Medical Gas Systems

Medical Gas System Maintenance Personnel (ASSE 6040)

- This standard applies to any individual who maintains medical gas and vacuum systems. Healthcare facility personnel installing medical gas or vacuum systems shall be certified to ASSE Standard 6040. Medical gas systems include vacuum systems.

- The purpose of this standard is to provide minimum performance criteria, identified by an industry consensus, for Medical Gas Systems Maintenance Personnel to ensure compliance with the referenced standards in Section 40-1.4.
Why is Medical Gas Maintenance training required?

- **Mistakes**
  - The first recorded medical gas cross connection deaths were in a hospital in Sudbury, Ontario Canada in 1972
    - Oxygen and nitrous oxide were cross connected in a new building addition.
    - 22 people died of asphyxiation as a result of this cross connection, between May 7, 1972 to Sept. 12, 1972.
  - The result of this tragedy was the development of a code requiring 3rd party verification, and later installer training.
Hospital deaths probed

By John LeBlanc
SUDBURY, Ont. (CP) – An expert said Monday that departure from the architect’s drawings for medical gas lines caused problems in a new wing of The Sudbury General Hospital last year.

The expert, Eric Heathcote of Toronto, was testifying at an inquest beginning an investigation into 22 deaths at the institution.

The lawyer for the family of one of the victims drew this evidence from Mr. Heathcote, a consulting engineer retained in the police and government investigation started after the five month succession of deaths.

Earlier, Dr. Ross Bennett of Toronto, deputy supervising coroner for Ontario and presiding at the inquiry, told the jury that investigation indicated there had been a crossing of oxygen and anesthetic nitrous oxide lines leading into at least one of the new wing’s treatment rooms.

Lawyer Elmer Sopha of Sudbury, acting for relatives of six-year-old Catherine Dominic who died last Sept. 7, asked Mr. Heathcote whether there would have been any problems if the drawings had been followed.

“In my opinion, there would not have been any trouble” the engineer replied. “We may anticipate that something went wrong by way of departure from the drawings?” asked Mr. Sopha, a former Liberal MP for Sudbury.

“Yes sir,” answered Mr. Heathcote, who said he has been involved in medical gas installations in several hospitals.

In Monday’s opening of sittings, expected to last about three weeks, there was no evidence of how the Sudbury installation departed from the drawings.

Mr. Heathcote said he was satisfied that the drawings showed a “proper system.” However, he said at one point that labeling of at least a part of the mechanical drawings was “not entirely accurate.”

This was in reply to a suggestion from lawyer R.P. Armstrong, representing Canadian Liquid Air Ltd., which supplied equipment for the gas system but did not install it.

Before the engineer could go into detail he was cut off by Sudbury Crown attorney John Takach, who is presenting the evidence.

Mr. Takach pushed to have a jury get more background before going into construction details.

However, the engineer did specify four “problem areas” in the new wing which opened last May. One of them the special procedures room where the Dominic girl from nearby Dowling, was stricken after being administered what supposedly was pure oxygen from the hospital’s central medical gas piping system.

The girl, who had broken her arm in a fall from a swing, was having it reset for the third time when she was placed under anesthetic in the special procedure room. Previous settings had been in other hospital departments. Dr. Bennett said that in the final attempt Miss Dominic was given a high mixture of nitrous oxide and oxygen from the central supply. As she was about to come out of the anesthetic, she was given what was believed to be 100 percent oxygen.

She turned blue and died shortly afterward, the coroner said.

Dr. Bennett said about 150 deaths which occurred in Sudbury General Hospital between last May 7 and Sept. 12 had been reviewed before investigators settled on 22 of the cases for the inquest. All had the common factor of being treated in the new section.
Bob Kroening

- Over 25 years designing, inspecting, and verifying plumbing systems in Healthcare Facilities
- President of Medical Gas Systems, Inc., A medical gas system consulting and verification company.
  - MGS has been consulting, inspecting, testing, and certifying medical gas systems in the United States and Canada since 1975

Currently credentialed:
- Medical Gas System Installer (ASSE 6010) by NITC
- Medical Gas System Inspector (ASSE 6020) by NITC
- Medical Gas System Verifier (ASSE 6030) by NITC
- Credentialed Medical Gas Verifier (CMGV) by Medical Gas Professional Healthcare Organization
- Bulk Medical Gas Verifier (ASSE 6015) by Medical Gas Institute
- Medical Gas System Instructor (ASSE 6050) by NITC
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Applicable Codes & Standards

- ANSI/ASSE Series 6000, 2012 edition
- NFPA 55, 2013 edition
NFPA 99 - 1999

- Chapter 4 Gas and Vacuum Systems
  - Level 1 Hospital type facilities.
  - Level 2 Ambulatory Care, Clinic and Nursing Home facilities.
  - Level 3 Medical, Dental offices and Limited Care facilities.

NFPA 99 - 2005

- Chapter 5 Gas and Vacuum Systems
  - Level 1 Hospital type facilities.
  - Level 2 Ambulatory Care, Clinic and Nursing Home facilities.
  - Level 3 Medical, Dental offices and Limited Care facilities.
NFPA 99 - 2012

- Chapter 5 Gas and Vacuum Systems
  - Category 1 - Hospital type facilities.
  - Category 2 - Ambulatory Care, Clinic and Nursing Home facilities.
  - Category 3 - Medical, Dental offices and Limited Care facilities.
  - Category 4 - Non-Health Care Facilities

NFPA 99 - 2015

- Chapter 5 Gas and Vacuum Systems
  - Category 1 - Hospital type facilities.
  - Category 2 - Ambulatory Care, Clinic and Nursing Home facilities.
  - Category 3 - Medical, Dental offices and Limited Care facilities.
  - Category 4 - Non-Health Care Facilities
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NFPA = National Fire Protection Association

NFPA 99 “Health Care Facilities Code”, is updated by the “NFPA Technical Committee” approximately every three years. (The latest version, 2015 Edition “Health Care Facility Code” was just released in October 2014 and is widely viewed as the most comprehensive medical gas system document with patient safety at its highest).

NFPA 99 is adopted by states, most commonly through, the adoption of NFPA 101 Life Safety Code

  - Chapter 18 NEW HEALTH CARE OCCUPANCIES
  - 18.3.2.4 Medical Gas.
    Medical gas storage and administration areas shall be protected in accordance with NFPA 99, Standard for Health Care Facilities.

Minnesota and Wisconsin have adopted NFPA 101-2000. Because a code document cannot reference a newer version than the year of its issuance, NFPA 99 - 1999 is considered the enforceable code document.
Medical Gas Systems

- Many specifying engineers will design and require that the installation meet the most current version of NFPA 99 (2012 and 2015).
- All medical gas equipment manufactures will update their equipment to meet the most current version of NFPA 99 (2012 and 2015).
NFPA 55 - 2013

- Chapter 9 Bulk Oxygen Systems
Certified Medical Gas Systems Maintenance Qualification Training Course

NFPA 99  2012 CODE
ASSE 6000
Professional Qualifications Standards for Medical Gas Systems Personnel

- The American Society of Sanitary Engineering is dedicated to the preservation of public health and safety through “Prevention Rather Than Cure.”
- These ASSE/IAPMO/ANSI Series 6000 Standards allow regulatory officials to have uniform minimum requirements for qualified Medical Gas Systems Installers, Medical Gas Systems Inspectors, Medical Gas Systems Verifiers, Medical Gas Systems Maintenance Personnel, Medical Gas Systems Instructors, Bulk Medical Gas Systems Installers, Bulk Medical Gas Systems Verifiers and Bulk Medical Gas Systems Instructors. In addition, these standards give uniform requirements for third-party certifiers so that individuals can be certified to these standards.
Joint Commissions

- An independent, not-for-profit organization, The Joint Commission accredits and certifies more than 20,500 health care organizations and programs in the United States. Joint Commission accreditation and certification is recognized nationwide as a symbol of quality that reflects an organization’s commitment to meeting certain performance standards.
- **Their Mission:** To continuously improve health care for the public, in collaboration with other stakeholders, by evaluating health care organizations and inspiring them to excel in providing safe and effective care of the highest quality and value.
- **Their Vision Statement:** All people always experience the safest, highest quality, best-value health care across all settings.
The Centers for Medicare & Medicaid Services (CMS), a branch of the Department of Health and Human Services (HHS), is the federal agency that runs the Medicare Program and monitors Medicaid programs offered by each state.

