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Preparing Activity: NAVFAC Replacing without change
UFGS-15211N (August 2003)

**UNIFIED FACILITIES GUIDE SPECIFICATIONS**

**References are in agreement with UMRL dated July 2023**
**********

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DIVISION 43 - PROCESS GAS AND LIQUID HANDLING, PURIFICATION, AND STORAGE EQUIPMENT

SECTION 43 15 00.00 20

LOW PRESSURE COMPRESSED AIR PIPING (NON-BREATHING AIR TYPE)

**04/06**

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|---|---|
| **USACE / NAVFAC / AFCEC / NASA** | **UFGS-43 15 00.00 20 (April 2006)** |
| | **----------** |
| **Preparing Activity: NAVFAC** | **Replacing without change UFGS-15211N (August 2003)** |

**UNIFIED FACILITIES GUIDE SPECIFICATIONS**

**References are in agreement with UMRL dated July 2023**
**********

SECTION 43 15 00.00 20

LOW PRESSURE COMPRESSED AIR PIPING (NON-BREATHING AIR TYPE)
**04/06**

**********
**NOTE: This guide specification covers the requirements for non-breathing air compressed air systems inside of buildings with pressures up to 862 kPa (gage) 125 psig.**

**Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

**Remove information and requirements not required in respective project, whether or not brackets are present.**

**Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).**
**********

**********
**NOTE: Project requirements may require supplemental information added to the paragraphs contained herein.**
**********

PART 1 GENERAL

1.1 REFERENCES

**********
**NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.**

**Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.**

**References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.**

**********

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

| | |
|---|---|
| ANSI/AHRI 520 | (2004) Performance Rating of Positive Displacement Condensing Units |

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

| | |
|---|---|
| ASME B1.20.1 | (2013; R 2018) Pipe Threads, General Purpose (Inch) |
| ASME B16.3 | (2021) Malleable Iron Threaded Fittings, Classes 150 and 300 |
| ASME B16.9 | (2018) Factory-Made Wrought Buttwelding Fittings |
| ASME B16.11 | (2022) Forged Fittings, Socket-Welding and Threaded |
| ASME B16.22 | (2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings |
| ASME B16.24 | (2022) Cast Copper Alloy Pipe Flanges, Flanged Fittings, and Valves Classes 150, 300, 600, 900, 1500, and 2500 |
| ASME B16.26 | (2018) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes |
| ASME B16.34 | (2021) Valves - Flanged, Threaded and Welding End |
| ASME B16.39 | (2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300 |
| ASME B31.1 | (2022) Power Piping |
| ASME B31.9 | (2020) Building Services Piping |
| ASME B40.100 | (2022) Pressure Gauges and Gauge |

| | |
|---|---|
| | Attachments |
| ASME B46.1 | (2020) Surface Texture, Surface Roughness, Waviness and Lay |
| ASME BPVC SEC IX | (2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications |
| ASME BPVC SEC VIII D1 | (2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1 |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS D1.1/D1.1M | (2020; Errata 1 2021) Structural Welding Code - Steel |
| AWS Z49.1 | (2021) Safety in Welding and Cutting and Allied Processes |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A53/A53M | (2022) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| ASTM A193/A193M | (2023) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications |
| ASTM A194/A194M | (2023) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both |
| ASTM B88 | (2022) Standard Specification for Seamless Copper Water Tube |
| ASTM B88M | (2020) Standard Specification for Seamless Copper Water Tube (Metric) |
| ASTM D1330 | (2004; R 2010) Rubber Sheet Gaskets |

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

| | |
|---|---|
| MSS SP-58 | (2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation |
| MSS SP-69 | (2003; Notice 2012) Pipe Hangers and Supports - Selection and Application (ANSI Approved American National Standard) |
| MSS SP-80 | (2019) Bronze Gate, Globe, Angle and Check Valves |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA ICS 2 | (2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V |
| NEMA ICS 6 | (1993; R 2016) Industrial Control and Systems: Enclosures |
| NEMA MG 1 | (2021) Motors and Generators |

NATIONAL FLUID POWER ASSOCIATION (NFLPA)

| | |
|---|---|
| ANSI/NFLPA T3.12.3 | (1992; Rev 2) Pneumatic Fluid Power - Pressure Regulator - Industrial Type |

PIPE FABRICATION INSTITUTE (PFI)

| | |
|---|---|
| PFI ES 22 | (2016) Recommended Practice for Color Coding of Piping Materials |

PLUMBING AND MECHANICAL CONTRACTORS ASSOCIATION (PMCA)

| | |
|---|---|
| PPIC Seismic Restraint | (1982) Guidelines for Seismic Restraints of Mechanical Systems and Plumbing Systems |

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

| | |
|---|---|
| SMACNA 1981 | (2008) Seismic Restraint Manual Guidelines for Mechanical Systems, 3rd Edition |

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

| | |
|---|---|
| SSPC SP 10/NACE No. 2 | (2015) Near-White Blast Cleaning |

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

| | |
|---|---|
| SAE J513 | (1999; R 2019) Refrigeration Tube Fittings - General Specifications |

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

| | |
|---|---|
| CID A-A-1689 | (Rev B) Tape, Pressure-Sensitive Adhesive, (Plastic Film) |
| CID A-A-58092 | (Basic; Notice 1; Notice 2) Tape, Antiseize, Polytetrafluoroethylene |
| CID A-A-59617 | (Basic, Notice 1) Unions, Brass or Bronze, Threaded Pipe Connections and Solder-Joint Tube Connections |
| CID A-A-60001 | (Rev A) Traps, Steam |
| FS F-F-351 | (2019; Rev G) Filters and Filter Elements, Fluid Pressure: Lubricating Oil, Bypass and Full Flow |

| | |
|---|---|
| FS QQ-B-654 | (Rev A; Notice 1; Notice 2) Brazing Alloys, Silver |
| FS WW-S-2739 | (Basic; Notice 1; Notice 2) Strainers, Sediment: Pipeline, Water, Air, Gas, Oil, or Steam |
| FS XX-C-2816 | (Rev A) Compressor, Air, Reciprocating or Rotary, Electric Motor Driven, Stationary, 10 HP and Larger |

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

| | |
|---|---|
| 29 CFR 1910.219 | Mechanical Power Transmission Apparatus |

## 1.2 RELATED REQUIREMENTS

Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS, applies to this section, with the additions and modifications specified herein.

## 1.3 SUBMITTALS

**********

**NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.**

**For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.**

**The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.**

**Choose the first bracketed item for Navy, Air Force, and NASA projects, or choose the second bracketed item for Army projects.**

**********

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Air compressor

Air Dryer

Air receiver

Desiccant air dryers

Desiccant

Pipe

Fittings

Valves

Pressure gages

Hangers and supports

Quick disconnect couplings

Filters

Strainers

Traps

Lubricators

Flexible connections

Dielectric unions

Hose reel assembly

Valve box

Identification labels for piping

Tubing

For receivers, include Manufacturer's Data Report Form U-1 or U-1A

SD-06 Test Reports

Non-Destructive Examination (NDE) report for welding of piping

Leak tightness tests

SD-07 Certificates

Employer's record documents

Welding procedures and qualifications

Cleaning and flushing procedures

SD-08 Manufacturer's Instructions

Air receiver

Include manufacturer's recommended certification test procedure and recommended procedure for cleaning, external painting, and delivery preparation.

