acceptable. McGuire No. 2165 LK, Specified Trim No. ST2165LK, or approved equivalent. Equip each supply stop with a polished chrome plated, ASTM B 43 80, threaded, red brass pipe nipple.

4. Traps. Furnish and provide 1 1/2 inch adjustable cast brass "P" trap with tubing drain to wall, 1 1/4 inch inlet, 1 1/2 inch outlet, ground swivel joint, cast brass nuts, cast brass clean out plug and brass escutcheon, all with polished chrome finish. McGuire No. 8902, Specified Trim No. 8902C, or approved equivalent.

5. Mixing Valve. Furnish and install point of use valve, lead free, ASSE 1070 certified. Bradley S59-4016 or approved equivalent.

6. Insulate all exposed drain pipes and hot water supply piping as required by the latest edition of Texas State Purchasing and General Services Commission

7. (Texas State Building Commission) Rules and Regulations on the Elimination of Architectural Barriers.

B. Wall Hung Lavatories (LAV 2).

1. Fixture. Furnish and install a white vitreous china, wall hung, lavatory with back and side splash guards. Lavatory fixture shall measure 20 inches wide by 18 inches deep and shall be drilled for concealed arm carrier. Furnish fixture with faucet holes on 8 inch centers and front overflow ports. American Standard No. 0356.015 or approved equivalent.

2. Trim. Furnish and install solid brass all polished chrome 8-inch center, concealed mounted, 4-inch wrist blade and rigid copper tube inlets. Faucet shall be equipped with

1.5 gpm flow restricting aerator. Furnish complete with 1 1/4-inch polished chrome plated brass vandal proof grid assembly and tail piece. Chicago Faucet No. 404-317CP or approved equivalent.

3. Supplies. Furnish and install 1/2 inch IPS, all brass lavatory supply assembly with 1/2 inch x 3/8 inch loose key handle angle valve with 1/2 inch IPS female thread inlet, 3/8 inch O.D. by 12 inch long flexible tube riser and brass pipe escutcheon all with polished chrome finish. Entire assembly shall be made of brass. Supply stops with plastic internal parts are not acceptable. McGuire No. 2165 LK, Specified Trim No. ST2165LK, or approved equivalent. Equip each supply stop with a polished chrome plated, ASTM B 43 80, threaded, red brass pipe nipple.

4. Traps. Furnish and provide 1 1/2 inch adjustable cast brass "P" trap with tubing drain to wall, 1 1/4 inch inlet, 1 1/2 inch outlet, ground swivel joint, cast brass nuts, cast brass clean out plug and brass escutcheon, all with polished chrome finish. McGuire No. 8902, Specified Trim No. 8902C, or approved equivalent.

5. Mixing Valve. Furnish and install point of use valve, lead free, ASSE 1070 certified. Bradley S59-4016 or approved equivalent.

6. Insulate all exposed drain pipes and hot water supply piping as required by the latest edition of Texas State Purchasing and General Services Commission

7. (Texas State Building Commission) Rules and Regulations on the Elimination of Architectural Barriers.

2.3 SINKS

A. Double Compartment Sinks (SK 1).

1. Fixture. Furnish and install self rimming, double compartment, 18 gauge type 302 stainless steel sink with 4 faucet holes and fully undercoated underside. Elkay "LUSTERTONE" No. LR 3319 4 33 inch x 19 1/2-inch x 7 1/2-inch deep or approved equivalent.

2. Faucet. Furnish and install a concealed mount, dual handle, washerless, 9-1/2 inch inlet to outlet projection spout with 1/2 inch inlets, removable/replaceable cartridges, stainless steel cartridge stem, 2.2 GPM flow restrictor, forged brass wing handles, swing spout, aerator and retractable spray and hose, all with polished chrome finish. American Standard No. 9316.401.002 or approved equivalent.

3. Trim. Furnish and install sink complete with a stainless steel strainer fitting with stainless steel conical strainer basket, neoprene stopper and stainless steel 1 1/2 inch tailpiece. Elkay "DUO STRAINER" No. LK 35B, Specified Trim No. ST151A, or approved equivalent.

4. Supplies. Furnish and install a 1/2 inch IPS angle stops with 1/2 inch O.D. by 12 inch flexible tube riser, escutcheon and loose key control all with polished chrome finish. McGuire No. 2167 LK, Specified Trim No. ST2167LK, or approved equivalent.

5. Traps. Furnish and install a 1 1/2 inch adjustable cast brass "P" trap with tubing drain to wall, ground swivel joint, clean out plug and cast brass escutcheon, all with polished chrome finish. McGuire No. 8912, Specified Trim No. ST8912C, or approved equivalent.

6. Equip trap complete with a 1 1/2 inch polished chrome plated, brass, continuous waste or drain connection tubing with end outlet for double compartment sink interconnection. Elkay No. LK 53 or approved equivalent.

B. Double Compartment Sinks (SK-2) (ADA/TAS compliant).

1. Fixture. Furnish and install self-rimming, double compartment, 18-gauge Type 302 stainless steel sink with 4-faucet holes and fully undercoated underside. Elkay "LUSTERTONE" No. LRAD-3319-4 33-inch x 19-1/2-inch x 5-1/2 inch deep or approved equivalent.

2. Faucet. Furnish and install a concealed mount, dual handle, washerless swing spout faucet with 1/2-inch inlets, removable/replaceable cartridges, stainless steel cartridge stem, 1.5 GPM flow restrictor, forged brass wing handles, swing and aerator, all with polished chrome finish. American Standard No. 9316.401.002 or approved equivalent.

3. Trim. Furnish and install sink complete with a stainless steel strainer fitting with stainless steel conical strainer basket, neoprene stopper and stainless steel 1-1/2-inch tailpiece. Elkay "DUO-STRAINER" No. LK-35B or approved equivalent.

4. Supplies. Furnish and install a 1/2-inch IPS angle stops with 1/2 –inch O.D. by 12-inch flexible tube riser, escutcheon and loose key control all with polished chrome finish. McGuire No. 2167-LK, Specified Trim No. ST2167LK, or approved equivalent.

5. Traps. Furnish and install 1-1/2-inch adjustable cast brass "P" trap with tubing drain to wall, ground swivel joint, clean-out plus and cast brass escutcheon, all with polished chrome finish. McGuire No. 8912, Specified Trim No. ST8912C, or approved equivalent.

6. Equip trap complete with 1-1/2-inch polished chrome plated, brass, continuous waste or drain connection tubing, with end outlet for double compartment sink interconnections. Elkay No. LK-53 or approved equivalent.

C. Single Compartment Sinks (SK 3).

1. Fixture. Furnish and install self rimming, single compartment, 18 gauge type 302 stainless steel sink with 3 faucet holes and fully undercoated underside. Elkay "LUSTERTONE" No. LR 2219 3 22 inch x 19 1/2-inch x 7 1/2-inch deep or approved equivalent.

2. Trim. Furnish and install concealed mount, dual handle, washerless, 9-1/2 inch inlet to outlet projection spout with 1/2 inch inlets, removable/replaceable cartridges, stainless steel cartridge stem, 2.2 GPM flow restrictor, forged brass wing handles, swing spout, reinforced gooseneck spout riser and aerator all with polished chrome finish. Chicago Faucet No. 201-ACP, or approved equivalent

3. Supplies. Furnish and install 1/2 inch IPS angle stops with 1/2 inch O.D. by 12 inch flexible tube riser, escutcheon and loose key control all with polished chrome finish. McGuire No. 2167 LK, Specified Trim No. ST2167LK, or approved equivalent.

4. Traps. Furnish and install 1 1/2-inch adjustable cast brass "P" trap with tubing drain to wall, ground swivel joint, clean out plug and brass escutcheon, all with polished chrome finish. McGuire No. 8912, Specified Trim No. ST8912C, or approved equivalent.

5. Strainer. Furnish and install sink complete with stainless steel strainer fitting with stainless steel conical strainer basket, neoprene stopper and stainless steel 1 1/2 inch tailpiece. Elkay "DUO STRAINER" No. LK 35B, Specified Trim No. ST151A, or approved equivalent.

6. Mixing Valve. Furnish and install point of use valve, lead free, ASSE 1070 certified. Bradley S59-4016 or approved equivalent

D. Triple Compartment Pot Sinks (SK 4).

1. Fixture. Furnish and install a 14 gauge type 304 stainless steel triple compartment scullery sink with left and right side drain boards and four LK 251 stainless steel tubular legs with adjustable bullet shaped feet. Elkay "WELDBILT" No. WNSF 8345 LR 96 inch x 27 1/2-inch x 14 inch deep or approved equivalent

2. Faucet. Furnish and install a 10 inch, cast brass swing spout faucet with 4” wristblade handles and aerator all with polished chrome finish. Elkay No. LK 94AT10T4H or approved equivalent.

3. Trim. Furnish and install sink complete with a stainless steel strainer fitting with stainless steel conical strainer basket, neoprene stopper and polished chrome plated brass 1 1/2-inch tailpiece. Elkay "STANDARD DUO STRAINER" No. LK 35, or approved equivalent.

4. Traps. See floor plan for grease trap capacity.

5. Equip trap complete with a 1 1/2-inch polished chrome plated, brass, continuous waste or drain connection tubing with center outlet for triple compartment sink interconnection. Elkay No. LK 60 or approved equivalent.

2.4 MOP SINKS (MS-1)

A. Fixture. Furnish and install a terrazzo mop sink with continuous stainless steel cap on all four sides and tilting flange on two sides. Stern Williams "SERVICEPTOR" No. SB 702 BP2 32 inch x 32 inch x 12 inch deep or approved equivalent.

B. Equip fixture complete with nickel bronze strainer and Stern Williams "BP" stainless steel splash catcher panels on two sides.

C. Trim. Furnish and install a Stern Williams No. T 15 VB mop service sink faucet with integral stops, spout with bucket hook, 3/4 inch hose thread end, vacuum breaker, adjustable top brace, inlets on 8 inch centers, all with polished chrome finish. Furnish a Stern Williams No. T 35 36

inch long hose with 3/4 inch polished chrome coupling and stainless steel wall bracket with rubber grip and T 40, 24 inch long stainless steel mop hanger with three rubber spring loaded grips.

2.5 MOP SINKS (MS-2)

A. Fixture. Open a mop sink wash area with floor drain. See architectural drawings.

B. Trim. Furnish and install a Stern Williams No. T 15 VB mop service sink faucet with integral stops, spout with bucket hook, 3/4 inch hose thread end, vacuum breaker, adjustable top brace, inlets on 8 inch centers, all with polished chrome finish.

2.6 SERVICE SINKS (SS-1)

A. Fixture. Furnish and install a white enameled cast iron service sink with blank back and stainless steel rim guard and wall hanger supports. American Standard No. 7692.008 or approved equivalent.

B. Trim. Furnish and install a polished chrome plated service sink faucet with vacuum breaker, threaded spout, pail hook, wall brace, valve units, loose key stops in shanks and inside thread couplings. American Standard No. 8344.112, Moen No. 8124, or approved equivalent. Equip complete with a Stern Williams No. T 35 36 inch long hose with 3/4 inch polished chrome coupling and stainless steel wall bracket with rubber grip.

C. Trap. Furnish and install a standard cast iron service sink trap adjustable for 3 inch iron pipe connection with cleanout and strainer. American Standard No. 7798.030 or approved equivalent.

2.7 SHOWERS

A. Stall Showers, Tile walls (SH 1)

1. Fixture. Reference Architectural drawings and specifications for fixture wall and floor construction.

2. Trim. Furnish a pressure balance valve with integral stops, volume control, 1.5 GPM shower head with arm and shower arm flange all with polished chrome finish. American Standard No. T508.507.

3. Drain. Furnish a 2 inch FD 1 as specified in section 22 13 00 within architectural shower construction. Ensure drain top is installed flush with finished tile of shower floor and incorporate drain body and clamping device into shower pan (membrane) to ensure a completely watertight drain installation.

B. ADA Stall Showers, Tile walls (SH-2)

1. Fixture. Reference Architectural drawings and specifications for fixture wall and floor construction.

2. Trim. Furnish a thermostatic mixing valve with integral stops, volume control, vacuum breaker, 30” slide bar handheld shower, metal hose, showerhead to be 1.5 GPM all polished chrome finish. American Standard No. 1662.600.

3. Drain. Furnish a 2 inch FD 1 as specified in section 22 13 00 within architectural shower construction. Ensure drain top is installed flush with finished tile of shower floor and incorporate drain body and clamping device into shower pan (membrane) to ensure a completely watertight drain installation.

2.8 SHOWER (SH-3)

A. Fixture. Reference Architectural drawings and specifications for fixture wall and floor construction.

B. Trim. Shower valve assembly shall be provided with ½” NPT female inlets and ½” NPSM male outlet, 59” metal hose, vacuum breaker, 3-function handheld shower, 2-way diverter valve, shower head, 36” slide grab bar, pressure balance valve with ceramic disc valve cartridge, hot water limit stop. American Standard No. 1662SG.223.002.

C. Drain. Furnish a 2-inch FD 1 as specified in section 22 13 00 within architectural shower construction. Ensure drain top is installed flush with finished tile of shower floor and incorporate drain body and clamping device into shower pan (membrane) to ensure a completely watertight drain installation.

2.9 EMERGENCY SHOWER AND EYE WASH (ESEW-1)

a. Furnish and install a free standing, combination shower and eye wash with self closing shower and eye wash valves, floor flange, 1 1/2 inch supply connection, stainless steel pull rod and triangle handle and "EMERGENCY SHOWER" identification sign. Support shower to wall as recommended by manufacturer, to ensure a rigid installation. HAWS No. 8309 with 8127 stainless steel showerhead or approved equivalent.

2.10 EYE/FACEWASH (EW-1)

A. Furnish and install a pedestal mounted eye wash with self closing eye wash valves, floor flange, 1 1/2-inch supply connection, and "EMERGENCY EYE/FACE SHOWER" identification sign. Guardian No. G1760 or approved equivalent.

2.11 WALL HUND TWO LEVEL ELECTRIC DRINKING FOUNTAIN (EDF 1)

A. Fixture. Furnish and install wall mounted two level ADA duel height electric water cooler with all stainless steel basin, 8 GPH capacity and combination self closing stop and regulator. Furnish an air cooled unit and motor that is 1/5 HP, 115 volt, single phase, 60 HZ. Elkay No. LZSTL8C W / LKAPR EZL or approved equivalent.

B. Supplies. Furnish and install straight screwdriver stop with 1/2 inch IPS inlet and outlet. Elkay No. LK 2680 or approved equivalent.

C. Trap. Furnish and install 1 1/4-inch adjustable cast brass "P" trap with tubing drain to wall, ground swivel joint, clean out plug and cast brass escutcheon, all with polished chrome finish. McGuire No. 8872 or approved equivalent.

2.12 WALL BOXES

A. Wall Boxes, Washing Machine (WB-1). Furnish and install Guy Gray No. WB 200HATM, top supply washing machine supply and drain box with 2 inch drain and 1/2 inch supply inlet single lever valve with hammer arresters or approved equivalent.

B. Wall Boxes, Refrigerator (WB-2). Furnish and install Oatey ice maker box with brass angle valve with water hammer arrestor or approved equivalent.

2.13 FIXTURE CARRIERS

A. Lavatory Carriers. For high back lavatories, furnish and install a ZURN ZR 1224 series concealed chair carriers with concealed arms or approved equivalent.

2.14 PROTECTIVE DEVICES

A. Approved backflow preventers shall be used to connect piping to plumbing fixtures or equipment that do not have an approved integral device for cross connection protection.

B. Reduced Pressure Principle Type. Furnish a Watts Number U 909 S HW QT Reduced Pressure Principle backflow preventer. Equip complete with bronze strainer, stainless steel check modules, quarter turn ball valves and integral body unions.

1. For each backflow preventer valve, furnish a Watts 909 AG Fixed Air Gap Fitting with inlet compatible with outlet of backflow preventer relief valve opening. Furnish a full size drain line from air gap fitting to floor drain or hub drain.

2.15 FLOW RESTRICTORS AND TEMPERING VALVES

A. Furnish and install flow restrictors and tempering valves to all fixtures requiring water flow and/or temperature regulation as required to meet local code requirements and to regulate water flow for instantaneous water heaters. Furnish either in line or faucet end type flow restrictors (Use of either type is acceptable). Furnish access to all in line flow restrictors located in walls or above ceilings.

2.16 CHROME FINISH

A. All exposed fixture trim, including (but not limited to) p traps, supplies, riser supports, flex tube risers, etc. shall have a polished chrome finish. Furnish all polished chrome finished nipples, extension pieces, escutcheons, etc. required to meet this requirement.

2.17 ACCEPTABLE MANUFACTURERS

A. Plumbing Fixtures: American Standard, Eljer, Kohler.

B. Trim: American Standard, Chicago Faucet, Eljer, Elkay, Kohler, McGuire, Speakman, T&S Brass, Watersaver, Moen

C. Water Closet Seats: Bemis, Beneke, Church, Sperzer.

D. Mop Sinks: Stern Williams, American Standard, Eljer, Elkay, Kohler.

E. Stainless Steel Sinks: Elkay, Just.

F. Flush Valves: Sloan, Zurn.

G. Emergency Showers and Eyewashes: Bradley, Haws, Guardian.

H. Mixing Valves: Leonard, Powers, Symmons, Bradley.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Set fixtures at heights as directed and approved by Architect.

B. Rigidly secure all water supply piping to wall structure. The piping in the wall shall be secured to wall such that flush valve or supply piping will not have any movement during valve activation or when jarred (typical for all plumbing fixtures).

C. Furnish and install adequate pipe supports in walls at all supply and drain lines extending through walls to rigidly secure all supply lines to all fixtures with special concentration on water closet and urinal supply lines. Contractor shall install additional pipe supports, metal framing, Unistrut, nuts, bolts, clamps and metal channels as required to adequately and rigidly secure all valves and supply piping in pipe chases and to prevent damage to plumbing fixtures. Movement of piping within wall due to valve activation or jarring will not be acceptable.

D. At each water supply stop serving lavatories and sinks, furnish and install a plastic support bracket as manufactured by P & M Company to adequately secure piping in wall. In lieu of such brackets, cast brass drop ear elbow fittings may be used when adequate blocking is installed in wall and brass elbow is rigidly secured to blocking in wall (secure to wall with brass screws or copper nails). In either case install an additional copper tubing strap located not more than 1 inch from elbow at supply stop and adequately secure to blocking in wall with brass screws or copper nails. Connect supply stop to elbow in wall using ASTM B 43 80, threaded, red brass pipe nipples. Conceal pipe nipples in wall. Where pipe nipples cannot be concealed, install polished chrome plated, threaded, red brass pipe nipples. Under no circumstances shall steel nipples be used.

E. All escutcheons shall be installed flush to wall (no gap between wall and escutcheon plate). Caulk all wall penetrations behind pipe escutcheons. Air tight with Dow Corning No. 2000 Fire Stop Sealant or approved equivalent. Wall penetrations shall not be larger than the

escutcheon installed. All escutcheons of same type service shall be of same physical size. Reference the section on Pipe and Pipe Fittings General for additional requirements on pipe escutcheons.

F. All plumbing trim shall be installed in a neat and well organized manner with services running parallel with the primary lines of the building construction.

G. Install all appurtenances required for a complete and working system.

H. Install all fixtures and trim in accordance with the manufacturer's recommendations and as shown on drawings.

3.2 ROUGH-IN AND FINAL CONNECTIONS

A. Make rough in and final connection of all services to all fixtures requiring plumbing connections. Contractor shall be responsible for installing fixtures at locations shown on the Architectural drawings and providing all service connections at required locations.

B. Rough in and final connection of services to all equipment shall be installed in accordance with the latest edition of the manufacturer's rough in measurements manual. Contractor shall obtain all such documents.

C. Install service connections to all plumbing fixtures specified and to all equipment furnished by others. Reference Section 23 21 00for rough in requirements of equipment furnished by others.

3.3 QUALITY AND PROTECTION

A. All plumbing fixtures shall be free from imperfections, true as to line, angles, curves and color, smooth, watertight and complete in every respect. Chipped, scratched, marred or disfigured fixtures shall be replaced with new fixtures. Contractor shall replace all fixtures found to be damaged or defective.

3.4 COORDINATION

A. Making adjustments to field conditions is considered a part of the work required. Do not use contract drawings accompanying these specifications for rough in locations but only for pipe sizing and general routing.

B. Contractor shall examine and familiarize himself with the Architectural, Structural, Electrical and Mechanical drawings to be knowledgeable of all plumbing connections required and space limitations

C. The Drawings are diagrammatic and are not intended to show all the fittings required. Contractor shall include in his bid, costs for items of material and labor which are not specifically called for in drawings or specifications, but which are required to make plumbing installation. Contractor shall make any necessary changes to avoid beams, footings, columns, piers, vents, ducts, equipment or other obstructions.

D. Contractor shall coordinate physical requirements of all countertop fixtures with all other trades. Prior to submittal on these fixtures, the contractor shall verify space limitations.

3.5 CLEANING AND ADJUSTING

A. Thoroughly clean and disinfect all plumbing fixtures, including all exposed trim. At work completion all plumbing fixtures and trim shall be clean and free from any stains, sediment, waterspouts, oils, factory shipping wrapping/protective covers, installation instruction stickers/labels, etc. Disinfect all plumbing fixtures using commercial disinfecting agents.

B. Properly flush all water systems, clean and service all strainers and plumbing connections to facilitate proper operation of fixture valves. Install servicing until all water systems and appurtenances prove to be clean, free of debris and operating properly.

C. Adjust all flush valves and self-closing valves for proper flushing or operation, but without excess use of water. Water closets shall not exceed 1.6 gallons per flush, urinals shall not exceed 1 gallon per flush and lavatory faucets shall remain open for a minimum of 10 seconds, and a maximum of 20 seconds. Demonstrate to the Architect (or representative) that the entire system and all components thereof are functioning properly.

D. Install such equipment and personnel as required to conduct tests and demonstrate the acceptability of the various plumbing systems.

E. Have the authorized representatives of the various manufacturers available if requested

END OF SECTION 22 40 00

SECTION 22 40 00.16 - PIPING AND PIPING APPURTENANCES FOR COLDWATER MAKE-UP AND EQUIPMENT DRAINS

PART 1 - GENERAL

1.1 SCOPE

A. This Section provides for the furnishing and installation of piping and piping appurtenances to drain air handlers, pumps, boilers and other equipment requiring drains, and for cold water make-up piping.

1.2 APPLICABLE PROVISIONS

A. Refer to Section 23 00 00, Mechanical General Provisions.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Furnish seamless, hard-drawn, Type L, copper water tube conforming to ASTM B 88, and wrought copper fittings.

2.2 VALVES AND STRAINERS

A. For pressure-reducing and relief valves, furnish Bell & Gossett dual unit No. D-250.

2.3 TRAPS

A. On each air handling unit condensate drain, furnish a trap deep enough to overcome pressure of the unit. All drain piping shall be Type L copper pipe.

2.4 BACKFLOW PREVENTER

A. Furnish a Watts Number U-909-S-HW-QT Reduced Pressure Principle backflow preventer on the city water header providing make-up water to all equipment, e.g., chillers, boilers, expansion tanks and any other items serving mechanical requiring cross connection protection. Equip complete with bronze strainer, stainless steel check modules, quarter turn ball valves and integral body unions.

1. At the Contractor's option, a backflow preventer may be installed at each piece of equipment.

2. For each backflow preventer valve furnish a Zurn Z-1025 Fixed Air Gap Fitting and full size drain line from air gap fitting to floor drain or hub drain.

PART 3 - EXECUTION

A. Install in strict and complete accordance with manufacturer's recommendations.

END OF SECTION 22 40 00.16

SECTION 23 00 00 – MECHANICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Except as modified in this section, General Conditions, Supplementary Conditions, applicable provisions of Division 01, General Requirements, and other provisions and requirements of the contract documents apply to work of Division 23, HVAC.

B. Applicable provisions of this section apply to all sections of Division 23, HVAC.

C. It is the intent of the Contract Documents to provide an installation complete in every respect. In the event that additional details of special construction may be required for work indicated or specified in this section or work specified in other sections, it shall be the responsibility of the Contractor to provide same as well as to provide material and equipment usually furnished with such systems or required to complete the installation, whether mentioned or not.

1.2 CODE REQUIREMENTS AND PERMITS

A. Perform work in accordance with applicable statutes, ordinances, codes, and regulations of governmental authorities having jurisdiction.

B. Resolve any code violation discovered in contract documents with the Engineer prior to award of the contract. After award of the contract, make any correction or additions necessary for compliance with applicable codes at no additional cost to Owner.

C. Obtain and pay for all permits and inspections.

1.3 REFERENCE SPECIFICATIONS AND STANDARDS

A. Materials which are specified by reference to Federal Specifications; ASTM, ASME, ANSI, or AWWA Specifications; Federal Standards; or other standard specifications must comply with latest editions, revisions, amendments or supplements in effect on date bids are received. Requirements in reference specifications and standards are minimum for all equipment, material, and work. In instances where capacities, size or other feature of equipment, devices or materials exceed these minimums, meet listed or shown capacities.

1.4 CONTRACTOR QUALIFICATIONS

A. An acceptable contractor for the work under this division shall be a specialist in this field and have the personal experience, training, skill and the organization to provide a practical working system. If required, he shall be able to furnish acceptable evidence of having contracted for and installed not less than three systems of comparable size and type to this one, that have served their owners satisfactorily for not less than three years.

B. The foreman for this work shall have had experience in installing not less than three such systems and shall be approved before the work is begun. Adequate and competent supervision shall be provided to ensure first class workmanship and installation.

C. Work shall be executed and all materials installed in accordance with the best practice of the trades in a thorough, substantial, workmanlike manner by competent workmen, presenting a neat appearance when completed. Work shall be performed by mechanics skilled in the trade.

D. The Contractor shall be responsible for all construction techniques required for all mechanical systems specified and shown on the drawings.

1.5 REQUEST FOR INFORMATION

A. The Contractor may, after exercising due diligence to locate required information, request from the Consultant clarification or interpretation of the requirements of the Contract Documents. The consultant shall respond to such Contractor's requests for clarification or interpretation. However, if the information requested by the Contractor is apparent from field observations, is contained in the Contract documents or is reasonably inferable from them, the Contractor shall be responsible to the Owner for all reasonable costs charged by the consultant to the Owner for the Additional Services required to provide such information.

1.6 CONTRACT DRAWINGS

A. Contract drawings are diagrammatic only and do not give fully dimensioned locations of various elements of work or show all offsets or required fittings. Determine exact locations from field measurements. Making adjustments to field conditions is considered a part of the work required.

B. When the mechanical and electrical Contract Documents do not give exact details to the elevation of pipe, conduit and ducts, the Contractor shall physically arrange the systems to fit in the space available at the elevations intended with proper grade for the functioning of the system involved. Piping, exposed conduit and the duct systems are generally intended to be installed true and square to the building construction, and located as high as possible against the structure in a neat and workmanlike manner. The Contract Documents do not show all required offsets, control lines, pilot lines and other location details. Work shall be concealed in all finished areas.

C. Prior to locating mechanical equipment, plumbing fixtures, water heaters, water coolers and other plumbing or mechanical items, obtain approval as to exact method and exact placement and location of equipment in the various areas shown on the drawings. In no case shall the locations be determined by scaling the drawings. Plumbing fixtures shall be mounted at the heights directed by the Architect and local code authorities. Relocate equipment and devices and pay all costs of modifying work of all trades necessitated by failure to comply with this requirement.

D. These specifications are accompanied by drawings of the building and details of the installation indicating the locations of equipment, piping, ductwork, outlets, switch controls, circuits, lines, etc. The drawings and these specifications are complementary to each other, and what is required by one shall be as binding as if required by both.

E. It is the Contractor's responsibility to properly use all information found on the Architectural, Structural, Mechanical and Electrical Drawings where such information affects his work.

F. The drawings show diagrammatically the location of the various outlets and apparatus. Exact locations of these outlets and apparatus shall be determined by reference to the general drawings and to all detail drawings, equipment drawings, rough-in drawings, etc., by measurements at the building, and in cooperation with the other trades. The Owner reserves the right to make any reasonable change in location of any outlet or apparatus before installation, without additional cost to the Owner.

G. Should the drawings or specifications disagree within themselves, or with each other, the better quality or greater quantity of work or materials shall be estimated upon, and unless otherwise directed by the Architect in writing, shall be performed or furnished.

1.7 OFFSETS

A. The Contract Documents are diagrammatic as stated above. Not all offsets are shown. This applies to all ductwork, piping, flues, or any other component that is routed underground or throughout the structure. The Contractor shall be responsible to layout all piping in a manner that allows for complete maintenance access. Contractor shall provide and install, without additional costs, all offsets necessary to complete this project and to provide a complete, working, accessible, and maintainable system.

1.8 BUILDING DEMOLITION

A. All salvage shall remain the property of the Owner and be delivered to a location, on site, as designated by the Owner. In the event the Owner does not desire to retain the salvage material, the material becomes the property of the Contractor and shall be disposed of by the Contractor.

B. Existing mechanical services and controls to items being removed by others must be disconnected as a requirement of this section.

C. Wherever a new to existing mechanical connection is required, the Contractor shall provide all materials and labor required to make the connections.

D. The Contractor shall be responsible to maintain all mechanical systems, in an operational condition, in all areas not included under this contract that may be affected during the demolition.

E. All concrete slab penetrations shall be coordinated and approved by the structural engineer. The Contractor shall X-ray the proposed slab penetration area prior to performing any work, to ensure that there are no existing conduit systems, concrete load bearing structural members, etc., that may otherwise be damaged by core drilling the concrete slab.

F. Equipment and devices not scheduled for removal and their associated mechanical systems shall remain in their original operating condition.

1.9 MOTORS CONTROLLED BY VFD

A. General Requirements - Shaft Grounding:

1. All motors operated on variable frequency drives shall be equipped with a maintenance free, conductive micro fiber, shaft grounding ring with a minimum of two rows of circumferential micro fibers to discharge damaging shaft voltages away from the bearings to ground, AEGIS Bearing Protection Ring.

a. Application Note: Motors up to 100HP shall be provided with one shaft grounding ring installed either on the drive end or non-drive end. Motors over 100HP shall be provided with an insulated bearing on the non-drive end and a shaft grounding ring on the drive end of the motor. Grounding rings shall be provided and installed by the motor manufacturer or contractor and shall be installed in accordance with the manufacturer's recommendations.

B. General Requirements - High Frequency Bonding:

1. All motors operated on variable frequency drives shall be bonded from the motor foot to system ground with a high frequency ground strap made of flat braided, tinned copper with terminations to accommodate motor foot and system ground connection.

a. Application Note: Proper grounding of motor frame for all inverter-driven induction motors.

C. References: ABB Technical Guide No. 5
Allen Bradley Publication 1770-4.1 Application Data, Industrial Automation Wiring and Grounding Guidelines

PART 2 - PRODUCTS

A. Not used.

PART 3 - EXECUTION

Consider space limitations imposed by contiguous work in selection and location of equipment and material. Do not provide equipment or material which is not suitable in this respect.

3.1 OBSTRUCTIONS

A. The drawings indicate certain information pertaining to surface and subsurface obstructions which have been taken from available drawings. Such information is not guaranteed, however, as to accuracy of location or complete information.

B. Before any cutting or trenching operations are begun, verify with Owner's representative, utility company, municipalities, and other interested parties that all available information has been provided. Verify locations given.

C. Should obstruction be encountered, whether shown or not, alter routing of new work, reroute existing lines, remove obstruction where permitted, or otherwise perform whatever work is necessary to satisfy the purpose of the new work and leave existing services and structures in a satisfactory and serviceable condition.

D. Assume total responsibility for and repair any damage to existing utilities or construction, whether or not such existing facilities are shown.

3.2 CUTTING AND PATCHING

A. The Contractor shall be responsible for timely placing of all equipment and piping to avoid cutting new construction.

3.3 OPENINGS

A. Framed, cast or masonry openings for piping or equipment is specified under other divisions. However, drawings and layout work for exact size and location of all such openings are included under this division.

3.4 COORDINATION

A. Contract Documents are diagrammatic in showing certain physical relationships to other trades. Interface and coordination with other work including utilities and electrical work is the exclusive responsibility of the contractor.

B. Contractor shall coordinate with Division 26 and other divisions as required. This is to include but not be limited to verification of power, voltage, phase and other characteristics as being compatible with that called for on the electrical drawings and Division 26 specifications, as well as that called for in Division 23 drawings and specifications or other divisions requiring electrical connections or interface with this division. This shall be done prior to placing orders for equipment. Controls contractor to coordinate with electrical contractor for all required 120 volt power for all DDC panels, 120 volt motor actuators, 120 volt motorized dampers, etc. prior to bids. If it is not coordinated prior to bid, mechanical is responsible for <u>all</u> 120 volt conduit, breakers, conductors, etc.

C. Arrange mechanical work in a neat, well organized manner with services running parallel with primary lines of the building construction, and with the maximum overhead clearance possible.

D. Locate operating and control equipment properly to provide easy access. Arrange entire mechanical work with adequate access for operation and maintenance.

E. Advise other trades of openings required in their work for the subsequent move-in of large units of mechanical work.

F. Verify exact locations of existing equipment and determine exact requirements for connections prior to routing services to equipment.

3.5 CONCEALED WORK

A. Where the word "concealed" is used in connection with insulating, painting, piping, ducts and the like, the word is understood to mean hidden from sight as in chases, furred spaces or suspended ceilings. "Exposed" is understood to mean open to view.

3.6 PROTECTION

A. The Contractor shall be responsible for the protection of all materials and equipment to be installed under this Division from physical and weather damage.

B. Provide all hoisting and scaffolding equipment required for proper installation of equipment. The contractor shall take full responsibility for the safety of the materials and equipment using such hoisting equipment and scaffolding.

C. Adequately protect work, equipment, fixtures, and materials. At work completion, all work shall be clean and in good condition.

3.7 AIR FILTERS AND PIPE STRAINERS

A. Immediately prior to final acceptance of project, clean and service strainers and replace disposable type air filters. If air handling units are operating during construction, install high efficiency filters in units and replace at end of construction. High Efficiency filters in the air handling units consist of minimum 2" pleat Farr 30/30 prefilter and final filter of 12" thick (if air unit frame is for 6" filter than use 6" thick) and minimum 85% efficient. As far as plenum exposed heating coils in fan powered VAV boxes, the plenum inlet shall have a minimum 2" pleat Farr 30/30 filter with a prefilter attached (preferably, the contractor will cover the inlet when debris is present). However, if the air units, fans, VAV boxes are operated during construction, and if the fan wheels, fan housings, coils, etc. are fouled by dust or debris, the Contractor, at his expense, shall clean all fouled components.

3.8 GUARANTEE

A. Guarantee work for 1 year from the date of final acceptance of the project and during that period make good any faults or imperfections that may arise due to defects or omissions in materials or workmanship.

3.9 MATERIALS AND EQUIPMENT

A. Furnish new and unused materials and equipment of Domestic Manufacturers meeting requirements of the paragraph specifying acceptable manufacturers. Where two or more units of same type or class of equipment are required, provide units of a single manufacture.

3.10 ACCEPTABLE MANUFACTURERS

A. The following is a list of acceptable manufacturers for items of equipment specified under Division 23, Mechanical. Manufacturers names and catalog numbers specified under sections of Division 23 are used to establish standards of design, performance, quality and serviceability and not to limit competition. Equipment of similar design, equal to that specified, manufactured by a manufacturer named below will be acceptable on approval.

B. A request for prior approval of equipment not listed must be submitted 14 days before bid due date. Only manufacturers specified in sections of Division 23, on drawings or listed below (including subsequent addenda) will be acceptable. There will be no exceptions to this requirement. Submit complete design and performance data to the Architect.

Item	**Manufacturer**
Wall Penetration Seals	Link Seal
Plumbing Fixtures	American-Standard, Kohler
Plumbing Fixtures, Trim	American-Standard, Chicago-Faucet, Moen Commercial, Elkay, Kohler, McGuire, Symmons, T & S Brass, Watersaver
Water Closet Seats	Bemis, Beneke, Church, Sperzel
Mop Sinks	Stern-Williams
Shower	American Standard, Kohler
Drinking Fountains	Elkay, Halsey-Taylor, Haws, Sunroc-Western
Stainless Steel Sinks	Elkay, Just
Flush Valves	Sloan, Delaney, Zurn
Mixing Valves	Leonard, Powers, Symmons
Drains, Cleanouts Carriers and Hydrants	J.R. Smith, Josam, Wade, Zurn
Water Hammer Arresters	J.R. Smith, Wade, Zurn
Trap Primers	Precision Plumbing Products
Access Doors	Inryco/Milicor, Karp
Domestic Water Pressure	Aurora, Paco, Syncroflo
Gas Regulators	Fisher, Rockwell
Water Treatment Products	Bruner, Water Refining Industrial

Fire Protection Accessories	Central, Grinnell, Potter-Roemer, Reliable, Viking
Fire Main Valves	Kennedy, Mueller, Nibco, Stockham
Fire Pumps	Aurora, Allis Chalmers
Fire Pump Controllers	Joslyn Clark
Grooved Pipe Fittings	Grinnell, Gustin-Bacon, Stockham, Victaulic
Valves	Hammond, Nibco, Powell, Stockham, Walworth
Backflow Preventer Valves	Beeco/Hersey, Febco, Watts
Pumps	Aurora, Bell and Gossett, Grundfos, Taco
Insulation	Certainteed, Johns-Manville, Knauf, Owens-Corning, Kingspan
Expansion Tanks	Taco, Wood Industrial, Amtrol
Controls	Johnson, Siemens, Trane
Circuit Setters	Bell & Gosset, Taco
Fire/Smoke Dampers	Nailor-Hart, Prefco, Ruskin, Greenheck
Automatic Air Vents	Clark, Metraflex
Filters	American Air Filter, Farr
Air Devices	Titus, Price, Metalaire
Vibration Isolation	Amber-Booth, Mason Industries
Air Cooled Condensing Units/Heat Pumps	Carrier, Trane, York
Variable Frequency Drives	ABB, Danfoss, Magnatek, Robicon
Air Handling Units	Trane, York, Temtrol, Governaire
Fans	Greenheck, Cook, Twin City
Fan Coil Units	Carrier, Trane, York
Thermometers and Gauges	Ashcroft, Dwyer, Marsh, Trerice
Flexible Duct	Flexmaster (only)
Chillers	Carrier, Trane, York

C. Manufacturers listed in schedules, on the drawings or in a specific section of the specifications for a specific product is the basis of design. Any other submitted product will be construed to be a proposed substitute, even if listed in the acceptable manufacturers list, and must comply with the following paragraphs.

D. Acceptance of materials and equipment will be based on manufacturer's published data and will be tentative subject to the submission of complete shop drawings indicating compliance with the contract documents and that adequate and acceptable clearances for entry, servicing, and maintenance will exist. Acceptance of materials and equipment under this provision shall not be construed as authorizing any deviations from the contract documents, unless the attention of the Architect has been directed in writing to the deviations.

E. Each proposed substitute shall be referenced to the trade name of the specified product, and the paragraph and page number of the specifications where the specified items occur. Each proposed substitute shall be accompanied by adequate supporting information including catalog cuts, diagrams, representative samples, published ratings, drawings, and other such descriptive information as may be required to properly illustrate the complete characteristics of materials and equipment. In addition, a detailed statement indicating item-by-item and paragraph-by-paragraph wherein the product to be offered deviates from the specification shall be submitted for each proposed alternate. Any such alternate proposal must include all necessary changes and additions to other work occasioned by such substitution. In addition, each alternate proposal must stipulate that the substituted product will fit the space allotted the specified product and provide the same or greater clearances for maintenance, removal and/or access.

F. When requested by the Architect, the Contractor shall provide a sample of the proposed substitute item. In some cases, samples of both the specified item and the proposed item shall be provided for comparison purposes.

G. Should a substitution be accepted, and should the substitute material prove defective, or otherwise unsatisfactorily for the service intended within the guarantee period, this material or equipment shall be replaced with the material or equipment specified at no additional cost to the Owner.

3.11 SUBMITTAL DATA AND SHOP DRAWINGS

A. The submittals shall include a specification compliance analysis for review and approval before work shall begin. The compliance document shall address each paragraph of the specification by indicating COMPLY, EXCEED, or EXCEPTION. Do not indicate COMPLY unless the proposed system exactly meets the paragraph requirement. If EXCEED or EXCEPTION is indicated, then provide a clear and concise explanation of the variance from the specifications and the net effect this would have on the specified system performance. This is to be included with each submittal.

B. Submittal data. Submit descriptive literature, physical data, and performance data by the appropriate specification section or the specific sheet where products are shown on the contract drawings that are not referenced by the specification for review. All specification sections require a submittal. Submit each spec section separately but at one time. Submittals can be contained in one binder or binders, however, each specification section must be submitted as a single submittal and each section must be clearly marked or tagged with the specification

section number. Each submittal shall bear the specification section number it is related to. Any submittal received without referring to the appropriate specification section number will be returned without review. Include identifying symbols and equipment numbers used in plans and specifications, with reference to specification paragraphs, and drawing numbers of all equipment and material submitted. Submittal data shall specifically list all proposed deviations from the contract documents. Submittals that are not clearly marked will be rejected for that reason.

C. Contractor's Check. Shop drawings and submittal data will be submitted only by the Contractor. Indicate by signed stamp that the drawings and submittal data have been checked, that the work shown on the drawings and submittal data is in accordance with contract requirements and that dimensions and relationship with work of other trades have been checked. If drawings and submittal data are submitted for approval that have not been checked and signed by the Contractor, they will be returned for checking before being considered by the Architect.

D. Equipment Rooms. Submit shop drawings of mechanical equipment rooms, mechanical yards, and HVAC closets, and where directed, other complex areas. Shop drawings shall include plan views and elevations, show actual equipment to be installed, with piping fully detailed to show clearances, headroom, pipe routing, valve positions, pipe hangars, insulation, and other pertinent information. Prepare drawings to a scale of at least 3/8 inch per foot.

E. Coordination Drawings: Coordination Drawings in electronic media and hard copy shall be prepared by the Contractor indicating Mechanical, Plumbing, Fire Protection, Electrical work, low voltage cable management systems (or cable tray, as applicable) miscellaneous steel for the general work, lights, air devices, speakers, ceiling heights, etc., drawings shall indicate all duct work, mechanical lines 2" and greater (except all lines that require gravity draining are to be shown), all plumbing lines 2" and greater, trunk lines of fire protection system, and all sprinkler heads. Electrical conduit 2" and greater as well as pull boxes or other elements over 6" x 6" shall be shown. Major pieces of equipment by all trades are to be indicated.

F. Coordination drawings shall depict the routing of all above ceiling items and shall identify elevations of these items as necessary to fit above specified ceiling systems. Preparation of section details at certain congested corridor locations will be required. The Contractor shall identify which, if any, above ceiling items cannot be installed as schematically shown on the Contract Documents and shall timely notify the Designer of these items with proposed resolution. Contractor shall submit to the designer a complete set of coordination drawings for all of this project, showing non-conflicting routing of all above-ceiling items. No above-ceiling installations shall proceed in any project area until the coordination drawing for that area is completed. These drawings shall bear the original signature of all Contractor (trade) superintendents, indicating that they agree with the routing of above-ceiling items shown. Dimensions are not required and will not be reviewed. Spool drawings are not required. Showing pipe joints and duct joints is not required or desired and will not be reviewed.

G. It is preferred that the Contractor provide these services with in-house personnel. If this is not possible, Contractor must submit at least two (2) firms or individuals proposed to provide these documents. The Engineer will advise the Contractor which firm or individual is acceptable, prior to services being procured. The Contractor‘s bid shall include all costs for those services noted herein.

H. The Contractor may obtain Revit files (if available) or AutoCAD files from the Engineer after signing the Engineer's release and receipt of $250 paid to the Engineer.

I. The Revit files from the Engineer will contain some clashes and it is important to note the engineers Revit files will not include fire sprinkler, electrical conduit, miscellaneous steel, etc. that may require the Contractor to modify routing/sizing of MEP systems to account for these additional systems. It is the Contractor's responsibility to recommend any required changes and update their Revit/Navisworks/AutoCAD 3-D models. At the completion of construction, Contractor shall provide the updated Revit file which shall include all changes/modifications due to RFI's, ASI's, change orders, etc. and will serve as as-built files (also provide 3 sets of full size prints). If 3-D drawings are not required by the Engineer, AutoCAD drawings must be provided by the Contractor for coordination and as-builts.

1. Drawings shall be produced in CAD at 1/4" scale, except that mechanical rooms, air handling equipment rooms, and the like, shall be produced in 1/2" scale.

    a. Single line drawing shall not be acceptable.

2. The suggested production of Drawings is as follows, however, the Contractor is solely responsible for the means, methods and sequences used:

    a. Mechanical trade shall initiate these drawings including furnishing of floor plan backgrounds. Sequence of preparation shall be:

        (1) Ductwork

        (2) Remainder of mechanical work including equipment and piping.

3. Plumbing trade shall show piping (supply, waste, vent, etc.) overlaid on the floor plan furnished by mechanical trade.

4. Fire protection work shall be shown on the same floor plan after completion of plumbing work drawings.

5. Electrical trade work shall be shown on the same floor plan after completion of the above.

6. General trade work shall be shown on the same floor plan after completion of the above.

J. Upon completion of coordination drawings, the project manager or superintendent for the HVAC, Plumbing, Fire Protection, Electrical, and General trades shall be required to sign each sheet of the coordination drawings. Signature shall attest to a diligent review and agreement to alleviate future space conflicts at no cost to the Owner. Any trade that installs elements of its work in locations other than those indicated on the coordination drawings that impacts the work of other trades, or installs elements of its work that is not shown on the coordination drawings, the trade in violation of the coordination drawings shall be required to either:

1. Move his work to resolve the conflict, or

2. Reimburse the affected trade(s) to move his work to resolve the conflict, or

3. Reimburse the Owner to move his work to resolve the conflict.

4. For record only, Coordination Drawings must be complete and submitted to the Designer within 90 days of award of contract. No review or approval will be forthcoming. Coordination drawings are required for the benefit of the Contractor and all trades as an aid to coordination of their work so as to eliminate or reduce conflicts that may arise during the installation of their work.

5. Copies of the project coordination drawings shall be submitted as part of the required closeout document package.

Owner:	1 copy
Architect:	1 copy
MEP Engineers:	1 copy

K. Engineer's approval of submitted material constitutes an acknowledgment only and in no way relieves the contractor of full responsibility for providing all systems complete in accordance with the intent of the drawings and specifications. Contractor is responsible for confirming and correlating dimensions at job site, for information which pertains to fabrication processes or construction techniques and for coordination of work with all other trades. Any materials or equipment provided by this contractor without approved shop drawings constitutes the contractor's agreement to comply with the engineer's intent whether specified, shown or implied.

3.12 OPERATING AND MAINTENANCE INSTRUCTIONS

A. Secure three copies of operating and maintenance instructions, service manuals, and parts listed applicable to each item of equipment furnished. Deliver three bound sets for the Owner's use. Include nameplate data and design parameters in operation and maintenance manuals. Clearly distinguish between information which applies to the equipment and information which does not apply. Also include all approved submitted data, all warranties on equipment, contractor's warranty and all test and balance reports. Delivery of required documents is a condition of final acceptance.

