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USACE / NAVFAC / AFCEC / NASA **UFGS 22 60 70 (May 2020)**

Preparing Activity: USACE **Superseding**
UFGS 22 60 70 (May 2009)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021

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SECTION TABLE OF CONTENTS

DIVISION 22 - PLUMBING

SECTION 22 60 70

GAS AND VACUUM SYSTEMS FOR HEALTHCARE FACILITIES

05/20

PART 1 GENERAL

1.1 REFERENCES
1.2 SYSTEM DESCRIPTION
1.2.1 Design Requirements
1.2.1.1 Patient Care Systems
1.2.1.2 Dental Surgical Vacuum (DSV), Medical-Surgical Vacuum (MV), and Waste Anesthesia Gas Disposal (WAGD)
1.2.1.3 Oral Evacuation (OE)
1.2.1.4 Support Utilities
1.2.1.5 High-volume Laboratory Dust Evacuation (LE)
1.2.2 Sustainable Design Requirements
1.2.2.1 Environmental Data
1.2.3 Performance Requirements
1.2.4 Accessibility of Equipment
1.3 SUBMITTALS
1.4 QUALITY ASSURANCE
1.4.1 Manufacturer Qualifications
1.4.2 Installer Qualifications
1.4.3 Agency Qualifications
1.4.3.1 Inspector qualifications
1.4.3.2 Verifier qualifications
1.4.4 Certifying Agency Qualifications
1.4.5 Regulatory Requirements
1.4.5.1 Standards
1.4.5.2 Referenced Publications
1.4.5.3 Alternative Qualifications
1.4.5.4 Service Support
1.4.6 Shop Drawings
1.5 DELIVERY, STORAGE, AND HANDLING
1.6 COMMISSIONING
1.6.1 Inspection, Testing, and Verification Agency
1.6.2 Responsibilities

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS
2.2 MANUFACTURER'S NAMEPLATE
2.3 BULK LIQUID OXYGEN (LOX) SOURCE
2.4 EMERGENCY OXYGEN SUPPLY CONNECTION
2.5 CYLINDER MANIFOLD SUPPLY SOURCE
2.6 DENTAL COMPRESSED AIR (DA) SOURCE
2.6.1 Air Compressors
2.6.2 Air Receiver
2.6.3 Control Panel
2.6.4 Desiccant Air Dryers
2.6.5 Filtration and Pressure Reducing Station
2.6.6 Dew Point Monitor
2.6.7 Carbon Monoxide Monitor
2.7 DENTAL SURGICAL VACUUM (DSV) SOURCE
2.7.1 Vacuum Pumps
2.7.2 Vacuum Receiver
2.7.3 Control Panel
2.8 DENTAL ORAL EVACUATION (OE) SOURCE
2.8.1 Vacuum Pumps
2.8.1.1 Turbines
2.8.1.2 Rotary-Vane Vacuum Pump
2.8.1.3 Regenerative Blower
2.8.2 Pipe Isolators
2.8.3 Valves
2.8.3.1 Volume Control Valve
2.8.3.2 Antisurge Valve
2.8.3.3 Directional Flow Valve
2.8.4 Exhaust Silencer
2.8.5 Control Panel
2.8.6 Central Wet Separators
2.8.7 Vacuum Relief Valve
2.8.8 Amalgam Separator
2.9 HIGH-VOLUME LABORATORY DUST EVACUATION (LE) SOURCE
2.9.1 Vacuum Pumps
2.9.2 Motor
2.9.3 Isolation Pads
2.9.4 Pipe Isolators
2.9.5 Volume Control Device
2.9.6 Exhaust Silencer
2.9.7 Control Panel
2.9.8 Central Separator
2.9.9 Primary Separator
2.9.10 Air Volume Relief Valve
2.9.11 Vacuum Inlets
2.10 MEDICAL COMPRESSED AIR (MA) SOURCE
2.10.1 Air Compressors
2.10.2 Air Receiver
2.10.3 Control Panel
2.10.4 Desiccant Air Dryers
2.10.5 Filtration and Pressure Reducing Station
2.10.6 Dew Point Monitor
2.10.7 Carbon Monoxide Monitor
2.11 MEDICAL-SURGICAL VACUUM (MV) SOURCE
2.11.1 Vacuum Pumps
2.11.2 Vacuum Receiver
2.11.3 Control Panel
2.12 WASTE ANESTHESIA GAS DISPOSAL VACUUM (WAGD) SOURCE
2.12.1 Vacuum Pumps
2.12.2 Vacuum Receiver

2.12.3 Control Panel
2.13 INSTRUMENT COMPRESSED AIR (IA) SOURCE
2.13.1 Air Compressors
2.13.2 Control Panel
2.13.3 Air Receiver
2.13.4 Desiccant Air Dryers
2.13.5 Filtration and Pressure Reducing Station
2.13.6 Dew Point Monitor
2.14 LAB COMPRESSED AIR (LA) [AND PROCESS COMPRESSED AIR (PA)] SOURCE
2.14.1 Air Compressors
2.14.2 Air Receiver
2.14.3 Control Panel
2.14.4 Desiccant Air Dryers
2.14.5 Filtration and Pressure Reducing Station
2.14.6 Dew Point Monitor
2.15 PIPE AND FITTINGS
2.15.1 Service Entrance
2.15.2 Positive pressure piping systems up to 1379 kPa 200 psi
2.15.3 [Dental surgical] [Medical-Surgical] Waste Anesthesia Gas Disposal vacuum piping systems up to 34 kPa 20 inches Hg vacuum
2.15.4 Dental Oral Evacuation System
2.15.5 High-Volume Laboratory Dust Evacuation System
2.15.6 Compressed Air Intake and Vacuum Pump Exhaust Line(s)
2.16 VALVES AND ASSEMBLIES
2.16.1 Valves
2.16.2 Zone Valve Assemblies
2.17 NITROGEN AND INSTRUMENT COMPRESSED AIR CONTROL PANELS
2.18 HANGERS AND SUPPORTS
2.19 GAUGES
2.20 DENTAL GAS AND SUPPORT SYSTEMS OUTLETS AND VACUUM SYSTEMS INLETS
2.20.1 Station Outlets/Inlets
2.20.1.1 Couplers
2.20.1.2 Faceplates
2.20.1.3 Rough-In Assembly
2.20.1.4 Ceiling Applications/Hose Assemblies
2.20.1.5 Vacuum Slides
2.20.2 Dental Compressed Air Outlets
2.20.3 Dental Oral Evacuation Inlets (Dental Treatment Room)
2.21 MEDICAL GAS AND SUPPORT SYSTEMS OUTLETS AND VACUUM SYSTEMS INLETS
2.21.1 Station Outlets/Inlets
2.21.1.1 Couplers
2.21.1.2 Faceplates
2.21.1.3 Rough-In Assembly
2.21.1.4 Ceiling Applications/Hose Assemblies
2.21.1.5 Vacuum Slides
2.22 LABORATORY COMPRESSED AIR [AND PROCESS COMPRESSED AIR] TERMINATION
2.23 WARNING SYSTEMS
2.23.1 Master Alarm Panels
2.23.2 Area Alarm Panels
2.23.3 Local Alarm Panels
2.24 IDENTIFICATION MATERIALS
2.24.1 Plastic Pipe Markers
2.24.2 Valve Tags
2.24.3 Engraved Plastic Laminate Signs
2.24.4 Plastic Equipment Markers
2.24.5 Plasticized Tags
2.24.6 Lettering and Graphics

PART 3 EXECUTION

3.1 EXAMINATION
3.2 BULK LIQUID OXYGEN SOURCE
3.3 EMERGENCY OXYGEN SUPPLY CONNECTION
3.4 CYLINDER MANIFOLD SUPPLY SOURCE
3.5 COMPRESSED AIR AND VACUUM SOURCES
3.5.1 Central Dry Separator for High-Volume Laboratory Dust Evacuation
3.5.2 Amalgam Separator for Dental Oral Evacuation
3.6 PIPING SYSTEMS
3.7 STATION OUTLETS/INLETS
3.7.1 Wall Outlets/Inlets
3.7.2 DISS Connections
3.7.3 Height of Hose-reel Type Outlets/Inlets
3.8 VALVES AND ASSEMBLIES
3.9 GAUGES
3.10 VIBRATION-ABSORBING FEATURES
3.10.1 Tank or Skid Mounted Compressors
3.10.2 Foundation Mounted Compressors
3.11 TRAINING
3.12 IDENTIFICATION SYSTEMS
3.12.1 Piping System Identification
3.12.2 Valves
3.12.3 Medical/Dental Source Equipment
3.12.4 Pipe Color Code Marking
3.12.5 Color Coding Scheme for Locating Hidden Utility Components
3.13 GAS, SUPPORT, AND VACUUM SYSTEMS TESTING
3.13.1 Joint Validation
3.13.2 Camera Inspection
3.13.3 Test Reports
3.13.4 Report Status
3.13.5 Tests and Reports Prior to Start of Installation
3.13.6 Category 3 Systems Testing
3.13.6.1 General
3.13.6.2 Initial Tests and Reports - All Category 3 Systems
3.13.6.3 I,T&V Agency Tests and Reports
3.13.6.4 Final Tests and Reports - All Category 3
3.13.7 Category 1 Systems Testing
3.13.7.1 General
3.13.7.2 Installer Performed Tests and Reports
3.13.7.3 I,T&V Agency Tests and Reports
3.14 WARNING SYSTEM
3.15 EXISTING PIPED DISTRIBUTION SYSTEMS

-- End of Section Table of Contents --

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SECTION 22 60 70

GAS AND VACUUM SYSTEMS FOR HEALTHCARE FACILITIES
05/20

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NOTE: This specification covers the requirements for medical and dental gas, support and vacuum systems for healthcare facilities.

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).
****

PART 1 GENERAL

****
NOTE: This guide specification covers healthcare facility dental and medical gas, support gas, and vacuum systems. This specification essentially implements the requirements of NFPA 99.

Show the following information on project drawings:

1. Only drawings (not specifications) should indicate capacity, efficiency, dimensions, details, plan view, sections, elevations, locations of fixtures and equipment, and space required for maintenance of equipment.

2. Configuration, slope, and location of each piping system such as: above or below floors, above

or below ceilings, above or below roofs, above or below ground.

3. Location of each sectionalizing valve.

****

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 ID 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.

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	(2015) Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A108.11	(1992; Reaffirmed 2005) Specifications for Interior Installation of Cementitious Backer Units

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A13.1	(2020) Scheme for the Identification of Piping Systems
ASME B16.22	(2018) Standard for Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.50	(2013) Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings
ASME B40.100	(2013) Pressure Gauges and Gauge

Attachments

ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 6000 SERIES	(2012) Professional Qualification Standard for Medical Gas Systems Installers, Inspectors and Verifiers

AMERICAN WELDING SOCIETY (AWS)

AWS C3.8M/C3.8	(2011) Specification for the Ultrasonic Pulse-Echo Examination of Brazed Joints

ASTM INTERNATIONAL (ASTM)

ASTM B88	(2020) Standard Specification for Seamless Copper Water Tube
ASTM B819	(2000; R 2011) Standard Specification for Seamless Copper Tube for Medical Gas Systems
ASTM D2564	(2012) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D2665	(2014) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM E2129	(2018) Standard Practice for Data Collection for Sustainability Assessment of Building Products
ASTM F437	(2015) Standard Specification for Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F439	(2019) Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F441/F441M	(2020) Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
ASTM F493	(2020) Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings

COMPRESSED GAS ASSOCIATION (CGA)

CGA G-4.1	(2009) Cleaning Equipment for Oxygen Service; 6th Edition
CGA M-1	(2018) Standard for Medical Gas Supply

	Systems at Health Care Facilities; 4th Edition
CGA V-5	(2019) Diameter-Index Safety System (Non-Interchangeable Low Pressure Connections for Medical Gas Applications); 6th Edition

INTERNATIONAL CODE COUNCIL (ICC)

ICC IPC	(2018) International Plumbing Code

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 9001	(2015) Quality Management Systems-Requirements
ISO 11143	(2008) Dentistry - Amalgam Separators

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2018) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA MG 1	(2018) Motors and Generators
NEMA Z535.1	(2017) Safety Colors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 55	(2016; TIA 16-1; TIA 16-2) Compressed Gases and Cryogenic Fluids Codes
NFPA 99	(2021) Health Care Facilities Code

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

29 CFR 1910.144	Safety Color Code for Marking Physical Hazards

UNDERWRITERS LABORATORIES (UL)

UL 508A	(2018; Reprint Aug 2020) UL Standard for Safety Industrial Control Panels

1.2 SYSTEM DESCRIPTION

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NOTE:
1. Choice of Category 1, Category 2, or Category 3 gas, support, and vacuum systems is determined by issues involving patient dependency on the system for life, effect of system failure on patient outcomes, and other criteria as defined in NFPA 99.
2. In general, dental facilities (or dental areas within combined medical/dental facilities) utilize Category 2 or Category 3 systems as defined in NFPA 99.

3. In general, medical facilities (or medical areas within combined medical/dental facilities) utilize Category 1 systems in patient care areas and Category 3 systems in non-patient care areas (Category 3 systems, if used, must be entirely separate from Category 1 systems).
4. Determine choice of Category 2 or Category 3 systems by performing and documenting a Risk Assessment as required by NFPA 99, Section 4.2. A Risk Assessment is not required for Category 1 systems.
****

a. Provide the following gas, support, and vacuum systems conforming to NFPA 99 Category 1 criteria: [oxygen (O),] [nitrous oxide (NO),] [medical compressed air (MA),] [NF-nitrogen (N),] [instrument compressed air (IA),] [laboratory compressed air (LA) supplied from IA source,] [process compressed air (PA) supplied from IA source,] [carbon dioxide (CO2),] [medical-surgical vacuum (MV),] [waste anesthesia gas disposal (WAGD)].

b. Provide the following gas, support, and vacuum systems conforming to NFPA 99 Category 2 criteria: [oxygen (O),] [nitrous oxide (NO),] [medical compressed air (MA),] [carbon dioxide (CO2),] [medical-surgical vacuum (MV),] [waste anesthesia gas disposal (WAGD),] [dental compressed air (DA),] [laboratory compressed air (LA),] [process compressed air (PA),] [NF-nitrogen (N),] [dental surgical vacuum (DSV),] [oral evacuation (OE),] [high-volume laboratory dust evacuation (LE)].

c.Provide the following gas, support, and vacuum systems conforming to NFPA 99 Category 3 criteria: [oxygen (O),] [nitrous oxide (NO),] [dental compressed air (DA),] [laboratory compressed air (LA),] [process compressed air (PA),] [NF-nitrogen (N),] [dental surgical vacuum (DSV),] [oral evacuation (OE),] [high-volume laboratory dust evacuation (LE)].

1.2.1 Design Requirements

1.2.1.1 Patient Care Systems

Oxygen (O), Medical Compressed Air (MA), Nitrous Oxide (NO), and Carbon Dioxide (CO2) systems intended for patient care must not be supplied to or used for any purpose other than patient care applications.

1.2.1.2 Dental Surgical Vacuum (DSV), Medical-Surgical Vacuum (MV), and Waste Anesthesia Gas Disposal (WAGD)

Systems are dry vacuum systems and must not be supplied to or used for any purpose other than patient care applications.

1.2.1.3 Oral Evacuation (OE)

System is a wet vacuum system and must not be supplied to or used for any purpose other than patient care applications.

1.2.1.4 Support Utilities

Nitrogen (N), Dental Compressed Air (DA), Instrument Compressed Air (IA),

Laboratory Compressed Air (LA), and Process Compressed Air (PA) systems are support utilities and must not be supplied to or used for patient respiration applications.

1.2.1.5 High-volume Laboratory Dust Evacuation (LE)

System is a dry vacuum system, support utility and must not be supplied to or used for patient care applications.

[1.2.2 Sustainable Design Requirements

1.2.2.1 Environmental Data

****
NOTE: ASTM E2129 provides for detailed documentation of the sustainability aspects of products used in the project. This level of detail may be useful to the Contractor, Government, building occupants, or the public in assessing the sustainability of these products. This is optional for Army projects.
****

Submit Table 1 of ASTM E2129 for products provided under work of this Section the following products: [_____].

]1.2.3 Performance Requirements

a. Provide all labor, equipment and services necessary for and incidental to the installation of piped [dental gas, support, and vacuum systems] [and] [medical gas, support, and vacuum systems]. [Provide oxygen systems complete to the source valve, ready for connection to the bulk gas supply system.] Provide all systems complete, started, tested and ready for use.

b. Government Furnished Materials provided to the Contractor for installation under this section include initial supply of gases in cylinders or containers as appropriate for cylinder sources [_____] [,and initial supply of liquid oxygen].

c. Provide system delivery pressure as follows:

****
NOTE: Process compressed air is generally supplied in the 827-862 kPa 120-125 psi range. However, a lower pressure may be required by the using facility. Modify range only if approved by the using facility.
****

Oxygen, medical compressed air, nitrous oxide, carbon dioxide	379 kPa 55 psi
Dental compressed air	621 kPa 90 psi
Nitrogen, instrument compressed air	1276 kPa 185 psi

Laboratory compressed air	345-379 kPa 50-55 psi
Process compressed air	827-862 kPa 120-125 psi

d. Provide system vacuum as follows:

Dental surgical vacuum, medical-surgical vacuum	37 kPa 19 inches Hg vacuum
Dental oral evacuation	73 kPa 8 inches Hg vacuum
Waste anesthesia gas disposal	60 kPa 12 inches Hg vacuum
High-volume laboratory dust evacuation	91 kPa 3 inches Hg vacuum at separator
kPa is absolute inches Hg vacuum is gauge	

1.2.4 Accessibility of Equipment

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NOTE: The following requirement is intended to solicit the installer's help in the prudent location of equipment when there is some control over locations. However, designers should not rely on it since enforcing this requirement in the field would be difficult. Therefore, the system designer needs to layout and indicate the locations of equipment, control devices, and access doors so that most of the accessibility questions are resolved inexpensively during design.
****

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, and equipment requiring access, in locations freely accessible through access doors.

