**PART 1 – GENERAL**

**1.01 SUMMARY**

A. Section Includes:

1. This Section provides the basic mechanical requirements that apply to the Work of Division 23.

B. Related Requirements:

1. Division 01: General Requirements.

2. Division 26: Electrical.

**1.02 REGULATORY REQUIREMENTS**

A. Materials, fabrication, equipment, and installation shall comply with industry standards and code requirements. Where manufacturer’s recommendations exceed industry standards, the manufacturer’s recommendation shall establish the minimum standard. As a minimum, standards from the following organizations shall apply:

1. AMCA - Air Movement and Control Association.

2. ANSI - American National Standards Institute.

3. ASME - American Society of Mechanical Engineers.

a. ASME Boiler and Pressure Vessel Code.

b. ASME B31 - Code for Pressure Piping.

4. AHRI - Air-Conditioning, Heating, and Refrigeration Institute.

5. ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers.

6. ASTM - American Society for Testing and Materials.

a. ASTM A53 - Specification for Welded and Seamless Pipe.

7. CSA - Canadian Standards Association.

8. FM Global - Factory Mutual Global

9. IAPMO - International Association of Plumbing and Mechanical Officials.

10. NFPA - National Fire Protection Association.

11. OSHA - Occupational Safety and Health Administration.

12. SMACNA - Sheet Metal and Air Conditioning Contractors’ National Association.

13. UL - Underwriters Laboratories Inc.

14. Intertek (ETL Certification).

B. Materials, fabrication, equipment, and installation shall comply with federal, state, and local codes including, but not limited to, the following:

1. CBC, California Building Code, and CMC, California Mechanical Code.

a. Latest edition as adopted by City of Fontana County of San Bernardino, and the State of California including amendments effective on the Effective Date of the Contract.

2. California Code of Regulations, Title 8, Industrial Relations, Division 1, Chapter 4, Division of Industrial Safety.

3. OSHA - Occupational Safety and Health Administration.

4. CDPH – California Department of Public Health.

5. SCAQMD - South Coast Air Quality Management District.

C. Specifications or Drawings shall not be construed to permit deviation from the requirements of governing codes unless approval has been obtained from legally constituted authorities having jurisdiction, and the Architect. The Contract Documents may contain more stringent requirements than those legally required.

D. Permits and Fees: Refer to the General and Supplementary Conditions.

**1.03 SUBMITTALS**

A. Provide submittals in accordance with Section 01 33 00: Submittal Procedures and with specific requirements of Division 23 sections, as applicable.

B. After Architect’s approval, the above information shall become the basis for inspecting and testing materials and actual installation procedures performed in the Work.

C. Shop Drawings: Submit one additional copy when control diagrams having line voltage connections are indicated. Shop Drawings shall be specifically prepared for the Work of this Project. Drawings prepared in accordance with requirements of Section 01 31 13: Project Coordination and Section
01 33 00 may be provided by the Architect to serve as a background for the Shop Drawings. Shop Drawings shall comply with the requirements of Section 01 31 13 and Section 01 33 00 and shall indicate at a minimum:

1. Complete system layout of equipment, components, ductwork, and piping, indicating service clearances, duct and pipe sizes, fitting types and sizes, top or bottom of duct and pipe elevations, distances of ducts, pipes and equipment from building reference points and hanger / support locations. All the above items shall be coordinated on the shop drawings according to the requirements of Section 01 31 13.

2. Schedule and description of equipment, ductwork, piping, fittings, valves, dampers, and controllers.

**1.04 PROJECT RECORD DOCUMENTS**

A. Comply with provisions of Section 01 77 00: Contract Closeout.

B. Project Record Drawings:

1. Provide a complete set of mechanical and control system drawings in AutoCAD and, if available, BIM, complete with external reference drawings, fonts, blocks and plotter pen color/line thickness settings on CD-ROM. Also submit one set of full-size reproducible plots on vellum and three sets of prints.

2. Before Contract Completion, deliver corrected and completed prints to the OAR. Delivery of project record documents to the OAR does not relinquish responsibility of furnishing required information omitted from project record documents.

