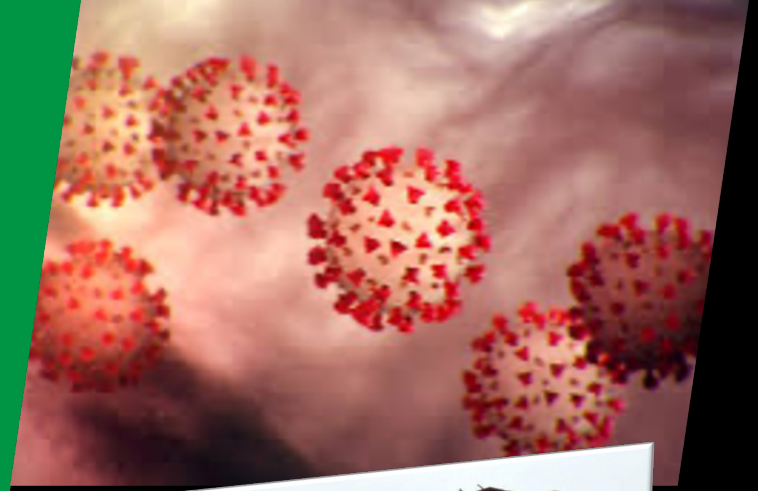

Presented By

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Brian Andrayo

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Medical Gas Systems: Implications of Infrastructure Design

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Paul Rumbos

Major Medical Hospital Services

- *Medical Gas Credentials: NITC/MGTI/MGPHO*
  - *ASSE 6050 Certified Medical Gas Instructor*
  - *ASSE 6030 Certified Medical Gas Verifier*
  - *ASSE 6020 Certified Medical Gas Inspector*
  - *ASSE 6010 Medical Gas System Installer*
  - *MGPHO Credentialed Medical Gas Verifier*
  - *NFPA 99 Committee Member (Alternate)*
  - *ASSE 6000 Committee Member*
  - *Affiliations in ASHE, ASSE and member in good standing with Hospital Engineers' Societies*

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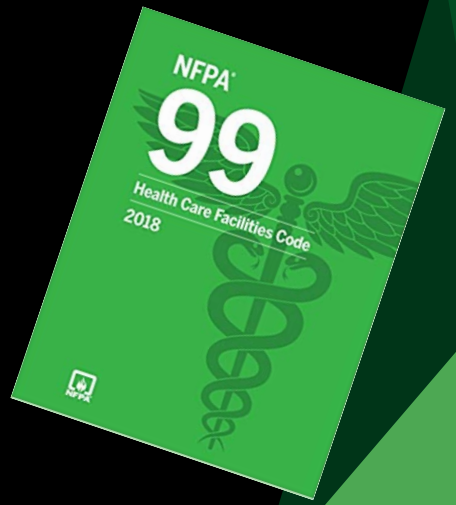
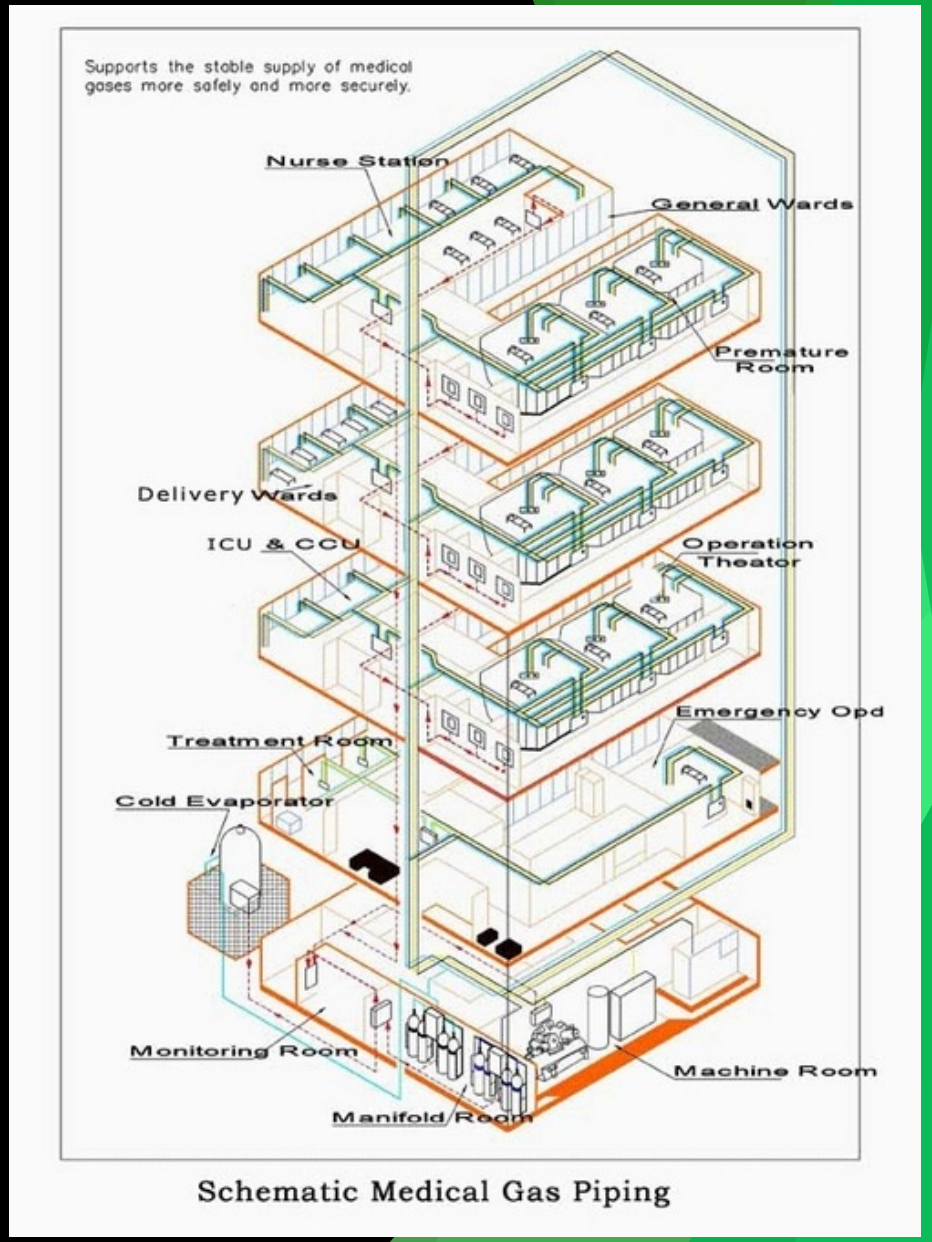


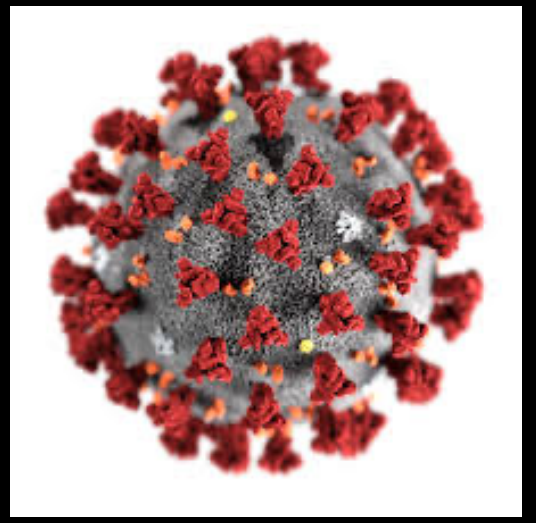
Typical Category 1 Medical Gas Systems



Schematic Medical Gas Piping

Presentation Outline

- Medical Gas Related Disasters
- Identifiable Medical Gas Issues Related to Infrastructure Caused by medical gas disasters and pandemics
- Solutions and Recovery for Medical Gas Systems
- Future Design Specifications
- Conclusions & Discussion



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Medical Gas Related Disasters

CBS NEWS

22 COVID patients die in Indian hospital as leak cuts oxygen supply

22 COVID patients die in Indian hospital as leak cuts oxygen supply

Medical Gas Related Disasters

Medical Gas Related Disasters

Medical Gas Related Disasters

Medical Gas Related Disasters

Hospital Deaths

- The Associated Press reported on four deaths in a Texas hospital. The initial report attributed the deaths to contaminated oxygen.

- Reports allege that the death toll has reached six with an additional 70 other patients under observation for hepatotoxic effects of the contaminant, which reliable sources have identified as trichloroethylene, a solvent used to clean pipes and gas tanks.

This tragedy supports and emphasizes the APSF's efforts to educate the anesthesia community about the dangers inherent in our gas pipeline systems, including the associated bulk supplies.