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-01 Preconstruction Submittals

Manufacturer Qualifications

Installer Qualifications

Inspector Qualifications

Verifier Qualifications

Inspection, Testing, and Verification Agency

Environmental Data; G[, [_____]]

SD-02 Shop Drawings

Dental Gas, Support and Vacuum Systems; G[, [_____]]

Medical Gas, Support and Vacuum Systems; G[, [_____]]

SD-03 Product Data

Bulk Liquid Oxygen (LOX) Source; G[, [_____]]

Emergency Oxygen Supply Connection; G[, [_____]]

Cylinder Manifold Supply Source; G[, [_____]]

Dental Compressed Air (DA) Source; G[, [_____]]

Dental Surgical Vacuum (DSV) Source; G[, [_____]]

Dental Oral Evacuation (OE) Source; G[, [_____]]

High-Volume Laboratory Dust Evacuation (LE) Source; G[, [_____]]

Medical Compressed Air (MA) Source; G[, [_____]]

Lab Compressed Air (LA) [and Process Compressed Air (PA)] Source; G [, [_____]]

Medical-Surgical Vacuum (MV) Source; G[, [_____]]

Waste Anesthesia Gas Disposal Vacuum (WAGD) Source; G[, [_____]]

Instrument Compressed Air (IA) Source; G[, [_____]]

Pipe and Fittings; G[, [_____]]
Valves and Assemblies; G[, [_____]]

Nitrogen and Instrument Compressed Air Control Panels; G[, [_____]]

Hangers and Supports; G[, [_____]]

Dental Gas and Support Systems Outlets and Vacuum Systems Inlets; G [, [_____]]

Medical Gas and Support Systems Outlets and Vacuum Systems Inlets; G[, [_____]]

Warning Systems; G[, [_____]]

Vibration-Absorbing Features; G[, [_____]]

SD-06 Test Reports

Test Reports

SD-07 Certificates

Station Outlets/Inlets

SD-10 Operation and Maintenance Data

Dental Gas, Support, and Vacuum Systems; G[, [_____]]

Medical Gas, Support, and Vacuum Systems; G[, [_____]]

Maintenance Data Package; [1] [2] [3] [4] [5]

Submit in accordance with Section 01 78 23 OPERATIONS AND MAINTENANCE DATA; G[, [____]].

1.4 QUALITY ASSURANCE

1.4.1 Manufacturer Qualifications

Manufacturers must be regularly engaging in the manufacturing, supplying,

and servicing of specified products and equipment, as well as, providing engineering services, for gas and vacuum systems for healthcare facilities. Provide evidence demonstrating compliance for a minimum of 5 years, and on 5 projects of similar complexity.

1.4.2 Installer Qualifications

a. [Dental gas, support, and vacuum systems] [and] [Medical gas, support, and vacuum systems] must be installed only by Certified Medical Gas Installers. Installer ASSE 6000 SERIES (Standard #6010 Medical Gas System Installer) certification card must be issued within the previous 36 months and Installers certified through a recognized third party certification agency. Certification must include the successful completion of a minimum 32-hour training course including a written and a practical examination covering all facets of ASSE 6000 SERIES Standard #6010, NFPA 99, and NFPA 55. Course instruction must have been conducted by a Medical Gas Systems Instructor certified to ASSE 6000 SERIES (Standard #6050 Medical Gas Instructors). The installer must have a minimum of four (4) years of documented practical experience in the installation of medical gas and vacuum piping systems.

[b. Dental oral evacuation systems must be installed only by contractors/tradespersons who have at least 5 years experience installing central oral evacuation systems for dental operatories.]

****
NOTE: Include following if bulk liquid oxygen source is included in project.
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[c. Bulk liquid oxygen systems must be installed only by Certified Bulk Medical Gas System Installer. Installer ASSE 6000 SERIES (Standard #6015 Bulk Medical gas Systems Installers) certification card must be issued within the previous 36 months and Installers certified through a recognized third party certification agency. Certification must include the successful completion of a minimum 32-hour training course including a written and a practical examination covering their firm's standard operating procedures as they relate to bulk installations for medical gases, the FDA CGMP Regulation 21 CFR, Parts 210 and 211, CGA M-1, applicable sections of the ASSE 6000 SERIES Standard #6015), NFPA 99, and NFPA 55. Course instruction must be conducted by a Bulk Medical Gas Systems Instructor certified to ASSE 6000 SERIES (Standard #6050 Medical Gas Systems Instructors). The bulk system installer must have a minimum of four (4) years of documented practical experience in the installation of bulk systems.]

1.4.3 Agency Qualifications

Retained by the general contractor, but independent of the facility, installing contractor, and product manufacturer(s). [The Government will provide [Certified Medical Gas System Inspectors] [and] [Certified Medical Gas System Verifiers] [in addition to the [Certified Medical Gas System Inspectors] [and] [Certified Medical Gas System Verifiers] retained by the general contractor].]

1.4.3.1 Inspector qualifications

Systems must be inspected only by Certified Medical Gas System

Inspectors. Inspector ASSE 6000 SERIES (Standard #6020 Medical Gas Systems Inspectors) certification card must be issued within the previous 36 months and Inspectors certified through a recognized third party certification agency. Certification must include the successful completion of a minimum 24-hour training course including a written and a practical examination covering all facets of ASSE 6000 SERIES (Standard #6020), NFPA 99, NFPA 55. Course instruction must be conducted by a Medical Gas Systems Instructor certified to ASSE 6000 SERIES (Standard #6050 Medical Gas Systems Instructors). Certification to ASSE 6000 SERIES (Standard # 6030 Medical Gas Systems Verifier) meets the requirements of this section. The inspector must have a minimum of four (4) years of documented practical experience in the inspection of medical gas and vacuum systems. [Certified Medical Gas System Inspectors will be retained by the general contractor, independent of Certified Medical Gas System Verifiers.]

1.4.3.2 Verifier qualifications

Systems must be verified only by Certified Medical Gas System Verifiers. Verifier ASSE 6000 SERIES (Standard #6030 Medical Gas System Verifiers) certification card must be issued within the previous 36 months and verifiers certified through a recognized third party certification agency. Certification must include the successful completion of a minimum 32-hour training course including a written and a practical examination covering all facets of ASSE 6000 SERIES Standard #6030, NFPA 99, NFPA 55 and CGA M-1. Course instruction must be conducted by a Medical Gas Systems Instructor certified to ASSE 6000 SERIES (Standard #6050 Medical Gas Systems Instructors). The verifier must have a minimum of four (4) years of documented practical experience in the verification of medical gas and vacuum systems. The verifier must have a current certificate of insurance, in the individual's name or employing verification company for general liability, and professional liability insurance. [Certified Medical Gas System Verifiers will be retained by the general contractor, independent of Certified Medical Gas System Inspectors.]

1.4.4 Certifying Agency Qualifications

Agency must be an American National Standards Institute accredited certifier. Agency is responsible for testing and certifying individuals in compliance with ASSE 6000 SERIES Standards. Provide installer, inspector, and verifier certifications by one of the following agencies or by an agency with comparable qualifications:

a. Medical Gas Professional Healthcare Organization (MGPHO).

b. National Inspection, Testing and Certification Corporation (NITC), Los Angeles, California.

1.4.5 Regulatory Requirements

1.4.5.1 Standards

The Standards for design, materials, installation, and testing of gas and vacuum systems for healthcare facilities:

a. National Fire Protection Association Standard for Health Care Facilities: NFPA 99.

[b. National Fire Protection Association Standard for Storage, use, and

Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders, and Tanks: NFPA 55.]

c. Interpret reference to the "Authority Having Jurisdiction" to mean the "Contracting Officer." For Government owned property, interpret references to the "owner" to mean the "Contracting Officer." For leased facilities, interpret references to the "owner" to mean the "lessor." Interpret references to the "permit holder" to mean the "Contractor."

d. The provisions of Chapter 1, "Administration" in NFPA 99 [and NFPA 55] do not apply. These administrative requirements are covered by the applicable Federal Acquisition Regulations (FAR) included in this contract and by the authority granted to the Officer in Charge of Construction to administer the construction of this project.

1.4.5.2 Referenced Publications

In each of the publications referred to herein, interpret references to the "authority having jurisdiction", or words of similar meaning, to mean the Contracting Officer.

1.4.5.3 Alternative Qualifications

Products having less than a three-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturer's factory or laboratory tests, can be shown.

1.4.5.4 Service Support

Provide equipment items supported by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations must be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract. Provide Maintenance Data Package [1] [2] [3] [4] [5].Submit manuals in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.4.6 Shop Drawings

Submit detailed Shop Drawings for the complete systems including piping layouts and location of connections; dimensions for roughing-in, foundation, and support points; schematic diagrams; and wiring diagrams or connection and interconnection diagrams. Indicate clearances required for maintenance and operation on detail drawings. Where piping and equipment are to be supported other than as indicated, include loadings and proposed support method. Draw all plans, elevations, views, and details to scale.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver equipment and parts to site factory cleaned and processed in their original factory sealed package ready for installation. Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

****

NOTE: Coordinate Article "Commissioning" and related paragraphs below with the project-specific requirements specified in Section 01 91 00.15 10 or 01 91 00.15 20, TOTAL BUILDING COMMISSIONING; revise as required.

****

1.6 COMMISSIONING

Refer to Section [01 91 00.15 10][01 91 00.15 20] TOTAL BUILDING COMMISSIONING for requirements

1.6.1 Inspection, Testing, and Verification Agency

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NOTE: If project does not have a CxC, Commissioning Specialist, delete references to "Project CxC, Commissioning Specialist."

****

Commissioning must include retaining the Inspection, Testing, and Verification Agency prior to commencement of the installation of these systems. The Inspection, Testing, and Verification Agency shall coordinate their scope of work with that of the [Project CxC, Commissioning Specialist] [and] [Project CxG, Government Commissioning Specialist] and shall function in coordination with, not in lieu of, the [Project CxC, Commissioning Specialist] [and] [Project CxG, Government Commissioning Specialist].

1.6.2 Responsibilities

The Inspection, Testing, and Verification Agencies responsibilities include:

a. Review of the project drawings and specifications and providing comments and additional clarification(s), as needed, to the Contracting Officer and the Designer of Record.

b. Witnessing by the Contracting Officer and a certified inspector or certified verifier of the brazing of a minimum of two joints (one vertical and one horizontal) by each brazer assigned to the project. Evaluation of adequacy of the brazed joints must be in accordance with NFPA 99 through observation of the brazing techniques, and by destructive methods (sectioning of the joint). This is required of all brazers utilized throughout the duration of the project. Brazing of project materials is not permitted until the brazer qualifications, and the adequacy of their joints have been determined to be acceptable.

c. Review and comment on the compliance of the project submittals required under "SUBMITTALS" and the specified items. Review must be concurrent with the review being performed by the designated representative of the Government.

d. Performing site observation visits prior to 1) backfilling exterior or interior below grade piping, 2) concealing above ceiling piping, and 3) concealing in wall piping. Conduct site observation visits by a certified inspector or certified verifier. Provide for each visit a written report stating progress of installation and any deficiencies needing corrective action.

e. Review of revisions/substitutions relating to the Contract Documents and/or the Project Commissioning Plan.

f. Coordination with the [Project CxC, Commissioning Specialist] [and] [Project CxG, Government Commissioning Specialist] in establishing a commissioning plan for components specific to the systems specified herein.

g. Coordination with the [Project CxC, Commissioning Specialist] [and] [Project CxG, Government Commissioning Specialist] of the equipment start-up, and the system testing and verification procedures required by this specification.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of such products, essentially duplicate equipment that has performed satisfactorily at least two years prior to bid opening, and have been in satisfactory commercial or industrial use for 3 years prior to bid opening. The 3-year use must include applications of equipment and materials under similar circumstances and of similar size. The product must have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 3 year period. Submit manufacturer's catalog data with highlighting to show features such as model, size, and options that are intended for consideration. Provide adequate data to demonstrate compliance with contract requirements.

2.2 MANUFACTURER'S NAMEPLATE

Provide each item of equipment with a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent is not acceptable.

[2.3 BULK LIQUID OXYGEN (LOX) SOURCE

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NOTE: Bulk liquid oxygen systems are usually leased from a gas supplier by the user, and the tank, vaporizer(s), and associated appurtenances are not part of the project contract. Include the following and modify as required.

****

Provide complete factory-packaged, factory-tested, continuous-duty source(s). Provide each source with LOX tank, source shutoff, valves, vaporizer(s), and other components required by the Regulatory Requirements, and necessary to provide complete performance. Provide each source with single-point connections to power wiring, warning system wiring, and piping system.

]2.4 EMERGENCY OXYGEN SUPPLY CONNECTION

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NOTE: Emergency oxygen supply connection is

required only on Category 1 systems where supply is remote from building. Coordinate location with building and site elements to assure accessibility.
****

Provide complete factory-packaged system including but not limited to enclosure, oxygen inlet, pressure gauge, 25 mm 1 inch shutoff valve, relief valve, and check valves. Provide lockable, weather tight enclosure for mounting on exterior of building. Provide [recessed] [surface mounted] enclosure. Provide check valves for main and emergency oxygen lines.

[2.5 CYLINDER MANIFOLD SUPPLY SOURCE

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NOTE: Coordinate manifold locations and power requirements with Division 26-Electrical.
****

Provide complete factory-packaged, factory-tested, continuous-duty source(s). Provide each source with control panel, source shutoff, isolation valves and other components required by NFPA 99, and necessary to provide complete performance. Provide each source with single-point connections to power wiring, warning system wiring, and piping system. Provide each source with the quantity of cylinder connections as indicated, but no less than two cylinders on each side of manifold.

a. Design the cylinder supply source so that when the switchover from the primary cylinders to the secondary cylinders occurs, there will be no drop or fluctuation in the line pressure. Provide control cabinet with a visual signal to indicate switchover from the primary to the secondary supply. Resetting of the control unit must be accomplished automatically. Provide with a bronze-bodied poppet-type pressure-relief adjusted to relieve at 50 percent above maximum working pressure. Equip with an approved pressure switch for actuating a warning signal when, or before, the secondary bank goes into operation. Locate control valve within a cabinet designed to prevent tampering by unauthorized personnel. One bank of cylinders must be in service while the other bank is in reserve. Equip each bank with a master regulator and a gauge for 28 MPa 4,000 psi or greater cylinder-contents pressure. Switching from the empty bank of cylinders to the full bank of cylinders must be fully automatic and shall not require resetting of the regulators.

b. Provide cylinder supply source as follows:

(1) Oxygen (O): Provide for [_____] primary and [_____] secondary cylinders, Item a).

(2) Nitrogen (N): Provide for [_____] primary and [_____] secondary cylinders. Item a).

****
NOTE: Locate nitrous oxide supply where it will not be exposed to freezing temperatures. Consult manufacturer's literature for details.
****

(3) Nitrous oxide (NO)

(a) Provide for [_____] primary and [_____] secondary cylinders.

****
NOTE: Coordinate requirements of heated supply with electrical engineer. Connect to emergency electrical power.
****

(b) Provide heated supply to prevent ice build-up during high demand.

[(4) Carbon dioxide (CO2)

(a) Provide for [_____] primary and [_____] secondary cylinders.

****
NOTE: Coordinate requirements of heated supply with electrical engineer. Connect to emergency electrical power.
****

(b) Provide heated supply to prevent ice build-up during high demand.]

][2.6 DENTAL COMPRESSED AIR (DA) SOURCE

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NOTE: Dental compressed air source can serve as dental laboratory compressed air source.
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a. Provide complete factory-packaged, factory-tested, continuous-duty source(s). Provide each source with air compressors, receiver, dryers, filters, control panel, source shutoff, compressor isolation valves and other components required by NFPA 99, and necessary to provide complete performance. Provide each source with single-point connections to power wiring, warning system wiring, and piping system.

b. Provide air compressors manufactured to comply with UL listing requirements. Provide air compressors with manufacturer's name and address, together with trade name and catalog number, on a nameplate securely attached to the equipment. Provide guards to shield exposed moving parts. Provide an intake air filter and silencer with each compressor. Provide aftercooler and moisture separator between compressors and air receivers, to remove moisture before the air enters the receiver. Provide air cooled aftercoolers. The air must pass through a sufficient number of tubes to affect cooling. Provide tubes sized to give maximum heat transfer. Size cooling capacity of the aftercooler for the total capacity of the compressors.

2.6.1 Air Compressors

Provide [scroll type compressors] [reciprocating teflon-ring type compressors designed such that no oil is administered to the air cylinder, the portion of the piston rod that travels in the crankcase section does not travel in any portion of the air-cylinder section, and with provision to prevent the flow of lubrication oil along the piston rod into the air-cylinder section]. Provide a pressure gauge calibrated to 2068 kPa

300 psi, and equipped with a gauge cock and pulsation dampener for installation adjacent to the pressure switch. Provide motors and compressors directly connected or operated by V-belt drive. Provide compressors sequenced to start automatically when the pressure drops to a preset point. Provide air cooled compressors. Provide each compressor chamber with a high-temperature sensor to activate a local alarm. Provide continuous duty NEMA rated, open dripproof motor with 1.15 service factor, and maximum of 3600 RPM.

2.6.2 Air Receiver

Provide air receiver delivering air to dental operatories designed for 1034 kPa 150 psi working pressure, factory air tested to 1.5 times the working pressure, meeting ASME BPVC SEC VIII D1. Provide receiver equipped with safety relief valves and accessories, including but not limited to pressure gauge, sight glass, and automatic and manual drains. Provide receiver with galvanized or supplied with factory applied commercial enamel finish exterior. Provide the interior of the receiver with a factory applied vinyl lining. Provide a display of the ASME seal on the receiver, or a certified test report from an approved independent testing laboratory indicating conformance to the ASME Code. Provide receiver(s) with a three (3) valve bypass for servicing.

2.6.3 Control Panel

Provide UL 508A listed and labeled control panel in a NEMA 250 Type 12 enclosure. Provide Hand-Off-Auto switch for each compressor for selection of normal operation (automatic alternation) or manual selection of lead and lag compressors. Provide automatic alternation of compressors based on a first-on/first-off principle with provisions for simultaneous operation. The lag compressor must be able to start automatically if the lead compressor fails to operate. Provide manual reset for thermal malfunction shutdown. All control and alarm functions must remain energized while any compressor in the system remains electrically online. Provide magnetic motor starters with integral overload and short circuit protection, with lockable disconnecting means. Provide running light and elapsed run-time meter for each compressor. Provide circuit breakers with single point power feed connection. Provide 120 VAC control circuit transformers with fused primary and secondary. Provide pressure control switches or pressure transducer. Provide integral PLC controller for automatically switching operating sequence of compressors. Provide back-up circuit in case of PLC failure. Provide digital display interface. User interface must display all alarm conditions, pump maintenance intervals, compressor performance warnings, average system air demand, average dewpoint and CO levels on system, compressors on/off status, system model number and serial number, and phone number to call for service. Provide audible and visual local alarms with silence button, remote alarm connections, and safety devices as required by NFPA 99. Provide local alarms with contacts to allow indication of a fault condition at the master alarm panel if one or more local alarms are activated. Provide the following alarms:

a. Lag compressor In Use.

b. High discharge temperature.

c. High carbon monoxide levels.

2.6.4 Desiccant Air Dryers

Provide two identical twin-tower heatless desiccant air dryers. Provide dryers to achieve a pressure dewpoint minus 40 degrees C minus 40 degrees F at the maximum calculated NFPA system capacity. Provide lubricant free operation. Provide economizer cycle that reduces purge air requirements to match actual moisture loading. Provide solid-state cycle timer, OSHA purge exhaust mufflers, and a pressure gauge for each tower.