In 2011, Medicare covered 48.7 million people. Total expenditures in 2011 were $549.1 billion. This money comes from the Medicare Trust Funds.
Federal Regulations

- FDA
  - Medical Gases are controlled drugs governed by FDA
- OSHA
  - Protects workers in the work place
Compressed Gas Association

- CGA maintains a library of over 300 publications, safety alerts, safety bulletins, technical bulletins, technical reports, and videos. CGA’s positions address safety and technical information related to the manufacture, transportation, storage, transfilling, and disposal of gases (liquefied, non-liquefied, dissolved, and cryogenic); and the containers and valve which hold compressed gases.
- CGA E-10-2013 Maintenance of Medical Gas and Vacuum Systems in Health Care Facilities
- CGA P-1-2015 Standard for Safe Handling of Compressed Gases in Containers
5.1.2 Nature of Hazards of Gas and Vacuum Systems. Potential fire and explosion hazards associated with positive pressure gas central piping systems and medical–surgical vacuum systems shall be considered in the design, installation, testing, operation, and maintenance of these systems.
DEFINITIONS

- General Anesthesia & Levels of Sedation
- Definition Change
- Important for determination of Anesthetizing Locations
General Anesthesia & Levels of Sedation / Analgesia

3.3.63.3 Minimal Sedation (Anxolysis).
A drug-induced state during which patients respond normally to verbal commands. Although cognitive function and coordination may be impaired, ventilatory and cardiovascular functions are unaffected.

3.3.63.4 Moderate Sedation (Conscious Sedation).
A drug-induced depression of consciousness during which patients respond purposefully to verbal commands, either alone or accompanied by light tactile stimulation. No interventions are required to maintain a patient airway, and spontaneous ventilation is adequate. Cardiovascular function is usually maintained.

3.3.63.1 Deep Sedation/Analgesia
A drug-induced depression of consciousness during which patients cannot be easily aroused but respond purposefully following repeated or painful stimulation. The ability to independently maintain ventilatory function may be impaired. Patients may require assistance in maintaining a patent airway, and spontaneous ventilation may be inadequate. Cardiovascular function is usually maintained.

3.3.63.2 General Anesthesia
A drug-induced loss of consciousness during which patients are not arousable, even by painful stimulation. The ability to independently maintain ventilatory function is often impaired. Patients often require assistance in maintaining a patent airway, and positive pressure ventilation may be required because of depressed spontaneous ventilation or drug-induced depression of neuromuscular function. Cardiovascular function may be impaired.
Patient Care Rooms

3.3.138* Patient Care Room.
Any room of a health care facility wherein patients are intended to be examined or treated.

3.3.138.2* Critical Care Room.
Room in which failure of equipment or a system is likely to cause major injury or death of patients or caregivers. (critical care, intensive care, delivery rooms, operating rooms, post-anesthesia care units, trauma rooms, and special care treatment rooms such as angiography laboratories, cardiac catheterization laboratories and other similar rooms).

3.3.138.3* General Care Room.
Room in which failure of equipment or a system is likely to cause minor injury to patients or caregivers (inpatient bedrooms, dialysis rooms, in vitro fertilization rooms, procedural rooms, and similar rooms).

3.3.138.1* Basic Care Room.
Room in which the failure of equipment or a system is not likely to cause injury to the patients or caregivers but can cause patient discomfort. (examination or treatment rooms in clinics, medical and dental offices, nursing homes, and limited care facilities).

3.3.138.4* Support Room.
Room in which failure of equipment or a system is not likely to have a physical impact on patients or caregivers. (anesthesia work rooms, sterile supply, laboratories, morgues, waiting rooms, utility rooms, and lounges).
Chapter 4  Fundamentals

4.1* Building System Categories. Building systems in health care facilities shall be designed to meet system Category 1 through Category 4 requirements as detailed in this code.

4.1.1* Category 1. Facility systems in which failure of such equipment or system is likely to cause major injury or death of patients or caregivers shall be designed to meet system Category 1 requirements as defined in this code.

4.1.2* Category 2. Facility systems in which failure of such equipment is likely to cause minor injury to patients or caregivers shall be designed to meet system Category 2 requirements as defined in this code.

4.1.3 Category 3. Facility systems in which failure of such equipment is not likely to cause injury to patients or caregivers, but can cause patient discomfort, shall be designed to meet system Category 3 requirements as defined in this code.

4.1.4 Category 4. Facility systems in which failure of such equipment would have no impact on patient care shall be designed to meet system Category 4 requirements as defined in this code.

4.2* Risk Assessment. Categories shall be determined by following and documenting a defined risk assessment procedure.

4.3 Application. The Category definitions in Chapter 4 shall apply to Chapters 5 through 11.
Categories Determined by a Risk Assessment

4.2* Risk Assessment

Categories shall be determined by following and documenting a defined risk assessment procedure.

**Category 1 Systems (Hospitals)**

- Facility systems in which failure of such equipment or system is likely to cause major injury or death of patients or caregivers shall be designed to meet system Category 1 requirements as defined in the code.
  - Category 1: Systems are expected to work or be available at all times to support patient needs.

Failure of a Category 1 system has very serious consequences. Major injury or death can be caused by the failure of any of the following:

- Emergency power for the operating rooms
- Medical gas system in the ICU
- Ventilator-assisted procedure in a medical office operating suite
- Cardiac catheterization imaging equipment
A.4.1.1 Major injury can include the following:

(1) Any amputation
(2) Loss of the sight of an eye (whether temporary or permanent)
(3) Chemical or hot metal burn to the eye or any penetrating injury to the eye
(4) Any injury that results in electric shock and electric burns leading to unconsciousness and that requires resuscitation or admittance to a hospital for 24 hours or more
(5) Any other injury leading to hypothermia, heat induced illness, or unconsciousness requiring resuscitation or admittance to a hospital for 24 hours or more
(6) Loss of consciousness caused by asphyxia or lack of oxygen or exposure to a biological agent or harmful substance
(7) Absorption of any substance by inhalation, skin, or ingestion causing loss of consciousness or acute illness requiring medical treatment
(8) Acute illness requiring medical treatment where there is reason to believe the exposure was to biological agents, its toxins, or infected materials
Category 2 Systems (Clinics)

- Facility systems in which failure of such equipment is likely to cause minor injury to patients or caregivers shall be designed to meet system Category 2 requirements as defined in the code.
  - Category 2: Systems are expected to provide a high level of reliability; however, limited short durations of equipment downtime can be tolerated without significant impact on patient care. Category 2 systems support patient needs but are not critical for life support.

A.4.1.2 A minor injury means *not serious* or involving *risk of life*.