B. Upon completion of work, and at time designated by Architect, provide services of a competent representative of the contractor for a period of at least 24 hours to instruct the owner's representative in the operation and maintenance of the entire system.

3.13 PROJECT RECORD DOCUMENTS

A. Preparation. Maintain at the job site a separate set of white prints of the contract drawings for the sole purpose of recording the "as built" changes and diagrams of those portions of work in which actual construction is significantly at variance with the contract drawings. Mark the drawings with a colored pencil. Prepare, as the work progresses and upon completion of work, drawings clearly indicating locations of various lines, valves, traps, equipment, and other pertinent items, as installed. Include flow-line elevation of sewer lines. Record underground and underslab piping installed, dimensioning exact location and elevation of such piping.

B. Throughout progress of the work of this Contract, maintain an accurate record of all changes in the Contract Documents. Upon completion of the Work of this Contract, transfer the recorded

changes the AutoCAD drawing files and specification word processing files. Delegate the responsibility for maintenance of Record Documents to one person on the Contractor's staff. Thoroughly coordinate all changes within the Record Documents, making adequate and proper entries on each page of Specifications and each sheet of Drawings and other Documents where such entry is required to properly show the change. Include all addenda items, request for information Architect's Supplemental Instructions and any other document that causes a change in the Construction Documents. Accuracy of records shall be such that future search for items shown in the Contract Documents may reasonably rely on information obtained from the approved Record Documents.

C. The Contractor shall mark any deviations on a daily basis. The Architect will visit the site and will require to see the "As-Built" documentation periodically. If the Contractor does not keep an accurate set of as-built drawings, the pay request may be altered or delayed at the request of the Architect. Mark the drawings with a colored pencil. Record installed feeder conduits. Dimension the location and elevation of the conduit.

D. Record Documents shall consist of the following:

1. Job Set: Promptly following award of Contract, secure from the Architect, at no charge to the Architect, one complete set of all mechanical documents comprising the Contract.

2. Final Record Documents: Obtain the AutoCAD drawings files at the Contractor's expense ($200 and signed release form).

   a. The Contractor shall transfer all change data shown on the job set of to the corresponding electronic files, coordinating the changes as required, and clearly indicating at each affected detail and other drawing the full description of all changes made during construction and the actual location of items. Call attention to each entry by drawing a "cloud" around the area or areas affected.

3. Submit the completed total set of Record Documents to the Engineer as described above. Participate in review meeting or meetings as required by the Engineer, make all required changes in the Record Documents, and promptly deliver the final Record Documents to the Architect. Upon completion of Work, the Contractor shall certify the "Record Drawings" for correctness by signing the following certification:

   CERTIFIED CORRECT (3/8" high letters)

   (Name of the Contractor)

   By _____

   Date _____

   (Name of the Sub-Contractor)

   By _____

   Date _____

4. Deliver record drawings to the Architect in the number and manner specified in Division 01 - General Requirements.

3.14 NOISE AND VIBRATION

A. Select equipment to operate with minimum noise and vibration. If objectionable noise or vibration is produced or transmitted to or through the building structure by equipment, piping, ducts or other parts of work, rectify such conditions without cost to the Owner.

3.15 OPERATING TESTS

A. After all mechanical systems have been completed and put into operation, subject each system to an operating test under design conditions to ensure proper sequence and operation throughout the range of operation. Make adjustments as required to ensure proper functioning of all systems. Special tests on individual systems are specified under individual sections.

3.16 LUBRICATION, REFRIGERANT AND OIL

A. Provide a complete charge of correct lubricant for each item of equipment requiring lubrication.

B. Provide complete and working charge of proper refrigerant, free of contaminants, into each refrigerant system. After each system has been in operation long enough to ensure completely balanced conditions, check the charge and modify it for proper operation as required.

3.17 EQUIPMENT NAMEPLATES

A. All air handling units, fan-coil units, air terminal boxes, VAV boxes, condensing units, chillers shall have an engraved Setonply Nameplate, black background, white letters, 1-1/2" x 4". Nameplate shall have equipment mark (same as indicated on drawings) in white. Plate shall be attached to equipment mark (same as indicated on drawings) in white. Plate shall be attached to equipment without using screws, per manufacturer's recommendations. All fans shall have an engraved aluminum plate with fan number, black background, white letters, 3/4" x 2-1/2". Fan nameplate shall also list rooms served by fan on one line and the service on the third line. Attach to fan per manufacturer's recommendations.

3.18 SUBSTITUTIONS REQUIRING CHANGES

A. Manufacturers and power requirements indicated on the mechanical and electrical drawings are the basis of design. If changes are required for the equipment submitted, such as changes in conduit size, conductors, breakers, disconnects, panels, etc., it shall be made at no additional cost to the Owner.

3.19 PIPE SLEEVES

A. Fit with sleeves all pipes passing through masonry and concrete construction. Fabricate sleeves of schedule 40 galvanized steel pipe. Size sleeve for minimum clearance between pipe or insulation and sleeve.

B. Extend each sleeve through the floor or wall. Cut the sleeve flush with each surface, except that in exposed locations, extend floor sleeves 3 inches from finished wall or above finished floor line.

C. Caulk all sleeves water and airtight. Seal annular space between pipes and sleeves with fire stop material, see specification on fire stopping found elsewhere in this specification. Install per manufacturer's recommendations to meet or exceed fire rating of penetrated wall (minimum 1-1/2 hour). Reference architectural drawings for wall fire ratings.

D. Sleeve pipe through concrete foundations, below grade with Thunderline Link-Seal wall penetration seals. Equip seals with stainless steel nuts , bolts and pressure plate.

3.20 FIRESTOPPING

A. All piping, tubing, ductwork, conduit, etc. passing through fire rated floors and/or walls shall have the void area between the material passing through floor and/or wall sealed with an approved fire-stop material to maintain the fire rating of the floor and/or wall. Depending on the particular installation, the contractor shall use FS900 series fire stop caulk or FS500/600 series fire-stop components as manufactured by International Protective Coatings or approved equivalent.

B. All fire stop systems shall be installed as required by the manufacturer and U.L. requirements for each application.

C. The Contractor shall procure the services of an independent inspection service to review and provide a certified letter to the Contractor, Engineer and the City of San Antonio, stating all firestopping has been installed per UL listing and the manufacturer’s recommendations. Independent service shall have experience in the inspection of firestopping materials and methods installed.

3.21 PRECEDENCE OF MATERIALS

A. The specifications determine the nature and setting of materials and equipment. The drawings establish quantities, dimensions and details.

B. The installation precedence of materials shall be as follows. Note that if an interference is encountered, this shall guide the Contractor in the determination of which trade shall be given the “Right-of-Way”.

C. Building lines

D. Structural Members

E. Soil and Drain Piping

F. Condensate Drains

G. Vent Piping

H. Supply, Return, and Outside Air Ductwork

I. Exhaust Ductwork

J. HVAC Water, Chilled Water Supply/Return, Hot Water Supply/Return

K. Fire Protection Piping

L. Natural Gas Piping

M. Domestic Water (Cold and Hot)

N. Refrigerant Piping

O. Electrical Conduit

END OF SECTION 23 00 00

SECTION 23 00 02 - EARTHWORK

PART 1 - GENERAL

A. This section provides for the excavating and backfilling required for pipe trenches for underground piping, and miscellaneous excavation for structures installed as part of mechanical work.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Excavate trenching for underground piping to the required depth to ensure two feet minimum cover over the pipe.

B. Cut the bottom of the trench or excavation to uniform grade so that pipe or structure will bear on undisturbed soil. Provide additional excavation at joints as required to allow full length of pipe to lay on undisturbed soil.

C. Should rock be encountered, excavate 6 inches below grade, fill with gravel and tamp well.

D. Carefully lay out alinement of pipe trenches to avoid obstructions.

3.2 BACKFILL

A. Backfill will not be placed until the work has been inspected, tested and approved. Complete backfill to the surface of natural ground or to the lines and grades shown on drawings. Except where special materials are requested, use suitable soils or select fill as backfill material. Do not use peat or other organic matter, silt, muck, debris or similar materials. Deposit backfill in uniform layers and compact each layer as specified.

B. Compacting Backfill. Place material in uniform layers of prescribed maximum thickness and wet or dry the material to approximately optimum moisture content. Compact with power-driven hand tampers to the prescribed density. Place regular backfill in 8-inch maximum layers, loose measure. Compact to not less than 95% of maximum soil density as determined by AASHTO Method T-99.

C. Restoration. Compact backfill where trenching or excavation is required in improved areas such as pavements, walks, and similar areas, to a condition equal to undisturbed earth, and restore surface of the area to the condition existing prior to trenching or excavating operation.

3.3 DISPOSAL OF EXCESS MATERIAL

A. Remove excess excavation material or material unsuitable for backfill from site.

END OF SECTION 23 00 02

SECTION 23 05 19 - GAUGES, THERMOMETERS AND FLOW METERS

PART 1 - GENERAL

1.1 This section provides for furnishing and installing pressure gauges, thermometers. This specification applies to all of Division 23.

PART 2 - PRODUCTS

2.1 PRESSURE GAUGES

A. Application. Provide pressure gauges where shown. Provide Ashcroft or approved equal, 3-1/2-inch gauges with 2% accuracy.

B. Provide 0-100 psi gauges for chilled and heating water service.

C. Provide liquid glycerine filled gauges across all pumps of ranges indicated above.

D. Use. Pressure gauges need not be furnished across in-the-line circulators.

E. Valves.

F. For all gauges, provide globe valves. Provide:

Jenkins 750	Stockham B-66
Crane 362E	Powell 120

2.2 BI-METAL THERMOMETERS

A. Provide bimetal thermometers similar to Dwyer Series BT, adjustable angle connection, +/- 1% full scale accuracy, 304 stainless steel stem, dual scale dial, 5" dial, 4" or 6" stem length as required.

END OF SECTION 23 05 19

SECTION 23 05 29 - EQUIPMENT SUPPORT

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This section specifies furnishing and installation of concrete equipment pads for all direct and isolated floor mounted equipment, and structural equipment supports for horizontal tanks, heat exchangers and similar equipment, where required.

1.2 RELATED WORK

A. Division 03 - Cast-in-Place Concrete.

B. Division 05 - Miscellaneous Metals.

C. Division 09 - Painting.

PART 2 - PRODUCTS

2.1 CONCRETE

A. Provide Class A concrete as specified in Division 03 - Concrete.

2.2 STRUCTURAL METAL

A. Furnish structural metal as specified in Division 05 - Metals.

PART 3 - EXECUTION

3.1 CONCRETE PADS

A. Pour 4-inch pads on roughened floor slabs unless otherwise noted. Extend outer edges of pads a minimum of 2 inches beyond equipment. Secure equipment with anchor bolts in accordance with equipment installation instructions.

3.2 FAN AND EQUIPMENT SUPPORTS

A. If fan curbs or equipment curbs are not furnished with the equipment, provide prefabricated roof curbs, compatible with the roofing system installed (metal material to be modified if required); slope curbs for sloped roofs so top of curb is parallel with floor below (level). Curbs to be similar to Thycurb model TEMS; attenuated curbs to be similar to Thycurb model TC-VB

(24" height). All seams and joints to be welded and hot dip galvanized. No shop fabricated products allowed. Secure fans to curbs per IBC.

END OF SECTION 23 05 29

SECTION 23 05 48 - VIBRATION ISOLATION

PART 1 - GENERAL

A. Refer to Section 23 00 00 for General Requirements for Mechanical Work.

1.1 SCOPE OF WORK

A. Unless otherwise noted on the equipment schedule, all mechanical equipment shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure.

B. Vibration isolators shall be selected in accordance with weight distribution so as to product reasonably uniform deflection. Deflections shall be as noted on the equipment isolator schedule noted here in.

C. All vibration isolation devices, including steel bases/forms shall be designed and furnished by a single manufacturer or his qualified representative.

D. All equipment is to be externally isolated to insure that all paths of vibration have been addressed. **Internal Factory Isolation Is Unacceptable.**

1.2 RELATED WORK

A. Division 23 - HVAC.

1. Refer to the section on Ductwork for flexible connections between fans and ducts.

2. Refer to the section on equipment Supports for equipment foundation pads.

1.3 SUBMITTALS

A. Submit product data showing type, size, load, deflection and other information required. Include clearly outlined procedures for installing and adjusting isolators.

B. Completely detail concrete bases including the 6-inch-thick foundation pad.

PART 2 - PRODUCTS

2.1 ISOLATOR DESIGN

A. Materials. Design and treat vibration isolators for resistance to corrosion. Furnished phosphatized steel components with industrial-grade, corrosion-resistant material. Coat components exposed to the weather with PVC coating or fabricate of galvanized steel. Furnish

zinc electroplated nuts, bolts and washers. Clean steel bases thoroughly of welding slag and prime with zinc-chromate or metal etching primer.

B. Design.

1. Unless otherwise instructed, use spring-type vibration isolators for all equipment driven by motors of 3 horsepower and larger. The isolator manufacturer must calculate the amount of spring deflection required for each isolator to achieve optimum performance and to prevent the transmission of objectionable vibration and noise.

2. All spring isolators must be completely stable in operation and must be designed for not less than 30% reserve deflection beyond actual operating condition.

3. Design isolators for equipment installed outdoors to provide adequate restraint due to normal wind conditions. The isolators must withstand wind loads of 30 pounds per square foot applied to any exposed surface of the isolated equipment.

4. Air handling equipment subjected to excessive horizontal air thrust shall be furnished with isolated thrust resisters to limit displacement to 1/4 inch.

5. Height saving brackets used with isolators having 2-1/2-inch deflection or greater shall be of the precompression type to limit exposed bolt length.

2.2 ISOLATOR TYPES

A. Type MH-1 Mountings

1. Neoprene mountings shall have a minimum static deflection of 0.35". All metal surfaces shall be neoprene covered and have friction pads both top and bottom. Bolt holes shall be provided on the bottom and a tapped hole and cap screw on top. Steel rails shall be used above the mountings under equipment such as small vent sets to compensate for the Overhang. Mountings shall be type ND or rails type DNR as furnished by Mason-Dallas, Inc. or equivalent product by Kinetics.

B. Type MH-2 Mountings

1. Spring isolators shall be free standing and laterally stable without any housing and complete with a molded neoprene cap or ¼" neoprene acoustical friction pad between the base plate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Installed and operating heights shall be equal. The ratio of the spring diameter divided by the compressed spring height shall be no less than 0.8. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Submittals shall include spring diameters, deflection, compressed spring height and solid spring height. Mountings shall be type SLF, as furnished by Mason-Dallas, Inc. or equivalent product by Kinetics.

C. Type MH-3 Mountings

1. Equipment with large variations in the operating and installed weight, such as chillers, boilers, etc., and equipment exposed to the wind such as cooling towers, roof mounted

fans and roof mounted air handling equipment shall be mounted on spring mountings, as described in Engineering Specification B, including the neoprene acoustical pad within a rigid sided housing that includes vertical limit stops to prevent spring extensions when weight is removed and temporary steel spacers between the upper and lower housings. Housings shall serve as blocking during erection. When the equipment is at full operating weight, the springs shall be adjusted to assume the weight and the spacers removed, without changing the installed and operating heights. All restraining bolts shall have large rubber grommets to provide cushioning in the vertical as well as horizontal modes. The hole through the bushing shall be a minimum of 0.75" larger in diameter than the restraining bolt. Horizontal clearance on the sides between the spring assembly and the housing shall be a minimum of 0.5" to avoid bumping and interfering with the spring action. Vertical limit stops shall be out of contact during normal operation. Cooling tower mounts are to be located between the supporting steel and the roof or the grillage and dunnage as shown on the drawings when there is no provision for direct mounting. Housings and springs shall be powder coated and hardware electro-galvanized. Mountings shall be SLR as furnished by Mason-Dallas, Inc. or equivalent product by Kinetics.

D. Type MH-2 Hangers

1. Vibration hangers shall contain a steel spring and 0.2" deflection neoprene element is series. The neoprene element shall be molded with a rod isolation bushing that passes through the hanger box. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Hangers shall be type **DNHS** as furnished by Mason-Dallas, Inc. or equivalent product by Kinetics.

E. Type MH-4 Horizontal Thrust Restraints

1. When total air thrust exceeds 10% of the isolated weight, floor mounted or suspended air handling equipment shall be protected against excessive displacement by the use of horizontal thrust restraints. The restraint shall consist of a modified Specification B spring mounting. Restraint springs shall have the same deflection as the isolator springs. The assembly shall be preset at the factory and fine tuned in the field to allow for a maximum of ¼" movement from stop to maximum thrust. The assemblies shall be furnished with rod and angle brackets for attachments to both the equipment and duct work or the equipment and the structure. Restraints shall be attached at the center line of thrust and symmetrically on both sides of the unit. Horizontal thrust restraints shall be WB as furnished by Mason-Dallas, Inc. or equivalent product by Kinetics.

F. Type R-1 All-Directional Acoustical Pipe Anchors

1. All directional acoustical pipe anchors, consist of two sizes of steel tubing separated by a minimum ½" thickness of 60 durometer or softer neoprene. Vertical restraint shall by provided by similar material arranged to prevent up or down vertical travel. Allowable loads on the isolation material shall not exceed 500 psi and the design shall by balanced for equal resistance in any direction. All directional anchors shall be type ADA as furnished by Mason-Dallas, Inc. or equivalent product by Kinetics.

G. Type R-2 Acoustical Pipe Guides

1. Pipe guides shall consist of a telescopic arrangement of two sizes of steel tubing separated by a minimum ½ thickness of 60 durometer or softer neoprene. The height of the guides shall be preset with a shear pin to allow vertical motion due to pipe expansion or contraction. Guides shall be capable of ±1 $^{5}/_{8}$" motion, or to meet location requirements. Pipe guides shall be type VSG as furnished by Mason-Dallas, Inc. or equivalent product by Kinetics.

H. Type IB-1 Bases

1. Vibration isolator manufacturer shall furnish rectangular structural beam or channel concrete forms for floating foundations. Bases for split case pumps shall be large enough to provide support for suction and discharge base ells.

2. The base depth need not exceed 12" unless specifically recommended by the base manufacturer for mass or rigidity. In general, bases shall be a minimum of 1/12th of the longest dimension of the base, but not less than 6". Forms shall include minimum concrete reinforcement consisting of 3/8" bars or angles welded in place on 6" centers running both ways in a layer 1½" above the bottom, or additional steel as is required by the structural conditions. Height saving brackets shall be employed in all mounting locations to maintain a 2" clearance below the base. Bases shall be type KSL/BMK as furnished by Mason-Dallas, Inc. or equivalent product by Kinetics.

I. Type FC-1 for Following: Locations Within MER & Water Applications up to 180 Degrees

1. Rubber expansion joints shall be peroxide cured EPDM throughout with Kevlar tire cord reinforcement. Substitutions must have certifiable equal or superior characteristics. The raised face rubber flanges must encase solid steel rings to prevent pull out. Flexible cable wire is not acceptable. Size 1½" through 14" shall have a ductile iron external ring between the two spheres. Sizes 16" through 24" may be single sphere. Sizes ¾" through 2" may have one sphere, bolted threaded flange assemblies and cable retention.

2. Minimum ratings through 14" shall be 250psi at 170□F and 215psi at 250□F. 16" through 24" 180psi at 170□F and 150psi at 250□F. Higher published rated connectors may be used where required.

3. Safety factors shall be a minimum of 3/1. All expansion joints must be factory tested to 150% of maximum pressure for 12 minutes before shipment.

4. The piping gap (distance between companion flanges) shall be equal to the length of the expansion joint under pressure. Control rods passing through ½" thick Neoprene washer bushing large enough to take the thrust at 1,000psi of surface area may be used on unanchored piping where the manufacturer determines the condition exceeds the expansion joint rating without them. Submittals shall include two test reports by independent consultants showing minimum reductions of 20 DB in vibration accelerations and 10 DB in sound pressure levels at typical blade passage frequencies on this or a similar product by the same manufacturer. All expansion joints shall be installed on the equipment side of the shut off valves. Expansion joints shall be SAFEFLEX SFDEJ, SFEJ, SFDCR or SFU and Control Rods CR as furnished by Mason-Dallas, Inc. or equivalent product by Kinetics.

J. Type FC-2 – (Steel Pipe) for Following: Locations Outside MER, Water Applications (over 180 degrees), Air and Steams

1. Flexible stainless steel hose shall have stainless steel braid and carbon steel fittings. Sizes 3" and larger shall be flanged. Smaller sizes shall have male nipples.

2. Length shall be as tabulated:

FLANGED	MALE NIPPLES
3 X 14 10 X 26½ X 9	1½ X 13
4 X 15 12 X 28¾ X 10	2 X 14
5 X 19 14 X 301 X 11	2½ X 18
6 X 20 16 X 32	1¼ X 12
8 X 22	

3. Hoses shall be type BSS or UPCS furnished by As furnished by Mason-Dallas, Inc. or equivalent product by Kinetics.

K. Type FC-3 – (Copper Lines)

1. Flexible bronze hose shall have bronze braid with sweat connections for copper piping up to 3" diameter. Above 3" diameter, both hose and braid shall be stainless steel with brass sweat ends.

2.3 APPLICATION

A. Horizontal Pipe Isolation

1. Isolate piping as follows to create a floating mechanical system:

2. Piping 1½" and larger, connected to isolated equipment in the central plant and mechanical equipment rooms.

3. Pumped water and refrigerant piping 2" and larger outside mechanical equipment rooms.

4. To create a floating piping system, install piping hangers at regular intervals according to pipe hanger schedule. Coordinate selection of piping supports with equipment supports to accommodate expansion and contraction without creating excessive stresses at equipment connections.

5. For the two supports nearest a piece of equipment on each pipe connected to the equipment, select isolators with an operating spring deflection not less than that specified for the equipment isolators. All other supports for horizontal piping must have a minimum operating deflection of ¾" with a capability of an additional 50% travel-to-solid.

B. Vertical Riser Isolation

1. All vertical risers shall be supported by spring isolators designed to support the riser filled with water, if it is a water line. Assigned loads must be within the building design

limits at the support points. Neutral central resilient anchors close to the center of the run shall direct movement up and down. The anchors shall be capable of holding an upward force equal to the water weight when the system is drained. If one level cannot accommodate this force, anchors can be located on 2 or 3 adjacent floors. Resilient guides shall be spaced and sized properly depending on the pipe diameter. Submittals must include the initial load, initial deflection, change in deflection, final load and change in load at all spring and anchor support locations, as well as guide spacing. The initial spring deflection shall be a minimum of 0.75" or four times the thermal movement at the isolator location, whichever is greater. Calculations shall include pipe stress at end conditions and branch off locations and the manufacturer must include installation instructions. Submittal must by stamped and signed by a licensed professional engineer in the employ of the vibration vendor for at least 5 years. The isolator manufacturer shall be the same firm supplying the mechanical contract. Support spring mountings shall be MH-3, anchors Specification R-1, telescoping guides Specification R-2.

2.4 ISOLATOR APPLICATIONS

EQUIPMENT	BASE TYPE	FLEX TYPE	ISOLATOR TYPE	DEFLECTION
Chillers (Slab on grade or basement)	—	* FC-1	MH-1	0.35"
Pumps:				
Pumps (slab on grade or basement)	IB-1	* FC-1	MH-1	0.35"
Packaged AHU (with internal isolators):			MH-1	0.35"
Fan Coil Units (suspended)	—	FC-2	MH-2	0.75"
Condensing Units/Condensers	—	* FC-1/2	MH-1	0.35"
Piping	(Refer to Specification Paragraph for Requirements)			

PART 3 - EXECUTION

A. Stock Requirements. The isolation manufacturer's representative must maintain an adequate stock of springs and isolators of type used so that changes made during construction and installation can be made.

END OF SECTION 23 05 48

SECTION 23 07 00 - INSULATION - GENERAL

PART 1 - GENERAL

1.1 SCOPE

A. This section specifies the general requirements for furnishing and installing insulation. These requirements apply to all other Mechanical Division sections specifying insulation.

1.2 INTENT

A. The intent of insulation specifications is to obtain superior quality workmanship resulting in an installation which is absolutely satisfactory in both function and appearance. Provide insulation in strict accordance with the specifications for each type of service and apply as recommended by the manufacturer.

1.3 RELATED WORK

A. Division 23, HVAC.

B. Air Handling Units. Internal insulation for air units is specified in the sections on air handling units. The units do not require external insulation.

C. Insulation. Refer to specific sections on individual insulation types.

1.4 APPROVALS

A. Submittals. Submit product data on each insulation type, adhesive, and finish to be used in the work. Make the submittal as specified in Division 01, General Requirements and obtain approval before beginning installation.

1.5 FIRE HAZARD RATING

A. All duct and piping insulation used on the project must have a flame spread rating not exceeding 25 and a smoke developed rating not exceeding 50 as determined by test procedures ASTM E 84, NFPA 255 and UL 723. These ratings must be as tested on the Composite of insulation, jacket or facing, and adhesive. Components such as adhesives, mastics and cements must meet the same individual ratings as the minimum requirements.

PART 2 – PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 INSULATION

A. Insulate valves, fittings, flanges, and special items to the full thickness required for corresponding piping.

B. Replace insulation damaged by either moisture or other means. Insulation which has been wet, whether dried or not, is considered damaged. Make repairs where condensation is caused by improper installation of insulation. Also repair any damage caused by the condensation.

C. Do not insulate any piping until all pressure tests have been performed in accordance with specifications.

END OF SECTION 23 07 00

SECTION 23 07 13 - EXTERNAL DUCT INSULATION

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This section provides for the furnishing and installation of external insulation on low-velocity supply, return and outside air ducts, all VAV box hot water coil housings and tube bends, and all round low-velocity supply ductwork.

B. External insulation of concealed and exposed ducts is included in this section. Internal acoustic duct linings are specified under Ductwork and not included in this section.

C. External fire rated wrapping for ductwork is included in this section.

1.2 RELATED WORK

A. Division 23 - HVAC. Insulation - General.

PART 2 - PRODUCTS

2.1 INSULATION

A. Duct, Round, Flat Oval, or Rectangular. Insulation R-values shall comply with the current International Energy Conservation Code requirements. Provide flexible glass fiber insulation with factory-applied, reinforced Foil-Kraft vapor retarder facing. A minimum thermal resistance of 6.0 (sq.ft. x degrees F x hrs. per BTU) at 75□F is required, after installation (not in bag). Provide minimum 1-pound density insulation, which complies with ASTM C1290, C1136, C553.

B. 1 and 2-Hour Duct Wrap. Ducts serving pressurized stairwells and ducts supplying air to atriums to have wrap equal to the fire rating of the enclosures they are serving. Air ducts to be wrapped per requirements of NFPA 96, UBC, UMC, SBC for 1- and 2-hour enclosures. Duct wrap to be similar to Premier Refractories Pyroscat FP fire barrier, duct wrap, 1-1/2" thick per 1-hour requirement. Requirement of 1-hour or 2-hour to be per local code authority. Insulation to meet requirements of UL 263, UL 723, UL 1479, ISO6944, UL-C FRD 6. Wrap to be listed for zero clearance.

C. Standing Seams. Insulate standing seams and stiffeners that protrude through the insulation with 0.6-pound-per-cubic-foot density, 1 ½ inch thick, unfaced, flexible blanket insulation. As a vapor seal, use 8-ounce canvas with vapor barrier coating. Insulation should not prevent adjustment of damper operators.

2.2 COATING AND ADHESIVE (Low VOC)

A. Coating. Provide Foster 30-65 or Childers CP-34 vapor barrier coating.

B. Adhesive. Provide Foster 85-60 or Childers CP-127 vapor barrier adhesive.

PART 3 - EXECUTION

3.1 FIRE SAFETY REQUIREMENTS

A. Do not extend duct coverings through walls or floors required to be firestopped or required to have a fire resistance rating. Interrupt duct coverings in the immediate vicinity of heat sources, such as electric resistance or fuel-burning heaters.

3.2 DUCT, ROUND, FLAT OVAL OR RECTANGULAR

A. Insulation shall be wrapped tightly on the ductwork with all circumferential joints butted and longitudinal joints overlapped a minimum of 2 inches. In addition, secure insulation to the bottom of rectangular ductwork over 24 inches wide by the use of mechanical fasteners at no more than 18 inches on center.

B. On circumferential joints, the 2-inch flange on the facing shall be stapled with 9/16-inch flare-door staples on 6-inch centers, and taped with a minimum 3-inch-wide strip of glass fabric and coating, or a 3-inch-wide strip of 8-ounce canvas adhered with adhesive. Cover all seams, joints, pin penetrations and other breaks with coating reinforced with glass fabric.

C. On circumferential joints, the 2-inch flange on the facing shall be stapled with 9/16-inch flare-door staples on 6-inch centers, and taped with a minimum 3-inch-wide strip of glass fabric and coating, or a 3-inch-wide strip of 8-ounce canvas adhered with adhesive. Adhesive systems employing release paper will not be acceptable.

END OF SECTION 23 07 13

SECTION 23 07 16 - CHILLERS, VESSELS AND HEAT EXCHANGER INSULATION

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This section provides for furnishing and installing insulation for both high and low temperature vessels.

B. Low temperature installations include chillers, expansion tanks, air eliminators and other vessels containing liquids and gases below 60°F.

1.2 RELATED WORK

A. Division 23 - HVAC. Insulation - General.

PART 2 - PRODUCTS

2.1 INSULATION

A. High Temperature Vessels. Furnish hydrous calcium silicate in the following thicknesses:

Vessel	Thickness, in Inches
Expansion Tanks, Tanks	1

B. Low Temperature Vessels. Provide fiberglass insulation with glass cloth vapor barrier facing. A minimum 3-pound density is required. Thickness as follows:

Vessel	Thickness, in Inches
Expansion Tanks and Air Eliminators	1

C. Low Temperature Vessels. Provide 1/2-inch thick, standard Armstrong Armaflex AP sheet insulation to chillers, expansion tanks, air eliminators, and other heat exchangers.

2.2 CEMENT AND COATINGS

A. Cement. Provide Johns-Manville No. 375 cement to seal insulation for high temperature vessels.

B. Coating. Furnish Foster 46-50 or Childers CP-10/11 coating to provide a finish coat and to secure finish cloth.

C. Sealant. Use Foster 95-44 or Childers CP-76 to seal the joints of insulation on low temperature vessels.

D. Finish. Use Foster 30-65 or Childers CP-34 finish to adhere and coat the canvas finish on low temperature vessels.

PART 3 - EXECUTION

3.1 LOW TEMPERATURE VESSELS (FIBERGLASS)

A. Apply a first layer of insulating board. Score and bend insulation to fit the contour of the equipment. Wire or band the board on immediately after application, using wire loops or bands on 12-inch centers, drawn tight and securely fastened.

B. Apply successive layers of insulation as specified for the first layer with joints staggered. Seal the joints with Benjamin-Foster 95-44 sealant. After the insulation has been applied, fill the joints and chipped places with finish reinforced with white, 20 x 20 glass fabric. Apply 8-ounce canvas adhered and given a smooth brush flood coating of Benjamin-Foster 30-70.

C. To insulate removable heads, provide two equal sections of heavy-gauge galvanized sheet metal covers, angle reinforced and lined with insulation board. Make covers easily removable to allow free access to the heads for inspection, cleaning and dismantling. Provide suitable flanges on the sections with neoprene gaskets between them, permitting a tight seal when the two sections are bolted together. Fill the voids with glass fiber wall cavity insulation.

3.2 LOW TEMPERATURE VESSELS (ARMAFLEX)

A. Adhere Armaflex sheet insulation to clean, oil-free metal surfaces by compression fit method and full coverage of Armstrong 520 adhesive. Seal butt joints with same adhesive.

B. Apply a minimum of two coats of white Armaflex finish to insulation with sufficient coats to provide satisfactory hiding qualities.

END OF SECTION 23 07 16

SECTION 23 07 16.02 - CHILLED WATER PUMP INSULATION (ARMAFLEX)

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This section provides for furnishing and installing Armaflex sheet insulation to chilled water pumps.

1.2 RELATED WORK

A. Division 23 - HVAC. Insulation - General

PART 2 - PRODUCTS

2.1 INSULATION

A. Provide standard Armstrong Armaflex sheet insulation, 1 inch thick.

2.2 MATERIALS

A. Adhesive. Use Armstrong 520 adhesive.

B. Finish (Indoor). Use Armaflex finish, white. Provide a minimum of two coats to entire surface, to provide satisfactory hiding qualities.

C. Finish (Outdoors). Apply glass fabric to all insulation, with Armstrong Insulcolor lagging adhesive. Then apply Armstrong Insulcolor primer, finished with white Armstrong Insulcolor. Finish can be applied by brush, roller or spray, as recommended by manufacturer.

PART 3 - EXECUTION

A. Construct a frame around the lower half of the chilled water pump, using angles made of .016-inch aluminum or galvanized sheet metal. If the chilled water pump is very large, add additional metal angles to rigidize the frame. The metal angles can be held together with galvanized nuts and bolts or pop rivets. Cut Armaflex sheets to fit each side and end of the metal angle frame. Each section of insulation should cover only the lower half of the top angle. The end insulation must be measured and cut out for the pipes or flanges. The side insulation must be cut out for protrusions at the drain at the bottom and at the shaft protrusion at the top. Then apply the insulation to the angle by use of the 520 adhesive.

B. Construct a frame around the upper half of the chilled water pump. Construct the upper half of the frame the same as specified for the lower half. The height of the frame is determined by the highest protrusion of the top section of the chilled water pump. A piece of .016-inch

galvanized steel or aluminum the dimension of the top of the frame shall be secured to the angles by use of galvanized nuts and bolts, or pop-rivets. This will provide a rigid top. Armaflex sheet shall then be cut to fit all sides of the cover. The height of the insulation for all sides is cut oversize to allow it to meet the body insulation plus 1/8 inch for a compression fit. The insulation is then adhered to the angles by use of the 520 adhesive. The extra 1/8 inch will be under compression from the weight of the top cover pushing down against the bottom cover insulation. Then cut another piece of insulation to fit the top cover and adhere it to the top by using the 520 adhesive. Assemble the cover.

C. Apply a finish to the cover as specified in paragraphs 2.2b and 2.2c.

D. Construct housing in accordance with manufacturer's recommendations.

END OF SECTION 23 07 16.02

SECTION 23 07 19.01 - LOW TEMPERATURE PIPING INSULATION

PART 1 - GENERAL

1.1 SCOPE

A. This section provides for installing and furnishing low temperature piping insulation of Fiberglass, Armaflex AP or Koolphen-K or as noted below. The insulation will be used for low temperature application including chilled water, refrigerant, domestic cold water, condensate drains, and horizontal portions of waste lines above grade that receive condensate from air handling units or evaporators.

1.2 RELATED WORK

A. Division 23, HVAC. Insulation - General.

PART 2 - PRODUCTS

2.1 PIPE INSULATION

A. Use one of the following as noted in the schedule below:

B. Fiberglass premolded pipe insulation, 4 PCF density, k-value 0.23 btu· in/hr· ft^2· °F at 75 °F, R-value = 4.3/inch, with factory-applied reinforced All Service Jacket having integral laminated aluminum vapor barrier.

C. Armaflex AP flexible closed cell elastomeric pipe insulation, 4 PCF density, k-value 0.27 btu· in/hr· ft^2· °F.

D. Premolded Phenolic Foam, closed cell pipe insulation, 2.5 PCF density, k-value 0.13 btu· in/hr· ft^2· °F at 75 °F, R-value = 7.6/inch, with factory-applied reinforced All Service Jacket having integral laminated aluminum vapor barrier. Koolphen-K, Insul-phen by Resol Co. or equal. Insulation shall be free of all CFC or HCFC. Material to comply with ASTM C1126 Type II and III grade 1, and comply with 25/50 flame smoke spread.

E. All above materials shall have Flame spread/Smoke developed rating less than 25/50 in accordance with ASTM E 84.

F. All materials to be installed and vapor sealed in accordance with the manufacturer's recommendations.

	Thickness (Inches)		
Insulated Unit	Fiberglass	Koolphen-K	Armaflex AP
Chilled Water Piping, 6" and smaller	1 1/2	1 1/2	—
Condensate Drain Lines	—	—	1/2
Above Ground Sanitary Waste Piping receiving Condensate from HVAC Equipment	1/2	3/4	—
Domestic Cold Water Piping (All)	1	3/4	—
Refrigerant Suction Piping	—	—	1 (1)
(1) Pipe 1-1/2" and less - 1" insulation; larger than 1-1/2" - 1-1/2" insulation			

2.2 FLANGE, VALVE AND FITTING INSULATION

A. Provide molded or mitered covers for flanges, valves and fittings. Refer to paragraph 3.2 for method of fabrication.

2.3 INSULATION SHIELD

A. Field Fabricated. Use sections of high density Koolphen-K, fiberglass, or foamglass insulation that will support the bearing area at hangers and supports. Further support insulation at hangers and supports with a shield of galvanized metal extending not less than 4 inches on either side of the support bearing area, covering at least half of the pipe circumference, and conforming to the schedule below.

B. Adhere metal shield to insulation so that metal will not slide with respect to insulation.

Pipe Diameter	Insulated Section Length in Inches	Minimum U.S. Standard Gauge of Metal Shield
3" and smaller	12	18
4" to 6"	12	16

2.4 SEALANT, ADHESIVE AND FINISH (Low VOC)

A. Sealant. Use Foster 95-44 or Childers CP-76 to be used at valve covers and vapor stops.

B. Adhesive. Furnish Foster 85-60 or Childers CP-127 to seal longitudinal laps of the vapor barrier jacket and to adhere butt joint covers. Self-sealing laps and butt strips are not allowed.

C. Finish. Use Foster 30-65 or Childers CP-34 with glass fabric reinforcement.

D. Finish Armaflex AP insulation installed outdoors with minimum two coats of Armstrong Finish per manufacturer's recommendations.

2.5 ALUMINUM JACKETING

A. Apply aluminum jacketing to all fiberglass and Phenolic insulated pipe located outdoors or as noted. For piping in crawl spaces, apply white PVC sealed jacketing.

B. Piping. Furnish for finishing insulated pipe, a self-fastening jacket of type 3003-H14 aluminum alloy, 0.016-inch thick.

C. Valves, Fittings and Flanges. For finishing all valves, fittings and flanges, and smaller installations, provide formed aluminum covers, 0.024-inches thick, Type 3003-H14 aluminum alloy.

D. Straps and seals. Provide aluminum strapping seals for jackets and covers according to manufacturer's recommendations.

E. Acceptable manufacturers. Jacketing as manufactured by Preformed Metal Products Company, Childers or Johns-Manville will be acceptable.

2.6 HEAT TRACING

A. Provide a parallel resistance heating cable with minimum 4.0 watts per lineal foot. Cable shall be UL listed and selected for 120 volt single phase service. Provide an adjustable thermostat with remote sensing bulb to energize cable when ambient temperature drops below 40□F, field adjustable, Thermon or approved equal. Heat trace all water piping located outdoors or exposed to outside temperatures.

B. Heat trace to be Thermon FLX self regulating cable, 5-FLX-1, 120/1/60, 5 watts per foot, with Thermon B4X-15140 adjustable ambient sensing thermostat, NEMA 4X. Thermon or approved equal. Heat trace all water piping and equipment components outdoors or in areas subject to freezing, whether shown or not.

PART 3 - EXECUTION

3.1 PIPE

A. Apply insulation to clean, dry pipes. Butt insulation joints firmly together. Seal longitudinal laps and butt strips with adhesive.

3.2 VALVES, FLANGES AND FITTINGS

A. Insulate all valves, flanges and fittings with factory molded or mitered fitting covers secured with wire. Thickness of insulation shall be equal to that of adjoining piping. Mitered covers for pipe 2" and smaller shall be minimum 3-piece to the side, and pipe 2-1/2" and larger shall be minimum 6 pieces to the side. The fitting shall then be rasped or otherwise formed to have a smooth appearance.

B. Finish with 1/4-inch layer of Foster 30-65 or Childers CP-34 reinforced with glass fabric.

3.3 CONTROL VALVE COVERS

A. Fabricate special covers, complete with troweled-on vapor seal, shaped to accommodate the valve stem. Insulation thickness shall be same thickness as adjoining pipe.

B. Seal covers to valve insulation proper with adhesive so that the seal may be broken with a knife blade without damage to either part. Arrange so that cover can be removed and replaced as necessary for operation of the valve. Finish valve cover with glass cloth and two coats of finish.

3.4 SHIELDS AND HANGERS

A. When the insulation is jacketed in aluminum, install a length of 40-pound roofing felt 1/2 inch longer than the insulation shield between shield and jacket.

END OF SECTION 23 07 19.01

SECTION 23 07 19.02 - HIGH TEMPERATURE PIPING INSULATION (FIBERGLASS)

PART 1 - GENERAL

1.1 SCOPE

A. This section provides for furnishing and installing high temperature piping insulation, including and hot water supply and return and domestic hot water piping. Emergency generator exhaust is not included.

1.2 RELATED WORK

A. Division 23, HVAC. Insulation - General.

PART 2 - PRODUCTS

2.1 INSULATION

A. Use premolded fiberglass pipe insulation, 4 PCF density, R-value = 4.3/inch with a factory-applied, all service reinforced jacket having integral laminated aluminum vapor barrier or phenolic foam rated for 210°F if listed for the service. Provide insulation thickness as listed.

Insulating Unit	Fiberglass Thickness (Inches)
Heating Water Piping, 5" and smaller	1-1/2
Heating Water Piping, 6" and larger	2
Domestic Hot Water Piping, 1-1/2" and smaller	1
Domestic Hot Water Piping, 2" and greater	1-1/2

2.2 INSULATION SHIELD

A. Field Fabricated. Use sections of high density fiberglass, calcium silicate, or foamglass insulation that will support the bearing area at hangers and supports. Further support insulation at hangers and supports with a shield of galvanized metal extending not less than 4 inches on either side of the support bearing area, covering at least half of the pipe circumference, and conforming to the schedule below. Adhere metal shield to insulation so that metal will not slide in respect to insulation.

Pipe Diameter	Insulated Section Length in Inches	Minimum U.S. Standard Gauge of Metal Shield
3" and smaller	12	18
4" to 6"	12	16

2.3 ADHESIVE, FINISH AND CEMENT (Low VOC)

A. Adhesive. Furnish Foster 85-60 or Childers CP-127 to seal longitudinal laps of vapor barrier jacket and to adhere joint butt covers.

B. Finish. Use Foster 46-50 or Childers CP-10/11 with glass fabric reinforcement.

C. Cement. Furnish Johns-Manville No. 460 on insulated fittings, flanges and valves.

2.4 ALUMINUM JACKETING

A. Apply aluminum jacketing to all insulated pipe located outdoors or as noted.

B. Piping. Furnish for finishing insulated pipe, a self-fastening jacket of type 3003-H14 aluminum alloy, 0.016-inch thick.

C. Valves, Fittings and Flanges. For finishing all valves, fittings and flanges, and smaller installations, provide formed aluminum covers, 0.024-inches thick, type 3003-H14 aluminum alloy.

D. Straps and seals. Provide aluminum strapping seals for jackets and covers according to manufacturer's recommendations.

E. Acceptable manufacturers. Jacketing as manufactured by Preformed Metal Products Company, Childers or Johns-Mansfille will be acceptable.

PART 3 - EXECUTION

3.1 PIPE

A. Apply insulation to clean, dry pipes. Butt insulation joints firmly together. Seal longitudinal laps and butt strips with adhesive. Insulation using self sealing laps and butt strips is acceptable.

3.2 VALVES, FITTINGS AND FLANGES

A. Omit insulation at screwed unions and at valves smaller than 1-1/2 inches, except at VAV box heating coils and on steam and condensate piping, where insulation is required.

B. On concealed piping, insulate fittings and valves 2-1/2 inches IPS and larger, with factory molded or mitered fitting covers. Mitered covers for pipe 2" and smaller shall be minimum 3-piece to the side, and pipe 2-1/2" and larger shall be minimum 6-pieces to the side. The fitting

shall then be rasped or otherwise formed to have a smooth appearance. Thickness of insulation shall be equal to that of adjoining pipe. Finish with coating reinforced with white 10" by 10" glass fabric.

C. On concealed piping, insulate fittings and valves 2 inches IPS and smaller with mineral wool and insulating cement to a thickness equal to or greater than adjoining straight pipe. At Contractor's option, provide molded or mitered fittings, finished with coating reinforced with glass fabric. Mitered covers for pipe 2" and smaller shall be minimum 3-piece to the side, and pipe 2-1/2" and larger shall be minimum 6-pieces to the side. The fitting shall then be rasped or otherwise formed to have a smooth appearance.

D. In exposed areas, insulate all fittings, flanges and valves with factory molded or mitered fitting covers. Thickness of insulation shall be equal to that of adjoining pipe. Mitered covers for pipe 2" and smaller shall be minimum 3-piece to the side, and pipe 2-1/2" and larger shall be minimum 6-pieces to the side. The fitting shall then be rasped or otherwise formed to have a smooth appearance. Finish with coating reinforced with white glass fabric.

E. Finish with 1/4-inch layer of Foster 46-50 or Childers CP-10/11 reinforced with glass fabric.

3.3 SHIELDS AND HANGERS

A. When the insulation is jacketed in aluminum, install a length of 40-pound roofing felt 1/2 inch longer than the insulation shield between shield and jacket.

END OF SECTION 23 07 19.02

SECTION 23 08 00 - AIR AND WATER BALANCE

PART 1 - GENERAL

1.1 SCOPE

A. This section covers final air balance operations after construction of the air system.

B. Testing Agency. The contractor shall secure the services of an independent air balance and testing agency to perform complete balance, adjustment and testing of air moving equipment and air distribution systems, including terminal units. Agency shall have on its staff at least one certified member of NEBB or AABC, who has been a member in good standing for at least 3 years, and the balancing agency shall be NEBB or AABC certified for a period of at least three years. Approved firms to provide this work are PHI Service Agency, Engineered Air Balance, and TAB Technologies.

C. Equipment. Instruments used shall be accurately calibrated and maintained in good working condition. Equipment shall be as listed by the Associated Air Balance Council or NEBB for this type work.

D. The items requiring testing, adjusting and balancing include the following:

1. AIR SYSTEMS:

    a. Supply Fan AHU

    b. Exhaust Fans

    c. Zone branch and main ducts

    d. VAV systems

    e. Diffusers, Registers and Grilles

    f. Coils (Air Temperatures)

2. HYDRONIC SYSTEMS:

    a. Pumps

    b. System Mains and Branches

    c. Chillers

    d. Boilers

    e. Heat Exchangers

    f. Coils

E. The balancing contractor shall provide tests to demonstrate the specified capacities and operation of all 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. The Balancing (HVAC) Contractor shall then make available to the Engineer such instruments and technicians as are required for spot checks of the system.

F. The drawings and specifications indicate valves, dampers, sheaves and miscellaneous adjustment devices for the purpose of adjustment to obtain optimum operating conditions, and it will be the responsibility of the Mechanical Subcontractor to install these devices in a manner that will leave them accessible and readily adjustable. The Balancing (HVAC) Contractor may be consulted if there is a questionable arrangement of a control or adjustable device.