SD-10 Operation and Maintenance Data

Air compressor, Data Package 4

Air dryer, Data Package 4

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

SD-11 Closeout Submittals

Posted operating instructions for air compressor

Posted operating instructions air dryer

## 1.4 QUALITY ASSURANCE

**********

**NOTE: The SMACNA Seismic Restraint Manual referenced in the paragraph below shall be applied to locations subject to significant risk of seismic induced loads. The degree to which this manual is to be used for contract drawings and specifications shall be determined by the designer of record in coordination with the NAVFAC Engineering Field Division's Mechanical Design Branch.**

**********

Provide work specified in this section, including design, materials, fabrication, assembly, erection, installation, and examination, inspection and testing of compressed air systems in conformance with ASME B31.9[ and SMACNA 1981], as modified and supplemented by this specification section and accompanying drawings. In ASME B31.1, ASME BPVC SEC VIII D1, and ASME BPVC SEC IX, the advisory provisions shall be considered mandatory, as though the word "shall" had been substituted for "should" wherever it appears; reference to the "authority having jurisdiction" and "owner" shall be interpreted to mean the Contracting Officer.

### 1.4.1 Welding procedures and qualifications

Provide welding work specified in this section for compressed air piping systems in conformance with ASME B31.9, as modified and supplemented by

this specification section and the accompanying drawings. The welding work includes: qualification of welding procedures, welders, welding operators, and nondestructive examination personnel; maintenance of welding records, and examination methods for welds.

1.4.1.1 Butt Welded Joints

Butt welded joints shall be full penetration joints.

1.4.2 Employer's Record Documents

Submit to the ROICC for his review and approval the following documentation. This documentation and the subject qualifications shall be in compliance with ASME B31.9.

a. List of qualified welding procedures that is proposed to be used to provide the work specified in this specification section.

b. List of qualified welders, and welding operators that are proposed to be used to provide the work specified in this specification section.

c. List of qualified weld examination personnel that are proposed to be used to provide the work specified in this specification section.

1.4.3 Welding Procedures and Qualifications

Specifications and Test Results: Submit copies of the welding procedure specifications and procedure qualification test results for each type of welding required. Approval of any procedure does not relieve the Contractor of the responsibility for producing acceptable welds. Submit this information on the forms printed in ASME BPVC SEC IX or their equivalent.

1.4.3.1 Certification

Certification: Before assigning welders or welding operators to the work, submit a list of qualified welders, together with data and certification that each individual is performance qualified as specified. Do not start welding work prior to submitting welder, and welding operator qualifications. The certification shall state the type of welding and positions for which each is qualified, the code and procedure under which each is qualified, date qualified, and the firm and individual certifying the qualification tests.

1.4.3.2 Renewal of Qualification

Requalification of a brazer or brazing operator shall be required under any of the following conditions:

a. When a brazer or brazing operator has not used the specific brazing process for a period of 6 months.

b. There is specific reason to question his ability to make brazes that will meet the requirements of the specifications.

1.4.4 Equipment Data

Submit the following data for equipment listed for "Operation and Maintenance Instructions, Parts and Testing."

a. Name and address of authorized branch or service department.

b. Characteristic curves.

c. Following applicable data completely filled in:

Manufacturer and model number [_____]

Operating speed [_____]

Capacity [_____ (CMS) (CFM)]

Type of bearings in unit [_____]

Type of lubrication [_____]

Type and adjustment of drive [_____]

Capacity of tank [_____]

Electric motor: Manufacturer, frame and type [_____]

Motor speed [_____] rad/sec RPM

Current characteristics and kW hp of motor [_____]

[_____] Thermal cut-out switch: Manufacturer, type and model [_____]

Starter: Manufacturer: Type and model [_____]

## 1.5 SAFETY PRECAUTIONS

### 1.5.1 Temperature Restriction

**********

**NOTE: The designer shall assure that the piping design temperature is not exceeded, especially for high pressure systems. Provide aftercoolers and high temperature shutdown devices as required for safe operation of the systems.**

**********

Compressors or other equipment shall not discharge compressed air to the piping systems above [38] [_____] degrees C [100] [_____] degrees F unless approved by the Contracting Officer. Aftercoolers or other devices shall be provided to comply with the temperature restriction.

### 1.5.2 Rotating Equipment

Fully guard couplings, motor shafts, gears and other exposed rotating or rapidly moving parts in accordance with OSHA 29 CFR 1910.219. Provide rigid and suitably secured guard parts readily removable without disassembling guarded unit.

### 1.5.3 Welding and Brazing

Safety in welding, cutting, and brazing of pipe shall conform to AWS Z49.1.

PART 2 PRODUCTS

2.1 LOW PRESSURE AIR COMPRESSOR, 7 1/2 TO 224 KW 10 TO 300 HP

**********
**NOTE: Prepare section for cooling water and include in project specification. See Section 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS for piping and equipment which may be useful.**
**********

7 1/2 kW to 224 kW, up to 862 kPa (gage) 10 to 300 hp, up to 125 psig. Configuration and dimensions of the air compressor shall be compatible with the indicated space allocated. Sound level shall not exceed 84 dBA one meter from compressor unit. Conform to FS XX-C-2816and following ordering data (paragraph 6.2) thereof:

a. Specification title, number and date: As listed hereinbefore under "REFERENCES."

b. Type: [I - Single acting (reciprocating)] [II - Double acting (reciprocating)] [III -Rotary (vane, screw)].

c. Issue date of applicable specifications and standards: As specified.

d. Packaged assembly requirement: [Packaged Unit required] [Field assembled].

e. First article inspection: [Not required; furnish certified test report.] [Required.]

f. Capacity (cms) (cfm): [At least as indicated.] [ cms cfm:[_____].]

Discharge working pressure: [At least as indicated.] [ kPa (gage) psig: [_____].]

g. Number of stages for Type I compressor: [Single stage.] Type I [Two stages.].

Water-jacketed cooling: [Not applicable.] [Required] [Not required].

h. Number of stages for Type II compressor: [Single Stage] [Two stages] [Not applicable].

i. Oil-free air delivery Type II compressors: [Required.] Type II [Not required.]

j. Type bearings: Manufacturer's standard.

k. Air filter to function as muffler: Required.

l. Air Filter conformance with MS: Not required; provide manufacturer's standard.

m. Safety valve in discharge line when no receiver provided: [Not applicable.] [Required, ASME BPVC SEC VIII D1 and ASME BPVC SEC IX Code stamped safety relief valve.]

n. Shut-off valve on compressor discharge: [Not required] [Required].

o. Oil Filter compliance with FS F-F-351: Not required; provide manufacturer's standard.

p. Drain plug conformance with MS: Not required; provide manufacturer's standard.

q. Electric, thermostatically controlled immersion oil heater: [Not] required.

r. Compressor regulation method: [Constant-speed control]. [Dual control: Alternative constant speed or automatic start-stop.]

s. Timed stop control (for constant speed control: [Not applicable] [Required].

**********
**NOTE: Edit Table A to select only the optional safety controls required for the project.**
**********

t. Optional safety controls required: As specified on Table A.