Failure of a Category 2 system will cause minor injury. Examples include the following:
- Task or procedure lighting in patient rooms
- Potable water in the patient care areas
Category 3 Systems (Dental)

- Facility systems in which failure of such equipment is not likely to cause injury to patient or caregivers, but can cause patient discomfort, shall be designed to meet system Category 3 requirements as defined in the code.

- Category 3: Normal building system reliabilities are expected. Such systems support patient needs, but failure of such equipment would not immediately affect patient care. Such equipment is not critical for life support.

If the following systems were not functioning, minor discomfort would be caused to the patient or caregiver:

- Heating system in the southern United States
- Humidity control in nonoperating areas
- Dental drill
- Motorized bed adjustments
- Cooling tower makeup water in the northwest United States
Category 4 Systems (Non-Patient Care)

- Facility systems in which failure of such equipment would have no impact on patient care shall be designed to meet system Category 4 requirements as defined in the code.

These systems do not affect the patient or caregivers. Examples include the following:

- Gray water lawn sprinkler systems
- Seasonal lighting systems
- Public address systems
- Pneumatic tube systems
- Vacuum system in the research portion of a facility
Category 1 Piped Gas and Vacuum Systems

Applicability

These requirements shall apply to health care facilities that require Category 1 systems as referenced in Chapter 4.

Nothing in NFPA 99 mandates the installation of any of the systems included in Section 5.1; however, if they are provided, then they must comply. For example, there is nothing in NFPA 99 that mandates a medical vacuum system; however, should a facility decide to install one, or be required to install one by another code or regulation, then it must comply with NFPA 99.

Where the terms medical gas or medical support gas occur, the provisions shall apply to all piped systems for oxygen, nitrous oxide, medical air, carbon dioxide, helium, nitrogen, instrument air, and mixtures thereof. Wherever the name of a specific gas service occurs, the provisions shall apply only to the gas
# Medical Gases

Standard designation colors and operating pressures for Category 1 Gas and Vacuum Systems

<table>
<thead>
<tr>
<th>GAS</th>
<th>Abbreviation</th>
<th>Colors (background/Text)</th>
<th>Pressures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical Air</td>
<td>MA</td>
<td>Yellow/black</td>
<td>50 - 55psig</td>
</tr>
<tr>
<td>Carbon Dioxide</td>
<td>CO2</td>
<td>Grey/black or grey/white</td>
<td>50 - 55psig</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>N2</td>
<td>Black/white</td>
<td>160 -185psig</td>
</tr>
<tr>
<td>Nitrous oxide</td>
<td>N2O</td>
<td>Blue/white</td>
<td>50 - 55psig</td>
</tr>
<tr>
<td>Oxygen</td>
<td>O2</td>
<td>Green/white or white/green</td>
<td>50 - 55psig</td>
</tr>
<tr>
<td>Medical vacuum</td>
<td>MV</td>
<td>White/black</td>
<td>15” – 30”HgV</td>
</tr>
<tr>
<td>WAGD</td>
<td>WAGD</td>
<td>Violet/white</td>
<td>15” – 30”HgV (typical)</td>
</tr>
<tr>
<td>(can vary based on supply type)</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

Lab Air          | LA           | yellow and white checkerboard/black      | no standard      |
Lab Vacuum       | LV           | White and black Checkerboard /black boxed | no standard      |
Instrument Air   | IA           | Red/White                                | 160 – 185psig    |
Maintenance of Medical Gas, Vacuum, WAGD, and Medical Support Gas Systems

5.1.14.2.1

**General.** Health care facilities with installed medical gas, vacuum, WAGD, or medical support gas systems, or combinations thereof, shall develop and document periodic maintenance programs for these systems and their subcomponents as appropriate to the equipment installed.
Maintenance Programs

5.1.14.2.2.1

**Inventories.** Inventories of medical gas, vacuum, WAGD, and medical support gas systems shall include at least all source subsystems, control valves, alarms, manufactured assemblies containing patient gases, and outlets.
Maintenance Programs

5.1.14.2.2.2

**Inspection Schedules.** Scheduled inspections for equipment and procedures shall be established through the risk assessment of the facility and developed in consideration of the original equipment manufacturer’s recommendations as required by the authority having jurisdiction.
OPERATION AND MANAGEMENT

- Maintenance Programs

5.1.14.2.2.3

**Inspection Procedures.** The facility shall be permitted to use an inspection procedure(s) or testing methods established through its own risk assessment.
Maintenance Programs
5.1.14.2.2.2

**Maintenance Schedules.** Scheduled maintenance for equipment and procedures shall be established through the risk assessment of the facility and developed in consideration of the original equipment manufacturer’s recommendations as required by the authority having jurisdiction.
OPERATION AND MANAGEMENT

Maintenance Programs

Note for CMS Certified Providers.
Memorandum dated December 12, 2011.

Alternative maintenance, inspection, and testing schedules permitted based on risk assessment by qualified personnel.

1.) All equipment “critical to patient health and safety” must follow manufacturer recommended maintenance frequencies.
2.) Any “new” equipment must follow manufacturer’s recommendations until sufficient history is available for risk assessment.
OPERATION AND MANAGEMENT

- Qualifications

5.1.14.2.2.5

Persons maintaining these systems shall be qualified to perform these operations. Appropriate qualification shall be demonstrated by any of the following.

1. Training and certification through the health care facility by which such persons are employed to work with specific equipment as installed in the facility.

2. ASSE 6040 Maintenance Personnel Certification

3. ASSE 6030 Verifier Certification
INSPECTION & TESTING OPERATIONS

5.1.14.2.3.1 (1) Medical Air Sources

- Room Temperature
- Shaft Seal Condition
- Filter Condition
- Presence of Hydrocarbons
- Room Ventilation
- Water Quality, if so equipped
- Intake Location
- Carbon Monoxide Monitor Calibration
- Air Purity
- Dew Point
INSPECTION & TESTING OPERATIONS

5.1.14.2.3.1 (2) Medical Vacuum Sources
- Exhaust Location

5.1.14.2.3.1 (3) WAGD Sources
- Exhaust Location

5.1.14.2.3.1 (4) Instrument Air Sources
- Filter Condition

5.1.14.2.3.1 (5) Manifold Sources
- Ventilation
- Enclosure Labeling
INSPECTION & TESTING OPERATIONS
5.1.14.2.3.1 (6) Bulk Liquid Sources
    - In accordance with NFPA 55: Compressed Gases and Cryogenic Fluids Code
5.1.14.2.3.1 (7) Final Line Regulators
    - Delivery Pressure
5.1.14.2.3.1 (8) Valves
    - Labeling
INSPECTION & TESTING OPERATIONS

5.1.14.2.3.1 (9) Alarm Warning Systems
  - Lamp and Audio Operation

5.1.14.2.3.1 (10) Alarm Warning Systems
  - Master Alarm Signal Operation
  - Area Alarm Signal Operation
  - Local Alarm Signal Operation
5.1.14.2.3.1 (11) Station Outlets and Inlets

- Flow
- Labeling
- Latching / Delatching
- Leaks
5.1.14.2.3.2 Manufactured Assemblies Employing Flexible Connections

(A) Non-stationary booms and articulating assemblies, other than headwalls utilizing flexible connectors, shall be tested for leaks, per the manufacturer’s recommendations, every 18 months or at a duration as determined by a risk assessment.
5.1.14.2.3.2 Manufactured Assemblies Employing Flexible Connections

(B) The system pressure to non-stationary booms and articulating arms shall be maintained at operating pressure until each joint has been examined for leakage by effective means of leak detection safe for use with oxygen.
5.1.14.2.3.2 Manufactured Assemblies Employing Flexible Connections

(C) Safe working condition of the flexible assembly shall be confirmed.
(D) D.I.S.S. connectors internal to the boom and assemblies shall be checked for leakage.
5.1.14.2.3.2 Manufactured Assemblies Employing Flexible Connections

(E) Leaks, if any, shall be repaired (if permitted), or the components replaced (if required), and the equipment retested prior to placing the equipment back into service.
INSPECTION & TESTING OPERATIONS

5.1.14.2.3.2 Manufactured Assemblies Employing Flexible Connections

(F) Additional testing of non-stationary booms or articulating assemblies shall be performed at intervals defined by documented performance data.
APPLICATION

PLEASE NOTE:
This presentation has been created to assist in the development and implementation of an Operation and Management Program for medical gas systems.

