

## **SECTION 22 20 00**

### **LABORATORY AIR COMPRESSORS AND VACUUM PUMPING SYSTEMS**

#### **PART 1 - GENERAL**

##### 1.1 RELATED DOCUMENTS:

- A. The Conditions of the Contract and applicable requirements of Division 1, "General Requirements", and Section 23 01 00, "Mechanical General Provisions", govern this Section.

##### 1.2 DESCRIPTION OF WORK:

- A. Work Included: Provide laboratory air compression and pumping systems as specified, scheduled, and indicated.
- B. Types: The types of laboratory pumping systems required for the project include, but are not limited to, the following:
  - 1. Laboratory air compressors.
  - 2. Laboratory vacuum pumps.

##### 1.3 QUALITY ASSURANCE:

- A. Manufacturers: Provide products complying with these specifications and produced by one of the following:
  - 1. Pumps:
    - a. Chemetron
    - b. Beacon Medical Products
    - c. Squire-Cogswell.
    - d. Busch.
    - e. AirtechSouth.
- B. Electrical Standards: Provide electric motors and products which have been listed and labeled by Underwriters' Laboratories, Inc. (UL) and comply with National Electrical Manufacturers' Association (NEMA) standards.

##### 1.4 SUBMITTALS:

- A. Shop drawing submittals shall include, but not be limited to, the following:
  - 1. Cut sheets on the following:
    - a. Laboratory Air compressor package, accessories, features, capacities, listings and all other features required to determine system characteristics.
    - b. Laboratory Vacuum pump package, accessories, features, capacities, listings and all other features required to determine system characteristics.
    - c. Controllers with all components and wiring diagrams.
    - d. Refrigerated Air Dryers.
    - e. [Bypass] [Discharge] Filters.**
  - 2. Floor plan layout showing all system components in the space available on the drawings.
  - 3. Additional information as required in Section 23 01 00.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver pumping systems, controllers, and accessories in factory-fabricated water-resistant wrapping.
- B. Handle pumping systems, controllers, and accessories carefully to avoid damage to material component, enclosure, and finish.
- C. Store pumping systems, controllers, and accessories in a clean, dry space and protect from the weather.

**PART 2 - PRODUCTS**

**[EDIT TO SUIT PROJECT]**

2.1 LABORATORY AIR COMPRESSORS

- A. General: Provide a factory assembled packaged **[duplex] [triplex], [skid mounted] [horizontal receiver mounted]** oil-free **[reciprocating] [liquid-ring]** air compressor assembly with all required trim and components for a complete and operational system. **Where self-contained breathing apparatus or supplied breathing air is required**, the system shall be capable of providing revised Grade "D" air quality as specified by CGA standards. **Pre-approval for such equipment must be secured from EHLS**

**[Select one of the following]**

- B. Compressors: Air compressors shall be the oil-free reciprocating types. Compressors shall be vertical, air-cooled, non-lubricated type designed with a positive pressure compressed air seal to prevent migration of lubricating oil from the crankcase to the compression chamber.
  - 1. Each compressor shall be capable of [ ]SCFM inlet capacity at 50 PSIG minimum with high efficiency open drip-proof motors rated for [ ] HP, **[460]** V, 3 PH, 60 hz. Refer to Section 23 04 00 for additional motor requirements.
  - 2. Motor-compressor units shall be capable cycling at a maximum rate of 10 starts per hour and shall be pressure controlled for on/off cycling.]

**[Or]**

- C. Compressors: Air compressors shall be the oil-free, single-stage, positive-displacement, non-pulsating, liquid ring type. Compressors shall have enclosed rotors, conical porting to facilitate adjustment of internal clearances and single piece cast iron bodies.
  - 1. Each compressor shall be capable of [ ]SCFM inlet capacity at [ ] PSIG minimum and shall be flexible coupled to a high efficiency open drip-proof motors rated for [ ] HP, **[460]** V, 3 PH, 60 Hz. Refer to Section 23 04 00 for additional motor requirements.
  - 2. Motor-compressor units shall be capable cycling at a maximum rate of 10 starts per hour and shall be pressure controlled for on/off cycling.