2.6.5 Filtration and Pressure Reducing Station

Provide two pre-filters rated 0.01 micron filtration with an efficiency of 99.9999 percent D.O.P. (Validated), two activated carbon filters, and two 1 micron final filters with an efficiency 99.9999 percent D.O.P. (Validated) installed downstream of the carbon filters. Provide all filters with a differential pressure gauge with color change indicator and automatic drain valve except the activated carbon filters. Provide downstream of the final filters a dual-line pressure regulating assembly consisting of two pressure regulators with pressure gauges, inlet and outlet isolation ball valves, and pressure relief valves. Arrange all filters/pressure regulators so that the isolation of one filter/ regulator will not affect the operation of the second filter/regulator.

2.6.6 Dew Point Monitor

Provide dew point monitor to continuously monitor the dew point of the dental compressed air. Provide ceramic type (aluminum oxide type is not acceptable) sensor with system accuracy of plus or minus 1 degree C 2 degrees F. Provide dew point alarm factory set at 2 degrees C 36 degrees F and be field adjustable. Provide activation of local alarm and all master alarms when the dew point at system pressure exceeds plus 4 degrees C 39 degrees F. Provide activation of monitor's signal at all master alarm panels if the monitor loses power. Provide monitor in conformance with NFPA 99.

2.6.7 Carbon Monoxide Monitor

Provide carbon monoxide monitor to continuously monitor the dental compressed air for carbon monoxide and to actuate a local alarm if the carbon monoxide level is 10 ppm or higher. Provide activation of monitor's signal at all master alarm panels if the monitor loses power. Provide monitor in conformance with NFPA 99.

][2.7 DENTAL SURGICAL VACUUM (DSV) SOURCE

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NOTE: Dental Surgical Vacuum was previously designated as Dental High Vacuum (DHV).
****

Provide complete factory-packaged, factory-tested, continuous-duty source(s). Provide each source with vacuum pumps, receiver, control panel, source shutoff, pump isolation valves and other components required by NFPA 99, and necessary to provide complete performance. Provide sources with single-point connections to power wiring, warning system wiring, and piping system.

2.7.1 Vacuum Pumps

****
NOTE: Water sealed liquid ring vacuum pumps should generally not be used. If used then they must fully meet the water conserving features outlined within.
****

Provide [non-lubricated rotary] [non-contacting dry claw] [recirculating water sealed liquid ring] vacuum pumps. Mount each pump and its motor on modular skids in a horizontal or vertical configuration with coupling and guard. Provide tank mounted pumps and motors for small systems. Provide shutoff valve on each pump inlet. Provide vacuum gauge at each pump inlet.

[a. Provide completely dry non-lubricated rotary vane pumps equipped with self-lubricating carbon/graphite vanes. Provide lubricated and sealed bearings. No oil is permitted in any pump. Provide each pump completely air-cooled and having absolutely no water requirement. Outfit each pump with a 5 micron inlet filter and equipped with a vacuum relief valve, check valve to prevent backflow through off-cycle units, flexible connector, isolation valve, and vibration isolators at each mounting location. Provide continuous duty NEMA rated, C-face, open dripproof motor with 1.15 service factor, and maximum of 1800 RPM.
]

[b. Provide non-contacting dry claw style rotary pumps. Internal construction must be friction free and the rotors must be non-contacting. Provide oil free air end and requiring no sealants. Provide air cooled and continuous duty rated pumps. Provide each pump with a single lubricated gearbox requiring oil change not more often than 5,000 operating hours. Provide each pump with an exhaust silencer. Equip the pumps with high vacuum shutdown, high temperature shutdown, and alarm. Provide lubricants inert with oxygen. Outfit each pump with a 5 micron inlet filter and equipped with a vacuum relief valve, check valve to prevent backflow through off-cycle units, flexible connector, isolation valve, and vibration isolators at each mounting location. Provide continuous duty NEMA rated, C-face, TEFC motor with 1.15 service factor, and maximum of 3500 RPM.]

[c. Provide oil-free, single-stage positive displacement, and non-pulsating recirculating water sealed liquid ring type pumps. Provide pumps with mechanical seals. Provide pumps of all iron construction with a bronze or stainless rotor and carbon steel shaft. Under normal operation, system must minimize fresh seal water required to 0.05 L/s 0.75 gpm. Provide system with reservoir of sufficient size for up to 48 hours operation without fresh water supply. Equip each pump with a vacuum relief valve, check valve to prevent backflow through off-cycle units, flexible connector, isolation valve, and vibration isolators at each mounting location. Provide totally self contained system. Provide continuous duty NEMA rated, open dripproof motor with 1.15 service factor, and maximum of 1800 RPM.]

2.7.2 Vacuum Receiver

Provide receiver designed for 1034 kPa 150 psi minimum working pressure, factory air tested to 1.5 times the working pressure, meeting ASME BPVC SEC VIII D1. Provide receiver equipped with safety relief valves and accessories, including but not limited to vacuum gauge, sight glass, and automatic and manual drains. Provide receiver with galvanized

or factory applied commercial enamel finish exterior. Provide interior of the receiver with a factory applied vinyl lining. Provide a display of the ASME seal on the receiver or a certified test report from an approved independent testing laboratory indicating conformance to the ASME Code. Provide receiver(s) with a three (3) valve bypass for servicing.

2.7.3 Control Panel

Provide UL 508A listed and labeled control panel in a NEMA 250 Type 12 enclosure. Provide Hand-Off-Auto switch for each vacuum pump for selection of normal operation (automatic alternation) or manual selection of lead and lag vacuum pump. Provide automatic alternation of vacuum pumps based on a first-on/first-off principle with provisions for simultaneous operation. The lag vacuum pump must be able to start automatically if the lead vacuum pump fails to operate. Provide manual reset for thermal malfunction shutdown. All control and alarm functions must remain energized while any vacuum pump in the system remains electrically online. Provide magnetic motor starters with integral overload and short circuit protection, with lockable disconnecting means. Provide running light and elapsed run-time meter for each vacuum pump. Provide circuit breakers with single point power feed connection. Provide 120 VAC control circuit transformers with fused primary and secondary. Provide vacuum control switches. Provide integral PLC controller for automatically switching operating sequence of vacuum pumps. Provide back-up circuit in case of PLC failure. Provide digital display interface. User interface must display all alarm conditions, vacuum pump maintenance intervals, vacuum pump performance warnings, average system vacuum demand, vacuum pumps on/off status, system model number and serial number, and phone number to call for service. Provide audible and visual local alarms with silence button, remote alarm connections, and safety devices as required by NFPA 99. Provide local alarms with contacts to allow indication of a fault condition at the master alarm panel if one or more local alarms are activated. Provide the following alarms:

a. Lag vacuum pump In Use

b. System Malfunction

][2.8 DENTAL ORAL EVACUATION (OE) SOURCE

Provide complete factory-packaged, factory-tested, continuous-duty source(s). Provide each source with vacuum pumps, separator(s), control panel, source shutoff, pump isolation valves and other components required by NFPA 99, and necessary to provide complete performance. Provide each source with single-point connections to power wiring, warning system wiring, and piping system.

2.8.1 Vacuum Pumps

Provide [turbine] [oil-lubricated rotary-vane] [regenerative blower] vacuum pumps. Connect pumps in parallel to the central wet separator tanks.

[2.8.1.1 Turbines

Provide self-governing, multistage, centrifugal type turbines of overhung or outboard design. The vacuum pumps must operate at a speed not to exceed 3,600 rpm and connected to its driving motor by a flexible coupling. Provide sealed or lubricatable type bearings. Provide a fan

connected directly to the vacuum pump shaft adjacent to vacuum pump shaft bearings to create a flow of ambient air over the bearing carrier while the unit is operating. Provide a steel coupling guard encompassing the flexible coupling between the motor and vacuum pump. Cases must be cylindrical in design. Provide cases and end plates (inlet and exhaust heads included) constructed of either heavy-gauge sheet steel rigidly welded at seams and sections, or of cast grey iron. Provide either concave or convex sheet steel end plates. Inlet and exhaust connections must be tangential to the vacuum pump except the inlet connection can be axial to vacuum pump and sized to allow free air movement through the vacuum pump, without flow restriction and have class 150 flanges. Provide vacuum pump input with an adjustable volume control valve, a directional flow valve and antisurge valve. Provide vacuum pump output with an exhaust silencer. Connect plumbing to the vacuum pump through flexible sleeve connectors. Construct internal moving parts with not less than 3 mm 0.125 inch clearance throughout to prevent damage by transient particulates. Construct impellers of fabricated sheet metal or high-tensile aluminum alloy, smooth on all surfaces to prevent imbalance by uneven dust deposits. Provide impellers of the backward curved or radial design to provide optimal performance over a wide range of volume requirements. Securely attach impellers to the vacuum pump shaft by set screws or clamps of high-tensile material. Provide individually balanced impellers. The complete assembly, with motor, must not exceed 0.038 mm 1.5 mils of vibration when given a running test. Power to operate the vacuum pump must be in direct proportion to the volume of air exhausted and must not exceed the normal motor rating. The vacuum produced must be substantially constant throughout the operating range of the vacuum pump. Provide continuous duty NEMA MG 1, 3500 RPM maximum, T-frame, dripproof design motor with either sealed or lubricatable bearings. Operating temperature rise of the motor must not exceed 22 degrees C 72 degrees F. Mount each vacuum pump assembly on resilient isolator pads as recommended by the manufacturer. Do not fasten pads to the facility floor.

][2.8.1.2 Rotary-Vane Vacuum Pump

Provide low speed, positive displacement, oil lubricated rotary-vane vacuum pumps with separate, standard NEMA frame size, high efficiency motors. Provide automatic lubrication of moving pump parts by an oiling system not dependent on moving parts and operated only by gravity and vacuum. Provide vacuum pump constructed to provide protection against ingesting particulates larger than 15 µ into pump, operating with insufficient lubrication, and water contamination of oil. Provide electrical overload by thermal sensors built into single phase motors or thermal sensors built into three phase motor starters; three phase motor starters additionally protected against single phasing. Provide continuous duty, NEMA rated, C-face, TEFC motor with 1.15 service factor, and maximum of 1800 RPM.

][2.8.1.3 Regenerative Blower

Provide regenerative blower consisting of one impeller, mounted directly on the motor shaft. Provide precision cast aluminum impeller with multiple radial blades at its periphery. The impeller must be the only moving part, and must not require any lubrication. Dynamically balance the impeller to provide vibration-free operation without the need for vibration isolators. Install the impeller between the blower housing and cover. Provide housing and cover of cast aluminum and provided with multiple heat-dissipating fins. There must be no metal-to-metal contact within the blower housing. Oil lubrication must not be required,

providing oil free discharge gas. The heat-dissipating fins must efficiently minimize heating of the compressed gas. Provide blower with a guaranteed ultimate vacuum of 60 kPa 12 inches Hg vacuum. Provide motor supported by outboard mounted, grease lubricated, anti-friction bearings. The bearings must be located outside of the compression chamber to maximize operating efficiency and bearing life. Provide bearing housing conservatively loaded and rated for an L(10) life of not less than 200,000 hours. Provide shaft main bearings of the sleeve type with heavy duty bushings or rolling element type in accordance with ABMA 9 or ABMA 11. Provide a lip seal to minimize leakage where the motor shaft passes through the blower housing. Blower producing noise levels must not exceed 75 dBA. Additional silencers may be installed to further reduce the noise level. Provide continuous duty NEMA rated, TEFC motor with 1.15 service factor, and maximum of 3600 RPM. Provide direct driven blowers. Provide blower manufactured in accordance with ISO 9001 and UL listed. Provide each blower module with a separator with check valve, flex connector, isolation valve, and a relief valve. Provide control panel mounted vacuum pump control switches and set as follows:

a. Lead Pump: Continuous Operation

b. Lag Pump Start: 84 kPa 5 inches Hg vacuum

c. Lag Pump Stop: 73 kPa 8 inches Hg vacuum

]2.8.2 Pipe Isolators

Provide flexible, resilient band-sealed (clamped) sleeves furnished to isolate the vacuum pump from associated piping. Size sleeve couplings in accordance with the exhauster intake and output connections. Provide pipe isolators with steel coupling guards.

2.8.3 Valves

2.8.3.1 Volume Control Valve

Provide the input of each vacuum pump with an adjustable air volume control valve to prevent accidental vacuum pump overload and to provide a means of adjusting the upper design capacity limit. Provide volume control valve built in or immediately adjacent to the first or input stage of the vacuum pump and preset by the manufacturer during certification procedure. Provide butterfly type valve with cast iron body with corrosive resistant internals.

2.8.3.2 Antisurge Valve

Provide the input of each vacuum pump with an antisurge valve that will operate proportionally and automatically throughout the vacuum pump's designed range. This valve must continually sense the motor current and maintain a predetermined operational level of volume by proportionally bleeding air into the system. Equip valve with a silencer to attenuate air noise to 85 dBA or below. Install the valve in, on, or near the first stage of the vacuum pump mounted in conjunction with the directional flow valve.

2.8.3.3 Directional Flow Valve

Provide the input of each vacuum pump with a directional flow valve to prevent back flow of air through the shutdown. Provide cast iron

directional flow valve with corrosive resistant internals.

2.8.4 Exhaust Silencer

Provide each vacuum pump exhaust with a separate air discharge silencer of the open-bore expansion type. No interior baffling or shrouding is permitted. Provide silencer to attenuate air noise to 85 dBA or less.

2.8.5 Control Panel

[Provide UL 508A listed and labeled control panel in a NEMA 250 Type 12 enclosure. Provide Hand-Off-Auto switch for each vacuum pump for selection of normal operation (automatic alternation) or manual selection of lead and lag vacuum pump. Provide automatic alternation of vacuum pumps based on a first-on/first-off principle with provisions for simultaneous operation. The lag vacuum pump must be able to start automatically if the lead vacuum pump fails to operate. Provide manual reset for thermal malfunction shutdown. All control and alarm functions must remain energized while any vacuum pump in the system remains electrically online. Provide magnetic motor starters with integral overload and short circuit protection, with lockable disconnecting means. Provide running light and elapsed run-time meter for each vacuum pump. Provide circuit breakers with single point power feed connection. Provide 120 VAC control circuit transformers with fused primary and secondary. Provide vacuum control switches. Provide integral PLC controller for automatically switching operating sequence of vacuum pumps. Provide back-up circuit in case of PLC failure. Provide digital display interface. User interface must display all alarm conditions, vacuum pump maintenance intervals, vacuum pump performance warnings, average system vacuum demand, vacuum pumps on/off status, system model number and serial number, and phone number to call for service. Provide audible and visual local alarms with silence button, remote alarm connections, and safety devices as required by NFPA 99. Provide local alarms with contacts to allow indication of a fault condition at the master alarm panel if one or more local alarms are activated. Provide the following alarms:

a. Lag vacuum pump In Use

b. System Malfunction]

****

NOTE: NOTE: Use control panel article below when basis of design product is similar to RAMVAC OWL Touch series.

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[Provide vacuum pump systems with microprocessor master control panel in a NEMA 250 Type 12 enclosure. Provide controls connections for vacuum pressure switch, oral evacuation remote control panel, and each individual vacuum pump controller to microprocessor. Microprocessor must provide for selection of normal operation (automatic alternation) or manual selection of lead, lag, and follow vacuum pumps. Provide automatic alternation of vacuum pumps based on a first-on/first-off principle with provisions for simultaneous operation. The lag vacuum pump must be able to start automatically if the lead vacuum pump fails to operate. Provide manual reset for thermal malfunction shutdown. All control and alarm functions must remain energized while any vacuum pump in the system remains electrically online. Provide a magnetic motor starter with integral overload and short circuit protection, with lockable disconnecting means

at each vacuum pump. Provide running light and elapsed run-time meter for each vacuum pump. Provide circuit breakers with a single point power feed connection to each vacuum pump. Provide control circuit transformers with fused primary and secondary. Provide vacuum control switches. Provide integral PLC controller for automatically switching operating sequence of vacuum pumps. Provide back-up circuit in case of PLC failure. Provide digital display interface. User interface must display all alarm conditions, vacuum pump maintenance intervals, vacuum pump performance warnings, average system vacuum demand, vacuum pumps on/off status, system model number and serial number, and phone number to call for service. Provide contacts to transmit system on/off status to the facility building management system to enable the separator tank liquid level control sequence. Provide audible and visual local alarms with silence button, remote alarm connections, and safety devices as required by NFPA 99. Provide local alarms with contacts to allow indication of a fault condition at the master alarm panel and the facility building management system if one or more local alarms are activated. Provide the master control panel with a remote control panel with visual indication of start/stop status located in the reception area adjacent to the master alarm and area alarm panels. Provide the master control panel with integrated controls for automatic actuation of the accumulator tank auto-wash system during off hours. For each vacuum pump system, provide the following alarms at the master alarm panel:

a. Lag vacuum pump In Use

b. System Malfunction]

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NOTE: Provide Central Wet Separators with automatic washdown feature in facilities with more than 10 dental chairs.

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2.8.6 Central Wet Separators

Provide the oral evacuation system with central wet separators. Provide separator tanks constructed of a nonmetallic, noncorrosive, inert material or composite such as glass-reinforced plastic (GRP). Provide freestanding tanks of one-piece construction, with smooth, interior walls. Tanks must be high-pressure vessels able to withstand a constant negative pressure of 51 kPa 15 inches Hg vacuum. Provide convex tank bottoms with drain at the apex of convexity. Provide separator tanks equipped with mechanical overflow protection. [Provide preplumbed with a 360 degree nozzle internal washdown system with timer. Provide washdown system with a 120 VAC automatic-flush, clock-controlled mechanism to provide a complete washdown of the interior of the separator at any predetermined time of day or night. Provide washdown time adjustable for up to at least 3 minutes. Locate timers in the main electric control panel. Equip the cold water supply to the automatic tank flush unit with an in-line filter with 40-mesh stainless steel screens. Filter must be supplied as part of the oral evacuation system.] Equip each separator tank with an electronic high-low liquid level sensor which must perform as the primary overfill protector. In multiple-tank installations, one tank must be adjusted to sense 90 percent of its capacity and the other tank 100 percent of its capacity via the liquid-level sensing devices. Each sensor must control a 120 volt ac electrically operated output air solenoid valve located to control the outgoing air from the tank to the vacuum pump. Equip each tank with a gate and swing type check valves at the bottom drain. With

negative pressure in the tank, the check valve must remain closed to maintain vacuum. When negative pressure ceases, either by vacuum pump shutdown or by closure of the outgoing air solenoid control by the liquid level sensor, the check valve must open and the tank will undergo gravity drain.

2.8.7 Vacuum Relief Valve

Provide vacuum relief valve. The valve must operate automatically. Equip the valve with a silencer to attenuate air noise to 85 dBA or below.

2.8.8 Amalgam Separator

Provide amalgam separator consisting of a sedimentation collection chamber that is removable. Separation process must be sedimentation which may be supplemented with filtration, and/or ion exchange. Provide unit compatible for use on wet and dry vacuum systems. Provide wall or floor mounted assembly. Provide minimum 40 mm 1-1/2 inch inlet and outlet connection. Unit must be ISO 11143 Certified and have a minimum of 99 percent removal efficiency.