G. The balancing contractor shall be responsible for inspecting, balancing, adjusting, testing and logging the data of the performance of fans, all dampers in the duct systems, all air distribution devices or heat exchangers and the flows of water through all coils. The General Contractor, the Mechanical Subcontractor and the suppliers of the equipment installed shall all cooperate with the Balancing (HVAC) Contractor to provide all necessary equipment cutsheets.

H. The Balancing (HVAC) Contractor shall provide the following services:

1. During construction, inspect the installation of heating and cooling pipe systems, sheet metal work, temperature controls and other component parts of the heating, air conditioning and ventilating systems. The inspection of the work will cover that part relating to proper arrangement and adequate provisions for the testing and balancing. The inspections shall be performed periodically as the work progresses. A minimum of three inspections are required as follows:

a. When 60% of the piping is installed.

b. When 60% of ductwork is installed.

c. When 90% of ductwork is installed.

I. Submit brief written report of each inspection to A/E, with copies to Contractor, Mechanical Engineer, Inspector, and Owner's Representative.

J. Upon completion of the installation and start-up of the mechanical equipment by the Mechanical Subcontractor, the Balancing (HVAC) Contractor will balance, test and adjust the systemic components to obtain optimum conditions in each conditioned space in the building. If construction deficiencies are encountered which preclude obtaining optimum conditions, and the deficiencies cannot be corrected by the Contractor within a reasonable period of time, cease TAB services and advise the Architect in writing with an information copy to the Owner's Representative. The Balancing (HVAC) Contractor is advised that deficiencies in HVAC construction are often encountered during final TAB services and he should include in his bid an amount he deems advisable to compensate for his time in identifying the deficiencies to the Mechanical Contractor and awaiting their correction.

K. Fourteen (14) days, or earlier, prior to the Owner's Final Inspection, as requested by the General Contractor, the TAB shall prepare seven (7) copies of the completed Balancing (HVAC) Test and Balance Report. The Report shall be complete with logs, data, and records as required

herein and all logs, data, and records shall be typed, produced on white bond paper, and bound with plastic spiral. The Reports shall be certified accurate and complete by a principal Engineer of the Balancing (HVAC) Contractor. Transmit one (1) copy direct to the Owner's Representative and the remaining six (6) copies to the Architect. The Architect will, in coordination with the Engineer, review the report. Upon approval, two (2) copies will be submitted to the Owner's Representative and two (2) copies transmitted to the Contractor.

L. The Report shall contain the following general data in a format selected by the TAB Agency for clarity and ease of reference.

1. Project No.
2. Contract No.
3. Project Title:
4. Project Location:
5. Project Mechanical Engineer: (Name)
6. TAB Field Test Engineer: (Name)
7. TAB Testing Diagnosis and Analysis by : (Name)
8. TAB Agency: (Firm name and address)
9. Mechanical Subcontractor: (Name and address)
10. General Contractor: (Name and address)
11. Inclusive dates tests were performed and date of Report
12. Test Certification Number:
13. Certification by principal engineer
14. The TAB Report shall normally contain the following sections:
15. Table of Contents
16. General data and certification
17. Brief Description of Tests and Test Procedures (including instruments used)
18. Summary of Test Results (note deficiencies, if any, and action taken for correction)
19. Logs, Data, and Records

1.2 REPORTS

A. Final TAB Report - The TAB agency shall submit the final TAB report for review by the engineer. All outlets, devices, HVAC equipment, etc., shall be identified, along with a numbering system corresponding to report unit identification. The TAB agency shall submit an AABC "National Project Performance Guaranty" assuring the project systems were tested, adjusted and balanced in accordance with the project specifications and AABC National Standards or NEBB procedures.

1.3 RELATED WORK

A. Division 23 - Mechanical.

1. Ductwork.

2. Fans.

3. Air Devices.

1.4 PROCEDURES

A. Operating Tests. After all mechanical systems have been completed, and prior to air balance, subject each system to an operating test under design conditions to ensure proper sequence of operation in all operating modes. Make adjustments as required to ensure proper functioning of all systems.

B. Certified Data. The contractor shall provide the balance and testing agency the certified data on fans, grilles, coils, filters and other equipment required for proper balancing of the system.

C. Adjustment. The balance and testing agency shall provide necessary adjustments to air flow dampers, fans, sheaves, extractors, splitters, and other controls as required to properly balance the system. TAB firm to include in his bid, all belts and sheaves, and labor to replace and adjust all sheaves to obtain scheduled air flow.

D. Balancing. The balance agency shall follow balancing and testing procedures published by the Associated Air Balance Council, or NEBB.

E. Reports. Compile the test data on report forms as listed in the AABC "National Standards for Total System Balance". Include data on air volume at supply and return grilles and diffusers. Include exhaust air volume. Contractor's forms are not acceptable unless all data included is in the latest "National Standards" by AABC.

F. The specified systems shall be reviewed and inspected for conformance to design documents. Testing, adjusting and balancing on each identified system shall be performed. The accuracy of measurements shall be in accordance with AABC National Standards. Adjustment tolerances shall be + or - 10% unless otherwise stated.

G. Equipment settings, including manual damper quadrant positions, manual valve indicators, fan speed control levels, and similar controls and devices shall be marked to show final settings.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 AIR AND WATER BALANCE (BY AIR BALANCE AGENCY)

A. General Requirements.

B. Do all work required for complete testing and adjusting of all HVAC systems.

C. Provide all instruments and equipment required to accomplish necessary testing, adjusting, and as required by the engineer to verify performance. All instruments shall be in accurate calibration and shall be calibrated in ranges that will be expected.

D. Prior to final observation, submit to the owner a letter certifying:

1. That all balancing is complete.

2. That all controls are calibrated and functioning properly.

3. That all parts of the various systems are complete and ready to be turned over to the owner for continuous operation. Submit with letter a report tabulating data requested by the Engineer.

E. Design Conditions. The HVAC systems have been designed to maintain the inside conditions indicated below when operating with the outside conditions stated. Install, test and adjust the systems so that they will produce the inside conditions for design; however, contractor must be prepared to provide a suitable test to prove that equipment is producing capacities scheduled.

1. Inside Conditions.

a. Summer: 75 F.D.B. 50% R.H.

b. Winter: 72 F.D.B.

2. Outside Conditions.

a. Summer: 98 F.D.B. 78 F.W.B.

b. Winter: 20 F.D.B.

F. Adjust all air system dampers and volume controllers to obtain proper air balance throughout the conditioned area. The air quantities shown on the drawings for individual outlets may be changed to obtain uniform temperature within each zone, but the total air quantity shown for each zone must be obtained. Maximum temperature variation within a zone to be 2°F.

G. Adjust all blower drives to obtain proper total amounts of air. Change drive if necessary to accomplish proper air flow. Costs for drive changes, including belts and sheaves will be borne by the TAB contractor.

H. Adjust all valves in the various water systems to obtain proper amount of water to each piece of equipment.

I. Calibrate, set and adjust all automatic temperature controls. Check proper amount of water to each piece of equipment.

3.2 AIR SYSTEMS

A. The TAB agency shall verify that all ductwork, dampers, grilles, registers, and diffusers have been installed per design and set in the full open position. The TAB agency shall perform the following TAB procedures in accordance with the AABC National Standards:

1. For supply fans:

a. Fan speeds - test and adjust fan RPM to achieve maximum or design cfm.

b. Current and voltage - test and record motor voltage and amperage, and compare data with the nameplate limits to ensure fan motor is not in or above the service factor.

c. Pitot-Tube traverse - perform a Pitot-tube traverse of main supply and return ducts, as applicable to obtain total cfm.

d. Outside air - test and adjust the outside air on applicable equipment using a pitot-traverse. If a traverse is not practical use the mixed air temperature method if the inside and outside temperature difference is at least 20 degrees Fahrenheit or use the difference between pitot-tube traverses of the supply and return air ducts.

e. Static pressure - test and record system static profile of each supply fan.

2. For exhaust fans:

a. Fan speeds - test and adjust fan RPM to achieve maximum or design cfm.

b. Current and voltage - test and record motor voltage and amperage, and compare data with the nameplate limits to ensure motor is not in or above the service factor.

c. Pitot-tube traverse - perform a pitot-tube traverse of main exhaust ducts to obtain total cfm.

d. Static pressure - test and record system static profile of each exhaust fan.

e. For zone, branch and main ducts:

f. Adjust ducts to within design cfm requirements. As applicable, at least one zone balancing damper shall be completely open. Multi-diffuser branch ducts shall have at least one outlet or inlet volume damper completely open.

3. For VAV systems:

a. Set volume regulators on all terminal boxes to meet design maximum and minimum cfm requirements.

b. Identification - identify the type, location, and size of each terminal box. This information shall be recorded on terminal box data sheets.

4. For diffusers, registers and grilles:

A. Tolerances - test, adjust and balance each diffuser, grille, and register to within 10% of design requirements. Minimize drafts.

B. Identification - identify the type, location and size of each grille, diffuser, and register. This information shall be recorded on air outlet data sheets.

C. For coils:

B. Air temperature - once air flows are set to acceptable limits, take wet bulb and dry bulb air temperatures on the entering and leaving side of each cooling coil. Dry bulb temperature shall be taken on the entering and leaving side of each heating coil.

3.3 HYDRONIC SYSTEMS. The TAB agency shall, as applicable, confirm that all hydronic equipment, piping, and coils have been filled and purged; that strainers have been cleaned; and that all balancing valves (except bypass valves) are set full open. The TAB agency shall perform the following testing and balancing functions in accordance with the AABC National Standards:

A. For pumps:

1. Test and adjust chilled water, hot water, pumps to achieve maximum or design GPM. Check pumps for proper operation. Pumps shall be free of vibration and cavitation. Record appropriate gauge readings for final TDH and Block-Off/Dead head calculations.

B. Current and Voltage - test and record motor voltage and amperage, and compare data with the nameplate limits to ensure pump motor is not in or above the service factor.

C. For system mains and branches:

1. Adjust water flow in pipes to achieve maximum or design GPM.

D. For chillers:

1. Verify that chillers have been started by others and are in operation. Test and adjust chiller water flows to achieve maximum or design GPM.

E. Current and voltage - test and record motor voltage and amperage, and compare data with the nameplate limits to ensure compressor motor is not in or above the service factor.

F. Test and record temperature profiles of chillers.

G. For boilers:

1. Verify that boilers have been filled and started by others, and are in operation.

2. Current and voltage - as applicable, test and record motor voltage and amperage, and compare data with the nameplate limits to ensure motor is not in or above the service factor.

3. Test and adjust water flow through water boilers.

4. Test and record temperature and pressure profiles of water or steam boilers.

H. For heat exchangers:

1. Verify that heat exchangers have been filled and started by others, and are in operation.

2. Test and adjust water flow through heat exchangers.

3. Test and record temperature and pressure profiles of water or steam heat exchangers.

I. For coils:

1. Tolerances - test, adjust, and balance all chilled water and hot water coils within 10% of design requirements.

2. Verification - verify the type, location, final pressure drop and GPM of each coil. This information shall be recorded on coil data sheets.

3.4 DUCT LEAKAGE TESTING. The installing contractor shall isolate and seal sections of ductwork for testing. The test pressures required and the amount of duct to be tested shall be described by the engineer in the appropriate duct classification section. All testing shall be based on one test per section only unless otherwise noted.

3.5 VERIFICATION OF HVAC CONTROLS. The TAB agency shall be assisted by the building control systems contractor in verifying the operation and calibration of all HVAC and temperature control systems. The following tests shall be conducted:

A. Verify that all control components are installed in accordance with project requirements and are functional, including all electrical interlocks, damper sequences, air and water resets, fire and freeze stats, and other safety devices.

B. Verify that all controlling instruments are calibrated and set for design operating conditions.

3.6 TEMPERATURE TESTING. To verify system control and operation, a series of three temperature tests shall be taken at approximately two-hour intervals in each separately controlled zone. The resulting temperatures shall not vary more than two degrees Fahrenheit form the thermostat or control setpoint during the tests. Outside temperature and humidity shall also be recorded during the testing periods.

3.7 TAB REPORT VERIFICATION. At the time of final inspection, the TAB agency may be required to recheck, in the presence of the Owner's representative, specific or random selections of data recorded in the certified report. Points and areas for recheck shall be selected by the Owner's representative. Measurements and test procedures shall be the same as approved for the initial work for the certified report. Selections for recheck, specific plus random, will not exceed 10% of the total number tabulated in the report.

A. The TAB agency shall test and adjust fume hood total air flow by duct pitot-tube traverse. If a pitot-tube traverse is not practical, an explanation of why a traverse was not made must appear on the appropriate data sheet. Test and record face velocities under design operating conditions using a maximum of a one square foot grid pattern across the entire open face. The TAB agency shall set sash height on hoods to obtain face velocities within 20% of 100 feet per minute unless specified otherwise. It shall test and adjust VAV controllers to obtain design exhaust air flows and make-up air flows to maintain design room pressurization. The TAB agency shall test for turbulence and proper air flow patterns at the face and inside the hoods using a hand-held smoke puffer or other approved smoke-emitting device.

3.8 STAIRWELL PRESSURIZATION. The TAB agency shall test and adjust stairwell pressurization system to provide design air flow into the stairwell and set reliefs to maintain required pressurization. When required by the local authority, it shall check door pull force on all exit doors to specific requirements.

3.9 FIRE AND SMOKE TESTING. The TAB agency shall test fire/smoke dampers to assure operation. It shall verify that an access door has been installed for each fire and smoke damper. For fire dampers, the TAB agency shall open the access door, disconnect the fusible link, and allow the damper to close. Operation should be smooth and all dampers must close completely. The TAB agency shall then reset the damper. For the smoke damper, the TAB agency shall open the access door, activate the damper, and observe operation. The damper must close quickly and completely. The TAB agency shall then reset the damper and observe its complete opening.

3.10 LIFE SAFETY CONTROLS. The TAB agency shall test and record life safety control operation on the HVAC equipment. It shall verify the installation of required smoke detectors in air handling equipment (AHE), and shall verify operation of the smoke detector by activating the smoke detector and observing air handler shutdown. With the controls and alarm contractors, the TAB agency shall verify the operation of interconnected systems such as the AHE smoke detector's activation of the fire alarm system and the alarm system's activation of the life safety control sequences.

A. After balancing is complete and before calling for final observation, record, and submit for record reports as noted herein and per recommendations of AABC or NEBB.

1. For each air unit:

a. Suction and discharge static pressure, and total static.

b. Fan rpm, measured by tachometer; verify rotation.

c. Motor nameplate F.L.A., actual amps, voltage.

d. Measured cfm for total supply, return and outside air.

e. Entering and leaving air temperature for each coil.

f. Entering and leaving water temperatures for each water coil.

g. Entering and leaving water pressures for each water coil.

2. For each pump:

a. Suction and discharge pressure readings at shutoff.

b. Suction and discharge pressure readings at final balance flow.

c. Motor nameplate F.L.A., actual amp at rated flow, voltage; verify rotation.

d. Copy of pump curve from manufacturer, with final balance point marked.

3. For each chilling unit:

a. Water temperature entering and leaving cooler.

b. Water pressure entering and leaving cooler.

c. Water temperature and pressure entering and leaving condenser.

d. Pressure drop-flow curves for cooler with flow points marked.

e. Motor nameplate F.L.A., actual amp, voltage.

f. Compressor suction and discharge pressures.

4. Each condenser unit:

a. Ambient air temperature, condenser discharge temperature.

b. Motor nameplate F.L.A., actual amp, voltage.

c. Suction and discharge pressures, temperature.

B. Other reports and forms to be completed and submitted. Provide instrument list, air moving test sheet, exhaust fan data sheet, static pressure profile, return air/outside air data, fan and motor pulley, duct traverse readings, duct traverse zone totals, air monitoring station data, air distribution test sheet, terminal units, pump data sheet, chillers, air cooled condensers, cooling coil data, heating coil data, duct leak test. All forms shall be as listed in the latest "National Standards for Total System Balance", or shall be similar, but must note same information.

C. After Owner Occupancy. After owner has occupied and is using the building, make three additional inspections of the system (at 1 month intervals) to:

1. Correct any owner observed temperature imbalances.

a. Check correct operation of equipment and verify by letter to the engineer on each trip. List in the letter corrections made.

D. At Time of Job Completion.

1. Provide such tools, equipment and personnel as required to conduct tests and demonstrate the acceptability of the various systems.

E. Have the authorized representatives of the various manufacturers available if requested.

END OF SECTION 23 08 00

SECTION 23 09 00.48 - VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes separately enclosed, preassembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

B. Related Requirements:

Section 262419 "Motor-Control Centers" for VFCs installed in motor-control centers.

1.3 DEFINITIONS

A. CPT: Control power transformer.

B. DDC: Direct digital control.

C. EMI: Electromagnetic interference.

D. LED: Light-emitting diode.

E. NC: Normally closed.

F. NO: Normally open.

G. OCPD: Overcurrent protective device.

H. PID: Control action, proportional plus integral plus derivative.

I. RFI: Radio-frequency interference.

J. VFC: Variable-frequency motor controller.

1.4 ACTION SUBMITTALS

A. Product Data: For each type and rating of VFC indicated.

1. Include dimensions and finishes for VFCs.

2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For each VFC indicated.

1. Include mounting and attachment details.

2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

3. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout , required working clearances and required area above and around VFCs. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

B. Seismic Qualification Certificates: For each VFC, accessories, and components, from manufacturer.

1. Certificate of compliance.

a. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

b. Detailed description of equipment anchorage devices on which the certification is based, and their installation requirements.

2. Product Certificates: For each VFC from manufacturer.

C. Harmonic Analysis Report: Provide Project-specific calculations and manufacturer's statement of compliance with IEEE 519.

D. Source quality-control reports.

E. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For VFCs to include in emergency, operation, and maintenance manuals.

B. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and motor-circuit protector trip settings.

    a. Manufacturer's written instructions for setting field-adjustable overload relays.

    b. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.

    c. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.

    d. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.

2. Indicating Lights: Two of each type and color installed.

1.8 QUALITY ASSURANCE

A. System efficiencies shall be certified by AHRI standard 1210, and shall be published for public review at http://www.ahrinet.org/. Equipment that is “rated” in accordance with AHRI Standard 1210 but not published for public review by AHRI shall not be accepted

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

C. Comply with NFPA 70.

1.9 DELIVERY, STORAGE, AND HANDLING

A. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers and install temporary electric heating, with at least 250 W per controller or connect factory-installed space heaters to temporary electrical service.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within specified warranty period at no cost to the owner.

B. Warranty Period: Three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Trane Drives; Trane Company .

2. Siemens Energy & Automation, Inc.

3. Yaskawa Electric America, Inc.

2.2 SYSTEM DESCRIPTION

A. General Requirements for VFCs:

1. Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508C.

B. VFC Description: Variable-frequency motor controller, consisting of power converter that employs pulse-width-modulated inverter, factory built and tested in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.

1. Units suitable for operation of NEMA MG 1, Design A and Design B motors, as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."

2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."

3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

C. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

D. Output Rating: Three phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.

E. Unit Operating Requirements:

1. Input AC Voltage Tolerance: Plus 10 and minus 15 percent of VFC input voltage rating.

2. Input AC Voltage Unbalance: Not exceeding 5 percent.

3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.

4. Minimum Efficiency: 97 percent at 60 Hz, full load.

5. Minimum Displacement Primary-Side Power Factor: 98 percent under any load or speed condition.

6. Minimum Short-Circuit Current (Withstand) Rating: 65 kA.

7. Ambient Temperature Rating: Not less than 32 deg F and not exceeding 104 deg F.

8. Humidity Rating: Less than 95 percent (noncondensing).

9. Altitude Rating: Not exceeding 3300 feet.

10. Vibration Withstand: Comply with NEMA ICS 61800-2.

11. Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.

12. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.

13. Speed Regulation: Plus or minus 10 percent.

14. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.

15. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

F. Inverter Logic: Microprocessor based, 16 bit, isolated from all power circuits.

G. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.

H. Signal: Electrical.

I. Internal Adjustability Capabilities:

1. Minimum Speed: 5 to 25 percent of maximum rpm.

2. Maximum Speed: 80 to 100 percent of maximum rpm.

3. Acceleration: 0.1 to 999.9 seconds.

4. Deceleration: 0.1 to 999.9 seconds.

5. Current Limit: 30 to minimum of 150 percent of maximum rating.

J. Self-Protection and Reliability Features:

1. Input transient protection by means of surge suppressors to provide three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage..

2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.

3. Under- and overvoltage trips.

4. Inverter overcurrent trips.

5. VFC and Motor-Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor-overload alarm and trip; settings selectable via the keypad.

6. Critical frequency rejection, with three selectable, adjustable deadbands.

7. Instantaneous line-to-line and line-to-ground overcurrent trips.

8. Loss-of-phase protection.

9. Reverse-phase protection.

10. Short-circuit protection.

11. Motor-overtemperature fault.

K. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

L. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.

M. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

N. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

O. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

P. Integral Input Disconnecting Means and OCPD: NEMA KS 1, fusible switch with pad-lockable, door-mounted handle mechanism.

Q. Disconnect Rating: Not less than 115 percent of VFC input current rating.

R. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.

2.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: VFCs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7. The designated VFCs shall be tested and certified by an NRTL as meeting the ICC-ES AC 156 test procedure requirements.

B. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.4 CONTROLS AND INDICATION

A. Status Lights: Door-mounted LED indicators displaying the following conditions:

1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.
6. External fault.

B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.

C. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.

1. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.
2. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.

D. Historical Logging Information and Displays:

1. Real-time clock with current time and date.
2. Running log of total power versus time.
3. Total run time.
4. Fault log, maintaining last four faults with time and date stamp for each.

E. Indicating Devices: Digital display and additional readout devices as required, mounted flush in VFC door and connected to display VFC parameters including, but not limited to:

1. Output frequency (Hz).
2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (V dc).
9. Set point frequency (Hz).
10. Motor output voltage (V ac).

F. Control Signal Interfaces:

1. Electric Input Signal Interface:

   a. A minimum of two programmable analog inputs: Operator-selectable 0- to 10-V dc or 4- to 20-mA.

   b. A minimum of six multifunction programmable digital inputs.

1. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the DDC system for HVAC or other control systems:

   a. 0- to 10-V dc.

   b. 4- to 20-mA dc.

   c. Potentiometer using up/down digital inputs.

   d. Fixed frequencies using digital inputs.

2. Output Signal Interface: A minimum of one programmable analog output signal(s) (operator-selectable 0- to 10-V dc or 4- to 20-mA), which can be configured for any of the following:

    a. Output frequency (Hz).

    b. Output current (load).

    c. DC-link voltage (V dc).

    d. Motor torque (percent).

    e. Motor speed (rpm).

3. Set point frequency (Hz).

4. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:

    a. Motor running.

    b. Set point speed reached.

    c. Fault and warning indication (overtemperature or overcurrent).

    d. PID high- or low-speed limits reached.

5. PID Control Interface: Provides closed-loop set point, differential feedback control in response to dual feedback signals. Allows for closed-loop control of fans and pumps for pressure, flow, or temperature regulation.

    a. Number of Loops: One.

6. Interface with DDC System for HVAC: Factory-installed hardware and software shall interface with DDC system for HVAC to monitor, control, display, and record data for use in processing reports. VFC settings shall be retained within VFC's nonvolatile memory.

7. Hardwired Points:

    a. Monitoring: On-off status, .

8. Control: On-off operation, .

9. Communication Interface: Comply with ASHRAE 135. Communication shall interface with DDC system for HVAC to remotely control and monitor lighting from a DDC system for HVAC operator workstation. Control features and monitoring points displayed locally at VFC’s panel shall be available through the DDC system for HVAC.

2.5 LINE CONDITIONING AND FILTERING

A. Input Line Conditioning: The VFD shall have a dual 5% impedance DC link reactor on the positive and negative rails of the DC bus to minimize power line harmonics and protect the VFD from power line transients. The chokes shall be non-saturating. Swinging chokes that do not provide full harmonic filtering throughout the entire load range are not acceptable. VFCs with saturating (non-linear) DC link reactors shall require an additional 3% AC line reactor to provide acceptable harmonic performance at full load, where harmonic performance is most critical.

B. If based on the manufacturer's harmonic analysis study and report, provide additional filtering, as required, to limit total demand (harmonic current) distortion and total harmonic voltage demand at the defined point of common coupling to meet IEEE 519 recommendations.

C. EMI/RFI Filtering: CE marked; certify compliance with IEC 61800-3 for Category C2.

2.6 BYPASS SYSTEMS

A. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.

B. Bypass Mode: Field-selectable automatic or manual, allows local and remote transfer between power converter and bypass contactor and retransfer, either via manual operator interface or automatic-control system feedback.

C. Bypass Controller: Two-contactor-style bypass allows motor operation via the power converter or the bypass controller; with input isolating switch and barrier arranged to isolate the power converter and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode.

E. Bypass Contactor: Load-break, IEC-rated contactor.

1. Output Isolating Contactor: Non-load-break, IEC-rated contactor.

2. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

E. Bypass Contactor Configuration: Full-voltage (across-the-line) or Reduced-voltage (autotransformer) type.

1. NORMAL/BYPASS selector switch.

2. HAND/OFF/AUTO selector switch.

3. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFC while the motor is running in the bypass mode.

4. Contactor Coils: Pressure-encapsulated type with coil transient suppressors.

5. Operating Voltage: Depending on contactor IEC size and line-voltage rating, manufacturer's standard matching control power or line voltage.

6. Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.

7. Control Circuits: 24 VDC; obtained from integral switch mode power supply, with primary and secondary fuses, with control power source of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices.

8. Overload Relays: NEMA ICS 2.

9. Melting-Alloy Overload Relays:

10. Inverse-time-current characteristic.

    a. Class 20 tripping characteristic.

    b. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.

    c. NC isolated overload alarm contact.

    d. External overload, reset push button.

2.7 OPTIONAL FEATURES

A. Multiple-Motor Capability: VFC suitable for variable-speed service to multiple motors. Overload protection shuts down VFC and motors served by it, and generates fault indications when overload protection activates.

B. Configure to allow two or more motors to operate simultaneously at the same speed; separate overload relay for each controlled motor.

C. Damper control circuit with end-of-travel feedback capability.

D. Sleep Function: Senses a minimal deviation of a feedback signal and stops the motor. On an increase in speed-command signal deviation, VFC resumes normal operation.

E. Motor Preheat Function: Preheats motor when idle to prevent moisture accumulation in the motor.

F. Firefighter's Override (Smoke Purge) Input: On a remote contact closure from the firefighter's control station, this password-protected input:

G. Overrides all other local and external inputs (analog/digital, serial communication, and all keypad commands).

1. Forces VFC to operate motor, without any other run or speed command, at a field-adjustable, preset speed.

2. Forces VFC to transfer to bypass mode and operate motor at full speed.

3. Causes display of override mode on the VFC display.

4. Reset VFC to normal operation on removal of override signal automatically or manually.

H. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer.

2.8 ENCLOSURES

A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.

1. Dry and Clean Indoor Locations: Type 1.

2. Outdoor Locations: Type 3R.

3. Kitchen Wash-Down Areas: Type 4X, .

4. Other Wet or Damp Indoor Locations: Type 4.

5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.

B. Plenum Rating: UL 1995; NRTL certification label on enclosure, clearly identifying VFC as "Plenum Rated."

2.9 ACCESSORIES

A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise indicated.

1. Push Buttons: Covered and Lockable.

2. Pilot Lights: Push to test.

3. Selector Switches: Rotary type.

B. Control Relays: Auxiliary and adjustable solid-state time-delay relays.

C. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.

D. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.

E. Supplemental Digital Meters:

1. Elapsed-time meter.

2. Kilowatt meter.

3. Kilowatt-hour meter.

F. Breather and drain assemblies, to maintain interior pressure and release condensation in NEMA 250, Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

G. Space heaters, with NC auxiliary contacts, to mitigate condensation in NEMA 250, Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

H. Cooling Fan and Exhaust System: For NEMA 250, Type 1; UL 508 component recognized: Supply fan, with composite intake and exhaust grills and filters; 120 -V ac; obtained from integral CPT.

I. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.

I. Spare control-wiring terminal blocks; unwired.

2.10 SOURCE QUALITY CONTROL

A. Testing: Test and inspect VFCs according to requirements in NEMA ICS 61800-2.

B. Test each VFC while connected to a motor that is comparable to that for which the VFC is rated.

1. Verification of Performance: Rate VFCs according to operation of functions and features specified.

2. VFCs will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the Work.

B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.

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

3.2 INSTALLATION

A. Wall-Mounting Controllers: Install with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor, unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

B. Floor-Mounting Controllers: Install VFCs on 4-inch nominal thickness concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.

2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

4. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Roof-Mounting Controllers: Install VFC on roofs with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished roof surface unless otherwise indicated, and by bolting units to curbs or mounting on freestanding, lightweight, structural-steel channels bolted to curbs. Seal roof penetrations after raceways are installed.

1. Curbs and roof penetrations are specified in Section 077200 "Roof Accessories."

2. Structural-steel channels are specified in Section 260529 "Hangers and Supports for Electrical Systems."

3. Seismic Bracing: Comply with requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

E. Install fuses in each fusible-switch VFC.

F. Install fuses in control circuits if not factory installed. Comply with requirements in Section 262813 "Fuses."

G. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors are installed.

H. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

I. Comply with NECA 1.

3.3 CONTROL WIRING INSTALLATION

A. Install wiring between VFCs and remote devices and facility's central-control system. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic-control devices where applicable.

D. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switches are in manual-control position.

1. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor-overload protectors.

3.4 IDENTIFICATION

A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

1. Label each VFC with engraved nameplate.

2. Label each enclosure-mounted control and pilot device.

C. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:

C. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.

1. Test continuity of each circuit.

2. Tests and Inspections:

3. Inspect VFC, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.

4. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
5. Test continuity of each circuit.

6. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Architect Construction Manager and Owner before starting the motor(s).

7. Test each motor for proper phase rotation.

8. Perform tests according to the Inspection and Test Procedures for Adjustable Speed Drives stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

9. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. VFCs will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.6 STARTUP SERVICE

A. Perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions.

3.7 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Adjust the trip settings of instantaneous-only circuit breakers and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to 6 times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed 8 times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Architect Construction Manager and Owner before increasing settings.

D. Set the taps on reduced-voltage autotransformer controllers.

E. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Study."

F. Set field-adjustable pressure switches.

3.8 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.

B. Replace VFCs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.9 DEMONSTRATION

A. Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.

END OF SECTION 262923

SECTION 230923 – DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

PART 1 - GENERAL

1.1 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Section 23 21 13.03 – Hot Water and Chilled Water Piing, Valves and Appurtenances

1. Control Valves
2. Flow Switches
3. Temperature Sensor Wells and Sockets
4. Hydronic Flow meters

1.2 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Division 23 – Ductwork Accessories

1. Automatic Dampers
2. Airflow Stations
3. Terminal Unit Controllers

B. Division 23 – Hydronic Piping

1. Control Valves
2. Flow Switches
3. Temperature Sensor Wells and Sockets
4. Hydronic Pressure Taps
5. Hydronic Flow Meters
6. Differential Pressure Tubing

1.3 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

A. Division 23 – Air Handling Equipment:

1. Field Sensors

B. Division 23 – Mini Splits/Electric Unit Heaters:

1. Remote Sensor

C. Division 23 – Refrigerant Detection:

1. Refrigerant Alarm System

1.4 PRODUCTS NOT FURNISHED OR INSTALLED BUT INTEGRATED WITH THE WORK OF THIS SECTION

A. Division 23 – Air Handling Equipment

1. VFDs

2. Air volume control

B. Division 23 – Mini Splits:

1. Local Zone Sensor (BAS Sensor to be mounted next to Local Sensor for temperature monitoring through BAS front end).

C. Division 27 – Fire Alarm Systems

1. Smoke Detectors

1.5 APPROVED CONTROL SYSTEM MANUFACTURERS

A. Trane

B. Siemens (Local OEM office – third party products are not acceptable)

1.6 QUALITY ASSURANCE

A. BAS Manufacturer Qualifications

1. The BAS manufacturer shall have an established business office within 50.00 miles of the project site and must provide 24 hours/day, 7 days/week response in the event of a customer warranty or service call.

2. The BAS Manufacturer shall have factory trained and certified personnel providing all engineering, service, startup, and commissioning field labor for the project from their local office location. BAS manufacturer shall be able to provide training certifications for all local office personnel upon request.

3. The BAS shall be provided by a single manufacturer and this manufacturer's equipment must consist of operator workstation software, Web-based hardware/software, Open Standard Protocol hardware/software, Custom application Programming Language, Graphical Programming Language, Building Controllers, Custom Application Controllers, and Application Specific Controllers. All other products specified herein (i.e., sensors, valves, dampers, actuators, etc.) need not be manufactured by the BAS manufacturer listed in this specification.

4. Independent representatives of BAS manufacturers are not acceptable. BAS vendor must be corporate owned entity of BAS manufacturer.

1.7 CODES AND STANDARDS

A. Codes and Standards: Meet requirements of all applicable standards and codes, except when more detailed or stringent requirements are indicated by the Contract Documents, including requirements of this Section.

1. Underwriters Laboratories: Products shall be UL-916-PAZX listed.

2. National Electrical Code -- NFPA 70.

3. Federal Communications Commission -- Part J.

4. ASHRAE/ANSI 135-2012 (BACnet) - (System Level Devices) - Building Controllers shall conform to the listed version of the BACnet specification in order to improve interoperability with various building system manufacturers' control systems and devices.

5. ASHRAE/ANSI 135-2012 (BACnet) - (Unit Level Devices) - Unit Controllers shall conform to the listed version of the BACnet specification in order to improve interoperability with various building system manufacturers' control systems and devices.

1.8 SYSTEM PERFORMANCE

A. Performance Standards. The BAS system shall conform to the following:

1. Graphic Display. The system shall display a graphic with a minimum of 20 dynamic points. All current data shall be displayed within 10 seconds of the operator's request.

2. Graphic Refresh. The system shall update all dynamic points with current data within 10 seconds.

3. Object Command. The maximum time between the command of a binary object by the operator and the reaction by the device shall be 5 seconds. Analog objects shall start to adjust within 5 seconds.

4. Object Scan. All changes of state and change of analog values shall be transmitted over the high-speed network such that any data used or displayed at a controller or workstation will be current within the prior 10 seconds.

5. Alarm Response Time. The maximum time from when an object goes into alarm to when it is annunciated at the workstation shall not exceed 10 seconds.

6. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 seconds. The Contractor shall be responsible for selecting execution times consistent with the mechanical process under control.

7. Programmable Controllers shall be able to execute DDC PID control loops at a selectable frequency from at least once every 5 seconds. The controller shall scan and update the process value and output generated by this calculation at this same frequency.

8. Multiple Alarm Annunciations. All workstations on the network shall receive alarms within 5 seconds of each other.

9. Reporting Accuracy. Table 1 lists minimum acceptable reporting accuracies for all values reported by the specified system.

a. Table 1: Reporting Accuracy

Measured Variable	**Reported Accuracy**
Space Temperature	±0.5°C [±0.5°F]
Ducted Air	±1.0°C [±2°F]
Outside Air	±1.0°C [±2°F]
Water Temperature	±0.5°C [±1°F]
Delta –T	±0.15°C[±0.25°F]
Relative Humidity	±5% RH
Water Flow	±5% of full scale
Air Flow (terminal)	±10% of reading *Note 1
Air Flow (measuring stations)	±5% of reading
Air Pressure (ducts)	±25 Pa [±0.1 "W.G.]
Air Pressure (space)	±3 Pa [±0.01 "W.G.]
Water Pressure	±2% of full scale *Note 2
Electrical Power	5% of reading *Note 3
Carbon Monoxide (CO)	± 50 PPM
Carbon Dioxide (CO2)	± 50 PPM

Note 1: (10%-100% of scale) (cannot read accurately below 10%)
Note 2: for both absolute and differential pressure
Note 3: * not including utility supplied meters

1.9 SUBMITTAL REQUIREMENTS

A. BAS manufacturer shall provide shop drawings and manufacturers' standard specification data sheets on all hardware and software being provided for this project. No work may begin on any segment of this project until the Engineer and Owner have reviewed submittals for conformity with the plan and specifications. (2) copies are required. All shop drawings shall be provided to the Owner electronically as .dwg or .dxf file formats once they have been approved and as-built drawings have been completed.

B. Quantities of items submitted shall be reviewed by the Engineer and Owner. Such review shall not relieve the BAS manufacturer of furnishing quantities required based upon contract documents. Should a non-approved vendor wish to bid, this firm must complete a line-by-line specification compliance review and submit for approval to the Engineer and Owner two weeks prior to bid date.

C. Provide the Engineer and Owner, any additional information or data which is deemed necessary to determine compliance with the specifications or which is deemed valuable in documenting and understanding the system to be installed.

D. Submit the following within 90 days of contract award:

1. A complete bill of materials of equipment to be used indicating quantities, manufacturers and model numbers.

2. A schedule of all control valves including the valve size, pressure drop, model number (including pattern and connections), flow, CV, body pressure rating, and location.

3. A schedule of all control dampers including damper size, pressure drop, manufacturer, and model number.

4. Provide all manufacturers' technical cut sheets for major system components. When technical cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Include:

   a. Building Controllers

   b. Custom Application Controllers

   c. Operator Workstations

   d. Portable Operator Terminals

   e. Auxiliary Control Devices

5. Provide proposed Building Automation System architectural diagram depicting various controller types, workstations, device locations, addresses, and communication cable requirements

6. Provide detailed termination drawings showing all required field and factory terminations, as well as terminal tie-ins to DDC controls provided by mechanical equipment manufacturers. Terminal numbers shall be clearly labeled.

7. Provide points list showing all system objects and the proposed English language object names.

8. Provide a sequence of operation for each controlled mechanical system and terminal end devices.

9. Provide a BACnet Protocol Implementation Conformance Statement (PICS) for each BACnet system level device (i.e. Building Controller & Operator Workstations) type. This defines the points list for proper coordination of interoperability with other building systems if applicable for this project.

E. Project Record Documents: Upon completion of installation, submit three (3) copies of record (as-built) documents. The documents shall be submitted for approval prior to final completion and include:

1. Project Record Drawings - These shall be as-built versions of the submittal shop drawings. One set of electronic media including CAD .dwg and .pdf drawing files shall be provided.

2. Testing and Commissioning Reports and Checklists signed off by trained factory (equipment manufacturers) and field (BAS) commissioning personnel.

3. Operating and Maintenance (O & M) Manuals - These shall be as-built versions of the submittal product data. In addition to the information required for the submittals, Operating & Maintenance manual shall include:

    a. Names, address and 24-hour/7-day per week telephone numbers of Contractor personnel managing and installing equipment, along with service personnel responsible for supporting the ongoing warranty and services of the control system.

    b. Procedures for operating the BAS including logging on/off, alarm management, generation of reports, trends, overrides of computer control, modification of setpoints, and other interactive system requirements.

    c. Description of the programming language including syntax, statement descriptions, algorithms, calculations, point database creation and modification, program creation and modification, and operator use of the editor.

    d. Explanation of how to design and install new points, new DDC controllers, and other BAS hardware.

    e. Preventative Maintenance and calibration procedures; hardware troubleshooting; and hardware repair and/or replacement procedures.

    f. Documentation of all software program logic created for Custom Programmable Controllers including the overall point database. Provide one set of magnetic media containing files of the software and point database.

    g. One set of electronic media containing files of all operator color graphic screens for the project.

    h. A list of recommended spare parts including pricing, manufacturer, supplier, and part numbers.

    i. Documentation, installation, and maintenance information for all third party hardware/software products provided including personal computers, printers, hubs, sensors, valves, etc.

    j. Original issue media for all software provided, including operating systems, programming language, operator workstation software, and graphics software.

    k. Licenses, Guarantee, and Warranty documents for all equipment and systems.

    l. Recommended preventive maintenance procedures for all system components including a schedule of tasks (inspection, cleaning, calibration, etc.) and task descriptions.

F. Training Manuals: The BAS manufacturer shall provide a course outline and copies of training manuals at least two weeks prior to the start of any corporate training class to be attended by the Owner.

1.10 WARRANTY REQUIREMENTS

A. Warrant all work as follows:

1. BAS system labor and materials shall be warranted free from defects for a period of twelve (12) months after final completion acceptance by the Owner. BAS failures during the warranty period shall be adjusted, repaired, or replaced at no charge to the Owner. The BAS manufacturer shall respond to the Owner's request for warranty service within 24 hours of the initiated call and will occur during normal business hours (8AM-5PM).

2. At the end of the final start-up/testing, if equipment and systems are operating satisfactorily to the Owner and Engineer, the Owner shall sign certificates certifying that the BAS is operational, and has been tested and accepted in accordance with the terms of this specification. The date of Owner's acceptance shall be the start of the warranty period.

3. Operator workstation software, project specific software, graphics, database, and firmware updates shall be provided to the Owner at no charge during the warranty period. Written authorization by the Owner must be granted prior to the installation of these updates.

4. The BAS manufacturer shall provide a web-accessible Users Network for the proposed System and give the Owner free access to question/answer forum, user tips, upgrades, and training schedules for a one year period of time correlating with the warranty period.

1.11 SYSTEM MAINTENANCE

A. Perform Building Automation System preventative maintenance and support for a period of 1 year (beginning the date of substantial completion).

1. Make a minimum of 2 complete Building Automation System inspections, in addition to normal warranty requirements. Inspections to include:

a. System Review – Review the BAS to correct programming errors, failed points, points in alarm, and points that have been overridden manually.

b. Seasonal Control Loop Tuning – Control loops are reviewed to reflect changing seasonal conditions and / or facility heating and cooling loads.

c. Sequence of operation verification – Systems all verified to be operating as designed and in automatic operation. Scheduling and setpoints are reviewed and modified.

d. Database back-up

e. Operator coaching

2. Technician shall review critical alarm log and advise owner of additional services that may be required.

3. Technician shall provide a written report to owner after each inspection.

B. Do not assign or transfer maintenance service to agent or subcontractor without prior written consent of owner.

1.12 OWNERSHIP OF PROPRIETARY MATERIAL

A. Project specific software and documantation shall become the owner's property upon project completion. This includes the following:

1. Operator Graphic files

2. As-built hardware design drawings

3. Operating & Maintenance Manuals

4. BAS System software database

5. Controller application programming databases

6. Required Licensed software

PART 2 - PRODUCTS

2.1 MATERIALS

A. Use new products that the manufacturer is currently manufacturing and that have been installed in a minimum of 25 installations. Do not use this installation as a product test site unless explicitly approved in writing by the owner or the owner's representative. Spare parts shall be available for at least five years after completion of this contract.

2.2 COMMUNICATION

A. This project shall be comprised of a high speed Ethernet network utilizing BACnet/IP communications between System Controllers and Workstations. Each System Controller shall function as a BACnet Router to each unit controller providing a unique BACnet Device ID for all controllers within the system. Communications between System Controllers and sub-networks of Custom Application Controllers and/or Application Specific Controllers shall be as defined below.

1. Each System Controller shall perform communications to a network of Custom Application and Application Specific Controllers using BACnet/Zigbee (802.15.4) as defined by the Zigbee Standard.

a. Each communication interface shall be Zigbee Building Automation Certified product as defined by the BACnet Standard and the Zigbee Alliance.

b. Each System Controller shall function as a BACnet Router to each unit controller providing a unique BACnet Device ID for all controllers within the system.

c. Wireless equipment controllers and auxiliary control devices shall conform to:

1) IEEE 802.15.4 radios to minimize risk of interference and maximize battery life, reliability, and range.

2) Communication between equipment controllers shall conform to ZigBee Building Automation (ZBA) standard as BACnet tunneling devices to ensure future integration of other ZBA certified devices.

3) Operating range shall be a minimum of 200 feet (60 m); open range shall be 2,500 ft. (762 m) with less than 2% packet error rate.

4) To maintain robust communication, mesh networking and two-way communications shall be used to optimize the wireless network health.

5) Wireless communication shall be capable of many-to-one sensors per controller to support averaging, monitoring, and multiple zone applications.

6) Certifications shall include FCC CFR47 - RADIO FREQUENCY DEVICES - Section 15.247 & Subpart E

2. Each System Controller shall perform communications to a network of Custom Application and Application Specific Controllers using BACnet/MSTP (RS485) as defined by the BACnet standard.

2.3 OPERATOR INTERFACE

A. Building operator web interface

1. The building operator web interface shall be accessible via a web browser without requiring any “plug-ins” (i.e. JAVA Runtime Environment (JRE), Adobe Flash).

2. The building operator web interface shall support the following Internet web browsers:

a. Internet Explorer 10.0+

b. Firefox 29.0+

c. Chrome 35.0+

3. The building operator web interface shall support the following mobile web browsers:

a. iOS (iPad/iPhone) V7.0+

b. Android (Tablet) V4.3+

c. Android (Phone) V2.3+

4. System Security

a. Each operator shall be required to login to the system with a user name and password in order to view, edit, add, or delete data.

b. User Profiles shall restrict the user to only the objects, applications, and system functions as assigned by the system administrator.

c. Each operator shall be allowed to change their user password.

d. The System Administrator shall be able to manage the security for all other users.

e. The system shall include pre-defined “roles” that allow a system administrator to quickly assign permissions to a user.

f. User logon/logoff attempts shall be recorded.

g. The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user definable.

h. All system security data shall be stored in an encrypted format.

5. Database

a. Database Save. A system operator with the proper password clearance shall be able to archive the database on the designated building operator web interface PC.

b. Database Restore. The system operator shall also be able to clear a panel database and manually initiate a download of a specified database to any panel in the system.

6. On-Line Help and Training

a. Provide a context sensitive, on line help system to assist the operator in operation and configuration of the system.

b. On-line help shall be available for all system functions and shall provide the relevant data for each particular screen.

7. System Diagnostics

a. The system shall automatically monitor the operation of all network connections, building management panels, and controllers.

b. The failure of any device shall be annunciated to the operators.

8. Equipment & Application Pages

    a. The building operator web interface shall include standard pages for all equipment and applications. These pages shall allow an operator to obtain information relevant to the operation of the equipment and/or application, including:

        1) Animated Equipment Graphics for each major piece of equipment and floor plan in the System. This includes:

            a) Each Chiller, Air Handler, VAV Terminal, Fan Coil, and Boiler. These graphics shall show all points dynamically as specified in the points list.

            b) Animation capabilities shall include the ability to show a sequence of images reflecting the position of analog outputs, such as valve or damper positions. Graphics shall be capable of launching other web pages.

        2) Alarms relevant to the equipment or application without requiring a user to navigate to an alarm page and perform a filter.

        3) Historical Data (As defined in Data Log section below) for the equipment or application without requiring a user to navigate to a Data Log page and perform a filter.

9. System Graphics. Building operator web interface shall be graphically based and shall include at least one graphic per piece of equipment or occupied zone, graphics for each chilled water and hot water system, and graphics that summarize conditions on each floor of each building included in this contract. Indicate thermal comfort on floor plan summary graphics using colors to represent zone temperature relative to zone set point.

    a. Functionality. Graphics shall allow operator to monitor system status, to view a summary of the most important data for each controlled zone or piece of equipment, to use point and-click navigation between zones or equipment, and to edit set points and other specified parameters.

    b. Graphic imagery – graphics shall use 3D images for all standard and custom graphics. The only allowable exceptions will be photo images, maps, schematic drawings, and selected floor plans.

    c. Animation. Graphics shall be able to animate by displaying different Image lies for changed object status.

    d. Alarm Indication. Indicate areas or equipment in an alarm condition using color or other visual indicator.

e. Format. Graphics shall be saved in an industry-standard format such as BMP, JPEG, PNG, or GIF. Web-based system graphics shall be viewable on browsers compatible with World Wide Web Consortium browser standards. Web graphic format shall require no plug-in (such as HTML and JavaScript) or shall only require widely available no-cost plug-ins (such as Active-X and Macromedia Flash).

