

SECTION 22 15 00
GENERAL SERVICE COMPRESSED-AIR SYSTEMS

SPEC WRITER NOTE:

1. Delete between // // if not applicable to project. Also delete any other item or paragraph not applicable in the Section and renumber the paragraphs.
2. This specification is for general shop air. Refer to Section 22 61 19.74, DENTAL COMPRESSED-AIR EQUIPMENT for dental air or Section 22 63 00, GAS SYSTEMS FOR LABORATORY AND HEALTHCARE FACILITIES for lab or medical air.

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section describes the requirements for NFPA 99 Category 4 compressed air systems for non-medical air piping materials, including compressors, electric motors and starters, receiver, all necessary piping, fittings, valves, gauges, switches and all necessary accessories, connections and equipment. NFPA 99 Category 4 systems are non-medical systems of 689 kPa (100 psig) or less in which failure of equipment would have no impact on patient care.
- B. A complete listing of common acronyms and abbreviations are included in Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

1.2 RELATED WORK

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- D. //Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.//
- E. //Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.//
- F. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- G. Section 22 05 12, GENERAL MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT.
- H. Section 22 05 19, METERS AND GAGES FOR PLUMBING PIPING: Exposed piping and gauges.
- I. //Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.//
- J. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.

1.3 APPLICABLE PUBLICATIONS

SPEC WRITER NOTE: Make material requirements agree with requirements specified in the referenced Applicable Publications. Verify and update the publication list to that which applies to the project, unless the reference applies to all plumbing systems. Publications that apply to all plumbing systems may not be specifically referenced in the body of the specification but shall form a part of this specification.

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only. Where conflicts occur these specifications and the VHA standards will govern.
- B. American Society of Civil Engineers (ASCE):
- 7-2016.....Minimum Design Loads and Associated Criteria or
Buildings and Other Structures
- C. American Society of Mechanical Engineers (ASME):
- A13.1-2015.....Scheme for the Identification of Piping Systems
- B1.20.1-2013.....Pipe Threads, General Purpose, Inch
- B16.3-2016.....Malleable Iron Threaded Fittings: Classes 150
and 300
- B16.39-2019.....Malleable Iron Threaded Pipe Unions: Classes
150, 250, and 300
- B16.5-2017.....Pipe Flanges and Flanged Fittings: NPS 1/2
through NPS 24 Metric/Inch
- B16.9-2018.....Factory-Made Wrought Buttwelding Fittings
- B16.21-2016.....Nonmetallic Flat Gaskets for Pipe Flanges
- B16.22-2018.....Wrought Copper and Copper Alloy Solder-Joint
Pressure Fittings
- B16.24-2016.....Cast Copper Alloy Pipe Flanges, Flanged
Fittings, and Valves: Classes 150, 300, 600,
900, 1500, and 2500
- B18.2.1-2012.....Square, Hex, Heavy Hex, and Askew Head Bolts
and Hex, Heavy Hex, Hex Flange, Lobed Head, and
Lag Screws (Inch Series)
- B40.100-2013.....Pressure Gauges and Gauge Attachments
- ASME Boiler and Pressure Vessel Code -

BPVC Section VIII-1-2019 Rules for Construction of Pressure
Vessels, Division 1

D. American Society for Testing and Materials (ASTM):

- A47/A47M-1999(2018)e1...Standard Specification for Ferritic Malleable
Iron Castings
- A53/A53M-2018.....Standard Specification for Pipe, Steel, Black
and Hot-Dipped, Zinc-Coated, Welded and
Seamless
- A106/A106M-2019a.....Standard Specification for Seamless Carbon
Steel Pipe for High-Temperature Service
- A126-2004 (R2019).....Standard Specification for Gray Iron Castings
for Valves, Flanges, and Pipe Fittings
- A135/A135M-2019.....Standard Specification for Electric-Resistance
Welded Steel Pipe
- A536-1984 (2019)e1.....Standard Specification for Ductile Iron
Castings
- A733-2016.....Standard Specification for Welded and Seamless
Carbon Steel and Austenitic Stainless Steel
Nipples
- B32-2008 (R2014).....Standard Specification for Solder Metal
- B61-2015.....Standard Specification for Steam or Valve
Bronze Castings
- B62-2017.....Standard Specification for Composition Bronze
or Ounce Metal Castings
- B88-2016.....Standard Specification for Seamless Copper
Water Tube
- B584-2014.....Standard Specification for Copper Alloy Sand
Castings for General Applications
- B813-2016.....Standard Specification for Liquid and Paste
Fluxes for Soldering of Copper and Copper Alloy
Tube
- B819-2019.....Standard Specification for Seamless Copper Tube
for Medical Gas Systems