It DOES NOT apply to the construction or repair of medical gas systems.
BACKGROUND

① Improves Patient Safety*
② Increases the life of the medical gas equipment, as well as, other hospital assets
③ Helps ensure Regulatory Compliance
④ Medical gases are FDA regulated pharmaceutical drugs
⑤ Medical Air is unique in that it is the only FDA regulated drug manufactured onsite at Healthcare Facilities
⑥ Protection from Liability*

- It will take some time to do it correctly
- You will need assistance from other departments
- You may need assistance from a subject matter expert
REGULATORY OVERVIEW

• NFPA 99, 2012 EDITION

  - ENVIRONMENT OF CARE STANDARDS
  - PHYSICAL ENVIRONMENT
  - EMERGENCY MANAGEMENT
Chapter 5 Requirements:

- Certification after a “breach” of the system
- Testing after repairs or component replacement
- Maintenance Programs must now include:
  - Equipment Inventories
  - Inspection Schedules
  - Inspection Procedures
  - Maintenance Schedules
- Persons maintaining medical gas systems must be qualified to perform these operations demonstrated by any of the following:
  1. ASSE 6040 Medical Gas Systems Maintenance Personnel
  2. ASSE 6030 Medical Gas Systems Verifier
  3. Training and certification by the healthcare facility by which they are employed through a documented training program.
REGULATORY OVERVIEW

Chapter 11 Requirements:
- Maintenance Programs and Record Keeping
- Cylinder & Container Storage Requirements
- Operation & Management of Cylinders & Containers
- Storage, Maintenance, Handling, and Use of Oxygen
- Qualification and Training of Personnel (Periodic Continuing Education for Medical Gases & Cylinders)

Chapter 12 Requirements:
- Emergency management planning for facilities that intend to provide services during an emergency or disaster situation.
- Staff education of the emergency management program, including their specific duties and responsibilities (Conducted at time of hire and annually thereafter).

Annex Materials: Assistance with further explanations of the requirements.
REGULATORY OVERVIEW

- Environment of Care Standards*
  - Utility Management (EC 02.05.01 & 02.05.05)
  - Medical Gas and Vacuum Systems (EC 02.05.09) - Top 20 Noted Deficiencies
  - Medical Equipment (EC 02.04.03) Serving Life Support Equipment

- Physical Environment
  - Medical Gases fall into the Joint Commission concern related to the immediate threat to life in the physical environment.
  - Contingency Planning for Utilities

- Emergency Management
  - Emergency Operations Plan
  - Contingency Planning for Utilities
REGULATORY OVERVIEW

Certified Providers:

- Medical gas storage and administration areas in existing health care facilities must be protected in accordance with 2005 edition of NFPA 99

Regulations and Interpretive Guidelines (Operations Manual):

- Equipment must be maintained to ensure an acceptable level of safety and quality
- Thus, a qualified individual must conduct a regular, periodic maintenance and testing program
- Also, if equipment is likely to be needed in an emergency, adequate provisions must be made to ensure its availability
OTHER IMPORTANT RESOURCES

- Equipment Inspection (Assessment) Checklists
- Maintenance, Inspection, and Testing Procedures
- Recommended Frequencies for Maintaining, Inspecting, and Testing Equipment
- Maintenance, Inspection, and Testing Qualification Standards

CGA M-1, Guide for Medical Gas Supply Systems at Consumer Sites, 2007 Edition*

CGA E-10, Maintenance of Medical Gas and Vacuum Systems in Healthcare Facilities, 2007 Edition*
SURVEY EXISTING SYSTEMS

- Conduct Survey of Existing Systems
- Creating an Equipment Inventory
- Determine Maintenance Strategies
- Establish an Equipment Spare Parts List
SURVEY & INVENTORY
Conducting a Survey of Existing Systems

All equipment should be surveyed for the following:

- Current Condition of Equipment
- Approximate Life Expectancy
  - To assist with Capital Planning
- Maintenance History
- Inspection & Testing History
- Equipment Issues or Problems
  - Ongoing items should be investigated.
- Are Operation & Maintenance Manuals Available?
- Equipment Inventories can be created at the same time the survey is conducted.
SURVEY & INVENTORY
Medical Gas System Inventory (Utilities Mgmt)

- Documentation of all equipment
  - Bulk Liquid Oxygen Systems
  - Motorized Equipment (e.g. Medical Air, Medical Vacuum, & WAGD)
  - Manifold Systems
  - Alarm Warning Systems (Master Alarms, Area Alarms, Local Alarms)
  - All Critical Control Valves (Source, Zone, Emergency, etc)
  - Station Outlets & Inlets

- Documentation Information (Standard Forms & Checklists)
  - Equipment Data, Location, Function, and Use (Areas Served)

- Operation & Maintenance Manuals

Are there any life safety systems?
SURVEY & INVENTORY

• **Must first understand:**
  - How the equipment operates
  - How it might fail* (e.g. full system failure vs. single component failure)
  - Clinical impact of different failure scenarios*

• **Types of Maintenance Strategies**
  - Interval-Based Maintenance
  - Predictive Maintenance
  - Reliability-Centered Maintenance
  - Metered Maintenance
  - Run-to-Fail or Corrective Maintenance

• **Not every strategy is appropriate for every piece of equipment***
SURVEY & INVENTORY

① Most manufacturer’s provide a recommended spare parts list in their O&M Manuals
② Other resources are ASSE 6000 and CGA Documents
③ Once spare parts list are established, determine availability of parts from supplier
④ If readily available, may choose not to keep on hand
⑤ Should be based on past experiences with equipment
COMPLIANCE REVIEW AND RISK ASSESSMENT

- CODE COMPLIANCE REVIEW
  - EXISTING SYSTEMS & COMPONENT REVIEW
- SAFETY & RISK ASSESSMENT
- DETERMINE IN-HOUSE PERSONNEL CAPABILITIES
COMPLIANCE REVIEW

Code Compliance Review

① **Audit:** All systems and components
   - Source Supply Systems, Alarm Warming Systems, Critical Valves, etc.
   - May want to consider assistance from subject matter expert
   - Can be very time consuming (Annual Inspection)*
   - Should include an audit of existing policies and procedures as well

② **Document:** All items not in Compliance
   - Documentation should include code references
   - Should include specifics about compliance issue
   - Should include specific concerns with existing policies and procedures

③ **Upgrades:** Any system improvements that will promote patient and/or personnel safety
   - Example: 20 year old bulk oxygen system with operational
RISK ASSESSMENT

- First, determine a “risk ranking” method
- What are the physical risks associated with equipment use?
- If equipment fails:
  - What is impact to patient safety?
  - What is impact on clinical processes?
  - What is impact on staff / personnel safety?
- If Medical Gas Systems are Life Supporting:
  - Should equipment be included in Emergency Management Program?
  - Typically, the oxygen, medical air, and medical-surgical vacuum systems are life supporting and will be included in the EOP.
- Assess Risks Identified in Code Compliance Review
- Other Outcomes:
  - Emergency Operations Plan and Impact on Medical Equipment
RISK ASSESSMENT

Risk Ranking Method

This method ties to the Joint Commission Levels of Criticality.