Medical Gas Related Disasters

Contractors New NFPA 99 Changes 2021

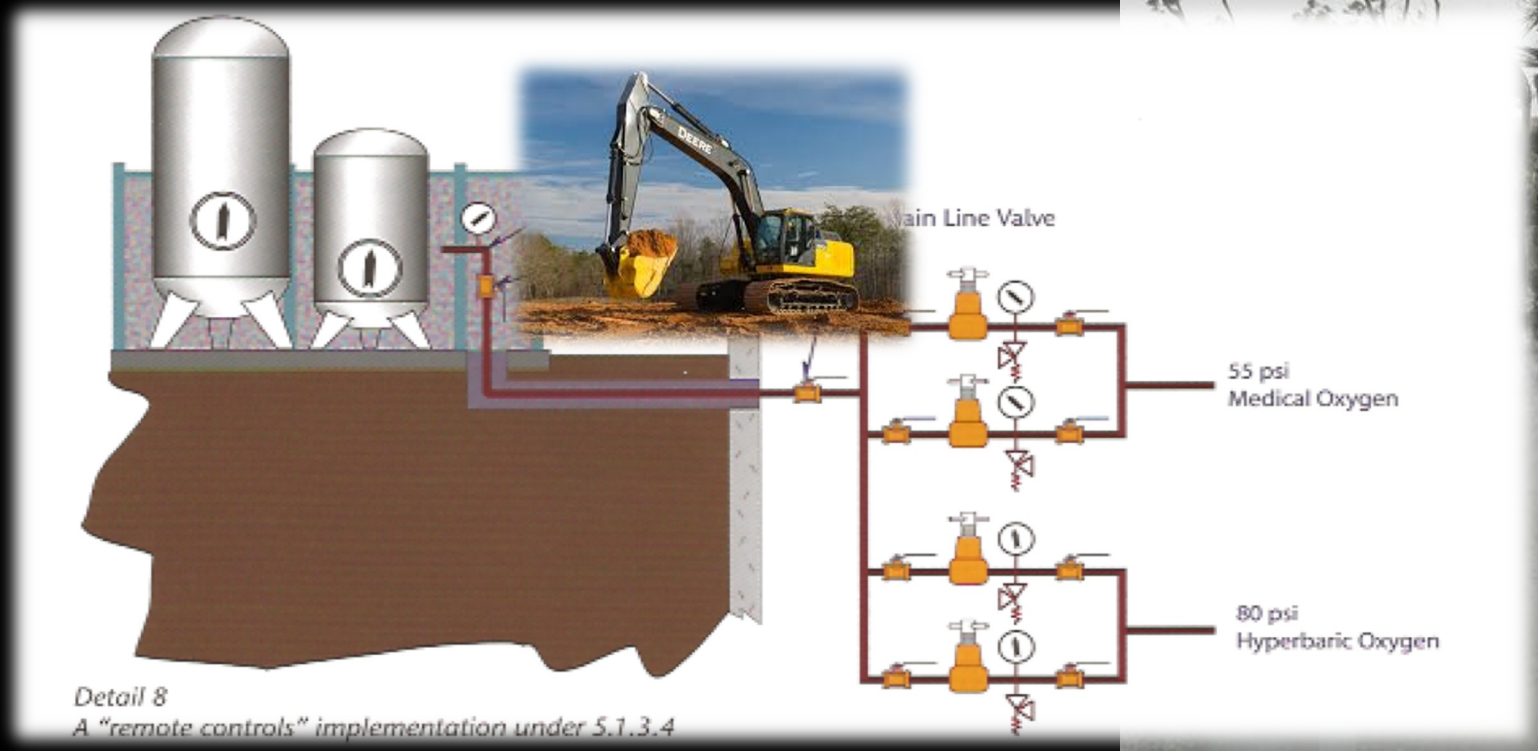
2 patients die at Maryland hospital after oxygen valve mistakenly turned off

Erica Carbajal - Friday, January 29th, 2021 Print | Email

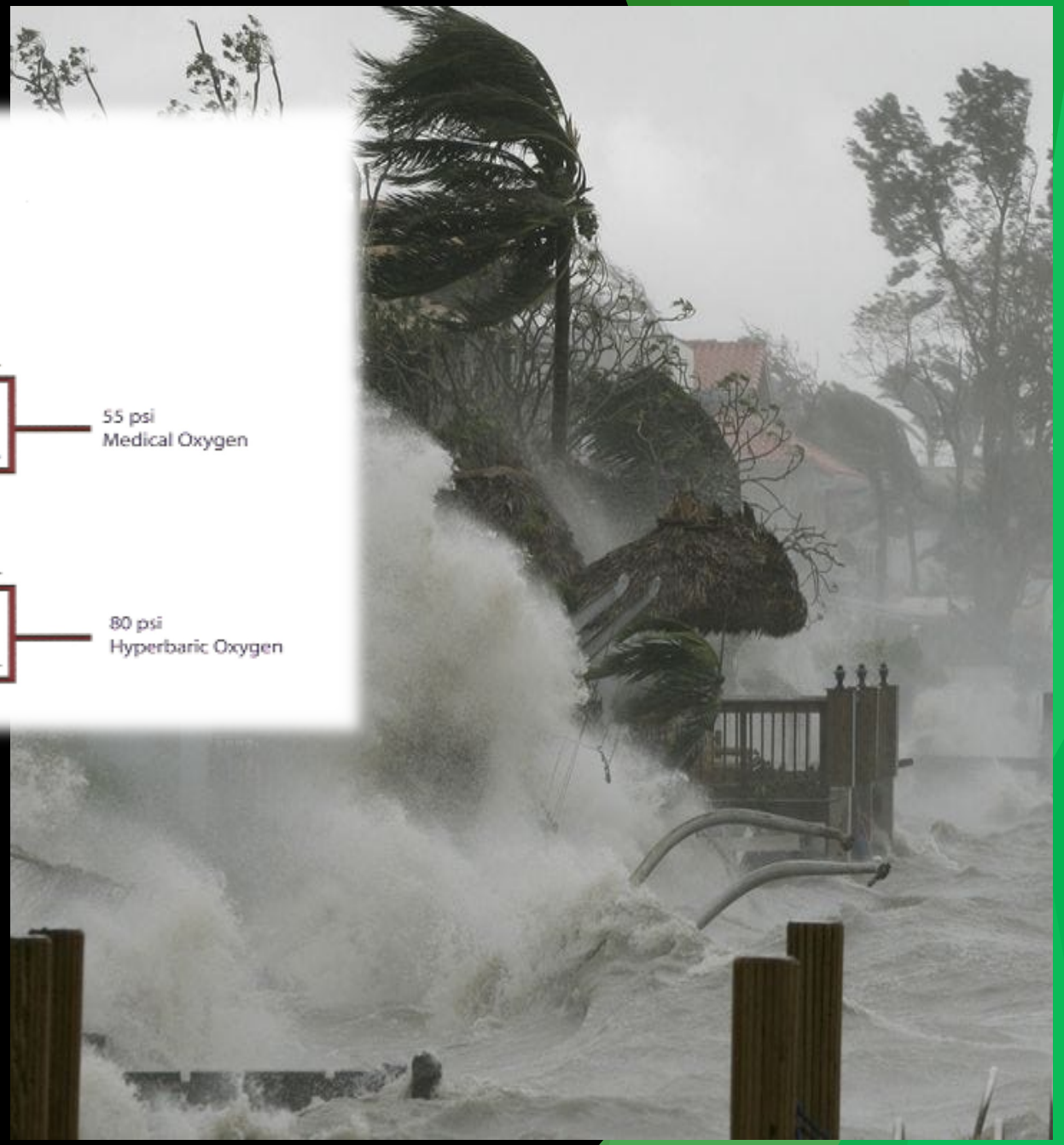
Two patients at Lanham, Md.-based Luminis Health Doctors Community Medical Center died after an oxygen valve was mistakenly turned off during maintenance Jan. 15, *FOX 5 DC* reported Jan. 28.

An oxygen valve was accidentally shut off during maintenance due to faulty valve labeling, according to a statement from a hospital spokesperson shared with *Becker's* Jan. 29. The hospital's team "immediately deployed portable oxygen to these patients," the statement said.

"We are saddened by this tragic accident and extend our deepest condolences to the families involved. We are communicating privately with them," the statement says. "We have taken action to prevent a similar occurrence in the future and have engaged outside experts as part of this review. Luminis Health Doctors Community Medical Center is committed to continuous improvement and providing the highest quality care to the communities we serve."



Detail 8
A "remote controls" implementation under 5.1.3.4



BULK SUPPLY DISASTERS During Construction

Oxygen Shortages News Release During Pandemic

COVID cases stress South Florida hospitals' oxygen supplies

Hospitals in U.S. South, Run Low on Oxygen Amid Covid Storm

The latest pandemic shortage: Oxygen

Covid-19 surges lead to oxygen shortages in several states

Why is delivering medical oxygen so complicated?

Shortage of Hospital Beds, Staff to deliver oxygen, Why US is Gasping for Breath as Delta

There's a Global Shortage of Medical Oxygen. Covid-19 Is Making It Worse.

Florida's Oxygen shortage: 4 things to know

Orlando Sentinel reported Aug. 13, 2021

Florida hospitals are treating the highest number of COVID-19 patients since the pandemic began, straining the supply of medical oxygen, the *Orlando Sentinel* reported Aug. 13.