E. American Water Works Association (AWWA):

- C606-2015.....Grooved and Shouldered Joints

F. American Welding Society (AWS):

- A5.8M/A5.8-2019.....Specification for Filler Metals for Brazing and
Braze Welding

- G. International Code Council (ICC):
 IPC-2018.....International Plumbing Code
- H. Manufacturer Standardization of the Valve and Fittings Industry, Inc
 (MSS):
 SP-70-2011.....Gray Iron Gate Valves, Flanged and Threaded
 Ends
 SP-71-2018.....Gray Iron Swing Check Valves, Flanged and
 Threaded Ends
 SP-72-2010a.....Ball Valves with Flanged or Butt-Welding Ends
 for General Service
 SP-80-2019.....Bronze Gate, Globe, Angle, and Check Valves
 SP-110-2010.....Ball Valves Threaded, Socket-Welding, Solder
 Joint, Grooved and Flared Ends
 SP-123-2018.....Non-Ferrous Threaded and Solder-Joint Unions
 for Use with Copper Water Tube
- I. National Electrical Manufacturers Association (NEMA):
 ICS 6-1993(R2016).....Industrial Control and Systems: Enclosures
- J. National Fire Protection Association (NFPA):
 70-2020.....National Electrical Code (NEC)
 99-2018.....Health Care Facilities Code
- K. Underwriters' Laboratories, Inc. (UL):
 213-2019.....ANSI/CAN/UL Standard for Rubber Gasketed
 Fittings for Fire-Protective Services
 508-2018.....Standard for Industrial Control Equipment

1.4 SUBMITTALS

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 22 15 00, GENERAL SERVICE COMPRESSED-AIR SYSTEMS", with applicable paragraph identification.
- C. Manufacturer's Literature and Data Including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
1. Aboveground Piping
 2. Underground Piping
 3. Supporting Elements

4. Valves
5. Pressure Gauges
6. Air Pressure Reducing and Regulating Valves
7. Automatic Drain Valves
8. Filter Capacity and Operating Characteristics
9. Vibration Isolation
10. Quick Couplings
11. Hose Assemblies
12. Air Compressor System:
 - a. Characteristic performance curves
 - b. Efficiency
 - c. Compressor; manufacturer and model
 - d. Compressor operating speed
 - e. Capacity (free air delivered at indicated pressure)
 - f. Type of bearing in compressor
 - g. Type of lubrication
 - h. Capacity of receiver
 - i. Unloader; manufacturer, type, and model
 - j. Type and adjustment of drive
 - k. Electrical motor; manufacturer, frame and model
 - l. Speed of motor
 - m. Current characteristics and HP of motor
 - n. Air muffler filter; manufacture, type, and model
 - o. After cooler; manufacturer, type, and model
- D. Pneumatic compressed air system and hydrostatic drainage piping test reports shall be submitted.
- E. Brazing and welding certificates shall be submitted.
- F. //For seismic restraint design the following shall be submitted:
 1. Dimensioned drawings of equipment identifying center of gravity and location and description of seismic mounting and anchorage systems.//

SPEC WRITER NOTE: Coordinate O&M Manual and commissioning requirements with Section 01 00 00, GENERAL REQUIREMENTS and Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS. O&M Manuals shall be submitted for content review as part of closeout documents.

- G. Complete operating and maintenance manuals including wiring diagrams, technical data sheets, information for ordering replaceable parts, and troubleshooting guide:
 - 1. Include complete list indicating all components of the systems.
 - 2. Include complete diagrams of the internal wiring for each item of equipment.
 - 3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
- H. //Completed System Readiness Checklist provided by the CxA and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.//
- I. //Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.//

1.5 QUALITY ASSURANCE

- A. The Contractor shall obtain the services of a qualified engineer or technician from the compressor manufacturer to review final installation and supervise startup and testing of the compressor. After satisfactory installation of the equipment, the engineer or technician shall provide a signed certification that the equipment is installed in accordance with the manufacturer's recommendations.
- B. Bio-Based Materials: For products designated by the USDA's Bio-Preferred Program, provide products that meet or exceed USDA recommendations for bio-based content, so long as products meet all performance requirements in this specifications section. For more information regarding the product categories covered by the Bio-Preferred Program, visit <https://www.biopREFERRED.gov>.
- C. Refer to Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS for additional sustainable design requirements.

1.6 AS-BUILT DOCUMENTATION

- A. Comply with requirements in Paragraph AS-BUILT DOCUMENTATION of Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

PART 2 - PRODUCTS

SPEC WRITER NOTE: Coordinate and assure that the electrical characteristics specified below are clearly shown on appropriate drawings. Coordinate with Electrical Engineer.