TABLE A. OPTIONAL SAFETY CONTROLS

| | Type I | | Type II | | Type III | |
|---|---|---|---|---|---|---|
| | Alarm | Shut Down | Alarm | Shut Down | Alarm | Shut Down |
| High-lubrication oil temp. | - | - | x | x | x | x |
| Cylinder lubrication failure | - | - | - | x | - | - |
| High main bearing temperature | - | x | - | x | - | x |
| High discharge-air temperature | x | x | x | x | x | x |
| High discharge-air pressure | x | x | x | x | x | x |
| High intercooler air temp. | x | x | x | x | - | - |
| Low cooling water flow | - | x | - | x | - | - |
| Low water pressure | - | x | - | x | - | - |
| High water temperature | x | x | x | x | - | - |
| High intercooler moisture separator level (two-stage compressors only) | x | x | x | x | - | - |

| TABLE A. OPTIONAL SAFETY CONTROLS | | | | | | |
|---|---|---|---|---|---|---|
| | Type I | | Type II | | Type III | |
| Excessively high motor temp. | x | - | x | - | x | - |
| Excessive vibration | - | x | - | x | - | - |

u. Gages and visual I.D. lights mounting (optional controls): [Panel-mounted.] [Mounted on separate console.]

[Not applicable.]

v. Aftercooler: Required; [Water-cooled, shell-and-tube type] [or] [air-cooled, tube-and-fin type]. A centrifugal moisture separator is also required.

w. Air receiver: [Required] [Not required].

x. Receiver volume: [As specified in FS XX-C-2816.] [As indicated.] [[_____] liter gal.] [[_____] cu. meter ft.] [Not applicable.]

y. Receiver mounting stand: [Required] [Not required] [Not applicable].

Position of receiver: [Horizontal] [Vertical].

z. Compressor and motor: [Required] [Not required]. To be mounted on receiver: [Not applicable].

aa. Compressor housing (III units): [Not applicable] [Required].

bb. Motor: As specified in FS XX-C-2816.

cc. Electrical power supply characteristics: As indicated.

dd. Motors 93 kW 125 hp and larger to be synchronous: [Required] [Not required] [Not applicable].

ee. Motor starter: As specified in FS XX-C-2816.

ff. Provision for limitation of starting current inrush: [Required] [Not required] [Not applicable].

gg. Type Drive: [Direct drive] [Multi-V-Belt drive].

Direct drive coupling: [Close-coupled] [Integral-coupled] [Flexible-coupled] [Not applicable].

hh. Electromagnetic interference control: [Not required] [Required].

ii. Fungus resistance: Not required.

jj. Cleaning, treatment, and painting: [As specified in FS XX-C-2816] [Other: (specify)].

kk. Cleaning, treatment and painting in accordance with Section 09 90 00 PAINTS AND COATINGS.

ll. Color of finish coat: [Manufacturer's standard] [Other: [_____]-(specify)-Samples required.]

mm. Initial lubrication: Factory lubrication service required.

nn. Skid base (Type II or III): Required.

oo. Lifting attachments and tiedown device: Lifting attachments as required. Tiedown devices [required.] [Not required.]

pp. Spare parts and maintenance tools: Not required.

qq. Tool boxes: Not required.

rr. Production pack inspection: Not required.

ss. Level of preservation packaging, and packing: Level C or better (Delivery of unit to project site in undamaged condition is Contractor's responsibility.)

tt. Preservation-packaging: Not applicable.

## 2.2 LOW PRESSURE AIR COMPRESSOR UNIT, LESS THAN 7 1/2 kW 10 HP

Low pressure air compressor unit, less than 7 1/2 kW 10 hp, up to 862 kPa (gage) 125 psig, shall conform to the following.

### 2.2.1 Compressor and Receiver Capacity

Sized as indicated. [Oil-free air] [Air] delivered at indicated pressure.

### 2.2.2 Mounting

Common sub-base for receiver and compressor.

### 2.2.3 Compressor Type

Reciprocating [or rotary].

### 2.2.4 Nameplate

Metal, securely fastened to equipment or base, listing:

Manufacturer's name and address
Model and serial numbers
Compressor operating data and rating.

### 2.2.5 Receiver

ASME BPVC SEC VIII D1 and ASME BPVC SEC IX stamp. Provide service valve, pressure gage, and ASME BPVC SEC VIII D1 and ASME BPVC SEC IX code safety valve.

### 2.2.6 Receiver Condensate Drain

Automatic float-type trap per CID A-A-60001.

2.2.7 Compressor Accessories

Air inlet filter and silencer. Air-cooled intercooler and aftercooler which reduce air discharge temperature to 38 degrees C 100 degrees F.

2.2.8 Control

Unloaded start with enclosed diaphragm-type pressure switch automatically controlling start-and-stop.

2.2.9 Motor

Squirrel-cage induction motor with drip-proof enclosure and conforming with NEMA MG 1, suitable for operation on the indicated power supply. Rated horsepower of motor shall equal or exceed power required for continuous operation of compressor at full load.

2.2.10 Starter

Capacity and electrical characteristics shall be compatible with motor. Starter shall conform with NEMA ICS 2 with NEMA ICS 6 enclosure. Include thermal overload protection of all phases.

2.2.11 Noise

84 dBA maximum sound level one meter from compressor unit.

2.3 LOW PRESSURE AIR RECEIVER

ASME BPVC SEC VIII D1, labeled and rated for [862] [1379] kPa (gage) [125] [200] psig, equipped with required valves and trimmings, including gage and automatic drain valve and ASME BPVC SEC VIII D1 and ASME BPVC SEC IX pressure safety relief valve. Pressure as indicated. [Sandblast exterior and interior to SSPC SP 10/NACE No. 2, near-white. Lining shall be a factory applied 0.20 mm 8 mil minimum white epoxy coating.] Exterior finish shall be [standard factory finish] [two coats of rust inhibitor primer and one coat epoxy enamel].

2.4 LOW PRESSURE COMPRESSED AIR DRYERS

**********
**NOTE: Normally used for under 944 scms 2000 SCFM capacity systems.**
**********

Provide low pressure compressed air dryers of the mechanical refrigeration type, equipped with an automatic temperature shutdown switch to prevent freezing, a regenerative air to air exchanger (in capacity sizes above 4.72 or 28.31 scms 10 or 60 scfm as standard with the manufacturer), and a main compressed air cooling exchanger. Refrigeration system shall cool compressed air to dry the air. Dryer shall have no internal traps or filters and shall have pressure drop not greater than [20.68] [_____] kPa [3] [_____] psi [indicated]. Air shall leave the dryer at a temperature of [_____] degrees C F and dew point of [_____] degrees C F, based on an inlet temperature of [38] [_____] [100] [_____] degrees C F. Provide internal tubing, wiring, and piping complete, such that only connections to air inlet and outlet, to refrigerant compressor contactor, and to condensate drain are necessary.

2.4.1 Air Circuit

a. Regenerative Heat Exchanger: Inlet compressed air to outlet compressed air heat exchanger (in capacity sizes above 4.70 or 28.30 scms 10 or 60 scfm as standard with the manufacturer) designed to reduce cooling load at design conditions minus 7 degrees C 20 degrees F by inlet air precooling.

b. Main Heat Exchanger: Single-pass, with air in the tubes, heat sink, direct expansion, or flooded cooler type.

c. Separator: Fabricated in accordance with ASME B31.1; code stamp not required; moisture separator low velocity type incorporating change of air flow direction to prevent moisture carryover.

d. Dryer Operating Pressure: 862 kPa (gage) 125 psig working pressure.

e. Drain Line: Provide with exterior mounted condensate trap to facilitate servicing.

