## PART 1 - GENERAL REQUIREMENTS

### 1.01 SUMMARY

A. This Section includes piping, equipment, and related accessories, for general building, compressed air systems operating at 200 psig and below.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 3 Section "Concrete Work" for specifications on concrete and reinforcing materials and concrete placing requirements for equipment pads.
2. Division 7 Section "Joint Sealants," for materials and methods for sealing pipe penetrations through basement and foundation walls, and fire and smoke barriers.
3. Division 22 Section "Coordination" for basic requirements for electrical components that are an integral part of packaged system components.
4. Division 22 Section, “Common Work Results for Plumbing” for materials and methods for fire barrier penetrations, wall and floor penetrations and concrete equipment pads.
5. Division 22 Section "Basic Piping Materials and Methods" for flexible metal braid connectors, pipe joining materials, specialties, unions, dielectric unions, dielectric flanges, dielectric flange kits and basic installation requirements.
6. Division 22 Section "Meters and Gauges for Plumbing Piping" for thermometers, pressure gauges, and fittings.
7. Division 22 Section "Hangers and Supports for Plumbing Piping" for equipment and piping hangers and supports.
8. Division 22 Section "Vibration Isolation for Plumbing Piping and Equipment" for inertia pads, isolation pads, spring supports, and spring hangers.
9. Division 22 Section "Seismic Controls for Plumbing Piping and Equipment" for field-installed seismic restraint devices used for equipment and piping systems.
10. Division 26 Section “Common Work Results for Electrical” required electrical devices.
11. Division 26 Sections "Enclosed Switches and Circuit Breakers" for field-installed disconnects.

### 1.02 DEFINITIONS

A. Low-Pressure Compressed Air Systems: ASME B31.9 "Building Services Piping" for systems operating at pressure of 125 psig or less, and temperature 200 deg F or less.

B. Medium-Pressure Compressed Air Systems: ASME B31.1 "Power Piping" for systems operating at pressure between 125 psig and 200 psig, or operating at temperature of more than 200 deg F.

C. High-Pressure Compressed Air Systems: ASME B31.1 "Power Piping" for systems operating at pressure greater than 200 psig.

## 1.03 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

B. Product data including rated capacities of selected models, weights (shipping, installed, and operating), furnished specialties, and accessories for all equipment; indicating dimensions, required clearances, and methods of assembly of components, and piping and wiring connections.

C. Wiring diagrams from manufacturers detailing electrical requirements for electrical power supply wiring to equipment. Include ladder-type wiring diagrams for interlock and control wiring required for final installation. Differentiate between portions of wiring that are factory-installed and portions that are field-installed.

D. Certificates of shop inspection and data report as required by provisions of the ASME Boiler and Pressure Vessel Code.

E. Coordination drawings for compressed air systems in accordance with Division 22 Section "General Plumbing Requirements."

F. Maintenance data for inclusion in Operating and Maintenance Manual specified in Division 1 and Division 22 Section "General Plumbing Requirements."

## 1.04 QUALITY ASSURANCE

A. Electrical Component Standard: NFPA 70 "National Electrical Code."

B. Listing and Labeling: Provide equipment that is listed and labeled.

1. Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

3. Furnish control panels manufactured in accordance with UL 508A.

C. ASME Code Compliance: Provide system components complying with the following:

1. Receiver Tanks: Comply with ASME Boiler and Pressure Vessel Code, Section VIII, Pressure Vessels, and bear the appropriate code symbols.

2. Safety Valves: ASME Boiler and Pressure Vessel Code, Section VIII, Pressure Vessels, National Board certified, bear the appropriate labeling, and have been factory-sealed after testing.
3. Low-Pressure Systems Piping: ASME B31.9, Building Services Piping.
4. Medium-Pressure Systems Piping: ASME B31.1, Power Piping.
5. High-Pressure Systems Piping: ASME B31.1, Power Piping.

D. Aluminum Tubing Systems:

1. All Aluminum tubing system components shall be of one manufacturer, be date and origin stamped for quality assurance and traceability.
2. Aluminum Tubing system mechanical piping shall conform to local code approval and/or as listed by ANSI-B-31.1, B-31.3, B-39.1, ASME, UL/ULC, IAPMO or ICC.
    a) Components shall be capable of providing system rigidity to accommodate hanging and support in accordance with ANSI B31.1 and ANSI B31.9.
3. Aluminum tubing system product manufacturer shall be ISO certified.
4. Aluminum tubing system grooving and cutting tools shall be of an approved manufacturer by the grooved fittings manufacturer. Verify tolerances of and maintain grooving tool components for duration of grooving processes. Replace grooving tool components that are found out of tolerance with new as required.
5. Obtain training from the Aluminum Tubing system manufacturer for all workers that will be installing or handling the Aluminum Tubing system.

E. Pipe, pipe fittings and pipe specialties shall be manufactured in plants located in the United States or certified to meet the specified ASTM and ANSI standards.

F. Design Concept: The Drawings indicate capacities, sizes, and dimensional requirements of system components. Components having equal performance characteristics that deviate from the indicated size and dimensions may be considered, provided deviations do not change the design concept or intended performance. The burden of proof for equality of products is on the proposer. Refer to Division 1.

G. Design Concepts: The Drawings indicate capacities, sizes, and dimensional requirements of system components and are based on the specific types, manufacturers, and models indicated. Components having equal performance characteristics by other manufacturers may be considered provided that deviations in dimensions, operation, and other characteristics are minor and do not change the design concept or intended performance as judged by the Architect. The burden of proof of equality of products is on the proposer. Refer to Division 1.

H. Design Concepts: The Drawings indicate sizes, profiles, and dimensional requirements of system components specified. Components having equal

performance characteristics by other manufacturers may be considered provided that deviations in dimensions, operation, and other characteristics are minor and do not change the design concept or intended performance as judged by the Architect. The burden of proof of equality of products is on the proposer. Refer to Division 1.