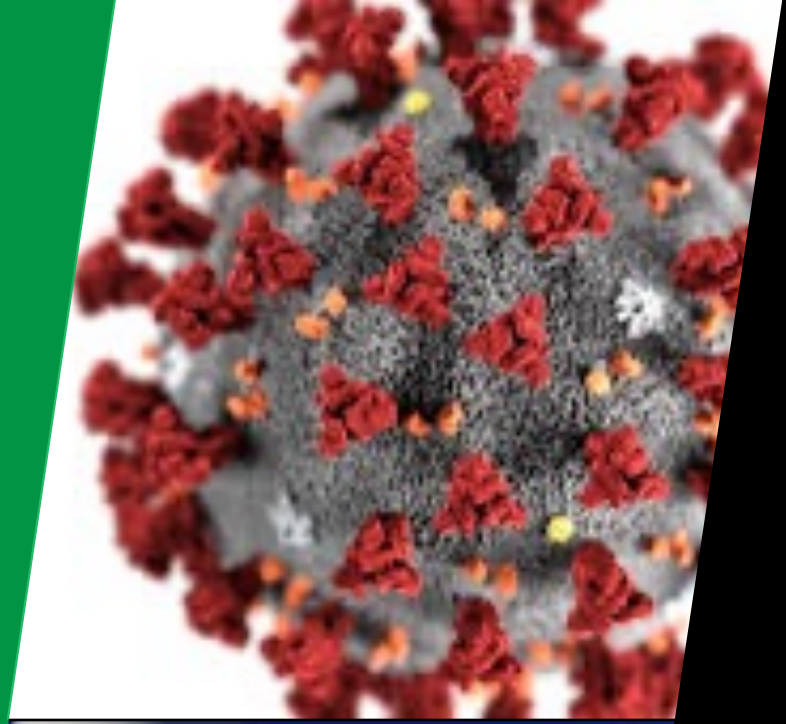
Four things to know:

Florida hospitals were treating *15,358 COVID-19 patients* as of Aug. 13, the Florida Hospital Association told the *Orlando Sentinel*

Hospital officials have said their *oxygen needs are being met, but the oxygen supply chain is strained*

There is a *shortage of drivers* licensed to transport liquid oxygen. The pandemic spurred a wave of early retirements in the trucking industry

Providers have discovered that *high-flow nasal oxygen* increases survival rates compared to mechanical ventilation. But that uses five to 10 times the amount of oxygen as a mechanical ventilator, he said.

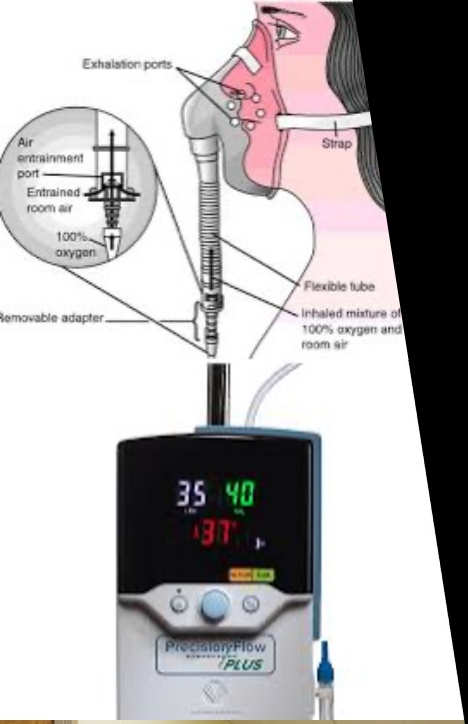


Pandemics & Medical Gas Conclusions

- **COVID patients use 10X more O2 than average patient**

EX: Vapo-therm 100% @ 35 Liters in some cases

Oxygen Shortages because of therapies



Therapies

Examples:

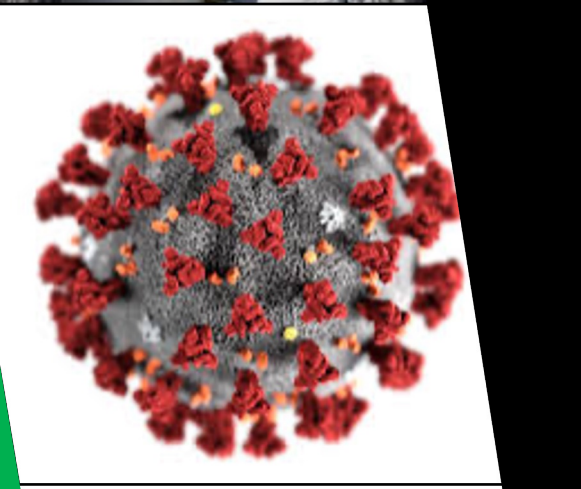
- Higher O2 Flow with simple, venturi or non-breather
- Mechanical Ventilation
- Bipap/CPAP
- *Vapotherm Technology*

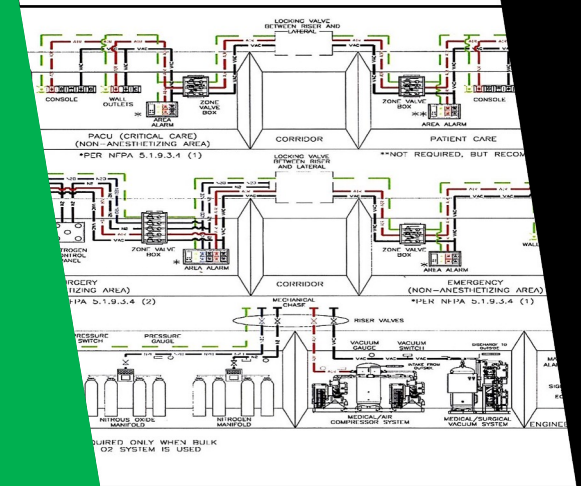
Could create higher O2 concentration in room (Why is that important?)

COVID Affects on Medical Gas

Look for…

- Patient Safety and Clinical Support Ventilator or Oxygen Therapy uses
- Bulk System Icing
- Pipe sizes feeding COVID locations (ZVB) provides estimates for Flow and Pressure to Different Areas of the Building
- Facility Memory (location of medical gas components)
- Updated Drawings and Labelling (Service Valves, etc.)
- Risk Assessments (What Risks will there be)
- Medical gas storage and air exchanges for those locations
- Any Other Examples not mentioned?





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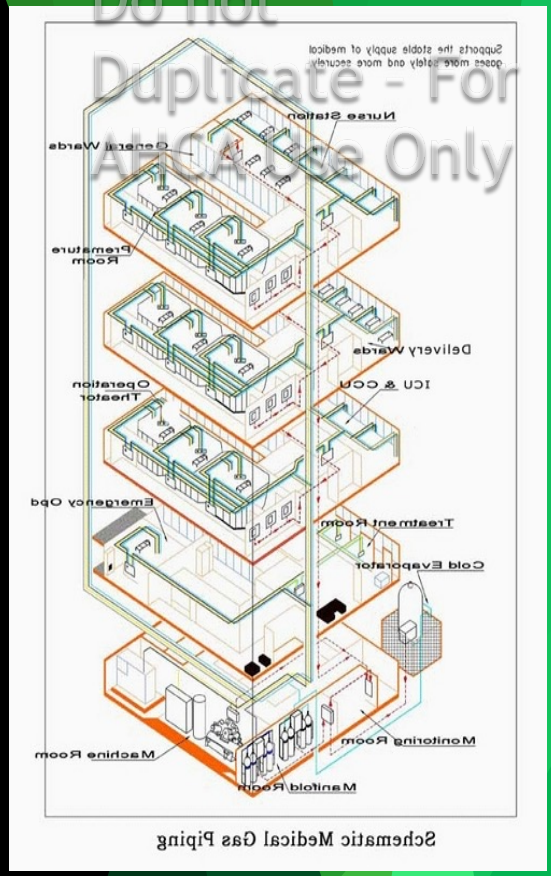
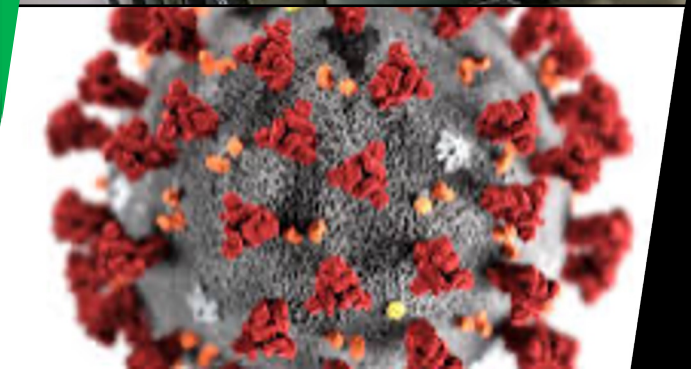


Schematic Medical Gas Piping

Pandemic Response:
What We Learned from Medical Gas Overuse

- **Medical Gas System Capabilities**
- **Ventilator Usage**
- **Infrastructure (Can it Handle It)**
- **How your bulk supply handles the usage**
- **Obsolescence of Systems**
- **New Facility Design**
- **Identifying Future Needs**
- **Utilize your Industry Experts**
- **Consider current or future codes for design of new systems**

Example: If You Have a 500 Bed Facility, can you use 500 Vents or More?



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Solutions and Recovery for Medical Gas Systems

Bulk Systems

- Frequent surveys and rounds
- Hot Water Bath/Steam vaporizers and piping
- Back-feeding from specific areas within a facility Areas
- Dewar Systems or Manifold Systems
- Vaporizer changeovers
- Emergency headers or temporary manifolds in pandemic designated areas
- See MGPHO.org for additional resources
- This presentation will be posted on majormedicalinc.com

Use Documentation for Emergency Preparedness (EPP).