2.1 PIPES, TUBES AND FITTINGS

- A. Pipe for general service compressed air system shall be drawn temper, Type "K" or "L" seamless copper tube, conforming to ASTM B88, //ASTM B819// with wrought copper solder joint fittings conforming to ASME B16.22.
- B. Copper unions shall conform to ASME B16.22 or MSS SP-123.
- C. Cast copper alloy flanges shall be Class 300 conforming to ASME B16.24.
 - 1. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos free, 3.2 mm (1/8 inch) maximum thickness, full-face type.
 - 2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.
- D. Solder filler metal shall consist of lead-free alloys conforming to ASTM B32 with water flushable flux conforming to ASTM B813.
- E. Silver Brazing Filler metals shall be BCuP series, copper phosphorus alloys for general duty brazing conforming to AWS A5.8M/A5.8.
- F. Schedule 40, Steel Pipe: ASTM A53/A53M, Type E or S, Grade B, black or hot-dip zinc coated with ends threaded according to ASME B1.20.1.
 - 1. Steel Nipples: ASTM A733, made of ASTM A53/A53M or ASTM A106/A106M, Schedule 40, galvanized seamless steel pipe. Include ends matching joining method.
 - 2. Malleable-Iron Fittings: ASME B16.3, Class 150 or 300, threaded.
 - 3. Malleable-Iron Unions: ASME B16.39, Class 150 or 300, threaded.
 - 4. Steel Flanges: ASME B16.5, Class 150 or 300, carbon steel, threaded.
 - 5. Wrought-Steel Butt-Welding Fittings: ASME B16.9, Schedule 40.
 - 6. Steel Flanges: ASME B16.5, Class 150 or 300, carbon steel.
 - 7. //Grooved-End Fittings and Couplings:
 - a. Grooved-End Fittings: ASTM A47/A47M, malleable-iron castings or ASTM A536, ductile-iron casting; with grooves according to AWWA C606 and dimensions matching steel pipe.
 - b. Couplings: AWWA C606 or UL 213, for steel-pipe dimensions and rated for 2070 kPa (300 psig) minimum working pressure. Include ferrous housing sections, gasket suitable for compressed air, and bolts and nuts. Provide EDPM gaskets for oil-free compressed air. Provide NBR gaskets if compressed air contains oil or oil vapor.//
- G. //Schedule 5, Steel Pipe: ASTM A135/A135M, carbon steel with plain ends and zinc-plated finish.//

SPEC WRITER NOTE: Retain seal material in paragraph below to match quality of compressed air. Do not retain EPDM seals

if compressed air contains oil or oil vapor.

1. //Pressure-Seal Fittings: Listed and labeled by a qualified testing agency and FMG-approved, carbon-steel, pressure-seal housing with O-ring end seals suitable for compressed-air piping and rated for 2070 kPa (300 psig) minimum working pressure. Provide EDPM seals for oil-free compressed air. Provide NBR seals if compressed air contains oil or oil vapor.//
- H. Transition Couplings for Metal Piping: Metal coupling or other manufactured fitting same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.
- I. Pipe identification shall comply with ASME A13.1. Pipe identification labels shall be located as follows:
 1. At intervals of not more than 6.1 m (20 feet).
 2. At least visible once in or above every room.
 3. On both sides of walls or partitions penetrated by the piping.
 4. At least once in every story height traversed by risers.

2.2 VALVES

- A. Ball:
 1. Ball valves 75 mm or DN80 (NPS 3 inches) and smaller shall be full port, two-piece or three-piece ball valve conforming to MSS SP-110. The ball valve shall have a SWP rating of 1034 kPa (150 psig) and a CWP rating of 4138 kPa (600 psig). The body material shall be Bronze ASTM B584, Alloy C844. The ends shall be soldered.
 2. Ball valves 100 mm or DN100 (NPS 4 inches) and larger shall be flanged, Class 150, full port steel ball valve conforming to MSS SP-72. The body shall be split design. The CWP rating shall be 1964 kPa (285 psig). The seals shall be PTFE or TFE. Ball and stem shall be stainless-steel.
- B. Check:
 1. Check valves smaller than 100 mm or DN100 (NPS 4 inches) shall be Class 125, bronze swing check valves with non-metallic Buna-N disc. The check valve shall meet MSS SP-80 Type 4 standard. The check valve shall have a CWP rating of 1380 kPa (200 psig). The check valve shall have a Y pattern horizontal body design with bronze body material conforming to ASTM B62, solder joints, and PTFE or TFE disc.

2. Check valves 100 mm or DN100 (NPS 4 inches) and larger shall be Class 125, iron swing check valve with lever and weight closure control. The check valve shall meet MSS SP-71 Type I standard. The check valve shall have a CWP rating of 1380 kPa (200 psig). The check valve shall have a clear or full waterway body design with gray iron body material conforming to ASTM A126, bolted bonnet, flanged ends, bronze trim.