## PART 2 - PRODUCTS AND MATERIALS

### 2.01 MANUFACTURERS

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

1. Oil-Flooded, Rotary Screw Air Compressors:

   a) Bauer Compressed Air, Inc.
   b) Champion Pneumatic Machinery Co., Inc.
   c) Gardner-Denver Products, Industrial Machinery; Cooper Industries.
   d) GrimmerSchmidt Corp.
   e) Ingersoll-Rand Co.
   f) Kaeser Compressors, Inc.
   g) LeROI Div.; Dresser Industries, Inc.
   h) Quincy Compressor Div.; Coltec Industries, Inc.
   i) Sullair Corp. Subsid.; Sundstrand Corp.

2. Oil-Free, Rotary Screw Air Compressors:

   a) Atlas Copco.
   b) GrimmerSchmidt Corp.
   c) Hitachi America, Ltd.

3. Liquid-Ring Air Compressors:

   a) Nash U.S., Inc.
   b) SIHI Pumps, Inc.

4. Aftercoolers, Air Cooled:

   a) Arrow Pneumatics, Inc.
   b) Curtis-Toledo, Inc.
   c) Hankison Div.; Hansen, Inc.
   d) Ingersoll-Rand Co.
   e) Saylor-Beall Manufacturing Co.
   f) Van Air Systems, Inc.
   g) Zeks Air Drier Corp.

5. Air Dryers:

   a) Arrow Pneumatics, Inc.
   b) Champion Pneumatic Machinery Co., Inc.
   c) Deltech Engineering, L.P.
   d) Hankison Div.; Hansen, Inc.

e) Ingersoll-Rand Co.
f) Saylor-Beall Manufacturing Co.
g) Sullair Corp. Subsid.; Sundstrand Corp.
h) Ultrafilter, Inc.
i) Van Air Systems, Inc.
j) Zeks Air Drier Corp.

6. Air Filters:

a) Deltech Engineering, L.P.
b) Hankison Div.; Hansen, Inc.
c) Ingersoll-Rand Co.
d) Ultrafilter, Inc.
e) Zurn Industries

7. Air Regulators & Lubricators:

a) Arrow Pneumatics, Inc.
b) Champion Pneumatic Machinery Co., Inc.
c) Wilkerson.

8. Automatic Drain Valves:

a) Arrow Pneumatics, Inc.
b) Deltech Engineering, L.P.
c) Ingersoll-Rand Co.
d) Zurn Industries

9. Quick Connect/Disconnect Hose Couplings:

a) Aeroquip Corp.; Industrial Connectors Div.
b) Bowes Manufacturing, Inc.
c) Amflo Products Div.; Bridge Products Inc.
d) Foster Manufacturing Co., Inc.
e) Hansen Coupling Div.; Tuthill Corp.
f) Milton Industries, Inc.
g) OBAC Corp.
h) Schrader Automotive, Inc.
i) Snap-Tite, Inc.

10. Air Hose Reels

a) COXREELS
b) Hannay Reels, Inc.
c) Reelcraft Industries

11. Ball Valves – 2" and smaller:

| MANUFACTURER | THREADED ENDS | SOLDER ENDS |
|---|---|---|
| Apollo | 77C-100 | 77C-200 |
| Hammond | 8301A | 8311A |
| Milwaukee | BA-400 | BA-450 |
| Nibco | T-585-70 | S-585-70 |

12. Ball Valves – 2" to 4":

| MANUFACTURER | THREADED ENDS | SOLDER ENDS |
|---|---|---|
| Apollo | 82-100 | 82-200 |
| Hammond | 8604 | 8614 |
| Milwaukee | BA-300 | BA-350 |
| Nibco | T-595-Y | S-595-Y |

13. Check Valves – 2" and smaller:

| MANUFACTURER | THREADED ENDS | SOLDER ENDS |
|---|---|---|
| Apollo | 161S | 161T |
| Hammond | IB940 | IB945 |
| Milwaukee | 509-T | 1509-T |
| Nibco | T-413-Y | S-413-Y |

14. Check Valves – 2" to 4":

| MANUFACTURER | |
|---|---|
| Apollo | 910F |
| Hammond | IR1124 |
| Milwaukee | F2974 |
| Nibco | F-918-B |

15. Aluminum Tube Systems

a) AIRPipe USA
b) Applied Systems Technologies, "INFINITY" for 2-1/2" and smaller, "ELEVATION" for 3" and larger
c) Atlas-Copco "AIRNet"
d) Ingersol-Rand "SimplAir"
e) Transair

## 2.02 PIPE AND TUBE MATERIALS

A. Steel Pipe: ASTM A 53, Type E, Electric-Resistance Welded or Type S, Seamless, Grade B, Schedule 40, black or hot-dipped, zinc-coated.

B. Copper Tube: ASTM B 88, Type K or Type L, Seamless, Water Tube, hard-drawn temper.

C. Copper Tube: ASTM B 88, Type K or Type L, Seamless, Water Tube, hard-drawn temper, factory-cleaned, purged, and sealed, and marked or labeled "cleaned for medical gas service," "cleaned for oxygen service," "acr/oxy," or "nitrogenized.".

D. Aluminum Tube: ASTM B241, Aluminum 6063-T5 (through the full wall thickness), rigid grade, blue in color, T5 thermal hardness treatment, powder coated.

## 2.03 PIPE AND TUBE FITTINGS

A. Malleable-Iron Pipe Fittings: ASME B16.3, Class 150, threaded, galvanized.

B. Wrought-Steel Pipe Fittings: ASME B16.9, Schedule 40, butt weld.

C. Forged-Steel Pipe Fittings: ASME B16.11, socket type.

D. Steel Pipe Flanges: ASME B16.5, Classes 150 and 300, carbon steel.

E. Copper Tube Fittings: ASME B16.22, wrought copper or copper alloy, solder-joint, pressure type.

F. Bronze Tube Flanges: ASME B16.24, Classes 150 and 300.

G. Copper Tube Fittings: ASME B16.22, wrought copper or copper alloy, solder-joint, pressure type, factory-cleaned, purged, and sealed, and marked or labeled "cleaned for medical gas service," "cleaned for oxygen service," "acr/oxy," or "nitrogenized."

H. Aluminum Tube System Fittings:

1. 2-1/2" and smaller: Polyamide with fiberglass reinforcement meeting UL94HB with compression joints with nitrile rubber O-ring seals.
2. 3" and larger: Aluminum body with compression joints with nitrile rubber O-ring seals.
3. 2" and smaller rated at maximum pressure of 232 psi at 188F.
4. 2-1/2" and larger rated at maximum pressure of 188 psi at 158F.