1) **High Risk / Level 1:** Immediate Threat to Life

   - Immediate Corrective Actions Required (Plan for Improvement)
   - This risk level identifies a finding that has a direct adverse impact on patient health and safety.
   - Findings with this designation are considered to be an immediate threat to life by the Joint Commission and will most likely constitute a distinct hazard to life by the Authority Having Jurisdiction.
   - Generally, if noted during a survey by the Joint Commission, a preliminary denial of accreditation may be issued. These findings are considered Level 1 deficiencies in the physical environment by the Joint Commission.
   - **Example:** Absence of master alarms for medical gas systems.
RISK ASSESSMENT

Risk Ranking Method

This method ties to the Joint Commission Levels of Criticality.

2) **Medium Risk / Level 2:** Possible Threat to Patient Safety
   - Situational Decision Rules Apply: May require additional assessment.
   - This risk level identifies a finding that has or may have an adverse impact on patient health and safety.
   - Findings with this designation are considered to have a direct impact on the operation of the medical gas and vacuum systems, which may constitute a distinct hazard to life by the Authority Having Jurisdiction.
   - Generally, if noted during a survey by the Joint Commission, a Requirement for Improvement (RFI) may be required and this finding would need to be corrected within 45 days of the finding.
   - For this level of risk the Joint Commission survey team may recommend a preliminary denial of accreditation (PDA) or contingent accreditation based on the impact of the finding on patient safety.
RISK ASSESSMENT

Risk Ranking Method

This method ties to the Joint Commission Levels of Criticality.

3) **Low Risk / Level 3:** Little to No Threat to Patient Safety

- This risk level identifies a finding that has little to no adverse impact on patient health and safety.
- Findings with this designation may be considered to have a direct impact on the operation of the medical gas and vacuum systems, but do not constitute a distinct hazard to life.
- However, if noted during a survey by the Joint Commission, a Requirement for Improvement (RFI) may be required, and this finding would need to be corrected within 45 days of the notice.
- May require review of Authority Having Jurisdiction (For determination)
- **Example:** The termination of the vacuum system exhaust is not turned down, with a screen to prevent the entry of precipitation or vermin.
RISK ASSESSMENT

Risk Ranking Method

This method ties to the Joint Commission Levels of Criticality.

4) **No Risk / Level 4:** No Threat to Patient Safety

- Indirect Impact Requirements
- Organizational decision to repair or not
- This risk level identifies a finding that has no adverse impact on patient health and safety.
- Findings with this designation are considered to have an indirect impact on the operation of the medical gas and vacuum systems and do not constitute a distinct hazard to life.
- However, if noted during a survey by the Joint Commission, a Requirement for Improvement (RFI) may be required, and this finding would need to be corrected within 60 days of the notice.
- May be placed on capital improvements program
- **Example:** No demand check fitting for alarm initiating device/sensor.
REVIEW AND ASSESSMENT

**Determine In-House Capabilities**

1. What are the capabilities of facility personnel?
2. What is their comfort level with the medical gas systems?
3. What qualifications do facility personnel possess?*
4. Are Personnel Training Programs available and are they adequate?*
POLICIES AND PROCEDURES

- EXISTING POLICY & PROCEDURE REVIEW
- GENERAL WORK REQUIREMENTS
- DEVELOPING & DOCUMENTING MAINTENANCE, INSPECTION, AND TESTING (MIT) PROCEDURES
- EMERGENCY OPERATIONS PLANNING
- SCHEDULED SYSTEMS SHUTDOWN AND TEMPORARY BACK FEED PROCEDURES
- NEW EQUIPMENT SELECTION PROCEDURE
- RECORD KEEPING
POLICIES AND PROCEDURES

- Are the following items included?
  - Safety Program
    - General Work Requirements
    - New Employee / Vendor Site Orientation Procedure
  - Procedures to prevent system cross connections
  - Maintenance, Inspection, and Testing Policies & Procedures
  - Emergency Operations Plan (Contingencies)
  - Scheduled System Shutdown / Temporary Back Feed Procedures
  - New Equipment Selection Procedure
  - Record Keeping Procedures

- Review Training Programs
  - Is additional training required to ensure qualified personnel?

Other Considerations:
- What is most cost effective?
- Are financial resources available?
General Work Requirements

- Incorporate Facility Safety Program*
- Site Orientation and Equipment Overview
  - Prior to commencement of any work
  - Both for new employees and vendors
  - Verification of vendor credentials (Ask for copy of certifications)
  - Review physical properties and the distinct hazards associated with the use of:
    - Motorized medical gas equipment
    - High pressure cylinders
    - Confined space and/or oxygen enriched/depleted environments
- Procedures to prevent cross connection of systems
  - Shutdown one system at a time
- Develop procedures to ensure tools and parts are kept clean and free from contamination (dust, dirt, grease, or oil).
POLICIES AND PROCEDURES

- If this work is performed by facility personnel, procedures performed must be documented.
  - Cookbook Style (Step by Step)
  - Make sure they are based on industry accepted procedures
  - If more than “Daily Inspections”, additional training should be considered for facility personnel
  - Don’t reinvent...These procedures may be available in the resources discussed.

- If this work is performed by a contractor, the procedures should be included in their Standard Operating Procedures.
  - Responsibility lies with the organization performing the work, but should be submitted for review prior to commencement of work

- A Statement of Compliance for outside vendors should be included in the Statement of Work.
POLICIES AND PROCEDURES

SAMPLE

Statement of Compliance

“All maintenance, inspections, and testing on the medical gas systems shall be performed per the equipment manufacturer’s recommendations and in accordance with NFPA 99, 2005 edition and industry accepted standard operating procedures. If adherence to these standards is not possible, substitute procedures shall be submitted to the organization for review prior to commencement of any work on the medical gas systems.”
**Testing Procedure (Example)**

**Manifold Inspection & Testing Procedure**

1. Start flow of gas from an outlet in the piping system or use vent valve.
2. Close header shutoff or cylinder valves on the primary supply (in-use) side of the manifold.
3. Verify changeover to secondary supply occurs.
4. Check mainline pressure to ensure proper operating pressure.
5. Verify “Empty” light for depleted header has activated.
6. Verify “Secondary in Use” alarm has activated at all master alarm panels.
7. Silence audible alarm at all master alarm panels.
8. Open valves that were closed in Step 2.
9. Verify “Ready” light is now activated on original header.
10. Verify master alarm panels are back to normal and alams are deactivated.
11. Repeat for other side of manifold to ensure both sides operate properly.
POLICIES AND PROCEDURES

Emergency Operations Planning

- Life Supporting Equipment
  - Oxygen, Medical Air, Vacuum (Potential Systems)
- How will you ensure systems are available during an emergency?
- What is the protocol for monitoring systems during the emergency?
- How will the EOP be activated / deactivated?
- Will the plan meet the (96) Hour Sustainability Requirement?*

Staff must be educated on their specific duties and responsibilities.

