This course is an introduction to Medical Gas systems in Healthcare Facilities. We will explore basic concepts such as:

1) Source and piping systems
2) Proper installation
3) Proper inspection
4) Proper verification
5) Proper maintenance
REALITY CHECK

Why Does This Matter?

- Have you ever been admitted to a hospital?
- Did you notice the Medical Gas outlets?
- Ever wonder what’s behind those outlets?
- Did you feel safe “connected” to those outlets?

NFPA 99

- Code recognized in USA
  - (and many countries)
  - National Fire Protection Association
  - Healthcare Facilities Code
- Covers
  - Design
  - Installation
  - Inspection
  - Maintenance
  - Of Medical Gas Systems

COURSE OUTLINE

- Definitions
- Source equipment
- Valves
- Outlets/Inlets
- Alarms
- Piping
- Installation
- Inspection
- Verification
- Operation and Management
- Maintenance
Definitions

3.3.3 Alarm Systems
- Area Alarm System
- Local Alarm System
- Master Alarm System

3.3.19 Bulk Systems
- per NFPA 55
- consist of:
  - Main supply
  - reserve supply
  - vaporizers
  - relief valves
  - regulators
  - cutoff valves
  - alarm switches
  - etc.
Definitions

- 3.3.21 Central Supply Systems:
  - Vacuum pump systems
  - Medical Air Compressor systems
  - Manifolds

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Definitions

- 3.3.108 Medical Gas

<table>
<thead>
<tr>
<th>Patient Support</th>
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<tr>
<td>Oxygen Medical Air Nitrous Oxide Carbon Dioxide Helium Nitrogen Instrument Air</td>
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Risk Categories

- 4.1 Risk Categories
  - Category 1
    - Risk of major injury or death
  - Category 2
    - Risk of minor injury
  - Category 3
    - Risk of discomfort only
  - Higher category systems allowed to feed lower category areas
Source Equipment
Where does it all begin?

- 5.1.3.5.10 Manifolds
  - Smaller systems
  - Cylinders or containers attached
  - Replaced as emptied

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Source Equipment

- 5.1.3.5.12 Cryogenic Fluid Systems
  - aka Bulks
  - Larger system of permanent storage tanks
  - Refilled as emptied
Source Equipment

- 5.1.3.6 Medical Air Compressor systems
  - Multiple compressors
  - Controls
  - Receiver (storage tank)
  - Dryers
  - Filters
  - Regulators
  - Monitors

Images courtesy of powerexinc.com

Source Equipment

- 5.1.3.7 Medical-Surgical Vacuum Systems
  - Multiple pumps
  - Receiver (storage tank)
  - Controls

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Valves

Stop/Go
**Valves**

- **5.1.4 Valves**
  - Installed in the Distribution system for:
    - Maintenance
    - Repair
    - Future expansion
    - Testing
    - Emergencies
  - Pre-cleaned by manufacturer

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**Outlets/Inlets**

- **5.1.5 Station Outlets/Inlets**
  - Must be “gas specific”
    - Ensures proper gas is dispensed
    - Allows only proper devices to be attached
Outlets/Inlets

- 5.1.5.5 Outlet/inlet labeling
  - Proper labeling (including color coding) required

Alarms

- What's going on?

Warning Systems

- 5.1.9 Category 1 Warning Systems
  - 5.1.9.2 Master Alarms
  - Two required for Category 1
  - Monitors all source equipment and main line med gas/vacuum pressures
Warning Systems

- **5.1.9.4 Area Alarms**
  - Required in Category 1 areas and Anesthetizing locations
  - Monitor pressures in specific areas

Images courtesy of powerexinc.com

Warning Systems

- **5.1.9.5 Local Alarms**
  - Monitor pumps, compressors,
  - Dewpoint, Carbon Monoxide, etc

Images courtesy of powerexinc.com

Piping

How do we get there?