## 2.04 VALVES

A. Valves For Laboratory Service: Three piece ball valves cleaned and rated for oxygen service with bronze-body, full-port, with chrome-plated brass ball, with TFE seat seals and stem seals, blow-out proof stem, tube extensions suitable for brazing, designed for quarter turn between open and closed positions and for 300 psig working pressure.

B. Ball Valves, 2 Inch and Smaller: MSS SP-110, Class 150 saturated steam pressure, 600-psi CWP; two-piece construction; with bronze body conforming to ASTM B 584, full port, chrome-plated brass ball, replaceable PTFE (Teflon) seats and seals, blowout-proof stem, and vinyl-covered steel handle. Provide solder ends for use with copper tubing or threaded ends for use with steel piping. Provide Class 150 valves meeting the above where system pressure requires. Provide with side vented ball where required.

C. Ball Valves, 2-1/2 Inch to 4 Inch: MSS SP-110, Class 150, 600-psi CWP; 3-piece construction; with bronze body conforming to ASTM B 584, full port, chrome-plated brass ball, replaceable PTFE (Teflon) seats and seals, blowout proof stem, and vinyl-covered steel handle. Provide solder ends for use with copper tubing or threaded ends for use with steel piping.

D. Swing Check Valves, 2-Inch and Smaller: MSS SP-80; Class 125, 200-psi CWP, cast-bronze body and cap conforming to ASTM B 62; with horizontal swing, Y-pattern, and PTFE (Teflon) disc; and having threaded or solder ends. Provide valves capable of being reground while the valve remains in the line. Provide Class 150, 300-psi CWP, valves meeting the above specifications, with threaded end connections, where system pressure requires or where Class 125 valves are not available.

E. Swing Check Valves, 2-1/2-Inch and Larger: MSS SP-71; Class 125 200-psi CWP, cast iron body and bolted cap conforming to ASTM A 126, Class B; with horizontal swing, bronze disc or ductile iron disc with bronze disc face ring, and bronze seat ring; and flanged ends. Provide valves capable of being refitted while the valve remains in the line.

## 2.05 JOINING MATERIALS

A. Screwed Joint Pipe Tape: Polytetrafluoroethylene (PTFE) plastic.

B. Gasket Material: ASME B16.21, nonmetallic, flat, asbestos-free composition.

C. Solder Filler Metal: ASTM B 32, Alloy Sb5 (95 percent tin and 5 percent antimony), with 0.20 percent maximum lead content.

D. Brazing Filler Metals: AWS A5.8, AWS A5.8, BAg-5, with a cadmium content of zero.

E. Brazing Filler Metals: AWS A5.8, AWS A5.8, BCuP-5, with a minimum silver content of 15%. Flux is prohibited.

F. Aluminum Tubing System: Nitrile rubber O-ring seals.

## 2.06 DUPLEX RECIPROCATING AIR COMPRESSORS

A. Provide factory-assembled and tested, duplex, packaged, air-cooled, continuous duty, piston-type, motor-driven air compressors as indicated, of capacities and having electrical characteristics indicated on the drawings, and with the following features:

1. Belt guards totally enclosing pulleys and belts.
2. Receivers: [150psi] [250psi] ASME-code-construction horizontal receiver with safety valve, pressure gauge, and automatic drain.
3. Inlet silencer filters
4. Safety valves
5. Shutoff valve.
6. Factory tank mounted air dryer
7. Factory tank mounted air filters and pressure regulator

B. Controls: NEMA 1 enclosure, lockable combination circuit breaker magnetic motor starter and 3 leg overload protection for each motor; internal test-off-automatic selector switches, overload relays, resets, 120V control circuit transformer fused on primary and secondary, automatic alternator for alternating lead-lag compressor selection and to provide for both compressors to operate simultaneously under high load condition, low oil level shutdown switch and alarm light, high temperature shutdown switch and alarm light and run time clock for each compressor. Circuit breakers shall have minimum AIC rating as indicated on the Electrical Drawings. Control panel shall have a unit short circuit current rating equal to or greater than the available short circuit current as indicated on the electrical drawings. Controls shall be configured for terminating one incoming power feeder.

C. Controls: NEMA 1 enclosure, lockable combination circuit breaker magnetic motor starter and 3 leg overload protection for each motor, compressor hand-off-automatic selector switches, overload relays, resets, automatic alternator for alternating lead-lag compressor selection and to provide for both compressors to operate simultaneously under high load condition, low oil level shutdown switch and alarm light, high temperature shutdown switch and alarm light and run time clock for each compressor. Circuit breakers shall have minimum AIC rating as indicated on the Electrical Drawings. Control panel shall have a unit short circuit current rating equal to or greater than the available short circuit current as indicated on the electrical drawings. Controls shall be configured for terminating one incoming power feeder.

D. Disconnect: Disconnect is provided under Division 26.

E. Tank-Mounted, Reciprocating Air Compressors: Two stage, single acting, splash lubricated with centrifugal unloader for loadless starting, crank shaft roller bearings and belt guard mounted air cooled aftercooler. Each compressor shall be equipped with a belt driven, high efficiency, dripproof, continuous duty, ball bearing, induction type motor mounted on adjustable slide base and provided with a totally enclosed drive guard.

F. Tank-Mounted, Reciprocating Air Compressors: Two stage, single acting, pressure lubricated with gear type oil pump, oil pressure gauge, centrifugal unloader for loadless starting, crank shaft roller bearings and belt guard mounted air cooled aftercooler. Each compressor shall be equipped with a belt driven, high efficiency, dripproof, continuous duty, ball bearing, induction type motor mounted on adjustable slide base and provided with a totally enclosed drive guard.

G. Tank-Mounted, Oil-Free, Reciprocating Air Compressors: single stage, single acting, non-lubricated type, with TFE piston rings and sealed, oil-free crank shaft and piston bearings, centrifugal unloader for loadless starting, oil-free crank shaft and piston bearings and belt guard mounted air cooled aftercooler. Each compressor shall be equipped with a belt driven, high efficiency, dripproof,

continuous duty, ball bearing, induction type motor mounted on adjustable slide base and provided with a totally enclosed drive guard.