10. Custom Graphics

a. The operator interface shall be capable of displaying custom graphics in order to convey the status of the facility to its operators.

b. Graphical Navigation. The building operator web interface shall provide dynamic color graphics of building areas, systems and equipment.

c. Graphical Data Visualization. The building operator web interface shall support dynamic points including analog and binary values, dynamic text, static text, and animation files.

d. Custom background images. Custom background images shall be created with the use of commonly available graphics packages such as Adobe Photoshop. The graphics generation package shall create and modify graphics that are saved in industry standard formats such as GIF and JPEG.

11. Graphics Library. Furnish a library of standard HVAC equipment such as chillers, air handlers, terminals, fan coils, unit ventilators, rooftop units, and VAV boxes, in 3-dimensional graphic depictions. The library shall be furnished in a file format compatible with the graphics generation package program.

12. Manual Control and Override.

a. Point Control. Provide a method for a user to view, override, and edit if applicable, the status of any object and property in the system. The point status shall be available by menu, on graphics or through custom programs.

b. Temporary Overrides. The user shall be able to perform a temporary override wherever an override is allowed, automatically removing the override after a specified period of time.

c. Override Owners. The system shall convey to the user the owner of each override for all priorities that an override exists.

d. Provide a specific icon to show timed override or operator override, when a point, unit controller or application has been overridden manually.

13. Engineering Units

a. Allow for selection of the desired engineering units (i.e. Inch pound or SI) in the system.

b. Unit selection shall be able to be customized by locality to select the desired units for each measurement.

c. Engineering units on this project shall be IP.

14. Scheduling. A user shall be able to perform the following tasks utilizing the building operator web interface:

a. Create a new schedule, defining the default values, events and membership.

b. Create exceptions to a schedule for any given day.

c. Apply an exception that spans a single day or multiple days.

d. View a schedule by day, week and month.

e. Exception schedules and holidays shall be shown clearly on the calendar.

f. Modify the schedule events, members and exceptions.

15. Data Logs

a. Data Logs Definition.

1) The building operator web interface shall allow a user with the appropriate security permissions to define a Data Log for any data in the system.

2) The building operator web interface shall allow a user to define any Data Log options as described in the Application and Control Software section.

b. Data Log Viewer.

1) The building operator web interface shall allow Data Log data to be viewed and printed.

2) The building operator web interface shall allow a user to view Data Log data in a text-based format (time –stamp/value).

3) The operator shall be able to view the data collected by a Data Log in a graphical chart in the building operator web interface.

4) Data Log viewing capabilities shall include the ability to show a minimum of 5 points on a chart.

5) Each data point data line shall be displayed as a unique color.

6) The operator shall be able to specify the duration of historical data to view by scrolling and zooming.

7) The system shall provide a graphical trace display of the associated time stamp and value for any selected point along the x-axis.

c. Export Data Logs.

1) The building operator web interface shall allow a user to export Data Log data in CSV or PDF format for use by other industry standard word processing and spreadsheet packages.

16. Alarm/Event Notification

a. An operator shall be notified of new alarms/events as they occur while navigating through any part of the system via an alarm icon.

b. Alarm/Event Log. The operator shall be able to view all logged system alarms/events from any building operator web interface.

1) The operator shall be able to sort and filter alarms from events. Alarms shall be sorted in a minimum of 4 categories based on severity.

2) Alarm/event messages shall use full language, easily recognized descriptors.

3) An operator with the proper security level may acknowledge and clear alarms/events.

4) All alarms/events that have not been cleared by the operator shall be stored by the building controller.

5) The alarm/event log shall include a comment field for each alarm/event that allows a user to add specific comments associated with any alarm.

c. Alarm Processing.

1) The operator shall be able to configure any object in the system to generate an alarm when transitioning in and out of a normal state.

2) The operator shall be able to configure the alarm limits, warning limits, states, and reactions for each object in the system.

17. Reports and Logs.

a. The building operator web interface shall provide a reporting package that allows the operator to select reports.

b. The building operator web interface shall provide the ability to schedule reports to run at specified intervals of time.

c. The building operator web interface shall allow a user to export reports and logs from the building controller in a format that is readily accessible by other standard software applications including spreadsheets and word processing. Acceptable formats include:

1) CSV, HTML, XML, PDF

d. Reports and logs shall be readily printed to the system printer.

e. Provide a means to list and access the last 10 reports viewed by the user.

f. The following standard reports shall be available without requiring a user to manually configure the report:

1) All Points in Alarm Report: Provide an on demand report showing all current alarms.

2) All Points in Override Report: Provide an on demand report showing all overrides in effect.

3) Commissioning Report: Provide a one-time report that lists all equipment with the unit configuration and present operation.

4) Points report: Provide a report that lists the current value of all points

5) VAV Air System. An operator shall be able to view and control (where applicable) the following parameters via the building operator web interface:

a) System Mode

b) System Occupancy

c) Ventilation (Outdoor air flow) setpoint

d) Ventilation (Outdoor air flow) status

e) Air Handler Static pressure setpoint

f) Air Handler Static pressure status

g) Air Handler occupancy status

h) Air Handler Supply air cooling and heating set points

i) Air Handler minimum, maximum and nominal static pressure setpoints

j) VAV box minimum and maximum flow

k) VAV box drive open and close overrides

l) VAV box occupancy status

m) VAV box Airflow to space

n) Average space temperature

o) Minimum space temperature

p) Maximum space temperature

6) Chilled Water System. An operator shall be able to view and control (where applicable) the following parameters via the building operator web interface:

a) System mode of the chiller plant

b) Chiller enable/disable status

c) System supply water setpoint

d) System supply and return water temperature

e) System Chilled water pump status

f) System Chilled water flow

g) Bypass pipe flow rate (if applicable)

h) Messages as to when an additional chiller will be added or removed from operational sequence

i) Chiller or system failure information

j) Chiller rotation information

k) Override capabilities to force an added chiller, subtract a chiller, or change of sequence.

l) Control to remove a chiller from a sequence temporarily for service purposes.

18. Mobile App Interface

a. Mobile App Operator Interface shall support the following Operating systems

1) Apple iOS 6

2) Apple iOS 7

3) Apple iOS 8

4) Android V2.3

5) Android V4.3

6) Android V4.4

b. The operator interface shall support system access on a mobile device via a mobile app to:

1) Alarm log

2) System Status

3) Equipment status

4) Space Status

5) Standard Equipment graphics

c. The operator interface shall support actions on a mobile device via a mobile app to:

1) Override set points

2) Override occupancy

3) Acknowledge Alarms

4) Comment on Alarms

2.4 CONTROLLER SOFTWARE

A. Furnish the following applications software for building and energy management. All software applications shall reside and run in the system controllers. Editing of applications shall occur at the building operator interface.

1. Scheduling. Provide the capability to schedule each object or group of objects in the system. Each of these schedules shall include the capability for start, stop, optimal start, optimal stop, and night economizer actions. Each schedule may consist of up to [10] events. When a group of objects are scheduled together, provide the capability to define advances and delays for each member. Each schedule shall consist of the following:

a. Weekly Schedule. Provide separate schedules for each day of the week.

b. Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule. This exception schedule shall override the standard schedule for that day. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed it will be discarded and replaced by the standard schedule for that day of the week.

c. Holiday Schedules. Provide the capability for the operator to define up to 99 special or holiday schedules. These schedules may be placed on the scheduling calendar and will be repeated each year. The operator shall be able to define the length of each holiday period.

d. Optimal Start. The scheduling application outlined above shall support an optimal start algorithm. This shall calculate the thermal characteristics of a zone and start the equipment prior to occupancy to achieve the desired space temperature at the specified occupancy time. The algorithm shall calculate separate sets of heating and cooling rates for zones that have been unoccupied for less then and greater than 24 hours. Provide the ability to modify the start algorithm based on outdoor air temperature. Provide an early start limit in minutes to prevent the system from starting before an operator determined time limit.

2. Trend Log Application

a. Trend log data shall be sampled and stored on the System Controller panel and shall capable of being archived to a BACnet Workstation for longer term storage.

b. Trend logs shall include interval, start-time, and stop-time.

c. Trend log intervals shall be configurable as frequently as 1 minute and as infrequently as 1 year.

3. Trend Logs

a. The system controller shall create trend logs for defined key performance indicators for each controlled HVAC device and HVAC application.

b. The trend logs shall monitor these parameters for a minimum of 7 days at 15 minute intervals. The automatic trend logs shall be user adjustable.

4. The following is a list of key measurements required to be trended by the system.

a. Fan Coil

Fan Coil	Discharge Air Temperature
	Space Temperature Active
	Space Temperature Setpoint Active
	Air Flow Setpoint Active
	Discharge Air Flow

b. Air Systems

Air Handling Unit/Rooftop (VAV)	Discharge Air Temperature
	Discharge Air Temperature Setpoint Active
	Space Temperature Active
	Cooling Capacity Status
	Discharge Air Flow

Air Handling Unit/Rooftop (CV)	Discharge Air Temperature
	Space Temperature Active
	Space Temperature Setpoint Active
	Cooling Capacity Status
	Heating Capacity Primary Status
	Outdoor Air Damper Position

VAV Box	Discharge Air Temperature
	Space Temperature Active
	Space Temperature Setpoint Active
	Air Flow Setpoint Active
	Discharge Air Flow

Variable Air System	Duct Static Optimization Duct Static Setpoint
	Space Temperature Average
	Ventilation Optimization Air Setpoint
	Operating Mode
	Duct Pressure Optimization Maximum

5. Alarm/Event Log

a. Any object in the system shall be configurable to generate an alarm when transitioning in and out of a normal or fault state.

b. Any object in the system shall allow the alarm limits, warning limits, states, and reactions to be configured for each object in the system.

c. An alarm/event shall be capable of triggering any of the following actions:

1) Route the alarm/event to one or more alarm log

2) The alarm message shall include the name of the alarm location, the device that generated the alarm, and the alarm message itself.

3) Route an e-mail message to an operator(s)

4) Log a data point(s) for a period of time

5) Run a custom control program

6. Point Control. User shall have the option to set the update interval, minimum on/off time, event notification, custom programming on change of events.

7. Timed Override. A standard application shall be utilized to enable/disable temperature control when a user selects on/cancel at the zone sensor, building operator interface, or the local operator display. The amount of time that the override takes precedence will be selectable from the building operator interface.

8. Anti-Short Cycling. All binary output points shall be protected from short cycling

9. VAV Air Systems Application

a. The BAS shall provide an Air Systems application program that coordinates air handlers (AHU)/rooftop units (RTU) and Variable Air Volume Terminal equipment.

b. The Air Systems application shall perform the following functions:

1) Startup and shutdown the air handler safely. Ensure the VAV boxes are open sufficiently when the air handler is running, to prevent damage to the ductwork and VAV boxes due to high air pressure.

2) Calibrate VAV boxes.

3) Fan Pressure Optimization (ASHRAE 90.1) - Minimize energy usage by controlling system static pressure to the lowest level while maintaining zone airflow requirements. System static pressure controlled to keep the "most open" zone damper between 65% and 75% open.

4) The Fan Pressure Optimization application shall have the ability to identify and display the discharge air setpoint of the air-handler and the VAV box that serves the critical zone (e.g., the zone with the most open VAV box damper). This information shall dynamically update with changes in the location of the critical zone.

5) During commissioning, and with the engineer/owner, the controls contractor shall confirm the performance of Fan Pressure Optimization by conducting a field functional test that demonstrates critical zone reset.

c. The Air Systems application shall provide a user interface that includes status of current system operation with real time data of key operating parameters. Key operating parameters include:

1) Duct Static Pressure

2) Duct Static Optimization Setpoint

3) Outdoor Airflow

4) Duct Static Optimization Maximum VAV Damper/Source VAV Box

d. The Air Systems status screens shall explain what optimization calculations are occurring, critical parameters, and source equipment members. The optimization status, inputs, and results shall be displayed for VAV Duct Static Pressure Optimization (calculating proper fan static pressure).

e. The Air Systems application shall provide a user interface that enables configuration changes made by swipe and type fields, selection list, and check box entry for feature definition:

1) VAV Auxiliary Night Heat

2) VAV Source Temperature Distribution

3) Changeover System control

4) Start/Stop Delay operation

5) Enable/Disable Optimization Strategies (Duct Static Optimization)

f. The Air Systems application shall provide a user interface that enables setup modifications made by entry field, check box, and selection fields for configuration and troubleshooting:

1) VAV System definition and operational parameters

a) RTU or AHU members

b) VAV box members

c) VAV Duct Static Pressure Optimization parameters

(a) Minimum, maximum, and initial static pressure setpoints

(b) Reset up increment, interval, and boundary air valve position

(c) Reset down decrement, interval, and boundary air valve position

d) Area (occupant space representation) definition and operation parameters

(a) RTU or AHU members (if constant volume)

(b) VAV box members (if VAV system)

(c) Enable Economizer mode operation, and settings

(d) Enable Night Purge operation, and settings

(e) Enable Humidity Control operation, and settings

(f) Optimal Start/Stop

(g) Timed Override

g. The operation of VAV Terminal equipment members of the VAV Air System shall be selected by check box to optionally participate in the following functions:

1) System calculations (min, max, average)

2) Duct Pressure Optimization

3) Drive to Maximum Override

4) Common Source Temperature

5) Common Space

h. The Air Systems application vendor shall provide a published applications guide that details the air system application operation, configuration, setup, and troubleshooting. The applications guide documentation shall be maintained under version control, and updated by the manufacture to reflect most recent feature updates as made available. Contents of the guide shall include:

1) Description of System Operation

2) Required Components

3) Sequences of Operation

4) Installation

5) Controller Setup

6) Required Programming

7) Commissioning

8) Optimization Strategies

9) Special Applications

10) Troubleshooting

i. The Air System application shall provide an automated commissioning function and report that confirms proper operation of the following:

1) VAV Terminal equipment air valve operation and airflow

2) VAV Terminal equipment fan operation

3) VAV terminal equipment local reheat operation

10. Chiller Plant Application

a. The BAS shall provide a chiller plant application program that coordinates chiller equipment operation for minimal energy usage.

b. The Chiller Plant application shall perform the following functions:

1) The chiller plant control application shall have the ability to control up to 25 chillers as detailed in the sequence of operations.

2) This application shall be able to control both constant and variable flow systems including variable primary flow as well as parallel, series and decoupled piping configurations.

3) The chiller plant control application shall be able to control multiple chiller plants per site.

4) Diagnostics/Protection The chiller plant application program shall be able to integrate individual chiller diagnostics into control action decisions.

5) Event Processing - All chiller plant control and status events shall be recorded, at the operator's selection, in the building management system event log to facilitate troubleshooting.

6) Alarm Indications - The chiller plant control status screens shall display chiller plant and individual chiller alarm messages.

7) Rotation of Chillers based on either runtime or schedule.

c. The chiller plant control application shall provide a user interface that includes textual descriptions of current plant operation with real time status and data. The textual description shall explain when a chiller will be added, or subtracted and under what conditions and timing.

d. The chiller plant control application shall provide a user interface that includes operator overrides for force add, force subtract, and rotation. Operator overrides for add and subtract shall revert to the application calculations and return to normal operation.

e. The chiller plant control application shall provide a user interface that enables configuration changes made by radio button, swipe and type fields, selection list, and check box entry for feature definition:

1) Plant type

2) Rotation method

3) Add method, and settings

4) Subtract method, and settings

5) Soft Start option, and settings

6) Rapid Power Fail Recovery option

7) Ambient Lockout option, and settings

f. The chiller plant application shall provide a user interface that enables setup modifications made by entry field, check box, and selection fields for chiller plant members:

1) Chiller members

2) Lockout interlock per chiller

3) Pump assignment per chiller

4) Unload at start option, and settings per chiller

5) Design capacity per chiller

6) Run hours per chiller

7) Auto restart option, per chiller

8) Sequence type, per chiller

g. The chiller plant control application vendor shall provide a published applications guide that details the chiller plant application operation, configuration, setup, and troubleshooting. The applications guide documentation shall be maintained under version control, and updated by the manufacture to reflect most recent feature updates as made available. Contents of the guide shall include:

1) Description of chiller types

2) Description of Plant types

3) Necessary hardware, equipment, sensors, outputs, and controls

4) Commissioning and programming

5) Sequences of operation

6) Soft Start

7) Rapid Power Fail Recovery

8) Ambient Lockout

9) Add Logic

10) Subtract Logic

11) Setpoint calculations

12) Unload at start

13) Rotation strategies

14) Sequencing options

15) Special Applications

16) Troubleshooting

h. The chiller plant application shall include the following plant system alarms to notify the BAS and operators of failure conditions:

1) Failed to command system pump on

2) Failed to confirm system flow on

3) Failed to command system pump off

4) Failed to confirm system flow off

5) System water flow lost

6) System supply water sensor failed

7) System return water sensor failed

8) All chillers have failed

9) All chillers are unavailable

2.5 ADVANCED APPLICATION CONTROLLERS

A. Advance Application Controllers shall be used to control all equipment or applications of medium and high complexity, including but not limited to Air Handlers, Fan Coil Units, Boiler Plants and Chiller Plants.

B. For Stand-Alone Operation of Advanced Application Controllers:

1. Shall operate a schedule in a standalone application using a Real Time Clock with a 7 day power backup.

    a. The Controller shall have a built in schedule (assessable with or without a display)

    b. Support will be for at least 3 schedules with up to 10 events for each day of the week.

    c. Each of the 3 schedules can be Analog, Binary or Multi-State

    d. The controller shall support a minimum of 25 exceptions each with up to 10 events.

C. For ease of troubleshooting, the Controller shall support data trend logging.

1. 25,000 samples minimum

2. Trends shall be capable of being collected at a minimum sample rate of once every second

3. Trends shall be capable of being scheduled or triggered.

D. To meet the sequence of operation for each application, the Controller shall use library programs provided by the controller manufacturer that are either factory loaded or downloaded with service tool to the Controller.

E. Environment. Controller hardware shall be suitable for the anticipated ambient conditions.

1. Storage conditions:

    a. Temperature: -67°F to 203°F (-55°C to 95°C)

    b. Humidity: Between 5% to 100% RH (non-condensing)

2. Operating conditions:

    a. Temperature: -40°F to 158°F (-40°C to 70°C)

    b. Humidity: Between 5% to 100% RH (non-condensing)

3. Controllers used indoors shall be mounted in a NEMA 1 enclosure at a minimum.

4. Controllers used outdoors and/or in wet ambient shall be mounted within NEMA 4 type waterproof enclosures, and shall be rated for operation at -40° F to 158° F [-40° C to 70° C].

F. Input/Output: The Controller shall have on board or through expansion module all I/O capable of performing all functionality needed for the application. Controls provided by the equipment manufacture must supply the required I/O for the equipment. In addition other controls must meet the following requirements:

1. Shall support flexibility in valve type, the controllers shall be capable of supporting the following valve control types: 0-10VDC, 0-5VDC, 4-20mA, 24VAC - 2 position.

2. Shall support flexibility in sensor type, the Controller shall be capable of reading sensor input ranges of 0 to10V, 0 to 20mA, 50ms or longer pulses, 200 to 20Kohm and RTD input.

3. Shall support flexibility in sensor type, all Analog Outputs shall have the additional capability of being programmed to operate as Universal Inputs or Pulse Width Modulation Outputs.

4. Shall support flexibility in sensor type, the Controller and/or expansion modules shall support dry and wetted (24VAC) binary inputs.

5. The controller shall support pulse accumulator for connecting devices like energy meters.

6. In order to support a wide range of devices, the Controller's binary output shall be able to drive at least 10VA each.

7. Any unused I/O that is not needed for the functionality of the equipment shall be available to be used by custom programs on the Controller and by any other controller on the network.

8. The Controller shall provide 24VAC and 24VDC power terminals sensors and other devices required.

9. The Controller shall provide a dedicated static pressure input.

G. Input/Output Expandability – The Controller shall provide the following functionality in order to meet current and future application needs:

1. For the application flexibility, the Controller shall be capable of expanding to a total of at least 100 hardware I/O terminations.

2. Expansion I/O can be mounted up to 650 ft. (200m) from control.

3. Expansion I/O can be added in as small as 4 point increments.

4. To keep BACnet MS/TP network traffic to a minimum, expansion I/O must communicate via an internal controller communication bus (point expansion via the BACnet MS/TP network is not allowed).

H. Serviceability – The Controller shall provide the following in order to improve serviceability of the Controller.

1. Diagnostic LEDs for power/normal operation/status, BACnet communications, sensor bus communications, and binary outputs. All wiring connections shall be clearly labeled and made to be field removable.

2. Binary and analog inputs and outputs shall use removable connectors or be connected to terminal strip external to the control box.

3. Software service tool connection through all of the following methods: direct cable connection to the Controller, connection through another controller on BACnet link and through the Controller's zone sensor.

4. For safety purposes, the controller shall be capable of being powered by a portable computer's USB port for the purposes of configuration, programming and testing programs so that this work can be accomplished with the power off to the associated equipment.

5. The Controller software tool service port shall utilize standard off-the-shelf USB printer cable.

6. Capabilities to temporarily override the BACnet point values with built-in time expiration in the Controller.

7. To aid in service replacement, the Controller shall easily attached to standard DIN rail mounting.

8. For future expansion, the Controller shall be capable of adding sequence of operation programming utilizing service tools software with a graphical programming interface (editing or programming in line code is not permissible).

9. To aid in service replacement, the Controller shall allow for setting its BACnet address via controller mounted rotary switches that correspond to the numerical value of the address. (DIP switch methodologies are not allowed). Setting of the address shall be accomplished without the need of a service tool or power applied to the controller.

10. Controller data shall be maintained through a power failure.

I. Software Retention: All Controller operating parameters, setpoints, BIOS, and sequence of operation code must be stored in non-volatile memory in order to maintain such information for months without power.

J. Transformer for the Controller must be rated at minimum of 115% of ASC power consumption, and shall be fused or current limiting type. 24 VAC, +/- 15% nominal, 50-60 Hz, 24 VA plus binary output loads for a maximum of 12 VA for each binary output.

K. Controller must meet the following Agency Compliance:

1. UL916 PAZX, Open Energy Management Equipment

2. UL94-5V, Flammability

3. FCC Part 15, Subpart B, Class B Limit

4. BACnet Testing Laboratory (BTL) Listed

2.6 INPUT / OUTPUT INTERFACE

A. Hardwired inputs and outputs may tie into the system through building or custom application.

B. All input points and output points shall be protected such that shorting of the point to itself, to another point, or to ground will cause no damage to the controller. All input and output points shall be protected from voltage up to 24V of any duration, such that contact with this voltage will cause no damage to the controller.

C. Binary inputs shall allow the monitoring of on/off signals from remote devices. The binary inputs shall provide a wetting current of at least 12 mA to be compatible with commonly available control devices and shall be protected against the effects of contact bounce and noise. Binary inputs shall sense “dry contact” closure without external power (other than that provided by the controller) being applied.

D. Pulse accumulation input objects. This type of object shall conform to all the requirements of binary input objects and also accept up to 10 pulses per second for pulse accumulation.

E. Analog inputs shall allow the monitoring of low voltage (0 to 10 VDC), current (4 to 20 mA), or resistance signals (thermistor, RTD). Analog inputs shall be compatible with and field configurable to commonly available sensing devices.

F. Binary outputs shall provide for on/off operation or a pulsed low-voltage signal for pulse width modulation control. Binary outputs on building and custom application controllers shall have status lights. Outputs shall be selectable for either normally open or normally closed operation.

G. Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0 to 10VDC or a 4 to 20 mA signal as required to provide proper control of the output device. Analog outputs shall not exhibit a drift of greater than 0.4% of range per year.

H. Tri-State Outputs. Provide tri-state outputs (two coordinated binary outputs) for control of three-point floating type electronic actuators without feedback. Use of three-point floating devices shall be limited to zone control and terminal unit control applications (VAV terminal units, duct-mounted heating coils, zone dampers, radiation, etc.). Control algorithms shall run the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.

I. System Object Capacity. The system size shall be expandable to at least twice the number of input/ output objects required for this project. Additional controllers (along with associated devices and wiring) shall be all that is necessary to achieve this capacity requirement. The operator interfaces installed for this project shall not require any hardware additions or software revisions in order to expand the system.

2.7 AUXILLARY CONTROL DEVICES

A. Motorized dampers, unless otherwise specified elsewhere, shall be as follows:

1. Damper frames shall be 16 gauge galvanized sheet metal or 1/8" extruded aluminum with reinforced corner bracing.

2. Damper blades shall not exceed 8" in width or 48" in length. Blades are to be suitable for medium velocity performance (2,000 fpm). Blades shall be not less than 16 gauge.

3. Damper shaft bearings shall be as recommended by manufacturer for application.

4. All blade edges and top and bottom of the frame shall be provided with compressible seals. Side seals shall be compressible stainless steel. The blade seals shall provide for a maximum leakage rate of 10 CFM per square foot at 2.5" w.c. differential pressure.

5. All leakage testing and pressure ratings will be based on AMCA Publication 500.

6. Individual damper sections shall not be larger than 48" x 60". Provide a minimum of one damper actuator per section.

B. Control dampers shall be parallel or opposed blade types as scheduled on drawings.

C. Electric damper/valve actuators

1. The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the rotation of the actuator.

2. Where shown, for power-failure/safety applications, an internal mechanical, spring return mechanism shall be built into the actuator housing.

3. All rotary spring return actuators shall be capable of both clockwise or counter clockwise spring return operation. Linear actuators shall spring return to the retracted position.

4. Proportional actuators shall accept a 0-10 VDC or 0-20 ma control signal and provide a 2-10 VDC or 4-20 ma operating range.

5. All non-spring return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 60 in-lb. torque capacity shall have a manual crank for this purpose.

6. Actuators shall be provided with a conduit fitting and a minimum 1m electrical cable and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections.

7. Actuators shall be Underwriters Laboratories Standard 873 listed.

8. Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuator's rated torque.

D. Control Valves

1. Control valves shall be two-way or three-way type for two-position or modulating service as scheduled or shown.

2. Close-off (differential) Pressure Rating: Valve actuator and trim shall be furnished to provide the following minimum close-off pressure ratings:

a. Water Valves:

1) Two-way: 150% of total system (pump) head.

2) Three-way: 300% of pressure differential between ports A and B at design flow or 100% of total system (pump) head.

E. Water Valves

1. Body and trim style and materials shall be in accordance with manufacturer's recommendations for design conditions and service shown, with equal percentage ports for modulating service.

2. Sizing Criteria:

a. Two-position service: Line size.

b. Two-way modulating service: Pressure drop shall be equal to twice the pressure drop through heat exchanger (load), 50% of the pressure difference between supply and return mains, or 34.5 kPa (5 psi), whichever is greater.

c. Three-way modulating service: Pressure drop equal to twice the pressure drop through the coil exchanger (load), 34.5 kPa (5 psi) maximum.

d. Valves DN 15 (1/2 in.) through DN 50 (2 in.) shall be bronze body or cast brass ANSI Class 250, spring-loaded, PTFE packing, quick opening for two-position service. Two-way valves to have replaceable composition disc or stainless steel ball.

e. Valves DN 65 (2 1/2 in.) and larger shall be cast iron ANSI Class 125 with guided plug and PTFE packing.

3. Water valves shall fail normally open or closed, as scheduled on plans, or as follows:

a. Water zone valves—normally open preferred

b. Heating coils in air handlers - normally open

c. Chilled-water control valves - normally closed

d. Other applications—as scheduled or as required by sequences of operation

4. Zone valves shall be sized to meet the control application and they shall maintain their last position in the event of a power failure.

F. Binary Temperature Devices

1. Low-voltage space thermostat shall be 24 V, bimetal-operated, mercury-switch type, with either adjustable or fixed anticipation heater, concealed setpoint adjustment, 13°C to 30°C (55°F to 85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover.

2. Low-limit thermostats. Low-limit airstream thermostats shall be UL listed, vapor pressure type, with an element of 6 m (20 ft) minimum length. Element shall respond to the lowest temperature sensed by any 30 cm (1 ft) section. The low-limit thermostat shall be manual reset only.

G. Wired Temperature Sensors

1. Temperature sensors shall be RTD or thermistor.

2. Duct sensors shall be single point or averaging as shown. Averaging sensors shall be a minimum of 1.5 m (5 ft) in length per 1 m2 (10 ft2) of duct cross section.

3. Immersion sensors shall be provided with a separable stainless steel well. Pressure rating of well is to be consistent with the system pressure in which it is to be installed. The well must withstand the flow velocities in the pipe.

4. Space sensors shall be equipped with setpoint adjustment, override switch, display, and/or communication port as shown on plans.

5. Provide matched temperature sensors for differential temperature measurement.

H. Static Pressure Sensors

1. Sensor shall have linear output signal. Zero and span shall be field-adjustable.

2. Sensor sensing elements shall withstand continuous operating conditions plus or minus 50% greater than calibrated span without damage.

3. Water pressure sensor shall have stainless steel diaphragm construction, proof pressure of 150 psi minimum. Sensor shall be complete with 4-20 ma output, required mounting brackets, and block and bleed valves. Mount in location accessible for service.

4. Water differential pressure sensor shall have stainless steel diaphragm construction, proof pressure of 150 psi minimum. Over-range limit (DP) and maximum static pressure shall be 3,000 psi. Transmitter shall be complete with 4-20 ma output, required mounting brackets, and five-valve manifold. Mount in a location accessible for service.

I. Low Limit Thermostats

1. Safety low limit thermostats shall be vapor pressure type with an element 6m [20 ft] minimum length. Element shall respond to the lowest temperature sensed by any one foot section.

2. Low limit shall be manual reset only.

J. Carbon Dioxide Sensors

1. Carbon Dioxide sensors shall measure CO2 in PPM in a range of 0-2000 ppm. Accuracy shall be +/- 3% of reading with stability within 5% over 5 years. Sensors shall be duct or space mounted as indicated in the sequence of operation.

K. Flow Switches

1. Flow-proving switches shall be either paddle or differential pressure type, as shown.

2. Paddle type switches (water service only) shall be UL listed, SPDT snap-acting with pilot duty rating (125VA minimum) and shall have adjustable sensitivity with NEMA 1 enclosure unless otherwise specified.

3. Differential pressure type switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum), NEMA 1 enclosure, with scale range and differential suitable for intended application or as specified.

L. Relays

1. Control relays shall be UL listed plug-in type with dust cover and LED “energized” indicator. Contact rating, configuration, and coil voltage shall be suitable for application.

2. Time delay relays shall be UL listed solidstate plug-in type with adjustable time delay. Delay shall be adjustable ±200% (minimum) from setpoint shown on plans. Contact rating, configuration, and coil voltage shall be suitable for application. Provide NEMA 1 enclosure when not installed in local control panel.

M. Current Switches

1. Current-operated switches shall be self-powered, solid state with adjustable trip current. The switches shall be selected to match the current of the application and output requirements of the DDC system.

N. Differential Pressure Type Switches (Air or Water Service)

1. Shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum), NEMA 1 enclosure, with scale range and differential suitable for intended application or as shown.

O. Wireless space sensors for use in Heating, Ventilating, and Air Conditioning (HVAC) systems

1. Temperature and Humidity Range

a. The ambient operating temperature range for the wireless space sensor shall be 32° to 122°F (0° to 50°C).

b. The ambient storage temperature range for the wireless space sensor shall be -40° to 185°F (-40° to 85°C).

c. The ambient operating and storage humidity range for the wireless space sensor shall be 5% to 95%, non-condensing.

2. Components

a. Wireless space sensors shall be available as: temperature only, field configurable model with digital display, and optional 2% humidity module for use in either model above. The field configurable model shall all allow field configuration without a field service tool. Configuration options include: setpoint, override pushbuttons, fan speed, and system mode switches. System mode, fan speed and setpoint shall include a lock option. The digital display shall also be field configurable to display in Fahrenheit or Celsius units of measure, and can also be configured to display setpoint only.

b. The wireless space sensor addresses shall be held in non-volatile memory to ensure operation through system voltage disturbances and to minimize the risk of incorrect association.

c. The wireless space sensor shall be addressed using pushbuttons and display with numerical indication to simplify and reduce installation time and minimize risk of incorrect addressing. Two position DIP switches are not acceptable.

d. Installation and replacement of failed sensors shall be accomplished automatically after power up.

e. The wireless space sensor shall include security screws to protect against theft.

f. Wireless space sensor component certifications shall include:

1) TFP-13651127 - Canada Compliance

2) UL 916 - Energy Management Equipment

3) UL 94 - The Standard for Flammability of Plastic Materials for Parts in Devices and Appliances: 5 VA flammability rating

4) UL 873 - Temperature regulating and indicating equipment

3. Accuracy

a. To ensure proper system performance, the wireless space sensors shall automatically determine when the space temperature is rapidly changing. When the space temperature is readily changing, the space temperature shall be transmitted at least once each 30 seconds. The maximum time between transmissions shall be 15 minutes. Space temperature sensing accuracy shall be +/- 0.5° F (+/- 0.28° C).

4. Power Requirements

a. The wireless space sensor battery life shall provide at least 15 years life under normal operating conditions and must be readily available size AA, 1.5V.

P. Wireless Communications Interface for use in Heating, Ventilating, and Air Conditioning (HVAC) systems

1. Temperature and Humidity Range

a. The ambient storage temperature range for the wireless communications interface shall be -40° to 185°F (-40° to 85°C).

b. The ambient operating and storage humidity range for the wireless communications interface shall be 5% to 95%, non-condensing.

2. Components

a. The wireless communications interface shall be addressed using rotary switches with numerical indication to simplify and reduce installation time and minimize risk of incorrect addressing. Two position DIP switches are not acceptable.

b. Wireless Comm Interface certifications shall include:

1) TFP-13651127 - Canada Compliance

2) UL 916 - Energy Management Equipment

3) UL 94 - The Standard for Flammability of Plastic Materials for Parts in Devices and Appliances: 5 VA flammability rating

4) UL 873 - Temperature regulating and indicating equipment

5) ZigBee Building Automation, BACnet Tunnelling Device

2.8 WIRING AND RACEWAYS

A. General: Provide copper wiring, plenum cable, and raceways as specified in the applicable sections of this specification.

B. All insulated wire to be copper conductors, UL labeled for 90°C (194°F) minimum service.

PART 3 - EXECUTION

3.1 EXAMINATION

A. The Contract Documents shall be thoroughly examined for coordination of control devices, their installation, wiring, and commissioning. Coordinate and review mechanical equipment specifications, locations, and identify any discrepancies, conflicts, or omissions that shall be reported to the Architect/Engineer for resolution before rough-in work is started.

B. The BAS manufacturer shall inspect the jobsite in order to verify that control equipment can be installed as required, and any discrepancies, conflicts, or omissions shall be reported to the Architect/Engineer for resolution before rough-in work is started.

3.2 PROTECTION

A. The BAS installation contractor shall protect all work and material from damage by their work or personnel, and shall be liable for all damage thus caused.

B. The BAS manufacturer shall be responsible for their work and equipment until final inspection, testing, and acceptance. The BAS installing contractor shall protect their work against theft or damage, and shall carefully store material and equipment received on site that is not immediately installed. The Contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.3 COORDINATION

A. Site

1. Where the mechanical work will be installed in close proximity to, or will interfere with, work of other trades, the contractor shall assist in working out space conditions to make a satisfactory adjustment. If the contractor installs his/her work before coordinating with other trades, so as to cause any interference with work of other trades, the contractor shall make the necessary changes in his/her work to correct the condition without extra charge.

2. Coordinate and schedule work with all other work in the same area, or with work that is dependent upon other work, to facilitate mutual progress.

B. Submittals. Refer to the “Submittals,” section of this specification for requirements.

C. Test and Balance

1. The Building Automation System contractor shall furnish a single set of software necessary to interface to the control system for test and balance purposes.

2. The Building Automation System contractor shall provide training in the use of these tools. This training will be planned for a duration of 4 hours.

3. In addition, the Building Automation System contractor shall provide a qualified technician to assist in the test and balance process, until the first 20 terminal units are balanced.

D. Life Safety

1. Duct smoke detectors required for air handler shutdown shall be supplied under Division 26 of this specification. The contractor shall interlock smoke detectors to air handlers for shutdown as described in the Sequences of Operation for this project.

2. Smoke dampers and actuators required for duct smoke isolation are provided under Division 23. The contractor shall interlock these dampers to the air handlers as described in the Sequences of Operation for this project as applicable.

3. Fire/smoke dampers and actuators required for fire rated walls are provided under another Division 23. Control of these dampers shall be by Division 26.

E. Coordination with Controls Specified in Other Sections or Divisions. Other sections and/or divisions of this specification include controls and control devices that are to be part of or interfaced to the control system specified in this section. These controls shall be integrated into the system and coordinated by the contractor as follows:

1. All communication media and equipment shall be provided as specified in the "Communication" section of this specification.

2. Each supplier of a controls product is responsible for the configuration, programming, start-up, and testing of that product to meet the sequences of operation described in this section.

3. The General Contractor shall coordinate and resolve any incompatibility issues that arise between the control products provided under this section and those provided under other sections or divisions of this specification.

3.4 GENERAL WORKMANSHIP

A. Install equipment, piping, wiring/conduit, parallel to building lines (i.e. horizontal, vertical, and parallel to walls) wherever possible.

B. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.

C. Install all equipment in readily accessible locations as defined by National Electric Code (NEC). Control panels shall be attached to structural walls or properly supported in a free-standing configuration, unless mounted in equipment enclosure specifically designed for that purpose. Panels shall be mounted to allow for unobstructed access for service.

D. Verify integrity of all control wiring to ensure continuity and freedom from shorts and grounds prior to commencing the startup and commissioning procedures.

E. All control device installation and wiring shall comply with Contract Documents, acceptable industry specifications, and industry standards for performance, reliability, and compatibility. Installation and wiring shall be executed in strict adherence to local codes and standard practices referenced in Contract Documents.

3.5 FIELD QUALITY CONTROL

A. All work, materials, and equipment shall comply with the rules and regulations of applicable local, state, and federal codes and ordinances as identified in Contract Documents.

B. BAS manufacturer shall continually monitor the field installation for building code compliance and quality of workmanship. All visible piping and or wiring runs shall be installed parallel to building lines and properly supported.

C. BAS installing Contractor(s) shall arrange for field inspections by local and/or state authorities having jurisdiction over the work.

3.6 WIRING

A. All control and interlock wiring shall comply with the National, Local Electrical Codes, and Section 260000 of these Contract Document specifications. Where the requirements of this section differ with those in Section 260000, the requirements of this section shall take precedence.

B. All NEC Class 1 (line voltage) wiring shall be UL Listed in approved raceway according to NEC requirements.

C. Where Class 2 wires are in concealed and accessible locations; including ceiling return air plenums, approved cables outside of electrical raceway can be used provided that the following conditions are met:

1. Circuits meet NEC Class 2 (current-limited) requirements. (Low-voltage power circuits shall be sub-fused when required to meet Class 2 current-limit.)

2. All cables shall be UL listed for application (i.e., cables used in ceiling plenums shall be UL listed specifically for that purpose).

D. Do not install Class 2 wiring in conduits containing Class 1 wiring. Boxes and panels containing high voltage may not be used for low voltage wiring except for the purpose of interfacing the two via control relays and transformers.

E. Where Class 2 wiring is run exposed, wiring shall be run parallel along a surface or perpendicular to it, and bundled, using approved wire ties at no greater than 3 m (10 ft.) intervals. Such bundled cable shall be fastened to the structure, using industry approved fasteners, at 1.5 m (5 ft.) intervals or more often to achieve a neat and workmanlike result.

F. All wire-to-device connections shall be made at a terminal blocks or terminal strip. All wire-to wire connections shall be at a terminal block, or with a crimped connector. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

G. Maximum allowable voltage for control wiring shall be 120Vac. If only higher voltages are available for use, the BAS manufacturer shall provide step-down transformers to achieve the desired control voltages.

H. All control wiring shall be installed as continuous lengths, where possible. Any required splices shall be made only within an approved junction box or other approved protective device.

I. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations in accordance with Contract Documents and National and/or Local Codes.

J. Conduit and wire sizing shall be determined by the BAS manufacturer in order to maintain manufacturer's recommendation and meet National and Local Codes.

K. Control and status relays are to be located in pre-fabricated enclosures that meet the application. These relays may also be located within packaged equipment control panel enclosures as coordinated. These relays shall not be located within Class 1 starter enclosures.

L. Follow manufacturer's installation recommendations for all communication and network bus cabling. Network or communication cabling shall be run separately from all control power wiring.

M. Adhere to Section 260000 requirements for installation of electrical raceways.

N. BAS manufacturer shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.

O. Flexible metal conduits and liquid-tight flexible metal conduits shall not exceed 3' in length and shall be supported at each end. Flexible metal conduit less than 1/2" electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal conduits shall be used.

3.7 COMMUNICATION WIRING

A. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling.

B. Do not install communication wiring in raceway and enclosures containing Class 1 or other Class 2 wiring.

C. Maximum pulling, tension, and bend radius for cable installation, as specified by the cable manufacturer shall not be exceeded during installation.

D. Contractor shall verify the integrity of the entire network following cable installation. Use appropriate test measures for each particular cable.

E. When a cable enters or exits a building, a lighting arrestor must be installed between the line and ground.

F. All runs of communication wiring shall be unspliced length when the length is commercially available.

G. All communication wiring shall be labeled to indicate origin and destination.

3.8 INSTALLATION OF SENSORS

A. Sensors required for mechanical equipment operation shall be factory installed and wired as specified in mechanical equipment specifications. BAS manufacturer shall be responsible for coordinating these control devices and ensuring the sequence of operations will be met. Installation and wiring shall be in accordance with the BAS manufacturer's recommendations.

B. Sensors that require field mounting shall meet the BAS manufacturer's recommendations and be coordinated with the mechanical equipment they will be associated.

C. Mount sensors rigidly and adequately for the environment the sensor will operate.

D. Room temperature sensors shall be installed on concealed junction boxes properly supported by the block wall framing. For installation in dry wall ceilings, the low voltage sensor wiring can be installed exposed and must meet applicable National and Local Electrical Codes.

E. All wires attached to wall mounted sensors shall be sealed off to prevent air from transmitting in the associated conduit and affecting the room sensor readings.

F. Install duct static pressure tap with tube end facing directly down-stream of air flow.

G. Install space static pressure sensor with static sensing probe applicable for space installation where applicable.

H. Sensors used in mixing plenums, and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip.

I. All pipe mounted temperature sensors shall be installed in matched thermowells. Install all liquid temperature sensors with heat conducting fluid in thermal wells for adequate thermal conductance.

J. Wiring for space sensors shall be concealed in building drywall. EMT conduit is acceptable within mechanical equipment and service rooms.

K. Install outdoor air temperature sensors on north wall complete with sun shield at manufacturer's recommended location and coordinated with Engineer.

3.9 FLOW SWITCH INSTALLATION

A. Coordinate installation of flow switch with Mechanical Contractor who will be responsible for installing a thread-o-let in steel piping applications. Copper pipe applications will require the use CxCxF Tee, and no pipe extensions or substitutions will be allowed.

B. Mount a minimum of 5 pipe diameters upstream and 5 pipe diameters downstream, or two feet, whichever is greater, from pipe fittings and other inline potential obstructions.

C. Install in accordance with manufacturers' instructions, which will require proper flow direction, horizontal alignment with flow switch mounting on the top of pipe.

3.10 ACTUATORS

A. Mount and link multiple control damper actuators where required, per manufacturer's instructions.

B. To compress seals when spring-return actuators are used on normally closed dampers, power the actuator to approximately 5° open position, manually close the damper, and then tighten the linkage.

C. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions. Coordinate any installation problems with Sheet metal Contractor.

D. Valves - Actuators shall be mounted on valves with adapters approved by both the actuator and valve manufacturer. Actuators and adapters shall be mounted in the factory as an approved design arrangement and shall not be field modified.

3.11 WARNING LABELS

A. Permanent warning labels shall be affixed to all equipment that can be automatically started by the BAS system.

B. Permanent warning labels shall be affixed to all motor starters and all control panels that are connected to multiple power sources utilizing separate disconnects.

3.12 IDENTIFICATION OF HARDWARE AND WIRING

A. All field wiring and cabling, including that within factory mounted, and wired control panels and devices for mechanical equipment, shall be labeled at each end within 2" of termination with a cable identifier and other descriptive information for troubleshooting, maintenance, and service purposes. BAS manufacturer to coordinate this labeling requirement with mechanical equipment manufacturer as it relates to controls.

B. Permanently label or code each point of field terminal strips to show the instrument or item served and correlate them to the BAS design drawings.

C. Identify control panels with minimum 1-cm letters on laminated plastic nameplates.

D. Identifiers shall match record documents. All plug-in components shall be labeled such that removal of the component does not remove the label.

3.13 CONTROLLERS

A. Provide a separate DDC Controller for individual HVAC mechanical equipment. DDC Controllers shall be factory mounted, installed, and wired by mechanical equipment manufacturer as specified. BAS manufacturer shall furnish and coordinate DDC controllers and control devices and ensure that installation and wiring adhere to BAS manufacturer’s design recommendations. For those mechanical equipment units that do not have factory installed controls specified, the BAS manufacturer shall field mount controls and coordinate all installation and termination information to ensure the specified sequence of operations are met.

B. Building Controllers and Custom Application Controllers shall be selected to provide a minimum of 15% spare I/O point capacity for each point type (analog or digital) found at each location. If input points are not universal, 15% of each type is required. If outputs are not universal, 15% of each type is required. A minimum of one spare is required for each type of point used in each controller.

1. Future use of spare I/O point capacity shall require providing the field instrument and control device, field wiring, engineering, programming, and commissioning. No additional Controller boards or point modules shall be required to implement use of these spare points.

3.14 PROGRAMMING

A. Provide sufficient internal memory for all controllers to ensure specified sequence of operations, alarming, trending, and reporting requirements are achieved. BAS manufacturer shall provide a minimum of 25% spare memory capacity for future use.

B. Point Naming: System point names shall be modular in design, allowing easy operator interface without the use of a written point index.

C. Software Programming

1. Provide programming for individual mechanical systems to achieve all aspects of the sequence of operation specified. It is the BAS manufacturer's responsibility to ensure all mechanical equipment functions and operates as specified in sequence of operations. Provide sufficient programming comments in controller application software to clearly describe each section of the program. The comment statements shall reflect the language used in the sequence of operations.

D. BAS Operator's Interface

1. When Operator Workstation is specified, provide color graphics for each piece of mechanical equipment depicting sufficient I/O to monitor and troubleshoot operation. Additionally, provide individual floor plans of the building allowing an operator to quickly view the overall floor plan area for any out of tolerance conditions that may need addressing. Operator color graphics shall include Chiller Plant, Boiler Plant, Air Handling Units, Rooftop Units, VAV Terminal Boxes, Fan Coil Units, Unit Ventilators, Heat Exchangers, Exhaust Fans, etc. These standard graphics shall depict all points dynamically as specified in the points list and/or indicated in sequence of operation.