- Some Options for Contingencies:
  - Cylinders available for critical care patients
  - Temporary back feed of all critical care portions of the system
  - Portable vacuum systems available for critical care areas
POLICIES AND PROCEDURES

Must address the four phases of an emergency*

- **Mitigation:**
  - Redundancy or duplication

- **Preparedness:**
  - Documented Inventory - Needed Systems
  - Resources & Assets - Replacing supplies consumed during emergency
  - Clinical Support Activities - Administration of medications
  - Essential Utilities - Plan for operation of critical systems

- **Response:**
  - Activation / Deactivation of EOP

- **Recovery:**
  - Restore Operational Capacity
  - Access & Update EOP
POLICIES AND PROCEDURES

- The facility should establish a documented procedure for planned interruption and/or temporary backfeed of medical gas systems.
- Who is involved in the shutdown?*
- What are each individual's responsibilities?
  - Healthcare Facility Personnel Responsibilities (Lockout/Tagout)
  - Shutdown Coordinator Responsibilities
  - Installer Responsibilities
  - Third-Party Verifier Responsibilities

Notification Procedures
- Which departments are affected?
  - Department Heads should be involved in planning process*
- Utility shutdown “Approval” prior to equipment shutdowns

- ASSE 6000 Series - Annex J & Annex*
POLICIES AND PROCEDURES

The Environment of Care states:

- The organization must consult with equipment manufacturers prior to acquisition of equipment.
- The organization must follow an established process for selecting and acquiring equipment.
- The organization must involve both the individuals who operated the equipment and those who service it.
- The organization must review how equipment will interface with other existing equipment at the facility.
- The organization should evaluate maintenance requirements and availability of repair parts and repair services.
POLICIES AND PROCEDURES

- Maintenance, Inspection, & Testing Results
  - All results should be documented
  - All sections of forms should be filled out ("Not Tested")
- Any scheduled shutdowns or "Breaches" of the system should be documented*
  - Verifiers report will suffice
- Utility Shutdown Approvals / Notice of Restoration to Service
- Incident Reporting for Medical Equipment per the Safe Medical Devices Act of 1990
  - SMDA has a broader definition than the Joint Commission
  - If equipment is suspected to have caused or contributed to the death, serious injury, or serious illness of individual (Reporting is Required).
ACTIVITIES SCHEDULES

- REVIEW OF THE FOLLOWING INFORMATION:
  - REGULATORY REQUIREMENTS
  - MANUFACTURER’S RECOMMENDATIONS
  - ACCEPTED INDUSTRY PRACTICES
  - ORGANIZATION’S PAST EXPERIENCES

- ESTABLISHING FREQUENCIES AND ACTIVITIES SCHEDULES

- REQUIRED VS. RECOMMENDED FREQUENCIES AND SCHEDULES
ACTIVITIES SCHEDULES

- Regulatory
  - Review local requirements
  - EC states that the hospital must test, inspect, and maintain the critical components of the piped medical gas systems
  - NFPA 99 states that a maintenance program shall be developed for the source supply systems in accordance with Manufacturer’s Recommendations
  - NFPA 99 also requires annual inspections of central supply systems
  - Manufacturer’s Recommendations: Good Starting Point!*
  - Accepted Industry Practices & Procedures (ASSE & CGA)
  - Review Organization’s Past Experiences*
  - Bottom Line...Must follow a “Documented Procedure”
ACTIVITIES SCHEDULES

- After completing document review
  - What will be maintained, frequency of task?
  - What will be inspected and tested, frequency of task?

- The organization determines frequency of maintenance, inspection, and testing of systems.

- Develop a schedule for these tasks
  - As simple as an Excel spreadsheet
  - As complex as a Work Order Management Program

- Who is responsible for each task?
  - Someone should be identified with responsibility
Maintenance of Motorized Equipment*
- Medical Air Compressors and Vacuum Pumps need ongoing maintenance
- Do you change the oil in your car regularly? So, why not the vacuum pumps.
- Liquid Ring Systems are a unique animal. Water Quality is Critical!
- Periodic maintenance should be at least as often as recommended in equipment manufacturer’s guidelines.
- Additional maintenance is recommended for older equipment and/or equipment used excessively.

Maintenance of Non-Motorized Equipment*
- As required (e.g. station outlet repair)
- Maintenance and repairs based on inspection and testing results
ACTIVITIES SCHEDULES
Inspection & Testing Schedules (Required)

Based on:

- NFPA 55, 2010 Edition: Medical Cryogenic System Inspection Requirements
- The Joint Commission: Environment of Care Standards
- Centers for Medicare and Medicaid: Requirements for Certified Providers
- Joint Commission Survey Experiences
ACTIVITIES SCHEDULES

Inspection & Testing Schedules (Required)

- **Annual Inspections**
  - Master & Area Alarm Panels
    - Inspect audible and visual signals function properly (Push Button Test)
    - Test function of all alarm initiating devices
  - Bulk Liquid Oxygen System*
    - Annual inspection of system required by NFPA 55. This testing should be conducted by a qualified representative of the gas supplier.
  - Source Supply Systems
    - Inspect for proper operation and performance
    - Test control (automatic) pressure switches to ensure proper operation and settings
    - Visual inspection of flexible connectors and cylinder pigtails for physical damage, excessive wear, or expiration
    - Test and calibrate carbon monoxide monitors (Medical Air Systems)
ACTIVITIES SCHEDULES

Inspection & Testing Schedules (Required)

- Periodic Inspections
  - Audible and Visual Alarm Indicators (1-3 Years)
    - Test for proper operation
  - Station Outlets & Inlets (1-3 Years) – Vacuum at least annually.
    - Inspect and test for proper location, labeling, operation, and performance.
    - Inspect for leakage
  - Articulating Booms and Manufactured Assemblies (18 Months)*
    - Inspect and test for leakage of flexible connectors (hoses)
    - Visual inspection of flexible connectors for physical damage or excessive wear
ACTIVITIES SCHEDULES
Inspection & Testing Schedules (Best Practices)

- Based on:
  - NFPA 99, 2012 Edition:
    Annex Materials
  - CGA E-10 – 2007:
    Recommended Minimum Maintenance Schedules
  - ASSE 6000 Series:
    Recommended Minimum Maintenance Schedules
  - Best Standard Operating Practices (Industry Accepted)
  - Compilation of Manufacturer’s Recommendations & Guidelines
Activities Schedules

Inspection & Testing Schedules (Best Practices)

- Daily Inspections
  - Source Supply System Operating Pressures (Main-line Gauges)
    - Inspect and confirm all main-line pressures are within acceptable limits (+/- 5%)
  - Medical Air Systems
    - Inspect moisture removal system and drain as necessary (e.g. aftercoolers, receivers, dryer drains, sight glass, etc.)*
    - Inspect dew point & carbon monoxide monitors for proper operation and readings are within acceptable limits
  - Medical-Surgical Vacuum & WAGD Systems
    - Visual inspection of receiver sight glass for water accumulation (drain if necessary)
  - Bulk Liquid Oxygen System
    - Inspect all main tank and reserve system pressures
    - Inspect tank contents (order as needed); If applicable, ensure Telemetry System is operating properly*
    - Inspect for unusual icing and system leakage*
ACTIVITIES SCHEDULES

Inspection & Testing Schedules (Best Practices)

- Monthly Inspections*
  - Alarm Warning Systems (Master, Area, & Local Alarms)
    - Inspect audible and visual signals function properly (Push Button Test)
  - Area Alarm Panels
    - Inspect and confirm pressure readouts are within acceptable limits
  - Medical Air Systems
    - Calibrate carbon monoxide monitor (Calibration kit required)
  - Source Equipment Reserve Systems
    - Inspect for adequate supply (How long will it last if needed?)*
ACTIVITIES SCHEDULES