2.3 DIELECTRIC FITTINGS

- A. Fittings joining copper alloy and ferrous materials shall be isolated.
- B. Dielectric unions shall be factory-fabricated union assemblies, rated at 1724 kPa (250 psig) minimum working pressure at 82 degrees C (180 degrees F) suitable for compressed air service.
- C. Dielectric flanges shall be factory-fabricated companion flange assemblies, rated at 2070 kPa (300 psig) minimum working pressure at 82 degrees C (180 degrees F) suitable for compressed air service.

2.4 FLEXIBLE PIPE CONNECTORS

- A. Stainless-steel hose flexible connectors shall be corrugated, stainless-steel tubing with stainless-steel wire braid covering and ends welded to inner tubing. The stainless-steel hose connectors shall be rated at 1380 kPa (200 psig) minimum. The end connections for 50 mm or DN50 (NPS 2 inches) and smaller shall be threaded steel pipe nipple. The end connections for 63 mm (NPS 2-1/2 inches) and larger shall be flanged steel nipple.
- B. Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing. The corrugated-bronze tubing shall be rated at //1380 kPa (200 psig)// //1724 kPa (250 psig)// minimum.

2.5 SPECIALTIES

- A. Pressure Gauges: Pressure gauges permanently installed in the system or used for testing purposes shall be listed for compressed air service and shall include a snubber or pulsation dampener and an isolation valve for maintenance access.
 1. For line pressure use adjacent to source equipment: ASME B40.100, pressure gauge, single, size 114 mm (4-1/2 inches), for compressed air, accurate to within two percent, with metal case. Range shall be two times operating pressure. Dial graduations and figures shall be black on a white background, or white on a black background. Gage shall be labeled for appropriate service and marked "USE NO OIL".

2. For all services downstream of main shutoff valve: Manufactured for compressed air use and marked "USE NO OIL", 38 mm (1-1/2 inch) diameter gauge with dial range 1 to 689 kPa (1 to 100 psig) for air service.
- B. Air Pressure Regulating Valves:
1. Air pressure regulating valves under 75 mm or DN80 (NPS 3 inches) shall be pilot or diaphragm operated, bronze body and trim, direct acting, spring loaded manual pressure setting adjustment and rated for 1380 kPa (200 psig) inlet pressure. Delivered pressure shall not vary more than one kPa for each 10 kPa (1.5 psig) variation in inlet pressure.
 2. Air pressure regulators 75 mm or DN80 (NPS 3 inches) and larger shall be pilot operated, bronze body, direct acting, spring loaded manual pressure setting adjustment and rated for 1724 kPa (250 psig) inlet pressure. Delivered pressure shall not vary more than one kPa for each 10 kPa (1.5 psig) variation in inlet pressure.
- C. Safety valves shall be constructed according to the ASME BPVC Section VIII and be National Board Certified, labeled, and factory sealed. The safety valve shall be constructed of bronze body with poppet type safety valve for compressed air service.
- D. The automatic drain valves shall have stainless-steel body and internal parts rated for 1380 kPa (200 psig) minimum working pressure. The automatic drain valve shall be capable of automatic discharge of collected condensate.
- E. The coalescing filter shall be capable of removing water and oil aerosols, efficiency of 99.9 percent retention of particles 0.3 micrometer and smaller, with color change dye to indicate when carbon is saturated and warning light to indicate when selected maximum pressure drop has been exceeded. The coalescing filter shall include mounting brackets for wall mount application.
- F. Air line lubricators shall come with a drip chamber and sight dome for observing oil drop entering air stream. The air line lubricator shall have oil feed adjustment screw and quick release collar for easy bowl removal. The Air line lubricators shall include mounting brackets for wall mount application. Lubricators shall be suitable for 1380 kPa (200 psig) at 71 degrees C (160 degrees F).

2.6 QUICK CONNECT COUPLINGS

- A. The quick connect coupling assemblies shall have a locking mechanism constructed to permit one-handed feature for quick connection and disconnection of compressed air hose and equipment. Furnish complete keyed indexing noninterchangeable coupling to prevent connection to medical compressed-air pressure outlets.
- B. Automatic shutoff quick couplings shall be straight through brass body with O-ring or gasket seal and stainless-steel or nickel plated steel operating parts. The automatic shutoff quick connect coupling shall consist of socket or plug ends with one way valve and with barbed outlet or threaded hose fittings for attaching hose.
- C. Valve less quick couplings shall be straight through brass body with O-ring or gasket seal and stainless-steel or nickel plated steel operating parts. The valve less quick connect coupling shall consist of socket or plug ends and with barbed outlet or threaded hose fittings for attaching hose.