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Remember
Chapters 5 & 9:
Storage of Medical Gas Cylinder

- 5.1.3.3.4.1 Full or empty medical gas cylinders, when not connected, shall be stored in locations complying with
- 5.1.3.3.2-5.1.3.3.3 permitted in the same room or enclosures as respective central supply systems.
- 9.3.6 Medical Gas Storage or Transfilling 9.3.6.5.2.1 Very Important on Ventilation

Important New Technologies Building System Categories

“EZ Find” Technology

- New technology allows for combo unit and access to sensors.
- Also includes “EZ Back Feed”
- 5 Year Warranty on Pipeline Product

Zone Valves Area Alarm Combo

Emergency Management

Important New Technologies
Building System Categories

Alternative Oxygen Supply

Emergency
Oxygen
Supply
Manifolds

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Important New Technologies
Building System Categories

Chapter 5: Oxygen Concentrator Supply Units (5.1.3.5.11)

Normal air is about 21% oxygen and 79% nitrogen

- ❑ Molecular sieve removes the nitrogen
- ❑ A vent, blower, or pump is used to remove the nitrogen and recycle the sieve.
- ❑ Sieve bed also removes particulates/contaminants
  - ➢ Filter required downstream, to remove stray particulate
  - ➢ Intake air requirements not as stringent as medical air

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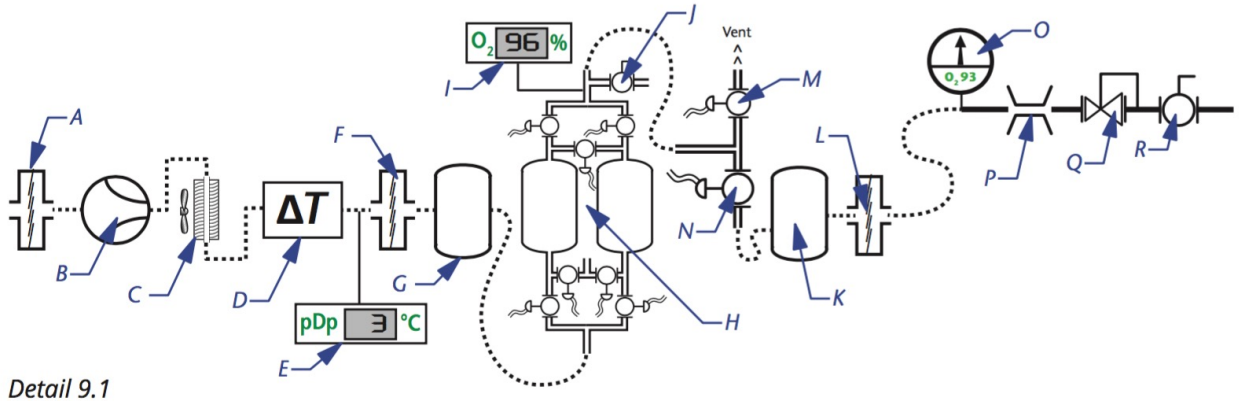
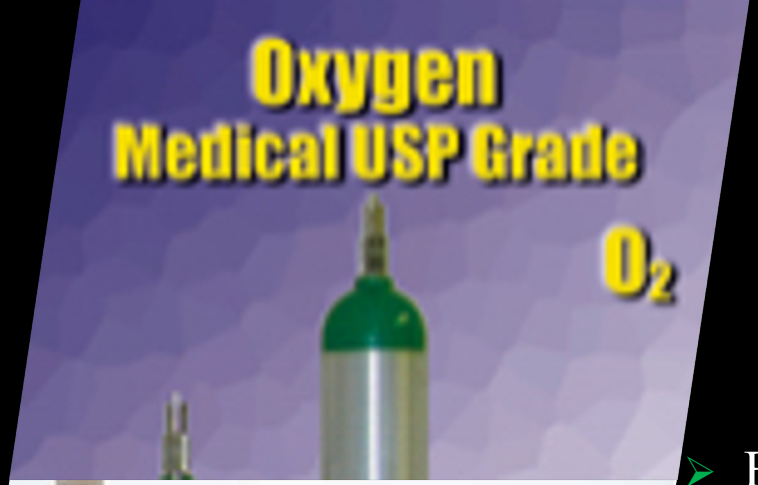
Chapter 5: Oxygen Concentrator Supply Units (5.1.3.5.11)

- Valved sample port and vent (to outside) are required
- "Outlet" valve to isolate all components from the pipeline required to be both manual and automatic
  - Manual to isolate source if needed for maintenance
  - Automatic if oxygen concentration drops too low (contaminated sieve bed)



Detail 9.1
Elements of a Typical Pressure Swing Absorber supply source
(Note: only elements with citations are required by NFPA 99. Other arrangements are possible)
(A) Concentrator Inlet filter 5.1.3.5.11.6; (B) Air Compressor; (C) Compressor aftercooler; (D) Dryer; (E) Dew point monitor; (F) Filter; (G) Receiver; (H) Concentrator; (I) Oxygen concentration monitor 5.1.3.5.11.13; (J) Sampling port 5.1.3.5.11.9; (K) Oxygen vessel; (L) Final filter 5.1.3.5.11.10; (M) Purge valve 5.1.3.5.11.8; (N) Automatic valve 5.1.3.5.11.12 and 5.1.3.9.2 (4); (O) Pressure Gauge; (P) Control orifice; (Q) Pressure regulator or check valve 5.1.3.5.11.11 and 5.1.3.9.2 (4); (R) Supply source isolation valve 5.1.3.5.11.12.



Important New Technologies Building System Categories

Typical Solutions?

- Bring cylinders to patients or transport multiple tanks with headers/regulators/carts for back feeding.

  (Always keeping safety in mind when transporting)

- Call the Bulk Supplier to bring an Oxygen Trailer/Truck with Vaporizers to site. Make sure area is cleared for truck

  (How long will that take and other contingencies?).

- Communicate with your Medical Gas Company & Suppliers to acquire enough rental supplies, cylinders/headers regulator/hoses, on hand for catastrophes.

- Or just a thought, utilizing resources within network and other local facilities.

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Medical Air

Contact your supplier for:

- ***Portable Medical Air Tanks***
- ***Ambulatory Medical Air Systems 3-20 HP***
- ***Concentrators***

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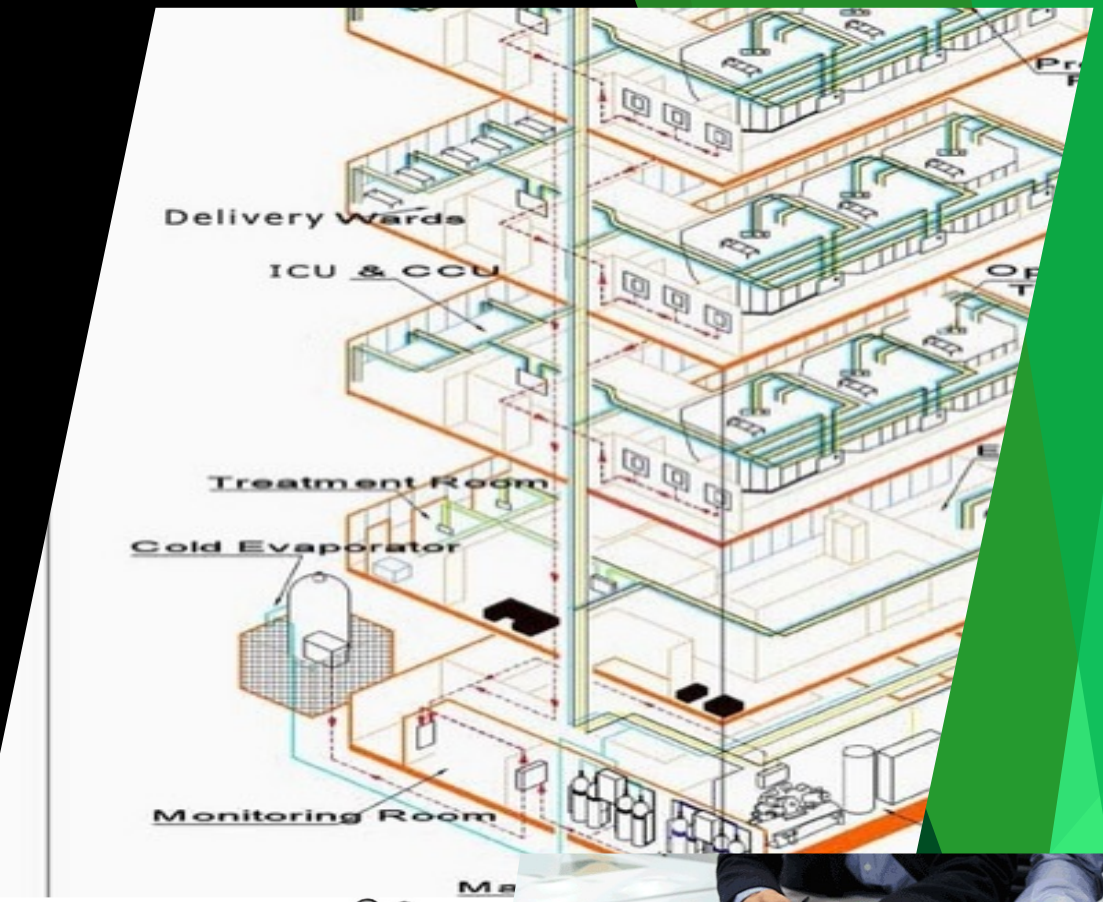
Important New Technologies
Building System Categories

Ventec Life VOCSN

- All-in-One Integrated Emergency Preparedness Device
- Portable Suction Pump, Oxygen Concentrator & Ventilator
- 9-Hour Battery Life for mobilization