][2.9 HIGH-VOLUME LABORATORY DUST EVACUATION (LE) SOURCE

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NOTE: The high-volume laboratory dust evacuation system (LE) is an independent vacuum system specifically designed for scavenging, collecting, and filtering of grinding and polishing particulates generated in the dental/medical laboratory. This system was previously designated LDE.

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a. Provide complete factory-packaged, factory-tested, continuous-duty source(s). Provide each source with vacuum pumps, receiver, control panel, source shutoff, pump isolation valves and other components as indicated, required by the Standards, and necessary to provide complete performance. Provide each source with single-point connections to power wiring, warning system wiring, and piping system.

b. Provide laboratory dust evacuation systems of standard manufactured products, complete with devices normally furnished and devices required herein. Provide laboratory dust evacuation system by an established manufacturer of commercially available industrial quality vacuum system. Provide a dry system for collection of dust and grinding particulates. Provide one vacuum pump, except for area laboratory (ADL) application, and a dry, cyclonic, filtered separator.

2.9.1 Vacuum Pumps

Provide self-governing, multistage, centrifugal type turbines of overhung or outboard design. The vacuum pump must operate at a speed not to exceed 3600 RPM. Provide vacuum pump connected to its drive motor by multiple V-belts. The vacuum pump shaft must have a minimum of two radial bearings and at least one support bracket. Provide permanently-lubricated sealed or lubricatable type bearings. Fasten the vacuum pump/connector/drive motor assembly to a plate or frame structure. Power to operate the exhauster at the calculated design load must not exceed the normal motor rating. Power required must be in direct proportion to the volume of air exhausted. The vacuum produced must be substantially constant throughout

the design operating range of the exhauster. Vacuum pump cases must be cylindrical in design. Provide cases and end plates constructed of either heavy-gauge sheet steel rigidly welded at seams or sections, or of cast grey iron. Provide either concave or convex sheet steel end plates for flex resistance. Inlet connections may be axially or tangentially placed. Exhaust connections may be tangential to the casing. Provide inlet and outlet connections sized to allow free air movement through the vacuum pump, without flow restrictions. Provide vacuum pump with an adjustable volume control device in, on, or adjacent to the first stage of the input and an exhaust silencer on the output. Provide flexible sleeve connectors for silencer and all plumbing connections to the vacuum. Internal moving parts of the vacuum pump must be constructed with not less than 3 mm 1/8 inch clearance throughout to prevent damage by transient particulates. Construct impellers of built-up sheet or high tensile composites. Impellers must be of the backward curved design. Securely attach impellers to the exhauster shaft by set screws or clamps of high-tensile material. Provide individually balanced impellers. The complete assembly with motor, must not exceed 0.038 mm 1-1/2 mils of vibration when given a running test. The vacuum pump must be sized to produce the designated performance standards at the above-sea-level elevation of the proposed installation site, and be certified by the manufacturer by equipment tag or plate, or by letter of certification identifying the turbo-exhauster by serial number.

2.9.2 Motor

Provide continuous duty NEMA MG 1, 3500 RPM maximum, T-frame, dripproof design motor with either sealed or lubricatable bearings. Operating temperature rise of the motor must not exceed 22 degrees C 72 degrees F.

2.9.3 Isolation Pads

Mount vacuum pump assembly on resilient isolator pads as recommended by the manufacturer. Do not fasten pads to the facility floor. Vibration transmission must be limited to less than 5 percent of the lowest frequency of vibration.

2.9.4 Pipe Isolators

Provide flexible, resilient clamped sleeves furnished to isolate the vacuum pump from associated plumbing. Sleeve couplings must be sized in accordance with the exhauster intake and output connections. Provide pipe isolators with steel coupling guards.

2.9.5 Volume Control Device

Provide input of the vacuum pump with an adjustable air volume control device to prevent accidental overload and to provide a means of adjusting the upper design capacity limit. The volume control device may be built-in or immediately adjacent to the first or input stage of the exhauster and preset by the manufacturer during the certification procedure.

2.9.6 Exhaust Silencer

The vacuum pump must output to an air discharge silencer of the open-bore expansion type. No interior baffling or shrouding will be permitted. Provide silencer to attenuate air noise to 85 dBA or less.

2.9.7 Control Panel

Provide UL 508A listed and labeled control panel in a NEMA 250 Type 12 enclosure. Provide Hand-Off-Auto switch for each vacuum pump for selection of normal operation (automatic alternation) or manual selection of lead and lag vacuum pump. Provide automatic alternation of vacuum pumps based on a first-on/first-off principle with provisions for simultaneous operation. The lag vacuum pump must be able to start automatically if the lead vacuum pump fails to operate. Provide manual reset for thermal malfunction shutdown. All control and alarm functions must remain energized while any vacuum pump in the system remains electrically online. Provide magnetic motor starters with integral overload and short circuit protection, with lockable disconnecting means. Provide running light and elapsed run-time meter for each vacuum pump. Provide circuit breakers with single point power feed connection. Provide 120 VAC control circuit transformers with fused primary and secondary. Provide vacuum control switches. Provide integral PLC controller for automatically switching operating sequence of vacuum pumps. Provide back-up circuit in case of PLC failure. Provide digital display interface. User interface must display all alarm conditions, vacuum pump maintenance intervals, vacuum pump performance warnings, average system vacuum demand, vacuum pumps on/off status, system model number and serial number, and phone number to call for service. Provide audible and visual local alarms with silence button, remote alarm connections, and safety devices as required by NFPA 99. Provide local alarms with contacts to allow indication of a fault condition at the master alarm panel if one or more local alarms are activated. Provide the following alarms:

a. Lag vacuum pump In Use.

2.9.8 Central Separator

Provide freestanding central separator of heavy-gauge steel and all-welded construction. Provide cyclonic type separator chamber and must effectively separate and trap all particulate matter contained in the vacuum input. The internal configuration of the separator must be such that air leaving the cyclonic chamber be directed upward through filter bags to effect final cleaning of the air before its entry into the vacuum pump. The lower part of the separator enclosure must contain an easily accessible and serviceable debris container. The container must lock into operating position to form a positive seal between the removable container and the separator enclosure. Provide removable debris container, reinstallable without the use of tools. Equip the container with casters to facilitate moving for emptying and reinstallation alignment and a pivoting handle to facilitate handling. Equip the separator with a filter-shaker mechanism actuated by an electric motor operating through mechanical linkage to the shaker mechanism. Provide an electrical switch to control the shaker motor on or adjacent to the separator. Provide the separator equipped with an easily removed screw- or bolt-fastened access panel to provide easy access for filter inspection and service.

2.9.9 Primary Separator

When necessary to satisfy specific design requirements, a primary separator must be used in addition to, and ahead of, the central separator. The primary separator must be of the cyclonic type and provide for initial separation of abrasive particulates before vacuum air and debris enter the central separator. Provide primary separator of heavy-gauge steel, all welded-seam construction, and may be freestanding

or wall-mounted.

2.9.10 Air Volume Relief Valve

Provide mechanically operated air volume relief valve, requiring no electrical power. The valve must operate automatically, sensing negative pressure in the system and opening and closing proportionately to maintain designed air capacity to the vacuum pump regardless of the number of inlets online. Equip the valve with a silencer to attenuate air noise to 85 dBA or less.

2.9.11 Vacuum Inlets

User inlets for technicians' benches must be 32 mm 1-1/4 inches ID and for fixed-equipment locations, 40 mm 1-1/2 inches ID, with removable friction fit adapters sized to receive 80 mm 3 inch ID flexible hose. Adapters must provide an airtight seal when inserted into the vacuum inlet. Provide inlets with attached pivot or hinge-mounted doors. When closed, the doors must provide an airtight seal to close off the vacuum inlet; when open, they must not interfere with insertion of the adapters with 80 mm 3 inch ID hose attached.

]2.10 MEDICAL COMPRESSED AIR (MA) SOURCE

Provide complete factory-packaged, factory-tested, continuous-duty source(s). Provide each source with air compressors, receiver, dryers, filters, control panel, source shutoff, compressor isolation valves and other components required by NFPA 99, and necessary to provide complete performance. Provide each source with single-point connections to power wiring, warning system wiring, and piping system. Tank-mounted air compressors must be manufactured to comply with UL listing requirements. Provide air compressors with manufacturer's name and address, together with trade name and catalog number, on a nameplate securely attached to the equipment. Provide guards to shield exposed moving parts. Provide an intake air filter and silencer with each compressor. Provide aftercooler and moisture separator installed between compressors and air receivers, to remove moisture before the air enters the receiver. Provide air cooled aftercoolers. The air must pass through a sufficient number of tubes to affect cooling. Provide tubes sized to provide maximum heat transfer. Cooling capacity of the aftercooler must be sized for the total capacity of the compressors.

2.10.1 Air Compressors

Provide [scroll type compressors] [reciprocating teflon-ring type compressors designed such that no oil is administered to the air cylinder, the portion of the piston rod that travels in the crankcase section does not travel in any portion of the air-cylinder section, and with provision to prevent the flow of lubrication oil along the piston rod into the air-cylinder section]. Provide a pressure gauge calibrated to 2068 kPa 300 psi, and equipped with a gauge cock and pulsation dampener for installation adjacent to the pressure switch. Provide motors and compressors directly connected or operated by V-belt drive. Compressors must be sequenced to start automatically when the pressure drops to a preset point. Provide air cooled compressors. Provide each compressor chamber with a high-temperature sensor to activate a local alarm. Provide continuous duty NEMA rated, open dripproof motor with 1.15 service factor, and maximum of 3600 RPM.

2.10.2 Air Receiver

Provide receiver designed for 1034 kPa 150 psi minimum working pressure, factory air tested to 1.5 times the working pressure, meeting ASME BPVC SEC VIII D1. Provide receiver equipped with safety relief valves and accessories, including but not limited to pressure gauge, sight glass, and automatic and manual drains. Provide receiver with galvanized or factory applied commercial enamel exterior finish. Provide the receiver with factory applied vinyl lining interior. Provide a display of the ASME seal on the receiver, or a certified test report from an approved independent testing laboratory indicating conformance to the ASME Code. Provide receiver(s) with a three (3) valve bypass for servicing.

2.10.3 Control Panel

Provide UL 508A listed and labeled control panel in a NEMA 250 Type 12 enclosure. Provide Hand-Off-Auto switch for each compressor for selection of normal operation (automatic alternation) or manual selection of lead and lag compressors. Provide automatic alternation of compressors based on a first-on/first-off principle with provisions for simultaneous operation. The lag compressor must be able to start automatically if the lead compressor fails to operate. Provide manual reset for thermal malfunction shutdown. All control and alarm functions must remain energized while any compressor in the system remains electrically online. Provide magnetic motor starters with integral overload and short circuit protection, with lockable disconnecting means. Provide running light and elapsed run-time meter for each compressor. Provide circuit breakers with single point power feed connection. Provide 120 VAC control circuit transformers with fused primary and secondary. Provide pressure control switches or pressure transducer. Provide integral PLC controller for automatically switching operating sequence of compressors. Provide back-up circuit in case of PLC failure. Provide digital display interface. User interface must display all alarm conditions, pump maintenance intervals, compressor performance warnings, average system air demand, average dewpoint and CO levels on system, compressors on/off status, system model number and serial number, and phone number to call for service. Provide audible and visual local alarms with silence button, remote alarm connections, and safety devices as required by NFPA 99. Provide local alarms with contacts to allow indication of a fault condition at the master alarm panel if one or more local alarms are activated. Provide the following alarms:

a. Lag compressor In Use.

b. High discharge temperature.

c. High carbon monoxide levels.

d. High dewpoint level.

2.10.4 Desiccant Air Dryers

Provide two identical twin-tower heatless desiccant air dryers. Provide dryers sized to achieve a pressure dewpoint minus 40 degrees C minus 40 degrees F at the maximum calculated NFPA system capacity. Provide lubricant free operation. Provide economizer cycle that reduces purge air requirements to match actual moisture loading. Provide solid-state cycle timer, OSHA purge exhaust mufflers, and a pressure gauge for each tower.

2.10.5 Filtration and Pressure Reducing Station

Provide two pre-filters rated 0.01 micron filtration with an efficiency exceeding 99.9999 percent D.O.P. (Validated), two activated carbon filters, and two 1 micron filters with an efficiency exceeding 99.9999 percent D.O.P. (Validated) installed downstream of the carbon filters. Provide all filters with a differential pressure gauge with color change indicator and automatic drain valve except the activated carbon filters. Provide downstream of the final filters a dual-line pressure regulating assembly consisting of two pressure regulators with pressure gauges, inlet and outlet isolation ball valves, and pressure relief valves. Arrange all filters/pressure regulators so that the isolation of one filter/ regulator will not affect the operation of the second filter/regulator.

2.10.6 Dew Point Monitor

Provide dew point monitor to continuously monitor the dew point of the medical compressed air. Provide ceramic type (aluminum oxide type is not acceptable) sensor with system accuracy of plus or minus 1 degree C 2 degrees F. The dew point alarm must be factory set at 2 degrees C 36 degrees F and be field adjustable. Provide activation of local alarm and all master alarms when the dew point at system pressure exceeds plus 4 degrees C 39 degrees F. Provide activation of monitor's signal at all master alarm panels if the monitor loses power. Provide monitor conforming to NFPA 99.

2.10.7 Carbon Monoxide Monitor

Provide carbon monoxide monitor to continuously monitor the medical compressed air for carbon monoxide, and to actuate a local alarm if the carbon monoxide level is 10 ppm or higher. Provide activation of monitor's signal at all master alarm panels if the monitor loses power. Provide monitor conforming to NFPA 99.

2.11 MEDICAL-SURGICAL VACUUM (MV) SOURCE

Provide complete factory-packaged, factory-tested, continuous-duty source(s). Provide each source with vacuum pumps, receiver, control panel, source shutoff, pump isolation valves and other components as indicated, required by NFPA 99, and necessary to provide complete performance. Provide each source with single-point connections to power wiring, warning system wiring, and piping system.

2.11.1 Vacuum Pumps

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NOTE: Water sealed liquid ring vacuum pumps should generally not be used. If used, then they must fully meet the water conserving features outlined within.

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Provide [non-lubricated rotary] [non-contacting dry claw] [recirculating water sealed liquid ring] vacuum pumps. Mount each pump and its motor on modular skids in a horizontal or vertical configuration with coupling and guard. Pumps and motors for small systems may be tank mounted. Provide high efficiency motors. Provide shutoff valve on each pump inlet. Provide vacuum gauge at each pump inlet.

[a. Provide completely dry non-lubricated rotary vane pumps equipped with self-lubricating carbon/graphite vanes. Provide lubricated and sealed bearings. No oil is permitted in any pump. Each pump must be completely air-cooled and have absolutely no water requirement. Outfit each pump with a 5 micron inlet filter and equipped with a vacuum relief valve, check valve to prevent backflow through off-cycle units, flexible connector, isolation valve, and vibration isolators at each mounting location. Provide continuous duty NEMA rated, C-face, open dripproof motor with 1.15 service factor, and maximum of 1800 RPM.
]

[b. Provide non-contacting dry claw style rotary pumps. Internal construction must be friction free and the rotors shall be non-contacting. The air end must be oil free and require no sealants. Provide air cooled and continuous duty rated pumps. Provide each pump with a single lubricated gearbox requiring oil change not more often than 5,000 operating hours. Provide each pump with an exhaust silencer. Equip pumps with high vacuum shutdown, high temperature shutdown, and alarm. The lubricant supplied must be inert with oxygen. Outfit each pump with a 5 micron inlet filter and equipped with a vacuum relief valve, check valve to prevent backflow through off-cycle units, flexible connector, isolation valve, and vibration isolators at each mounting location. Provide continuous duty NEMA rated, C-face, TEFC motor with 1.15 service factor, and maximum of 3500 RPM.]

[c. Provide oil-free, single-stage positive displacement, and non-pulsating recirculating water sealed liquid ring type pumps. Provide pumps fitted with mechanical seals. Provide all iron pump construction with a bronze or stainless rotor and carbon steel shaft. Under normal operation, system must minimize fresh seal water required to 0.05 L/s 0.75 gpm. Provide system with reservoir of sufficient capacity for up to 48 hours operation without fresh water supply. Equip each pump with a vacuum relief valve, check valve to prevent backflow through off-cycle units, flexible connector, isolation valve, and vibration isolators at each mounting location. Provide totally self contained system. Provide continuous duty NEMA rated, open dripproof motor with 1.15 service factor, and maximum of 1800 RPM.]

2.11.2 Vacuum Receiver

Provide receiver designed for 1034 kPa 150 psi minimum working pressure, factory air tested to 1.5 times the working pressure, meeting ASME BPVC SEC VIII D1. Provide receiver equipped with safety relief valves and accessories, including but not limited to vacuum gauge, sight glass, and automatic and manual drains. Provide receiver with galvanized or factory applied commercial enamel exterior finish. Provide interior of receiver with a factory applied vinyl lining. Provide a display of the ASME seal on the receiver or a certified test report from an approved independent testing laboratory indicating conformance to the ASME Code. Provide receiver(s) with a three (3) valve bypass for servicing.

2.11.3 Control Panel

Provide UL 508A listed and labeled control panel in a NEMA 250 Type 12 enclosure. Provide Hand-Off-Auto switch for each vacuum pump for selection of normal operation (automatic alternation) or manual selection of lead and lag vacuum pump. Provide automatic alternation of vacuum pumps based on a first-on/first-off principle with provisions for

simultaneous operation. The lag vacuum pump must be able to start automatically if the lead vacuum pump fails to operate. Provide manual reset for thermal malfunction shutdown. All control and alarm functions must remain energized while any vacuum pump in the system remains electrically online. Provide magnetic motor starters with integral overload and short circuit protection, with lockable disconnecting means. Provide running light and elapsed run-time meter for each vacuum pump. Provide circuit breakers with single point power feed connection. Provide 120 VAC control circuit transformers with fused primary and secondary. Provide vacuum control switches. Provide integral PLC controller for automatically switching operating sequence of vacuum pumps. Provide back-up circuit in case of PLC failure. Provide digital display interface. User interface must display all alarm conditions, vacuum pump maintenance intervals, vacuum pump performance warnings, average system vacuum demand, vacuum pumps on/off status, system model number and serial number, and phone number to call for service. Provide audible and visual local alarms with silence button, remote alarm connections, and safety devices as required by NFPA 99. Provide local alarms with contacts to allow indication of a fault condition at the master alarm panel if one or more local alarms are activated. Provide the following alarms:

a. Lag vacuum pump In Use.