2. The BAS manufacturer shall provide all the labor necessary to install, initialize, start-up, and trouble-shoot all operator interface software and their functions as described in this section. This includes any operating system software, the operator interface data base, and any third party software installation and integration required for successful operation of the operator interface.

3. As part of this execution phase, the BAS manufacturer shall perform a complete test of the operator interface. Test duration shall be a minimum of (8) hours on-site. Tests shall be made in the presence of the Owner and/or Engineer.

3.15 CONTROL SYSTEM CHECKOUT AND TESTING

A. Start-up testing. All testing in this section shall be performed by the contractor and shall make up part of the necessary verification of an operating control system. This testing shall be completed before the owner's representative is notified of the system demonstration.

1. The contractor shall furnish all labor and test apparatus required to calibrate and prepare for service all of the instruments, controls, and accessory equipment furnished under this specification.

2. Verify that all control wiring is properly connected and free os all shorts and ground faults. Verify that terminations are tight.

3. Enable the control systems and verify calibration of all input devices individually. Perform calibration procedures according to manufacturer's recommendations.

4. Verify all binary output devices (relays, solenoid valves, two-position actuators and control valves, magnetic starter, etc.) operate properly and normal positions are correct.

5. Verify all analog output devices (I/Ps, actuators, etc) are functional, that startand span are correct, and that direection and normal positions are correct. The contractor shall check all control valves and autoatic dampers to ensure proper action and closure. The contractor shall make any necessary adjustments to valve stem and damper blade travel.

6. Verify the system operation adheres to the sequences of operation. Simulate and observe all modes of operation by overriding and varying inputs and schedules. Tune all DDC loops and optimal start/stop routimes.

7. Alarms and Interlocks

    a. Check each alarm separately by including an appropriate signal at a value that will trip the alarm.

    b. Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction,

    c. Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.

3.16 CLEANING

A. Provide The BAS manufacturer's installing contractor(s) shall clean up all debris resulting from their installation activities on a daily basis. The installation contractors shall remove all cartons, containers, crates, etc. under his control as soon as their contents have been removed. Waste shall be collected and placed in a location designated by the Owner, Construction Manager, General Contractor, and/or Mechanical Contractor.

B. At the completion of work in any area, the installation contractor shall clean all of their work, equipment, etc., making it free from dust, dirt and debris.

C. At the completion of work, all equipment furnished under this Section shall be checked for paint damage. Any factory finished paint that has been damaged shall be repaired to match the adjacent areas. Any metal cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

3.17 TRAINING

A. Provide minimum of (4) classroom training sessions, and (4) hours for each session, throughout the contract period. The training will be provided for personnel designated by the Owner.

B. These objectives will be divided into logical groupings; participants may attend one or more of these, depending on level of knowledge required:

1. Day-to-day BAS Operators

2. BAS Troubleshooting & Maintenance

C. Provide course outline and materials prior to schedule training session. The instructor(s) shall provide one copy of training material per student.

D. The instructor(s) shall be factory-trained and experienced in teaching this technical material.

3.18 HVAC SYSTEM PERFORMANCE SERVICE

A. Description

1. Shall provide data collection, analytics and professional analysis for general facility performance, airside systems , variable air systems and chiller performance including, but not limited to, analytics, charts and graphs which indicate both current building performance and opportunities for building and HVAC system performance improvement.

B. Service Performance Standards

1. Data Collection Standards

a. The Building Performance Service must be capable of:

1) Continuous collection of building interval data, 24 hours/day, 7 days/week

2) Remote access to building/system data, 24 hours/day, 7 days/week

2. Communication architecture shall allow data to be collected by hardwired, or wireless, direct connection to range of gateways including:

a. Tridium (Niagara) platforms: JENE, JACE or other

b. Tracer SC

3. HVAC System Performance Service shall use “push” technology to communicate with and send data to the central server, requiring limited outbound ports

4. Data shall be stored in a Class 5 secure hosting location protected by ISO 5001-complaint firewall and intrusion detection systems with support for major network security protocols such as HTTPS and SFTP to securely access and store data.

    a. Professional Analysis Standards

    b. Provider shall have trained personnel with relevant professional credentials in HVAC systems, energy management and building optimization methodologies to be able to:

        1) Identify building system performance trends and deviations from normal operation

        2) Prepare actionable recommendations to optimize HVAC system performance

        3) Prepare recommendations for operational adjustments

        4) Prepare risk analysis of emergency maintenance or failure

        5) Develop Energy Conservation Measures (ECMs)

C. Mandatory HVAC System Performance Service Capabilities and Tests

1. For all of the analytics listed is this section, the Building Performance Service must be capable of indicating evidence of failures and exceptions that could result in energy savings or improved performance.

2. General Facility Analytic Capabilities shall include:

    a. Weather conditions at the actual building location

    b. Validation of the accuracy of outside air temperature and humidity sensors

    c. Identification of user-initiated overrides that could affect system performance

3. Outdoor Air Temperature and Relative Humidity Accuracy Test : Outdoor air temperature and relative humidity versus reference; the reference selection is auto-calculated based on the customer facility latitude and longitude. This test determines if the Outdoor Air Temperature and Relative Humidity sensors are accurate.

4. Airside System Analytics Capabilities Shall include:

    a. Constant volume operation

    b. Economizer damper status and operation

    c. Percentage of outside air used to ventilate the building

    d. Control of space temperature

    e. Ventilation control

5. Economizer Operation Tests

    a. Air handling unit shall use mechanical cooling in lieu of economizer: this test indicates that the air-handling unit should have the capability to meet its cooling load by economizer alone. If this condition is detected, energy is being wasted and the opportunity to provide beneficial ventilation.

    b. Air handling unit controls making improper economizer decision: this test compares the calculated outdoor air intake percentage against the commanded economizer output percentage in order to identify improper economizer physical damper operation. This can detect outdoor air dampers stuck open or closed, both of which result in significant energy waste.

6. Unitary System Tests

    a. Space, zone temperature versus setpoint: this test calculates the difference between the actual space, the zone temperature, and its setpoint. The defined averaged results are over a time range. In addition, this test detects excessively positive or negative space temperature control, which can result in approaching comfort and equipment service problems.

    b. Space, zone temperature versus setpoint: this test calculates the difference between the actual space temperature and its setpoint. The standard deviation of the resulting values is then calculated over a defined time range. This test detects erratic space temperature control that can result in approaching comfort and equipment service problems.

7. Ventilation Test

    a. Compares outdoor ventilation setpoint to measured value; this indicates that outdoor air ventilation is unacceptably low when compared to the setpoint.

8. Variable Air Systems (VAS) Analytics capabilities shall include:

    a. Distribution of VAV box airflows

b. Individual VAV box damper positions

c. Comparison of the current position of a VAV box to the mean position for the variable air system

9. Supply air temperature control tests shall include:

a. Building and Air-handling Unit Static Pressure Tests

b. Supply air pressure setpoint versus measured value; this calculates the difference between the actual supply air pressure and the mean of the supply air pressure setpoint values over a defined time range. This test detects erratic static pressure control that can result in energy waste and acoustic problems.

c. Systemic variable air volume box (VAV) position versus variable air system (VAS) mean; this identifies prolonged periods of time when VAV boxes in a VAS remain below the normal range, indicating that the fan speed was unnecessarily high. This test detects opportunities for the deployment of duct static pressure reset and associated energy savings.

d. Supply air pressure setpoint versus measured value; this calculates the difference between the actual supply air pressure and the setpoint. In addition, it also calculates the standard deviation of the value over the defined time range. This test detects erratic static pressure control that can result in energy waste and acoustic problems.

e. Building static pressure setpoint versus measured value; this calculates the difference between the measured space pressure and setpoint, and averages that value over the defined time range.

f. Building static pressure setpoint versus measured value/erratic control; this calculates the difference between the measured space pressure and setpoint. In addition, it also calculates the standard deviation over the defined time range.

g. Variable Air Volume Box Terminal Test

1) Analyzes the behavior of individual VAV box positions during occupied periods: under normal circumstances, the majority of VAV box position samples should lie within their identified normal control range. Abnormal position proportions shall be a precursor to problems with space ventilation, comfort, and acoustics.

10. Chiller Data Analytics Capabilities shall include analysis of the following parameters:

a. Operating mode

b. Approach temperature

c. Condenser water and chilled water flow status

d. Chilled water temperature control

e. Performance of compressor, condenser, evaporator, various motors, purge system

f. Overview of oil system

11. Chiller Equipment Tests

a. Compare chilled water setpoint to actual leaving value: this poor chilled water control can be an indicator of many issues including approaching maintenance conditions, obvious energy waste, and process and comfort problems.

b. Compare condenser water set point to actual leaving value: a poor condenser water control can be an indicator of many issues including approaching maintenance conditions and obvious energy waste due to poor efficiency.

c. Compare chilled water pump status to flow system status: detecting stuck closed switch status can help prevent improper chiller operation, which can result in machine damage.

d. Compare condenser pump status to actual flow status: detecting stuck closed switch status can help prevent improper chiller operation, which can result in machine damage.

e. Compressor short cycle: this compares the operation of compressors over time and determine if they are operating properly per specification. Excessive compressor starts and stops can deteriorate the life of a compressor.

f. Motor performance: this compares voltage, current, and temperature of motor versus specification on an ongoing basis. This can determine approaching maintenance requirement and prevent failures.

g. Purge pump out: this demonstrates activity of purge activity and can be used to detect oncoming centrifugal breach problems.

h. Evaporator efficiency: this maps the evaporator approach temperatures versus chiller load over time. In addition, it compares this data to as built chiller data, and is used to troubleshoot evaporator issues and predicting maintenance events.

i. Condenser efficiency: this maps the condenser approach temperatures versus chiller load over time. In addition, it compares this data to as built chiller data and is used to troubleshoot evaporator issues and predicting maintenance events.

D. Analytics Reports

1. Failed test reports: reports can be requested from a library of failed tests. A report is generated and is placed in a system library each time a test fails. Each report is available in the various electronic formats.

2. Ad hoc retrieval of reports: these reports can be requested by user on an ad hoc basis. The user can select reports based on time and date range and output to various electronic formats.

3. Raw data reports; any data logged in the system can be accessed by the user. The user can select data based on time, date range, attribute and individual equipment or category of equipment.

4. Predefined reports: the user can select from a large library of reports based on time and date including the following:

a. Scheduling (inventory of time programs)

b. Override (inventory of user initiated override actions)

c. Equipment Inventory (listing of control automation and mechanical equipment)

d. Event and Alarms (topical events and alarms that have occurred in the facility)

e. Exceptions (listing of all detected failed test)

E. Professional Analysis Services

1. Initial Assessment shall include the baseline performance of the building.

2. HVAC system and equipment analysis shall diagnoses system performance against expectations for optimal operation and must indicate the following in order to assess the severity of the issue: most recent failure, count of failures and exceptions throughout building history for a particular point, most dramatic failure or exception for a particular point, first time the exception or failure was generated.

F. Energy analysis includes tracking monthly energy consumption for benchmarking purposes.

END OF SECTION

SECTION 23 13 13.01 - STEEL TANKS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This section specifies furnishing and installation of tanks not specified elsewhere. Provide tanks of minimum size and type, as shown.

1.2 RELATED WORK

A. Division 23 - HVAC. Equipment Supports.

PART 2 - PRODUCTS

2.1 EXPANSION TANKS

A. Provide full acceptance volume captive air expansion tank with a replaceable bladder, flanged connection to replace bladder, steel skirt for vertical mounting, and certified to ASME Section VIII. Provide ball valve and pressure at remote air connection coupling to register air pressure inside bladder chamber.

PART 3 - EXECUTION

A. Install tanks in locations shown. Connect and test as specified.

END OF SECTION 23 13 13.01

SECTION 23 21 00 - PIPE AND PIPE FITTINGS - GENERAL

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This section specifies pipe and pipe fittings for all piping systems. The section applies to all sections of Division 23 - HVAC that employ pipe and pipe fittings.

1.2 RELATED WORK

A. Division 23 - HVAC.

1. Earthwork.
2. Valves, Strainers, and Vents.
3. Vibration Isolation.
4. Insulation.

1.3 WELDERS CERTIFICATION

A. Employ welders qualified to perform welding operations required either by certifications or by submitting to required tests.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. The particular type of pipe and fittings for each system is specified in the section on that system. All pipe and pipe fittings shall be domestically manufactured (foreign pipe will not be acceptable).

2.2 JOINTS

A. Screwed. Make screwed joints using machine cut USASI taper pipe threads. Apply a suitable joint compound to the male threads only. Ream the pipe to full inside diameter after cutting. All-thread nipples are not permitted.

B. Dissimilar Metals. Make joints between copper and steel pipe and equipment using insulating unions such as Crane Company No. 1259; EPCO as manufactured by EPCO Sales, Inc.; or an approved equal.

C. Solder Joints.

1. Prior to making joints, cut pipe square and ream to full diameter. Clean exterior of pipe and socket. Apply a thin coat of suitable fluxing compound to both pipe and socket, and fit parts together immediately.

2. Heat assembled joint only as required to cause the solder to flow. Run the joint full, slightly on the outside, and wipe to remove excess solder.

3. Use silver brazing alloy or Sil-Fos on refrigerant piping. Use 95.5 solder on all other copper piping, except domestic water piping.

4. For domestic water piping, use Harris "Stay-Safe-Bridgit", lead free, UPC and NSF approved, silver bearing solder with Harris "Stay-Clean" liquid solder flux. Apply per manufacturer's recommendations.

D. Welded. Make welded joints as recommended by the standards of the American Welding Society. Ensure complete penetration of deposited metal with base metal. Provide filler metal suitable for use with base metal. Keep inside of fittings free from globules of weld metal. Do not use mitered joints.

E. Flanged.

1. Prior to installation of bolts, accurately center and aline flanged joints to prevent mechanical prestressing of flanges, pipe and equipment. Aline bolt holes to straddle the vertical, horizontal or north-south centerline. Do not exceed 3/64 inch per foot inclination of the flange face from true alignment.

2. Use flat-face companion flanges only with flat-faced fittings, valves or equipment. Otherwise, used raised-face flanges.

3. Install proper gaskets, suitable for intended service and factory cut to proper dimensions. Secure with a suitable gasket cement.

4. Use ANSI nuts and bolts, galvanized or black to match flange material. Use ANSI 316 stainless steel nuts and bolts underground. Tighten bolts progressively to prevent unbalanced stress. Draw bolts tight to ensure proper seating of gaskets.

5. Use carbon steel flanges conforming to ANSI B16.5 with materials conforming to ASTM A 105 Grade II or ASTM A 108 Grade II. Use slip-on type flanges on pipe only. Use welding neck type flanges on all fittings. Weld slip-on flanges inside and outside.

6. Keep flange covers on equipment and shop-fabricated piping until ready to install in system.

7. No Hub. Install according to manufacturer's recommendations, using recommended tools.

F. Victaulic Joints. Make joint with Victaulic Style 77, 300 PSI, coupling fitted with Grade E molded synthetic rubber gasket. Before assembling couplings, lightly coat pipe ends and outside of gaskets with cup grease or liquid vegetable soap to facilitate installation. Groove pipe to manufacturer's specifications. Victaulic joints are allowed only if specified in a specific piping section.

2.3 UNIONS

A. Use Class-150 standard (300-pound WOG) malleable iron, ground joint unions with bronze seat. Provide flanged union joints on piping larger than 2-1/2 inches.

2.4 BRANCH CONNECTIONS

A. For Pipe 2-1/2 Inches and Smaller. For threaded piping, use straight size of reducing tee. When branch is smaller than header, a nipple and reducing coupling or swaged nipple may be used.

B. For 3 Inches and larger. For welding piping, when branch size is the same as header size, use welding tee. Use Weldolet when branch is smaller than header. For threaded branch connections, use 3000-pound full coupling welded to header.

2.5 GASKETS

A. High Temperature Piping. Provide 1/16-inch-thick ring gaskets such as Garlock No. 7022.

B. Other Piping. Provide ring rubber gaskets, Garlock No. 10. Use 1/8-inch-thick cloth reinforced rubber gaskets. For pipe smaller than 6 inches, use 1/16-inch-thick gasket.

PART 3 - EXECUTION

3.1 PIPE FABRICATION AND INSTALLATION

A. Make piping layout and installation in the most advantageous manner possible with respect to headroom, valve access, opening and equipment clearance, and clearance for other work.

B. Give particular attention to piping in the vicinity of equipment. Preserve the maximum access to various equipment parts for maintenance.

C. Do not cut or weaken any structural member.

D. Cut all pipes accurately to measurement determined at the site. After cutting pipe, ream it to remove burrs.

E. Install piping neatly, free from unnecessary traps and pockets. Work into place without springing or forcing. Use fittings to make all changes in direction. Field bending and mitering are prohibited. Make all connections to equipment using flanged joints or unions. Make reducing connections with reducing fittings only.

3.2 WELDING

A. Weld and fabricate piping in accordance with ASME Standard B31.1, latest edition, Code for Power Piping, which is for all steam piping and all piping with internal pressures higher than 160 psig. For chilled and heating water piping, weld and fabricate in accordance with ASME

B31.9. Machine beveling in shop is preferred. Field beveling may be done by flame cutting to recognized standards.

B. Align piping and equipment so that no part is offset more than 1/16 inch. Set all fittings and joints square and true, and preserve alinement during welding operation. Use of alinement rods inside pipe is prohibited.

C. Do not permit any weld to project within the pipe so as to restrict it. Tack welds, if used, must be of the same material and made by the same procedure as the completed weld. Otherwise, remove tack welds during welding operation.

D. Do not split, bend, flatten or otherwise damage piping before, during or after installation.

E. Remove dirt, scale and other foreign matter from inside piping before tying in sections, fittings, valves or equipment.

3.3 OFFSETS AND FITTINGS

A. Because of the small scale of drawings, the indication of all offsets and fittings is not possible. Carefully investigate the structural and finish conditions affecting the work and take such steps as may be required to meet such conditions.

B. Install all piping close to walls, ceilings and columns so piping will occupy the minimum space. Provide proper space for covering and removal of pipe, special clearances, and for offsets and fittings.

3.4 SECURING AND SUPPORTING

A. Support piping adequately to maintain line and grade, with due provision for expansion and contraction. Use approved, clevis-type, split-ring or trapeze-type hangers properly connected to structural members of the building. On insulated pipe, provide hangers that are large enough in diameter to accommodate the insulation (Do not use line size hangers). Do not support piping from other piping.

B. Use copper hangers with copper pipe.

C. Support vertical risers with steel strap pipe clamps of approved design and size, properly supported at every floor. Support piping assemblies in chases adequately enough to be rigid and self-supporting before the chase is closed. Provide adequate structural support for piping penetrating chase walls to fixtures. Ensure that flush valve will not pull away from wall.

D. Where insulation occurs, design hangers to protect insulation from damage. Pipe saddles and insulation shields, where required, are specified in the appropriate insulation section.

E. Perforated bar hangers, straps, wires or chains are not permitted. Plastic support brackets as manufactured by P & M Company may be used in accordance with the manufacturer's recommendations.

F. Roof supports. Roof supports to be level, sloped curbs as required, compatible with roofing system installed (metal material to be modified if required), similar to Thycurb TEMS with

roller assemblies with stainless steel rod, channel, nuts; 18" height (unless noted otherwise or required for proper installation). All seams and joints to be welded and hot dip galvanized. No shop fabricated products allowed.

G. Pipe roof penetrations to utilize 12" high curb assembly, compatible with the roof system installed (metal material to be modified if required) and level, similar to Thycurb Model TC with TP piping covers (sizes and number determined by Contractor), installed per manufacturer recommendation. All joints and seams to be welded and hot dip galvanized. No shop fabricated products allowed.

3.5 UNISTRUT PIPE SUPPORTS

A. Provide standard Unistrut metal framing members and appurtenances for pipe support where shown. Mult-A-Frame and Power-Strut pipe support systems also are acceptable. Hot-dip galvanize all such members and appurtenances.

3.8 PIPE SLEEVES AND FIRESTOPPING

A. Reference the specification on Mechanical General Provisions, Section 23 00 00.

3.9 ISOLATION VALVES

A. Provide piping systems with line size shutoff valves located at the risers, at main branch connections to mains for all equipment, and at other locations as indicated and required.

3.10 DRAIN VALVES

A. Install drain valves at all low points of water piping systems so that these systems can be entirely drained. Install a 2-inch drain for 2-inch pipes and larger. Install a line size drain valve for pipes smaller than 2 inches.

3.11 CLEANING AND FLUSHING OF WATER SYSTEMS

A. Water circulating Systems shall be thoroughly cleaned before placing in operation to rid systems of rust, dirt, piping compound, mill scale, oil, grease, silt, any and all other material foreign to water being circulated.

B. Extreme care shall be exercised during construction to prevent dirt and other foreign matter from entering the pipe or other parts of systems. Pipe stored on the project shall have open ends capped and equipment shall have openings fully protected. Before erection, each piece of pipe, fitting, or valve shall be visually examined and dirt removed.

C. At pipe end locations a temporary bypass will be installed. Bypass shall be *same* size as the supply and return pipe. Prior to flushing the distribution system, the Contractor shall install the temporary bypass and a temporary line size strainer between the supply and return pipes. Contractor shall verify that the isolation valves are open.

D. Install temporary strainers in front of pumps, tanks, solenoid valves, control valves, and other equipment where permanent strainers are not indicated. Keep these strainers in service until the equipment has been tested, then remove either entire strainer or straining element only. Fit strainers with a line size blowoff valve.

E. After the temporary bypasses are installed, the Contractor shall provide and operate one pump which will cause a velocity of 7 feet per second in the main piping. This pump will be provided with a shot chemical feeder and a strainer assembly. Pump shall be connected to system at the point where the new piping connects to the existing piping. The pump can be either electric driven or engine driven. The Contractor shall provide all temporary electrical disconnects, wiring, fuses, and other electrical devices that are required for safe operation. All cleaning shall be performed in the presence of the owner's representative.

F. Circulation will be started using the temporary pump. A nonhazardous cleaning compound (Entec 324 or approved equal) shall be added using the shot feeder until the concentration level of 20 parts per million is reached. Once this 20 parts per million concentration is reached, circulation will be maintained for 48 hours. After this period of time, the cleaning water shall be dumped to the sanitary sewer.

G. The distribution system will then be refilled with city water and circulated with continual bleed and make-up until the water is certified clean by the water treatment consultant, and accepted by the Owner. At the completion of this step an inhibitor shall be introduced. All waste water shall be dumped into the sanitary sewer system.

H. After the system is certified as clean, the Contractor shall close the valves. The bypass piping shall be removed as final connections to the building are accomplished.

I. During the flushing procedure, strainers shall be cleaned as often as necessary to remove debris and, in any event, all strainers shall be cleaned by physically removing the strainer screen from the body of the strainer at the end of flushing. Replace strainer basket and gasket. Contractor shall not flush through control valves, coils, etc. Contractor shall provide temporary bypasses at coils and spool pieces at control valves. Flush the coils individually wasting water to sanitary sewer. Connect coils and install control valves after flushing.

J. Test samples shall be taken at all bypass locations and all tests shall indicate that the entire system has reached a PH, conductivity, and chemical concentration level as approved by the Owner to match present systems. Contractor shall purchase needed chemicals from Owner’s chemical treatment supplier.

K. Contractor shall provide a smaller assembly to clean and flush any miscellaneous piping that cannot be included in the initial system flush. All other criteria shall remain the same.

L. Contractor shall add Betz Entec 338, (or approved equal) nitride borate with MBP inhibitor, at 350 ppm, to the chilled and heating water systems.

M. Once the system is approved as cleaned and treated, by the owners representative, there shall not be any delay in connecting the new system to the existing system, (if any). This is to prevent any corrosion after the new pipe is clean.

N. Special requirements, if any, are specified in the sections on each type of piping.

3.12 PIPE MARKERS

A. Identify all exposed piping and piping in accessible chases or plenums with Brady Perma-Code Pipe Markers, System 2, consisting of pipe marker, arrows, and 1-1/2-inch wide banding tape. Use Brady B-350 material, 35 ounces per inch, for all indoor applications and Brady B-946G, 35 ounces per inch, for all outdoor applications. Background colors of markers, arrows and tape shall be the same.

B. Use a pipe marker at every point of pipe entry or exit through a wall, roof or floor. Apply markers at intervals not exceeding 50 feet. Apply marker where view is unobstructed.

C. Pipe Marker Listing. Use pipe markers conforming to ANSI "Scheme for Identification of Piping Systems."

END OF SECTION 23 21 00

SECTION 23 21 13.02 - PIPING AND PIPING APPURTENANCES FOR COLD WATER MAKEUP AND EQUIPMENT DRAINS

PART 1 - GENERAL

1.1 SCOPE

A. This section provides for furnishing and installing piping and piping appurtenances to drain air handlers, pumps, boilers and other equipment requiring drains, and for cold water makeup piping.

1.2 RELATED WORK

A. Division 23 - HVAC.

1. Valves, Strainers and Vents.

2. Pipe and Pipe Fittings.

3. Insulation.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Provide Schedule 40, galvanized steel pipe conforming to ASTM A 120, and galvanized class-150 malleable iron fittings.

2.2 PIPE AND FITTINGS

A. Provide seamless, hard-drawn, Type L, copper water tube conforming to ASTM B 88, and wrought copper fittings.

2.3 VALVES AND STRAINERS

A. For pressure-reducing and relief valves, provide Bell & Gossett dual unit No. D-250.

2.4 TRAPS

A. On each air handling unit condensate drain, provide a trap deep enough to overcome pressure of the unit.

2.5 BACKFLOW PREVENTER

A. Provide a Watts Number U-909-S-HW-QT Reduced Pressure Principle backflow preventer on the city water header providing makeup water to all equipment, e.g., chillers, boilers, expansion tanks and any other items serving mechanical requiring cross connection protection. Equip complete with bronze strainer, stainless steel check modules, quarter turn ball valves and integral body unions.

1. At the contractor's option, a backflow preventer may be installed at each piece of equipment.

2. For each backflow preventer valve provide a Zurn Z-1025 Fixed Air Gap Fitting and full size drain line from air gap fitting to floor drain or hub drain.

PART 3 - EXECUTION

A. Install according to manufacturer's recommendations.

END OF SECTION 23 21 13.02

SECTION 23 21 13.03 - HOT WATER AND CHILLED WATER PIPING, VALVES AND APPURTENANCES

PART 1 - GENERAL

1.1 SCOPE

A. This section provides for furnishing and installing heating water and chilled water piping, valves and appurtenances, including fittings, expansion joints and strainers. Domestic hot water piping is specified in the section on Domestic Water Piping and Appurtenances.

1.2 RELATED WORK

A. Division 09, Finishes. Painting.

B. Division 23, HVAC.

1. Pipe and Pipe Fittings - General
2. Valves, Strainers and Vents
3. Vibration Isolation
4. Insulation

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Above Ground.

1. For pipe 2-1/2-inches and less in diameter, provide pipe conforming to ASTM A 53, Grade A or B, standard weight seamless, or electric-resistance welded black steel pipe. Furnish 150-pound screwed malleable iron fittings conforming with ANSI B 16.4 for hot water. At contractor's option, provide ASTM B 88 hard drawn, Type L copper water tube with wrought copper fittings.

2. For pipe 3-inches in diameter and larger, provide pipe meeting the requirements of ASTM A 53, Grade A or B, standard weight seamless, or electric-resistance welded black steel pipe with standard weight seamless steel welded fittings, satisfying ASTM A 234, Grade WPA or WPB, ANSI B 16.9.

B. Underground (Option #1: + 35°F to 210°F).

1. All underground chilled water and/or hot water distribution piping shall be factory pre-insulated as manufactured by INSUL-PIPE SYSTEMS, INC.

2. Carrier pipe shall be Schedule 40, black steel, A-53 or A-120 ERW. Fittings and straight runs for all piping sizes shall be joined by fusion welding. Insulation shall be foamed-in-place polyurethane with a density of not less than 2.5 lbs. per cubic foot to a thickness of

not less than 1.25 inches. Insulation shall be completely encased within a seamless PVC jacket of not less than .060 inches thick.

3. Insulation at each end of each length of pipe shall be protected with an end seal bonded both to the carrier pipe and the outer jacket. Piping cuts made in the field must be provided with end seals equal to factory type.

4. Fittings and joints on straight runs shall be field insulated with pre-cut polyurethane half-sections of the same thickness as the adjacent pipe, wired in place with all voids being eliminated. Vapor barrier jacketing material for fittings and joints shall be of the same material and thickness as the pipe jacketing. Installation shall be as per manufacturer's instructions.

5. For additional corrosion protection for the carrier pipe and fittings a heavy coat of asphalt mastic is to be applied directly to the exposed portions of all steel pipe and fittings after specified leak testing has been performed and before field insulation kits are installed.

6. Pipe schedule to be as noted below:

   a. BELOW GROUND INSTALLATIONS

      (1) For additional corrosion protection on steel carrier pipe only, apply a heavy coat of mastic directly to the carrier pipe before installing insulation sections.

      (2) Seal exposed ends of insulation with mastic provided by manufacturer.

      (3) Insulation materials for ells, tees, and joints to be field cut to the exact length required for each individual fitting or joint.

      (4) After insulation half-sections have been cut to length, install sections on the fitting and/or core pipe with tape provided by manufacturer, eliminating voids at ends and seams.

      (5) Insulate all fittings and couplings.

   b. BACKFILLING UNDERGROUND PIPING

      (1) Fill material within six inches all around the pipe should be sand or sandy loam, free of rock. Fill should be hand tamped around the pipe to ensure an even, uniform support. Final backfill should be free of large rocks and should be installed in one (1) foot layers, watered and tamped to 95% of original compaction.

2.2 CHECK VALVES

A. For pipe 2-1/2-inches in diameter and smaller, furnish 300-pound screwed, "Y" pattern, swing check valve, all bronze, with screwed cap, such as one of the following or approved equal:

Crane 76E	Powell 563-Y
Stockham B-375	Nibco T-473-B

B. For pipe 3-inches in diameter and larger, provide 150-pound, raised-face, wafer check valve, cast iron or ductile iron body and plate, Buna-N seal, and 316 stainless steel spring, such as one of the following or approved equal:

Mission Duo-Check 15 HMP	Stockham WG-970
Marlin HZNSF	WECO 15-AHATT-R
	Nibco W-920-W

2.3 BUTTERFLY VALVES

A. For pipe 3 inches and larger in diameter, furnish 150-pound flanged or tapped full lug type butterfly valve with ductile iron body, stainless steel stem, aluminum-bronze disc conforming to ASTM B-148 Alloy 9-C, seat rated for 210˚F. Provide lever-operated valves 6 inches and smaller. Use valves designed for drip-tight shutoff in dead end service against 200 psi with downstream flange removed in either direction. Provide one of the following or approved equal:

DeZurik 660-L-RS82-3-PLG-1	Keystone Fig. 129 or 105
Demco Series NE-175-5214351	Nibco LD 2000

2.4 STRAINERS

A. Furnish semisteel, 150-pound strainers conforming with ASTM A 126, Class B, screwed, 20-mesh screen opening through 2 inches. Provide flanged 0.045 perforations through 3 inches, 0.125 perforations through 16 inches and 0.250 perforations above 16 inches.

2.5 BALL VALVES (TWO-PIECE)

A. Nibco T-585-70-66 series ball valves, 2 1/2" and smaller, screwed ends, stainless steel ball and stem, with balancing stop, 2 1/4" non-metallic stem extension, 600 lb. WOG and full port.

2.6 CIRCUIT SETTERS (1/2" to 4")

A. Circuit setter equal to Bell & Gossett ULTRASET flow limiting valve, pressure independent, externally field adjustable automatic valve. Circuit setters to include memory stop, drain connection, pre-insulated molded insulation kit for easy removal, valved read-out ports, one portable differential pressure flow meter (with case, hoses, calculators, over range protection) to be turned over to Owner at end of project.

2.7 SUCTION DIFFUSERS (2" to 10")

A. Diffusers to be equal to Bell & Gossett with integral strainer (bronze mesh), stainless steel inlet vanes and orifice cylinder, pressure drop to be less than one psi; provide with adjustable floor support foot.

PART 3 - EXECUTION

3.1 TESTING

A. Apply a hydraulic pressure 1-1/2 times the operating pressure, 150 psig minimum, and carefully check for leaks. Repair all leaks and retest the system until proved airtight.

END OF SECTION 23 21 13.03

SECTION 23 21 23 - PUMPS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This section provides general characteristics for pumps specified in Division 23 - HVAC.

1.2 RELATED WORK

A. Requirements for particular pumps are specified in other sections of Division 23 - HVAC, including the following:

1. Division 23 - HVAC.

2. Domestic Water Piping and Appurtenances. Domestic Water Booster Pumps.

3. Fire Protection System. Fire Pumps.

1.3 PUMP SELECTION

A. Select pumps conservatively for scheduled conditions. Furnish pumps which have reasonably high efficiencies, with peak of efficiency at or near rated conditions. Select pumps that will operate stably at 15-foot suction lift despite substantial reduction in head or substantial increase in delivery.

B. If the pumps proposed are not considered suitable, submit manufacturer's data on other pumps for review.

1.4 PUMP SIZE AND TYPE

A. Provide motor driven pumps of the type and speed scheduled. Select pumps that are not overloaded throughout the entire range of pump operation. Provide pump connection sizes as drawn.

1.5 CERTIFIED TEST DATA

A. Submit certified pump curves showing actual performance of the actual pump to be shipped and installed at the site. The test shall be performed prior to shipment of the pump and signed by witnesses at the factory. Also, submit to test and balance contractor for use in balancing operations, and inclusion in the Balance report.

1.6 TRIMMING PUMP IMPELLER

A. This applies to constant flow pumps without VFDs only. After TAB firm has provided balance, TAB firm will advise Mechanical Contractor of amount of trim required to the impeller (with 15% safety on pump head). Mechanical Contractor to remove impeller, have impeller trimmed, reinstall impeller; after this procedure is completed, pump can then be insulated.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL PUMPS

A. Casing. Provide a cast iron, volute type, centrifugal pump with screwed or Class 125 ANSI flanged connection and tapped openings for vent and drain, equipped with petcocks. Casing for pumps 3" x 4" and larger must accommodate an impeller 15% greater in diameter than the impeller actually selected to meet specified performance. Design casings to provide for complete removal of bearing, seals and impeller without disturbing connection piping.

B. Impeller. Furnish an enclosed, cast bronze impeller, keyed and locked to the shaft, statically and hydraulically balanced.

C. Wearing Rings. Provide bronze, renewable wearing rings on all pumps 1-1/2 inches and larger.

D. Shaft. Furnish a stainless steel shaft, turned and ground to accurate dimension, of ample size to prevent deflection and key slotted as required.

E. Bearing. Provide antifriction type bearings, grease lubricated.

F. Mechanical Seals. Equip pumps with mechanical seals selected for intended service, taking into account temperature and quality of water pumped, with special water lubrication provisions, if necessary.

G. Motor Extension Shaft. For close-coupled pumps, provide a motor with an extension shaft and a special end bracket. Machine the end bracket to receive the pump support bracket for rigid bolted assembly to ensure permanent, accurate alinement of pump and motor.

H. Couplings. Provide a flexible mechanical coupling rated for the full rated horsepower of the driving motor at motor speed. Provide coupling guard that complies with ANSI B15.11, Section 8 and OSHA 1910.219, slotted viewing holes and change-out kits.

I. Base Plates. Mount the pump assembly and the motor on a common rigid steel or cast iron base fabricated and arranged to ensure rigid and true alinement of pump and motor shafts.

J. Furnish base plate with drip pan having tapped drain opening.

K. Use chilled water pumps with extended steel base big enough to receive all drip from suction and discharge flanges.

L. Motors. Motors shall be 1800 rpm, ODP (for indoor application), Reliance Electric Model XE or approved equal. For outdoor application, provide TEFC motor, but efficiencies shall be as stated below.

Motor HP	Full Load Nominal Efficiency	3/4 Load	2/4 Load
3	88.5	88.8	87.5
5	89.5	89.	89.2
7-1/2	1.0	91.0	90.8
10	91.0	91.0	90.8
15	91.7	91.7	91.4

2.2 MOTORS CONTROLLED BY VFD

A. General Requirements - Shaft Grounding:

1. All motors operated on variable frequency drives shall be equipped with a maintenance free, conductive micro fiber, shaft grounding ring with a minimum of two rows of circumferential micro fibers to discharge damaging shaft voltages away from the bearings to ground, AEGIS Bearing Protection Ring.

2. Application Note: Motors up to 100HP shall be provided with one shaft grounding ring installed either on the drive end or non-drive end. Motors over 100HP shall be provided with an insulated bearing on the non-drive end and a shaft grounding ring on the drive end of the motor. Grounding rings shall be provided and installed by the motor manufacturer or contractor and shall be installed in accordance with the manufacturer's recommendations.

B. General Requirements - High Frequency Bonding:

1. All motors operated on variable frequency drives shall be bonded from the motor foot to system ground with a high frequency ground strap made of flat braided, tinned copper with terminations to accommodate motor foot and system ground connection.

2. Application Note: Proper grounding of motor frame for all inverter-driven induction motors.

C. References: ABB Technical Guide No. 5

1. Allen Bradley Publication 1770-4.1 Application Data, Industrial Automation Wiring and Grounding Guidelines

2.3 CIRCULATORS

A. Furnish an all bronze centrifugal circulator designed for inline mounting, with a resiliently mounted motor, a centrifugal impeller, an alloy-steel shaft with thrust collar, a bronze sleeve bearing, a mechanical seal, a spring-type flexible coupling. and a wick-type oil circulating system.

END OF SECTION 23 21 23

SECTION 23 25 13 - CLOSED LOOP WATER TREATMENT SYSTEMS

PART 1 - GENERAL

1.1 OVERVIEW

A. Provide chemicals and equipment to clean, flush, and passivate a closed recirculating loop prior to start-up.

1.2 WORK INCLUDED

A. Provide chemical feeder.

B. Provide chemicals, services, and recommendations for the pre-operation cleaning and passivation for a closed loop.

C. Provide comprehensive service to manage the water treatment program. On-site service visits will be provided weekly for the first month. Thereafter services completed will be from the agreed upon service plan established and contracted by the Owner.

D. Provide the necessary test equipment , reagents, and glassware required to test and control the water treatment program.

E. All of the control equipment will be installed by the mechanical subcontractor. This subcontractor will follow the specific written installation instructions provided by the selected water treatment supplier. Provide a one year warranty of all the equipment provided under this bid.

1.3 QUALITY ASSURANCE

A. The pre-flush and passivation step shall be supervised by the selected water treatment system installer. The water treatment system installer shall report to the Owner throughout the this phase of the operation.

B. All chemicals shall be compatible with system materials or construction and shall comply with all applicable EPA and regulatory agency standards.

C. The water treatment vendor must hold an ISO9000 certification for their chemical production plant.

D. Water treatment representative experience must conform to either one of the following conditions.

1. Have over 6 years of water treatment experience with his current employer.

E. Water treatment service representative must reside within 2 hrs of the project.

F. The supplier will monitor corrosion rates of the closed loop. Afterward the coupon will be analyzed for corrosion rate and type. The water treatment provider will provide the coupons and analysis. Acceptable corrosion rates for the closed loop shall not exceed 0.1 mpy for copper and < 1.0 mpy for mild steel.

G. The water treatment system installer shall provide comprehensive training to the Owner in the proper administration and control of the water treatment program.

H. The water treatment supplier shall provide a troubleshooting manual that contains the necessary program parameters, MSDS's, testing procedures, and emergency numbers.

1.4 SUBMITTALS

A. Please compile the information in the following:

1. Specification sheets on all equipment provided.

2. Detailed procedures for Pre-flush and Passivation.

3. Copy of ISO9000 Certification.

4. Description of suppliers representative. Include education background, work experience, and home address.

5. Trouble-shooting manual for program.

6. Proof of workman's compensation insurance.

PART 2 - PRODUCT AND EQUIPMENT

2.1 MANUFACTURERS

A. The only acceptable manufacturers are:

1. Nalco Chemical Company.

2. Diversey.

3. Betz.

2.2 FEEDING AND TESTING EQUIPMENT

A. Shot Feeder.

1. Shot Feeder shall be constructed for 200 PSIG operating pressure. Feeder will have a chemical resistant prime coat. Feeder shall be provided with 3 1/2" screw-type cover,

with replaceable gasket. The feeder shall have a capacity of 5 gallons and shall include a drain, outlet, and inlet valves.

2. Testing Equipment.

3. Provide all test reagents, glassware to perform nitrite or molybdate testing on-site.

2.3 TREATMENT REQUIREMENTS

A. Closed Loop.

1. Pre-flush and passivation.

a. Please provide a detailed procedure for cleaning and passivating the closed loop system. The following basic chemical formulations, concentrations, and procedures must be used in the proposed procedure.

b. An Alkaline cleaner must be used to remove oil, mill scale, and other foreign deposits from the system piping. The cleaner must contain penetrants, emulsifiers, peptizers, dispersants, wetting agents, and a corrosion inhibitor. The cleaner's concentration must be clearly stated. The cleaning solution must recirculate for at least 12 hours prior to flush.

c. After the system has been flushed and filled with fresh water the system will need to be sterilized with and EPA approved non-oxidizing biocide. Slug feed at least 38 ppm of Glutaraldehyde into the closed loop. Please note the dosage is as Glutaraldehyde and not as product. Indicate the percent actives in the proposed biocide.

d. The long term corrosion inhibitor will be the product used to passivate the system metallurgy. The product will contain molybdate , nitrate, and tolytriazole. Nitrite levels must be raised to 500 to 600 ppm and recirculated for 48 hours. Molybdate should be approximately 120 to 140 ppm during this phase (if this is a hot-loop the nitrite level should be 600 to 800 ppm and the 150 to 250 ppm of molybdate). Indicate percent actives for the proposed product.

2. Continuous Treatment.

a. The closed loop will be continuously treated with a multi-functional product containing molybdate, nitrite, and tolytriazole. The control limits for the Nitrite will be 500 to 600 ppm and 120 to 140 for molybdate. (If this is a hot-loop the nitrite level should be 600 to 800 ppm and the 150 to 250 ppm of molibdate.) This will be the same product as used in the passivation step. For calculation purposes assume 10% annual make-up to the closed loop system.

PART 3 - EXECUTION

A. Install all equipment per manufacturer recommendations.

END OF SECTION 23 25 13

SECTION 23 25 13 - CLOSED LOOP WATER TREATMENT SYSTEMS

PART 1 - GENERAL

1.1 OVERVIEW

A. Provide chemicals and equipment to clean, flush, and passivate a closed recirculating loop prior to start-up.

1.2 WORK INCLUDED

A. Provide chemical feeder.

B. Provide chemicals, services, and recommendations for the pre-operation cleaning and passivation for a closed loop.

C. Provide comprehensive service to manage the water treatment program. On-site service visits will be provided weekly for the first month. Thereafter services completed will be from the agreed upon service plan established and contracted by the Owner.

D. Provide the necessary test equipment , reagents, and glassware required to test and control the water treatment program.

E. All of the control equipment will be installed by the mechanical subcontractor. This subcontractor will follow the specific written installation instructions provided by the selected water treatment supplier. Provide a one year warranty of all the equipment provided under this bid.

1.3 QUALITY ASSURANCE

A. The pre-flush and passivation step shall be supervised by the selected water treatment system installer. The water treatment system installer shall report to the Owner throughout the this phase of the operation.

B. All chemicals shall be compatible with system materials or construction and shall comply with all applicable EPA and regulatory agency standards.

C. The water treatment vendor must hold an ISO9000 certification for their chemical production plant.

D. Water treatment representative experience must conform to either one of the following conditions.

1. Have over 6 years of water treatment experience with his current employer.

E. Water treatment service representative must reside within 2 hrs of the project.

F. The supplier will monitor corrosion rates of the closed loop. Afterward the coupon will be analyzed for corrosion rate and type. The water treatment provider will provide the coupons and analysis. Acceptable corrosion rates for the closed loop shall not exceed 0.1 mpy for copper and < 1.0 mpy for mild steel.

G. The water treatment system installer shall provide comprehensive training to the Owner in the proper administration and control of the water treatment program.

H. The water treatment supplier shall provide a troubleshooting manual that contains the necessary program parameters, MSDS's, testing procedures, and emergency numbers.

1.4 SUBMITTALS

A. Please compile the information in the following:

1. Specification sheets on all equipment provided.

2. Detailed procedures for Pre-flush and Passivation.

3. Copy of ISO9000 Certification.

4. Description of suppliers representative. Include education background, work experience, and home address.

5. Trouble-shooting manual for program.

6. Proof of workman's compensation insurance.

PART 2 - PRODUCT AND EQUIPMENT

2.1 MANUFACTURERS

A. The only acceptable manufacturers are:

1. Nalco Chemical Company.

2. Diversey.

3. Betz.

2.2 FEEDING AND TESTING EQUIPMENT

A. Shot Feeder.

1. Shot Feeder shall be constructed for 200 PSIG operating pressure. Feeder will have a chemical resistant prime coat. Feeder shall be provided with 3 1/2" screw-type cover,

with replaceable gasket. The feeder shall have a capacity of 5 gallons and shall include a drain, outlet, and inlet valves.

2. Testing Equipment.

3. Provide all test reagents, glassware to perform nitrite or molybdate testing on-site.

2.3 TREATMENT REQUIREMENTS

A. Closed Loop.

1. Pre-flush and passivation.

a. Please provide a detailed procedure for cleaning and passivating the closed loop system. The following basic chemical formulations, concentrations, and procedures must be used in the proposed procedure.

b. An Alkaline cleaner must be used to remove oil, mill scale, and other foreign deposits from the system piping. The cleaner must contain penetrants, emulsifiers, peptizers, dispersants, wetting agents, and a corrosion inhibitor. The cleaner's concentration must be clearly stated. The cleaning solution must recirculate for at least 12 hours prior to flush.

c. After the system has been flushed and filled with fresh water the system will need to be sterilized with and EPA approved non-oxidizing biocide. Slug feed at least 38 ppm of Glutaraldehyde into the closed loop. Please note the dosage is as Glutaraldehyde and not as product. Indicate the percent actives in the proposed biocide.

d. The long term corrosion inhibitor will be the product used to passivate the system metallurgy. The product will contain molybdate , nitrate, and tolytriazole. Nitrite levels must be raised to 500 to 600 ppm and recirculated for 48 hours. Molybdate should be approximately 120 to 140 ppm during this phase (if this is a hot-loop the nitrite level should be 600 to 800 ppm and the 150 to 250 ppm of molybdate). Indicate percent actives for the proposed product.

2. Continuous Treatment.

a. The closed loop will be continuously treated with a multi-functional product containing molybdate, nitrite, and tolytriazole. The control limits for the Nitrite will be 500 to 600 ppm and 120 to 140 for molybdate. (If this is a hot-loop the nitrite level should be 600 to 800 ppm and the 150 to 250 ppm of molibdate.) This will be the same product as used in the passivation step. For calculation purposes assume 10% annual make-up to the closed loop system.

PART 3 - EXECUTION

A. Install all equipment per manufacturer recommendations.

END OF SECTION 23 25 13

SECTION 23 30 00 - DUCTWORK

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This section provides for furnishing and installing low, medium pressure ductwork and includes duct construction and accessories.