Forward Thinking Designing: Medical Gases for the Future



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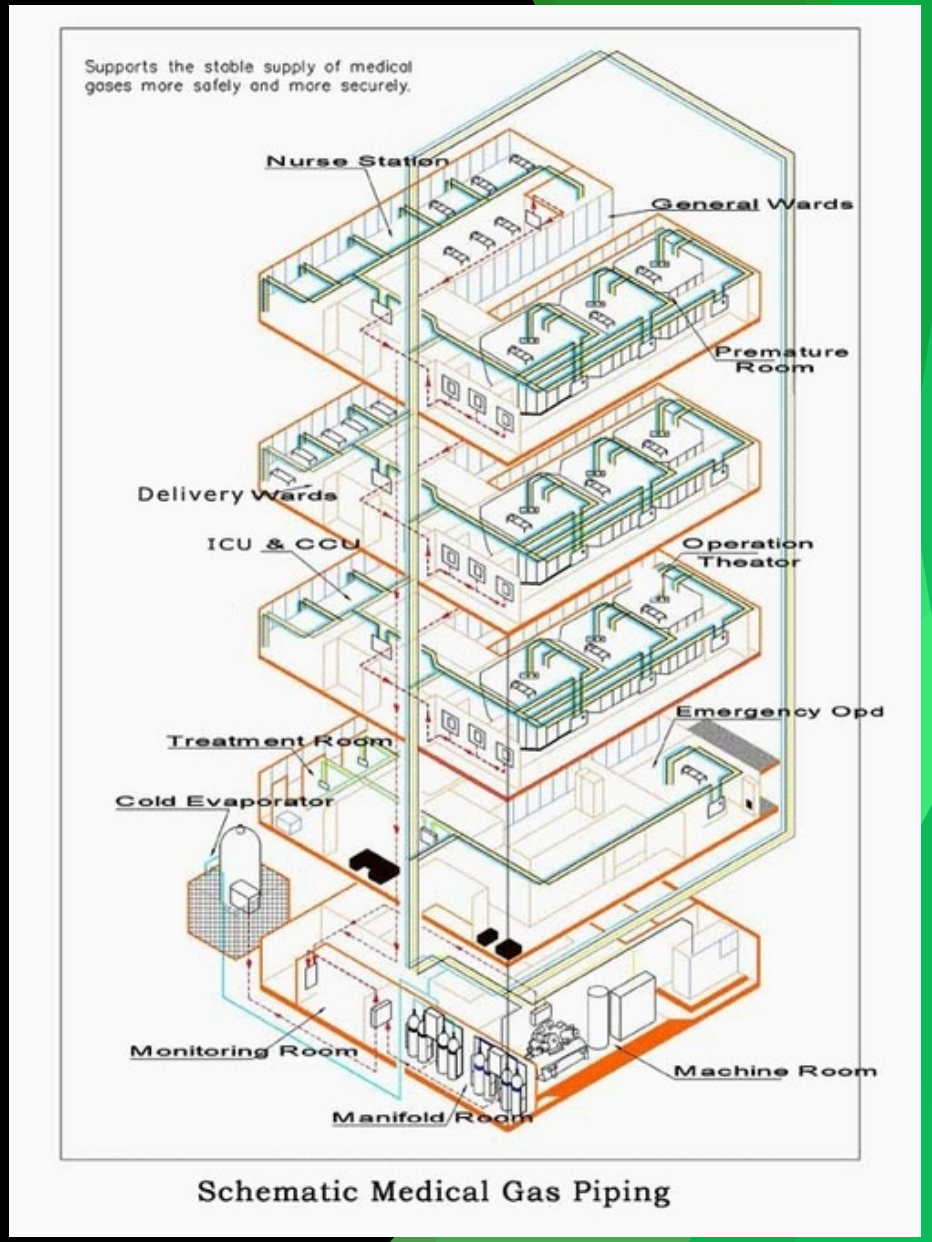
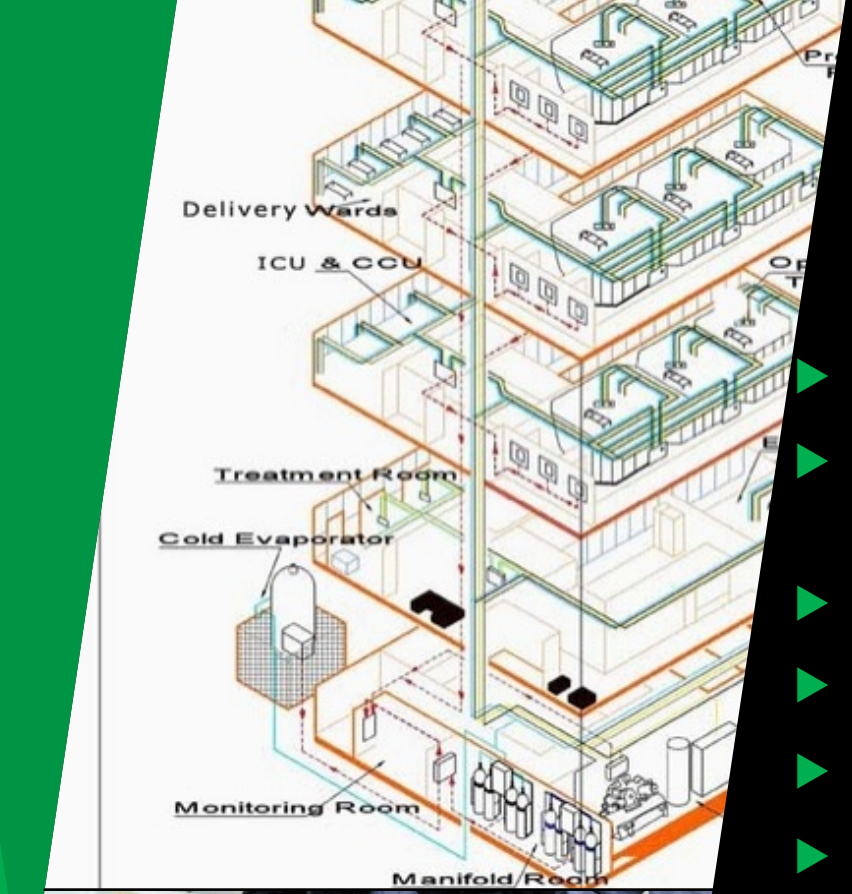
Typical Category 1 Medical Gas Systems



Schematic Medical Gas Piping



Future Design Specifications for Medical Gasses

- New and existing building renovations
- Support and clinical staff or third-party medical gas experts involved during discovery (Get them involved)
- Engineers, architects and design experts to support their thoughts and ideas
- Pipe sizing for specific areas for pandemic preparedness
- Labelling to current pipeline accuracy
- Documentation and drawing reviews for “as-built” on any new renovations
- Alleviate stress to infrastructure of the medical gas systems
- Pipe Size Evaluations are important

  (size to 1.5 capacity?)
- Source auxiliary connections throughout facility
- Future Valves

Regulatory Codes & Standards

NFPA 99: *Health Care Facilities Code*, 2015/2021 Edition

The scope of the NFPA 99: *Health Care Facilities Code* is to establish criteria to minimize the hazards of fire, explosion, and electricity in health care facilities providing services to human beings.

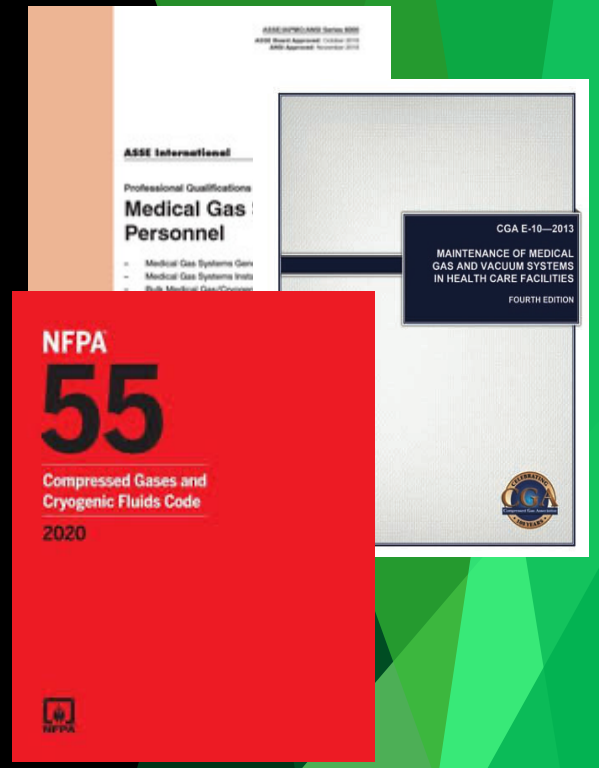
Chapter 5, Gas and Vacuum Systems, covers the performance, maintenance, installation, and testing of nonflammable medical gas systems with operating pressures below a gauge pressure of 300 psi, vacuum systems used within health care facilities, waste anesthetic gas disposal (WAGD) systems, also referred to as scavenging systems, and manufactured assemblies that are intended for connection to the medical gas, vacuum, or WAGD systems.