H. Tank-Mounted, Oil-Less, Reciprocating Air Compressors: Two stage, single acting, double acting, oil free type, with TFE piston rings and exposed separation spacer and shaft with oil stop collar and sealed crank case with pressure lubricated crank shaft roller bearings with gear type oil pump, oil pressure gauge and belt guard mounted air cooled aftercooler. Each compressor shall be equipped with a belt driven, high efficiency, dripproof, continuous duty, ball bearing, induction type motor mounted on adjustable slide base and provided with a totally enclosed drive guard.

I. Air Dryers, Refrigerated Type: Provide with capacities and characteristics as indicated on the drawings. Equip with drain connection.

J. Filters and regulators: Air line filtration system for removal of liquids and particulate matter shall include coalescing prefilter with automatic drain, particulate filter and final charcoal adsorption filter, air line pressure regulators with gauges, final pressure relief valve installed on discharge side of air dryers.

## 2.07 SIMPLEX RECIPROCATING AIR COMPRESSORS

A. Provide factory-assembled and tested, simplex, packaged, air-cooled, continuous duty, piston-type, motor-driven air compressors as indicated, of capacities and having electrical characteristics indicated on the drawings, and with the following features:

1. Belt guard totally enclosing pulleys and belts.
2. Receivers: 150psi 250psi ASME-code-construction horizontal, vertical receiver with safety valve, pressure gauge, and automatic drain.
3. Inlet silencer filter
4. Safety valves
5. Shutoff valve.

B. Controls: NEMA 1 enclosure, lockable combination circuit breaker magnetic motor starter and 3 leg overload protection for each motor, compressor hand-off-automatic selector switch, overload relay, reset, 120V control circuit transformer fused on primary and secondary, low oil level shutdown switch and alarm light, high temperature alarm shutdown switch and alarm light and run time clock. Circuit breaker shall have minimum AIC rating as indicated on the Electrical Drawings. Control panel shall have a unit short circuit current rating equal to or greater than the available short circuit current as indicated on the electrical drawings. Controls shall be configured for terminating one incoming power feeder.

C. Controls: NEMA 1 enclosure, lockable combination circuit breaker magnetic motor starter and 3 leg overload protection for each motor, compressor hand-off-automatic selector switch, overload relays, reset, low oil level shutdown switch and alarm light, high temperature shutdown switch and alarm light and run time clock.

Circuit breaker shall have minimum AIC rating as indicated on the Electrical Drawings. Control panel shall have a unit short circuit current rating equal to or greater than the available short circuit current as indicated on the electrical drawings. Controls shall be configured for terminating one incoming power feeder.

D. Disconnect: Disconnect is provided under Division 26.

E. Tank-Mounted, Reciprocating Air Compressors: Two stage, single acting, splash lubricated with centrifugal unloader for loadless starting, crank shaft roller bearings and belt guard mounted air cooled aftercooler. Each compressor shall be equipped with a belt driven, high efficiency, dripproof, continuous duty, ball bearing, induction type motor mounted on adjustable slide base and provided with a totally enclosed drive guard.

F. Tank-Mounted, Reciprocating Air Compressors: Two stage, single acting, pressure lubricated with gear type oil pump, oil pressure gauge, centrifugal unloader for loadless starting, crank shaft roller bearings and belt guard mounted air cooled aftercooler. Each compressor shall be equipped with a belt driven, high efficiency, dripproof, continuous duty, ball bearing, induction type motor mounted on adjustable slide base and provided with a totally enclosed drive guard.

G. Tank-Mounted, Oil-Free, Reciprocating Air Compressors: single stage, single acting, non-lubricated type, with TFE piston rings and sealed, oil-free crank shaft and piston bearings, centrifugal unloader for loadless starting, oil-free crank shaft and piston bearings. Each compressor shall be equipped with a belt driven, high efficiency, dripproof, continuous duty, ball bearing, induction type motor mounted on adjustable slide base and provided with a totally enclosed drive guard.

H. Tank-Mounted, Oil-Less, Reciprocating Air Compressors: Two stage, single acting, double acting, oil free type, with TFE piston rings and exposed separation spacer and shaft with oil stop collar and sealed crank case with pressure lubricated crank shaft roller bearings with gear type oil pump, oil pressure gauge and belt guard mounted air cooled aftercooler. Each compressor shall be equipped with a belt driven, high efficiency, dripproof, continuous duty, ball bearing, induction type motor mounted on adjustable slide base and provided with a totally enclosed drive guard.

## 2.08 ROTARY SCREW AIR COMPRESSORS

A. General: Provide factory-assembled and tested, packaged, single-stage, heavy-duty, asymmetrical, rotary screw air compressors as indicated, of capacities and having electrical characteristics as indicated.

B. Bearings: Separate axial and thrust anti-friction bearings.

C. Coupling: Nonlubricated flexible type.

D. Cooling/Lubrication System: Unit-mounted, air-cooled exchanger package, prepiped to unit with air pressure circulation system, with coolant stop valve, full flow coolant filter, and thermal bypass valve.

E. Air Filter: Dry type, with maintenance indicator and cleanable replaceable filter element.

F. Air/Coolant Receiver and Separation System: 150-psig-rated tank with ASME safety valve; coolant level gauge; multistage, air coolant separator element; minimum pressure valve; blowdown valve; discharge check valve; and coolant stop valve, full flow coolant filter, and thermal bypass valve.

G. Capacity Control: Capacity modulation between 0 and 100 percent air delivery, with operating pressures between 50 and 125 psig using manufacturer's standard control. Control inlet butterfly valve by diaphragm and pressure regulator to hold a constant pressure. When air demand is zero, unload compressor by use of pressure switch and blowdown valve.

H. Control Panel: Include air receiver pressure gauge, discharge line pressure gauge, air filter maintenance indicator, hourmeter, compressor discharge air and coolant temperature gauge, control transformer, start-stop switches, and numbered wiring terminal strip.

1. Provide automatic alternator to switch lead compressor at each start, for duplex air compressor units.

I. Motor Starter: Full-voltage, magnetic starter with NEMA 12 enclosure. Factory mount starter on compressor package and wire to motor and control panel.