C. Operation and Maintenance Manuals:

1. Submit operation and maintenance manuals in required form and content. If no revisions are required, furnish one additional copy. If revisions are required, one copy shall be returned with instructions for changes; perform such changes and return manuals. Manuals shall be bound in accordance with Section 01 77 00. Deliver manuals to the OAR. Submit an electronic copy of the entire manual in PDF file format.
2. Contents of Manual:
3. Title sheet with Project name, including names, addresses and telephone number of CONTRACTOR, installer, and related equipment suppliers.
4. Manufacturer's operating instructions including, but not limited to, the following:
	1. Identification of components and controls.
	2. Pre-start checklist and start-up procedures.
	3. Normal operation settings and checklists.
	4. Pre-shut down checklist and shut down procedures.
	5. Trouble shooting checklist and guidelines.
	6. Recommendations for optimum performance.
	7. Warnings and safety precautions on improper or hazardous operational procedures or conditions
5. Manufacturer's product data and parts and maintenance booklet for each item of equipment furnished under Division 23 that includes the following as a minimum:
6. Manufacturer’s model, identification and serial numbers.
7. Exploded view of assembly drawings identifying each component or part with the relevant part number.
8. Directory of manufacturer’s representatives, service CONTRACTORs and part distributors.
9. Maintenance and trouble-shooting instructions, including schedule for preventive maintenance, periodic inspection and cleaning criteria.

d. Project Record Drawings: Complete set of mechanical and control system drawings in 50 percent reduced print format shall be furnished with the manual. Submit the above record drawings on CD-ROM in AutoCAD and, if available, BIM, complete with external reference drawings, fonts, blocks, and plotter pen color/line thickness settings.

e. Testing, Adjusting, and Balancing reports: Submit as specified in Section 01 45 25.

f. South Coast Air Quality Management District (SCAQMD) permits to install and operate boilers, water heaters and other fuel burning equipment and third-party source test reports as required by SCAQMD to allow start-up and operation of equipment.

g. Los Angeles County industrial waste permits.

h. Valve directories complete with location, function, size, and model of each valve with reference to the project record drawings.

i. Equipment and component identification chart complete with location, function, size, and model of each equipment or component with reference to the project record drawings.

**1.05 COORDINATION**

A. Contract Documents indicate extent and general arrangement of Work under Division 23. CONTRACTOR shall coordinate work in accordance with Section 01 3113 requirements and make adjustments as required to provide maximum headroom, a neat arrangement to keep passageways and openings clear to provide accessibility and provisions for maintenance, and to meet code requirements.

**1.06 DELIVERY, STORAGE, AND HANDLING**

A. Delivery and Storage: Deliver materials to Project site in their original unopened containers with labels intact and legible at time of delivery. Store in strict accordance with manufacturer's recommendations.

B. Do not store plastic pipe or materials in direct sunlight.

**1.07 PRELIMINARY OPERATION**

A. OAR may require any portion of mechanical Work to be operated before Substantial Completion. Such operation shall be in addition to regular tests, demonstrations and instructions required under the Contract Documents, and shall be performed as required.

B. Notify the Project Inspector at least 24 hours in advance of lighting or re-lighting pilots.

**1.08 TRAINING OF OWNER PERSONNEL**

A. Training of Owner’s personnel shall include:

1. A minimum of 8 hours of on-site overview of the overall Mechanical System.

2. Refer to Division 23 sections for specific training on each of the components of the Mechanical System.

3. A minimum of 8 hours of on-site overview identifying location and function of all Control Valves and Actuator assemblies.

4. A minimum of 40 hours of (in classroom) software training for a minimum of 20 OWNER personnel on EMS/BMS if such systems are utilized in the project. Training shall be conducted at control CONTRACTOR training facility with computer setup for each person attending.

B. Contract shall include the cost of training Owner operation and maintenance personnel in operating, adjusting, maintenance, trouble-shooting, and Project site repair of each component, equipment, or system provided under this Contract.

C. Operational and maintenance training shall be conducted on the Project site, unless indicated otherwise.

D. Upon completion of Owner training, a completion certificate indicating the nature of the training and a description of the systems, complete with equipment and component lists shall be issued to each trainee. The certificate should be issued in duplicate with one copy retained by OAR.

E. An attendance sheet with the names and signatures of all participants attending the training shall be submitted to the OAR and kept as part of the project documents.

**1.09 GUARANTEES AND DAMAGE RESPONSIBILITY**

A. Sound of water flowing in piping shall not be transmitted to building structure. Operation of mechanical system shall not produce operational sounds that can be heard outside of rooms enclosing apparatus or equipment.

**PART 2 – PRODUCTS**

**2.01 MATERIALS AND EQUIPMENT**

A. Unless otherwise specified, materials and equipment shall be new, in good and clean condition. Equipment, materials, and components shall be of the make; type and model number noted on Drawings or specified. Pieces of equipment of the same type shall be by the same manufacturer.