Other Reference Guides

CGA E-10: Maintenance of Medical Gas and Vacuum Systems at Health Care Facilities

- ✓ A guide to the preparation of a maintenance program regarding piped medical gas/vacuum systems in health care facilities.
- ✓ National codes require health care facilities with these systems to have an effective, documented maintenance program.
- ✓ Covers inspection and testing of Gas/Vacuum Outlets, Gas/Vacuum Alarm Systems, Compressed Gas Manifolds, Vacuum Pumps, Medical Air Compressors, Suggested Frequency of Inspection, Test Methods, & Documentation.
- ✓ Also, *CGA M-1*, P-1&2 Safe Handling, P-2.7 Guide for safe storage, Handling, and use of small portable liquid 02 systems, P-2.6 Trans- filling Liquid 02 use for Resp., P-30 Cryogenics, P-39 02 Rich Atm. & G-4 Oxygen

NFPA 55 Cryobulk



CGA
Compressed Gas Association
The Standard For Safety Since 1913

Document	Individual / Organization
Medical Gas and Vacuum Systems Installation Handbook, 2015 Edition	Jonathan R. Hart, P.E. National Fire Protection Association (NFPA)
NFPA 70: National Electric Code, 2014 Edition	National Fire Protection Association (NFPA)
Guidelines for Design and Construction of Hospitals and Outpatient Facilities, 2014 Edition	American Institutes of Architects (AIA)
Handbook of Compressed Gas, 5th Edition	Compressed Gas Association, Inc. (CGA)
Guide for Medical Gas Supply Systems at Consumer Sites CGA M-1, 3rd Edition	Compressed Gas Association (CGA)
Plumbing Engineering Design Handbook – Volume 2: Plumbing Systems, 2014 Edition	American Society of Plumbing Engineers (ASPE)
Professional Qualifications Standard For Medical Gas Systems Personnel ASSE/ IAPMO/ANSI Series 6000-2015, 2015 Edition	American Society of Sanitary Engineers (ASSE)
Guide for Medical Gas Installations at Consumer Sites CGA M-1, 3rd Edition	Compressed Gas Association, Inc. (CGA)
The Copper Tube Handbook, 2011 Edition	Copper Development Association Inc.
Standard Specification for Seamless Copper Tube for Medical Gas Systems ASTM B819, 2011 Edition	American Society of Testing and Materials (ASTM)
Safe Handling of Compressed Gases CGA P-1, 12th Edition	Compressed Gas Association, Inc. (CGA)
Characteristics and Safe Handling of Medical Gases CGA P-2, 10th Edition	Compressed Gas Association, Inc. (CGA)

Reference Documents

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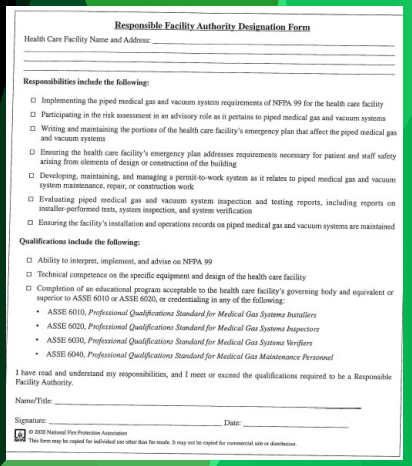
NFPA 2021 5.1.14.1.1 – 5.1.14.2.2(4)
Facility must designate an individual as *Responsible Facility Authority*.
Roles & Responsibilities include:

- O&M of piped medical gas and vacuum systems.
- Consultation on all matters pertaining to design or repair.
- Ensuring facility adheres to NFPA code and performs risk assessments as needed.
- Emergency management planning accounting for safety of patients and staff.
- Develop, maintain and manage Permit-to-Work System
- Educating staff - vendors or in house
- Maintaining up to date in line drawings
- Utilizing Software (medical gas management program)
- Managing Medical Gas Inventory
- Knowing Flow Parameters



Responsible Facility Authority Designation Form

Health Care Facility Name and Address: _____

Responsibilities include the following:

- ☐ Implementing the piped medical gas and vacuum system requirements of NFPA 99 for the health care facility
- ☐ Participating in the risk assessment in an advisory role as it pertains to piped medical gas and vacuum systems
- ☐ Writing and maintaining the portions of the health care facility's emergency plan that affect the piped medical gas and vacuum systems
- ☐ Ensuring the health care facility's emergency plan addresses requirements necessary for patient and staff safety arising from elements of design or construction of the building
- ☐ Developing, maintaining, and managing a permit-to-work system as it relates to piped medical gas and vacuum system maintenance, repair, or construction work
- ☐ Evaluating piped medical gas and vacuum system inspection and testing reports, including reports on installer-performed tests, system inspection, and system verification
- ☐ Ensuring the facility's installation and operations records on piped medical gas and vacuum systems are maintained

Qualifications include the following:

- ☐ Ability to interpret, implement, and advise on NFPA 99
- ☐ Technical competence on the specific equipment and design of the health care facility
- ☐ Completion of an educational program acceptable to the health care facility's governing body and equivalent or superior to ASSE 6010 or ASSE 6020, or credentialing in any of the following:
  - ASSE 6010, *Professional Qualifications Standard for Medical Gas Systems Installers*
  - ASSE 6020, *Professional Qualifications Standard for Medical Gas Systems Inspectors*
  - ASSE 6030, *Professional Qualifications Standard for Medical Gas Systems Verifiers*
  - ASSE 6040, *Professional Qualifications Standard for Medical Gas Maintenance Personnel*

I have read and understand my responsibilities, and I meet or exceed the qualifications required to be a Responsible Facility Authority.

Name/Title: _____

Signature: _____ Date: _____

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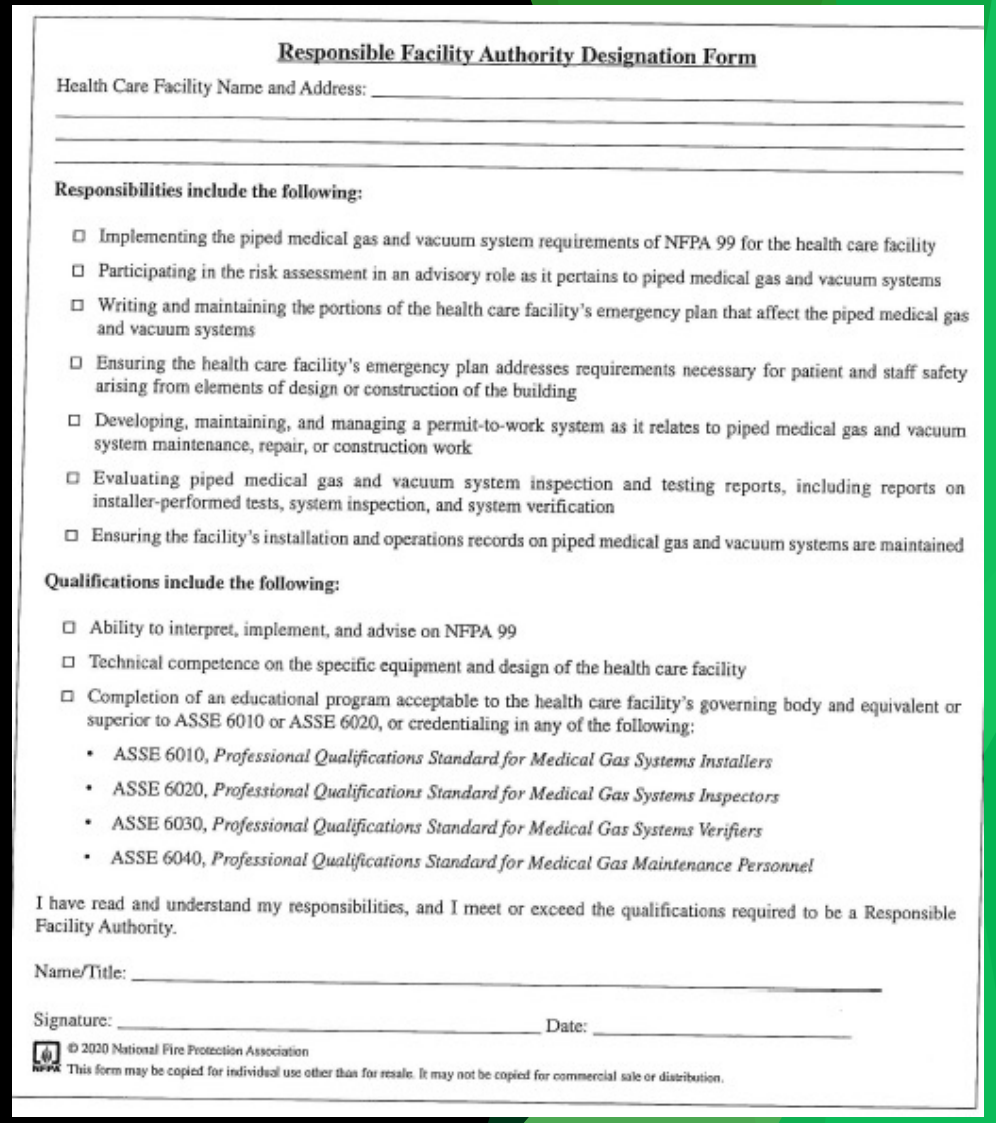
NFPA 2021 5.1.14.1.1 – 5.1.14.2.2(4)
Responsible Facility Authority

Qualifications Requirements Include:

- Technical competence on facility equipment
- Credentials designated by governing body ASSE 6010/6020/6030/6040
- Completion of Educational Programs substantially equivalent to ASSE credentialing



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  - ASSE 6040, *Professional Qualifications Standard for Medical Gas Maintenance Personnel*

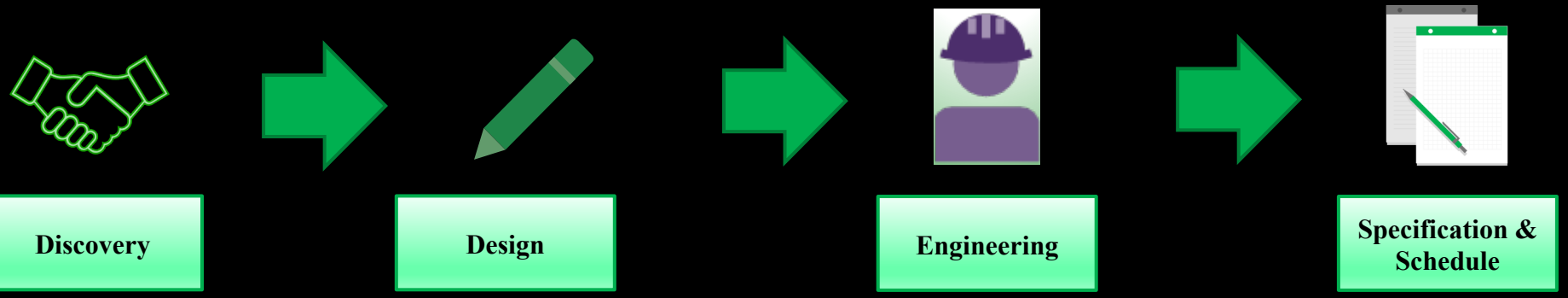
I have read and understand my responsibilities, and I meet or exceed the qualifications required to be a Responsible Facility Authority.