[2.12 WASTE ANESTHESIA GAS DISPOSAL VACUUM (WAGD) SOURCE

Provide complete factory-packaged, factory-tested, continuous-duty source(s). Provide each source with vacuum pumps, receiver, control panel, source shutoff, pump isolation valves and other components as indicated, required by NFPA 99, and necessary to provide complete performance. Provide each source with single-point connections to power wiring, warning system wiring, and piping system.

2.12.1 Vacuum Pumps

Provide [non-lubricated rotary] [non-contacting dry claw] [regenerative blower] [recirculating water sealed liquid ring] vacuum pumps. Mount each pump and its motor on modular skids in a horizontal or vertical configuration with coupling and guard. Provide tank mounted pumps and motors for small systems. Provide high efficiency motors. Provide shutoff valve on each pump inlet. Provide vacuum gauge at each pump inlet.

[a. Provide completely dry non-lubricated rotary vane pumps equipped with self-lubricating carbon/graphite vanes. Provide lubricated and sealed bearings. No oil is permitted in any pump. Each pump must be completely air-cooled and have absolutely no water requirement. Outfit each pump with a 5 micron inlet filter and equipped with a vacuum relief valve, check valve to prevent backflow through off-cycle units, flexible connector, isolation valve, and vibration isolators at each mounting location. Provide continuous duty NEMA rated, C-face, open dripproof motor with 1.15 service factor, and maximum of 1800 RPM.
]

[b. Provide non-contacting dry claw style rotary pumps. Internal construction shall be friction free and the rotors shall be non-contacting. The air end must be oil free and require no sealants. Provide air cooled and continuous duty rated pumps. Provide each pump with a single lubricated gearbox requiring oil change not more often than 5,000 operating hours. Provide each pump with an exhaust silencer. Equip the pumps with high vacuum shutdown,

high temperature shutdown, and alarm. The lubricant supplied must be inert with oxygen. Outfit each pump with a 5 micron inlet filter and equipped with a vacuum relief valve, check valve to prevent backflow through off-cycle units, flexible connector, isolation valve, and vibration isolators at each mounting location. Provide continuous duty NEMA rated, C-face, TEFC motor with 1.15 service factor, and maximum of 3500 RPM.]

[c. Provide regenerative blower vacuum pumps consisting of one impeller, mounted directly on the motor shaft. Provide precision cast aluminum impeller with multiple radial blades at its periphery. The impeller must be the only moving part, and not require any lubrication. Dynamically balance the impeller to provide vibration-free operation without the need for vibration isolators. Install the impeller between the blower housing and cover. Provide housing and cover of cast aluminum and provided with multiple heat-dissipating fins. There must be no metal-to-metal contact within the blower housing. Oil lubrication must not be required providing oil free discharge gas. The heat-dissipating fins must efficiently minimize heating of the compressed gas. Blower must have a guaranteed ultimate vacuum of 38 kPa11 inches Hg vacuum. Provide motor supported by outboard mounted, grease lubricated, anti-friction bearings. The bearings must be located outside of the compression chamber to maximize operating efficiency and bearing life. Provide bearing housing conservatively loaded and rated for an L(10) life of not less than 200,000 hours. Provide shaft main bearings of the sleeve type with heavy duty bushings or rolling element type in accordance with ABMA 9 or ABMA 11. Provide a lip seal to minimize leakage where the motor shaft passes through the blower housing. Blower producing noise levels must not exceed 75 dBA. Additional silencers may be installed to further reduce the noise level. Provide continuous duty NEMA rated, TEFC motor with 1.15 service factor, and maximum of 3600 RPM. Provide direct driven blower. Provide blower manufactured in accordance with ISO 9001, and UL listed. Provide each pump with a check valve, inlet filter, flex connector, isolation valve and a relief valve mounted at the pump inlet. Provide control panel mounted vacuum pump control switches set as follows:]

(1) Lead Pump: Continuous Operation

(2) Lag Pump Start: 88 kPa 4 inches Hg vacuum

(3) Lag Pump Stop: 81 kPa 6 inches Hg vacuum

[d. Provide oil-free, single-stage positive displacement, and non-pulsating recirculating water sealed liquid ring type pumps. The pumps must be fitted with mechanical seals. Provide pump of all iron construction with a bronze or stainless rotor and carbon steel shaft. Under normal operation, system must minimize fresh seal water required to 0.05 L/s 0.75 gpm. Provide system with reservoir of sufficient capacity for up to 48 hours of operation without fresh water supply. Equip each pump with a vacuum relief valve, check valve to prevent backflow through off-cycle units, flexible connector, isolation valve, and vibration isolators at each mounting location. Provide totally self contained system. Provide continuous duty NEMA rated, open dripproof motor with 1.15 service factor, and maximum of 1800 RPM.]

2.12.2 Vacuum Receiver

Provide receiver designed for 1034 kPa 150 psi minimum working pressure, factory air tested to 1.5 times the working pressure, meeting ASME BPVC SEC VIII D1. Provide receiver equipped with safety relief valves and accessories, including but not limited to vacuum gauge, sight glass, and automatic and manual drains. Provide exterior of receiver with galvanized or factory applied commercial enamel finish. Provide interior of the receiver with factory applied vinyl lining. Provide a display of the ASME seal on the receiver or a certified test report from an approved independent testing laboratory indicating conformance to the ASME Code. Provide receiver(s) with a three (3) valve bypass for servicing.

2.12.3 Control Panel

Provide UL 508A listed and labeled control panel in a NEMA 250 Type 12 enclosure. Provide Hand-Off-Auto switch for each vacuum pump for selection of normal operation (automatic alternation) or manual selection of lead and lag vacuum pump. Provide automatic alternation of vacuum pumps based on a first-on/first-off principle with provisions for simultaneous operation. The lag vacuum pump must be able to start automatically if the lead vacuum pump fails to operate. Provide manual reset for thermal malfunction shutdown. All control and alarm functions must remain energized while any vacuum pump in the system remains electrically online. Provide magnetic motor starters with integral overload and short circuit protection, with lockable disconnecting means. Provide running light and elapsed run-time meter for each vacuum pump. Provide circuit breakers with single point power feed connection. Provide 120 VAC control circuit transformers with fused primary and secondary. Provide vacuum control switches. Provide integral PLC controller for automatically switching operating sequence of vacuum pumps. Provide back-up circuit in case of PLC failure. Provide digital display interface. User interface must display all alarm conditions, vacuum pump maintenance intervals, vacuum pump performance warnings, average system vacuum demand, vacuum pumps on/off status, system model number and serial number, and phone number to call for service. Provide audible and visual local alarms with silence button, remote alarm connections, and safety devices as required by NFPA 99. Provide local alarms with contacts to allow indication of a fault condition at the master alarm panel if one or more local alarms are activated. Provide the following alarms:

a. Lag vacuum pump In Use.

][2.13 INSTRUMENT COMPRESSED AIR (IA) SOURCE

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NOTE: Instrument compressed air may be used in lieu of nitrogen as a support gas in medical and dental facilities with prior approval by the using facility. If instrument compressed air is present in the facility, the source equipment can also supply the laboratory compressed air (LA) and/or the process compressed air (PA) systems. Pressure regulators are required.

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a. Provide complete factory-packaged, factory-tested, continuous-duty source(s). Provide each source with air compressors, receiver, dryers, filters, control panel, source shutoff, compressor isolation

valves and other components as indicated, required by NFPA 99, and necessary to provide complete performance. Provide each source with single-point connections to power wiring, warning system wiring, and piping system.

b. Manufacture tank-mounted air compressors to comply with UL listing requirements. Provide air compressors with manufacturer's name and address, together with trade name and catalog number, on a nameplate securely attached to the equipment. Provide guards to shield exposed moving parts. Provide an intake air filter and silencer with each compressor. Provide aftercooler and moisture separator installed between compressors and air receivers, to remove moisture before the air enters the receiver. Provide air cooled aftercoolers. The air must pass through a sufficient number of tubes to affect cooling. Provide tubes sized to give maximum heat transfer. Cooling capacity of the aftercooler must be sized for the total capacity of the compressors.

2.13.1 Air Compressors

Provide compressors with the scheduled capacity at a minimum of 1378 kPa 200 psi. Provide two stage, high pressure oil-lubricated continuous duty reciprocating type air compressors. A pressure gauge calibrated to 2068 kPa 300 psi, and equipped with a gauge cock and pulsation dampener must be provided for installation adjacent to the pressure switch. Connect motors and compressors by V-belt drive. Compressors must be sequenced to start automatically when the pressure drops to a preset point. Provide air cooled compressors. Provide each compressor chamber with a high-temperature sensor to activate a local alarm. Provide continuous duty NEMA rated, C-face, open dripproof motor with 1.15 service factor, and maximum of 1800 RPM.

2.13.2 Control Panel

Provide UL 508A listed and labeled control panel in a NEMA 250 Type 12 enclosure. Provide Hand-Off-Auto switch for each compressor for selection of normal operation (automatic alternation) or manual selection of lead and lag compressors. Provide automatic alternation of compressors based on a first-on/first-off principle with provisions for simultaneous operation. The lag compressor must be able to start automatically if the lead compressor fails to operate. Provide manual reset for thermal malfunction shutdown. All control and alarm functions must remain energized while any compressor in the system remains electrically online. Provide magnetic motor starters with integral overload and short circuit protection, with lockable disconnecting means. Provide running light and elapsed run-time meter for each compressor. Provide circuit breakers with single point power feed connection. Provide 120 VAC control circuit transformers with fused primary and secondary. Provide pressure control switches or pressure transducer. Provide integral PLC controller for automatically switching operating sequence of compressors. Provide back-up circuit in case of PLC failure. Provide digital display interface. User interface must display all alarm conditions, pump maintenance intervals, compressor performance warnings, average system air demand, average dewpoint and CO levels on system, compressors on/off status, system model number and serial number, and phone number to call for service. Provide audible and visual local alarms with silence button, remote alarm connections, and safety devices as required by NFPA 99. Provide local alarms with contacts to allow indication of a fault condition at the master alarm panel if one or more local alarms are

activated. Provide the following alarms:

a. Lag compressor In Use.

b. High discharge temperature.

c. High carbon monoxide levels.

d. High dewpoint level.

2.13.3 Air Receiver

Provide receiver designed for 1724 kPa 250 psi minimum working pressure, factory air tested to 1.5 times the working pressure, meeting ASME BPVC SEC VIII D1. Provide receiver equipped with safety relief valves and accessories, including but not limited to pressure gauge, sight glass, and automatic and manual drains. Provide exterior of receiver with galvanized or factory applied commercial enamel finish. Provide interior of the receiver with factory applied vinyl lining. Provide a display of the ASME seal on the receiver or a certified test report from an approved independent testing laboratory indicating conformance to the ASME Code. Provide receiver(s) with a three (3) valve bypass for servicing.

2.13.4 Desiccant Air Dryers

Provide two identical twin-tower heatless desiccant air dryers. Provide dryers sized to achieve a pressure dewpoint minus 40 degrees C minus 40 degrees F at the maximum calculated NFPA system capacity. Provide lubricant free operation. Provide economizer cycle that reduces purge air requirements to match actual moisture loading. Provide solid-state cycle timer, OSHA purge exhaust mufflers, and a pressure gauge for each tower.

2.13.5 Filtration and Pressure Reducing Station

Provide two separators with zero loss drain valve, two pre-filters rated 0.01 micron filtration with an efficiency exceeding 99.9999 percent D.O.P. (Validated), two activated carbon filters, and two final filters rated 0.01 micron filtration with an efficiency exceeding 99.9999 percent D.O.P. (Validated) installed downstream of the carbon filters. Provide all filters with a differential pressure gauge with color change indicator and automatic drain valve except the activated carbon filters. Provide downstream of the final filters with a dual-line pressure regulating assembly consisting of two pressure regulators with pressure gauges, inlet and outlet isolation ball valves, and pressure relief valves. Arrange all filters/pressure regulators so that the isolation of one filter/ regulator will not affect the operation of the second filter/regulator.

2.13.6 Dew Point Monitor

Provide dew point monitor to continuously monitor the dew point of the instrument compressed air. Provide ceramic type (aluminum oxide type is not acceptable) sensor with system accuracy of plus or minus 1 degree C 2 degrees F. The dew point alarm must be factory set at minus 30 degrees C minus 22 degrees F and be field adjustable. Provide activation of local alarm and all master alarms when the dew point at system pressure exceeds minus 30 degrees C minus 22 degrees F. Provide activation of monitor's signal at all master alarm panels if the monitor loses power. Provide monitors conforming to NFPA 99.

][2.14 LAB COMPRESSED AIR (LA) [AND PROCESS COMPRESSED AIR (PA)] SOURCE

a. Provide complete factory-packaged, factory-tested, continuous-duty source(s). Provide each source with air compressors, receiver, dryers, filters, control panel, source shutoff, compressor isolation valves and other components required by NFPA 99, and necessary to provide complete performance. Provide each source with single-point connections to power wiring, warning system wiring, and piping system.

b. Manufacture tank-mounted air compressors to comply with UL listing requirements. Provide air compressors with manufacturer's name and address, together with trade name and catalog number, on a nameplate securely attached to the equipment. Provide guards to shield exposed moving parts. Provide an intake air filter and silencer with each compressor. Provide aftercooler and moisture separator between compressors and air receivers, to remove moisture before the air enters the receiver. Provide air cooled aftercoolers. The air must pass through a sufficient number of tubes to affect cooling. Provide tubes sized to give maximum heat transfer. Cooling capacity of the aftercooler must be sized for the total capacity of the compressors.

2.14.1 Air Compressors

Provide [scroll type compressors] [reciprocating teflon-ring type compressors designed such that no oil is administered to the air cylinder, the portion of the piston rod that travels in the crankcase section does not travel in any portion of the air-cylinder section, and with provision to prevent the flow of lubrication oil along the piston rod into the air-cylinder section]. Provide a pressure gauge calibrated to 2068 kPa 300 psi, and equipped with a gauge cock and pulsation dampener for installation adjacent to the pressure switch. Provide motors and compressors directly connected or operated by V-belt drive. Compressors must be sequenced to start automatically when the pressure drops to a preset point. Provide air cooled compressors. Provide each compressor chamber with a high-temperature sensor to activate a local alarm. Provide continuous duty NEMA rated, open dripproof motor with 1.15 service factor, and maximum of 3600 RPM.

2.14.2 Air Receiver

Provide air receiver delivering air to laboratories designed for 1034 kPa 150 psi working pressure, factory air tested to 1.5 times the working pressure, meeting ASME BPVC SEC VIII D1. Provide receiver equipped with safety relief valves and accessories, including but not limited to pressure gauge, sight glass, and automatic and manual drains. Provide exterior of receiver with galvanized or supplied with factory applied commercial enamel finish. Provide interior of the receiver with a factory applied vinyl lining. Provide a display of the ASME seal on the receiver, or a certified test report from an approved independent testing laboratory indicating conformance to the ASME Code. Provide receiver(s) with a three (3) valve bypass for servicing.

2.14.3 Control Panel

Provide UL 508A listed and labeled control panel in a NEMA 250 Type 12 enclosure. Provide Hand-Off-Auto switch for each compressor for selection of normal operation (automatic alternation) or manual selection of lead and lag compressors. Provide automatic alternation of compressors based on a first-on/first-off principle with provisions for simultaneous

operation. The lag compressor must be able to start automatically if the lead compressor fails to operate. Provide manual reset for thermal malfunction shutdown. All control and alarm functions must remain energized while any compressor in the system remains electrically online. Provide magnetic motor starters with integral overload and short circuit protection, with lockable disconnecting means. Provide running light and elapsed run-time meter for each compressor. Provide circuit breakers with single point power feed connection. Provide 120 VAC control circuit transformers with fused primary and secondary. Provide pressure control switches or pressure transducer. Provide integral PLC controller for automatically switching operating sequence of compressors. Provide back-up circuit in case of PLC failure. Provide digital display interface. User interface must display all alarm conditions, pump maintenance intervals, compressor performance warnings, average system air demand, average dewpoint and CO levels on system, compressors on/off status, system model number and serial number, and phone number to call for service. Provide audible and visual local alarms with silence button, remote alarm connections, and safety devices as required by NFPA 99. Provide local alarms with contacts to allow indication of a fault condition at the master alarm panel if one or more local alarms are activated. Provide the following alarms:

a. Lag compressor In Use.

b. High discharge temperature.

2.14.4 Desiccant Air Dryers

Provide two identical twin-tower heatless desiccant air dryers. Provide dryers to achieve a pressure dewpoint minus 40 degrees C minus 40 degrees F at the maximum calculated NFPA system capacity. Provide lubricant free operation. Provide economizer cycle that reduces purge air requirements to match actual moisture loading. Provide solid-state cycle timer, OSHA purge exhaust mufflers, and a pressure gauge for each tower.

2.14.5 Filtration and Pressure Reducing Station

Provide two pre-filters rated 0.01 micron filtration with an efficiency of 99.9999 percent D.O.P. (Validated), two activated carbon filters, and two 1 micron final filters with an efficiency 99.9999 percent D.O.P. (Validated) installed downstream of the carbon filters. Filters without validation must not be used except the activated carbon filters. Provide all filters with a differential pressure gauge with color change indicator and automatic drain valve except the activated carbon filters. Provide downstream of the final filters a dual-line pressure regulating assembly consisting of two pressure regulators with pressure gauges, inlet and outlet isolation ball valves, and pressure relief valves. Arrange all filters/pressure regulators so that the isolation of one filter/ regulator will not affect the operation of the second filter/regulator.

2.14.6 Dew Point Monitor

Provide dew point monitor to continuously monitor the dew point of the laboratory compressed air. Provide ceramic type (aluminum oxide type is not acceptable) sensor with system accuracy of plus or minus 1 degree C 2 degrees F. The dew point alarm shall be factory set at 2 degrees C 36 degrees F and be field adjustable. Provide activation of local alarm and all master alarms when the dew point at system pressure exceeds plus 4 degrees C 39 degrees F. Provide activation of monitor's signal at all

master alarm panels if the monitor loses power. Provide monitors conforming to NFPA 99.

]2.15 PIPE AND FITTINGS

2.15.1 Service Entrance

Piping at service entrance (from 305 mm 12 inches inside building to 1525 mm 5 feet outside): Same as Indicated for outside utilities.

2.15.2 Positive pressure piping systems up to 1379 kPa 200 psi

****
NOTE: The following applies to dental/medical compressed air, instrument compressed air, laboratory compressed air, process compressed air, oxygen, nitrogen, nitrous oxide, carbon dioxide. Fittings complying with ASME B16.50 are currently not manufactured.
****

Hard-drawn seamless copper tubing (ASTM B819), Type K or L, bearing one of the following markings, OXY, MED, OXY/MED, and brazed solder-type wrought copper fittings (ASME B16.22), or brazed fittings (ASME B16.50) cleaned for oxygen service by the manufacturer in accordance with Pamphlet CGA G-4.1. Cast fittings must not be used. Minimum size must be 15 mm 1/2 inch. Install branch piping full size to each terminal device, including vertical drops, and provide reducer fitting at the device pigtail. Type L tubing is not acceptable for installation below grade. Provide with NF nitrogen purge and capped/plugged ends until prepared for installation. Tubing joining material must be ANSI/AWS-BCuP series filler material.