B. Whenever an item is listed by a single proprietary name, with or without model number and type, it shall be for purpose of design only, to indicate characteristics and quality desired. Proprietary designation listed on Drawings, or listed first in Specifications, is used as a basis for design to establish a standard for quality and performance and space requirements.

C. HVAC equipment products from different manufacturers are never identical. Equipment approved as being equal is interpreted as being equivalent in capacity, performance and quality. The dimensions, weight, configuration and utility requirements could be quite different from the equipment used as the basis of design. Due to these differences, additional coordination and adjustments by the CONTRACTOR are required. For the equipment to be deemed truly equal, the additional coordination and adjustments by the CONTRACTOR should not incur any additional cost to the Owner and any additional labor to the design team.

D. Equipment and materials indicated or required to be installed outdoors shall be of the type that is designed, manufactured, listed or approved by authorities having jurisdiction for outdoor installation by being resistant to the adverse effects of weather. All the additional protective measures against outdoor weather required by the manufacturers’ installation instructions and prevalent practice shall be provided.

E. For substitution of materials or products, refer to the General Conditions.

**PART 3 – EXECUTION**

* 1. **GENERAL INSTALLATION REQUIREMENTS**
		1. CONTRACTOR shall arrange for a preconstruction meeting with IOR prior to the installation of refrigerant piping to discuss installation and testing requirement.

**3.02 SERVICE INTERRUPTIONS, OFF-SITE, GAS AND WATER**

A. Schedule Work so there shall be no service interruptions of existing systems or systems during normal hours of operation of affected systems and facilities.

B. When service interruptions are mandatory, arrange in advance with the OAR as to time and date of such interruptions.

C. Systems, which are interrupted, shall be returned back into operation in such manner that they will function as originally intended.

**3.03 CUTTING, NOTCHING, AND BACKING**

A. Conform to California Building Code, Title 24, Part 2, for notches and bored holes in wood and for pipes and sleeves embedded in concrete and for cuts in steel, as detailed on structural Drawings.

B. Where pipes or ducts pass through or are located within one inch of any construction element, install a resilient pad, 1/2 inch thick minimum, to prevent contact.

C. Furnish all necessary provisions for recesses, chases, and accesses and provide blocking and backing as necessary for proper reception and installation of mechanical Work.

**3.04 LOCATION OF PIPING AND EQUIPMENT**

1. Location of piping, apparatus and equipment as indicated on Drawings is approximate and shall be altered to avoid obstructions, preserve headroom, and provide free and clear openings and passageways.
2. Trenches parallel to footings shall not be closer than 18 inches to the face of footings and shall not be below a plane having a downward slope of 2 horizontal to one vertical, from a line 9 inches above bottom of footing.
3. Pipe in tunnels shall be installed close to one side of tunnel to provide maximum space for passage. Pipe shall not be installed through crawl hole unless otherwise specified or detailed on Drawings.
4. Place equipment in locations and spaces indicated, disassemble and/or reassemble equipment as required by Project conditions.

**3.05 VALVE AND SPECIALTY APPLICATIONS**

1. Install thermostatic/ electronic expansion valves as close as possible to distributors on evaporators.
2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
4. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.
5. Install moisture/liquid indicators in liquid line near condensing unit.
6. Install filter dryers in liquid line between compressor and thermostatic expansion valve.
7. Consult refrigeration equipment manufacturer to determine the need for a receiver.
8. Install receivers sized to accommodate pump-down charge.
9. See Evaluations for discussion of flexible connectors.
10. Install flexible connectors at condensing unit.

**3.06 PIPING INSTALLATION**

1. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
2. Install refrigerant piping according to ASHRAE 15.
3. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
4. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
5. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
6. Install piping adjacent to machines to allow service and maintenance.
7. Install piping free of sags and bends.
8. Install fittings for changes in direction and branch connections.
9. Select system components with pressure rating equal to or greater than system operating pressure.
10. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
11. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Division 08 Section "Access Panels Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.
12. Install refrigerant piping in protective conduit where installed belowground.
13. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
14. Slope refrigerant piping as follows:
15. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
16. Install horizontal suction lines with a uniform slope downward to compressor.
17. Install traps and double risers to entrain oil in vertical runs.
18. Liquid lines may be installed level.
19. When brazing or soldering nitrogen must be presented and flow in the piping, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
20. Retain first paragraph and subparagraphs below for steel pipe. Review the cost of steel pipe using these procedures versus the cost of copper piping. Also consider limiting the size of the refrigerant system and its piping to avoid the use of steel pipe.
21. Install pipe sleeves at penetrations in exterior walls and floor assemblies.
22. Seal penetrations through fire and smoke barriers according to Division 07 Section "Penetration Firestopping."
23. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
24. Install sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.
25. Seal pipe penetrations through exterior walls according to Division 07 Section "Joint Sealants" for materials and methods.
26. Identify refrigerant piping and valves according to Division 23 Section "HVAC Identification."