Name/Title: _____

Signature: _____ Date: _____

Discovery/Design/Engineering/Specifications and Scheduling:
Planning Based on Discovery and Risk Factors

- Obsolescence of Medical Gas Source Equipment
- Design Factors Involving Medical Gas
- Supporting Critical Care Areas
- Pandemic Increases Perils



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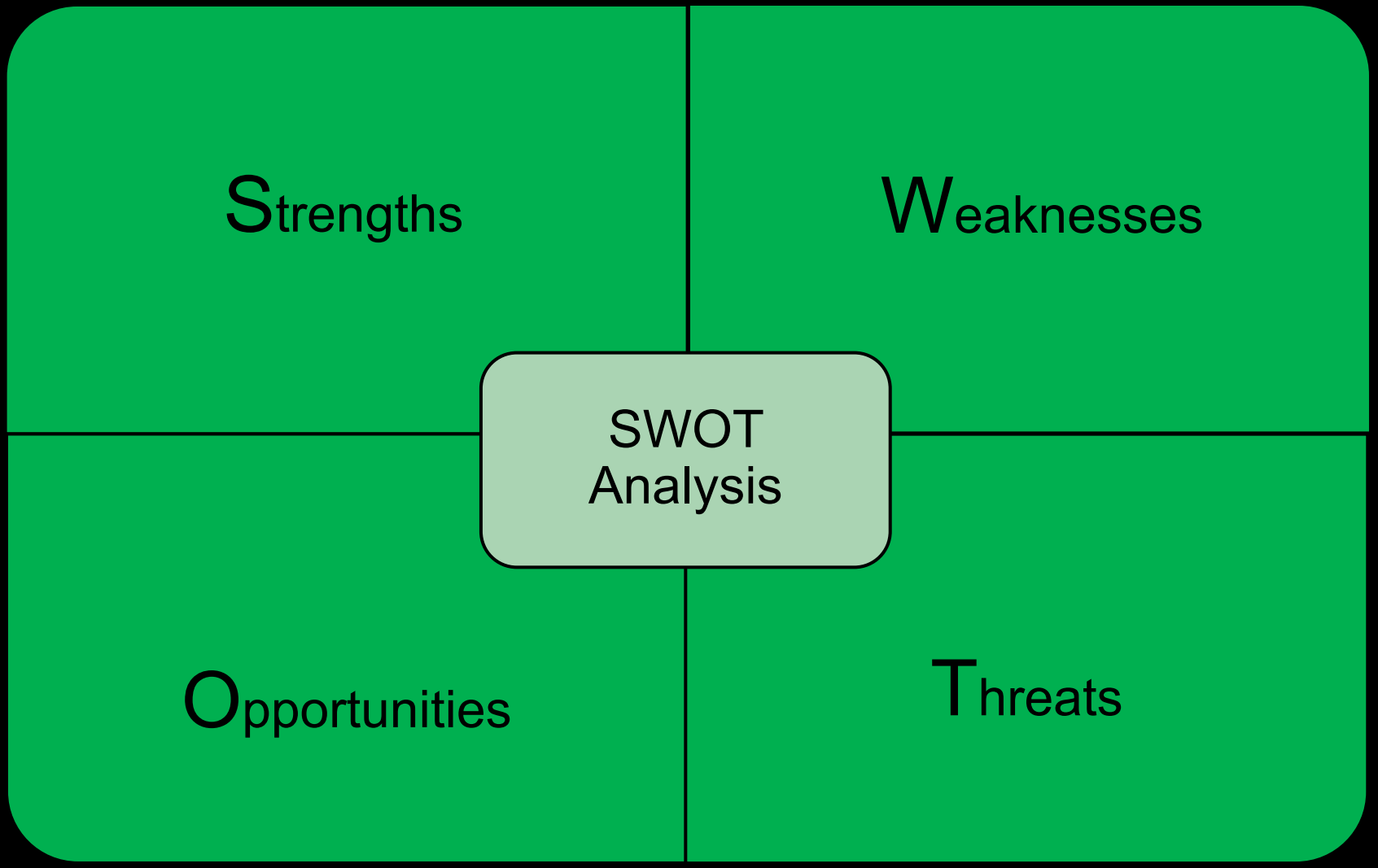
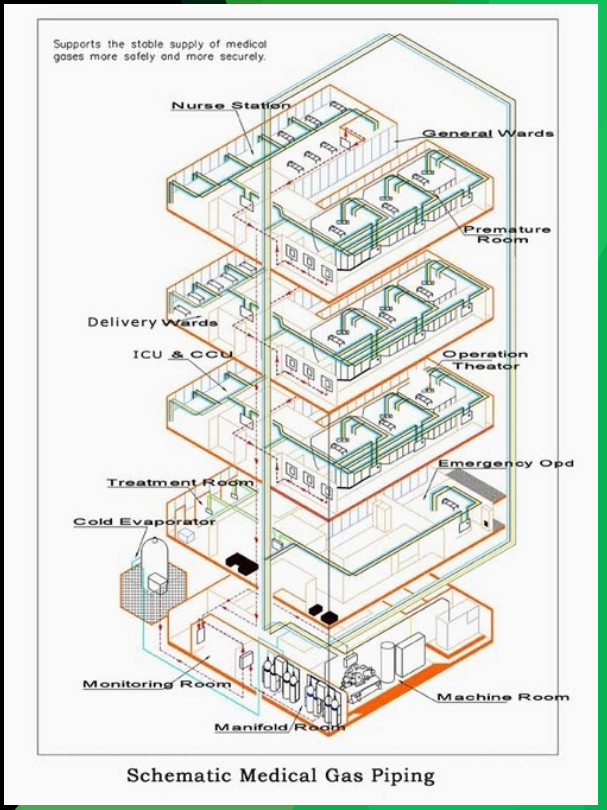
Considerations for Medical Gas Design





Schematic Medical Gas Piping

Considerations for Medical Gas Design

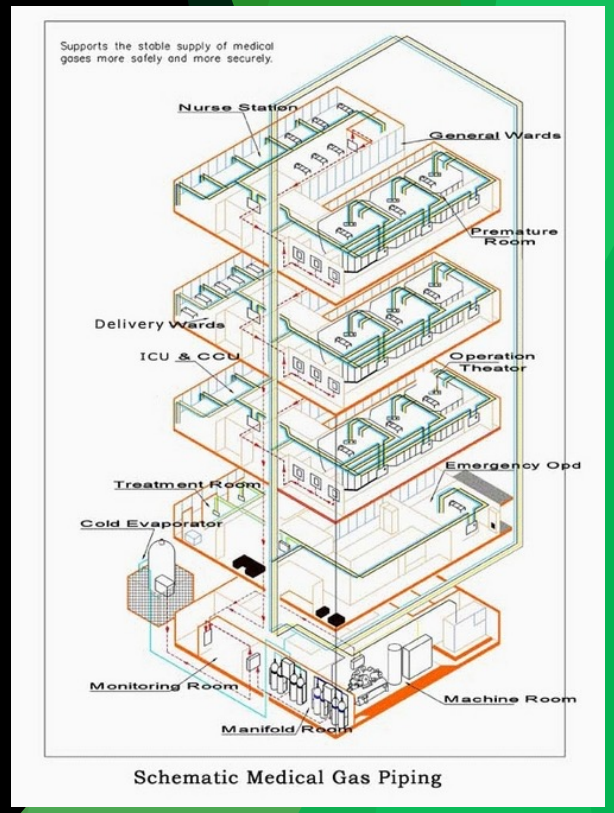
Discovery

Design

SWOT Analysis

Engineering

Specifications & Scheduling



Schematic Medical Gas Piping

A few things to remember…

Chapter 5: Design and Construction

All outdoor locations require 2 forms of egress 5.1.3.3.2 (3)

2018 Change: 5.1.3.3.2 (4) If greater than 200 ft², you must provide a minimum of two entry/exit.

Adding additional reserves or infrastructure design to existing system systems will bring new challenges to the areas Identified as your Cryogenic Oxygen Supply

- Pipe Sizing, into building meeting requirements and enhancements to the system
- Additional Emergency Oxygen fill (if needed)

Medical Gas Design Resources

- *American Society for Healthcare Engineering*
  Pipe Medical Gas Consumption Evaluation Tool