J. Receiver Tank: ASME stamped.

K. Prepipe entire unit at factory.

L. Oil-Flooded, Rotary Screw Air Compressors: Oil-cooled and oil-flooded lubricated screws.

M. Oil-Free, Rotary Screw Air Compressors: Nonlubricated screws and air cooled; with construction to prohibit oil from entering compression chamber.

N. Disconnect: Disconnect is provided under Division 26.

## 2.09 LIQUID-RING AIR COMPRESSORS

A. Liquid-Ring Air Compressors: Provide factory-assembled and tested, packaged, nonpulsating, rotary, liquid ring, air compressors; of capacities and having electrical characteristics as indicated.

B. Construction: Cast-iron body and rotor, cast-iron body with bronze rotor, or bronze body and rotor.

C. Sealing Fluid: Potable water, with recirculation of up to 90 percent.

D. Bearings: Separate axial and thrust anti-friction bearings.

E. Coupling: Nonlubricated, flexible type.

F. Air Filter: Dry type, with maintenance indicator and cleanable replaceable filter element.

G. Controls: NEMA 1 enclosure, lockable combination circuit breaker magnetic motor starter and 3 leg overload protection for each motor; internal test-off-automatic selector switches, overload relays, resets, 120V control circuit transformer fused on primary and secondary, automatic alternator for alternating lead-lag compressor selection and to provide for both compressors to operate simultaneously under high load condition, compressor discharge air and coolant temperature gauge and run time clock for each compressor. Circuit breakers shall have minimum AIC rating as indicated on the Electrical Drawings. Control panel shall have a unit short circuit current rating equal to or greater than the available short circuit current as indicated on the electrical drawings. Controls shall be configured for terminating one incoming power feeder.

H. Controls: NEMA 1 enclosure, lockable combination circuit breaker magnetic motor starter and 3 leg overload protection for each motor, compressor hand-off-automatic selector switches, overload relays, resets, automatic alternator for alternating lead-lag compressor selection and to provide for both compressors to operate simultaneously under high load condition, compressor discharge air and coolant temperature gauge and run time clock for each compressor. Circuit breakers shall have minimum AIC rating as indicated on the Electrical Drawings. Control panel shall have a unit short circuit current rating equal to or greater than the available short circuit current as indicated on the electrical drawings. Controls shall be configured for terminating one incoming power feeder.

I. Control Panel: Include air receiver pressure gauge, discharge line pressure gauge, air filter maintenance indicator, hourmeter, compressor discharge air and coolant temperature gauge, control transformer, start stop switches, and numbered wiring terminal strip.

1. Provide automatic alternator to switch lead compressor at each start, for duplex air compressor units.

J. Motor Starter: Full-voltage, magnetic starter with NEMA 12 enclosure. Factory mount starter on compressor package and wire to motor and control panel.

K. Receiver Tank: ASME stamped.

L. Prepipe entire unit at factory.

M. Disconnect: Disconnect is provided under Division 26.

## 2.010 AFTERCOOLERS

A. Aftercoolers, Air Cooled: Tubular, rated at 250 psig and leak-tested at 350-psig minimum air pressure, in capacities indicated. Size units to cool compressed air in compressor-rated capacities to 10 deg F above summertime maximum ambient temperature.

B. Aftercoolers, Water Cooled: Fixed-bundle, tubular intercoolers and aftercoolers, rated at 250 psig and leak-tested at 350-psig minimum air pressure, in capacities indicated. Size units to cool compressed air in compressor rated capacities to 10 deg F above summertime maximum water temperature.

## 2.011 AIR DRYERS

A. Air Dryers, Refrigerated Type: Provide with capacities and characteristics as indicated on the drawings. Equip with drain connection.

B. Air Dryers, Deliquescent Type: Single tower, charged with an absorbent desiccant, in capacities and with characteristics indicated. Equip with drain connection.

C. Air Dryers, Regenerative Type: Twin towers, charged with an adsorbent desiccant, in capacities and with characteristics indicated. Equip with drain connection.

## 2.012 ACCESSORIES

A. General: Provide accessories having working pressure rating not less than system pressure at location where used, and compatible with equipment and piping system used.

B. Intercoolers: Air-cooled, fixed-bundle, tubular intercoolers, rated at 250 psig and leak-tested at 350-psig minimum air pressure, in capacities indicated. Size units to cool compressed air in compressor-rated capacities to 10 deg F above summertime maximum ambient temperature.

C. Intercoolers: Water-cooled, fixed-bundle, tubular intercoolers, rated at 250 psig and leak-tested at 350-psig minimum air pressure, in capacities indicated. Size units to cool compressed air in compressor-rated capacities to 10 deg F above summertime maximum water temperature.

D. Separators: Conical shaped, centrifugal air-line separators in sizes and capacities indicated. Equip with water-removal trap and drain. Size units for maximum pressure drop through units of 3 psig from air inlet to outlet.

E. Receivers: ASME stamped, cylindrical, vertical or horizontal installation as indicated, galvanized steel; with safety valves in sizes, working pressures and temperatures indicated, and with drain connection.

1. Pressure rating: Not less than maximum discharge pressure.

F. Safety Valves: ASME Boiler and Pressure Vessel Code, Section VIII, Pressure Vessels construction, National Board certified, labeled, and factory-sealed; constructed of bronze body with poppet safety valve for compressed air service.

1. Pressure Settings: Higher than discharge pressure and same or lower than receiver pressure rating.

G. Pressure Regulators: Bronze body, direct-acting, spring-loaded, manual pressure setting adjustment, and rated for 250-psig inlet pressure except where otherwise indicated.

1. Type: Diaphragm-operated.
2. Type: Pilot-operated.

H. Pressure Regulators (Reducing Valves): Aluminum alloy or plastic body, diaphragm-operated, direct-acting, spring-loaded, manual pressure setting adjustment, and rated for 250-psig inlet pressure except where otherwise indicated.

I. Air-Line Lubricators: Sizes and capacities indicated; equip with drip chamber and sight dome for observing oil drop entering air stream; with oil feed adjustment screw, and quick-release collar for easy bowl removal.