2.4.2 Refrigeration System

a. Refrigeration Compressor: ANSI/AHRI 520. Hermetic, semi-hermetic, or open reciprocating type equipped with automatic start-stop or unloading capacity control; standard components include inherent motor protection, crankcase oil strainer, and suction screen. Refrigerant shall be R-22.

b. Dryer Controls: Capable of automatic 0 to 100 percent capacity control. Refrigeration controls shall maintain pressure dew point within the specified range without freezing of condensate. Controls shall include such devices as capillary tube, expansion valve, suction pressure regulator, thermostat, or other approved devices as standard with the manufacturer. Dryer shall have automatic shutdown switch sensor located at point of lowest temperature to prevent freezing.

c. Refrigerant dryer and suction line strainer.

d. Air-cooled condenser, with condenser fan and motor.

2.4.3 Instrumentation and Control

Include control panel in dryer cabinet containing:

a. Indicators for the Following Services: Inlet air pressure gage, discharge air pressure gage, inlet air temperature gage, main exchanger temperature gage, refrigeration compressor suction pressure gage, refrigeration compressor discharge pressure gage, green "Power On" light, power interruption light, and high temperature light.

b. Electrical Relays: Locate in an enclosed portion of the panel, accessible for ease of servicing.

c. Controls and Interlocks: To maintain required compressed air dew point and to cycle air-cooled condenser with refrigeration compressor [while maintaining head pressure control with low ambient temperature].

## 2.5 LOW PRESSURE COMPRESSED AIR DRYER (CHILLED WATER TYPE)

**********

**NOTE: Chilled water air dryers are usually provided for 944 scms 2000 scfm and larger capacities. CAUTION: Specify correct system pressure. If the specification is edited to use a dryer with direct heat exchange between air and refrigerant, assure that the air is not used for breathing since refrigerant leakage into the compressed air may be hazardous to personnel; warning signs may be required.**

**********

Provide low pressure compressed air dryer of the mechanical refrigerator type, with closed chilled water system, regenerative air to air exchanger, and main compressed air to water heat exchanger. Refrigeration system shall produce chilled water which, in turn, circulates through air-water exchanger to dry the air. Provide internal tubing, wiring and piping complete, such that only connections to air inlet and outlet, to pump contactor, to refrigerant compressor contactor, to condensate drain, and to air cooled condenser need be provided. Dryer shall be suitable for a compressed air operating pressure of 862 kPa (gage) 125 psig, with air leaving temperature of [_____] degrees C F and dew point of [_____] degrees C F at rated pressure.

### 2.5.1 Air Circuit

a. Regenerative Heat Exchanger: Air to air exchanger, with inlet air passing through tubes and outlet air in shell, designed to reduce cooling load at design conditions by precooling inlet air minus 7 degrees C 20 degrees F.

b. Main Heat Exchanger: Shell and tube construction, single-pass, with air in tubes and water in shell, designed for minimum air pressure drop, flanged connections, tubes rolled into tube sheets, and ASME BPVC SEC VIII D1 and ASME BPVC SEC IX Code stamped.

c. Separator: Fabricated of carbon steel to ASME BPVC SEC VIII D1and ASME BPVC SEC IX Code and stamped.

d. Drain: With condensate trap.

### 2.5.2 Chilled Water Circuit

a. Circulating Pump: Single stage, mechanical seals, electric motor driven with line shut-off valves.

b. Liquid Cooler: Direct expansion, refrigerant in tubes, water in shell, designed for 2068 kPa (gage) 300 psig working pressure, removable tube bundle, ASME BPVC SEC VIII D1 and ASME BPVC SEC IX Code stamped and insulated with foam type insulation.

c. Expansion Tank: With sight glass, vent, and fill cock.

d. Flow Switch: To shut down refrigeration compressor on loss of chilled water flow.

2.5.3 Refrigeration System

a. Refrigeration Compressor: ANSI/AHRI 520. Hermetic or semihermetic reciprocating type, with 183 rad/sec 1750 rpm motor, integral capacity control, oil pressure pump, oil scavenger pump, full-flow oil filter, oil sight glass, inherent motor protection, crankcase heater, suction and discharge service valve, crankcase oil strainer, Monel suction screen, and hot gas bypass capacity control below last step of unloading. Refrigerant shall be R-22.

b. Accessories: Include a discharge line muffler, sight glass, refrigerant dryer, solenoid valve, thermostatic expansion valve, and suction line strainer.

c. Air-cooled Condenser: As indicated. Complete air-cooled condenser factory-fabricated and assembled unit consisting of coils, fans, and electric-motor drive. Base capacity at design conditions on minus 7 degrees C 20 degrees F temperature differential between entering air and condensing refrigerant. Saturated refrigerant condensing temperature not over 40.5 degrees C 105 degrees F. Base entering dry bulb outside air temperature on [32] [_____] degrees C [90] [_____] degrees F. Do not take subcooling into account in determining compressor and condenser capacities. Air-cooled condenser may be used for refrigerant storage in lieu of a separate receiver, provided that condenser storage capacity is 20 percent in excess of fully charged system. [Provide head pressure control during low ambient temperature.]

2.5.4 Instrumentation and Control

Provide a control panel on the dryer containing:

a. Pressure gages 114 mm 4 1/2 inches diameter) for the following services:

(1) Inlet air

(2) Condenser water inlet

(3) Refrigeration compressor suction

(4) Refrigeration compressor oil pressure

(5) Outlet air

(6) Condenser water outlet

(7) Refrigeration compressor discharge

b. Electrical Relays: Locate in an enclosed portion of the panel, accessible from front of panel.

c. Start-Stop buttons and green running indicating light.

d. Controls and Interlocks

(1) 115-volt control transformer

(2) Circulating pump across the line contactor

(3) Compressor across the line contactor

(4) Condenser water pressure safety switch

(5) Freeze protection safety switch

(6) Pump-out relay with normally open and normally closed contacts

(7) Oil safety switch

(8) Four stage thermostatic control

(9) Refrigerant dual pressure switch

2.5.5 Temperature Indicators

a. Air inlet

b. Air outlet

c. Chilled water in

d. Chilled water out

e. Dew point

## 2.6 DESICCANT AIR DRYERS

Chamber of welded steel, 862 kPa (gage) 125 psig working pressure, ASME labeled conforming to ASME BPVC SEC VIII D1, with flanged or threaded fittings, and [manual] [automatic] drain valve. Manufacturer's recommended desiccant in tablet form which will not nest or cake. Contractor shall provide a supply of desiccant for initial operations in unbroken shipping containers equal to not less than four charges of desiccant for the dryer.

## 2.7 LOW PRESSURE COMPRESSED AIR PIPING AND ACCESSORIES

Low pressure compressed air piping and accessories 862 kPa (gage) at 65 1/2 degrees C 125 psig at 150 degrees F, shall conform to the following:

2.7.1 Steel Piping

a. Pipe: ASTM A53/A53M, seamless [or electric resistance welded] carbon steel, Schedule 40, black.

b. Fittings, size 50 mm 2 inches and larger: ASME B16.9, carbon steel, butt welding, schedule 40, or ASME B46.1, carbon steel welding neck flanges, Class 150, ASME B46.1, flanged fittings, carbon steel, Class 150, gaskets 1.50 mm 1/16 inch oil resistant synthetic rubber ASTM D1330, bolts ASTM A193/A193M, Grade B7, and nuts, ASTM A194/A194M, Grade 7. Butt welded joints shall be full penetration consumable insert or backing ring type.

c. Fittings, size 40 mm 1 1/2 inches and smaller: ASME B16.3, threaded malleable iron, Class 150, or ASME B16.11, forged carbon steel Class 3000 socket welding or Class 2000 threaded. Joints may also be butt welded or flanged, as specified for sizes 50 mm 2 inches and larger.

d. Flat-faced steel flanges: Where connections are made to Class 125 cast iron flanges with steel flanges, use only flat-faced Class 150 steel flanges.

e. Unions: ASME B16.39, Class 1 ( 2068 kPa (gage) 300 psig WOG).