Inspection & Testing Schedules (Best Practices)

- Quarterly Inspections
  - Medical Air Systems
    - Inspect medical air intake location for changes in condition, debris, and clearances
    - Test function of automatic alternating controls
    - Test control (automatic) pressure switches to ensure proper operation and settings*
    - Inspect filters for performance
    - Inspect compressor hours meter for required maintenance
  - Medical-Surgical Vacuum & WAGD Systems
    - Inspect vacuum exhaust location for changes in condition, debris, and clearances
    - Test function of automatic alternating controls
    - Test control pressure switches to ensure proper operation and settings
    - Inspect pump hours meter for required maintenance
ACTIVITIES SCHEDULES

Inspection & Testing Schedules (Best Practices)

- Semi-Annual Inspections
  - Manifold Systems
    - Inspect for leakage (Manifold components, valves, pigtails, etc.)*
    - Visual inspection of cylinder pigtails for physical damage or excessive wear
    - Test function of automatic alternating controls (Secondary in Use)
  - Area Alarm Systems
    - Test function of alarm sensors*
  - Zone Valves
    - Inspect zone valves for proper labeling, configuration, cleanliness, and access
    - Inspect for leakage*
    - Inspect and confirm gauge pressures are within acceptable limits
  - Station Outlets & Inlets
    - Inspect and test critical care areas for proper gas flows, terminal leakage, and proper operation*
ACTIVITIES SCHEDULES

Inspection & Testing Schedules (Best Practices)

- **Additional Annual Inspections**
  - All Central Supply (Source) Systems
    - Inspect locations for proper design, construction, and ventilation requirements*
    - Inspect pressure gauges to ensure proper operation and calibration
    - Test local alarms for proper operation
  - Medical Air Quality Monitoring
    - Recalibrate dew point sensor (usually sent off-site for recalibration)
    - Test medical air for conformance to USP and NFPA 99 standards
  - All Critical Valves (Source, Riser, Mainline, and Service Valves)
    - Inspect valves for proper labeling, configuration, cleanliness, and access
    - Inspect for leakage
  - Medical Gas Pipeline
    - Test each patient use system for conformance to USP and NFPA 99 Standards
    - Test pipeline of each patient use system for particulates and purity
PERSONNEL QUALIFICATIONS

- WHO WILL BE PERFORMING THE WORK?
- ADOPTING QUALIFICATION STANDARDS
- TOOLS & TESTING

  EQUIPMENT REQUIREMENTS
  - Accuracy, reading, and calibration standards.
PERSONNEL QUALIFICATIONS

- Will scheduled activities be performed by facility personnel or vendor performed?
- What qualifications are you going to require for those performing the work?
- If in-house, is additional training required to ensure qualified personnel?
- Other Considerations:
  If in-house personnel, is organization committed to continuing education of personnel?
QUALIFICATION STANDARDS

- Maintenance, inspections, and testing should be conducted by individuals technically competent and experienced with medical gas systems.

Qualifications to Consider:

- **Maintenance Personnel**
  - Documented Training (Manufacturer, Online Courses, etc.)
  - ASSE 6040 Medical Gas Systems Maintenance Personnel

- **Inspections & Testing**
  - Documented Training (Manufacturer, Online Courses, etc.)
  - ASSE 6020 Medical Gas Systems Inspector
  - ASSE 6030 Medical Gas Systems Verifier
  - MGPHO Credentialed Medical Gas Verifier (CMGV™)
QUALIFICATION STANDARDS
Tools and Testing Equipment Requirements

① Tools should be clean, free of oils, and acceptable for use with oxygen service*
② Testing equipment should meet the requirements of NFPA 99 and ASSE 6000 Series, as well as, other applicable standards
③ Testing equipment should be National Institute of Standards and Technology (NIST) Traceable
④ All equipment calibrations should be current and up-to-date
⑤ May want to develop a “Testing Equipment Specification”
FACILITY PERSONNEL TRAINING

- Organizations must provide adequate training of personnel
- Organizations must ensure competency of individuals for the operations that they perform
- Organizations must provide continuing education to minimize physical risks to patients and personnel

- Organizations must provide continuing education to minimize physical risks to patients and personnel

- Organizations must provide continuing education to minimize physical risks to patients and personnel
FACILITY PERSONNEL TRAINING

- Organization should document all personnel training and continuing education.
- Keep documentation in employee personnel files.
  - Can be a simple “Memo” with pertinent information.
- Continuing Education Options:
  - Manufacturer Training
  - Bulk Supplier Training
  - Online Training
  - Subject Matter Courses
  - Code Update Courses
CONCLUSION

PROGRAM DELIVERABLES

 Inventory of Equipment and Critical Components
 Compliance Review & Risk Assessment
 New / Updated Policies & Procedures
 Activities Schedules
 Qualification Standards
  • Both In-House Personnel and Vendors
 Facility Personnel Training Program
 Final Product:
  A SITE SPECIFIC OPERATION & MANAGEMENT PROGRAM FOR YOUR MEDICAL GAS SYSTEMS
Patients rely on health care organizations to ensure that their safety and well-being are continuously protected.

This is an ongoing process, not a one time procedure.

Developing a comprehensive Medical Gas Systems Operation & Management Program is the best way to ensure these systems remain safe and reliable.
American Society of Sanitary Engineering

- Professional Qualification Standard for Installers
- Minimum qualifications for medical gas system maintenance personnel (ASSE 6040)
- These requirements are referenced in current versions of NFPA 99
ASSE 6040 Medical Gas System
Maintenance Personnel

- **Scope**
  This standard applies to any individual who maintains medical gas and vacuum systems. Healthcare facility personnel installing medical gas or vacuum systems shall be certified to ASSE Standard 6010. Medical gas systems include vacuum systems.
Limitations for Medical Gas Systems Maintenance Personnel

- Compliance with this standard in itself shall not constitute compliance with the requirements for a Medical Gas Systems Installer per ASSE Standard 6010, Bulk Medical Gas Systems Installer per ASSE Standard 6015, Medical Gas Systems Inspector per ASSE Standard 6020, Medical Gas Systems Verifier per ASSE Standard 6030, Bulk Medical Gas Systems Verifier per ASSE Standard 6035, Medical Gas Systems Instructor per ASSE Standard 6050 or Bulk Medical Gas Systems Instructor per ASSE Standard 6055.
Maintenance Procedures for Personnel Qualified under ASSE Standard 6040

- Piped gas systems present certain characteristic hazards, usually related to original construction modification or repair. Problems can also develop during the working lifetime of the systems, particularly medical compressed air systems, outlets and vacuum inlets.
Some problems which may occur include:

a) The use and degradation of materials incompatible with the gases delivered;
b) Reduced flow caused by material left in pipelines;
c) Gas contamination by residual debris or accumulated foreign matter (e.g., scale, hydrocarbons, moisture or particulate matter in medical gas and compressed air pipelines);
d) Gas contamination due to chemical interaction, including fire and explosion, between the gases and pipeline components or foreign matter; and

e) Gas contamination due to a contaminated source (e.g., air intake near diesel exhausts).

Problems related to how the system is used and maintained during its lifetime include leaking outlet seals, clogged vacuum inlets and piping (e.g., by dust, by body fluids, inadequate particulate filtration, corrosion of automatic condensate drains, wear or embrittlement of valve seals, physically damaged or loose outlets, wear of compressor or pump seals and bearings, and pressure sensor drift).
Minimum Maintenance Schedule

- **Daily**
  a) Bulk liquid systems - check tank contents, reorder as needed. Visually inspect for any leakage or unusual icing.
  b) Bulk medical gas supply cylinder system with reserve - check proper pressure of reserve bank.
  c) Bulk medical gas systems - check to ensure that proper pressure is maintained.
  d) Manifold systems - Check to ensure that proper pressure is maintained.
  e) Mainline pressure gauges - check pipeline pressure for acceptable limits. Variations of more than 5% should be investigated and corrected.
  