1. Provide with automatic feed device for supplying oil to lubricator.

J. Filters: Capacities and types indicated on the drawings. Equip with cartridges capable of removing particles, water and oil aerosols, and with warning light to indicate when selected maximum pressure drop has been exceeded with characteristics indicated on the drawings.

K. Automatic Drain Valves: Electronic controlled corrosion-resistant metal body and internal parts, rated for 200-psig minimum working pressure, capable of automatic discharge of collected condensate.

L. Hose, Clamps, and Couplings: Provide compatible hose, hose clamps, and hose couplings, suitable for compressed air service, of nominal diameter, and rated for 300-psig minimum working pressure except where otherwise indicated.

1. Quick Connect/Disconnect Hose Couplings: One-way, automatic shutoff, brass body, with O-ring or gasket seal, and stainless steel or nickel-plated steel operating parts. Select socket end with threaded inlet that is considered the fixed end and has a one-way valve.

    a) Plug End: Flow-sensor bleeder, check-valve type, with serrated outlet for hose.
    b) Plug End: Straight-through type, with serrated outlet for hose.

2. Quick Connect/Disconnect Hose Couplings: Straight through, brass body, with stainless-steel or nickel-plated steel operating parts. Select socket end with O-ring or gasket seal, and without valve. Select socket and plug ends with serrated outlets for hose.

3. Hose Coupling: Two-piece, threaded, brass or stainless steel, O-ring or gasket seal, swivel coupling, with serrated ends, 300-psig minimum working pressure.
4. Hose Adapter: One-piece, brass or stainless-steel fitting, with serrated ends.
5. Hose: Reinforced, single- or double-braid, neoprene-covered hose, for compressed air service.
6. Hose Clamps: Stainless steel, clamps, bands, or wire.

M. Air Hose Reels: As specified on the drawings.

## PART 3 - EXECUTION

### 1.1 INSTALLATION, GENERAL

A. Install air compressors, air dryers, accessories, piping, valves and specialties in accordance with manufacturer's installation instructions.

### 3.01 CONCRETE EQUIPMENT BASES

A. Refer to Division 22 Section "Common Work Results for Plumbing" for concrete equipment bases.

1. Form concrete equipment bases by using framing lumber with form release compounds. Chamfer top edge and corners of pad.
2. Install reinforcing bars, tied to frame, and place anchor bolts and sleeves using manufacturer's installation template.
3. Place concrete and allow to cure before installation of pumps.

### 3.02 EQUIPMENT INSTALLATION

A. Install air compressors on concrete bases. Set and connect units in accordance with manufacturers' written installation instructions. Install units plumb and level, firmly anchored, in locations indicated, and maintain manufacturers' recommended clearances. Orient so equipment controls and devices needing servicing are accessible. For indirect drain material and installation.

B. Install seismic restrains for equipment as indicated refer to Division 22 Section "Seismic Controls for Plumbing Piping and Equipment".

C. Install flexible connectors where indicated on the drawings. Refer to Division 22 "Basic Piping Material and Methods" for installation.

D. Install indirect drains on air compressor accumulator tank drain valve, air dryer condensate drain and each automatic air drain valve and route to nearest floor drain. Refer to Division 22 Section "Sanitary Drainage and Vent Piping and Specialties".

E. Provide equipment pad and vibration isolation, refer to Division 22 Section "Vibration Isolation For Plumbing Piping & Equipment".

F. Provide equipment pad, concrete inertia base and vibration isolation, refer to Division 22 Section “Vibration Isolation For Plumbing Piping & Equipment”.

## 3.03 PIPING APPLICATIONS

A. Low-Pressure Systems: Use the following pipe and fittings:

1. 2 to 12 Inches: Black steel pipe with threaded, malleable-iron fittings; threaded joints.
2. 1-1/2 Inches and Smaller: Galvanized steel pipe with galvanized, threaded, malleable-iron fittings; threaded joints.
3. 2 Inches and Larger: Black steel with grooved-end, mechanical fittings; mechanical joints.
4. 2-1/2 to 6 Inches: Copper tube with grooved-end copper tube fittings and grooved-end copper couplings; mechanical joints.
5. 2 Inches and Smaller: Copper tube with copper and copper alloy solder fittings; soldered joints.
6. 4 Inches and Smaller: Copper tube with copper, copper alloy, and bronze fittings; soldered joints.
7. 4 Inches and Smaller: Copper tube with copper and bronze fittings; brazed joints.
8. 6 inches and smaller: Aluminum tube with compression fittings.

B. Medium-Pressure Systems: Use the following pipe and fittings:

1. 2 Inches and Larger: Black steel pipe, steel buttwelding fittings, Class 300 carbon steel flanges; welded and flanged joints.
2. 1-1/2 Inches and Smaller: Black steel pipe with forged-steel, socket welding fittings; welded joints.
3. 4 Inches and Smaller: Copper tube, copper fittings, and Class 300 bronze tube flanges; brazed and flanged joints.
4. 2 inches and smaller: Aluminum tube with compression fittings.

## 3.04 JOINT CONSTRUCTION

A. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe tape, suitable for the service for which the pipe is intended, on the male threads at each joint. Tighten joint to leave not more than 3 threads exposed.

B. Welded Joints: Weld pipe joints in accordance with ASME Code for Pressure Piping, B31.9 Building Service Piping for low-pressure systems and B31.1 Power Piping for medium-pressure systems.

C. Brazed and Soldered Joints: For copper tube and fittings, braze and solder joints in accordance with ASME B31 - Standard Code for Pressure Piping.

1. Braze joints in accordance with ASME B31.1 - Power Piping with BAg-5 brazing filler metal
2. Solder joints in accordance with ASME B31.9 - Building Service Piping.
3. Thoroughly clean tube surface and inside surface of the cup of the fittings, using very fine emery cloth, prior to making soldered or brazed joints. Wipe tube and fittings clean and apply flux. Flux shall not be used as the sole means for cleaning tube and fitting surfaces.
4. Mechanical Joints: Follow grooved-end mechanical coupling manufacturer's written instructions.

D. Joints in laboratory piping, except those at valves or equipment regularly provided with threaded connections, shall be made with BCuP brazing alloy high melting point. The outside of the tube and fittings shall be cleaned by washing with hot water after assembly.