2.7.2 Copper Tubing

a. Tubing: ASTM B88M ASTM B88, Type K or L, hard drawn, Class 1.

b. Fittings: ASME B16.22 wrought copper or bronze, with silver brazed joints.

c. Brazing filler metal: FS QQ-B-654, Class III.

d. Unions: bronze, CID A-A-59617, brazed joint type.

e. Flanges and flanged fittings: ASME B16.24, bronze, Class 150, gaskets, oil resistant synthetic rubber, ASTM D1330, bolts ASTM A193/A193M, Grade B7, and nuts ASTM A194/A194M, Grade 7.

f. Flared fittings: ASTM B88M ASTM B88, Type K or L, annealed, with ASME B16.26 or SAE J513 flared fittings.

2.7.3 Valves

2.7.3.1 Gate Valves

a. Bronze Gate Valves: MSS SP-80, Class 150, 50 mm 2 inches and smaller, wedge disc, rising stem, inside screw type, with brazed joints ends when used with copper tubing.

b. Steel Gate Valves: ASME B16.34, 50 mm 2 inches and smaller, ASME B16.34, over 50 mm 2 inches, flanged ends, outside screw and yoke type with solid wedge or flexible wedge disc, [Class 150] [as recommended by the manufacturer for the conditions indicated.] [Provide motor operator where indicated.]

2.7.3.2 Globe and Angle Valves

a. Bronze globe and angle valves: MSS SP-80, Class 150, 50 mm 2 inches and smaller, Class 200, except that Class 150 valves with brazed ends may be used for copper tubing. Valves shall have renewable seats and discs except brazed-end valves which shall have integral seats.

b. Steel globe and angle valves: ASME B16.34, 50 mm 2 inches and smaller, ASME B16.34, over 50 mm 2 inches, flanged ends, [Class 150.] [As recommended by the manufacturer for the conditions indicated.] [Provide motor operator where indicated.]

2.7.3.3 Pressure Reducing Valves

ANSI/NFLPA T3.12.3, with nominal pressure rating of not less than inlet system pressure indicated. Provide pressure reducing valves capable of being adjusted to specified flow and pressure, and suitable for intended service. Provide pilot valve for dome loaded type if required for proper operation.

2.7.3.4 Safety Valves

ASME BPVC SEC VIII D1 and ASME BPVC SEC IX Code stamped safety valve), 862 kPa (gage) 125 psig, for unfired pressure vessels, bronze, with threaded or flanged connections; factory set and sealed.

2.7.3.5 Check Valves

MSS SP-80, Bronze body with brazed joint or threaded ends or steel body with flanged end, ASME B16.34, or threaded ends, ASME B16.34. The check valve shall have a perforated piston with closed downstream end, in line with the pipe and held closed by a steel poppet return spring.

2.7.3.6 Pressure Regulators

Diaphragm type, air loaded, tight closing single seat, brass body [with integral filter and bowl]. [Pressure regulators used to deliver compressed air for cleaning shall be factory set at not more than 207 kPa (gage) 30 psig and shall be nonadjustable.]

2.7.3.7 Needle Valves

One-piece bodies with integral or screwed bonnet, stems of hardened stainless steel with fine thread for metering and ease of adjusting, teflon packing; and shall be of the pressure balanced type. Needle valves shall be of the slow opening type.

2.7.3.8 Ball Valves

Full port design, copper alloy body, except sizes 65 mm 2.5 inches and larger shall be ANSI Class 150 steel-bodied. Valves shall have two-position lever handles.

2.7.4 Pressure Gages

ASME B40.100, Accuracy Grade A, for air, with steel or brass case, and nonshatterable safety glass, and a pressure blowout back to prevent glass from flying out in case of an explosion. Gages shall have a 90 mm 3 1/2 inch minimum diameter dial and a dial range of approximately twice working pressure.

2.7.5 Hangers and Supports

Provide pipe hangers and supports conforming to MSS SP-58, MSS SP-69, and ASME B31.1, except as specified or indicated otherwise. Furnish zinc plated pipe hangers and supports except for copper plated inserts for copper piping. Provide tubing supports of U-shaped steel bolts and nuts firmly secured to adequately support structures such as walls, columns, floors, or brackets. Clips shall fit closely around piping but shall have sufficient clearance to permit longitudinal movement of piping during normal expansion and contraction. Provide supports at valves, fittings, branch lines, outlets, changes in direction, equipment, and accessories.

2.7.6 Quick Disconnect Couplings

All brass and suitable for a working pressure of not less than 862 kPa (gage) 125 psig. Female side of coupling (fixed end) shall have male thread connection with automatic shutoff. Provide male side of coupling with hose stem and ball check to bleed pressure from hose and prevent hose

whipping.

2.7.7 Single Cartridge Type Filters

862 kPa (gage) 125 psig operating pressure and filter housing of brass or bronze. Provide cellulose cartridge filters of graded density construction capable of removing liquids and solids of 5 microns and larger. Filter capacity shall be compatible with rated flow of equipment or pressure reducing valves provided.

2.7.8 Strainers

FS WW-S-2739. Bronze or malleable iron body, Class 125, Style Y, Type II, simplex type, with 20-mesh Monel or stainless steel screen.

2.7.9 Traps

CID A-A-60001 to drain water and other liquids from system. Type of traps, as indicated, and rated working pressure not less than system operating pressure.

2.7.10 Lubricators

Brass body, 862 kPa (gage) 125 psig minimum rating, with [clear plastic bowl and metal guard.] [metal bowl.]

2.7.11 Flexible Connections

Vibration isolation, wire braid reinforced corrugated metal hose type, line-sized, with bronze end connections, suitable for pressure indicated. Length as recommended by manufacturer but not less than [457] [_____] mm [18] [_____] inches.

2.7.12 Dielectric Unions

Steel female pipe thread end and copper solder-joint ends, conforming to dimensional, strength and pressure requirements of ASME B16.39, Class 1. Steel parts shall be galvanized or plated. Union shall have a water-impervious insulation barrier capable of limiting galvanic current to one percent of the short-circuit current in a corresponding bimetallic joint. When dry, it shall also be able to withstand a 600-volt breakdown test.

2.7.13 Tetrafluoroethylene Tape

CID A-A-58092 for screw-jointed pipe.

2.7.14 Hose Reel Assembly

Complete with 15 meters 50 foot hose rated for a minimum of 862 kPa (gage) 125 psig, ball stop, hose extension with air coupler, hose rollers, [reel enclosure,] [nonsparking ratchet pawl,] and required accessories.