**[Use the following with liquid ring compressors]**

- D. Compressor Cooling: Each compressor shall be cooled using a **[recirculated]** compressant seal water system including **[a heat exchanger and]** provisions for a **[1.0] [ ]** gpm fresh water constant purge. **[Heat exchanger shall be of a tube and shell design and shall be sized for nominal [61°F] cooling water in the heat exchanger shell.]** The cooling system shall be completely factory piped and wired such that the only required field connections shall be cold water supply[.] **[and] drain[.] [and cooling water supply and return.]** All required, isolation valves, control valves, controls, backflow preventers and other accessories shall be factory installed, piped, wired and tested. **[A separate manually valved [7.0] [ ] gpm once-through seal water system shall be provided for backup operation.]** A Clayton RP-2 or approved equal reduced pressure type backflow preventer

shall be provided on the inlet to the seal water supply system. A high temperature sensor shall be factory installed in each cooling water circuit and shall be factory wired to a terminal block in the compressor control panel for monitoring **[by \_\_\_\_\_.]**

- E. **Controller:** All electrical controls shall be furnished in a UL approved NEMA 1 control panel for sequential operation of the compressors and shall be **[factory mounted on the package] [wired for remote wall mounting].**
1. Panel shall include:
    - a. **[2][3]** - Magnetic full voltage, non reversing (FVNR) magnetic motor starters with three phase overload protection.
    - b. **[3][4]** - Fused disconnect switches, one for each compressor and one for the control transformer.
    - c. **[2][3]** - Run time meters, one for each compressor.
    - d. Cam time alternator to automatically switch lead/lag operating sequence of the compressors.
    - e. Phase failure relay (Refer to Section 23 04 00).
    - f. Primary and secondary fused control power transformer.
    - g. **[2][3]** - HOA switches, one for each compressor.
    - h. **[2][3]** - Red running indicator lamps, one for each compressor.
    - i. Alarm indicator light and silenceable alarm with remote alarm contact for thermal overload (loss of cooling water flow) alarm. This alarm will be monitored by **[\_\_\_\_.]**
  2. The control panel shall be designed for a single [480] Volt, 3 Phase 60 Hz input feeder. Control Power shall have a separate fused disconnect tapped off of the main input feeder such that the compressor disconnect switches do not disconnect control power.
- F. **Refrigerated Air Dryers:** Provide refrigerated type air dryers with capacities as scheduled on the drawings. **[Air dryers shall be piped in parallel with the air purifier for standby use and in series with the air purifier for aftercooling.]**
1. Each air dryer shall be as shown or required and the unit shall be furnished with an on-off power switch, power on light, high air temperature warning light, refrigerant suction pressure gauge, inlet air pressure gauge, outlet air pressure gauge, inlet air temperature gauge, outlet air temperature gauge, automatic drain with shut off valve, thermal protection for the compressor with automatic reset, low ambient fan control, a unit mounted disconnect switch and all controls required for automatic operation.
  2. The dryer installed for bypass use shall be standard air dryer with an air-to-air heat exchanger to reheat discharge air. The air purifier air dryer (aftercooler) shall be similar to a standard air dryer but shall not have an air-to-air heat exchanger and shall have a knob for external adjustments of discharge air temperature from 35°F to 70°F.
  3. Air dryer shall be a **[Hankison Series 80 or approved equal.]**
- G. **[Bypass Loop] [Discharge] Filters:** **[Provide a filtered air purifier bypass loop.]** The filters installed in the air [purifier bypass loop] [compressor discharge] shall consist of a Hankison 3100 Series or approved equal one micron absolute filter with auto drain and a Hankison Model 3801-2 or approved equal activated carbon absorbent filter. Hankison Model 3801-2 or approved equal differential pressure alarms shall be installed across each of the bypass loop filters for monitoring by **[\_\_\_\_\_]** Alarm pressure settings shall be set as recommended by the filter manufacturer. The absolute filter auto drain connection shall be piped to the nearest floor drain.]
- H. **Aftercooler:** Factory assembled Medical Air Compressor package shall include integral aircooled aftercoolers with 25°F CTD.]

- I. Accessories: Provide a weatherproof outside air intake filter/muffler for installation on the system intake. Provide the following accessories for each compressor: isolation valves, pressure relief valves, inlet and discharge check valves, regulators, pressure reducing valves, gauge glass and ball float valves, pressure switches, flow control valves, solenoid valves, strainers, shock arrestors, flexible connections, flow switches, gauges and other required accessories for a complete and fully functional and operational system.
- J. Air Tank: Provide a [ ] [gallon] [cubic foot] vertical galvanized 125 psi ASME air receiver suitable for [medical] [laboratory] air use and provided with suitable leg supports, automatic drain, tank level sight glass, ASME pressure relief valve and pressure gauges. Tank shall be factory mounted on the compressor skids and pre-piped.
- K. Factory Testing: The compressor manufacturer shall conduct factory tests to verify that the actual compressor performance is within 5 percent of the specified rating and that compressor power consumption does not exceed the nominal rating or the compressor horsepower nominal rating. Certified test data shall be included in the system Operating and Maintenance Manuals.
- L. Components: All components of the Laboratory Air Compressor System shall be furnished by a single supplier who shall provide a complete shop drawing package detailing all system components and with detailed system field installation drawings. The supplier shall certify that the system as provided meets all the requirements of NFPA 56F and 99.
- M. Testing, Start-up and Certification: The entire installation of the Laboratory Air Compressor System shall be checked out, tested, started up and certified by the system supplier. After checkout, testing and startup, the system supplier shall provide the Owner with a notarized letter certifying that the system is properly sized and installed and that the system is in proper working order and complies with all applicable requirements of NFPA 56F and 99. Refer to Section 23 05 3 for additional testing requirements.