2.7 HOSE ASSEMBLIES

- A. Hose, clamps, couplings, splicers shall be suitable for compressed air service of nominal diameter indicated and rated for 2070 kPa (300 psig) minimum working pressure.
- B. The hose shall be reinforced double wire braid, chloroprene reinforced covered hose.
- C. Hose clamps shall be stainless-steel.
- D. Hose couplings shall be two-piece straight through, threaded brass or stainless-steel O-ring or gasket seal swivel coupling with barbed ends for connecting two sections of hose.
- E. Hose splicers shall be one piece, straight through brass or stainless-steel fitting with barbed ends.

2.8 PERFORMANCE REQUIREMENTS

SPEC WRITER NOTE: Retain paragraph below if Contractor is required to assume responsibility for design.

- A. //Delegated Design: Engage a qualified professional engineer, as defined in Section 01 45 00 QUALITY CONTROL, to design compressed-air equipment mounting.//

SPEC WRITER NOTE: Retain paragraph below for projects requiring seismic design. Delete paragraph if performance requirements are indicated on Drawings. Model building codes and ASCE/SEI 7

establish criteria for buildings subject to earthquake motions. Refer to the VA Seismic Design Manual for additional information. Coordinate requirements with structural engineer.

- B. //Seismic Performance: Compressed-air equipment shall withstand the effects of earthquake motions determined according to //ASCE/SEI 7//
//Insert requirement// as specified in Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.//

SPEC WRITER NOTE: Retain paragraph below to define the term "withstand" as it applies to this Project. Definition varies with type of building and occupancy and is critical to valid certification. Option is used for essential facilities where equipment shall operate immediately after an earthquake.

1. //The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified// and the unit will be fully operational after the seismic event//."//

SPEC WRITER NOTE: Schedule capacities and characteristics of compressors on Drawings.

2.9 AIR COMPRESSOR FOR SHOP AIR SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASME Compliance: Fabricate and label receivers to comply with ASME BPVC Section VIII.

2.10 GENERAL REQUIREMENTS FOR PACKAGED AIR COMPRESSORS AND RECEIVERS

- A. System Design: Factory assembled automatic control system with load control and protection functions, mounted, -wired, -piped, and -tested; electric-motor-driven; air-cooled; continuous-duty air compressors and receivers that deliver air of quality equal to intake air
- B. Control Panels: Shall comply with NEMA ICS 6, Type 12 and UL 508 labeled.
1. Enclosure: NEMA ICS 6, Type 12 control panel unless otherwise indicated.

2. Motor Controllers: Full-voltage, combination magnetic type with undervoltage protective feature and motor-circuit-protector-type disconnecting means and short-circuit protective device.
3. Control Voltage: 120-V ac or less, using integrated control power transformer.
4. Motor Overload Protection: Overload relay in each phase.
5. Starting Devices: Hands-off-automatic selector switch in cover of control panel, plus pilot device for automatic control.

SPEC WRITER NOTE: Retain paragraph below if project has duplex and multiplex air compressors.

6. Automatic control switches to //alternate lead-lag compressors for duplex// //sequence lead-lag compressors for multiplex// compressors.
 7. Instrumentation: Include discharge-air pressure gauge, air-filter maintenance indicator, hour meter, compressor discharge-air and coolant temperature gauges, and control transformer.
 8. Alarm Signal Device: For connection to alarm system to indicate when backup air compressor is operating.
- C. Air Receiver: Vertical air receiver, Steel tank constructed according to ASME BPVC Section VIII, Division 1.
1. Rated for minimum 1034 kPa (150 psig) design pressure and bearing appropriate code symbols. Including a sight gauge glass as well as a timed automatic solenoid drain valve.
 2. Interior Finish: Corrosion-resistant coating.
 3. Accessories: Include safety valve, pressure gauge, drain, pressure-reducing valve and three valve bypass on supply.

SPEC WRITER NOTE: Retain paragraph below for projects in seismic areas.

- D. //Mounting Frame: Fabricate mounting and attachment to pressure vessel with reinforcement strong enough to resist packaged equipment movement during a seismic event when base is anchored to building structure.//

2.11 OIL-FREE, ROTARY-SCREW AIR COMPRESSORS

- A. Compressor(s): Oil-free, rotary-screw type with nonlubricated helical screws and lubricated gear box, and of construction that prohibits oil from entering compression chamber.
1. Coupling: Nonlubricated, flexible type.

2. Cooling/Lubrication System: Unit-mounted, air-cooled exchanger package pre-piped to unit; with air pressure circulation system with coolant stop valve, full-flow coolant filter, and thermal bypass valve.
3. Air Filter: Dry type, with maintenance indicator and cleanable, replaceable filter element.
4. Air/Coolant Receiver and Separation System: 1034 kPa (150 psig) rated steel tank with ASME safety valve, coolant-level gauge, multistage air-coolant separator element, minimum pressure valve, blowdown valve, discharge check valve, coolant stop valve, full-flow coolant filter, and thermal bypass valve.
5. Capacity Control: Capacity modulation between zero and 100 percent air delivery, with operating pressures between 345 kPa and 689 kPa (50 psig and 100 psig). Include necessary control to hold constant pressure. When air demand is zero, unload compressor by using pressure switch and blowdown valve.