2.8 SLEEVES

2.8.1 Floor Slabs, Roof Slabs, and Outside Walls Above and Below Grade

Galvanized-steel pipe having an inside diameter at least 12.70 mm 1/2 inch larger than the outside diameter of the pipe passing through it. Provide

sufficient sleeve length to extend completely through floors, roofs, and walls, so that sleeve ends are flush with finished surfaces except that ends of sleeves for floor slabs shall extend 15 mm 1/2 inch above finished floor surface. Sleeves located in waterproofed construction shall include flange and clamping ring.

2.8.2 Partitions

Galvanized sheet steel, 26 gage or heavier, of sufficient length to completely extend through partition thickness with sleeve ends flush with partition finished surface.

## 2.9 VALVE BOX

Provide rectangular concrete design with words "Compressed Air" cast or otherwise marked on the cover. Size shall be large enough for removal of valve without removing box. Provide valve box for areas as follows:

a. Roads and traffic areas: Heavy Duty, cast iron cover

b. Other areas: Standard duty, heavy steel plate or concrete cover

## 2.10 IDENTIFICATION LABELS FOR PIPING

Labels for pipes 20 mm 3/4 inch o.d. and larger shall bear printed legends to identify contents of pipes and arrows to show direction of flow. Except that of pipes smaller than 20 mm 3/4 inch o.d., labels shall have color coded backgrounds to signify levels of hazard in accordance with PFI ES 22. Legends and type and size or characters shall also conform to PFI ES 22. Labels shall be made of plastic sheet in conformance with CID A-A-1689 with pressure-sensitive adhesive suitable for the intended applications or they may be premolded of plastic to fit over specific pipe outside diameters 20 mm 3/4 inch and larger. For pipes smaller than 20 mm 3/4 inch o.d., furnish brass identification tags 38 mm 1 1/2 inches in diameter with legends in depressed black-filled characters.

## 2.11 BURIED UTILITY WARNING AND IDENTIFICATION TAPE

Polyethylene plastic tape manufactured specifically for warning and identification of buried utility lines. Tape shall be of the type provided in rolls, 150 mm 6 inches minimum width, color codes for compressed air (gray) with warning and identification imprinted in bold black letters continuously and repeatedly over entire tape length. Warning and identification shall be "CAUTION BURIED COMPRESSED AIR LINE BELOW" or similar wording. Code and letter coloring shall be permanent, unaffected by moisture and other substances contained in trench backfill material.

## 2.12 FRESH WATER

Fresh water for cleaning, flushing, and testing shall be clean and potable.

## 2.13 SOURCE QUALITY CONTROL

Test air compressors and compressed air dryers at the factory to assure proper operation. Certify satisfactory accomplishment of tests.

## PART 3 EXECUTION

### 3.1 INSTALLATION

Install materials and equipment as indicated and in accordance with the manufacturer's recommendations.

#### 3.1.1 Excavation and Backfilling

Section 31 00 00 EARTHWORK.

#### 3.1.2 Corrosion Protection

Provide corrosion protection for buried steel piping in accordance with Section 09 97 13.28 PROTECTION OF BURIES STEEL PIPING AND STEEL BULKHEAD TIE RODS.

#### 3.1.3 Piping

Provide Non-Destructive Examination (NDE) report for welding of piping. Unless specifically stated to the contrary, fabrication, assembly, welding, and brazing shall conform to ASME B31.1 for all piping of the air system. Piping shall follow the general arrangement shown. Cut piping accurately to measurements established for the work. Work piping into place without springing or forcing, except where cold-springing is specified. Piping and equipment within buildings shall be entirely out of the way of lighting fixtures and doors, windows, and other openings. Locate overhead piping in buildings in the most inconspicuous positions. Do not bury or conceal piping until it has been inspected, tested, and approved. Where pipe passes through building structure, pipe joints shall not be concealed, but shall be located where they may be readily inspected and building structure shall not be weakened. Avoid interference with other piping, conduit, or equipment. Except where specifically shown otherwise, vertical piping shall run plumb and straight and parallel to walls. Piping connected to equipment shall be installed to provide flexibility for vibration. Adequately support and anchor piping so that strain from weight of piping is not imposed on the equipment.

##### 3.1.3.1 Fittings

**********
**NOTE: Delete bending of medium and high pressure pipe when not included in project.**
**********

Use long radius ells where appropriate to reduce pressure drops. Pipe bends in lieu of fittings may be used for low pressure piping where space permits. Pipe bends shall have a uniform radius of at least five times the pipe diameter and must be free from any appreciable flattening, wrinkling, or thinning of the pipe. Mitering of pipe to form elbows, notching straight runs to form full sized tees, or any similar construction shall not be used. Make branch connections with welding tees, except factory made forged welding branch outlets or nozzles having integral reinforcements conforming to ASME B31.1 may be used.

##### 3.1.3.2 Clearances for Welding

Provide clearances from walls, ceilings, and floors to permit the installation of joints. The clearances shall be at least 150 mm 6 inches

for pipe sizes 100 mm 4 inches and less, 250 mm 10 inches for pipe sizes over 100 mm 4 inches, and sufficient in corners. However, the specified clearances shall not waive requirements for welders to be qualified for the positions to be welded.

#### 3.1.3.3 Cleaning and Flushing Procedures

Before jointing and erection of piping or tubing, thoroughly clean interiors of pipe sections, tube, and components. In steel pipe, loosen scale and other foreign matter by rapping sharply and expel by wire brush and swab. Blow out both steel pipe and copper tube and components with compressed air at 689 kPa (gage) 100 psig or more. Maintain cleanliness by closure of pipe/tube openings with caps or plugs. Before making final terminal connections, blow out complete system with compressed air at 689 kPa (gage) 100 psig or more.

#### 3.1.3.4 Changes in Pipe Size

Use reducing fittings for changes in pipe size. The use of bushings will not be permitted. In horizontal lines, 65 mm 2 1/2 inches and larger, reducing fittings shall be of the eccentric type to maintain the bottom of the lines in the same plane.

#### 3.1.3.5 Drainage and Flexibility

Compressed air piping shall be free of unnecessary pockets and pitched approximately 25 mm per 10 meters 3 inches per 100 feet in the direction of flow to low points. Where pipes must be sloped so that condensate flows in opposite direction to air flow, slope 50 mm per 10 meters 6 inches per 100 feet or greater. Provide flexibility by use of fittings, loops, and offsets in piping. Install branches at top of a main to prevent carryover of condensate and foreign matter.

### 3.1.4 Threaded Joints

Where possible use pipe with factory cut threads, otherwise cut pipe ends square, remove fins and burrs, and cut taper pipe threads in accordance with ASME B1.20.1. Threads shall be smooth, clean, and full cut. Apply thread tape to male threads only. Work piping into place without springing or forcing. Backing off to permit alignment of threaded joints will not be permitted. Engage threads so that not more than three threads remain exposed.

### 3.1.5 Welding and Brazing Procedures

Perform welding and brazing in accordance with qualified procedures using qualified welders and welding operators and brazers. Do not perform welding and brazing when the quality of the completed weld or braze could be impaired by the prevailing working or weather conditions. The Contracting Officer will determine when weather or working conditions are unsuitable for welding. Welding of hangers, supports, and plates to structural members shall be in accordance with AWS D1.1/D1.1M.

#### 3.1.5.1 Cleaning for Welding and Brazing

Surfaces to be welded or brazed shall be free from loose scale, slag, rust, paint, oil, and other foreign material. Joint surfaces shall be smooth and free from defects which might affect proper welding. Clean each layer of weld metal thoroughly by wire brushing, grinding, or chipping prior to inspection or deposition of additional weld metal.