2.15.3 [Dental surgical] [Medical-Surgical] Waste Anesthesia Gas Disposal vacuum piping systems up to 34 kPa 20 inches Hg vacuum

****
NOTE: The following applies to dental/medical vacuum, Waste Anesthesia Gas Disposal.
****

Hard-drawn seamless copper tubing (ASTM B819), Type K or L, bearing one of the following markings, OXY, MED, OXY/MED, and brazed solder-type wrought copper fittings (ASME B16.22), or brazed fittings (ASME B16.50) cleaned for oxygen service by the manufacturer in accordance with Pamphlet CGA G-4.1.. Cast fittings must not be used. Minimum size must be 20 mm 3/4 inch. Install branch piping full size to each terminal device, including vertical drops, and provide reducer fitting at the device pigtail. Tubing joining material must be ANSI/AWS-BCuP series filler material. Nitrogen purge not required. Labeled or otherwise identified prior to installation in order to preclude inadvertent inclusion into the pressurized systems. Labeling is not required if installation meets all requirements for pressurized piping including prohibition of flux on copper-to-copper joints and the use of a NF nitrogen purge during brazing.

2.15.4 Dental Oral Evacuation System

Provide polyvinyl chloride (PVC) solid-wall drainage, waste and vent (DWV) pipe and fittings conforming to ASTM D2665. Provide solvent cement for

PVC pipe fittings conforming to ASTM D2564. Provide fittings, supports, and joint assembly complying with ICC IPC. Provide long-radius type fittings for turns and the wye type for branches. The most distant end of each trunk line from the separators may terminate with a vacuum relief valve.

2.15.5 High-Volume Laboratory Dust Evacuation System

Provide polyvinyl chloride (PVC) solid-wall drainage, waste and vent (DWV) pipe and fittings conforming to ASTM D2665. Provide solvent cement for PVC pipe fittings conforming to ASTM D2564. Provide fittings, supports and joint assembly complying with ICC IPC. The assembled piping system must be suitable for 84 kPa 5 inches Hg vacuum. Provide long-radius type fittings for turns and the wye type for branches. The most distant end of the main trunk line from the central filter-separator may terminate with an air volume relief valve.

2.15.6 Compressed Air Intake and Vacuum Pump Exhaust Line(s)

****
NOTE: CPVC vacuum exhaust piping is permissible for Dental Oral Evacuation systems only.
****

Hard-drawn seamless copper tubing (ASTM B88 or ASTM B819), Type K or L, and solder-type wrought copper fittings (ASME B16.22). Cast fittings must not be used. Tubing joining material must be ANSI/AWS-BCuP series filler material. [For Dental Oral Evacuation systems only, provide ASTM F441/F441M Schedule 80 chlorinated polyvinyl chloride (CPVC) pipe, ASTM F439 Schedule 80 CPVC socket fittings and ASTM F437 Schedule 80 CPVC threaded fittings. Provide solvent cements for joining CPVC pipe conforming to ASTM F493.]

2.16 VALVES AND ASSEMBLIES

2.16.1 Valves

a. Positive pressure piping systems up to 1379 kPa 200 psi: Bronze, full port, quarter-turn ball type, three piece construction, 4137 kPa 600 psi WOG, blow-out proof stem, in-line repairable. Cleaned for oxygen service by manufacturer in accordance with Pamphlet CGA G-4.1. All sizes: 316 stainless steel ball and stem, glass reinforced polytetrafluoroethylene (RPTFE) seat seals and packings. Clean, cap and deliver to site in sealed package bearing manufacturer's identifying tag or stamp. Keep sealed until prepared for installation. Provide with valve manufacturer installed brazed Type K copper tube extensions a minimum of 150 mm 6 inch long on the inlet and outlet side of the valve for making connection to the pipeline(s). Provide a purge port on both the inlet and outlet tube extensions. Valves in locations other than zone valve boxes must be lockable.

b. Vacuum piping systems up to 34 kPa 20 inches Hg vacuum: Bronze full port, quarter-turn ball type, three piece construction, 3 kPa 29 inches Hg vacuum, blow out proof stem, in-line repairable. All sizes: 316 stainless steel ball and stem, glass reinforced polytetrafluoroethylene (RPTFE) seat seals and packings. Provide with valve manufacturer installed brazed Type K copper tube extensions a minimum of 152 mm 6 inch long on the inlet and outlet side of the

valve for making connection to the pipeline(s). Provide a purge port on both the inlet and outlet tube extensions. Valves in locations other than zone valve boxes must be lockable.

2.16.2 Zone Valve Assemblies

****
NOTE: Coordinate stud depth with architects. Provide minimum 152 mm 6-inch stud to allow for varying box depths.
****

a. Recessed wall box, minimum 1.21 mm 18 GA sheet steel, baked enamel finish. Stainless steel or chrome front trim. Transparent plastic door with pull handle or ring for emergency access to valves. Service access to valves must be by removal and replacement of door, which must neither cause damage nor require special tools. Opaque plastic is not acceptable. Openings to box interior must be dust-tight. Provide each shutoff valve with pressure gauge and integral extension tubes for joining to piping system outside of box. Provide gauge port on each tubing extension. Lockable valves are not required..

b. Up to 5 shutoff valves of 25 mm 1 inch size or smaller may be installed in one box. Use single-valve boxes for 32 mm 1-1/4 inch valves and larger. Front trim with interlocking edges where single-valve boxes are jointed together for multiple valve installations. Provide custom-made boxes as specified above for those valves that are too large for pre-manufactured boxes.

c. Surface mounted wall box, same as recess mounted except provide with exposed surface finish primed for field painting and provide only where surface mounting is specifically indicated on drawings.

d. Arrange shutoff valves in following order from top to bottom: Oxygen, nitrous oxide, carbon dioxide, dental compressed air, medical compressed air, nitrogen, Waste Anesthesia Gas Disposal, dental surgical vacuum, and medical-surgical vacuum. If 2 or more valves for same service are located in common box, larger of valves must be lower.

2.17 NITROGEN AND INSTRUMENT COMPRESSED AIR CONTROL PANELS

Nitrogen and instrument compressed air control panels must be designed to deliver variable pressures to power pneumatic surgical tools. Provide the control panel with a 0-2070 kPa 0-300 psi pressure gauge, shutoff valve, pressure regulator, delivery pressure gauge and Diameter-Index Safety System (DISS) outlet. Provide quarter turn valves to obtain a fully "open" or "closed" position. Provide an adjustable self relieving type pressure regulator, with a operating range of 70 to 1725 kPa 10 to 250 psi. Control panels must be pre-piped internally requiring only external supply line connections. Additional outlets in the same room may be connected to the remote outlet pigtail furnished in the control panel. Remote outlets must be regulated by the adjustable pressure regulator within the panel and shall match the nitrogen control panel outlet type. Provide control panels in horizontal or vertical orientation.

2.18 HANGERS AND SUPPORTS

Provide copper plated pipe hangers and supports when in direct contact with copper tubing. Tubing installed on trapeze hanger must be secured in

place with appropriately sized clamp and be fully isolated from dissimilar metals.

2.19 GAUGES

a. Provide for line pressure use adjacent to source equipment, ASME B40.100 pressure gauges, 114 mm 4 1/2 inches in diameter with metal case for oxygen, nitrous oxide, carbon dioxide, dental compressed air, medical compressed air, laboratory compressed air, process compressed air, and nitrogen, accurate to within two percent. Range must be two times operating pressure. Dial graduations and figures must be black on a white background, or white on a black background. Provide gauges expressly made for and cleaned for oxygen use, labeled for appropriate service, and marked "USE NO OIL". Provide bourdon tube and brass movement. Install with gauge cock. Gauges for all services downstream of main shutoff valve must be same as those adjacent to source equipment except diameter may be reduced to 40 mm 1-1/2 inches. Dial ranges must be 0 to 690 kPa 0 to 100 psi for pressurized gases and compressed air services except nitrogen and instrument compressed air; 0 to 2070 kPa 0 to 300 psi for nitrogen and instrument compressed air.

b. Provide for vacuum line use adjacent to source equipment, ASME B40.100 vacuum compound gauges, 114 mm 4 1/2 inches in diameter with metal case for dental surgical vacuum, medical-surgical vacuum, dental oral evacuation, Waste Anesthesia Gas Disposal, and laboratory dust evacuation, accurate to within two percent. Dial graduations and figures must be black on a white background, or white on a black background. Label for vacuum service. Provide with bourdon tube and brass movement. Install with gauge cock. Gauges for all services upstream of main shutoff valve must be same as those adjacent to source except diameter may be reduced to 40 mm 1 1/2 inches. Dial range must be 100 to 0 kPa 0 to 30 inches Hg vacuum.

2.20 DENTAL GAS AND SUPPORT SYSTEMS OUTLETS AND VACUUM SYSTEMS INLETS

2.20.1 Station Outlets/Inlets

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NOTE: The type of connectors at station outlets will be as specified by the using service. This is required to ensure that the connectors provided are compatible with those on Government-furnished mobile apparatus. Unless otherwise required by the using facility, provide DISS type outlets/inlets.

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Submit proof that outlets/inlets, as an assembly, are listed by Underwriters Laboratories, Inc., and are manufactured in accordance with applicable NFPA 99 and CGA standards. Provide station outlets/inlets (Oxygen, Nitrogen, Nitrous Oxide, Dental Surgical Vacuum, Waste Anesthesia Gas Disposal, Instrument Compressed Air) conforming to NFPA 99. Provide station outlets/inlets for concealed piping made of brass and having an adjustable valve mechanism to compensate for variation in wall thickness. Each unit must be securely mounted and self-sealing. Each unit as an assembly must conform to the requirements of the Underwriters Laboratories Inc.; submit proof of such conformance. The label or listing of the specified agency will be acceptable evidence. In lieu of the label or listing, the Contractor may submit a written certificate from any approved

nationally recognized testing organization adequately equipped and competent to perform such services, including the follow-up service, stating that the item has been tested and conforms to the requirements, including method of testing, of the specified agency. Provide station outlets/inlets equipped with threaded DISS connector per CGA standards [noninterchangeable quick disconnect coupler, except for nitrogen which shall be equipped with DISS connections as assigned for gas and vacuum systems in CGA V-5, except that inlets for the Waste Anesthesia Gas Disposal system must be 22 mm 7/8 inch nonthreaded connections]. Provide DISS outlets for all dental vacuum and ceiling mount applications. Provide recessed wall type outlets/inlets unless specified otherwise. Provide station outlets cleaned for oxygen service in accordance with Pamphlet CGA G-4.1 and the assembly capped and the finished assembly poly bagged for shipment.

[2.20.1.1 Couplers

Where quick-disconnect couplers are furnished they must be of the noninterchangeable type. Connector must lock firmly into position and have a finger-type quick release. Coordinate quick-disconnect coupler type with the Contracting Officer.

]2.20.1.2 Faceplates

Provide polished chromium-plated metal or satin-finish stainless steel faceplates secured with chromium-plated countersunk screws. Provide service identification either cast into, or permanently etched by the manufacturer into each faceplate.

2.20.1.3 Rough-In Assembly

Provide rough in assembly of modular design and include a gas specific 16 gauge steel mounting plate designed to permit on-site ganging of multiple outlets, on 127 mm 5 inch center line spacing. Provide a machined brass outlet block permanently attached to the mounting bracket to permit the 15 mm 1/2 inch OD, type-K copper inlet to swivel 360 degrees for attachment to the piping system. The rough in assembly must contain a double seal to prevent gas leakage between the rough in and latch-valve assemblies after the wall is finished. A single o-ring seal is not acceptable. The latch-valve assembly shall telescope up to 19 mm 3/4 inches to allow for variation in finished wall thickness from 13 to 32 mm 1/2 to 1-1/4 inches.

2.20.1.4 Ceiling Applications/Hose Assemblies

Provide hose assemblies for all ceiling outlets for the finished ceiling height as indicated on drawings. Provide each hose with a heavy-duty chain type dual retractor for pressure gases and for vacuum. Retractions made of stainless cable are not acceptable. Allow an extra 457 mm 18 inches of hose length for retractors.

2.20.1.5 Vacuum Slides

Provide one vacuum slide of the same manufacturer of the vacuum inlet for each vacuum inlet. Coordinate location with room elevations.

2.20.2 Dental Compressed Air Outlets

Provide dental compressed air outlets as follows:

a. Provide dental treatment rooms (DTR) with a 15 mm 1/2 inch service pipe terminated with a 15 by 10 mm 1/2 by 3/8 inch compression angle stop valve.

b. Dental laboratory. Provide each of the following, and coordinate locations with the laboratory casework supplier.

(1) 15 mm 1/2 inch service pipe terminated with a ball valve. 15 mm 1/2 inch service pipe terminated with a needle valve.

(2) 15 mm 1/2 inch service pipe terminated with a quick disconnect brass body coupler and sleeve, 10 mm 3/8 inch NPT, 2070 kPa 300 psi maximum pressure rating, Buna-N seals, and complying with the dimensional requirements of military specification MIL-C-4109.

c. Provide dental instrument processing center with a 16 mm 5/8 inch OD service pipe terminated with a quick disconnect brass body coupler and sleeve, 10 mm 3/8 inch NPT, 2070 kPa 300 psi maximum pressure rating, Buna-N seals, and complying with the dimensional requirements of military specification MIL-C-4109.

2.20.3 Dental Oral Evacuation Inlets (Dental Treatment Room)

Provide dental51 mm 2 inches above bottom of floor box or above finished floor. Cover pipe end to prevent entrance of debris. Prepare end for continuation of service by another Division.

2.21 MEDICAL GAS AND SUPPORT SYSTEMS OUTLETS AND VACUUM SYSTEMS INLETS

2.21.1 Station Outlets/Inlets

****

NOTE: The type of connectors at station outlets will be as specified by the using service. This is required to ensure that the connectors provided are compatible with those on Government-furnished mobile apparatus. Unless otherwise required by the using facility, provide DISS type outlets/inlets.

****

Provide station outlets/inlets (Oxygen, Nitrogen, Nitrous Oxide, Carbon Dioxide, Medical Compressed Air, Medical-Surgical Vacuum, Waste Anesthesia Gas Disposal, Instrument Compressed Air) conforming to NFPA 99. Provide station outlets/inlets for concealed piping made of brass and having an adjustable valve mechanism to compensate for variation in wall thickness. Each unit must be securely mounted and self-sealing. Each unit as an assembly must conform to the requirements of the Underwriters Laboratories Inc.; submit proof of such conformance. The label or listing of the specified agency will be acceptable evidence. In lieu of the label or listing, the Contractor may submit a written certificate from any approved nationally recognized testing organization adequately equipped and competent to perform such services, including the follow-up service, stating that the item has been tested and conforms to the requirements, including method of testing, of the specified agency. Equip station outlets/inlets with threaded DISS connector per CGA standards [noninterchangeable quick disconnect coupler, except for nitrogen which shall be equipped with DISS connections as assigned for gas and vacuum systems in CGA V-5, except that inlets for the Waste Anesthesia Gas Disposal system must be 22 mm 7/8 inch nonthreaded connections]. Provide

DISS outlets for all ceiling mount applications. Provide recessed wall type outlets/inlets unless specified otherwise. Provide station outlets cleaned for oxygen service in accordance with Pamphlet CGA G-4.1 and the assembly be capped and the finished assembly poly bagged for shipment.

[2.21.1.1 Couplers

Where quick-disconnect couplers are furnished they must be of the noninterchangeable type. Connector must lock firmly into position and have a finger-type quick release. Coordinate quick-disconnect coupler type with the Contracting Officer.

]2.21.1.2 Faceplates

Provide polished chromium-plated metal or satin-finish stainless steel faceplates secured with chromium-plated countersunk screws. Provide service identification either cast into, or permanently etched by the manufacturer in to each faceplate.

2.21.1.3 Rough-In Assembly

Provide rough in assembly of modular design and include a gas specific 16 gauge steel mounting plate designed to permit on-site ganging of multiple outlets, on 127 mm 5 inch center line spacing. A machined brass outlet block must be permanently attached to the mounting bracket to permit the 15 mm 1/2 inch OD, type-K copper inlet to swivel 360 degrees for attachment to the piping system. Provide rough in assembly with a double seal to prevent gas leakage between the rough in and latch-valve assemblies after the wall is finished. A single o-ring seal is not acceptable. The latch-valve assembly must telescope up to 19 mm 3/4 inches to allow for variation in finished wall thickness from 13 to 32 mm 1/2 to 1-1/4 inches.

2.21.1.4 Ceiling Applications/Hose Assemblies

Provide hose assemblies for all ceiling outlets for the finished ceiling height as indicated on drawings. Provide each hose with a heavy-duty chain type dual retractor for pressure gases and for vacuum. Retractions made of stainless cable are not acceptable. Allow an extra 457 mm 18 inches of hose length for retractors.

2.21.1.5 Vacuum Slides

Provide one vacuum slide of the same manufacturer of the vacuum inlet for each vacuum inlet. Coordinate location with room elevations.

2.22 LABORATORY COMPRESSED AIR [AND PROCESS COMPRESSED AIR] TERMINATION

Provide 15 mm 1/2 inch tube at each location and terminate 102 mm 4 inches from finished face of wall/partition with 15 mm 1/2 inch ball valve and 152 mm 6 inch long capped extension.

2.23 WARNING SYSTEMS

****

NOTE: Coordinate alarm panel locations and power requirements with Division 26.

****

Locate alarm panels for gas and vacuum systems as specified and indicated. Each signal and gauge must be appropriately labeled "OPERATING" and "EMERGENCY." Clearly identify each gauge and device by means of engraved plastic nameplates. Provide alarms and pressure gauges for each pressurized system. Provide alarms and vacuum gauges for each vacuum, Waste Anesthesia Gas Disposal, and oral evacuation system. Energize signal systems by the normal and emergency power systems.

2.23.1 Master Alarm Panels

****
NOTE: Coordinate locations with using facility. Recommended locations include emergency room, central information desk, and a connection to the UMCS (UFGS 23 09 00) as determined by the project.
****

a. Master alarm panel features:

(1) Provide recessed panel, complete with all necessary displays, factory wiring, transformers, and circuitry requiring only [115] [230] VAC 60 Hz primary power connected to the Life Safety branch. Provide with metallic back (rough-in) box. Provide panel that is compliant with NFPA 99 and UL Listed as an assembly.

(2) Provide one green Light Emitting Diode (LED) indicating that the panel is powered and operating normally, and one red LED indicating a fault in the panel power and/or microprocessor has been detected. The red LED must not be able to be reset until the fault has been repaired, and then the red LED must automatically reset to green. Muting of the audible alarm in "Abnormal" status must not cancel illumination of the red LED. Only correction of the abnormal condition must allow resetting of the LED to green.