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### Piping

- **5.1.10 Category 1 Distribution**
  - Positive pressure piping materials must be either
    - Rigid Medical Gas Copper tube
    - CMT
  - Pipe & fittings must be
    - Precleaned
    - Sealed
    - Kept sealed until ready to install

### Piping

- **5.1.10.2 Vacuum piping materials**
  - Piping must be
    - Rigid copper
    - Stainless steel
    - CMT
  - Precleaning not necessary

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**Installation**

*This is how we do it*
Installation

- 5.1.10.3.1 Joints for rigid tubing
  - Brazing (most common)
  - Welding (typically for stainless steel)
  - Memory metal fittings (expensive, rarely used)
  - Axially swaged fittings (expensive, rarely used)
  - Threaded (in limited locations)

- 5.1.10.4.5 N2 purge
  - Required while brazing
  - Prevents oxidation inside pipe

- 5.1.10.8 Threaded Fittings
  - Limited locations
  - Tapered pipe threads
  - Teflon tape or equal
Installation

5.1.10.10 Prohibited Joints
- Flared / compression
- Straight threads
- Pipe crimping
- Push-fit fittings

Installation

5.1.10.11.3 Location of Piping
- Piping not allowed in:
  - Kitchens
  - Stairwells
  - Elevator shafts
  - Elevator machine rooms
  - Areas with open flames
  - High voltage areas
- (with some exceptions)

Installation

5.1.10.11.10 Qualification of Installers
- Must be ASSE 6010 (minimum)
- AHJ may have additional requirements
Installation

- 5.1.10.11.11 Qualification of Brazing
  - Brazing procedure are specified by:
    - American Society of Mechanical Engineers
    - American Welding Society

Installation

- 5.1.12.2 Installer-Performed Tests
  - Tests to be performed prior to Verifier testing include:
    - Initial Piping Blowdown
    - Initial Pressure Test
    - Initial Cross-Connection Test
    - Initial Piping Purge Test
    - Standing Pressure Test- gases
    - Standing Vacuum Test- vacuum

Inspection

Checking
Inspection

- 5.1.12.3 System Inspection
- Must be performed prior to concealing piping
  - By properly qualified personnel
  - Witnessing Installer Initial Pressure Testing
  - Check for proper labeling

Verification

Double Checking

- 5.1.12.4 System Verification
- Must be performed:
  - By properly qualified personnel
  - After Installer testing
  - After Inspection
  - Prior to putting system into service
Verification

- Verification includes-
  - Standing Pressure Test
  - Cross-Connection Test
  - Valve Test
  - Alarm Test
  - Piping Purge Test
  - Piping Particulate Test
  - Piping Purity Test
  - Final Tie-In Test

Verification (cont’d)

- Verification includes-
  - Operational Flow Pressure Drop Test
  - Medical Gas Concentration Test
  - Medical Air Purity Test - compressors
  - Labeling
  - Source Equipment Verification
Operation and Management

Keeping it running

5.1.14.1 Responsible Facility Authority
- Responsibilities
- Qualifications
- Permit to work system

Maintenance

Keeping it running
Maintenance

5.1.14.4 Maintenance of Systems
- Maintenance to consist of:
  - Inventories of system components
    - Sources, valves, alarms, etc
  - Inspection Schedules
  - Inspection Procedures
  - Maintenance Schedules

5.1.14.4.2.5 Qualifications
- Maintenance personnel must be properly trained

5.1.14.4.3 Inspection and Testing Operations
- All components of system must be periodically
  - Inspected
  - Tested
  - Maintained periodically
    - Source equipment
    - Valves
    - Alarms
    - Hoses
    - Labeling
    - Outlets/inlets
    - Pressure/vacuum indicators
KEY POINTS

1) Medical Gas systems are life support systems.
2) They must be installed properly for patient/staff safety
3) Inspections and verifications are critical to assure proper installation.
4) Oversight/management is critical to assure systems are not compromised.
5) Maintenance is necessary for continued reliability.

Discussion

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