2.12 OIL-FREE, RECIPROCATING AIR COMPRESSORS

- A. Compressor(s): Oil-free, reciprocating-piston type with nonlubricated compression chamber, lubricated crankcase, and of construction that prohibits oil from entering compression chamber.
 1. Submerged gear-type oil pump.
 2. Oil filter.
 3. Combined high discharge-air temperature and low lubrication-oil pressure switch.
 4. Belt guard totally enclosing pulleys and belts.

2.13 OILLESS, RECIPROCATING AIR COMPRESSORS

- A. Compressor(s): Oilless (nonlubricated), reciprocating-piston type, with sealed oil-free bearings, that deliver air of quality equal to intake air.
 1. High discharge-air temperature switch.
 2. Belt guard totally enclosing pulleys and belts.

2.14 LUBRICATED, RECIPROCATING AIR COMPRESSORS

- A. Compressor(s): Lubricated, reciprocating-piston type with lubricated compression chamber and crankcase.
 1. Submerged gear-type oil pump.
 2. Oil filter.
 3. Combined high discharge-air temperature and low lubrication-oil pressure switch.

4. Belt guard totally enclosing pulleys and belts.

2.15 OIL-FLOODED, ROTARY-SCREW AIR COMPRESSORS

- A. Compressor(s): Oil-flooded, rotary-screw type with lubricated helical screws and lubricated gear box.
 1. Coupling: Nonlubricated, flexible type.
 2. Cooling/Lubrication System: Unit-mounted, air-cooled exchanger package pre-piped to unit; with air pressure circulation system with coolant stop valve, full-flow coolant filter, and thermal bypass valve.
 3. Air Filter: Dry type, with maintenance indicator and cleanable, replaceable filter element.
 4. Air/Coolant Receiver and Separation System: 1034 kPa (150 psig) rated steel tank with ASME safety valve, coolant-level gauge, multistage air-coolant separator element, minimum pressure valve, blowdown valve, discharge check valve, coolant stop valve, full-flow coolant filter, and thermal bypass valve.
 5. Capacity Control: Capacity modulation between zero and 100 percent air delivery, with operating pressures between 345 kPa and 689 kPa (50 psig and 100 psig). Include necessary control to hold constant pressure. When air demand is zero, unload compressor by using pressure switch and blowdown valve.

2.16 OIL-FREE, ROTARY, SLIDING-VANE AIR COMPRESSORS

- A. Compressor(s): Oil-free, nonpulsating, rotary, sliding-vane type with nonlubricated sliding vanes.
 1. Cleanable inlet screens.
 2. Outlet silencers on discharge connections.

2.17 OIL-SEALED, ROTARY, SLIDING-VANE AIR COMPRESSORS

- A. Compressor(s): Nonpulsating, rotary, sliding-vane type with oil-sealed sliding vanes.
 1. Cleanable inlet screens.
 2. Outlet silencers and oil-mist separators on discharge connections.

SPEC WRITER NOTE: Schedule capacities and characteristics of pressure regulators on Drawings.

2.18 PRESSURE REGULATORS

- A. For 689 kPa (100 psig) regulator, provide duplex in parallel, valve for maintenance shut-down without service interruption. For additional

pressures, locate regulators remote from compressor near point of use, and provide with isolation valves and valve bypass.

1. For systems 5 L/s (10 SCFM) and below: Brass or bronze body and trim, reduced pressure range 170 to 850 kPa (25 to 123 psig) adjustable, spring type, diaphragm operated, relieving. Delivered pressure shall vary not more than 1.0 kPa (0.15 psig) for each 10 kPa (1.5 psig) variation in inlet pressure.

2.19 INLET-AIR FILTERS

SPEC WRITER NOTE: Retain one of two "Description" paragraphs.

- A. //Description: Combination inlet-air filter-silencer, suitable for remote installation, for each air compressor.

SPEC WRITER NOTE: Revise paragraph below if filter is in-line type and installed in an interior space. Install gooseneck with screen on exterior air inlet.

1. Construction: Weatherproof housing for replaceable, dry-type filter element, with silencer tubes or other method of sound reduction.
2. Capacity: Match capacity of air compressor, with filter having collection efficiency of 99 percent retention of particles larger than 10 micrometers.//

- B. //Description: Combination inlet-air filter-silencer, suitable for remote installation, for multiple air compressors.

SPEC WRITER NOTE: Revise paragraph below if filter is in-line type and installed in an interior space. Install gooseneck with screen on exterior air inlet.