E. Brazing For Laboratory Air Copper Tube and Fittings:

1. Braze joints in accordance with ASME B31.1 - Power Piping with BCup-5 brazing filler metal.
2. Thoroughly clean tube surface and inside surface of the cup of the fittings, using very fine emery cloth, prior to making brazed joints. Wipe tube and fittings clean. Prevent the entry of matter into the tube. If matter enters the tube, replace the tube or clean the tube in the field with 1lb of sodium carbonate or trisodium phosphate per 3 gallons of water, rinse with hot potable water. Use of flux is prohibited.
3. Make brazed joints with dry oil-free nitrogen flowing through the pipe to prevent oxidation and scale formation.
4. Clean the outside of the tube and fittings after assembly with hot water.

F. Threaded joints for Laboratory Air Piping: Threaded joints in piping systems shall be made up with polytetrafluorethylne (such as Teflon) tape or other thread sealants for oxygen service. Sealants shall be applied to the male threads only. Leave first thread clean if possible.

G. All brazing shall be done with dry nitrogen flowing through the pipe to prevent oxidation and scale formation. Flow rate shall be 0.5 cfm for ½" tube and 1 cfm for ¾" tube.

## 3.05 VALVE APPLICATIONS

A. General-Duty Valve Applications: The Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shut-off duty - 2" and smaller: Use 2-piece ball valves.
    a) Provide side vented ball valves only at individual equipment connections and air drops to relieve air downstream of ball valve when closed for equipment repair or removal.
2. Shut-off duty - 2-1/2" and larger: Use 3-piece ball valves.

3. Shut-off duty laboratory air: Use 3-piece ball valves with brazing tube extensions.

## 3.06 INSTALLATION OF VALVES

A. Sectional Valves: Install sectional valves on each branch and riser, close to main, and elsewhere as indicated.

B. Shutoff Valves: Install shutoff valves on outlet of each compressed air equipment item, on each supply to each compressed air outlet, and elsewhere as indicated.

C. Locate valves for easy access and provide separate support where necessary. Provide access doors and fire rated access doors as required.

D. Install valves and unions for each fixture and item of equipment arranged to allow equipment removal without system shutdown. Unions are not required on flanged devices.

E. Install three-valve bypass around each pressure reducing valve using throttling-type valves.

F. Install valves in horizontal piping with stem at or above the center of the pipe.

G. Install valves in a position to allow full handle rotation.

H. Installation of Check Valves: Install for proper direction of flow as follows:

1. Swing Check Valves: Horizontal position with hinge pin level.

## 3.07 PIPING INSTALLATION, GENERAL

A. Install air and drain piping with 1/8-inch-per-foot slope downward in direction of air flow.

B. Install eccentric reducers where pipe is reduced in size in the direction of flow, with bottoms of both pipes and reducer flush.

C. Connect branch air piping to mains from top of main. Provide drain leg and drain trap at end of each main, each branch, and each low point in piping system.

D. Install horizontal piping as high as possible. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1 inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

E. Install piping specialties in accordance with Division 22 Section "Basic Piping Materials and Methods."

F. Install supports and anchors in accordance with Division 22 Section "Hangers and Supports for Plumbing Piping."

1. Spacing: Do not exceed 10'-0" spacing between pipe hangers.

G. Install valves in accordance with Division 22 Section "General Duty Valves for Plumbing Piping."

H. Install thermometers and pressure gauges in accordance with Division 22 Section "Meters and Gauges for Plumbing Piping."

I. Fire Barrier Penetrations: Where pipes pass though fire-rated walls, partitions, ceilings, and floors, maintain the fire-rated integrity. Refer to Division 22 Section “Common Work Results for Plumbing” for special sealers and materials.

J. Exterior Wall Penetrations: Seal pipe penetrations through exterior wall constructions with sleeves packing, and sealant. Refer to Division 22 Section “Basic Piping Materials and Methods” for additional information.

K. Underground Exterior Wall Penetrations: Seal pipe penetrations through underground exterior walls with sleeves and mechanical sleeve seals. Refer to Division 22 Section “Basic Piping Materials and Methods” for additional information.

L. Elevated Floor Penetrations of Waterproof Membrane, Interior Penetrations of Non-Fire Rated Walls and Concrete Slab on Grade Penetrations: Provide sleeves and seal pipes that pass through waterproof floors, non-fire rated walls, partitions and ceilings or concrete slab on grade. Refer to Division 22 Section "Common Work Results for Plumbing” for special sealers and materials.

M. Joints Containing Dissimilar Metals: Provide dielectric unions for 2” and smaller and dielectric flanges for piping 2-1/2” and larger. Dielectric unions and flanges are specified in Section “Basic Piping Materials and Methods”.

N. Joints at Valve Assemblies: Provide unions downstream of shutoff valves at valve assemblies. Unions are not required at flanged connections. Unions are specified in Division 22 section “Basic Piping Materials and Methods”.

## 3.08 HANGERS AND SUPPORTS

A. General: Hanger, support, insulation protection shield, and anchor components and installation procedures conforming to MSS SP-58 and SP-69 are specified in Division 22 Section "Hangers and Supports for Plumbing Piping." Conform to the table below for maximum spacing of supports.

B. Pipe Attachments: Install the following:

1. Adjustable band hangers, MSS SP-69 Type 7, for steel pipe for individual horizontal runs and for copper tube for horizontal runs.

2. Steel riser clamps, MSS SP-69 Type 8, for individual vertical runs of steel pipe.
3. Plastic coated adjustable band hangers with, MSS SP-69 Type 7, for copper tube for horizontal runs.
4. Plastic coated steel riser clamps, MSS SP-69 Type 8, for individual vertical runs of copper tube.
5. Extension split ring pipe clamp, MSS SP-69 Type 12, for individual vertical exposed runs of steel pipe 2" and smaller on walls or for securing steel pipe inside walls.
6. Copper coated extension split ring pipe clamp, MSS SP-69 Type 12, for individual vertical exposed runs of copper tube 2" and smaller on walls or for securing copper tube inside walls.
7. Provide roll hangers for individual horizontal runs 100 feet or longer.
8. Aluminum tubing system fixing clips, clamps, and hangers.