## 2.2 LABORATORY VACUUM PUMPS

- A. General: Provide a factory assembled packaged [duplex] [triplex], [skid mounted] [horizontal receiver mounted] [rotary vane] [liquid ring] type vacuum pump assembly with all required trim and components for a complete and operational system. The entire system shall be capable of passing liquids and soft solids directly through the vacuum pumps to waste.

### [select one of the following]

- B. Vacuum Pumps: **Vacuum pumps shall be rotary positive displacement, direct drive, total oil recirculated, air cooled type with cast iron body, rotor and end plates. Fiber vanes shall be free sliding in the rotor to compensate for wear and shall be designed for long life operation.**
  - 1. Pumps shall be single stage, multi-vane, rated for continuous duty, capable of operation at 29.3" Hg. The pump shall be equipped with a built-in exhaust filter to make exhaust air 99.9% oil-free, exhaust pressure gauge, inlet check valve, wire mesh inlet screen and full oil recirculation system with four stages of oil separation.
  - 2. Pumps shall run quietly, not to exceed 85 decibels when running and shall be capable of using any standard SAE 10W-30 non-detergent oil.
  - 3. Motor-pump units shall be capable of continuous operation or cycling at a maximum rate of 10 starts per hour and shall be vacuum pressure controlled for on/off cycling.
  - 4. Pumps shall be rated at minimum [ ] SCFM @ [19"][20"] Hg. Motors shall be open drip-proof high efficiency [ ] HP, [460] V, 3 PH, 60 Hz. Refer to Section 23 04 00 for additional motor requirements.

### [Or]

- C. Vacuum Pumps: Vacuum pumps shall be oil-free, single-stage, positive-displacement, non-pulsating, liquid ring type as scheduled. Pumps shall have enclosed rotors and single piece cast iron bodies.

1. Each pump shall be capable of a minimum of [ ] SCFM @ 20" Hg minimum shall be flexible coupled to a high efficiency open drip-proof rated for [ ] HP, [460] V, 3 PH, 60 Hz. Refer to Section 23 04 00 for additional motor requirements.
2. Motor-pump units shall be capable of continuous operation or cycling at a maximum rate of 10 starts per hour and shall be vacuum pressure controlled for on/off cycling.]