1. Construction: Weatherproof housing for replaceable, dry-type filter element, with silencer tubes or other method of sound reduction.
2. Capacity: Match total capacity of connected air compressors, with filter having collection efficiency of 99 percent retention of particles larger than 10 micrometers.//

2.20 REFRIGERANT COMPRESSED-AIR DRYERS

- A. Description: Noncycling, air-cooled, electric-motor-driven unit with steel enclosure and capability to deliver 2 degrees C (35 degrees F), 689 kPa (100 psig) air at dew point. Include automatic ejection of condensate from airstream, step-down transformers, disconnect switches, inlet and outlet pressure gauges, thermometers, automatic controls, and filters.

SPEC WRITER NOTE: Schedule capacities and characteristics of aftercoolers on Drawings.

2.21 AIR-COOLED, COMPRESSED-AIR AFTERCOOLERS

- A. Description: Electric-motor-driven, fan-operation, finned-tube unit; rated at //1724 kPa (250 psig)// // kPa () psig// and leak tested at 2413 kPa (350 psig) minimum air pressure; in capacities indicated. Size units to cool compressed air in compressor-rated capacities to //6 degrees C (10 degrees F)// // degrees C (degrees F)// above summertime maximum ambient temperature. Include moisture separator and automatic drain.

2.22 WATER-COOLED, COMPRESSED-AIR AFTERCOOLERS

- A. Description: Shell-and-tube unit, rated at //1724 kPa (250 psig)// // kPa () psig// and leak tested at 2413 kPa (350 psig) minimum air pressure, in capacities indicated. Include moisture separator and automatic drain.

SPEC WRITER NOTE: Schedule capacities and characteristics of air dryers on Drawings.

2.23 DESICCANT COMPRESSED-AIR DRYERS

- A. Description: Twin-tower unit with purge system, mufflers, and capability to deliver //minus 12 degrees C (plus 10 degrees F), 689 kPa (100 psig)// //Insert values// air at dew point. Include dew point controlled purge, step-down transformers, disconnect switches, inlet and outlet pressure gauges, thermometers, automatic controls, and filters.

2.24 MOTORS

SPEC WRITER NOTE: Default motor characteristics are specified in Section 22 05 12, GENERAL MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT.

- A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 22 05 12, GENERAL MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT.

SPEC WRITER NOTE: Delete paragraph below if included in schedule on Drawings.

1. //Enclosure: //Open, drip-proof// //Totally enclosed, fan cooled//
//Totally enclosed, air over// //Open, externally ventilated//

//Totally enclosed, nonventilated// //Severe duty// //Explosion proof// //Dust-ignition-proof machine//.//

2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load does not require motor to operate in service factor range above 1.0.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. If an installation is unsatisfactory to the COR, the contractor shall correct the installation at no additional cost or time to the Government.
- B. Piping shall be installed concealed from view and protected from physical contact unless indicated to be exposed. Piping shall be installed exposed in mechanical rooms and service areas.
- C. All pipe shall be installed at right angles or parallel to building walls. Diagonal runs are prohibited unless indicated.
- D. Piping shall be installed above accessible ceilings, allowing for sufficient space for ceiling panel removal and to coordinate with other services occupying that that space.
- E. Piping installed adjacent to equipment shall be located to allow for the required service clearances.
- F. Air and drain piping shall be installed with a 1 percent slope downward in direction of flow.
- G. Nipples, flanges, unions, transitions, and special fittings, and valves shall be installed with pressure ratings same as or higher than system pressure rating.
- H. Cast copper alloy companion flange with gasket and //brazed// //soldered// joints shall be used to connect equipment and specialties with flanged connections.
- I. Flanged joints may be used instead of specified joint for any piping or tubing system.
- J. Only eccentric reducers shall be installed where compressed air piping is reduced in direction of flow, with bottoms of both pipes and reducers fitting flush.
- K. Branch connections shall be installed from the top of the main compressed air line. Drain legs and drain trap shall be installed at the end of each main and branch and at all low points in the system.
- L. Thermometers and pressure gauges shall be installed on discharge piping from each air compressor and on each receiver.