(3) Provide each individual signal with one green and one red LED. Provide illuminated green LED for "Normal" status. Provide illuminated red LED for "Abnormal" status. Muting of the audible alarm in "Abnormal" status must not cancel illumination of the red LED. Only correction of the abnormal condition must allow resetting of the LED to green.

(4) Provide audible alarm upon actuation of any abnormal condition. Provide audible signal producing a minimum sound pressure level of 80 dBA measured at a distance of 914 mm 3 feet. Provide the audible alarm with a reset relay to shut off only the audible alarm and not affect the illuminated "Abnormal" LED, until the condition is corrected. The audible alarm must sound again upon actuation of any additional abnormal condition.

(5) Provide back (rough-in) box factory configured for internal sensor mounting. Provide gas specific sensors for periodic testing without interrupting pipeline pressures or vacuum. External sensors, when applicable, must be designed to function up to 1524 m 5,000 feet from the alarm panel.

(6) Provide front panel TEST button to initiate a self-test function to test the LED indicators, visual displays, audible alarm, and to view alarm set points.

(7) Provide contacts for connecting to UMCS (UFGS 23 09 00). Alarms requiring installation of additional circuit boards for PC-based monitoring are not acceptable.

b. Provide alarm points based on installed systems:

(1) Oxygen Liquid (Main Supply) Less Than One Day [Notify [_____]]

(2) Oxygen Changeover to Secondary Supply [Notify [_____]]

(3) Oxygen Reserve in Use [Notify [_____]]

(4) Oxygen Reserve Supply Less Than One Day [Notify [_____]]

(5) Oxygen Reserve Pressure Low [Notify [_____]]

(6) Oxygen Main Line Pressure High/Low

(7) Nitrous Oxide Main Supply Less Than One Day [Notify [_____]]

(8) Nitrous Oxide Changeover to Secondary Supply [Notify [_____]]

(9) Nitrous Oxide Reserve in Use [Notify [_____]]

(10) Nitrous Oxide Reserve Supply Less Than One Day [Notify [_____]]

(11) Nitrous Oxide Reserve Pressure Low [Notify [_____]]

(12) Nitrous Oxide Main Line Pressure High/Low

(13) Nitrogen Changeover to Secondary Supply [Notify [_____]]

(14) Nitrogen Main Line Pressure High/Low

[(15) Carbon Dioxide Changeover to Secondary Supply [Notify [_____]]]

[(16) Carbon Dioxide Main Line Pressure High/Low]

(17) Medical Compressed Air Main Line Pressure High/Low

(18) Medical Compressed Air Dew Point High

****

NOTE: Use following only if medical compressed air is provided by cylinder manifold.

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[(19) Medical Compressed Air Changeover to Secondary Supply [Notify [_____]]]

(20) Medical-Surgical Vacuum Main Line Vacuum Low

(21) Waste Anesthesia Gas Disposal Main Line Vacuum Low

(22) Instrument Compressed Air Main Line Pressure High/Low

(23) Instrument Compressed Air Dew Point High

****

NOTE: Use following only if instrument compressed air is provided by cylinder manifold.
****

[(24) Instrument Compressed Air Cylinder Reserve in Use [Notify [_____]]
]

[(25) Instrument Compressed Air Cylinder Reserve Less Than One Hour Supply [Notify [_____]]]

(26) Dental Compressed Air Main Line Pressure High/Low

(27) Dental Surgical Vacuum Main Line Vacuum Low

(28) Dental Oral Evacuation Vacuum Low

(29) Medical Compressed Air Compressor(s) Local Alarm

(30) Instrument Compressed Air Compressor(s) Local Alarm

(31) Medical-Surgical Vacuum Pump(s) Local Alarm

(32) Waste Anesthesia Gas Disposal Vacuum Pump(s) Local Alarm

2.23.2 Area Alarm Panels

****
NOTE: Alarm panels are only required in areas designated in NFPA 99 unless otherwise required by using facility.
****

a. Area alarm panel features:

(1) Provide recessed panel, complete with all necessary displays, factory wiring, transformers, and circuitry requiring only [120] [230] VAC 60 Hz primary power connected to the Life Safety branch. Provide with metallic back (rough-in) box. Provide panel that is compliant with NFPA 99 and UL Listed as an assembly.

(2) Provide one green Light Emitting Diode (LED) indicating that the panel is powered and operating normally.

(3) Provide each individual signal with one green and one red LED. Provide illuminated green LED for "Normal" status. Provide illuminated red LED for "Abnormal" status. Muting of the audible alarm in "Abnormal" status must not cancel illumination of the red LED. Only correction of the abnormal condition must allow resetting of the LED to green.

(4) Provide audible alarm upon actuation of any abnormal condition. Provide audible signal producing a minimum sound pressure level of 80 dBA measured at a distance of 914 mm 3 feet. Provide the audible alarm with a reset relay to shut off only the audible alarm and not affect the illuminated "Abnormal" LED, until the condition is corrected. The audible alarm must sound again upon actuation of any additional abnormal condition.

(5) Provide back (rough-in) box factory configured for internal sensor

mounting. Provide gas specific sensors for periodic testing without interrupting pipeline pressures or vacuum. External sensors are not permitted.

(6) Provide front panel TEST button to initiate a self-test function to test the LED indicators, visual displays, audible alarm, and to view alarm set points.

[(7) Provide alarm panels in each nursing unit on a wing/ward basis as indicated, but these panels must not include nitrous oxide, nitrogen, nor Waste Anesthesia Gas Disposal and oral evacuation vacuum alarms, unless specifically indicated.]

b. Provide alarm points based on installed systems:

(1) High/Low Line Pressure (for each positive pressure system piped to the area). Actuation when the pressure in the line being monitored reaches approximately 20 percent above or below normal operating pressure.

(2) Low Line Vacuum (for each vacuum system piped to the area). Medical-surgical alarm must be actuated when the vacuum in the line being monitored reaches 60 kPa 12 inches Hg vacuum. [Waste Anesthesia Gas Disposal and oral evacuation alarm[s] must be actuated when the vacuum in the line being monitored reaches 80 kPa 6 inches Hg vacuum].

2.23.3 Local Alarm Panels

a. Provide alarm points based on installed systems:

****
NOTE: Use following for oil-less and oil-free medical compressed air sources.
****

(1) Medical Compressed Air Source Backup (Lag) Compressor Operating

(2) Medical Compressed Air Source Carbon Monoxide High

(3) Medical Compressed Air Source High Discharge Air Temperature

(4) Medical Compressed Air Source High Water in Receiver

(5) Medical Compressed Air Source Dew Point High

****
NOTE: Use following for instrument compressed air sources.
****

(6) Instrument Compressed Air Source Backup (Lag) Compressor Operating

(7) Instrument Compressed Air Source Dew Point High

****
NOTE: Use following for medical-surgical vacuum sources.
****

(8) Medical-Surgical Vacuum Source Backup (Lag) Vacuum Pump Operating

****
NOTE: Use following for Waste Anesthesia Gas Disposal vacuum sources.
****

(9) Waste Anesthesia Gas Disposal Vacuum Source Backup (Lag) Vacuum Pump Operating

2.24 IDENTIFICATION MATERIALS

General: Provide manufacturer's standard products of categories and types required for each application. Where more than single type is specified for application, selection is Installer's option, but provide single selection for each product category.

2.24.1 Plastic Pipe Markers

Provide snap-on or adhesive type pipe markers with nomenclature that closely matches Contract Drawings. Comply with designations indicated on Contract Drawings for piping system nomenclature and abbreviate only as necessary for each application length. Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as a separate unit of plastic.

a. Snap-On Type: Provide manufacturer's standard pre-printed, semi-rigid snap-on, color-coded pipe markers, complying with ANSI A108.11 ASME A13.1.

b. Pressure-Sensitive Type: Provide manufacturer's standard pre-printed, permanent adhesive, color-coded, pressure-sensitive vinyl pipe markers, complying with ASME A13.1.

c. Application: For exterior diameters greater than 50 mm 2-inch (including insulation if any), provide continuous directional flow arrow tape around pipe circumference; two places, before and after pipe marker. Provide adhesive plastic pipe markers. For external diameters less than 50 mm 2 inches (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:

(1) Snap-on application of pre-tensioned semi-rigid plastic pipe marker.

(2) Adhesive lap joint in pipe marker overlap.

(3) Laminated or bonded application of pipe marker to pipe (or insulation).

2.24.2 Valve Tags

Provide 19-gage polished brass valve tags with stamp-engraved piping system abbreviation in 6 mm 1/4-inch high letters and sequenced valve numbers 13 mm 1/2-inch high, and with hole for fastener, or engraved plastic laminate valve tags, with piping system abbreviation in 6 mm 1/4-inch high letters and sequenced valve numbers 13 mm 1/2-inch high, and

with hole for fastener. Provide manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose. Compile valve schedule for each service. For each page of valve schedule, provide laminated plastic coated cardboard stock sheets.

a. Provide 38 mm 1 1/2-inch diameter tags, except as otherwise indicated.

b. Provide size and shape as specified or scheduled for each piping system.

c. Fill tag engraving with black enamel.

2.24.3 Engraved Plastic Laminate Signs

Provide manufacturer's standard laminated plastic, color coded equipment markers. Include terminology matching equipment schedules as closely as possible. Provide approximate 51 mm by 102 mm 2-inch by 4-inch markers for control devices, and 102 mm by 152 mm 4-inch by 6-inch for equipment. Identify equipment and electrical devices furnished under this section.

2.24.4 Plastic Equipment Markers

Provide manufacturer's standard laminated plastic, color coded equipment markers. Include terminology matching equipment schedules as closely as possible. Provide approximate 51 mm by 102 mm 2-inch by 4-inch markers for control devices, and 102 mm by 152 mm 4-inch by 6-inch for equipment. Identify equipment and electrical devices furnished under this section.

2.24.5 Plasticized Tags

Provide pre-printed or partially pre-printed accident-prevention tags, of plasticized card stock with matt finish suitable for writing, approximately, 51 mm by 152 mm 2-inch by 6-inch with brass grommets and wire fasteners, and with appropriate pre-printed wording including large-size primary wording (as examples; DANGER, CAUTION, DO NOT OPERATE).

2.24.6 Lettering and Graphics

Coordinate names, abbreviations and other designations used in plumbing identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of plumbing systems and equipment. Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples; Oral Evacuation Pump No. 2, Dental Air Compressor No. 1).

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with details of the work, verify dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

[3.2 BULK LIQUID OXYGEN SOURCE

****
NOTE: Include only if bulk liquid oxygen source exists.
****

Bulk liquid oxygen source: Connect oxygen gas supply line to bulk storage facility in accordance with the Regulatory Requirements.

][3.3 EMERGENCY OXYGEN SUPPLY CONNECTION

****
NOTE: Delete if no emergency oxygen supply connection exists.
****

Pipe relief valve discharge to exterior of building.

]3.4 CYLINDER MANIFOLD SUPPLY SOURCE

a. Provide complete set of full primary and secondary cylinders after successful completion of final tests. Coordinate source of cylinders with Owner.

b. Pipe system relief discharges to exterior of building.

c. Provide check valve between each cylinder head and the manifold header. Connect each header to the manifold controls with shutoff valves. Vent relief valve to the outside atmosphere if the total capacity of the system is more than 57 cubic meters 2,000 cubic feet of gas. Venting must be accomplished by piping the relief valve to the outside atmosphere or by approved ductwork having a minimum opening of 0.047 square meters 72 square inches. Install the manifold according to the manufacturer's recommendation and as required by NFPA 99.

3.5 COMPRESSED AIR AND VACUUM SOURCES

Installation must be in accordance with manufacturer's instructions and recommendations and NFPA 99. Align compressor and vacuum pump couplings in accordance with manufacturers' specifications. Provide factory service representative to supervise installation and to set pressure and vacuum switches. Perform system start-up by factory trained personnel and documented.

3.5.1 Central Dry Separator for High-Volume Laboratory Dust Evacuation

Locate the separator so that the lower canister can be removed easily and cleaned. Equip the separator with a cut-off valve to permit shutdown when the system is not in use.

3.5.2 Amalgam Separator for Dental Oral Evacuation

Install amalgam separator between the treatment rooms and the central wet separator in a location that is accessible from a standing position adjacent to the separator.

3.6 PIPING SYSTEMS

a. Piping must be cleaned, tested, and installed as specified in NFPA 99.

b. Provide Nitrogen NF gas purge to prevent oxide formation inside the copper tubing when brazing joints. Make joints with BCuP series brazing alloy, except as permitted otherwise by NFPA 99. Brazing alloy must fully penetrate joints to the depth of an ASME B16.50 fitting.

c. Make up threaded joints, as permitted by NFPA 99, with polytetrafluoroethylene tape, or other thread sealant approved for oxygen service. Apply thread sealant to male threads only.

d. Install pipe lines where they will not be subject to physical damage.

e. Install branch piping full size to each outlet/inlet, including vertical drops. Provide reducer at the outlet/inlet pigtail connection.

f. Provide protection of underground piping against frost, corrosion, and physical damage by installing piping in nonmetallic ducts or casings. Encase underground piping passing beneath load bearing surfaces and traffic areas in split PVC pipe sized to accommodate piping. Secure split PVC piping with galvanized steel draw bands. Support at regular intervals by insulating spacers providing complete circumferential clearance.

g. Install piping intended to contain cryogenic liquids such that the liquid does not come in contact with concrete in the event of a leak.

h. Connect piping near the top of receivers.

i. Extend compressed air intake pipe, and vacuum pump exhaust pipe to the outside of the building and turn their end down and screen against insects. Terminate compressed air intake piping a minimum of 36 inches above the roofing surface.

j. Provide vibration-absorbing couplings between the compressed air and vacuum source(s) and the system pipeline, and the compressed air and vacuum sources and the intake air/vacuum pump exhaust piping.

k. Provide laboratory and process air piping system(s) separate from the dental and medical compressed air system(s).

l. Install dental oral evacuation system piping with a minimum slope of 6 mm per 3.05 m 1/4 inch per 10 feet from the DTR utility box to the separator tanks.

m. Provide pipelines with appropriate system labeling conforming to NFPA 99.

n. Provide protective bushings on medical gas and vacuum piping passing through metal stud partitions.

o. Install vacuum exhaust piping with a minimum slope of 6 mm per 3.05 m 1/4-inch per 10 feet towards vacuum source equipment.

3.7 STATION OUTLETS/INLETS

3.7.1 Wall Outlets/Inlets

Locate wall outlets/inlets 1524 mm 60 inches from finished floor or as indicated. Permanently stamp back boxes with the gas or vacuum service identification and must be safety-keyed to accept only the appropriate gas or vacuum faceplate.

3.7.2 DISS Connections

Where threaded connections are furnished, DISS connections as described in CGA V-5 must be used to provide noninterchangeable connections. In order to facilitate connection making, the threads of the connection must engage before the check valve is depressed and pressure is allowed to enter the attached fitting. No leakage must occur when threads are fingertight.

3.7.3 Height of Hose-reel Type Outlets/Inlets

Termination must be a minimum of 2032 mm 80 inches above the finished floor.

3.8 VALVES AND ASSEMBLIES

Valve cabinets must be recess mounted on the corridor side of the partition. Cabinets must house alarm system sensors and zone control valves. The valves must be installed in the cabinet 1524 mm 5 feet above the floor at the center line of the box and provide complete shutoff of each of the piped services. Provide valves and exposed piping connecting the valves with appropriate system labeling conforming to NFPA 99. Valves and exposed piping connecting the valves must be labeled or identified in an approved manner with colors as follows:

System	Colors (Background/Text)
Dental Compressed Air	Yellow and White Diagonal Stripe/Black
Dental Surgical Vacuum	White and Black Diagonal Stripe/Black Boxed
Medical Compressed Air	Yellow/Black
Carbon Dioxide	Gray/Black or Gray/White
Instrument Air	Red/White
Laboratory Air	Yellow and White Checkerboard/Black
Laboratory Vacuum	Yellow and White Checkerboard/Black Boxed
Nitrogen	Black/White
Nitrous Oxide	Blue/White
Oral Evacuation	White and Black Checkerboard/Black Boxed

System	Colors (Background/Text)
Dental Compressed Air	Yellow and White Diagonal Stripe/Black
Oxygen	Green/White or White/Green
Medical Surgical Vacuum	White/Black
Waste Anesthetic Gas Disposal	Violet/White

Securely mount each valve in a fixed position by means of brackets. Position of each valve must allow for a firm grip to facilitate easy closing and opening. Each valve or valve box must be labeled in substance as follows:

"Caution - (Name of applicable system) Valves. Do not close except in emergency. This valve controls (Name of applicable system) to [insert room name/number]."

3.9 GAUGES

a. Calibrate and zero gauges at job site.

b. Permanently label gauges with system name.

3.10 VIBRATION-ABSORBING FEATURES

****

NOTE: Designer will indicate on the drawings where equipment should be mounted resiliently. Details for proper mounting of equipment will be indicated on the drawings. Designer will insert required isolation efficiency in the blank space for installations where specific values for reduction of noise and vibration transmission are necessary; otherwise the sentence will be deleted. For areas where the maximum tolerable transmissibility in percent is considered necessary, the isolation efficiency will be given. Recommended transmissibility in percentages is as follows: 10 percent for equipment mounted in very critical areas, 10 to 20 percent for critical areas, and 20 to 40 percent for noncritical areas. The drawings should be checked to ensure that all structural and equipment connection factors or conditions surrounding the equipment, which are to be provided with vibration isolation units, favorably influence the effectiveness of the isolators. Where many items of equipment require different transmission values because of different equipment locations, the specification may be revised to indicate the appropriate values on the drawings.

Delete submittal of vibration-absorption features when not required.

****

Isolate mechanical equipment, including compressors and pumps, from the building structure by approved vibration-absorbing features unless otherwise shown. Each foundation must include standard isolation units as indicated. Each unit must consist of machine and floor or foundation fastening, together with intermediate isolation material, and be a standard product with printed loading rating. Provide piping connected to mechanical equipment with flexible connectors. Isolation unit installation must limit vibration to [_____] percent of the lowest equipment rpm. Submit details of vibration-absorbing features, including arrangement, foundation plan, dimensions and specifications.

3.10.1 Tank or Skid Mounted Compressors

Provide floor attachments as recommended by compressor manufacturer. Mount compressors to resist seismic loads as specified in [Section 13 48 73 SEISMIC CONTROL FOR MECHANICAL EQUIPMENT] [Section 22 05 48.00 20 MECHANICAL SOUND, VIBRATION, AND SEISMIC CONTROL].

3.10.2 Foundation Mounted Compressors

Provide foundation attachment as recommended by the compressor manufacturer. Mount compressors to resist seismic loads as specified in Section 22 05 48.00 20 MECHANICAL SOUND, VIBRATION, AND SEISMIC CONTROL.