**3.07 PIPE JOINT CONSTRUCTION**

* + - * 1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
				2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
				3. Fill pipe and fittings with an inert gas (nitrogen), during brazing or welding, to prevent scale formation.
				4. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."
				5. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.

Use Type Bag, cadmium-free silver alloy for joining copper with bronze or steel.

* + - * 1. Welded Joints: Construct joints according to AWS D10.12/D10.12M.

**3.08 TESTS AND TESTING**

A. Tests shall be as required under the applicable sections of Division 23, including this Section.

B. Tests required by other sections of the Contract Documents include the following:

1. Test and balance of mechanical equipment and systems: Refer to Section 01 45 25: Testing, Adjusting, and Balancing for HVAC.

2. Hydrostatic test of boilers: Refer to Section 01 45 25: Testing, Adjusting, and Balancing.

3. Test of smoke and fire detectors: Refer to Division 26: Electrical.

C. Additional tests may be required in the case of products, materials, and equipment if:

1. Submitted items are altered, changed, or cannot be determined as exactly conforming to the Contract Documents.

2. Performance testing and results may also be required on certain items which are as specified, including fan, and pump performance.

D. Piping Tests:

1. Perform tests required to demonstrate that operation of mechanical systems and their parts are in accordance with Specifications covering each item or system, and furnish materials, instruments and equipment necessary to conduct such tests. Tests shall be performed in presence of the Project Inspector of Record and Owner Authorized Representative. Work shall not be concealed or covered until required results are provided.
2. Pressure gages furnished in testing shall comply with CPC. Air shall be bled from lines requiring hydrostatic or water tests.
3. Systems shall be pressure-tested in accordance with pipe testing schedule below. Pipe test shall indicate no loss in pressure after a minimum duration of 48 hours at test pressures indicated. Where local codes require higher test pressures than specified herein for fire sprinkler systems, local codes shall govern.
4. Fuel gas lines shall be first tested with piping exposed, before backfilling trenches or lathing; second with piping in finished arrangement, backfilled and paved where required, and walls finished.
5. Piping systems could be tested as a unit or in sections, but entire system shall successfully meet requirements specified herein, before final testing by the Project Inspector.
6. Repair of damage to pipes and their appurtenances or to any other structures resulting from or caused by these tests, shall be provided.
7. Refrigerant piping shall be pressure tested by using a calibrated electronic testing equipment.
8. Refrigerant Piping Brazing and Deburring Testing procedures for each building:
9. OWNER will randomly select maximum Two installed split systems serving each building for the inspection of proper brazing and deburring of associated refrigerant piping systems. Maximum Two copper fittings within the piping systems shall be randomly selected by OWNER and cut and removed by CONTRACTOR for inspection.
10. If a sign of oxidation is found on any selected fittings or adjacent piping, then the tested split system piping, and all connected equipment including evaporator and condensing unit with sign of oxidation shall be removed and replaced in entirety by CONTRACTOR at no additional cost to OWNER.
11. If a burr is found on any selected joint, then the entire tested refrigerant piping system shall be removed and replaced by CONTRACTOR at no additional cost to OWNER.
12. CONTRACTOR shall repair all tested systems after OWNER’s inspection and approval at no additional cost to OWNER.
13. Inspector of Record shall be present during the replacement of the defective systems and the repair of the tested systems by CONTRACTOR.
14. If one or more selected split systems fail, then two additional split systems (not including the ones previously tested) shall be selected for further testing. Selection of additional split systems and retesting will be performed until neither oxidation nor bur is found within the tested systems.
15. Pipe Testing Schedule:

|  |  |  |
| --- | --- | --- |
| **System Tested** | **Test Pressure (psig)** | **Test With:** |
| Steam piping, hot water heating system piping and chilled water piping | 150 | Water |
| Vacuum pump or condensate pump discharge and condensate return piping | 150 | Water |
| Refrigeration piping | 600 | Dry nitrogen |

E. Equipment Performance Assurance Tests:

1. Before operating any equipment or systems, a thorough check shall be performed to determine that systems have been flushed and cleaned as required and that equipment has been properly installed, aligned, lubricated, and serviced. Factory instructions shall be checked to verify installations have been completed and recommended lubricants have been installed in bearings, gearboxes, crankcases, and similar equipment. Particular care shall be furnished in lubricating bearings to avoid damage by over-lubrication and blowing out seals. Equipment shall also be checked for damage that may have occurred during shipment, after delivery, or during installation. Damaged equipment, products, and materials shall be replaced or repaired as required.