- M. Valves shall be installed to permit servicing to all equipment.
- N. Pipes shall be installed free of all sags and bends.
- O. //Seismic restraint shall be installed for all piping and equipment as required for location.//
- P. Piping shall be cut square and accurately with a tube cutter (sawing is prohibited) to measurements determined at place of installation and worked into place without springing or forcing the pipe. Tube shall bottom in each solder socket so there are no gaps between tube and fitting where solder can enter the inside of line. The tube shall be reamed to remove burrs, being careful not to expand tube and that no chips of copper remain in the line. Care shall be exercised in handling equipment and tools used in cutting or reaming of pipe to prevent oil or grease being introduced into piping.
- Q. Particular care shall be exercised, when flux is applied to avoid leaving any excess inside the completed joints. Thoroughly wash the outside of each joint with clean hot water after assembly to remove oxide coating.
- R. Hanger spacing shall be based upon NFPA 99.
- S. The Filtered Muffler shall be mounted to the air compressor outdoor intake line without the use of foundations or support frames. Silencer tubes shall be located between the filter and the housing.
- T. Rigidly support valves and other equipment to prevent strain on tube or joints.
- U. Compressor assembly shall have an equipment identification nameplate and data in accordance with 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- V. Suitably brace piping against sway and vibration. Bracing shall consist of brackets, anchor chairs, rods, and structural steel for vibration isolation.

3.2 PRELIMINARY STAGE TESTS

- A. Preliminary tests shall be performed by the contractor prior to testing witnessed by the COR. Tests shall be pneumatic and shall use dry, oil-free compressed air, carbon dioxide or nitrogen in metallic systems.
- B. Testing of any system for any purpose shall include preliminary testing by swabbing joints under test with standard soap solution and observing for bubbles at internal pressures not in excess of 34 kPa (5 psig).
- C. When testing reveals system leakage, isolate and repair the leaks, replace defective materials where necessary, and retest the system

until there is no loss of pressure. Remake leaking gaskets with new gaskets and new flange bolting, and discard used bolting and gaskets.

- D. Drainage piping shall be hydrostatically tested to a pressure of 34 kPa (5 psig) to ensure the piping does not leak. Repair all observed leaks and retest until all leaks have been corrected.

3.3 STARTUP AND TESTING

- A. Perform tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part. Tests shall be pneumatic and shall use dry, oil-free compressed air, carbon dioxide or nitrogen in metallic systems.
- B. The tests shall include initial piping purge test, initial pneumatic test for positive-pressure gas systems, initial cross-connection test, and initial standing positive-pressure gas piping tests, system capacity, control function, and alarm functions.
- C. Pneumatic tests shall be performed utilizing a test pressure of 345 kPa (50 psig) higher than the MAWP, minimum of 1034 kPa (150 psig). Test pressure shall be maintained for a minimum period of four hours to ensure the temperature in the piping system stabilizes, then the pressure is refreshed and held for two hours with no loss of pressure. Pneumatic testing performance shall be in accordance with industry safety standards with the pressure gradually increased in increments of 25 percent of the MAWP until the required test pressure is reached. At each interval, the system pressure shall be held long enough for piping strains to stabilize. If leaks are observed, the leaks shall be identified, the system de-pressurized and repairs made before proceeding.
- D. Other than standard piping flanges, plugs, caps and valves, only use commercially manufactured expandable elastomer plugs for sealing off piping for test purposes. Published safe test pressure rating of any plug used shall be not less than three times the actual test pressure being applied. During pneumatic testing evacuate personnel from areas where plugs are used.
- E. Remove components that could be damaged by test pressure from piping systems to be tested.

- F. Perform valve-operating tests and drainage tests to ensure valves do not leak when operating under pressure and are correctly labeled.
- G. Check piping system components, such as valves, for proper operation under system test pressure.
- H. No test media shall be added to a system during a test for a period specified or determined by the COR.
- I. Duration of a test will be determined by the COR and will be for a minimum of //15// // // minutes with a maximum of //24// // // hours. Test may be terminated by direction of the COR at any point after it has been determined that the pressure leak test has been satisfied.
- J. Prepare and maintain test records of all piping systems tests. Records shall show Governmental and Contractor test personnel responsibilities, dates, test gauge identification numbers, ambient temperatures, pressure ranges, rates of pressure drop, and leakage rates.
- K. System verification and final testing shall be conducted comprising of a system verifier standing pressure test, verifier cross-connection test, verifier piping purge test, verifier final tie-in test, verifier operational pressure test, verifier piping particulate test, verifier piping purity test, labeling, and source equipment verification test.
- L. When any defects are detected, correct defects and repeat test at no additional cost or time to the Government. When testing reveals system leakage, isolate and repair the leaks, replace defective materials where necessary, and retest the system until there is no loss of pressure. Remake leaking gaskets with new gaskets and new flange bolting, and discard used bolting and gaskets.
- M. //The CxA will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the COR and CxA. Provide a minimum notice of 10 working days prior to startup and testing.//

3.4 //COMMISSIONING

- A. Provide commissioning documentation in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.//

3.5 DEMONSTRATION AND TRAINING

- A. Provide services of manufacturer's technical representative for //4//
// // hour//s// to instruct each VA personnel responsible in
operation and maintenance of the system.
- B. //Submit training plans and instructor qualifications in accordance
with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING
SYSTEMS.//

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