3.1.5.2 Stress Cracking During Brazing

For material susceptible to stress corrosion cracking from molten brazing filler metal, avoid applying stress during brazing.

3.1.5.3 Welding or Brazing of Valves

Welding or Brazing of Valves: Disassemble valves subject to damage from heat during welding or brazing and reassemble after installation. Open valves two or three turns off the seat when not subject to heat damage during welding or brazing; do not backseat valve.

3.1.6 Flare Fittings

Provide flare fittings only where necessary to connect copper tubing to equipment. Use short sections of annealed tubing soldered or brazed to hard drawn tubing using couplings on expanded ends on the annealed tubing made with special tools designed for that purpose. Make flares with the appropriate flaring tools. Cut annealed tubing only with cutting wheel tool. Do not ream out inside burr or lip left by the cutting wheel but fold back lip with flare tool to form seal/gasket inside flare. When new, the flare should cover not more than 75 percent of the flare seating surface of either the male or female flare fittings. Put the flare nut on the tube before making the flare.

3.1.7 Valves

ASME B31.1. Install valves at the locations indicated and elsewhere as required for the proper functioning of the system.

3.1.7.1 Gate Valves

Provide gate valves unless otherwise directed. Install valves in positions accessible for operation and repair. Install valve with stem horizontal or above.

3.1.7.2 Globe Valves

Install globe valves so that the pressure will be below the disk. Install globe valves with the stems vertical.

3.1.7.3 Pressure-Reducing Valves

Provide compressed air entering each pressure-reducing valve with a strainer. Provide each pressure-reducing valve unit with two block valves and with a globe or angle bypass valve and bypass pipe. Provide a bypass around a reducing valve of reduced size to restrict its capacity to approximately that of the reducing valve. Provide each pressure reducing valve unit with an indicating gage to show the reduced pressure, and a safety valve on the low pressure side. These requirements do not apply to small pressure regulating valves used to adjust pressure for pneumatic equipment.

3.1.8 Hangers and Supports

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**NOTE: See NAVFAC P-355, "Seismic Design for Buildings," Chapter 10, "Mechanical and Electrical**

**Elements," for calculating pipe support spacing for schedules not shown. Delete Table I and reference to seismic requirements if not required.**
**********

Selection, fabrication and installation of piping hangers and supports shall conform to MSS SP-58, MSS SP-69 [except that spacing of the hangers and supports shall be as per Table I.] [Provide seismic restraints for piping in accordance with PPIC Seismic Restraint.]

| TABLE I. MAXIMUM SPAN FOR PIPE (METERS) | | | | |
|---|---|---|---|---|
| DIAMETER MM | STD. WT. STEEL PIPE SCHEDULE 40 | EX. STRONG STEEL PIPE SCHEDULE 80 | COPPER TUBE TYPE K | COPPER TUBE TYPE L |
| 15 | 1.50 | 1.50 | 1.10 | 1.00 |
| 20 | 1.75 | 1.75 | 1.30 | 1.30 |
| 25 | 2.00 | 2.00 | 1.50 | 1.45 |
| 40 | 2.30 | 2.35 | 1.75 | 1.70 |
| 50 | 2.60 | 2.60 | 2.00 | 2.00 |
| 65 | 2.80 | 2.90 | 2.20 | 2.10 |
| 80 | 3.10 | 3.20 | 3.35 | 2.30 |
| 90 | 3.35 | 3.35 | 2.50 | 2.50 |
| 100 | 3.50 | 3.60 | 2.75 | 2.70 |
| 125 | 3.90 | 3.90 | 3.05 | 2.90 |
| 150 | 4.20 | 4.25 | 3.25 | 3.20 |
| 200 | 4.70 | 4.90 | | |
| 250 | 5.20 | 5.30 | | |
| 300 | 5.55 | 5.80 | | |

| TABLE I. MAXIMUM SPAN FOR PIPE (FEET-INCHES) | | | | |
|---|---|---|---|---|
| DIAMETER INCHES | STD. WT. STEEL PIPE SCHEDULE 40 | EX. STRONG STEEL PIPE SCHEDULE 80 | COPPER TUBE TYPE K | COPPER TUBE TYPE L |
| 1/2 | 5'-0" | 5'-0" | 3'-9" | 3'-9" |

| TABLE I. MAXIMUM SPAN FOR PIPE (FEET-INCHES) | | | | |
|---|---|---|---|---|
| DIAMETER INCHES | STD. WT. STEEL PIPE SCHEDULE 40 | EX. STRONG STEEL PIPE SCHEDULE 80 | COPPER TUBE TYPE K | COPPER TUBE TYPE L |
| 3/4 | 5'-9" | 5'-9" | 4'-3" | 4'-3" |
| 1 | 6'-6" | 6'-6" | 5'-0" | 4'-9" |
| 1-1/2 | 7'-6" | 7'-9" | 5'-9" | 5'-6" |
| 2 | 8'-6" | 8'-6" | 6'-6" | 6'-6" |
| 2-1/2 | 9'-3" | 9'-6" | 7'-3" | 7'-0" |
| 3 | 10'-3" | 10'-6" | 7'-9" | 7'-6" |
| 3-1/2 | 11'-0" | 11'-0" | 8'-3" | 8'-3" |
| 4 | 11'-6" | 11'-9" | 9'-0" | 8'-9" |
| 5 | 12'-9" | 13'-0" | 10'-0" | 9'-6" |
| 6 | 13'-9" | 14'-0" | 10'-9" | 10'-6" |
| 8 | 15'-6" | 16'-0" | | |
| 10 | 17'-0" | 17'-6" | | |
| 12 | 18'-3" | 19'-0" | | |

### 3.1.9 Pressure Gages

Provide pressure gages with a shut-off valve or petcock installed between the gage and the line.

### 3.1.10 Strainers

Provide strainers with meshes suitable for the services where indicated, or where dirt might interfere with the proper operation of valve parts, orifices, or moving parts of equipment.

### 3.1.11 Equipment Foundations

Provide equipment foundations of sufficient size and weight and of proper design to preclude shifting of equipment under operating conditions or under any abnormal conditions which could be imposed upon the equipment. Provide foundations which meet the requirements of the equipment manufacturer, and when required by the Contracting Officer, obtain from the equipment manufacturer approval of the foundation design and construction for the equipment involved. Equipment vibration shall be maintained within acceptable limits, and shall be suitably dampened and isolated.

### 3.1.12 Equipment Installation

Install equipment strictly in accordance with these specifications, and the manufacturers' installation instructions. Grout equipment mounted on concrete foundations before piping is installed. Install piping in a manner that does not place a strain on any of the equipment. Do not bolt flanged joints tight unless they match properly. Extend expansion bends adequately before installation. Grade, anchor, guide and support piping without low pockets.

### 3.1.13 Cleaning of System

Clean the various system components before final closing as the installations are completed. Remove foreign matter from equipment and surrounding areas. Preliminary or final tests will not be permitted until the cleaning is approved by the Contracting Officer.

### 3.1.14 Pipe Sleeves

Provide pipe sleeves where pipes and tubing pass through masonry or concrete walls, floors, roofs, and partitions. Hold sleeves securely in proper position and location before and during construction. Sleeves shall be of sufficient length to pass through entire thickness of walls, partitions, or slabs. Extend sleeves in floor slabs 50 mm 2 inches above the finished floor. Pack space between the pipe or tubing and the sleeve firmly with oakum and caulk both ends of the sleeve with elastic cement.