C. Install hangers for horizontal piping with the following maximum spacing and minimum rod sizes:

| Nom. Pipe Size - In. | Steel Pipe Max. Span - Ft. | Copper Tube Max. Span - Ft. | Min. Rod Dia. - In. |
|---|---|---|---|
| Up to 1-1/4 | 12 | 6 | 3/8 |
| 1-1/2 to 2 | 12 | 10 | 3/8 |
| 2-1/2 to 4 | 12 | 10 | 3/8 |
| 5 | 12 | 10 | 1/2 |
| 6 | 12 | 10 | 1/2 |

| Nom. Pipe Size - In. | Aluminum Tube Max. Span - Ft. | Min. Rod Dia. - In. |
|---|---|---|
| Up to 3/4 | 5 | 3/8 |
| 1 | 6 | 3/8 |
| 1-1/4 | 7 | 3/8 |
| 1-1/2 | 8 | 3/8 |
| 2 | 8 | 3/8 |
| 2-1/2 | 9 | 3/8 |
| 3 | 10 | 3/8 |
| 3-1/2 | 11 | 3/8 |
| 4 | 12 | 1/2 |
| 6 | 13 | 1/2 |

1. Support vertical steel pipe at each floor.
2. Support vertical copper tube at each floor and in intervals not to exceed 10 feet.

D. Support piping within 12" of each elbow or tee and for piping 2-1/2" and larger at each valve or strainer.

E. Support piping above the floor with pipe supports attached to the floor with anchor bolts where indicated on the drawings. Conform to the table above for maximum spacing of supports.

F. Provide vibration isolation for piping connected to rotating equipment. Vibration isolators are specified in Division 22 specification Section “Vibration Isolation for Plumbing Piping and Equipment”.

## 3.09 CONNECTIONS

A. Install piping adjacent to equipment to allow servicing and maintenance.

B. Connect air piping to units with shutoff valves and unions.

1. Where air piping connections are dissimilar metals, install dielectric waterway fittings or dielectric unions for joints 2” and smaller and dielectric flanges for joints 2-1/2” and larger. Dielectric waterway fittings, unions and flanges are specified in Division 22 Section "Basic Piping Materials and Methods."
2. Install thermometers on compressor discharge piping, on receiver tanks, and where indicated.
3. Install pressure gauges on compressor discharge piping, on receiver tanks, and where indicated.

C. Connect water piping to intercooler and aftercooler units with union and reduced-pressure-zone-type backflow-preventer assembly having strainer, gate valves, and air gap fitting for indirect waste. Connect cooler unit drains with union and flow control valve, and discharge over closest floor drain.

1. Where air piping connections are dissimilar metals, install dielectric waterway fittings or dielectric unions for joints 2” and smaller and dielectric flanges for joints 2-1/2” and larger. Dielectric waterway fittings, unions and flanges are specified in Division 22 Section "Basic Piping Materials and Methods."

D. Install safety valves in receiver tanks, in quantity and size to relieve capacity not less than that of connected compressor.

E. Install automatic drain valves on intercoolers, aftercoolers, separators, receivers, dryers, filters and other locations indicated. Discharge condensate over nearest floor drain.

F. Install flexible connectors where indicated in accordance with Division 22 Section "Basic Piping Materials and Methods".

G. Securely attach hose reels to the structure as specified in Division 22 Section "Hangers and Supports for Plumbing Piping."

H. Electrical Connections:

1. Power wiring is specified in Division 26 Section “Common Work Results for Electrical”
2. Field-installed disconnects are specified in Division 26 Sections "Enclosed Switches and Circuit Breakers".
3. Grounding: Connect unit components to ground in accordance with the National Electrical Code.

## 3.010 AIR HOSE REELS

A. Install horizontal hanging hose reels with “I” or “H” beam brackets

B. Install vertical hangin hose reels with swing brackets.

## 3.011 FIELD QUALITY CONTROL

A. General: Provide the services of a factory-authorized service representative to test and inspect unit installation, provide startup service, and to demonstrate and train Owner's maintenance personnel as specified below.

1. Test and adjust operating and safety controls. Replace damaged and malfunctioning controls and equipment.

B. Piping System Tests: Cap and fill new and parts of existing systems that have been modified, with oil-free, dry air or gaseous nitrogen, to pressure of 50 psig above system operating pressure, but not less than 150 psig. Isolate the test source and let stand for 4 hours to equalize temperature. Refill system, if required, to test pressure and hold pressure for 2 hours with no drop in pressure.

1. Repair leaks and defects with new materials and retest system until satisfactory results are obtained.

## 3.012 STARTUP

A. Preparation: Perform the following final checks before startup:

1. Complete tests of piping systems.
2. Check for piping connection leaks.
3. Check lubricating oil for lubricated-type equipment.
4. Check V-belts for proper tension.
5. Check that compressor inlet filters and piping are clear.
6. Check equipment vibration-control supports and flexible pipe connectors, and that equipment is properly attached to substrate.
7. Check for proper seismic restraints.
8. Check that safety valves have correct setting; greater than compressor discharge pressure, but not greater than pressure rating of system components.
9. Test operation of equipment safety controls and devices.
10. Check water supply to water-cooled equipment.
11. Check water supply to liquid-ring air compressors.

12. Drain receiver tanks.
13. Check for adequate room ventilation.

B. Starting Procedures: Follow the manufacturer's written procedures. If no procedures are prescribed by the manufacturer, proceed as follows:

1. Energize circuits.
2. Start and run equipment through complete sequence of operations.
3. Check for excessive vibration and noise. Correct problems.
4. Check air pressures.
5. Manually operate safety valves.
6. Adjust operating controls including pressure settings.

## 3.013 TRAINING

A. General: At a time mutually agreed upon between the Owner and Contractor, provide the services of a factory trained and authorized representative to train Owner's designated personnel for a minimum of [two] [four] [eight] hours on the operation and maintenance of the equipment provided under this section.

B. Content: Training shall include but not be limited to:

1. Overview of the system and/or equipment as it relates to the facility as a whole.
2. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.
3. Review data included in the operation and maintenance manuals. Refer to Division 1 Section "Operating and Maintenance Data."

C. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner’s designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner’s representative indicating agreement that the training has been provided.

D. Schedule: Schedule training with Owner with at least 7 days' advance notice.

**END OF SECTION**