3.11 TRAINING

a. Provide the services of competent instructors to give full instruction to the designated Government personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the specified equipment or system. Instructors must be thoroughly familiar with all parts of the installation and be trained in operating theory as well as practical operation and maintenance work.

b. Instruction must be given during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished must be as specified in the individual section. When more than 4 man-days of instruction are specified, use approximately half of the time for classroom instruction. Use other time for instruction with the equipment or system.

c. When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instruction to acquaint the operating personnel with the changes or modifications.

3.12 IDENTIFICATION SYSTEMS

Identify piping and physical hazards in accordance with 29 CFR 1910.144, ASME A13.1, and NEMA Z535.1. Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment. Identify each piping system and item of equipment indicated on Contract Drawings.

3.12.1 Piping System Identification

Install plastic pipe markers on each system, and include arrows to show normal direction of flow. Locate pipe markers and color bands wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, crawl spaces) and exterior non-concealed locations as follows.

a. Near each valve and control device.

b. Near each branch; mark each pipe at branch, where there could be question of flow pattern.

c. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.

d. At access doors, manholes and similar access points which permit view of concealed piping.

e. Near major equipment items and other points of origination and termination.

f. Spaced intermediately at maximum spacing of 6.1 meters20 feet along each piping run, except reduce spacing to 3 meters10 feet in congested areas of piping and equipment. Provide a minimum of one pipe label in each space where partitions extend to structure.

g. Align pipe labels and flow arrows on systems where parallel piping is installed.

3.12.2 Valves

Provide valve tag on every valve, cock and control device in each piping system. List each tagged valve in valve schedule for each piping system. .Mount laminated valve schedules under glass in mechanical equipment rooms. Coordinate location with the Contracting Officer. Provide 13 mm 1/2-inch red adhesive identification dots on ceiling tiles located immediately below balancing valves and shutoff valves.

3.12.3 Medical/Dental Source Equipment

Provide minimum 6 mm1/4-inch high lettering for name of unit where viewing distance is less than 13 mm 1/2-inch high for distances up to 1.8 meters 6 feet, and proportionately larger lettering for greater distances. Provide secondary lettering of 2/3 to 3/4 of size of the principal lettering. In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

3.12.4 Pipe Color Code Marking

Color code marking of piping shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

3.12.5 Color Coding Scheme for Locating Hidden Utility Components

Scheme must be provided in buildings having suspended grid ceilings. The color coding scheme must identify points of access for maintenance and

operation of operable components which are not visible from the finished space and installed in the space directly above the suspended grid ceiling. The operable components must include valves. The color coding scheme must consist of a color code board and colored metal disks. Each colored metal disk must be approximately 10 mm 3/8-inch in diameter and secured to removable ceiling panels with fasteners. Insert fasteners into the ceiling panels so that the fasteners will be concealed from view. The fasteners must be manually removable without tools and must not separate from the ceiling panels when panels are dropped from ceiling height. Installation of colored metal disks must follow completion of the finished surface on which the disks are to be fastened. Provide the color code board with approximate dimensions of 3-foot width, 30-inch height, and 13 mm 1/2-inch thickness. Provide board made of wood fiberboard and framed under glass or 2 mm 1/16-inch transparent plastic cover. Unless otherwise directed, the color code symbols must be approximately 19 mm 3/4-inch in diameter and the related lettering in 13 mm 1/2-inch high capital letters. Mount and locate the color code board in the mechanical or equipment room.

3.13 GAS, SUPPORT, AND VACUUM SYSTEMS TESTING

3.13.1 Joint Validation

At its discretion, the Government reserves the right to validate joint fill through destructive and non-destructive methods. Non-destructive methods include, but are not limited to, Visual Examination and Ultrasonic Examination, in accordance with AWS C3.8M/C3.8. Validation of joint fill through destructive or non-destructive methods and extents of examinations will be as determined by the Contracting Officer.

[3.13.2 Camera Inspection

a. Prior to testing, perform camera (borescope) inspection of the interior of patient pressurized medical gas piping systems. The Contracting Officer will select [5 percent] [_____ percent] of each patient medical gas system for inspection. Prior to inspection, borescope probes must be free of dirt and debris. Any noted copper-oxide on the interior of joints will require replacement of the offending joints and affected piping to a point 12 inches beyond observed limits of copper-oxide. Locations where joints were replaced, camera re-inspection is required. Continue joint replacement and camera re-inspection until no evidence of copper-oxide is observed. Upon completion of camera inspection and replacement work, purge patient pressurized medical gas systems with NF nitrogen.

b. Provide the camera inspection report complete with log of locations inspected and re-inspected, copper-oxide observation pass/fail, joints replaced, photographs of the interior of each piping system at each inspection location, video of the interior of each piping system inspection, and floor plans indicating inspection locations. Provide video to the Government in Audio Video Interleave (AVI) format stored on Digital Video Disc (DVD). The use of Universal Serial Bus (USB) drives for video submission to the Government is not acceptable.

]3.13.3 Test Reports

a. Certified installers, inspectors, and verifiers must conduct, document tests in accordance with NFPA 99, furnish their own test equipment and supplies (including gases) for their respective tests. Reports must be certified with the signature of an officer of the company

responsible for conducting the test.

b. Submit reports in booklet form, within two weeks of test date with separate copies of each report for Contractor Quality Control, and Contracting Officer. Submit reports of both failed and passed tests. Except as indicated under specific test description, reports may be subdivided by tested area to allow timely submission. Submit test reports showing all field tests performed to adjust each component and field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed systems. Each test report must indicate the final position of controls.

c. Document each report separately in an easy-to-follow manner, organized by areas and systems tested. (An area is typically a group of outlets downstream of a zone valve assembly.)

d. At the beginning of each report, document the following information:

(1) Name of project.

(2) Date of report.

(3) Name of company responsible for performing test.

(4) Name of person conducting test.

(5) Date of test.

(6) Area(s) tested.

(7) Name and address of facility.

e. Make pressure readings with calibrated gauges that have accuracies of plus or minus 7 kPa 1 psi.

f. Make temperature readings with calibrated thermometers that have accuracies of plus or minus 0.5 degrees C 1 degrees F.

3.13.4 Report Status

Project is acceptable only after systems have passed tests performed by the Inspection, Testing, and Verification Agency. Failure of test requires corrective action and retesting. Corrective actions taken to pass test and subsequent retesting must be provided at no extra cost.

3.13.5 Tests and Reports Prior to Start of Installation

****

NOTE: Delete this test and report when interconnections will not be made between new and existing systems.

****

Conduct test of existing medical gas/vacuum warning system to verify existing conditions and document.

3.13.6 Category 3 Systems Testing

3.13.6.1 General

a. Perform inspection and testing on all new piped systems, additions, renovations, temporary installations, or repaired systems, to ensure by a documented procedure, that all applicable provisions of NFPA 99 and the Contract Documents have been adhered to and system integrity has been achieved or maintained.

b. Inspection and testing to include all components of the system or portions thereof, including, but not limited to, medical gas source(s), compressed air sources (e.g., compressors, dryers, filters, regulators), alarms and monitoring safeguards, pipelines, isolation valves, and station inlets (vacuum) and outlets (positive pressure gases).

c. Inspect and test all systems that are breached and components that are subject to additions, renovations, or replacement (e.g., new medical gas sources, compressors, dryers, alarms). Systems are deemed breached at the point of pipeline intrusion by physical separation or by system component removal, replacement, or addition. Breached portions of the systems subject to inspection and testing must be confined to only the specific altered zone and components in the immediate zone or area that is located upstream (inlet side) for vacuum systems and downstream (outlet side) for positive pressure gases at the point or area of intrusion.

d. Provide inspection, testing and verifier reports containing detailed findings and results directly to the Contracting Officer. Maintain all inspection, testing, and verification records on-site within the facility. The Contracting Officer must review the records prior to the use of all systems.

e. The Contracting Officer will accept the Verifier's Report as determining that the gas/vacuum delivered to the outlet/inlet is that shown on the outlet/inlet label and the proper connecting fittings are installed for the specific gas/vacuum service.

3.13.6.2 Initial Tests and Reports - All Category 3 Systems

The installing Contractor, a representative of the system supplier, or a representative of the system manufacturer is responsible for conducting and documenting these tests. Test gas must be oil-free, dry Nitrogen NF. Provide all necessary materials and test apparatus to satisfactorily perform tests.

a. Initial Blow Down Test.

b. Initial Pressure Test for Positive Pressure Gas Systems and Copper Vacuum Piping.

c. Initial Leak Test for PVC Vacuum Piping. Subject piping to a vacuum of not less than 60 kPa 12 inches Hg vacuum.

d. Initial Cross-Connection Test. Conduct this test only after completion of every system within test area.

e. Initial Piping Purge Test.

f. Initial Standing Pressure Test for Positive-Pressure Gas Piping.

g. Initial Standing Vacuum Test for Copper and PVC Vacuum Systems. Subject PVC piping to a vacuum of not less than 60 kPa 12 inches Hg which must not reduce to less than 73 kPa 8 inches Hg vacuum at the end of the 24 hour test period.

3.13.6.3 I,T&V Agency Tests and Reports

****
NOTE: Delete Final Tie-In Test Report when interconnections will not be made between new and existing systems.
****

The Inspection, Testing and Verification Agency is responsible for conducting and documenting gas and Nitrogen tests. Test gas must be oil-free, dry Nitrogen NF. Provide all necessary materials and test apparatus to satisfactorily perform tests.

[a. Verifier Final Tie-In Test.]

b. Verifier Standing Pressure Test.

c. Verifier Cross-Connection Test.

d. Verifier Warning System Test.

e. Verifier Piping Purge Test.

f. Verifier Piping Particulate Test.

g. Verifier Piping Purity Test.

h. Verifier Operational Pressure Test.

i. Verifier Gas Concentration Test.

j. Labeling.

k. Oxygen and Nitrous Oxide Source Equipment Operational Test.

3.13.6.4 Final Tests and Reports - All Category 3

****
NOTE: Delete Final Tie-In Test Report when interconnections will not be made between new and existing systems.
****

The installing Contractor, a representative of the system supplier, a representative of the system manufacturer, or a certified system verifier is responsible for conducting and documenting Gas, Support, and Vacuum Systems (except Oxygen and Nitrous Oxide) tests. Test gas must be oil-free, dry Nitrogen NF. Provide all necessary materials and test apparatus to satisfactorily perform tests.

[a. Final Tie-In Test.]

b. Final Standing Pressure Test.

c. Final Standing Vacuum Test.

d. Final Cross-Connection Test.

e. Final Piping Purge Test.

f. Labeling.

g. Gas, Support Systems Source Equipment Operational Test.

h. Vacuum Systems Source Equipment Operational Test.

i. Dental Oral Evacuation (OE) System Test

Materials needed: Two vacuum gauges, accuracy of at least ±0.15 kPa at 79-73 kPa ±0.5" Hg at 6-8" Hg. Flow restrictors (quantity = 70 percent by number of dental treatment rooms). Flow restrictor components:

(1)

Part A	Hose, smooth bore OE tubing, 16 mm ID by 102 mm 5/8 inch ID by 4 inch long.
Part B	Hose adaptor, brass, 15 mm male pipe thread by 10 mm 1/2 inch male pipe thread by 3/8 inch hose barb.
Part C	Tubing, vinyl, 15 mm ID by 35 mm 1/2 inch ID by 1-3/8 inch long.
Part D	Tubing, vinyl, 15 mm OD, 5 mm ID by 25 mm 1/2 inch OD, 3/16 inch ID by 1 inch long.
Part E	Tubing, soft copper, 8 mm by 51 mm 5/16 inch by 2 inch long.

(2) Clear burrs on cut ends with 24 mm 15/16 inch drill bit.

Flow restrictor assembly:

a. Insert threaded end of the hose barb (Part B) completely into the 16 mm 5/8 inch OE hose (Part A).

b. Slip the 15 mm 1/2 inch ID tubing (Part C) completely over the hose barb (Part B).

c. Slip 15 mm 1/2 inch OD tubing (Part D) into the 15 mm 1/2 inch ID tubing (Part C) to butt against the hose barb (Part B).

d. Slip the copper tubing (Part E) into the 15 mm 1/2 inch OD tubing (Part D) approximately 19 mm 3/4 inch.

e. Flow restrictors as designed allow a flow of 3.5 L/s 7.4 SCFM when attached to plumbing under 79 kPa 6 inches Hg vacuum pressure.

****

NOTE: Show vacuum gauge No. 1 on the contract documents.

****

(1) Install vacuum gauge No. 1 on a pipe common to the power units close to the separating tanks. Install this gauge in a manner

that will have minimal effect on airflow through the pipe.

(2) Install vacuum gauge No. 2 on the dental oral evacuation inlet in the floor box of the dental treatment room (DTR) farthest from the vacuum power units. Note that this inlet will be closed, with no flow passing through it.

(3) Place a flow restrictor over one dental oral evacuation inlet in 70 percent of the facility DTRs. DTRs fitted with flow restrictors should include a mix of DTRs most distant and DTRs nearest the vacuum source.

(4) Block off all other dental oral evacuation inlets and any other openings in the fixed pipe system.

****

NOTE: Dental oral evacuation systems utilize two or more vacuum pumps and are sized so that when one pump is inoperable the remaining pump(s) are capable of meeting the demand of 70 percent of the facility DTRs. For this reason, testing will be conducted with one pump inoperable. Utilization of flow restrictors simulates flow obtained through a functioning dental unit. Attaching flow restrictors to inlets in 70 percent of the DTRs (with other inlets blocked) verifies that an appropriate vacuum level can be obtained, with one pump inoperable, under flow conditions at a 70 percent system demand.

****

(5) Operate the vacuum system with one pump inoperable and note the readings on the two vacuum pressure gauges. Next, operate the vacuum system with a different pump inoperable and note the reading on both vacuum pressure gauges. Continue this process until a vacuum reading has been obtained with each of the system pumps taking a turn as the inoperable pump.

(6) An acceptable dental oral evacuation system must be able to maintain a minimum of 79 kPa 6 inches Hg vacuum as measured on the vacuum gauge on the furthest DTR inlet (gauge No. 2) under the conditions outlined above. The system piping pressure drop between the vacuum gauge near the power units (gauge No. 1) and the vacuum gauge at the farthest DTR (gauge No. 2) must be no more than 0.3 kPa 1 inch Hg vacuum.

3.13.7 Category 1 Systems Testing

3.13.7.1 General

a. Perform inspection and testing on all new piped systems, additions, renovations, temporary installations, or repaired systems, to assure by a documented procedure, that all applicable provisions of NFPA 99 and the Contract Documents have been adhered to and system integrity has been achieved or maintained.

b. Inspection and testing must include all components of the system or portions thereof, including, but not limited to, bulk source(s), cylinder manifolds, compressed air sources (e.g., compressors, dryers, filters, regulators), source alarms and monitoring safeguards, master

alarms, pipelines, isolation valves, area alarms, zone valves, and station inlets (vacuum) and outlets (pressure gases).

c. All systems that are breached and components that are subject to additions, renovations, or replacement (e.g., new gas sources: bulk, manifolds, compressors, dryers, alarms) must be inspected and tested. Systems are deemed breached at the point of pipeline intrusion by physical separation or by system component removal, replacement, or addition. Breached portions of the systems subject to inspection and testing must be confined to only the specific altered zone and components in the immediate zone or area that is located upstream for vacuum systems and downstream for pressure gases at the point or area of intrusion.

d. Provide inspection, testing, and verifier reports containing detailed findings and results directly to the Contracting Officer. Maintain all inspection, testing, and verification records on-site within the facility. The Contracting Officer or their appointed representative must review the records prior to the use of all systems.

e. Before piping systems are initially put into use the Contracting Officer must accept the Verifier's Report as determining that the gas/vacuum delivered to the outlet/inlet is that shown on the outlet/inlet label and the proper connecting fittings are installed for the specific gas/vacuum service.

3.13.7.2 Installer Performed Tests and Reports

****

NOTE: Delete Connection Report when interconnections will not be made between new and existing systems.

****

The installing Contractor is responsible for conducting and documenting these tests. Test gas must be oil-free, dry Nitrogen NF. Provide all necessary materials and test apparatus to satisfactorily perform tests. Tests apply to all Gas, Support, and Vacuum Systems.

[a. Connection Report.]

b. Initial Blow Down Test.

c. Initial Pressure Test.

d. Cross Connection Test.

e. Piping Purge Test.

f. Standing Pressure Test for Positive Pressure Piping.

g. Standing Vacuum Test for Vacuum Piping.

3.13.7.3 I,T&V Agency Tests and Reports

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NOTE: Delete Final Tie-In Test Report when interconnections will not be made between new and existing systems.

Delete Initial Alarm Test Report when interconnections will not be made between new and existing systems.
****

The Inspection, Testing, and Verification Agency is responsible for conducting and documenting these tests. Test gas must be oil-free, dry Nitrogen NF. Provide all necessary materials and test apparatus to satisfactorily perform tests. Tests apply to all Gas, Support, and Vacuum Systems.

[a. Final Tie-In Test.]

[b. Initial Alarm Test. For each system, document operation of existing alarm systems prior to interconnecting new and existing systems.]

c. Standing Pressure Test.

d. Cross Connection Test.

e. Individual Pressurization Test.

f. Pressure Differential Test.

g. Valve Test.

h. Alarm Test. Master Alarms. Area Alarms.

i. Piping Purge Test.

j. Piping Particulate Test.

k. Piping Purity Test.

l. Operational Pressure Test.

m. Medical Gas Concentration Test.

n. Medical Compressed Air Purity Test.

o. Labeling.

p. Source Equipment Verification:

(1) Gas Cylinder Supply Sources.

(2) Medical Compressed Air Compressor Sources.

(3) Medical-Surgical Vacuum Sources.

3.14 WARNING SYSTEM

Provide wiring required for warning system except for power source at each alarm panel, which is provided by Electrical Specification Division contractor. Install wiring in conduit [including underground portion to the bulk oxygen site].

a. Label each alarm position on each alarm panel. Coordinate

designations with using facility. Coordinate area designations with associated zone valve assembly designations.

b. Do not daisy-chain master alarm panels. Provide panel dedicated sensors and wiring from the alarm points to each installed master alarm panel.

c. Provide master alarm panels at the following locations:

Emergency Receiving Desk	Room [_____]
Central Information Desk	Room [_____]
Building Engineers Office	Room [_____]
Building Security Office	Room [_____]

d. Provide master alarm connection to UMCS (UFGS 23 09 00).

e. Do not daisy-chain area alarm panels.

[3.15 EXISTING PIPED DISTRIBUTION SYSTEMS

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NOTE: Include existing piped distribution systems when remodels affect them. Edit to match project.

When bulk oxygen systems are leased to the Hospital, their upgrade is not part of these construction documents: Include the bracketed sentence.
****

Upgrade existing systems as indicated and as required to comply with the Regulatory Requirements.[Do not upgrade the bulk oxygen system, but do provide upgraded alarms at system site.]

] -- End of Section --