2. Upon completion of the above, adjust the system settings to within normal operating conditions to prevent the system from being damaged upon start-up.

3. Run-test the equipment after start-up for five consecutive days. Tests shall include operation of heating, ventilating, and air conditioning equipment and systems for a period of not less than two 8-hour periods at 90 percent of the full specified heating and cooling capacities. If equipment passes, install new filters. If equipment fails, it shall be adjusted and retested until system meets all applicable codes.

4. Equipment Start-up Reports: For each equipment or system on which start-up is performed, submit 8 copies of start-up report for review by the Architect.

a. The start-up report shall include the manufacturer's standard start-up form completed and signed by the start-up technician.

5. Provide, maintain, and pay costs for equipment, instruments, and operating personnel as required for specified tests.

6. Provide electric energy and fuel required for tests.

7. Final adjustment to equipment or systems shall meet specified performance requirements.

8. Equipment, systems, or Work deemed defective during testing shall be replaced or corrected as required. Test until satisfactory results are provided.

F. Specific Coordinated Plan for Test and Balance:

1. Provide a narrative of the operational intent that clearly describes the function and sequence of operation of each component, equipment, or system installed. Instruct designated Owner personnel in the operation of the installed systems.

2. Prior to final test and balance, mechanical equipment and systems shall be operated and tested as indicated in Paragraph 3.04.F above to demonstrate satisfactory overall operation of the installed systems.

3. Immediately before starting tests, air filter media shall be cleaned or renewed. Roll-type filters shall be advanced to provide new clean media. Cleanable type media shall be thoroughly cleaned and re-oiled with new, clean oil as recommended by manufacturer if they are of viscous impingement type. Disposable type filters shall be replaced with new filters. Replaceable media shall be replaced with new media.

4. An accurate means of measuring air flow and temperatures shall be furnished to balance air supply, return, and exhaust systems so uniform temperatures occur in every room and design airflow is obtained through registers, diffusers, and grilles.

5. Systems shall be adjusted to provide airflows indicated including maximum fresh air and maximum return air. Dampers shall be checked for proper settings and operation. Air and water inlet and leaving temperatures at coils shall be checked. Complete operational data including airflows, room temperatures, fan speeds, motor currents, plenum, and duct static pressures shall be tabulated.

6. Welding performed as part of this Division may be subject to radiographic inspections at random in accordance with requirements specified in Section 23 0513: Basic HVAC Materials and Methods.

**3.09 NOISE AND VIBRATION REDUCTION**

A. Correct noise or vibration caused by mechanical systems. Provide all necessary adjustments to specified and installed equipment and accessories to reduce noise to the lowest possible level

B. Correct noise or vibration problems caused by failure to install work in accordance with Contract Documents. Include all labor and materials required as a result of such failure. Pay for re-testing of corrected noise or vibration problems by the project acoustical consultant including travel, lodging, test equipment expenses, etc.

**3.10 PROTECTION, CARE AND CLEANING**

A. In addition to storage criteria of the General Conditions, and provisions under Section 01 50 00: Construction Facilities and Temporary Controls, the following shall be provided:

1. Provide for the safety and good condition of materials and equipment until Substantial Completion. Protect materials and equipment from damage.

2. Protect installed Work.

3. Replacements: In case of damage, immediately provide repairs and/or replacements as required.

4. Protect covering for bearings, open connections to tanks, pipe coils, pumps, compressors and similar equipment.

5. Interior of ductwork shall be maintained free of dirt, grit, dust, loose insulation, and other foreign materials.

6. Air handling equipment shall not be operated until building is cleaned and air filters are installed.

7. Fixtures, piping, finished brass or bronze, and equipment shall have grease, adhesive, labels, and foreign materials removed. Chromium, nickel plate, polished bronze or brass Work shall be polished. Glass shall be cleaned inside and out.

8. Before initial start-up and again before Substantial Completion, piping shall be drained and flushed to completely remove grease and foreign matter. Pressure regulating assemblies, traps, strainers, boilers, flush valves, and similar items shall be thoroughly cleaned. Tag system with an information tag listing responsible party and date of element, before initial start-up and again before Substantial Completion. Compressed air, oil, and gas piping shall be blown out with oil-free compressed air or inert gas. Refrigerant piping shall be cleaned as specified.

## **END OF SECTION**