### 3.1.15 Floor, Wall, and Ceiling Plates

Provide chromium-plated steel or nickel-plated cast iron plates on pipes passing through floors and partitions of finished rooms. Provide painted cast-iron, malleable iron, or steel for other areas.

### 3.1.16 Flashing for Buildings

Provide flashing [as required] [in accordance with Section 07 60 00 FLASHING AND SHEET METAL] where pipes pass through building roofs and outside walls.

### 3.1.17 Unions and Flanges

Provide unions and flanges where necessary to permit easy disconnection of piping and apparatus, and as indicated. Provide a union for each connection having a screwed-end valve. [Provide unions or flanges not farther apart than 30 meters 100 feet.] [Provide unions or flanges as indicated.] Provide unions on piping under 50 mm 2 inches in diameter, and provide flanges on piping 50 mm 2 inches and over in diameter. Install dielectric unions or flanges between ferrous and non-ferrous piping, equipment, and fittings; except that bronze valves and fittings may be used without dielectric couplings for ferrous-to-ferrous or non-ferrous to non-ferrous connections.

### 3.1.18 Painting of Piping and Equipment

Paint piping and equipment in accordance with Section 09 90 00 PAINTS AND COATINGS.

### 3.1.19 Identification of Piping

Identify piping in accordance with PFI ES 22. Use commercially manufactured piping identification labels. Space identification marking on runs not farther apart than 15 meters 50 feet. Provide two copies of the piping identification code framed under glass and install where directed.

### 3.1.20 Warning and Identification Tape

Coordinate installation of utility warning and identification tape with backfill operation. Provide tape above buried lines at a depth of 200 to 300 mm 8 to 12 inches below finish grade.

## 3.2 CLEANING SILVERBRAZED PIPING

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**NOTE: All silverbrazed piping, including low pressure systems, should be cleaned to preclude corrosion from residual brazing flux.**

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Clean silverbrazed piping to remove residual flux remaining in the system after fabrication. Use one of the procedures below. The hot flush and hot recirculating flush are preferred. Minimum flow rate through any part of the system in liters per second gallons per minute shall be 0.0037 1.5 times the inside diameter of the pipe in mm inches. For any flushing method used, the system shall be full of water so that joints are completely submerged at all times.

### 3.2.1 Hot Flushing Method

Hot flush the system for one hour using heated fresh water. No part of the system shall go below 43 degrees C 110 degrees F.

### 3.2.2 Hot Recirculating Flush Method

Perform hot recirculating flush for one hour. Heat water during flushing so that no part of the system falls below 43 degrees C 110 degrees F. After completing the hot recirculating flush, flush the system with cold fresh water for 15 minutes.

### 3.2.3 Cold Soak Method

Cold soak the system using fresh water at not less than 15.50 degrees C 60 degrees F for 12 hours. Following the 12 hour soak, flush the system with fresh water at not less than 15.50 degrees C 60 degrees F for 4 hours.

## 3.3 FIELD QUALITY CONTROL

### 3.3.1 Examinations

#### 3.3.1.1 Welding Examinations

[The Contractor shall] [The Government will] perform visual examinations to detect surface and internal discontinuities in completed welds. NDE on piping welds covered by ASME B31.9 is visual inspection only. Verify piping welds meet the acceptance criteria. Submit a NDE report meeting the requirements specified in ASME B31.9. Visually examine all welds.

When examination indicates defects in a weld joint, the weld shall be repaired by a qualified welder. Remove and replace defects as specified in ASME B31.1, unless otherwise specified. Repair defects discovered between weld passes before additional weld material is deposited. Whenever a defect is removed, and repair by welding is not required, blend the affected area into the surrounding surface, eliminating sharp notches, crevices, or corners. After defect removal is complete and before rewelding, examine the area by the same methods which first revealed the defect to ensure that the defect has been eliminated. After rewelding, reexamine the repaired area by the same test methods originally used for that area. Any indication of a defect shall be regarded as a defect unless reevaluation by surface conditioning and reexamination shows that no unacceptable defects are present. The use of any foreign material to mask, fill in, seal, or disguise welding defects will not be permitted.

3.3.1.2 Brazing Examinations

The Contractor shall perform brazing examinations. Visually examine all compressed air systems as follows:

a. Check brazed joint fit-up. Diametrical clearances shall conform to brazing procedure requirements.

b. Check base material of pipe and fitting for conformance to the applicable drawing or specification.

c. Check grade of brazing alloy for conformance to the brazing procedure before fit-up or brazing.

d. Check completed brazed joint for a complete ring of brazing alloy between the outside surface of the pipe and the face of the fitting, and for a visible fillet.

e. Check stainless steel and other susceptible material for evidence of stress cracks. Check inside of joint if possible with borescope or other aids.

Defective joints may be repaired. However, no more than two attempts to repair by reheating and additional face feeding of brazing filler metal will be permitted, after which the defective joint shall be unsweated, reprepared as a new joint, examined for defects on pipe and fittings, and rebrazed.

3.3.2 Testing

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**NOTE: If air (pressure) drop tests are used for system acceptance, assure leakages at acceptable rates through valves (or other components) are not causing pressure drop. Most hard-seated valves have some allowable leakage rate (about 10 cubic centimeters 0.0026 gal per hour of water per 25 mm one inch of valve size or 3 liters per hour 0.1 cubic feet per hour of gas per mm inch of valve size). Delete check for cross-connection if only one type of system is involved in project.**

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3.3.2.1 General Requirements, Testing

Perform testing after cleaning. Contractor shall provide everything required for tests. Tests shall be subject to the approval of the Contracting Officer. Calibrate the test pressure gages with a dead weight tester within [15] [_____] days before use and certify by initial and date on a sticker applied to dial face. [Pressurize each piping system individually and check to assure that there are no cross-connections between different systems prior to hydrostatic and operational tests.]

3.3.2.2 Hydrostatic Tests and Leak Tightness Tests

a. Preliminary Preparation

Remove or isolate from the system the compressor, air dryer, filters, instruments, and equipment which would be damaged by water during hydrostatic tests and reinstall after successful completion of tests.

b. Performance of Hydrostatic Tests

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**NOTE: Specify or show on the drawings the design working pressure of each system in the project.**
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Hydrostatically test piping systems in accordance with ASME B31.1. Vent or flush air from the piping system. Pressurize system for 10 minutes with water at one and one-half times design working pressure, then reduce to design working pressure and check for leaks and weeps.

c. Compressed Air Leak Test

After satisfactory completion of hydrostatic pressure test, blow systems dry with clean, oil-free compressed air, and test with clean, dry air at design working pressure. Brush joints with soapy water solution to check for leaks. Install a calibrated test pressure gage in piping system to observe any loss in pressure. Maintain required test pressure for a sufficient length of time to enable an inspection of joints and connections.

3.3.2.3 Operational Tests

Test equipment as in service to determine compliance with contract requirements and warranty. During the tests, test equipment under every condition of operation. Test safety controls to demonstrate performance of their required function. Completely test system for compliance with specifications.

3.4 INSTRUCTION TO GOVERNMENT PERSONNEL

Provide [2] [_____] man-days of instruction to [2] [_____] Government personnel in accordance with Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS for each type of compressor and compressed air dryer in the project.

-- End of Section --