1.2 RELATED WORK

A. Division 23 - HVAC.

1. Air Devices
2. Air Balance
3. Fans
4. Insulation

1.3 GUARANTEE

A. Guarantee all ductwork for one year from the date of final acceptance. The guarantee will cover workmanship. noise, chatter, whistling, or vibration. Ductwork must be free from pulsation under all conditions of operation.

1.4 CONTRACTOR COORDINATION

A. Erect all ducts in the general locations shown, but conform to all structural and finish conditions of the building. Before fabricating any ductwork, check the physical conditions at the job site and make all necessary changes in cross sections, offsets, and similar items, whether they are specifically indicated or not.

1.5 STANDARD AND CODES

A. Except as otherwise indicated, sheet metal ductwork material and installation shall comply with the latest edition of the SMACNA HVAC Duct Construction Standards. All air distribution devices (such as dampers) included in this specification shall comply with the latest applicable SMACNA manual and NFPA 90A.

PART 2 - PRODUCTS

2.1 DUCT MATERIAL

A. Except for the special ducts specified elsewhere, use prime galvanized steel sheets or coils up to 60 inches wide. Stencil each sheet with proper gauge and manufacturer's name. Stencil coils of sheet steel throughout on 10-foot centers with gauge and manufacturer's name. Contractor shall be cautioned that Engineer may random check duct and strap gauges with a micrometer to verify compliance with the specifications.

2.2 SEALING OF SEAMS AND JOINTS (LOW VOC)

A. The entire duct system shall be sealed. The seams and joints shall be sealed by use of low VOC Hardcast DT tape with FTA-20 (indoor) adhesive or low VOC RTA-50 adhesive for outdoor applications. Duct shall be thoroughly cleaned prior to application.

B. Provide Seal Class A to all transverse and longitudinal joints and all openings for all locations. Joints includes additional sealing of TDF, duct-mate or other mechanical/gasketed joints. Spiral lock seams in round and flat oval duct need not be sealed.

2.3 LOW PRESSURE DUCTWORK (LESS THAN 2 INCHES STATIC PRESSURE)

A. Low pressure ductwork is defined as all exhaust ductwork downstream of fans and supply ductwork downstream of terminal units and fan-coil units.

B. Rectangular. Provide rectangular, low-pressure duct construction, gauges and reinforcing in accordance with the latest edition of the SMACNA HVAC Duct Construction Standards for 2" w.g. static pressure class (positive or negative), however, the gauges listed below are the minimum gauges to be used. Internal rod reinforcement will not be allowed for any ductwork with a largest dimension of less than 54".

Largest Dimension	U.S. Gauge
12" and less	No. 26
13" to 30"	No. 24

C. Round. Furnish round, low-pressure ducts which are spiral wound, such as manufactured by United McGill Sheet Metal Company. Use the following minimum gauges for shop fabricated spiral wound ducts under positive pressure, however, the gauges listed below are the minimum gauges to be used. Internal rod reinforcement will not be allowed for any ductwork with a largest dimension of less than 50".

Diameter	U.S. Gauge
26 " and less	No. 26

D. Use the following minimum gauges for shop fabricated spiral wound ducts under negative pressure, however, the gauges listed below are the minimum gauges to be used. Internal rod reinforcement will not be allowed for any ductwork with a largest dimension of less than 60".

Diameter	U.S. Gauge
17" and less	No. 26
18" to 23"	No. 24

2.4 MEDIUM PRESSURE DUCTWORK (2 INCHES THROUGH 6 INCHES STATIC PRESSURE)

A. Medium pressure ductwork is defined as all ductwork downstream of all air handlers, up to and including terminal units.

B. Rectangular. Provide rectangular, medium-pressure duct construction, gauges and reinforcing in accordance with the latest edition of the SMACNA HVAC Duct Construction Standards for 6" w.g. static pressure class (positive or negative), however, the gauges listed below are the minimum gauges to be used. Internal rod reinforcement will not be allowed for any ductwork with a largest dimension of less than 72".

Largest Dimension	U.S. Gauge
18" and less	No. 24
19" through 48"	No. 22

C. Round. Use spiral-wound ducts up to 84 inches in diameter, equal to those of United McGill Sheet Metal Company, however, the gauges listed below are the minimum gauges to be used. Internal rod reinforcement will not be allowed for any ductwork with a largest dimension of less than 50". Also provide fittings equal to those of United McGill Sheet Metal Company. Use the following minimum gauges for shop fabricated spiral wound ducts under positive pressure:

Diameter	U.S. Gauge
14" and less	No. 26
15" through 26"	No. 24

D. Medium Pressure Insulated Flexible Supply Duct. Provide factory-fabricated flexible ducts for connection between high velocity ducts and air terminal boxes consisting of an inner liner, insulation, and outer jacket. Construct the inner liner of coated steel helix and neoprene impregnated fiberglass fabric substantially bonded together to prevent the duct from collapsing or kinking in short radius bends. Provide fiberglass insulation of 2-inch minimum thickness and R6 rated around inner liner. Sheath the entire assembly in a heavy, outer vapor barrier jacket consisting of 3-ply laminate of Kraft paper, fiberglass reinforcement and aluminum foil, or closely woven fiberglass cloth impregnated with rubber or vinyl. Maximum length of flexible duct is 6 feet. Use duct rated at minimum working pressure of 10 inches of water. Provide duct listed and labeled by UL at flame spread of not more than 25 and smoke developed rate of not more than 50, and complying with NFPA Standard 90A, paragraph 113a. Acceptable products include PeppertreeAir Solutions, Thermaflex.

2.7 FIRE AND SMOKE DAMPERS

A. Quality Standards. Furnish and Install fire and smoke dampers according to NFPA Standards and SMACNA Duct Manual. Dampers must bear UL label. Use blade dampers when blade width exceeds 12 inches. Provide access doors in attached ductwork for inspection. Stencil each door "FIRE DAMPER ACCESS."

B. Fire Dampers. Use fire dampers that are 95% minimum free area, as manufactured by Greenheck, or approved equal. Dampers to be similar to Ruskin DIBD2, Styles C, CR, CO, dynamic dampers, listed per latest edition of UL 555, listed for two-way airflow and vertical or horizontal mounting. Closure springs to be 301 stainless steel. Dampers shall be activated by a fusible link designed to react at 165ºF or as required by code. Code (UBC) requires 165ºF, but minimum 50ºF above maximum operating conditions. Links for smoke control may be up to 365ºF per code official. Coordinate requirements with the code official.

C. Combination Fire and Smoke Dampers. Provide parallel blade UL listed dynamic damper and assembly with 120 volt motor, and sleeve assembly, similar to Ruskin FSD 60 with Class I leakage per UBC. Rate dampers for 4000 FPM and pressure level of 4000 FPM. Temperature rating to be as recommended by the manufacturer for the application. Dampers to be rated for airflow in both directions. Accessories to be provided are:

1. Heat activated release devices, which are automatically resettable after test, smoke detection or power failure conditions.

2. TS150 fire stat to provide remote override of fire-induced closure when F/SD is used in smoke management system for hi-rise buildings or buildings with atriums. When this feature is used, provide with switch package to remotely indicate damper blade position.

D. Coordinate the location of motor actuators to provide adequate maintenance access.

E. For three-hour applications, provide same as above except FSD60-3, three-hour rated fire/smoke damper.

F. Provide with blade position indicator and blade position indicator switch.

G. All motors for F/SD in stairwells an vestibules for stairwell pressurization shall have motors which are UL listed for modulating service, but can be used for open/closed positions also.

2.8 WALL LOUVERS

A. Louvers are provided under other sections of these specifications.

2.9 TEST OPENINGS:

A. Furnish and install in the return air duct and in the discharge duct of each fan unit Ventlok No. 699 instrument test holes. The test holes shall be installed in locations as required to measure pressure drops across each item in the system, e.g., O.A. louvers, filters, fans, coils, intermediate points in duct runs, etc.

2.10 DRYER EXHAUST

A. Dryer exhaust duct materials and installation shall comply with the current IMC and UMC. Ductwork shall be sheetmetal (minimum 0.016 inch thick), smooth interior finish, minimum 4" diameter (sized per manufacturers listing). Ducts shall not be joined with screws or similar fasteners that protrude into the inside of the duct. Maximum allowable length shall be 35 ft from the connection at the dryer to the termination with deductions for fittings per IMC and UMC. Provide protection shields in wall to protect duct from penetration by screws or nails. Terminate with a listed dryer vent with backdraft damper. Vertical risers shall be provided with a means for cleanout per IMC, UMC.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Construction Standards. Use construction methods which follow the requirements outlined in paragraph 1.5, as well as SMACNA Balancing and Adjusting publications, unless otherwise indicated in these specifications or accompanying drawings.

B. Reinforcement. Reinforce ducts having one side equal to 25 inches or more in accordance with recommended construction practice of SMACNA.

C. Plenum Construction. Construct Plenum chambers of not less than No. 20 U.S. gauge metal reinforced with galvanized structural angles.

D. Cross Breaking or Beading. Cross break or bead sheet metal for rigidity, except ducts which are 12 inches or less in the longest dimension.

E. Wall Penetrations. Where ducts pass through walls in exposed areas, Install suitable escutcheons made of sheet metal angles as closers. At all locations where ductwork passes through floors, provide watertight sleeves projecting 3 inches above finished floor and flush with bottom of floor slab. Fabricate sleeves of 1/8-inch thick steel, galvanized after fabrication. Anchor into adjacent floor slab as required. Sleeves are required inside as well as outside chases. Support ducts where passing through floors with steel structural angles of adequate bearing surface, galvanized after fabrication and resting on top of the sleeve.

F. Interior Painting. Interior painting of metal ductwork exposed to view through grilles, registers, and other openings is specified in the section on painting. Do not Install grilles, registers, or similar items until painting is complete.

3.2 LOW PRESSURE DUCTWORK

A. Construction. Construct rectangular ducts in accordance with the SMACNA Duct Manual.

B. Splitters. Provide adjustable, galvanized splitter-dampers pivoted at the downstream end with appropriate control device at each supply duct split, in accordance with SMACNA Duct Manual. Provide a splitter for each duct branch to two or more outlets.

C. Extractors. Provide Titus AG225 or equal extractors with an appropriate control device at each rectangular zone or branch supply duct connection in accordance with SMACNA Duct Manual.

D. Volume Dampers. Provide opposed-blade volume dampers with an appropriate control device in each return air, outside air and exhaust branch duct, in exhaust connections to hoods or equipment, in each zone at multizone unit discharge, and where otherwise indicated, in accordance with SMACNA Duct Manual. Manual balancing damper to be similar to Greenheck Model MBD-15, multi-blade, 6" maximum blade height, 16-gauge galvanized steel reinforced blades, 20-gauge frame, manual hand quadrant with standoff for externally insulated ductwork, synthetic sleeve. Dampers suitable for service to 4" w.c. for 12" width, 3" w.c. for 24" width, 2" w.c. for 36" width, 2" w.c. for 48" width and rated for 2000 fpm.

E. Elbows.

1. Rectangular. Where square elbows are shown, or are required for good air flow, provide and Install Barber-Colman or equal double-wall air foil turning vanes. Job-fabricated turning vanes, if used, must be double thickness vanes of galvanized steel sheets of the same gauge metal as the duct in which they are installed. Furnish vanes fabricated for the same angle as the duct offset. Use radius elbows with a center line radius of not less than 1-1/2 times the duct width. Radius elbows may be provided in lieu of vaned elbows where space and air flow requirements permit.

2. Round and Oval Duct. Provide elbows with a centerline radius of 1-1/2 times the duct diameter or duct width. For round ducts, furnish smooth elbows or 5-piece, 90º elbows and 3-piece, 45º elbows.

F. Controls. For control devices concealed by ceilings, furring, or in other inaccessible locations, furnish extension rods and appropriate recessed-type Young regulators, mounted on the surface of the ceiling or the furring, unless specified, or shown otherwise. For ducts which are not concealed, or ducts which are above lay-in ceiling but accessible, provide heavy-duty, quadrant-type, adjustable regulators having wing nuts for locking in position. Saw-mark the ends of all operating rods for dampers and air control devices to indicate damper position.

G. Low Pressure Insulated Flexible Duct. Do not exceed 6 feet in length with any flexible duct. Support duct independently of lights, ceiling and piping.

H. Low Pressure Duct Supports.

1. Horizontal Ducts Up To 40 Inch. Support horizontal ducts up to and including 40 inches in their greater dimension by means of No. 22 U.S. gauge band iron hangers attached to the ducts by means of screws, rivets or clamps, and fastened to inserts with toggle bolts, beamclamps or other approved means. Place supports on at least 8'-0" centers. Use clamps to fasten hangers to reinforcing on sealed ducts.

2. Horizontal Ducts Larger Than 40 Inch. Support horizontal ducts larger than 40 inches in their greatest dimension by means of hanger rods bolted to angle iron trapeze hangers. Place supports on at least 8'-0" centers according to the following:

Angle Length	Angle	Rod Diameter
4'-0"	1-1/2" x 1-1/2" x 1/8"	1/4"

6'-0"	1-1/2" x 1-1/2" X 1/8"	1/4"
8'-0"	2" X 2" X 1/8"	5/16"

I. Vertical Ducts. Support vertical ducts where they pass through the floor lines with 1-1/2" x 1-1/2" x 1/4" angles for ducts up to 60 inches. Above 60 inches the angles must be increased in strength and sized on and individual basis considering space requirements.

3.3 MEDIUM PRESSURE DUCTWORK

A. Rectangular. Construct rectangular ducts in paragraph 1.5. Provide reinforcing method as shown without tie rods through 60-inch-size. For rods 61 inches and over, use tie rods to keep reinforcing angles to 2-inch maximum. Use sealant (3M EC-800) or equal and 4-inch-wide Glasfab at all of the joints on rectangular ducts in shop fabrication to provide positive seal. Provide sufficient sealant to completely embed the cloth.

B. Round. Provide round, medium-pressure duct construction as noted in paragraph 1.5. Seal joints with 3M EC-800, lapped a minimum of 3 inches, secured with sheet metal screws and covered with sealant, over which is applied a 4-inch wide Glasfab cloth. Apply additional sealant until cloth is completely embedded, or welded. Mark 90° branch take-offs with conical tees. Weld take-off fittings to fittings or to the main duct. Clean and coat all welds with rust-inhibiting paint. Stamp elbows as smooth-type, or 5-or 3- piece gore type, with either type having a centerline radius of 1-1/2 times the duct diameter.

C. Oval. Provide construction taps, sealing, and other features similar to that specified for round, medium-pressure ductwork.

D. Elbows.

1. Rectangular. Construct radius and vaned elbows in accordance with paragraph 1.5.

2. Round and Oval. Provide elbows having a center radius 1-1/2 times the duct diameter or width. For round ducts, smooth elbows, or 5-piece, 90° elbows and 3-piece, 45° elbows are permitted.

E. Medium Pressure Insulated Duct. Do not exceed 6 feet in length nor make any bend greater than 90° with flexible ducts. Seal flexible duct connections with 3M 900 mastic end tape or equal. Support duct independently of lights, ceiling and piping.

F. Medium Pressure Duct Supports. Provide hangers and supports in accordance with paragraph 1.5.

3.4 KITCHEN, DISHWASHER, AND SHOWER ROOM EXHAUST DUCTWORK

A. Provide kitchen, dishwasher and shower room exhaust ductwork as specified for sheet metal ductwork. In addition, make all joints in the bottom of horizontal runs watertight. Slope horizontal runs to exhaust outlet. Use unlined duct in all such installations.

3.5 FLEXIBLE CONNECTIONS

A. Where ducts connect to fans or air handling units, make flexible airtight connections using "Ventglas" fabric. The fabric must be fire-resistant, waterproof and mildew resistant with a weight of approximately 30 ounces per square yard. Provide a minimum of 1/2-inch slack in the connections, and a minimum of 2-1/2-inches distance between the edges of the ducts. Also provide a minimum of 1-inch slack for each inch of static pressure on the fan system. Securely fasten fabric to apparatus and to adjacent ductwork by means of galvanized flats or draw bands. Where rectangular connections are made in outdoor locations, seal fabric to metal with mastic.

3.6 ACCESS DOORS

A. Install ductwork access doors in structural angle frames and provide with sash locks and hinges arranged for convenient access. Construct doors which occur in insulated ducts with an insulation filler.

3.7 FLASHING

A. Where ducts pass through roofs or exterior walls, provide suitable flashing to prevent rain or air currents from entering the building. Provide flashing not less than No. 26 gauge stainless steel or 16-ounce copper.

3.8 DUCT LINING (If shown on drawings)

A. Install glass fiber acoustical lining in all rectangular low velocity supply and return ductwork as shown on drawings. Provide 1/2-inch thick, 1-1/2 pound density, flexible lining coated on the air stream side to reduce attrition. Liner to also have an anti-microbial coating. Secure to duct surfaces with low VOC adhesive and sheet metal fasteners on 12-inch centers. Omit lining as necessary to permit satisfactory operation of air control devices. Coat all exposed edges and leading edges of cross joints with adhesive. Use liner such as Johns-Manville Lina-Coustic, or equal which meets requirements of NFPA 90-A.

3.9 DUCT LEAKAGE TESTS

A. Unless noted otherwise in paragraph below, all ductwork operating less than 2'in. w.c., to be less than 5% leakage, per SMACNA Duct Leakage Test Manual 1985. Document all tests, and forward to Engineer.

B. For ductwork operating in excess of 2-in. w.c., and all ductwork from air units/fans to VAV boxes, and from exhaust air valves to exhaust fans, it shall be tested at 1 1/2 times operating pressure, minimum 3" w.c. and shall be leak tested per sections 5 and 6, SMACNA HVAC Air Duct Leakage Test Manual, 1985. Tests must be performed only for representative sections of ductwork, minimum 33% of the installed ductwork areas for the tested pressure class. Document all tests, and forward to Engineer. Maximum leakage to be Lmax per below:

1. $Lmax = C_L P^{0.65}$

2. Where Lmax = maximum permitted leakage in CFM per 100 s.f. duct surface area.

3. Where CL = 6 for rectangular sheet metal or fireglass duct and round flex ducts.

4. Where CL = 3 for round/flat oval sheetmetal ducts.

5. Where P = test pressure (design class pressure rating in in. w.c., min. 3").

C. Mains. Test mains after risers and branches are tied in and all equipment set. Close runout connections and place fan in operation. Provide pressure in mains above design pressure. Visually inspect joints. Repair leaks detected by sound or touch. Release mains for completion after joints are tight.

END OF SECTION 23 30 00

SECTION 23 33 00 - AIR DEVICES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This section provides for the furnishing and installation of air distribution devices, including grilles, diffusers, registers, dampers, extractors, and sound attenuators.

1.2 RELATED WORK

A. Division 23 - HVAC.

1. Ductwork.

2. Air Balance.

1.3 COOPERATION WITH OTHER TRADES

A. Coordinate this work with work under Division 26 Electrical, to ensure that intended functions of lighting and air systems are achieved.

1.4 SUBMITTALS

A. Submit product data for outlets, grilles, registers, control devices, sound attenuators, and similar equipment for review prior to placement of purchase order.

1.5 FINISHES

A. Paint devices with factory standard white enamel finish.

PART 2 - PRODUCTS

2.1 DIFFUSERS

A. Louvered. Provide louvered, fixed-pattern, multiple cone diffusers with removable center cone, frames and white factory finish.

B. Select faces and necks that are circular, rectangular or square, of the size and configuration indicated.

1. Construct diffusers and frames of aluminum.

2. Use a frame compatible with the type of ceiling in which the diffuser is installed.

C. Dampers. Furnish an opposed-blade damper easily adjustable through the outlet for all diffusers. Provide operating rod extensions as required for damper adjustment.

2.2 GRILLES

A. Supply. Use double-deflection supply grilles made of aluminum.

1. Install vertical face blades and horizontal rear blades. Provide solid, extruded aluminum blades which are individually adjustable. Space at not more than 3/4-inch centers for rear blades and 1/2-inch centers for face blades and not less than 5/8-inch deep.

2. Employ grille frames of extruded aluminum with welded and mitered corners and mounting gaskets.

B. Return.

1. For ceiling return, provide aluminum egg-crate or louvered type as scheduled, with white factory finish. Use construction and frame styles as specified for ceiling diffusers. Use neck sizes as shown.

2. For wall return, provide a fixed-blade, aluminum grille, essentially sightproof, having curved or angular break, inclined blades. Space the blades at 1/2-inch centers to achieve sightproof feature. Furnish hemmed or fully rounded leading edges. Provide extruded aluminum grille frames with welded and mitered corners. Include mounting gaskets.

2.3 REGISTERS

A. Supply. Provide double-deflection supply registers with aluminum, vertical face blades and horizontal rear blades. Use an integral, key-operated, opposed blade damper.

B. Furnish solid, extruded aluminum blades which are individually adjustable. Space not more than 3/4-inch centers for rear blades and 1/2-inch centers for face blades and not less than 5/8-inch deep.

C. Employ grille frames of extruded aluminum with welded and mitered corners and mounting gaskets.

D. Return and Exhaust. Furnish return and exhaust registers identical to return grilles except for the addition of an integral key-operated, opposed-blade damper.

2.4 ACCESSORIES

A. Mounting Frames. Provide each grille or register not equipped with a removable core with a companion, all-purpose mounting frame constructed like a grille frame to facilitate installation and removal of the grille or register without marring adjacent mounting surfaces.

1. Furnish frames with 1/2-inch-thick sponge rubber gasket to prevent air leakage.

2. Provide a frame that neatly fits the grille. Mounting frames will not be required for grilles or registers mounted directly on exposed ductwork.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Diffusers. Attach the frame assembly by a concealed hinge assembly to an outer frame compatible with the type of ceiling on which the diffuser is installed.

END OF SECTION 23 33 00

SECTION 23 33 33 - ACCESS DOORS

PART 1 - GENERAL

1.1 SCOPE

A. This section provides for furnishing and installing access doors in all wall or ceiling locations as required or shown for access to valves, controls, regulating devices, water hammer arrestors, trap primers, fire dampers, air distribution boxes and other equipment requiring maintenance, adjustment or operation. Provide access doors to provide access to all mechanical items requiring service or maintenance, whether shown on drawings or not.

1.2 WORK NOT INCLUDED

A. Doors or panels required in acoustical ceilings are provided for under Division 09. However doors required in plaster, gypboard, masonry, or other solid wall or ceiling are included under this section.

PART 2 - PRODUCTS

2.1 NON-FIRE-RATED ACCESS DOORS

A. Furnish INRYCO/MILCOR approved equal with 16- frames, 14- panels, and 22- casing bead. Provide continuous concealed hinges and flush screwdriver cam lock. Use Style K access doors for plastered surfaces, Style M for masonry or gypboard surfaces, and Style AP for acoustical plaster ceilings, with 18- panel and all galvanized construction.

2.2 FIRE-RATED ACCESS DOORS (1-1/2 HOUR LABEL DOORS)

A. Furnish INRYCO/MILCOR or approved equal UL-listed 1-1/2 HR Label "B". Access doors with 16- steel frames, and 20- insulated sandwich type door panel. Provide door with an automatic closing and latching mechanism. Fire-rated access doors are required.

PART 3 - EXECUTION

A. Doors furnished by this contractor will be installed by this contractor. Not all required access doors are shown. The contractor will be responsible for proper coordination in locating access doors for ease of operation and maintenance of concealed equipment.

END OF SECTION 23 33 33

SECTION 23 34 00 - FANS

PART 1 - GENERAL

A. This section provides for furnishing and installing fans, including centrifugal with all supplemental equipment.

1.2 RELATED WORK

a. Division 23 - HVAC.

1. Ductwork.

2. Vibration Isolation.

3. Air Balance.

1.3 PERFORMANCE

A. Provide fan type, arrangement, rotation, capacity, size, motor horsepower, and motor voltage as shown. Fan capacities and characteristics are scheduled on the drawings.

B. Rate fans according to appropriate Air Moving and Conditioning Association, Inc. (AMCA), approved test codes and procedures. Supply fans with sound ratings below the maximums permitted by AMCA standards. All fans provided must be licensed to bear the Certified Ratings Seal.

C. Statically and dynamically balance all fans.

PART 2 - PRODUCTS

2.1 PROTECTIVE COATINGS

A. Manufacturer's Standard. Apply to all fans, motors and accessories, the manufacturer's standard prime coat and finish, except on aluminum surfaces or where special coatings are required.

B. Galvanizing. After fabrication of the parts, hot-dip all surfaces which require galvanizing. Where galvanizing is specified, a zinc coating may be used. After fabrication, apply the zinc coating and air-dry the coating to 95% pure zinc. Acceptable zinc coatings include Zincilate, Sealube, Amercoat, Diametcoat, or an approved equal.

2.2 SUPPLEMENTAL EQUIPMENT

A. Motor Covers. Provide weatherproof motor covers for installation out of doors. Apply the same finish as used on the fan.

B. Belt Drives.

1. Unless otherwise specified for belt-driven fans, equip the fan motors with variable pitch sheaves. Select the sheave size for the approximate midpoint of adjustment and to provide not less than 20% speed variation from full open to full closed size drives for 150% of rated horsepower.

2. Provide belt guards and apply the same finish as used for the fan.

C. Safety Disconnect Switch. Provide a factory-wired, safety disconnect switch on each unit equipped with a 115/1/60 motor.

D. Relief Vents and Air Inlets. Provide vents and inlets with aluminum frames and ½-inch mesh, galvanized bird screens. Include with dampers.

E. Prefabricated Roof Curbs. Furnish prefabricated roof curbs with built in cant strips and lined with glass fiber insulation. Curbs may be made of No. 18 U.S. standard gauge galvanized steel or 0.063-inch aluminum. The minimum height is 8-inch. Include on each roof curb a resilient pad for equipment mounting on the top flange. Curbs to be compatible with roofing system.

2.3 ROOF-MOUNTED GENERAL EXHAUST FANS

A. Furnish centrifugal fans with backward curved aluminum fan wheels. Fans shall be belt driven. Place motors on resilient mounts outside the air-stream. The selected motor must have enclosed, prelubricated bearings. Make provisions for forced air cooling of the motor. Construct unit hoods, housing and bases of aluminum. Provide 1/2-inch mesh, galvanized bird screen over openings, where required. Supply a disconnect switch and have the switch and motor factory wired to the junction box. Provide automatic dampers with curb flanges.

2.4 ACCEPTABLE MOTOR MANUFACTURERS

A. Baldor

B. Marathon

C. Reliance

D. Century

PART 3 - EXECUTION

A. Install fans according to the manufacturer's instructions and in the locations shown on the drawings.

END OF SECTION 23 34 00

SECTION 23 36 16 - AIR TERMINAL UNITS (SINGLE DUCT VAV BOXES)

PART 1 - GENERAL

A. Record Documents: Record documents shall be kept in the General Contractor's on site office. Record documents/as-builts shall be updated on a weekly basis.

1.1 SECTION INCLUDES

A. Constant volume terminal units.

B. Variable volume terminal units.

C. Single duct terminal units.

D. Variable volume regulators.

E. Integral sound attenuator.

F. Integral heating coils.

G. Integral damper motor operators.

H. Integral controls.

1.2 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Controls and Instrumentation: Thermostats and control components.

B. Testing, Adjusting and Balancing.

1.3 RELATED SECTIONS

A. Section 23 00 00 - Basic Mechanical Requirements.

B. Section 23 21 1303 - Hydronic Piping.

C. Section 23 30 00 - Ductwork.

D. Section 23 09 23 – Direct Digital Controls.

E. Section 23 08 00 - Testing, Adjusting and Balancing.

1.4 REFERENCES

A. NFPA 90A - Installation of Air Conditioning and Ventilation Systems.

B. UL 181 - Factory-Made Air Ducts and Connectors.

C. ADC 1062 - Air Distribution and Control Device Test Code.

D. ARI 880 - Standard for Air Terminals.

1.5 SUBMITTALS

A. Submit shop drawings under provisions of Section 23 00 00.

B. Submit shop drawings indicating configuration, general assembly, and materials used in fabrication.

C. Submit product data under provisions of Section 23 00 00.

D. Submit product data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings which indicate air flow, static pressure, and NC designation.

E. Include schedules listing discharge and radiated sound power level for each of second through seventh octave bands at inlet static pressures of one inch wg.

F. Submit manufacturer's installation instructions under provisions of Section 23 00 00.

1.6 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 23 00 00.

B. Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum three years documented experience.

PART 2 - PRODUCTS

2.1 VARIABLE OR CONSTANT VOLUME TERMINAL UNITS

A. The contractor shall furnish and install pressure independent dual and/or single duct variable air volume control assemblies with integral attenuator (single duct units) and attenuator-mixers (dual duct units), of the sizes, capacities and configurations shown on the Drawings.

2.2 CASING CONSTRUCTION

A. The units shall be constructed of a minimum of 20 gauge galvanized steel and internally lined with a minimum of 1 inch thick, three pound per cubic foot density insulation. The insulation shall be foil faced with the edges and seams sealed or "captured", encapsulating all fibers of the insulation. The insulation shall be neatly installed with no rough edges to interrupt the smooth flow of air through the box. Closed cell polymer insulation by IMCOA may be used instead of the fiberglass described above. The casing shall be insulated throughout its interior, up to or at least to within 2" of the heating coil connection. Insulation for the heating coil shall enclose the coil casing and tube bends and shall overlap the box internal lining by at least 3". The external insulation shall be as specified in other sections of this specification for duct insulation with full vapor barrier, and shall be field installed unless coil and plenum section is furnished as an integral part of the box.

B. All interior features of the boxes (such as mixing baffles, damper housings, etc.) shall be secured within the casing to avoid excessive movement or rattling with air movement or externally generated vibration. All external features of the terminal units shall be designed not to extend beyond the ends of the unit. (For example, the actuator mounting brackets, etc. shall not extend beyond the plane of the inlet "bulkhead.") The only exception shall be flow sensors installed in the inlet duct connections. Note that if a separate flow station is installed within a frame within the casing, then it shall be so installed not to allow air flow to bypass the flow measurement station.

C. The terminal units shall be constructed with inlet and discharge ductwork connections. The inlet ductwork connections shall extend a minimum of 4 inches from the unit casing including an allowance for the installation of air flow station(s) or probe(s). The discharge connection shall include 1" extension with slip and drive connections for use by the contractor to secure the discharge ductwork or appurtenances to the unit and shall be reinforced to provide a rigid assembly.

2.3 CASING LEAKAGE: Assembled Units shall be so constructed and sealed to limit air leakage to the following listed quantities at 6" static pressure. If sealing is required to obtain the leakage performance, seal as for medium pressure ductwork Hardcast 1602 tape may be used to seal lap joints and flat seams only. Leakage curves or tables will be required as part of the submittal data. The following is the maximum allowable casing leakage including all components:

Maximum Allowed CFM Diameter	Maximum Allowable (Area x 2000 fpm)	CFM Casing Leakage
4"-5"-6"	393	8.0
7"-8"	698	14.0
9"-10"	1091	22.0
11"-12"	1571	30.0
13"-14"	2138	40.0

2.4 ACCESS PLENUM AND DOOR: Single duct units provided with hot water coils also shall be provided with an access section or plenum between the single duct terminal and the coil for coil inspection. The construction of the plenum shall be equal to the quality of materials and

workmanship to that of the terminal unit. The access plenum may also be used as a transition, and shall be constructed with a transition angle not to exceed 15 degrees. The access plenum shall contain a minimum of a 12 inch diameter or 12 inch by 12 inch (or full width of unit if less than 12") access door as manufactured by Ventlok, Flexmaster Inspector, Ward or equal. Door frame may be bolted, screwed or flanged and sealed to the casing. Door shall be gasketed and shall be double all construction or insulated similar to main casing. Door shall be held in place with latches or other captive retainer devices. On both single duct and double duct boxes, an additional access panel shall be provided immediately downstream of the dampers for inspection and service of the dampers. If the damper assembly is easily removed from the rear of the box, the access size can be reduced to 8" round or 8" x 8" for inspection only.

2.5 DAMPER CONSTRUCTION: The damper blades shall be an equivalent of 18 gauge galvanized steel or equal aluminum and shall be securely riveted or bolted through the damper shafts to assure no slippage of the blades. The damper shafts shall operate in rust-proof self-lubricating bearings. Damper shafts penetrating the unit casings shall be sealed against leakage, and bearings shall be installed for protection against wear in the casing penetration. Damper shafts shall be formed of, or cut from solid stock; no hollow shafts will be allowed. The dampers shall seat against gasketed stops or the dampers shall have gasketed edges. Gaskets shall be mechanically fastened to the blades. If the fastening method is not full contact clamping type, then the addition of adhesive to the gasket shall be required. The dampers shall be so constructed to prevent "oil canning" of the damper blade. The units shall be tested for leakage in both inlets with 6" static pressure imposed on one inlet at a time. The maximum percent leakage from all tests shall be reported. Leakage curves as a function of pressure shall be supplied as part of the submittal data. The damper actuator linkage, if used, shall be constructed of material of sufficient strength to avoid buckling under extreme loads. Also, linkages shall not allow play greater than 5 degrees of damper movement. The controls for the dampers shall cause the dampers to fail in the position of last control (freeze in place), or fail to the open position.

2.6 DAMPER LEAKAGE: The following is the maximum damper leakage allowable for the various size diameter inlets at 6" w.g. differential pressure. The damper leakage shall not exceed the values listed in the table below at 6" S.P., following ARI 880 Testing Procedures.

Maximum Allowed CFM Diameter	Maximum Allowable (Area x 2000 fpm)	CFM Damper Leakage
4"-5"-6"	393	6.0
7"-8"	698	10.5
9"-10"	1091	16.5
11"-12"	1571	20.0
13"-14"	2138	30.0

2.7 UNIT PRESSURE DROP: For dual duct units with an integral attenuator-mixer, but with no other accessories, the static pressure across the assembly with an equivalent 2000 fpm inlet velocity through one inlet shall not exceed 0.50 inches water gauge, with the total flow through

either inlet. Single duct unit pressure drop shall be limited to 0.15 inches water gauge under the same conditions above.

2.8 FLOW MEASUREMENT: Air flow thru the unit shall be accomplished by the use of a multi-port sensing device with a minimum of four radially distributed pick-up points connected to a center averaging chamber with adequate internal passages to prevent restrictions that can result in control 'hunting'. On all systems, sensors shall be mounted as required by the temperature controls supplier.

2.9 SOUND: (Note that the maximum sound levels listed in this paragraph refer to raw sound levels, with no credits taken for the construction.)

2.10 DISCHARGE SOUND

A. Maximum discharge Sound Power Levels at 2000 fpm primary air inlet velocity with 1.5 inch w.g. inlet static pressure shall not exceed that listed in the following table. No credit for lined discharge duct, branching, flow division, end reflection, room absorption or any other effects shall be allowed.

Octave Band (Hz)	Center Frequency (dB re 10-12 Watts)	Sound Power Level
2	125	76
3	250	66
4	500	63
5	1000	58
6	2000	60
7	4000	55

2.11 RADIATED SOUND

A. Maximum discharge Sound Power Levels at 2000 fpm primary air inlet velocity with 1.5 inch w.g. inlet static pressure shall not exceed that listed in the following table. No credit for ceiling plenum, ceiling tiles, room absorption, or any other effects shall be allowed.

Octave Band (Hz)	Center Frequency (dB re 10-12 Watts)	Sound Power Level
2	125	72
3	250	67
4	500	64
5	1000	54
6	2000	47
7	4000	45

All sound power levels shall be obtained from testing in accordance with ARI-ADC Standard 880 and shall be certified at ARI-880 certification points.

2.12 MANUFACTURER: All Terminal Units shall be as manufactured by Titus (Model MDV-3100-UT or MDC-3100-UT), Metal*Aire (Series 400DDUT), or Naylor Industries 3000-UT or 3200-UT. Note that the model and series numbers listed may differ slightly from catalogue information. No other manufacturers or models are acceptable. Even though specific manufacturers may be named herein, the material supplied by any approved manufacturer shall meet all of the provisions of this specification without exception.

2.13 GENERAL PERFORMANCE: Devices using mechanical CFM limiters will not be accepted, nor shall it be necessary to change control components to make airflow rate changes. If used, pneumatic actuator motors, pneumatic controllers, and pneumatic or DDC flow stations shall be furnished, mounted and adjusted by the terminal unit assembly manufacturer to assure their proper placement within the units. It shall be noted that the terminal unit manufacturer shall be responsible for the workmanship and materials of the entire assembly of unit and controls if pneumatic controls are specified and supplied with the unit. If DDC controls of another manufacturer (NOT the terminal unit manufacturer) are provided for this project, the terminal unit manufacturer shall be responsible only for the construction of the terminal unit and the installation of internal control components installed at the manufacturers factory, and shall not be responsible for the installation of controls not installed at the terminal unit manufacturers factory, nor shall the manufacturer be responsible for the performance of the DDC controls. The performance of DDC controls, especially in connection with terminal units, shall be the responsibility of the DDC controls manufacturer.

2.14 HOT WATER COILS: Hot water coils installed in conjunction with single duct terminal units shall be factory installed, one or two row with a maximum of 10 aluminum fins per inch. Air side pressure drop shall be limited to 0.2" wg at box rated cold air flow. Full fin collars shall be provided for accurate fin spacing and maximum fin-to-tube contact. Tubes shall be 1/2 inch diameter seamless copper with a minimum wall thickness of 0.016 inch, tested at 300 psig air pressure under water with a minimum rated burst pressure of 1500 psig. Male sweat-type water connections shall be provided. Side and end plates shall be a minimum of 18 gauge galvanized sheet metal construction. All coils shall be constructed and tested in accordance with UL and/or ARI Standards. The tube ends shall be protected with tube end caps of sheet metal similar to the casing material, and shall be insulated within the caps.

2.15 CONTROL PERFORMANCE: Assemblies shall be able to be reset to any airflow between zero and the maximum cfm shown on Drawings. To allow for maximum flexibility and future changes, it shall be necessary to make only simple screwdriver or keyboard adjustments to arrange each unit for any maximum air flow within the ranges for each inlet size as scheduled on the Drawings. The control devices shall be designed to maintain the desired flow regardless of inlet flow deflection. All terminal units shall be installed with a minimum of four diameters of straight duct directly prior to the entry into each terminal unit connection and of the same size as the box connection.

2.16 DDC SYSTEMS

A. Electronic motors and controllers shall be installed by the terminal unit manufacturer unless specifically prohibited by the by the controls manufacturer. In such an event, the controls manufacturer shall be responsible for the installation of the controls. The controls manufacturer shall be responsible for the operational performance of the entire system. The terminal unit manufacturer shall remain responsible only for the performance of the mechanical components of the unit.

PART 3 - EXECUTION

A. Material damaged by weather, humidity, dust or by construction shall be replaced at no cost to the Owner. Visible rust on material shall be replaced at no cost to the Owner.

3.1 INSTALLATION

A. Refer also to requirements included in Part 2 of this specification.

B. Install in accordance with manufacturer's instructions.

C. Provide ceiling access doors or locate units above easily removable ceiling components.

D. Support units individually from structure. Do not support from adjacent ductwork.

3.2 DAMAGED INSULATION

A. Wet or damaged insulation shall be replaced at no cost to the Owner. Refer to manufacturer instructions for storage of material.

END OF SECTION 23 36 16

SECTION 23 36 16.01 - AIR TERMINAL UNITS (FPVAV)

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Fan-powered Variable Volume (VAV) Terminal Units.

B. Variable Volume Regulators.

C. Integral Sound Attenuator.

D. Integral Controls.

1.2 RELATED SECTIONS

A. Section 23 00 00 - Basic Mechanical Requirements.

B. Section 23 21 13.03 - Hydronic Piping:

C. Section 23 30 00 - Ductwork.

D. Section 23 09 23 - Direct Digital Control Systems.

E. Section 26 05 19 – Insulated Conductors.

F. Section 25 27 26 – Wiring Devices and Floor Boxes.

G. Section 23 08 00 - Testing, Adjusting and Balancing.

1.3 REFERENCES

A. NFPA 90A - Installation of Air Conditioning and Ventilation Systems.

B. UL 181 - Factory-Made Air Ducts and Connectors.

C. ADC 1062 - Air Distribution and Control Device Test Code.

1.4 SUBMITTALS

A. Submit shop drawings under provisions of Section 23 00 00.

B. Submit shop drawings indicating configuration, general assembly, and materials used in fabrication.

C. Submit product data under provisions of Section 23 00 00.

D. Submit product data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings which indicate air flow, static pressure, and NC designation.

E. Include schedules listing discharge and radiated sound power level for each of second through seventh octave bands at inlet static pressures of one inch wg.

F. Submit manufacturer's installation instructions under provisions of Section 23 00 00.

1.5 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 23 00 00.

B. Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum three years' documented experience.

PART 2 - PRODUCTS

2.1 FAN-POWERED VAV (VARIABLE AIR VOLUME) TERMINAL UNITS

A. Units shall be constant air volume secondary, variable air volume primary air distribution assemblies complete with casing, insulation, fan, hot water heating coil, dampers, actuators, controls, transformers, and other appurtenances required for a complete installation. Units shall be of the sizes and capacities scheduled.

B. Casing assembly shall be 20-gauge (minimum) galvanized steel. Interior surfaces of casing shall be acoustically and thermally lined with a 1" thick, 1 1/2-pound density glass fiber insulation with a smooth black coated mat finish equal to Manville "Linacoustic" Fiber Glass Duct Liner or IMCOA closed cell polymer material of equal thermal value. Casing leakage shall not exceed 2% of the box's maximum scheduled CFM at 6" static pressure. Insulation shall be UL-listed and in compliance with NFPA 90A requirements.

C. Damper (air valve) shall have a leakage rate of less than 2% of the box's maximum scheduled CFM at two times primary supply air duct static pressure or 6" (whichever is smaller). Unit shall incorporate primary air flow sensing devices to provide input for volume regulation as indicated hereinafter.

D. Fans shall be forward curved, centrifugal, direct-drive type with 120-volt/1-phase ECM motor for air flow adjustment from 60 - 100% of nominal box scheduled CFM. Fan and motor assembly shall be internally suspended and isolated from the casing on rubber in shear isolators. Fan and motor assembly shall be easily accessible through access panels without

disassembling the entire unit. The fan motor shall be harmonically balanced to reduce electrical noise. Fan assembly shall include an anti-backward rotation device.

E. The fan-powered boxes shall be provided with a flow cross sensor located in the primary air inlet duct suitable for interfacing with the DDC system flow transducer.

F. The boxes shall be provided with a 24 VAC transformer connected to the unit's incoming power source and properly protected. The transformer shall be of adequate size to provide 24 VAC power for all DDC system components associated with the box.

G. Hot water control valves associated with each fan-powered box shall be furnished and installed by the Contractor and connected to the DDC system under Section "Direct Digital Control System".

H. The Automation Contractor shall furnish a DDC Controller and an electronic inlet damper actuator for installation on each fan-powered box by the fan-powered box manufacturer. These DDC (Direct Digital Control) devices shall be delivered to the fan-powered box manufacturer's factory in sufficient time for the manufacturer to meet its scheduled delivery obligations. The fan-powered box manufacturer shall factory mount and connect these devices as required for proper operation as required under Division 23. The cost of factory-mounting these devices shall be included in the cost of the fan-powered boxes.

I. Hot Water Coils: Hot water coils installed in conjunction with fan-powered VAV terminal units shall be factory-installed, one or two row with a maximum of 10 aluminum fins per inch. Air side pressure drop shall be limited to 0.2" wg at box rated flow. Full fin collars shall be provided for accurate fin spacing and maximum fin-to-tube contact. Tubes shall be 1/2 inch diameter seamless copper with minimum wall thickness of 0.016 inch, tested at 400 psig air pressure under water with a minimum rated burst pressure of 1500 psig. Male sweat-type water connections shall be provided. Side and end plates shall be a minimum of 18-gauge galvanized sheet metal construction. All coils shall be constructed and tested in accordance with UL and/or ARI Standards. The tube ends shall be protected with tube end caps of sheet metal similar to the casing material, and shall be insulated within the caps.

J. CONTROL PERFORMANCE: Assemblies shall be able to reset the primary air to any airflow between zero and the maximum CFM shown on Drawings. To allow for maximum flexibility and future changes, it shall be necessary to make only keyboard adjustments to arrange each unit for any maximum air flow within the ranges for each inlet size as scheduled on the Drawings. The control devices shall be designed to maintain the desired flow regardless of inlet flow deflection. <u>All terminal units shall be installed with a minimum of four diameters of straight duct directly prior to the entry into each terminal unit connection.</u>

K. GENERAL PERFORMANCE: Devices using mechanical CFM limiters will not be accepted, nor shall it be necessary to change control components to make airflow rate changes. If used, Automation Contractor furnished flow stations shall be furnished, mounted and adjusted by the Automation Contractor with assistance from the Terminal Unit Manufacturer to assure their proper placement. The terminal unit manufacturer shall be responsible only for the construction of the terminal unit and the installation of internal control components installed at the manufacturer's factory, and shall not be responsible for the installation of controls not installed at the terminal unit manufacturer's factory, and shall not be responsible for the performance of the DDC controls. <u>The performance of DDC controls, especially in connection</u>

with terminal units, shall be the responsibility of the DDC Trades and the Automation Contractor (DIV. 17).

L. DDC SYSTEMS:

(1) Electronic operators and controllers shall be installed by the terminal unit manufacturer. The Direct Digital Control System Trades and the Automation Contractor shall be responsible for the operational performance of the entire system. The terminal unit manufacturer shall be responsible for the performance of the mechanical components of the unit.

(2) DDC Controls Description:

(a) These fan-powered boxes shall each be provided with a unit-mounted DDC terminal equipment controller (TEC) provided by the DDC Trades to accept input signals from a room space temperature sensor, the box's velocity sensor and the DDC system controller and output start/stop signals to the unit's fan, a modulating signal to the unit's primary damper, and a modulating signal to the unit's two-way modulating hot water valve as required to start/stop the unit and maintain the desired space temperature via the DDC System.

(b) These fan-powered boxes served by primary air handling units shall be energized before the air handling unit is energized. The boxes shall be individually energized by the DDC System when the respective air handling unit is to operate or when a Space Sensor is below its "Low Limit" setpoint.

(c) A DDC Trades furnished electronic space sensor shall modulate, through the unit's TEC, the unit's primary air damper and its respective heating coil valve as required to maintain the desired space temperature.

(d) The fan-powered boxes shall be furnished by the box manufacturer complete with all necessary operating hardware and sensing devices to accept the modulating signals from the Terminal/Equipment Controller (TEC) for the unit's DDC Trades furnished electronic damper operator and DDC Trades furnished electronic control valve for the hot water heating coil and a contact closure to energize/de-energize the unit fan and controls operations.

(e) Coordinate requirements for all controls components for proper operation of these fan-powered boxes with the DDC Trades.

M. MANUFACTURER: All Terminal Units shall be as manufactured by Titus (Model DTFQ) Metal*Aire (Series 400), or Trane (Series VFPE). Note that the model and series numbers listed may differ slightly from catalogue information. No other manufacturers or models are acceptable. Even though specific manufacturers may be named herein, the material supplied by any approved manufacturer shall meet all of the provisions of this specification without exception.

PART 3 - EXECUTION

A. Material damaged by weather, humidity, dust or by construction shall be replaced at no cost to the Owner. Visible rust on material shall be replaced at no cost to the Owner.