**[Use the following with liquid ring compressors]**

- D. Pump Cooling: Each pump shall be cooled using a **recirculated** compressant seal water system including [a heat exchanger and] provisions for a [1.2] [ ] gpm fresh water constant purge. **[Heat exchanger shall be of a tube and shell design and shall be sized for nominal [61°F] cooling water in the heat exchanger shell.]** The cooling system shall be completely factory piped and wired such that the only required field connections shall be cold water supply[,] **[and] drain [.] [and cooling water supply and return.]** All required, isolation valves, control valves, controls, backflow preventers and other accessories shall be factory installed, piped, wired and tested. **[A separate manually valved [12.0] [ ] gpm once-through seal water system shall be provided for backup operation.]** A Clayton RP-2 or approved equal reduced pressure type backflow preventer shall be provided on the inlet to the seal water supply system. A high temperature sensor shall be factory installed in each cooling water circuit and shall be factory wired to a terminal block in the pump control panel for monitoring **[by \_\_\_\_\_.]**
- E. Controller: All electrical controls shall be furnished in a UL approved NEMA 1 control panel for sequential operation of the compressors and shall be **[factory mounted on the package] [wired for remote wall mounting]**.
1. Panel shall include:
    - a. **[2][3]** - Magnetic full voltage, non-reversing (FVNR) motor starters with three phase overload protection.
    - b. **[3][4]** - Fused disconnect switches, one for each pump and one for the control transformer.
    - c. **[2][3]** - Run time meter, one for each vacuum pump.
    - d. A cam time alternator to automatically switch lead/lag operating sequence of the pumps.
    - e. A phase failure relay (Refer to Section 23 04 00).
    - f. Primary and secondary fused control power transformer.
    - g. **[2][3]** - HOA switches, one for each pump.
    - h. **[2][3]** - Red running indicator lamps, one for each pump.
    - i. Alarm indicator light and silenceable alarm with remote alarm contact for thermal overload (loss of cooling water flow) alarm. This alarm will be monitored by **[\_\_\_\_\_.]**
  2. The control panel shall be designed for a single **[480]** Volt, 3 Phase 60 Hz input feeder. Control Power shall have a separate fused disconnect tapped off of the main input feeder such that the compressor disconnect switches do not disconnect control power.
- F. Vacuum Tank: Provide a [ ] **[gallon] [cubic foot]** vertical galvanized 125 psi ASME vacuum receiver suitable for **[medical] [laboratory]** vacuum use and provided with tank drain valve, relief valve, gauge glass assembly and tank gauge.
- G. Accessories: Provide gauges, isolation valves, inlet check valves, sediment strainers, vacuum switches, flow control valves, solenoid valves, shock arrestors, antisiphon fittings, flexible connections, flow switches, discharge separators/ silencers and other required accessories for a complete and fully functional and operational system.
- H. Factory Testing: The pump manufacturer shall conduct factory tests to verify that the actual pump performance is within 5 percent of the specified rating and that pump power consumption does not

exceed the nominal rating or the pump horsepower nominal rating. Certified test data shall be included in the system Operating and Maintenance Manuals. Refer to Section 23 05 93.

- I. Components: All components of the Laboratory Vacuum Pump System shall be furnished by a single supplier who shall provide a complete shop drawings package detailing all system components and with detailed system field installation drawings. The supplier shall certify that the system as provided meets all the requirements of NFPA 99F.
- J. Testing, Start-up and Certification: The entire installation of the Laboratory Vacuum System shall be checked out, tested, started up and certified by the system supplier. After checkout, testing and startup, certifying that the system is properly sized and installed and that the system is in proper working order and complies with all applicable requirements of NFPA 99. Refer to Section 23 05 93 for additional testing requirements.

### **PART 3 - EXECUTION**

#### 3.1 INSTALLATION:

- A. General: Installer shall examine conditions under which pumping are to be installed and notify Contractor in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.
- B. Installation: The systems shall be installed as shown on the drawings and in accordance with manufacturer's written instructions and detailed field installation drawings.
- C. Alignment: Check alignment and, where necessary, realign shafts of motors and pumps within tolerances recommended by manufacturer.
- D. Housekeeping Pads/Vibration Isolation: Refer to Section 23 03 00 and Section 23 05 48 for applicable requirements.
- E. Drain Lines: Provide drain lines (3/4" minimum) from each pumping system to the nearest floor drain.
- F. **Cooling Water: Coordinate cooling water connections to the system[.] [with the HVAC Subcontractor.]**
- G. Air Compressor Intake: The air compressor filter shall be located **[as shown on the Drawings] [a minimum of 3 feet above the roof level]**, a minimum of 25 feet away from sources of contamination and a minimum of 10 feet away from the other intakes.
- H. Vacuum Pump Discharge: The vacuum pump discharges shall be discharged through the roof and shall be turned down and screened to prevent entry of water, insects and foreign matter. The discharge outlet shall be located a minimum of 25 feet from any air intakes.

#### 3.2 START-UP SERVICES:

- A. General: The pumping system supplier shall provide pump checkout, start-up, testing and adjusting of system components. The pump supplier shall also train the Owner's Engineer in the proper operation and maintenance of these pumping systems.
- B. Checkout: After pumps have been in operation for 90 days, the contractor shall check all seals and replace any which are defective.

#### 3.3 TESTING:

- A. General: Test and adjust all installed laboratory pumps[.] **[and] controllers[, and annunciators]** to verify proper operation as specified herein and as recommended by the manufacturers. Where specified hereinabove, start-up, testing, and adjustment shall be provided by a representative of the equipment supplier.
- B. Functional Tests: Test pumps[.] **[and] controllers[, and annunciators]** to verify that all control, alarm and indicator functions operate properly and to verify that pump discharge pressures and flows are as specified.

C. Refer to Section 23 05 93 for additional start-up, testing, and adjustment requirements.

3.4 IDENTIFICATION:

A. Refer to Section 23 03 00 for applicable painting, nameplates, and labeling requirements.

**END OF SECTION 22 20 00**