  1) For patient safety, it is recommended that the facilities normal operating pressure of nitrous oxide be initially set and continually maintained at least 34.5 kPag (5 psig) below the normal operating pressures of the oxygen and medical air.
  f) Moisture removal system - check for proper operation (e.g., aftercooler, dryer drains, receiver drains, sight gauges, etc.).
  g) Dew point and CO monitor - check for proper operation.
Minimum Maintenance Schedule

Monthly

a) Area alarm - activate all audible and visual signals using test buttons.
b) Test master alarm functions for audible and visual signal.
c) Vacuum area alarm panel with test buttons - activate audible and visual alarm signals.
d) Area alarm panel gauges/pressure readouts - check line pressures.
e) System main line low and high pressure alarms - test audible and visual signals at the master alarm panel(s).
f) Manifold reserve in use alarm - test audible and visual signals.
g) Reserve supply low warning signals - test audible and visual signals.
h) Dew point and CO alarm - test audible and visual signals.
i) Vacuum main line low vacuum alarm - test audible and visual signals at the master alarm panel(s).
j) Medical air compressors and vacuum pumps - check for proper operation and preventive maintenance per manufacturers specifications.
k) Pressure check across filters.
Minimum Maintenance Schedule

- **Quarterly**
  a) Intake for medical air compressors - check intake location and filter for trash and debris.
  b) Source evaluation on medical air and vacuum systems:
     1) Function of automatic alternating controls
     2) Correct pressure/vacuum switch
     3) Frequency of pump starts and duration of runs
     4) Cut in/out pressure/vacuum
  c) Proper water flow to water-cooled aftercoolers (where present).
  d) Check hour meters for required maintenance schedule for pumps and compressors. Service shall be in accordance with manufacturer’s instructions.

- **Semi-Annually**
  Manifold system - leak check (valves, pigtails and regulators). Visually check cylinder pigtails for physical damage.
Minimum Maintenance Schedule

- **Annually**
  a) Check all outlets in critical care areas - flow, pressure/vacuum, damage and wear (e.g., ICU, CCU, NICU, Surgery, Recovery, ER).
  b) Bulk liquid systems - test the operation of the reserve and activation of reserve-in-use signal.
  c) Bulk medical gas system supply - check proper level activating switch.
  d) Manifold reserve-in-use alarm - test proper function of switch.
  e) Manifold - test operation of the changeover for the secondary supply.
  f) Pressure gauges - assure gauges are mechanically functional.
  g) Air compressor - performance testing.
  h) Dew point and CO monitor - calibrate and test operation.
  i) Maintenance and periodic testing of the bulk medical gas system in conjunction with the bulk medical gas supplier.

- **Periodically**
  a) Shut-off valves - external leakage test.
  b) Station outlets and inlets - check for leakage and flow.
  c) Calibration of pressure gauges.
General Work Requirements

- During disassembly and reassembly of any equipment, procedures shall be followed to ensure tools and parts are kept clean and free of contamination in the form of dust, dirt, grease or oil.
- After reassembly of any equipment, the equipment shall be tested prior to being returned to service for gas flow, pressure and cross-connection.
- When a piping system has been breached, reference shall be made to all appropriate sections of NFPA 99-2012 to ensure procedures as specified for new installations are followed.
Periodic Testing

- Alarms
  Master, area and local - evaluate alarms for proper activation, labeling, general condition, service location, test button for audible and visual signal, and system pressure at gauges.

- Manifold Changeover Testing is recommended for all systems that have a changeover from one supply to another during normal operations.
Periodic Testing

- Reserve-in-Use Signal Testing is recommended for all systems that have a backup supply connected to the main source.
  
  CAUTION: For assistance in testing bulk medical gas systems, consult the supplier.

- Reserve Supply Low Testing is recommended for all reserve sources.
Periodic Testing

- **High/Low Pressure Alarms**
  If the pressure/vacuum sensors are installed with gas-specific demand checks fittings, they can be removed from the piping system and individually tested using a source of test gas or vacuum.

- **All Valves**
  Evaluate all valves for leakage, proper labeling and general condition. Use an “oxygen” compatible leak solution or an equally effective means for leak detection safe for use with oxygen. An ultrasonic leak detector and/or an oxidizing gas leak detector may be used. Reserve Supply Low Testing is recommended for all reserve sources.
Periodic Testing

- Outlet/Inlet Performance
  Test all patient terminals for pressure and flow, latching, delatching, leakage and proper labeling. Use proper gas-specific adapters.
Labeling

- **Valves**
  a) Proper gas label.
  b) Correct directional arrow (if installed).
  c) Proper color code (if applied).
  d) Rooms (areas) controlled.
  e) Warning sign stating: “Do not close/open except in case of emergency.”

- **Pipeline**
  a) Proper gas labeling.
  b) Correct directional arrow (if installed).
  c) Proper color code.
  d) Maximum spacing of 20 feet (6 m) or at least one in each room.
  e) Each side of pipe penetration of a wall.
**Base Performance**

- Determine a base line performance level of the present health care medical gas/vacuum system terminal performance. An initial record should be made for comparison with future readings. The initial certification record may be used for this purpose.

- Measure maximum outlet/inlet flow at normal pressure/vacuum condition and record results. If future readings are more than 10% below those obtained from base line testing, appropriate measures should be taken. Use only a gas specific adapter as described by the manufacturer.
Thank You!

Any Questions?
Proper Label Placement
Proper Hanger Placement
Mistakes Happen!

- The following slides show mistake found in the field.
- In 1972, in Sudbury, Ontario, an oxygen and nitrous oxide line were cross connected during installation. 22 people died by asphyxiation resulting from this error.
- This incident caused codes to be changed, requiring third party testing of all new installations.
Cross Connection Found in Operating Room
Oxygen Tank installation mishap
Vacuum Pump Fire Damage
Medical Air Gauge Not Functioning
Alarm Panel Light Not Functioning
Non-Gas Specific Coupler used on Nitrogen Outlet
Vacuum Switch not mounted with gas specific demand check assembly.
Medical Air System found with 95psi system pressure
Zone Valve located behind door
Soft Copper tubing hidden in flexible conduit
Cylinder Explosion
Oxygen Tank on its side
Cross Connection causes severe injury:

On March 30, High School student went to the dental office to have his wisdom teeth removed. After being sedated with medical gas, complications occurred. The student was taken to a Hospital after he stopped breathing, and later was taken to a University Hospital. Building inspection leaders confirmed that they have no record of whether a required third-party inspection of the medical gas system was ever conducted at the dental surgery center. The International Plumbing Code adopted by the city requires a certified inspector — often a privately owned inspection company — to test the medical gas system.

But the city’s director of planning and development services said he believes the law does not require the city to ensure that the test actually has been done.

Instead, that responsibility is left solely in the hands of private builders and contractors.

“Events like this highlight the importance of contractors knowing and understanding the code and fulfilling its own requirements,” said the city’s director of planning and development services.

An attorney for the company that installed the system — said he did not know whether a third-party inspection had been done on the medical gas system. A representative for the general contractor — declined to comment.

The dentist did not receive a certificate of inspection from the contractors, and was unaware that he was supposed to receive a certificate showing the system had been tested.