3.1 INSTALLATION

A. Refer also to requirements included in Part 2 of this specification.

B. Install in accordance with manufacturer's instructions.

C. Provide clearance for inspection, repair, replacement, and service. The mechanical contractor shall ensure all fan-powered VAV terminal unit controllers and operators are located a minimum of 30” from all obstructions (walls, pipes, etc.).

D. Provide ceiling access doors or locate units above easily removable ceiling components.

E. Support units individually from structure. Do not support from adjacent ductwork.

F. Install heating coils in accordance with Section 23 09 23.

3.2 DAMAGED MATERIALS

A. Wet or damaged insulation shall be replaced at no cost to the Owner. Refer to manufacturer’s instructions for storage of material.

B. Material damaged by weather, humidity, dust or by construction shall be replaced at no cost to the Owner. Visible rust on material shall be replaced at no cost to the Owner.

END OF SECTION 23 36 16.01

SECTION 23 64 23.01 - AIR-COOLED PACKAGED ROTARY SCREW CHILLER (70 - 500 TONS)

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This section specifies the installation of the package air cooled liquid chillers of the rotary/screw type.

B. The Contractor is responsible to perform all work required to complete installation as indicated by the Contract Documents and to furnish all supplementary and/or miscellaneous items necessary for the proper acceptance and installation of the equipment. Contractor shall be responsible for chiller procurement, for delivery, off-loading, on-site handling, storage and protecting chillers.

1.2 MANUFACTURER'S WARRANTY

A. Provide a full parts, labor and refrigerant warranty of two (2) years from final acceptance.

B. Provide a five (5) year from final acceptance warranty for compressors – parts or replacement not including labor.

1.3 MANUFACTURER'S FIELD SERVICES

A. Provide a factory trained representative for a minimum period of two (2) days to supervise testing, start-up and instruction on operation and maintenance to Owner.

B. Start-up logs shall be submitted to the Engineer for record.

1.4 QUALITY ASSURANCE

A. Unit shall be rated in accordance with ARI Standard 590-92, latest edition (USA).

B. Unit construction shall be designed to conform to ASHRAE 15 latest revision safety standard, NEC (USA) and ASME (USA) applicable codes.

C. Factory Assembled, Air Cooled Liquid Chiller. Contained within the unit cabinets shall be all factory wiring, piping, controls, refrigerant charge, and special features required prior to field start-up.

D. Factory Functional Test: The chiller shall be pressure tested, evacuated and fully charged with refrigerant and oil. In addition, a factory functional test shall be conducted to verify correct operation by cycling condenser fans and compressors and confirming operation of temperature and pressure sensors. Unit shall meet efficiencies of ASHRAE 90.1.

1.5 RELATED WORK

A. Division 23 - Mechanical.

1. Chilled Water Piping.

2. Insulation.

3. Controls.

4. Vibration Isolation.

1.6 PERFORMANCE

A. Provide performance as scheduled on drawings. All submittals for chiller performance must include an AHRI approved selection method. Verification of date and version of computer program selection or catalog is available through AHRI.

PART 2 - PRODUCTS

2.1 ROTARY/SCREW LIQUID CHILLERS

A. General Description. The units shall be factory assembled and tested outdoor air cooled liquid chillers consisting of rotary/screw semi-hermetic direct drive compressors, condenser, evaporator, electronic expansion valves, refrigeration accessories, starters and control panel. Unit shall be dehydrated and charged with refrigerant and oil at the factory. Construction and ratings shall be in accordance with ANSI/ARI standards 550 and 590.

2.2 COMPRESSORS

A. Construct helical screw compressors with heat treated forged steel or ductile iron shafts, discharge valves and sealing surface immersed in oil. Rotors shall be of high grade steel or cast iron alloy.

B. Statically and dynamically balance rotating parts. Provide oil lubrication system with oil charging valve and oil filter to ensure adequate lubrication during starting, stopping and normal operation.

C. Provide compressor with automatic capacity reduction equipment consisting of capacity control slide valve or variable speed drive(s).

D. Provide constant speed compressor motor, suction gas cooled with solid state or Wye delta starter and electronic winding overheating protection.

E. Provide crankcase heater to evaporate refrigerant returning to crankcase during shut down. Energize heater when compressor is not operating.

2.3 EVAPORATOR

A. Provide shell and tube evaporator, seamless or welded steel construction with cast iron or fabricated steel heads, seamless internally finned copper tubes roller expanded into tube sheets. Furnish minimum tube wall thickness of .025". Provide water drain connection, vent and fittings for factory installed entering and leaving water temperature sensors, low temperature cutout sensors and factory installed IFM efector switch for flow proving. Paddle type flow switch shall not be acceptable.

B. Design, test and stamp refrigerant side for 200 psig working pressure and water side for 150 psig working pressure, in accordance with ANSI/ASME SEC. 8.

C. Insulate with 0.75 inch (20 mm) minimum thick flexible elastometric rubber closed cell insulation with maximum K value of 0.26. Provide heat tape to protect evaporator to -20 degrees F (-29 degrees C).

D. Provide water drain connection, vent connection and fittings for factory installed leaving water temperature control and low temperature cutout sensors.

E. Water connections shall be victaulic. Evaporator shall have one (1) entering and one (1) leaving connection.

2.4 CONDENSER AND FANS

A. Construct condenser coils of aluminum fins mechanically bonded to seamless copper tubing. Provide sub-cooling circuits and oil cooling for the compressor bearing and injection oil. Air test under water to 506 psig. Provide sound absorbing, painted louvers for condenser coil and area underneath coil.

B. Provide vertical discharge direct driven propeller type condenser fans with fan guard on discharge. Entire fan assembly shall be statically and dynamically balanced and fan assembly shall be either painted or zinc coated steel. Fan guard shall be either PVC, chrome or zinc coated.

C. Provide three (3) phase condenser fan motors with permanently lubricated ball bearings and built-in thermal overload protection.

D. Chiller shall be capable of operation down to 25F.

2.5 ENCLOSURE

A. House components in 12 gauge galvanized steel frame and mount on welded structural steel base. Hot-dip galvanized steel frame coating shall be Underwriters Laboratories, Inc. (UL) recognized as G90-U, UL guide number DTHW2.

B. Unit panels and control panels shall be finished with a baked or powder paint. Control panel doors shall have door stays. Paint system shall meet the requirements for outdoor equipment Federal Government Agencies.

C. Casings fabricated from steel that do not have a zinc coating conforming to ASTM A 123 or ASTM A 525 shall be treated for the prevention of corrosion with factory coating or paint system. The coating or paint system shall withstand 500 hours in a salt-spray fog test in accordance with ASTM B117.

D. Mount starters and Hi-Interrupt Circuit Breaker in weatherproof panel provided with full opening access doors. Circuit breaker shall be a lockable, through-the-door type with an operating handle and clearly visible from outside of unit indicating if power is on or off. Provide Short Circuit Current Rating of 65,000 Amps.

2.6 REFRIGERANT CIRCUIT

A. All units shall have a minimum of two (2) independent refrigeration circuits designed for independent operation. Each circuit may contain one (1) compressors.

B. Provide for each refrigerant circuit:

1. Liquid line shut-off valve.
2. Removable core filter dryer.
3. Liquid line sight glass with moisture indicator.
4. Electronic or thermal expansion valve sized for maximum operating pressure.
5. Charging valve.
6. Discharge and oil line check valves.
7. Compressor suction and discharge service valves.
8. High side pressure relief valve.
9. Full operating charge of R-134A and oil.
10. Unit factory leak tested at 200 psig.

C. Capacity Modulation. Provide capacity control modulation by using a slide valve or variable speed compressor. Unit shall be capable of operation down to 20% capacity.

2.7 CHILLER CONTROLS AND POWER CONNECTION

A. On chiller, mount weather-proof control panel, containing starters, micro-processor, power and control wiring, factory wired with terminal block power connection. Provide single point power connection on units. Heat tape shall be powered by separate 115-volt electrical circuits. Provide unit mounted central power transformer.

2.8 MICRO-PROCESSOR

A. The micro-processor shall provide the following safety controls with diagnostic readouts in clear English language.

1. Loss of chilled water temperature protection.
2. High and low refrigerant pressure.
3. Low oil flow protection.
4. Loss of chilled water flow.
5. Contact for remote emergency shut-down.
6. Loss of refrigerant charge protection.
7. Motor current overload.
8. Phase reversal/unbalance/single phasing.
9. Over/under voltage.
10. Failure of water temperature sensor used for control.
11. Compressor on-off status, % RLA, anti short cycle protection timer and lead/lag programming to balance run-time.
12. Alarm contact to EMCS.

B. The micro-processor shall provide the following operating controls:

1. Leaving chilled water temperature ± 1 degrees F.
2. Load limit thermostat to limit compressor loading on high return water temperature to prevent nuisance trip-outs.
3. Low ambient controls for operation down to 25 degrees F.
4. High condensing pressure control that starts condenser fans and unloads compressors to keep head pressure under control and help prevent high pressure nuisance trip-outs.
5. Compressor current sensors that unload compressors to prevent current overload nuisance trip-outs.
6. Automatic lead-lag that equalizes running hours and compressor starts. If manufacturer cannot provide this function, a cycle counter and hour meter shall be provided for each compressor and Owner can be instructed by the manufacturer on how to manually change lead-lag on compressors to equalize compressor starts and running hours.

7. Low ambient lockout control with adjustable set point.

8. Condenser fan sequencing which automatically cycles fans in response to ambient, condensing pressure and expansion valve pressure differential thereby optimizing unit efficiency.

9. Low suction pressure control to unload compressors and throttle expansion valve to prevent low pressure nuisance trip-outs.

10. Chilled water reset from EMCS.

2.9 BUILDING MANAGEMENT SYSTEM INTERFACES

A. Chiller controls shall:

1. Prefer via BacNet

2. Alarm for abnormal operation and safety shutdown.

3. Start-stop unit.

4. Have run indication.

5. Have outside air temperature indication.

6. Have chiller status indication.

7. Digital Communications to BAS system shall consist of a BACnet interface.

2.10 ISOLATORS

A. Provide rubber in shear isolators.

2.11 OPERATING CHARACTERISTICS

A. Unit shall be capable of starting and running fully loaded at outdoor ambient temperatures from 25°F to 125°F.

B. Unit shall be capable of starting up with 95°F entering fluid temperature to the cooler.

C. Two refrigerant circuits shall be provided in each unit to protect against loss of total capacity.

D. Unit shall operate without special controls down to an ambient temperature of 25°F.

E. Unit shall have automatic lead-lag feature to automatically alternate the lead circuit to ensure even compressor wear.

2.12 MOTOR STARTERS

A. Furnish with reduced inrush starters or variable speed compressors. For each starter provide a current transformer to signal the control center for current limiting control. Place an ammeter in the door of the starter panel. Use three-leg overload protection and other features required by the control system. Provide across-the-line oil pump starters, where required. Provide all current transformers required to operate auxiliaries.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All work shall be performed in accordance with the manufacturer's published diagrams, recommendations, and equipment warranty requirements.

B. Necessary supports shall be provided for all equipment, appurtenances, and pipe as required, including frames or supports for compressors and similar items. Equipment shall be set on not less than a 6 inch concrete pad.

C. Equipment shall be properly leveled, aligned, and secured in place in accordance with manufacturer's instructions.

D. Mount and wire flow switches.

E. Install double boilers rubber pipe flex connectors, Pete’s plug, and shut-off balance valves.

F. Wire heat tape at chiller and all exposed connecting piping, make-up water piping, or any other assemblies containing water exposed to the outdoors.

3.2 START-UP

A. A factory-trained engineer is required for two working days. The engineer will adjust and start the chillers and instruct designated personnel on operation and maintenance.

END OF SECTION 23 64 23.01

SECTION 23 73 00 - AIR HANDLING UNITS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This section specifies furnishing and installing factory standard air handling units and includes casing, fans, coils, filters and special items.

1.2 PERFORMANCE

A. Unit capacities and characteristics are as scheduled on the drawings. Units must be UL or ETL listed and display the appropriate label as a complete assembly. Units must be certified in accordance with ARI Standard 430-66.

1.3 SUBMITTALS

A. Shop Drawings: Show assembly, unit dimensions, weight loading, required clearances, construction details, and field connection details. ┼Air handling unit dimensional drawings shall be prepared on AutoCAD compatible CAD system, specific to each tag number. CAD disk shall be made available to Mechanical Contractor upon request.┼

B. Product Data: Show dimensions, weights, capacities, ratings, fan performance, motor electrical performance, motor electrical characteristic, and gauges and finishes of materials. Include all scheduled data.

C. Submit fan curves showing specified maximum and minimum operating points clearly plotted against fan total pressure and brake horsepower. Curves shall be multiple RPM type covering a range of plus or minus 20 percent of design operating RPM. Indicate surge points.

D. Submit sound power levels for fan inlet, outlet, and casing radiation at rated capacity in accordance with AHRI 260. Base Test Data on submitted fan sizes rather than estimated data on other fan sizes.

1.4 INFORMATIONAL SUBMITTALS

A. Submittals require no response by A/E.

B. Operation and Maintenance Data: Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists and wiring diagrams.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Seal fluid and air openings prior to shipment.

B. Deliver Products in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs.

PART 2 – PRODUCTS

2.1 GENERAL

A. Provide factory-assembled unit. Unit may be shipped in assembled sections.

B. Furnish unit with sealing and fastening hardware supplied by the manufacturer. Include written instructions needed to complete field assembly of the components.

C. Provide units designed and constructed to that coils, panels, fan housing and fans can be removed without affecting the structural integrity of the unit.

D. Equipment Noise. The octave band sound power levels for each fan inside the air handling units shall be determined at the specified design operating point shown on the mechanical equipment schedule. The maximum allowable octave band sound power levels for each fan (radiating from the fan inlet) shall not exceed the following levels expressed in dB (ref 1 picowatt):

	MAXIMUM SOUND POWER per AHRI 430								
	Octave Band								A-Weighted
	63	125	250	500	1k	2k	4k	8k	Hz
Supply Fans	92	94	96	91	90	85	80	75	95

2.2 ACCEPTABLE MANUFACTURERS

A. Temtrol

B. Trane Performance Climate Changer

C. Daikin Vision Custom

D. York XT High Performance

2.3 CASING

A. Unit manufacturer shall ship unit in segments as specified by the contractor for ease of installation in tight spaces. The entire air handler shall be constructed of galvanized steel. Casing finished to meet ASTM B117 250-hour salt-spray test. The removal of access panels or access doors shall not affect the structural integrity of the unit. All removable panels shall be gasketed. All doors shall have gasketing around full perimeter to prevent air leakage.

Contractor shall be responsible to provide connection flanges and all other framework that is needed to properly support the unit. Casing performance - Casing air leakage shall not exceed leak class 6 (CL = 6) per ASHRAE 111 at specified casing pressure, where maximum casing leakage (cfm/100 ft2 of casing surface area) = CL X P0.65.

B. Air leakage shall be determined at 1.00 times maximum casing static pressure up to 8 inches w.g. Specified air leakage shall be accomplished without the use of caulk. Total estimated air leakage shall be reported for each unit in CFM, as a percentage of supply air, and as an ASHRAE 111 Leakage Class.

C. Under 55F supply air temperature and design conditions on the exterior of the unit of 81F dry bulb and 73F wet bulb, condensation shall not form on the casing exterior. The AHU manufacturer shall provide tested casing thermal performance for the scheduled supply air temperature plotted on a psychrometric chart. The design condition on the exterior of the unit shall also be plotted on the chart. If tested casing thermal data is not available, AHU manufacturer shall provide, in writing to the Engineer and Owner, a guarantee against condensation forming on the unit exterior at the stated design conditions above. The guarantee shall note that the AHU manufacturer will cover all expenses associated with modifying units in the field should external condensate form on them. In lieu of AHU manufacturer providing a written guarantee, the installing contractor must provide additional external insulation on AHU to prevent condensation. Unit casing (wall/floor/roof panels and doors) shall be able to withstand up to 1.5 times design static pressure, or 8-inch w.g., whichever is less, and shall not exceed 0.0042 per inch of panel span (L/240).

D. Floor panels shall be double-wall construction and designed to support a 300-lb load during maintenance activities and shall deflect no more than 0.0042 per inch of panel span.

E. Unit casing panels shall be 2-inch double-wall construction, with solid galvanized exterior and solid galvanized interior, to facilitate cleaning of unit interior.

F. Unit casing panels (roof, walls, floor) and doors shall be provided with a minimum thermal resistance (R-value) of 13 Hr*Ft2*°F/BTU.

G. Unit casing panels (roof, walls, floor) and external structural frame members shall be completely insulated filling the entire panel cavity in all directions so that no voids exist. Panel insulation shall comply with NFPA 90A. Casing panel inner liners must not extend to the exterior of the unit or contact the exterior frame. A mid-span, no-through-metal, internal thermal break shall be provided for all unit casing panels.

H. Access panels and/or access doors shall be provided in all sections to allow easy access to drain pan, coil(s), motor, drive components and bearings for cleaning, inspection, and maintenance.

I. Supports. Manufacturer to provide a full perimeter integral base frame to support and raise all sections of the unit for proper trapping. Base frame will either be bolted construction or welded construction. Base height shall be a minimum of 6” and condensate connection must be above the base rail. Contractor will be responsible for providing a housekeeping pad when unit base frame is not of sufficient height to properly trap unit. Unit base frames not constructed of galvanized steel shall be chemically cleaned and coated with both a rust-inhibiting primer and finished coat of rust-inhibiting enamel.

2.4 FAN SECTION

A. All fans shall meet the scheduled type, size and performance and shall not exceed the horsepower specified on the schedule. Fan base assembly shall be fabricated from welded structural steel. Fan assemblies shall be independently isolated with 2" spring-type vibration isolators.

B. Supply fans shall be double-inlet, squirrel-cage, centrifugal fans with air foil wheel and constructed for full AMCA Class II or Class III as required. All fans shall bear the AMCA seal. Manufacturer shall provide fan curves identifying the surge point lines for each fan.

C. Provide 12" x 12" removable covers for access to grease bearings.

D. Fan wheels shall be statically and dynamically balanced prior to fan assembly. Completed assemblies shall be dynamically IRD balanced in two planes to 0.080 in/sec or less at design RPM with project belts and sheaves. Fan assemblies exceeding allowance shall be field balanced at manufacturer's expense.

E. Provide fans of type and class as specified on the schedule. Fan shafts shall be solid steel, coated with a rust-inhibiting coating, and properly designed so that fan shaft does not pass through first critical speed as unit comes up to rated RPM. All fans shall be statically and dynamically tested by the manufacturer for vibration and alignment as an assembly at the operating RPM to meet design specifications. Fans that are selected with inverter balancing shall first be dynamically balanced at design RPM. The fans then will be checked in the factory from 25% to 100% of design RPM to insure they are operating within vibration tolerance specifications, and that there are no resonant frequency issues throughout this operating range. Inverter balancing that requires lockout frequencies inputted into a variable frequency drive to in order to bypass resonant frequencies shall not be acceptable. If supplied in this manner by the unit manufacturer, the contractor will be responsible for rebalancing in the field after unit installation. Fans selected with inverter balancing shall have a maintenance free, circumferential conductive micro fiber shaft grounding ring installed on the fan motor to discharge shaft currents to ground.

F. Fan bearings shall be heavy-duty, pillow block, self-aligning ball or roller type, and grease lubricated. Bearings shall be selected for a minimum L-50 life of 200,000 hours, at the maximum horsepower and operating speed for classification.

G. Extended lube lines shall be provided and extended to the outside of the fan cabinet.

H. Fan shafts shall be solid turned and polished steel. Shafting shall be selected for operations not to exceed 70% of first critical speed. Shaft shall be "ring gauged" for precision fit in bearing journals. Each fan submittal shall include complete shaft material and dimensional specification for owner's use for shaft replacement.

I. Sheaves and Belts. All sheaves and belts shall be provided with a 1.5 service factor. Fixed pitch sheaves shall be provided on motors larger than 15 horsepower. Belts shall be oil and heat resistant.

J. Drives. Drives shall be driven by electrical motors through short center V-belt drives with cast-iron sheaves. All sheaves (motor and fan) shall be dynamically balanced and matched. In no

case shall the driven pulley diameter exceed 0.57 of the drive pulley, or the number of drive belts increased if necessary to meet this requirement.

K. Motors.

1. Acceptable Manufacturers:

   a. Baldor
   b. Marathon
   c. Reliance
   d. Century

2. Provide grease-lubricated ball bearings with alemite fittings.

3. Provide fan motors that will not overload when scheduled fan rpm is increased 10%. Submit a fan curve for each scheduled unit showing operating points at scheduled conditions and at scheduled rpm increased 10%.

4. Motors shall be 1800 rpm, ODP (for indoor application), Reliance Electric Model XE or approved equal, premium high-efficiency NEMA design B rated for inverter duty.

Motor HP	Full Load Nominal Efficiency	3/4 Load Efficiency	2/4 Load Efficiency
3	88.5	88.8	87.5
5	89.5	89.5	89.2
7-1/2	91.0	91.0	90.8
10	91.0	91.0	90.8
15	91.7	91.7	91.4
20	93.0	93.0	93.0
25	93.0	93.0	93.0
30	93.0	93.0	93.0
40	93.8	94.0	94.0

Provide motor wiring in sealtight conduit to junction box mounted on unit exterior.

2.5 MOTORS CONTROLLED BY VFD

A. General Requirements - Shaft Grounding:

1. All motors operated on variable frequency drives shall be equipped with a maintenance free, conductive micro fiber, shaft grounding ring with a minimum of two rows of circumferential micro fibers to discharge damaging shaft voltages away from the bearings to ground, AEGIS Bearing Protection Ring.

2. Application Note: Motors up to 100HP shall be provided with one shaft grounding ring installed either on the drive end or non-drive end. Motors over 100HP shall be provided with an insulated bearing on the non-drive end and a shaft grounding ring on the drive end of the motor. Grounding rings shall be provided and installed by the motor manufacturer or contractor and shall be installed in accordance with the manufacturer's recommendations.

B. General Requirements - High Frequency Bonding:

1. All motors operated on variable frequency drives shall be bonded from the motor foot to system ground with a high frequency ground strap made of flat braided, tinned copper with terminations to accommodate motor foot and system ground connection.

2. Application Note: Proper grounding of motor frame for all inverter-driven induction motors.

3. References: ABB Technical Guide No. 5

a. Allen Bradley Publication 1770-4.1 Application Data, Industrial Automation Wiring and Grounding Guidelines

C. Variable Frequency Drive

1. Unit motors for air handling units, where scheduled, will be driven by a variable frequency drive as specified in Section 23 09 00.A, VARIABLE FREQUENCY DRIVES, supplied by mechanical contractor.

2.6 COILS

A. Standards. Supply products of leading manufacturers with dependable published ratings, or equal. Certify performance in accordance with ARI Standard 410-72. Submit coil descriptive literature and rating information for review.

B. Fabrication. Construct coils of ½-inch or 5/8-inch O.D. copper tubes with aluminum fins bonded to the tubes.

C. Mount in a stainless steel casing permitting removal of coil from unit. Coil sections shall have heavy-duty coil tracks extending the full width of the unit.

D. Fins may be either plate type, with tubes mechanically bonded into the fins, or ribbon type, helically wound on individual tubes. Provide a tight, mechanical bond between fins and tubes. Use a minimum of six and a maximum of 10 fins per linear inch of tube (unless schedule indicates otherwise).

E. Design coil section to prevent condensate carryover at face velocities greater than design velocities.

F. Water Coils. Provide chilled water coils. Balance the circuits for equal pressure drop and shall not exceed the scheduled pressure drop.

G. Arrange each circuit for counterflow cooling with bottom supply connections. Provide drain and vent connections at bottoms and top. Furnish access holes and covers. Locate coil headers at the same end of the coil.

H. Select water coils for approximately 3 to 4 feet per second velocity (2 fps minimum, 5 fps maximum and 250 psig working pressure. Provide minimum .025 inch wall tubes and .008 inch fins.

I. Supply and return connections shall be red brass or schedule 40 black steel and shall be clearly marked.

J. Heating Coils.

1. Hot Water. Provide hot water coils two rows deep except where otherwise noted. Design and construct hot water coils the same as cooling coils.

2.7 FILTERS

A. Slide Racks. Provide and arrange suitable galvanized filter slide racks to permit easy removal of filters from the accessible side of unit.

B. Replacement Filters. Furnish one spare set of all air conditioning system filters.

C. Prefilters. 30% efficient, 2-inch thick pleat, Farr 30/30.

D. Provide two (2) complete sets of all types of filters, one as specified and one construction set shipped within the unit.

E. A magnehelic differential pressure gauge for measuring the pressure drop across each filter bank shall be factory installed.

2.10 DAMPERS

A. All dampers, with the exception of external bypass and multizones (if scheduled), shall be internally mounted. Dampers shall be premium ultra low leak and located as indicated on the schedule and plans. Blade arrangement (parallel or opposed) shall be provided as indicated on the schedule and drawings. Dampers shall be Ruskin CD60 double-skin airfoil design or equivalent for minimal air leakage and pressure drop. Leakage rate shall not exceed 3 CFM/square foot at one inch water gauge complying with ASHRAE 90.1 maximum damper leakage and shall be AMCA licensed for Class 1A. All leakage testing and pressure ratings shall be based on AMCA Standard 500-D. Manufacturer shall submit brand and model of damper(s) being furnished, if not Ruskin CD60.

2.11 ACCESS SECTIONS

A. Access sections shall be provided where indicated in the schedule and plans to allow additional access for inspection, cleaning, and maintenance of unit components. The unit shall be installed for proper access. Procedure for proper access, inspection and cleaning of the unit shall be provided in the AHU manufacturer's maintenance manual. Access section doors to be provided for filter mixing box, fan section, vertical cooling coil and access sections between coils.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install air handling unit according to manufacturer's instructions.

B. Make ductwork connections to unit discharge plenum using bell-mouth fittings.

3.2 START-UP

A. Equipment start-up: When installed and connected, the unit shall be inspected, checked, and approved as ready for operation by the mechanical contractor before unit is initially operated. The contractor shall then initiate and thoroughly check the unit operation, make or direct all adjustments necessary to place the unit in satisfactory operation, and certify [in writing] that the unit is properly installed, connected and operating. The equipment shall not be placed in service until that certification is received. Also provide instruction of Owner's personnel on operation and maintenance after certification.

B. Owner's Instruction: After the AHU is operating normally, provide instructional time with the Owner's personnel to review the maintenance manuals and perform each step necessary for startup, shutdown, troubleshooting, and routine maintenance. This service orientation shall be scheduled through the contractor so that they may observe the training sessions.

END OF SECTION 23 73 00

AIR HANDLING UNITS 23 73 00 - 8

SECTION 23 82 19.01 - CASED FAN COIL UNITS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This section specifies horizontal draw-through cased fan coil units for concealed overhead installation.

1.2 RELATED WORK

A. Division 23 - HVAC.

1. Electric Motors.

2. Insulation.

3. High Temperature Piping Insulation.

4. Low Temperature Piping Insulation.

B. Division 26 - Electrical. Motors.

PART 2 - PRODUCTS

A. Assembly.

1. Provide a unit of horizontal draw-through design for concealed overhead installation.

2. Provide units complete with coils, motors and drives.

3. Furnish minimum 18-gauge galvanized steel casings with one-inch thick, 1 ½ pound minimum density insulation. Provide foil facing for insulation or galvanized inner liner.

4. Make provision for duct connections at each end of the fan coil unit.

B. Coils.

1. Provide 1/2-inch outside diameter copper tubes and up to 11 aluminum fins per inch.

2. Provide manual air vents and drain plugs for each coil.

3. Allow no more than 10 feet of water pressure drop.

C. Motors.

1. Provide motors of the open drip-proof type with permanently sealed ball bearings and a minimum service factor of 1.15.

2. Wire the motors to a unit-mounted control box.

3. Provide built-in thermal overload protection.

D. Fans.

1. Provide forward curved, centrifugal fans with adjustable speed V-belt drives.

2. Support the fan shaft with heavy-duty permanently sealed ball bearings.

3. Supply units with only one fan per unit. Provide with fan status switch wired to control box.

E. Drain Pan. Provide heavy-duty, rust inhibited drain pans extending under coils, and pipe connection assembly within units. Provide primary and secondary drains and a condensate overflow switch to de-energize the unit upon a rise in condensate level.

F. Filters. Provide two-inch thick, 30% efficient filters, complete with dirty filter switch wired to control box.

G. Coil Valving. Provide coil piping package for each coil consisting of ball valve and strainer on supply piping and flow setting valve and two-way electric control valve on return piping.

H. Control Box.

1. Mount control box on outside of unit.

2. Provide with termination for fan motor, manual disconnect, control transformer, terminations for condensate overflow switch, fan status switch, dirty filter switch and interface connections to central DDC system.

PART 3 - EXECUTION

A. Coil connections are detailed on the drawings.

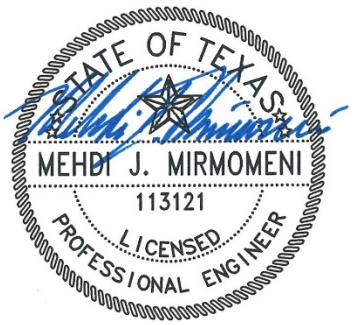
END OF SECTION 23 82 19.01

8000 IH-10 West, Suite 1002
San Antonio, Texas 78230
Phone: 210-525-0220

H2MG Consulting Mechanical • Electrical • Plumbing Engineers

Texas Firm Registration #F-12003

Addendum No. 1



7/3/18

DATE:	July 3, 2018
ADDENDUM NO.:	1
PROJECT NO.:	99060
PROJECT NAME:	Victoria Plaza
PROJECT ENGINEER:	H2MG, LLC 8000 IH-10 West, Suite 1002 San Antonio, TX 78230 Phone: 210-298-3390
TO:	ALL CONTRACT BIDDERS TO WHOM DRAWINGS AND SPECIFICATIONS HAVE BEEN ISSUED

This Addendum forms a part of the Contract Documents for this Project. All items in the drawings and specifications referenced herein shall be supplemented and modified as follows:

REFER TO DRAWINGS:

Item No. 1 Sheet M3.4 Enlarged Basement Plan-Plumbing

a. Keyed note 8 shall read as follows: "Extend condensate drains to existing large floor drain adjacent to water softener. Terminate drains 2" above floor."

Item No. 2 Sheet P1.0 Basement Underfloor Plan - Plumbing

a. Revise routing and size of fire department connection pipe – see attached full size drawings.

Item No. 3 Sheet P1.1 Floor Plan Level 1 – Plumbing

a. Extend fire dept. connection adjacent to fire lane. See attached full size drawings.

Item No. 4 Sheet E0.2 – Site Plan – New Electrical

a. Add to Keyed Note 13 "Connect genset heater to ELA-11, battery charger to ELA-13 and genset controls to ELA-15."

b. Add to Keyed Note 22 "Concrete encase the CPS service from the transformer to the main switchboard MSBH."

Item No. 5 Sheet E2.0 – Basement Power

a. The electrical service from the CPS transformer to the switchboard MSBH shall be concrete encased.

b. The fire pump disconnecting cubicle shall be separated from the switchboard and shall not be a part of the switchboard.

c. Indicate a 60 amp, 3 pole, 250 volt NEMA 1 fused switch next to transformer T-ELA to serve Panel ELA on the first floor.

Item No. 6 Sheet E4.1 – Enlarged Floor Plans

a. In Units A, B, C and D change the homerun from Keyed Note 5 in the bathroom from "10" to be "11." Circuit 10 shall become a "Spare."

b. In Panels A, B, C and D indicate Keyed Note 9 for all 20 amp, 1 pole circuits serving all receptacles, lighting, and the bathroom light/heater. All of these circuits shall comply with NEC Article 210.12 and have arc-fault protection.

Item No. 7 Sheet E4.2 – Enlarged Floor Plan

a. In Units E, F, G, and H change the homerun from Keyed Note 5 in the bathroom from "10" to be "11." Circuit 10 shall become a "Spare."

b. In Panels E, F, G, and H indicate Keyed Note 9 for all 20 amp, 1 pole circuits serving all receptacles, lighting, and the bathroom light/heater. All of these circuits shall comply with NEC Article 210.12 and have arc-fault protection

Item No. 8 Sheet E4.3 – Enlarged Floor Plans

a. In Units I, J, K, and M change the homerun from Keyed Note 5 in the bathroom from "10" to be "11." Circuit 10 shall become a "Spare."

b. In Panels I, J, K, and M indicate Keyed Note 9 for all 20 amp, 1 pole circuits serving all receptacles, lighting, and the bathroom light/heater. All of these circuits shall comply with NEC Article 210.12 and have arc-fault protection.

c. In Unit M on the divider wall between the kitchen and the living room add a duplex receptacle centered on each side of the wall and connected to Circuit M-14.

Item No. 9 Sheet E5.3 – Electrical Details

a. In Detail 2 – Provide concrete encased ducts for the CPS service entrance conduits from the CPS transformer to the Main Switchboard MSBH.

Item No. 10 Sheet E6.1 – Electrical One Line Diagram

a. Change the feeder for the Jockey Pump from Panel EHB to be from Panel EHA.

b. The 1200 AF, 800 AT fire pump disconnecting means shall be in an independent piece of switchgear and shall not be part of the Main Switchboard MSBH.

c. Indicate a 60 amp, 3 pole, NEMA 1 fused switch next to transformer T-ELA to serve Panel ELA.

Item No. 11 Sheet E7.1 – Panelboard Schedules

a. Change the 400 amp main circuit breaker in Panel DP4 to a 600 amp size.

Item No. 12 Sheet 7.3 – Panelboard Schedules

a. Relocate circuits ELB -11, 13, and 15 to become ELA- 11, 13, 15. ELB 11, 13 and 15 shall become “spare”.

8000 IH-10 West, Suite 1002
San Antonio, Texas 78230
Phone: 210-525-0220

H2MG Consulting Mechanical • Electrical • Plumbing Engineers

Texas Firm Registration #F-12003

Addendum No. 6

7/18/18

DATE:	July 18, 2018
ADDENDUM NO.:	6
PROJECT NO.:	99060
PROJECT NAME:	Victoria Plaza
PROJECT ENGINEER:	H2MG, LLC 8000 IH-10 West, Suite 1002 San Antonio, TX 78230 Phone: 210-298-3390
TO:	ALL CONTRACT BIDDERS TO WHOM DRAWINGS AND SPECIFICATIONS HAVE BEEN ISSUED

This Addendum forms a part of the Contract Documents for this Project. All items in the drawings and specifications referenced herein shall be supplemented and modified as follows:

REFER TO SPECIFICATIONS:

Item No. 1 Section 23 09 00.48 – Variable Frequency Motor Controllers

a. Include specification Section 23 09 00.48 – Variable Frequency Motor Controllers. See attached specification.

Item No. 2 Section 23 82 19.01 – Cased Fan Coil Units

a. PART 2 – PRODUCTS, Paragraph E – change *rust inhibited* to **stainless steel.** Remainder of the paragraph remains unchanged.

Item No. 3 Section 26 05 19 - Insulated Conductors

Ralph E. Martin Jr
7/18/18

Add the following to this section:

a. In paragraph 1.2 add:
"D. ANSI/UL – Armored Cable"

b. At the end of paragraph 2.2, add the following:
G. **METAL CLAD (MC) CABLE**

1. Conductors shall be soft-drawn annealed copper with conductivity of not less than 98% at 20°C (68°F), including internal ground wire. Armor shall

be galvanized steel or aluminum.

2. Minimum wire size shall be No. 12 AWG unless otherwise noted on the drawings.

3. Conductors No. 10 AWG and smaller may be stranded or solid and conductors No. 8 AWG and larger shall be stranded.

4. Conductors shall be permanently marked to indicate voltage, insulation type and temperature rating and size in accordance with NEC Article 310.11.

5. Insulation Identification:

   a) Ungrounded Conductors: Furnish factory colored insulation for conductors No. 10 AWG and smaller. Color code No. 8 AWG and larger insulated conductors with a field applied tape.

   b) Grounded and Grounding Conductors: Furnish factory colored insulation for conductors No. 6 and smaller. Color code No. 4 AWG and larger insulated conductors with field applied tape.

6. Insulation shall be as follows:

   a) Type THHN: For dry locations; maximum operating temperature 90°C. Flame-retardant, heat resistant thermoplastic insulation with nylon outer jacket.

7. Use of these cables must be authorized by the Authority Having Jurisdiction (AHJ). Contractor shall confirm the use of the cables with AHJ.

8. The sheath shall not be used as a current carrying conductor.

c. At the end of paragraph 3.1 add the following:
"G. Install metal clad cable in accordance with NEC Article 330. Metal clad cable, type MC with copper sheath may only be used for branch circuits installed in walls without thermal insulation. Use fittings specifically designed for metal clad cable."

d. At the end of paragraph 3.4 add the following:
"F. Metal clad cable may only be used in accordance with NEC 330 as appropriate. **Do not** install exposed nor in thermal insulation. Use fittings designed for this cable type.

Item No. 4 Section 26 05 03 – Raceways

a. At the end of paragraph 3.1B.1 add the following: "EMT shall not be used in crawl spaces."

Item No. 5 Section 26 32 13.13 – Emergency Standby Power Systems Generator Set

a. In paragraph 2.5E. change the "8 hour" to be "16 hour".

b. At the end of paragraph 4.4 add the following:
"D. After final testing, refill fuel tank."

REFER TO DRAWINGS:

Item No. 1 Sheet M1.1 – Floor Plan – Level 1 – HVAC - New

a. Provide thermostats for the apartments where shown – see attached full size Sheet M1.1.

Item No. 2 Sheet M1.2 – Floor Plan – Level 2 thru 9 – HVAC/Piping - New

a. Provide thermostats for the apartments where shown – see attached full size Sheet M1.2

Item No. 3 Sheet E1.1 – Level 1 Lighting

a. In General Note 2 insert "1, 2, or 3" after the 'R'.

Item No. 4 Sheet E2.0 – Basement Power

a. The 6 pumps along the south side do not require a disconnect switch as the VFD has a built-in disconnect and the VFD shall be wall mounted.

b. Concrete encase the service raceways from the CPS transformers to the main switchboard per COSA requirements.

Item No. 5 Sheet E2.1 – Level 1 – Power

a. The circuit P2-10 serving the electric drinking fountain GFCI receptacle shall be changed to be a GFI circuit and a normal receptacle may be provided.

Item No. 6 Sheet E2.2 – Level 2 thru 9 – Power

a. In the unit note on the right side of the plan along column C between columns 17 and 18 add '5' to the Unit B listing.

b. Provide 120 volt power to unit K fire/smoke damper and Janitor fire/smoke damper from Panel DP*62 spare breaker.

Item No. 7 Sheet E2.3 – Roof Level - Power

a. Add Keyed Note 10 next to existing 16 KVA transformer as follows: "10. Provide a 60A, 3 pole fused feeder switch on the secondary side of the transformer to serve Panel ELEP."

Item No. 8 Sheet E3.2 – Level 2 thru 9 – Special Systems

a. In the Floor Plan Title at the bottom of this sheet insert "thru 9" after '2'.

b. In Unit K add a smoke detector in the restroom connected to the smoke detector in the Janitor to control operation of the two fire/smoke dampers at each floor level. Coordinate with HVAC installer.

Item No. 9 Sheet E4.1 – Enlarged Floor Plans A, B, C and D

a. Delete the Audio/Visual and Visual Fire Alarm devices shown in the Bedroom and the Restroom of each unit unless required by the Fire Marshal.

b. Connect the 120 volt smoke detector in the Living Room to spare circuit 15 in each room. In lieu of connection to a 120 volt circuit from the Fire Alarm System Installer may provide an addressable wired connection to the Fire Alarm System.

c. Provide a smoke detector for each bedroom.

Item No. 10 Sheet E4.2 – Enlarged Floor Plans E, F, G and H

a. Delete the Audio/Visual and Visual Fire Alarm devices shown in the Bedroom and the Restroom of each unit unless required by the Fire Marshal. Unit M is an ADA unit.

b. Connect the 120 volt smoke detector in the Living Room to spare circuit 15 in each room. In lieu of connection to a 120 volt circuit from the Fire Alarm System Installer may provide an addressable wired connection to the Fire Alarm System.

c. Provide a smoke detector for each bedroom.

Item No. 11 Sheet E4.3 – Enlarged Floor Plans I, J, K, and M

a. Delete the Audio/Visual and Visual Fire Alarm devices shown in the Bedroom and the Restroom of each unit unless required by the Fire Marshal, except Unit M shall remain as shown.

b. Connect the 120 volt smoke detector in the Living Room to spare circuit 15 in each room. In lieu of connection to a 120 volt circuit from the Fire Alarm System Installer may provide an addressable wired connection to the Fire Alarm System, except Unit M shall be connection to spare circuit 21.

c. Provide a smoke detector in each bedroom.

Item No. 12 Sheet E6.1 – Electrical One Line Diagram

a. In Keyed Note 25 and 27 change "3 pole" to be "4 pole" and provide grounding per NEC.

b. Add Keyed Note 17 as follows: "Coordinate power and control connections between the Fire Pump and the generator as required by COSA."

c. Adjust Keyed Note 6 to be next to Keyed Note 29 on the riser diagram.

d. Add the following to Keyed Note 6 – "See Keyed Note 1 on Sheet E6.3."

Item No. 13 Sheet E7.3 – Panel Board Schedules

a. Panel ELA – delete the 60 amp main breaker since a 60 amp, 3 pole fused switch has been provided in the basement next to the transformer T-ELA.

8000 West IH-10, Suite 1002
San Antonio, Texas 78230
Phone: 210-525-0220

H2MG Consulting Mechanical • Electrical • Plumbing Engineers

Texas Firm Registration #F-12003

Project Memo

DATE: July 3, 2018 4 PAGE(S)

SENT TO: William Poland

WITH: DHR Architects

PROJECT: Victoria Plaza

PROJECT NO.: 99060

RE: COSA Denial Comments dated 07/02/18 by Vivian Lopez on the Mechanical Drawings for Permit 2380232

SENT BY: Mehdi J. Mirmomeni, P.E.

Message:

COSA Comment #1: Sheet M1.0 – Condensing unit location indoors? Provide locations for condensing unit to comply with 304.1-IMC 2015.

H2MG Response: **Condensing unit location shown on M1.0 is within an outdoor area way and complies with 304.1-IMC 2015.**

COSA Comment #2: Sheet M3.2 – Condensate location indicates down to crawl space. Provide condensate waste water line to drawing to sanitary drainage system per IB 163.

H2MG Response: **Condensate piping is routed to floor drain in basement mechanical room. Sheet note 8 will be revised as follows, "Extend condensate drains to existing large floor drain adjacent to water softener. Terminate drains 2" AFF."**

COSA Comment #3: Sheet M3.5-Fire/smoke dampers accessibility. Provide an approved means of access, large enough to permit inspection and maintenance of the damper and it operating parts to comply with 607.4-IMC 2015

H2MG Response: **Intended fire damper access is through 24"x 58" air terminal located in stairwell. Air terminal shall be removed for access to damper.**

8000 West IH-10, Suite 1002
San Antonio, Texas 78230
Phone: 210-525-0220

H2MG Consulting Mechanical • Electrical • Plumbing Engineers

Texas Firm Registration #F-12003

Project Memo

DATE: July 3, 2018 4 PAGE(S)

SENT TO: William Poland

WITH: DHR Architects

PROJECT: Victoria Plaza

PROJECT NO.: 99060

RE: COSA Denial Comments dated 6/27/18 by Valerie Gleason on the Electrical Drawings for Permit 2380232

SENT BY: Ralph E. Martin, Jr., PE

Message:

COSA Comment #1: 2014 NEC 210.12 -Arc fault protection is required for all 15/20 amp,125-volt branch circuits in all areas defined in this code section:

> According to the unit panel schedules on sheets E4.1 through E4.3, arc fault protection is only indicated for receptacle circuits.

H2MG Response: **All 20-amp, 120-volt branch circuits in the dwelling units shall have arc-fault protection per 2014 NEC 210-12. On drawings E4.1, E4.2 and E4.3 Keyed Note 9 shall apply to each 20-amp, 120-volt branch circuit serving receptacles, lighting, and exhaust fans.**

COSA Comment #2: 2014 NEC 210.52(A)(3)-For the purposes of residential receptacle placement, space afforded by fixed room dividers shall be considered usable wall space:

A) The freestanding closets in most of the units will require at least one receptacle.
B) The fixed room divider in unit M will require a receptacle on the living room side.

H2MG Response: **A. The freestanding closets are actually a piece of furniture similar to a large armoire for a wardrobe to hang clothes. It does not extend to the ceiling. Outlets cannot be mounted on the furniture.**

B. A receptacle will be added on each side of the fixed room divider in Unit M and connected to circuit M-14.

COSA Comment #3: 2014 NEC 695.4(B)(3)(3)-The additional disconnecting means for a fire pump permitted by 695.4B(1) shall not be located in the same switchboard overcurrent devices supplying other loads:

While 2014 NEC Section 695.3A(1) permits a tap ahead of the service disconnecting mean in a separate compartment of a switchboard, as is indicated on the plans, the one additional disconnecting means is not permitted to be located in this same switchboard. The resolution is to place the locked rotor disconnect adjacent to the switchboard or eliminate the disconnect and concrete-encase the fire pump service conductors.

H2MG Response: **The service disconnecting means for the fire pump will be in a separate cubicle next to the main switchboard. It will not be a part of the switchboard.**

COSA Comment #4 Chapter 10, Building Related Codes, Section 10-8(b)(1)-Information on plans:

A) Sheet E6.1 shows the jockey pump feeding from panel "EHB" (standby) which is not reflected by the panel schedule on sheet E7.3. However, the jockey pump is shown as a load on panel "EHA" (emergency).

B) The schedule for "ELB" (standby) indicates the loads for the generator, such as the battery charger, genset heater, etc. Notes to the generator on the riser diagram indicate these loads feeding from the emergency panel "EL", as is required. Please relocate these loads to panel "ELA".

C) The main breaker for "DP4" on sheet E7.I is shown as 400 amps. However, all of the other "DP " panels are shown with 600 amp main breakers with similar demand loads.

H2MG Response:

A. The feeder for the jockey pump is incorrectly shown on drawing E6.1 It should be connected to Panel EHA not EHB.

B. The 3-120 volt circuits serving the generator for the controls, battery charger and genset heater will be shifted from Panel ELB to be on Panel ELA.

COSA Comment #5 2014 NEC 240.21C(6)-Maximum length of transformer secondary conductors:

Xfmr "T-ELA" is shown located in the basement electrical room behind the elevators, while panel "ELA" is shown in the first t4oor fire command center. No secondary overcurrent protection is shown located within the required maximum distance of 2.5 ft.

H2MG Response:

A. Panel ELA is almost directly above transformer T-ELA and probably within the 25 foot maximum distance, however a 60 amp 3 pole fused switch shall be added next to the transformer T-ELA to serve Panel ELA.

COSA Comment #6

2014 NEC 230.6-Installation of service conductors sha11 be outside the building or concrete encased; Chapter 10, Building Related Codes, Article *VI,* Section 230.30B(3)-(6) & 230.43(7) & (10)-(12):

A) Will the service entrance conduits run through the crawl space, or underground, below the crawl space? If run through the crawl space**,** concrete encasement will be required.

B) What type of underground conduit will be used? If PVC or other type of plastic/resin conduit, concrete encasement will be required.

H2MG Response:

A. Concrete encasement will be provided for the service entrance conduits in the crawl space.

B. With the concrete encasement, PVC conduits may be used for the service conduits.

COSA Comment #7:

2014 NEC 700.10D(1)-Protection of emergency feeders in high-rise buildings:

Please demonstrate how the emergency feeders to panels "EHA" and "ELA" are protected. It's understood that the room in which "EHA" and its secondary xfmr are located may be sprinklered, but the run to panel "ELA" on the first floor will need to meet one of the other methods of protection listed in this section if its entire path is not sprinklered.

H2MG Response:

The entire building is sprinklered so the feeder for panel ELA will be protected by the fire sprinkler system.

COSA Comment #8

2015 IMC 513**.** I I-The standby power source and transfer switches shall be located in a room separate from the normal power, shall be rated a minimum of I-hour fire resistance, and shall be ventilated directly to and from the exterior:

A) What is the rating of the electrical room in which the standby and emergency panels are located (basement, sheet E2.0)?

B) A note on sheet E2.0 shows a run from panel "EHA" (emergency) to SP-1, which supports the stair pressurization. However, SP-1 & SP-2 feed from panel "EHB" (standby) as is required by the IMC.

H2MG Response:

A. The electrical room for the standby and emergency panels has a 1-hour fire rating and is ventilated directly to and from the exterior.

B. The feeder for stair pressurization is serving fan SPF-1 from Panel EHA. The sump pumps SP-1 and SP-2 are served from panel EHB.

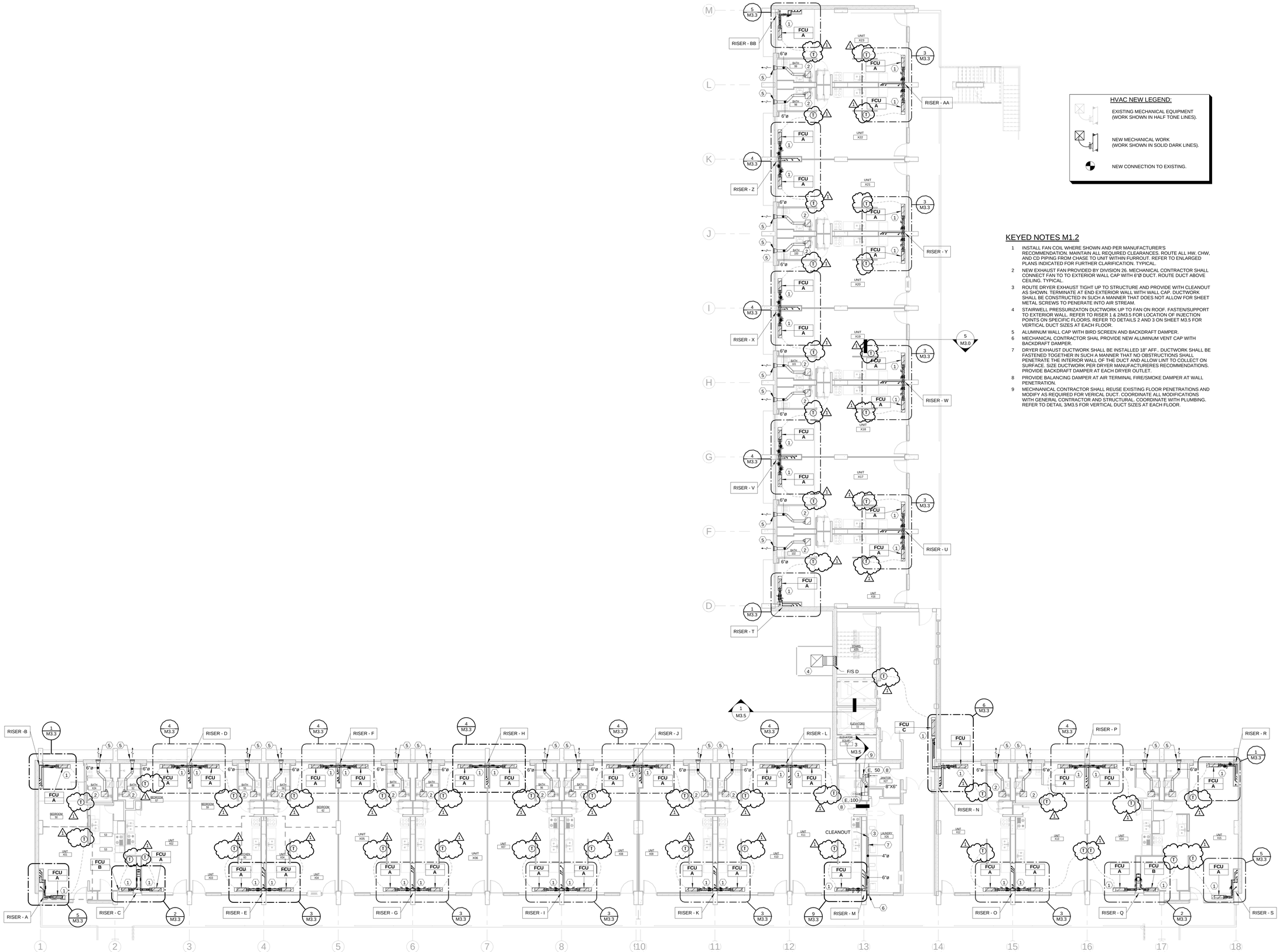
COSA Comment #9:

2015 IECC C405.4.2-Interior lighting power; C405.5.1-Exterior lighting power:

The lighting COMcheck reports could not be located in the plan package. Please provide the interior and exterior allowable and actual wattages.

H2MG Response:

COMcheck reports for lighting were not submitted as Dwelling units within commercial buildings are not required to comply with IECC C405.2 through C405.5. LED lighting fixtures were provided throughout the facility for interior and exterior lighting per Section R404.1.



FLOOR PLAN – LEVELS 2 THRU 9 – HVAC/PIPING – NEW

1 M1.2 1/8" = 1'-0"

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DURAND–HOLLIS RUPE ARCHITECTS, INC.
14603 HUEBNER ROAD
BUILDING 18
SAN ANTONIO, TEXAS 78230
TEL. 210 308–0080
FAX. 210 697–3309
eMAIL OFFICE@DHRARCHITECTS.COM

OWNER:

SAN ANTONIO HOUSING AUTHORITY
818 SOUTH FLORES STREET
SAN ANTONIO, TX 78204
T: 210.477.6262

LOCATION:

SAN ANTONIO HOUSING AUTHORITY
VICTORIA PLAZA MODERNIZATION-PHASE 1
411 BARRERA, SAN ANTONIO, TEXAS 78210

REVISIONS		
ISSUE	DESCRIPTION	DATE
1	ADDENDUM 6	07/18/18

05/25/18

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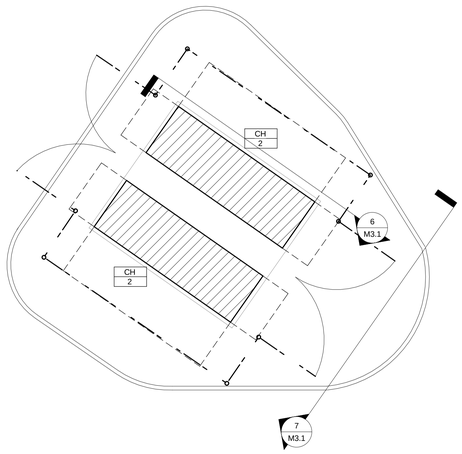
STATE OF TEXAS
MEHDI J. MIRMOMENI
113121
LICENSED
PROFESSIONAL ENGINEER
05/25/18

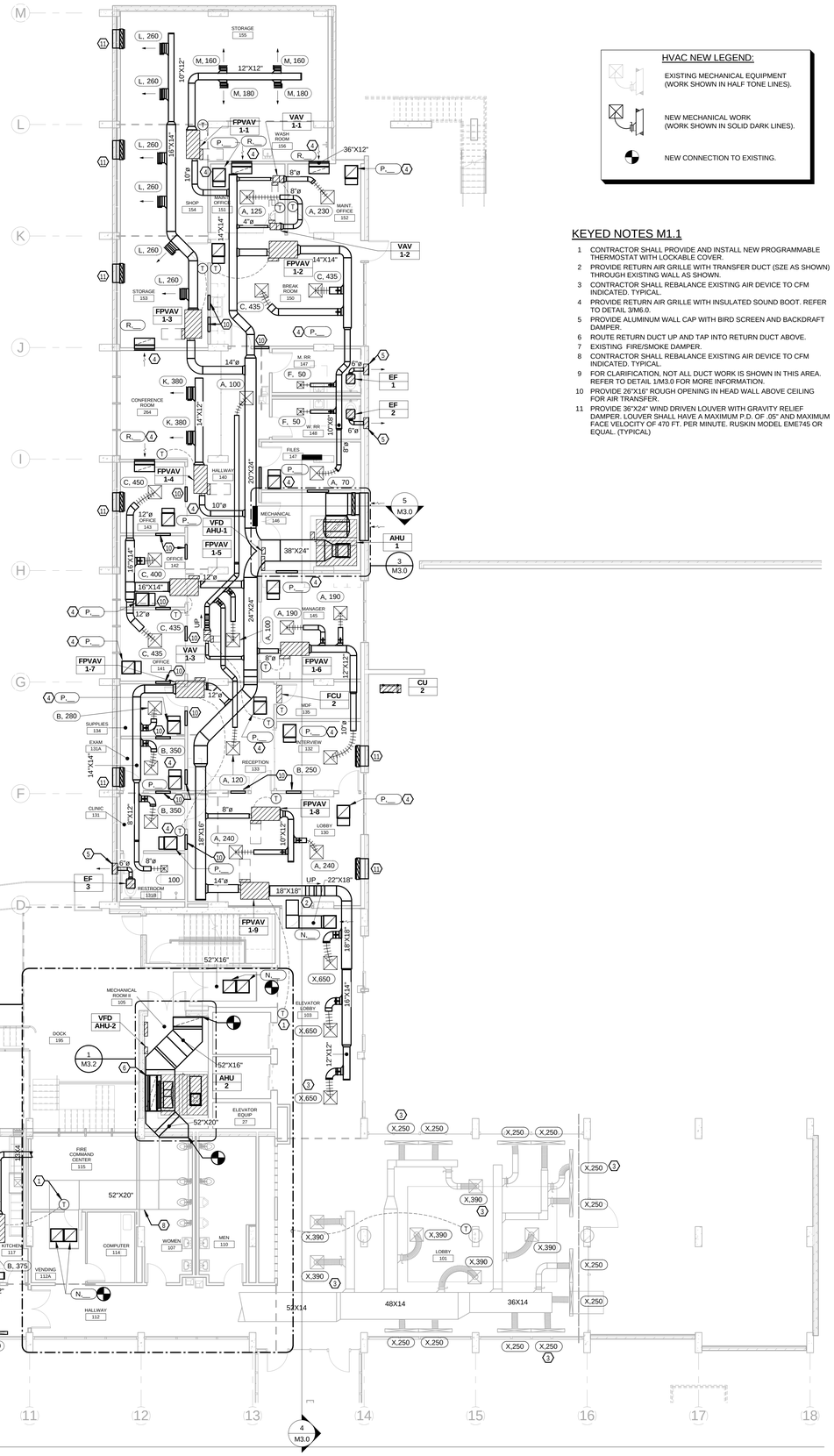
PROJECT ARCHITECT
GABRIEL DURAND–HOLLIS, AIA
TEXAS LICENSE NO. 10–881

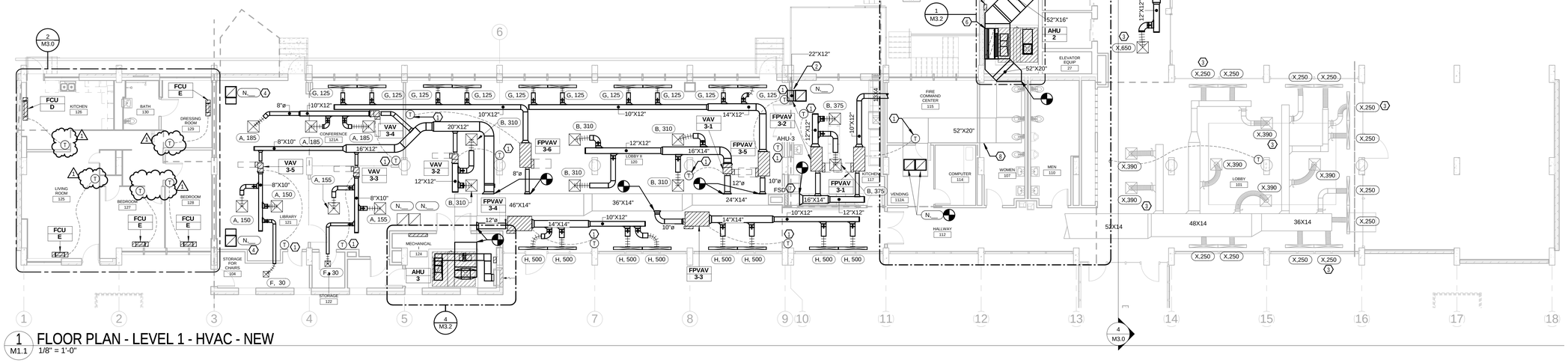
FLOOR PLAN - LEVEL 2 THRU 9 - HVAC/PIPING - NEW

SHEET NUMBER

M1.2







HVAC NEW LEGEND:

- EXISTING MECHANICAL EQUIPMENT (WORK SHOWN IN HALF TONE LINES).
- NEW MECHANICAL WORK (WORK SHOWN IN SOLID DARK LINES).
- NEW CONNECTION TO EXISTING.

KEYED NOTES M1.1

1. CONTRACTOR SHALL PROVIDE AND INSTALL NEW PROGRAMMABLE THERMOSTAT WITH LOCKABLE COVER.
2. PROVIDE RETURN AIR GRILLE WITH TRANSFER DUCT (SZE AS SHOWN) THROUGH EXISTING WALL AS SHOWN.
3. CONTRACTOR SHALL REBALANCE EXISTING AIR DEVICE TO CFM INDICATED. TYPICAL.
4. PROVIDE RETURN AIR GRILLE WITH INSULATED SOUND BOOT. REFER TO DETAIL 3/M6.0.
5. PROVIDE ALUMINUM WALL CAP WITH BIRD SCREEN AND BACKDRAFT DAMPER.
6. ROUTE RETURN DUCT UP AND TAP INTO RETURN DUCT ABOVE.
7. EXISTING FIRE/SMOKE DAMPER.
8. CONTRACTOR SHALL REBALANCE EXISTING AIR DEVICE TO CFM INDICATED. TYPICAL.
9. FOR CLARIFICATION, NOT ALL DUCT WORK IS SHOWN IN THIS AREA. REFER TO DETAIL 1/M3.0 FOR MORE INFORMATION.
10. PROVIDE 26"X16" ROUGH OPENING IN HEAD WALL ABOVE CEILING FOR AIR TRANSFER.
11. PROVIDE 36"X24" WIND DRIVEN LOUVER WITH GRAVITY RELIEF DAMPER. LOUVER SHALL HAVE A MAXIMUM P.D. OF .05" AND MAXIMUM FACE VELOCITY OF 470 FT. PER MINUTE. RUSKIN MODEL EME745 OR EQUAL. (TYPICAL)

1 FLOOR PLAN - LEVEL 1 - HVAC - NEW
M1.1 — 1/8" = 1'-0"

DURAND–HOLLIS RUPE ARCHITECTS, INC.
14603 HUEBNER ROAD
BUILDING 18
SAN ANTONIO, TEXAS 78230
TEL. 210 308–0080
FAX. 210 697–3309
eMAIL OFFICE@DHRARCHITECTS.COM

OWNER:

SAHA SAN ANTONIO HOUSING AUTHORITY
Opportunity Lives Here
SAN ANTONIO HOUSING AUTHORITY
818 SOUTH FLORES STREET
SAN ANTONIO, TX 78204
T: 210.477.6262

LOCATION:

SAN ANTONIO HOUSING AUTHORITY
VICTORIA PLAZA MODERNIZATION-PHASE 1
411 BARRERA, SAN ANTONIO, TEXAS 78210

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MEHDI J. MIRMOMENI
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05/25/18

PROJECT ARCHITECT
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TEXAS LICENSE NO. 10–881

FLOOR PLAN - LEVEL 1 - HVAC

SHEET NUMBER
M1.1

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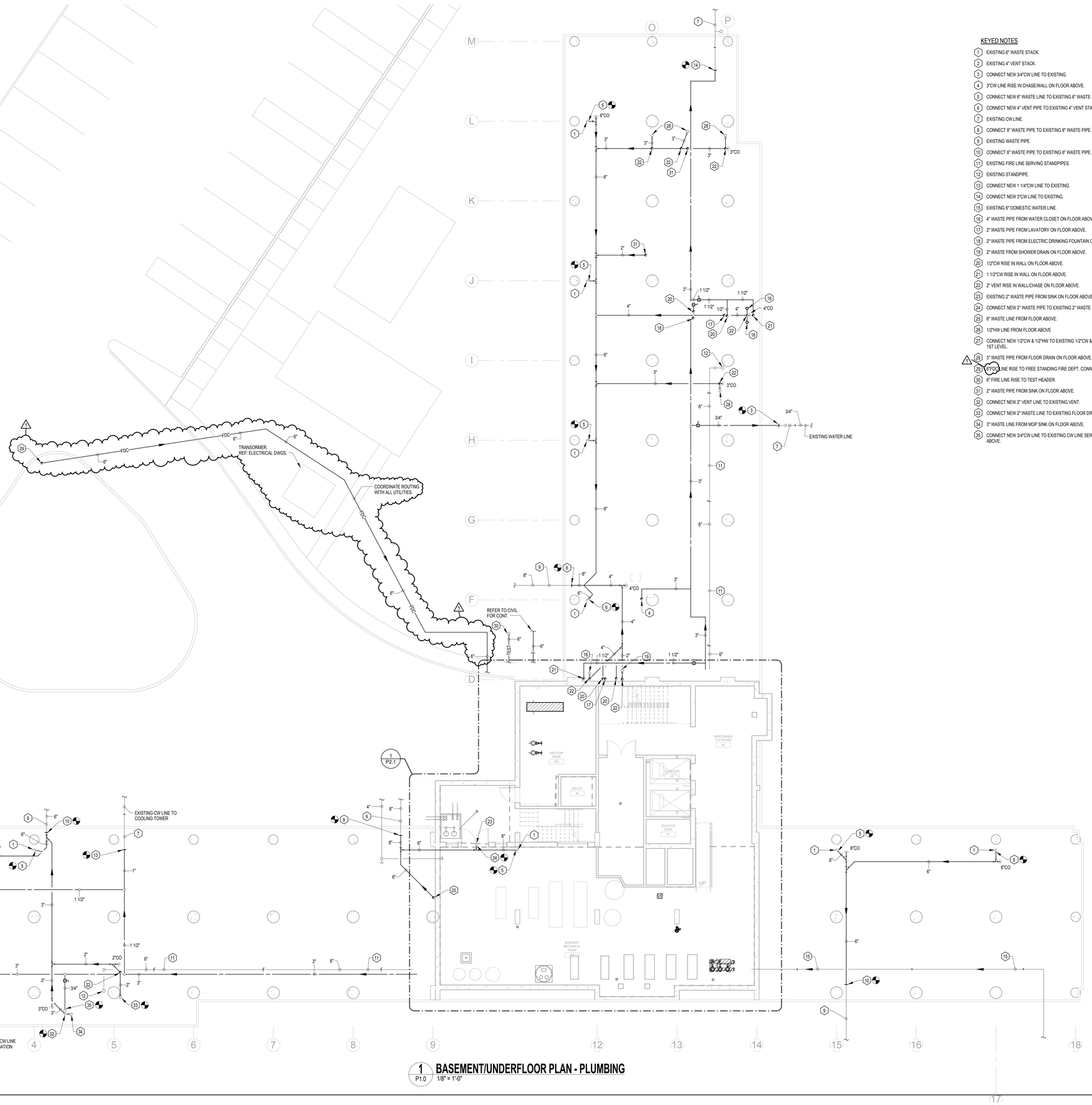

KEYED NOTES

1. EXISTING 6" WASTE STACK.
2. EXISTING 4" VENT STACK.
3. CONNECT NEW 3/4"CW LINE TO EXISTING.
4. 3"CW LINE RISE IN CHASE/WALL ON FLOOR ABOVE.
5. CONNECT NEW 6" WASTE LINE TO EXISTING 6" WASTE STACK.
6. CONNECT NEW 4" VENT PIPE TO EXISTING 4" VENT STACK.
7. EXISTING CW LINE.
8. CONNECT 8" WASTE PIPE TO EXISTING 8" WASTE PIPE.
9. EXISTING WASTE PIPE.
10. CONNECT 6" WASTE PIPE TO EXISTING 6" WASTE PIPE.
11. EXISTING FIRE LINE SERVING STANDPIPES.
12. EXISTING STANDPIPE.
13. CONNECT NEW 1 1/4"CW LINE TO EXISTING.
14. CONNECT NEW 3"CW LINE TO EXISTING.
15. EXISTING 6" DOMESTIC WATER LINE.
16. 4" WASTE PIPE FROM WATER CLOSET ON FLOOR ABOVE.
17. 2" WASTE PIPE FROM LAVATORY ON FLOOR ABOVE.
18. 2" WASTE PIPE FROM ELECTRIC DRINKING FOUNTAIN ON FLOOR ABOVE.
19. 2" WASTE FROM SHOWER DRAIN ON FLOOR ABOVE.
20. 1/2"CW RISE IN WALL ON FLOOR ABOVE.
21. 1 1/2"CW RISE IN WALL ON FLOOR ABOVE.
22. 2" VENT RISE IN WALL/CHASE ON FLOOR ABOVE.
23. EXISTING 2" WASTE PIPE FROM SINK ON FLOOR ABOVE.
24. CONNECT NEW 2" WASTE PIPE TO EXISTING 2" WASTE PIPE.
25. 6" WASTE LINE FROM FLOOR ABOVE.
26. 1/2"HW LINE FROM FLOOR ABOVE
27. CONNECT NEW 1/2"CW & 1/2"HW TO EXISTING 1/2"CW & 1/2"HW RISING TO SINK ON 1ST LEVEL.
28. 3" WASTE PIPE FROM FLOOR DRAIN ON FLOOR ABOVE.
29. 6"FDC LINE RISE TO FREE STANDING FIRE DEPT. CONNECTION.
30. 6" FIRE LINE RISE TO TEST HEADER.
31. 2" WASTE PIPE FROM SINK ON FLOOR ABOVE.
32. CONNECT NEW 2" VENT LINE TO EXISTING VENT.
33. CONNECT NEW 2" WASTE LINE TO EXISTING FLOOR DRAIN ON FLOOR ABOVE.
34. 3" WASTE LINE FROM MOP SINK ON FLOOR ABOVE.
35. CONNECT NEW 3/4"CW LINE TO EXISTING CW LINE SERVING MOP SINK ON FLOOR ABOVE.

1 BASEMENT/UNDERFLOOR PLAN - PLUMBING
P1.0 1/8" = 1'-0"

DHR ARCHITECTS

DURAND–HOLLIS RUPE ARCHITECTS, INC.
14603 HUEBNER ROAD
BUILDING 18
SAN ANTONIO, TEXAS 78230
TEL. 210 308–0080
FAX. 210 697–3309
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818 SOUTH FLORES STREET
SAN ANTONIO, TX 78204
T: 210.477.6262

H2MG
Consulting Mechanical • Electrical • Plumbing Engineers
8000 IH-10 West, Suite 1002
San Antonio, Texas 78230
Office: 210.525.0220
Fax: 210.525.0225
Texas Firm Registration #F-12003

SAN ANTONIO HOUSING AUTHORITY
VICTORIA PLAZA MODERNIZATION
411 BARRERA, SAN ANTONIO, TEXAS 78210

LOCATION:

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05/25/18
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GABRIEL DURAND–HOLLIS, AIA
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BASEMENT/UNDERFLOOR PLAN - PLUMBING

SHEET NUMBER
P1.0

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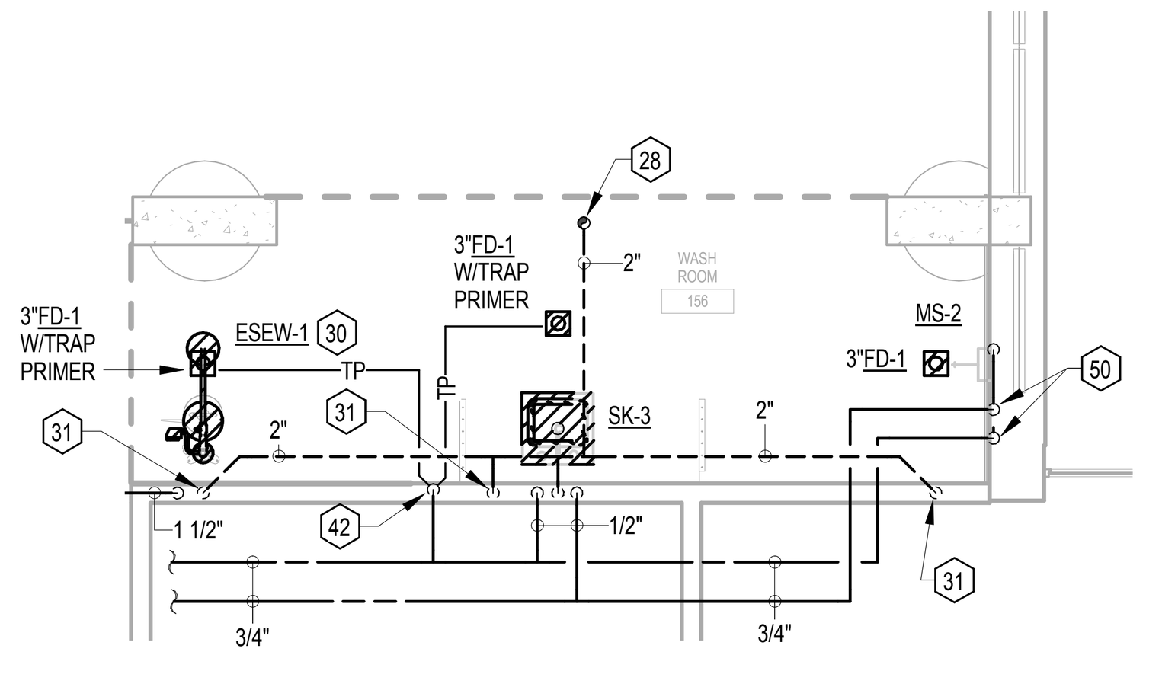
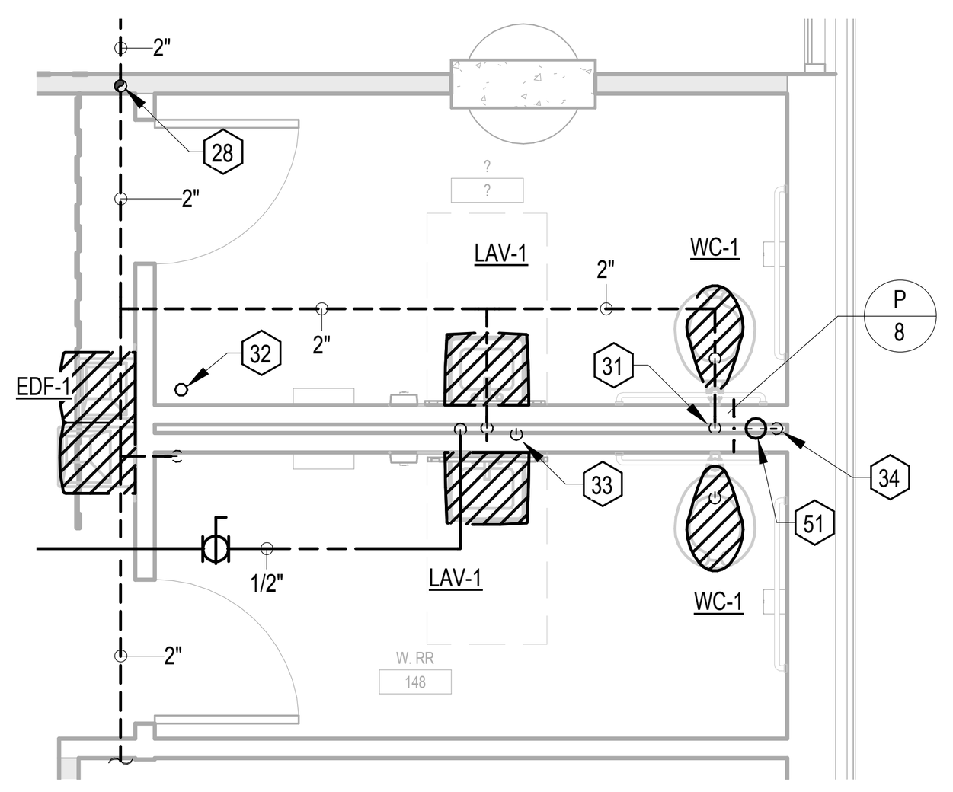
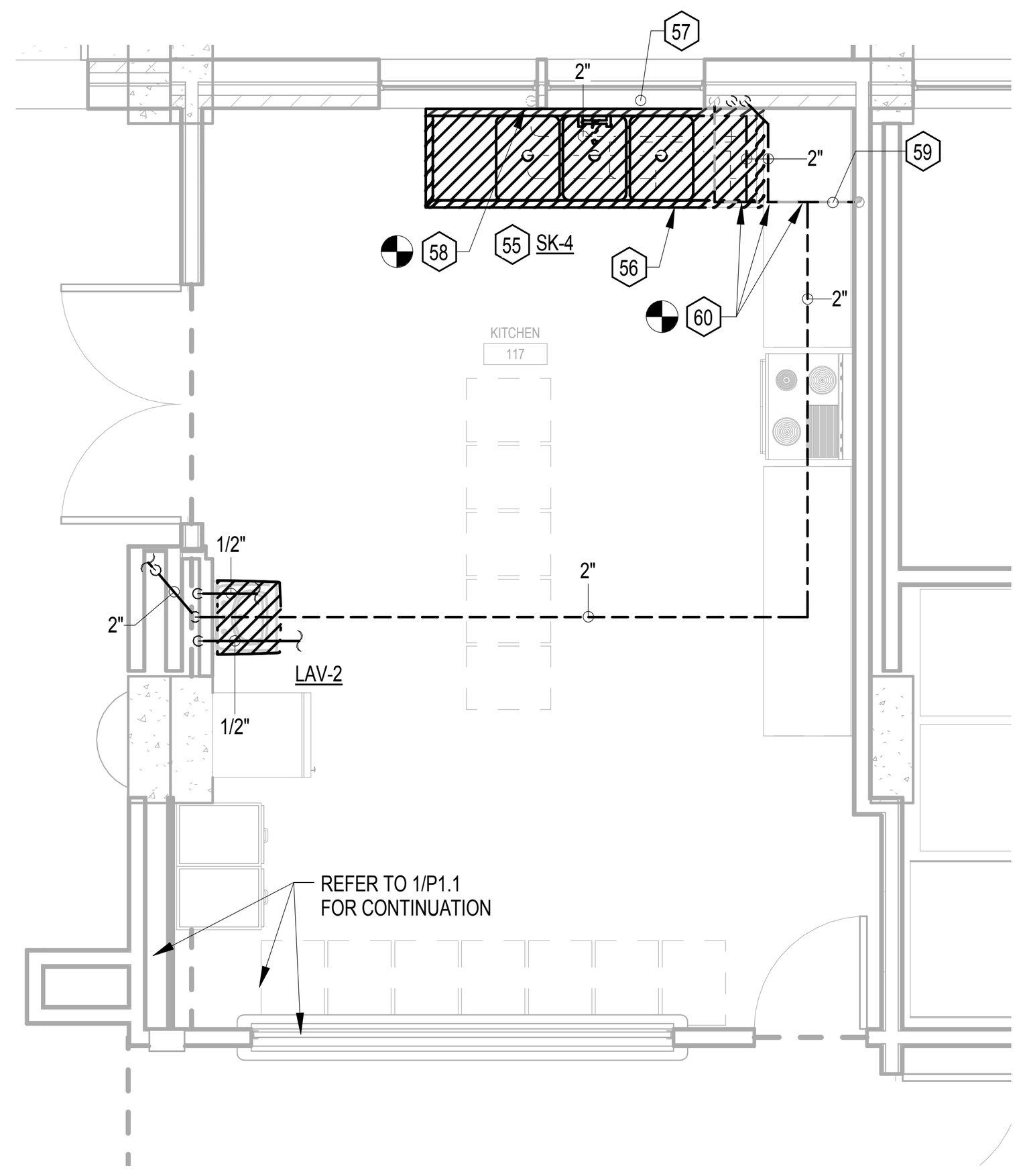


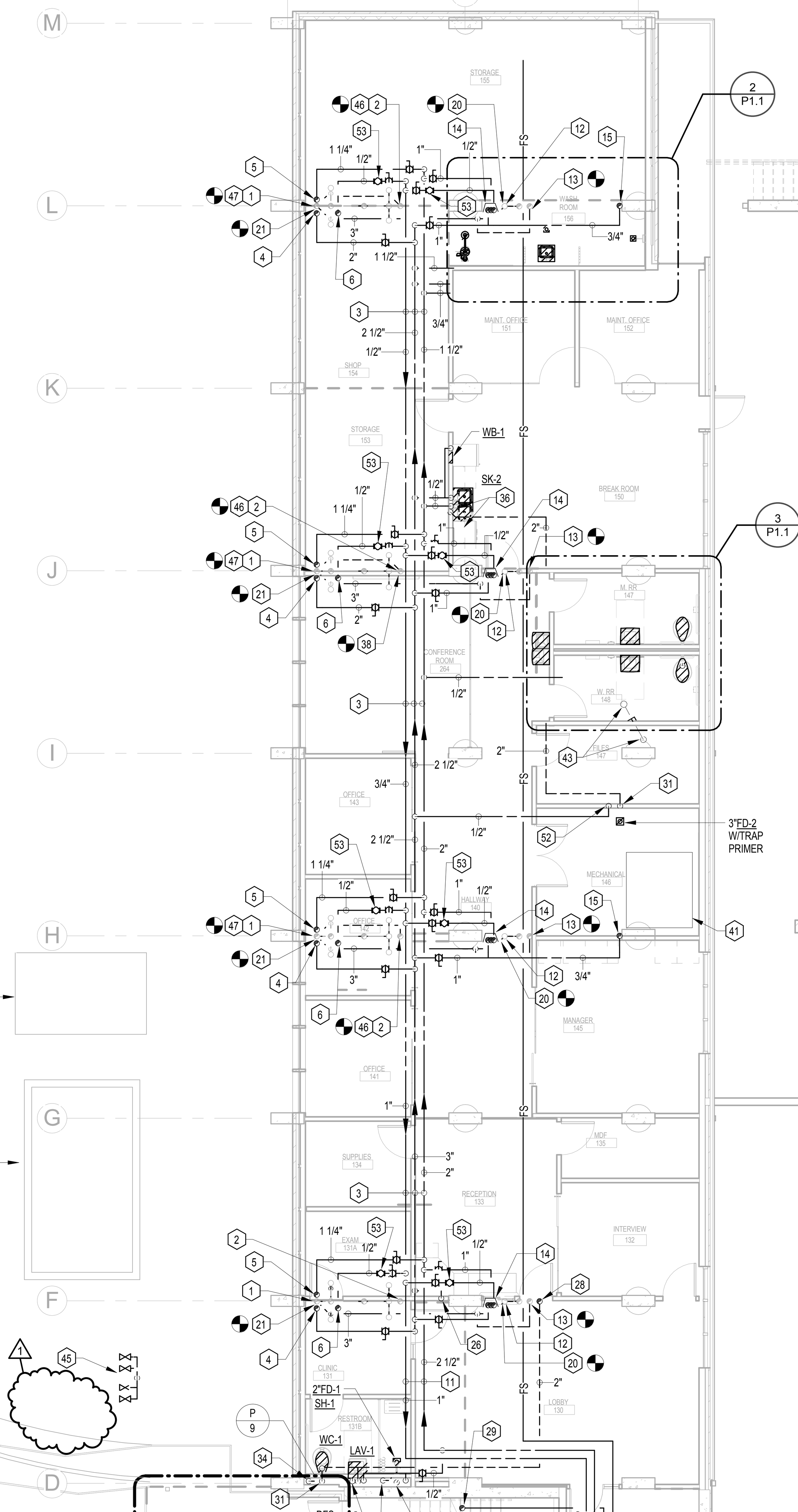
2 ENLARGED FLOOR PLAN - WASH ROOM 189 - PLUMBING
P1.1 1/4" = 1'-0"

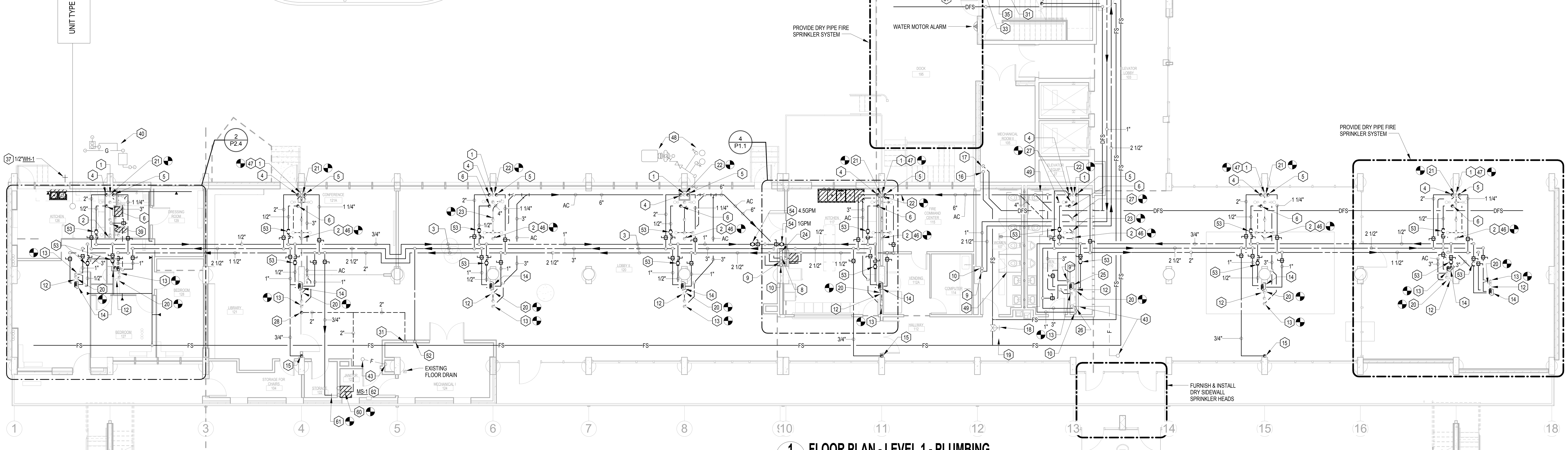


3 ENLARGED FLOOR PLAN - M.RR 192 & W.RR 188 - PLUMBING
P1.1 1/4" = 1'-0"



4 ENLARGED FLOOR PLAN - KITCHEN 166 - PLUMBING
P1.1 1/4" = 1'-0"





1 FLOOR PLAN - LEVEL 1 - PLUMBING
P1.1 1/8" = 1'-0"

KEYED NOTES

1. EXISTING 6" WASTE STACK.
2. EXISTING 4" VENT STACK.
3. NEW CW, HW & HWR PIPING ABOVE CEILING.
4. NEW 2" CW RISER.
5. NEW 1 1/4" HW RISER.
6. NEW 1/2" HWR RISER.
7. NEW WASTE PIPING ABOVE CEILING.
8. NEW 4"CW PIPE FROM BELOW FLOOR RISE TO ABOVE CEILING
9. NEW 2 1/2"HW PIPE RISE FROM BELOW FLOOR TO ABOVE CEILING
10. NEW 1"HOT WATER RETURN PIPING FROM BELOW FLOOR TO ABOVE CEILING.
11. NEW HW & HWR PIPING ABOVE CEILING.
12. EXISTING 3"WASTE STACK.
13. EXISTING 3"VENT STACK. CONNECT NEW 3"VENT TO EXISTING 3"VENT STACK ABOVE CEILING.
14. 1"CW, 1"HW & 1/2"HWR RISERS.
15. 3/4"CW RISER FOR HOSE BIBBS ON FLOOR ABOVE.
16. WET PIPE FIRE SPRINKLER PIPE RISE FROM BELOW. EXTEND TO ABOVE CEILING.
17. DRY PIPE FIRE SPRINKLER PIPE RISE FROM BELOW. EXTEND TO ABOVE CEILING.
18. FLOOR CONTROL VALVE.
19. FLOW SWITCH.
20. CONNECT NEW 3" WASTE TO EXISTING 3" WASTE STACK.
21. CONNECT NEW 3" WASTE PIPE TO EXISTING 6" WASTE STACK.
22. CONNECT NEW 6" WASTE PIPE TO EXISTNG 6" WASTE STACK.
23. CONNECT NEW 4" WASTE PIPE TO EXISTING 4" WASTE PIPE.
24. 6" WASTE DROP IN CHASE TO FLOOR BELOW.
25. 1 1/2"CW, 1 1/2"HW & 1/2"HWR RISERS.
26. 3"CW RISE FROM BELOW FLOOR EXTEND TO ABOVE CEILING.
27. CONNECT NEW 2" WASTE PIPE TO EXISTING 2" WASTE PIPE ABOVE CEILING.
28. 2" VENT RISE IN CHASE ON FLOOR ABOVE. CONNECT TO EXISTING 3" VENT STACK APPROX. 5' ABOVE 2ND FLOOR
29. FIRE SPRINKLER RISER.
30. EMERGENCY SHOWER/EYEWASH. REFER TO DETAIL 3/P3.2.
31. 2" VENT RISE FROM BELOW FLOOR EXTEND TO ABOVE CEILING/OVERHEAD.
32. 1/2"CW RISE FROM BELOW FLOOR EXTEND TO ELECTRIC DRINKING FOUNTAIN CW ROUGH-IN.
33. 1/2"CW RISE FROM BELOW FLOOR EXTEND TO LAVATORY CW ROUGH-IN.
34. 1 1/2"CW RISE FROM BELOW FLOOR EXTEND TO WATER CLOSET CW ROUGH-IN.
35. 1/2"CW RISE FROM BELOW FLOOR EXTEND TO SHOWER VALVE CW ROUGH-IN.
36. EXTEND 1/2"HW LINE WITH BALL VALVE FROM SINK HW ROUGH-IN TO DISHWASHER CONNECTION & EXTEND DISHWASHER DRAIN THROUGH APPROVED AIR GAP FITTING & ROUTE TO DISHWASHER DRAIN CONNECTION ON SINK TAILPIECE.
37. NEW WALL HYDRANT CONNECT TO EXISTING CW LINE IN WALL.
38. CONNECT 2" VENT TO EXISTING VENT STACK.
39. 3/4"HW LINE DROP IN CHASE & EXTEND TO PLUMBING FIXTURES.
40. EXISTING GAS METER SET-UP.
41. AIR HANDLING UNIT. REFER TO HVAC DWGS.
42. 1/2"CW LINE DROP TO TRAP PRIMER VALVE EXTEND DISCHARGE TO BELOW FLOOR & ROUTE TO TRAP PRIMER CONNECTION ON FLOOR DRAIN. REFER TO DETAIL 4/P3.2.
43. EXISTING STANDPIPE.
44. 4-WAY FREE STANDING FIRE DEPT. CONNECTION. REFER TO DETAIL 5/P3.2.
45. TEST HEADER.
46. CONNECT NEW 4" VENT TO EXISTING 4" VENT STACK ABOVE CEILING/OVERHEAD.
47. CONNECT NEW 4" VENT TO EXISTING 6" WASTE STACK ABOVE CEILING/OVERHEAD.
48. EXISTING STORM DRAIN SYSTEM PUMPS.
49. EXISTING PLUMBING FIXTURE TO REMAIN.
50. 3/4"HW & 3/4"CW DROP IN WALL, OFFSET BELOW WINDOW SILL & EXTEND TO SINK FAUCET ROUGH-IN.
51. PDI SIZE "B" SHOCK ARRESTOR WITH ACCESS DOOR.
52. 1/2"CW LINE DROP TO TRAP PRIMER VALVE EXTEND DISCHARGE TO FLOOR DRAIN. REFER TO DETAIL 4/P3.2.
53. CIRCUIT SETTER. BALANCE @ 0.5GPM.
54. CIRCUIT SETTER. BALANCE @ FLOW INDICATED.
55. NEW 3-COMPT. SINK. CONNECT TO MODIFIED HW & CW ROUGH-INS.
56. GREASE TRAP BELOW 3-COMPT. SINK. GREASE TRAP SHALL BE MIFAB MI-G-3, 15GPM, 30 GREASE CAPACITY OR APPROVED EQUIVALENT. EXTEND 2"WASTE FROM GREASE TRAP OUTLET TO MODIFIED WASTE ROUGH-IN.
57. EXISTING VENT PIPE IN WALL BELOW WINDOW SILL.
58. CONNECT 2" WASTE PIPE TO MODIFIED WASTE ROUGH-IN.
59. EXISTING VENT PIPE ABOVE CEILING.
60. CONNECT NEW 2" VENT PIPE TO EXISTING VENT PIPE ABOVE CEILING.
61. CONNECT NEW 3/4"HW LINE TO EXISTING HW LINE ABOVE CEILING.
62. NEW MOP SINK. CONNECT TO MODIFIED HW & CW ROUGH-IN.

DHR ARCHITECTS
DURAND–HOLLIS RUPE ARCHITECTS, INC.
14603 HUEBNER ROAD
BUILDING 18
SAN ANTONIO, TEXAS 78230
TEL. 210 308–0080
FAX. 210 697–3309
eMAIL OFFICE@DHRARCHITECTS.COM

OWNER:
SAHA SAN ANTONIO HOUSING AUTHORITY
Opportunity Lives Here
SAN ANTONIO HOUSING AUTHORITY
818 SOUTH FLORES STREET
SAN ANTONIO, TX 78204
T. 210.477.6262

H2MG
Consulting Mechanical • Electrical • Plumbing Engineers
8000 IH-10 West, Suite 1002
San Antonio, Texas 78230
Office: 210.525.0220
Fax: 210.525.0225
Texas Firm Registration #F-12003

SAN ANTONIO HOUSING AUTHORITY
VICTORIA PLAZA MODERNIZATION
411 BARRERA, SAN ANTONIO, TEXAS 78210

LOCATION:

REVISIONS

ISSUE	DESCRIPTION	DATE
1	Addendum #1	07/03/18

05/25/18

PERMIT SET

STATE OF TEXAS
MEHDI J. MIRMOMENI
113121
LICENSED PROFESSIONAL ENGINEER
05/25/18

PROJECT ARCHITECT
GABRIEL DURAND–HOLLIS, AIA
TEXAS LICENSE NO. 10–881

FLOOR PLAN - LEVEL 1 - PLUMBING

SHEET NUMBER
P1.1