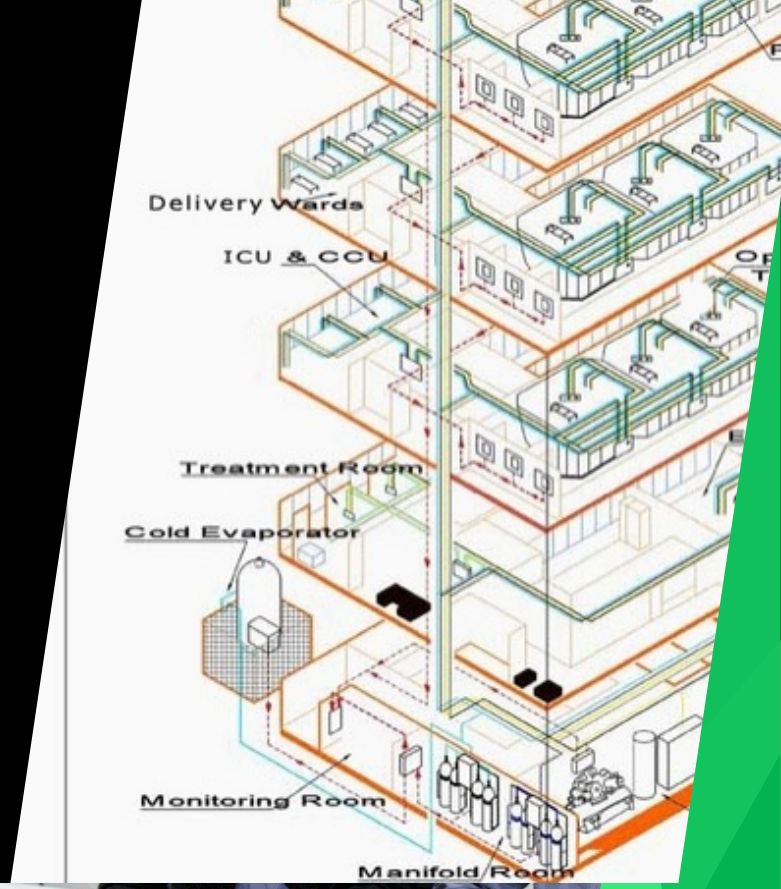
- *Kaiser Permanente National Facility Services*
  Medical Air and Oxygen Capacities

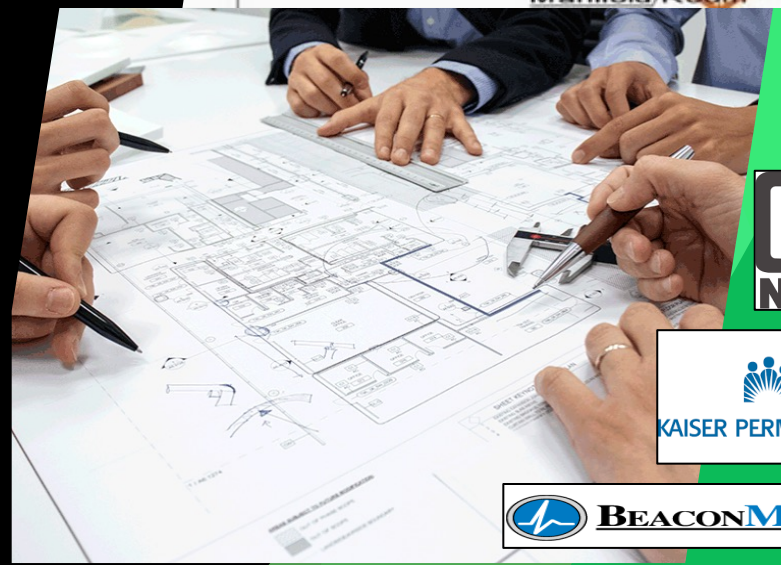
- *Beacon Medaes*
  Sizing Medical Gasses for Covid-19

- *National Fire Protection Agency*
  Considerations for Temporary Compliance Options in Healthcare Environments During Covid-19

  Safe Quantity of Open Medical Gas Storage in Healthcare Facility Smoke Compartments

- *Health Facility Management/ NFPA*
  Oxygen Tank Storage Regulations





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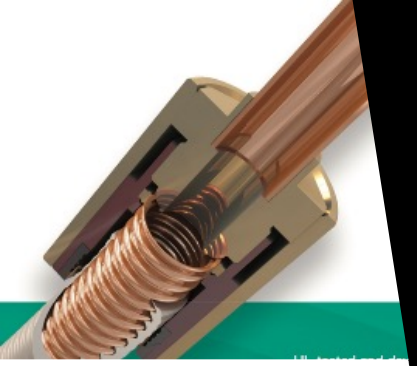
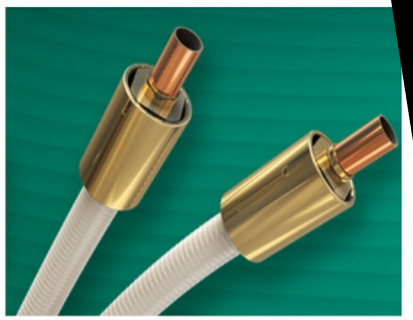
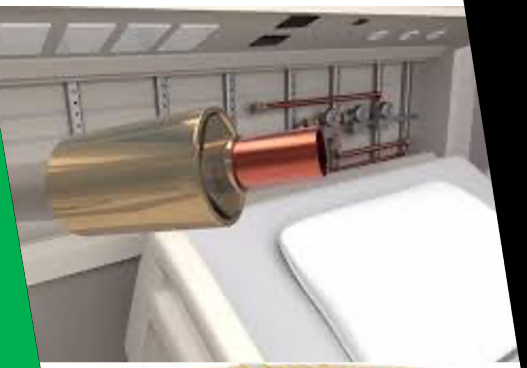






Chapter 5: Manufactured Assemblies/ Corrugated Medical Tubing

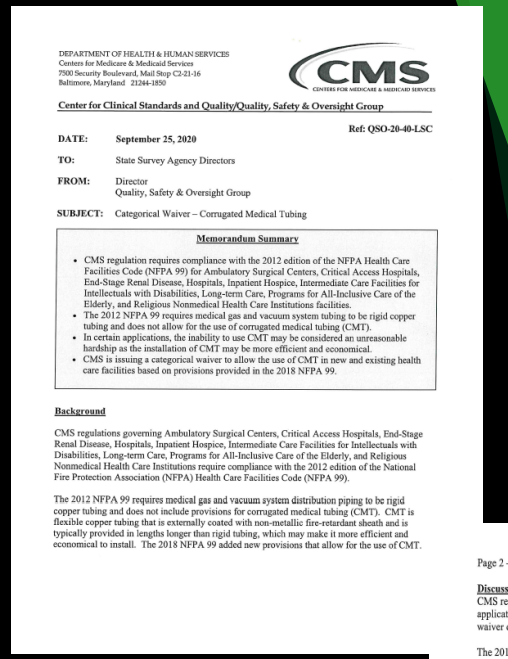
- New 5.1.10.1.4 (2) **Corrugated Medical Tubing (CMT)**
- Flexible
- Much easier & not utilizing brazing
- Swaged Fitting-type connection
- Good for Temporary Ancillary Service Locations

Chapter 5: Manufactured Assemblies/ Corrugated Medical Tubing

September 2020

The *Categorical Waiver Process* allows providers and/or suppliers to request special permission to violate specific code based on the "unreasonable hardship" it may cause.

- Health and Safety of patients is priority
- Decision must be formally elected, documented and communicated to survey team
- Surveyor will describe under Tag K000 and form CMS-2786 will indicate waiver.



DEPARTMENT OF HEALTH & HUMAN SERVICES
Centers for Medicare & Medicaid Services
7500 Security Boulevard, Mail Stop C2-21-16
Baltimore, Maryland 21244-1850

CMS
CENTERS FOR MEDICARE & MEDICAID SERVICES

Center for Clinical Standards and Quality/Quality, Safety & Oversight Group

Ref: QSO-20-40-LSC

DATE: September 25, 2020

TO: State Survey Agency Directors

FROM: Director
Quality, Safety & Oversight Group

SUBJECT: Categorical Waiver – Corrugated Medical Tubing

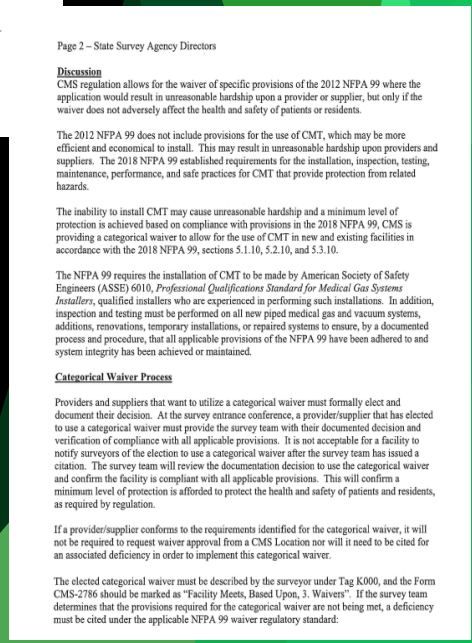
Memorandum Summary

- CMS regulation requires compliance with the 2012 edition of the NFPA Health Care Facilities Code (NFPA 99) for Ambulatory Surgical Centers, Critical Access Hospitals, End-Stage Renal Disease, Hospitals, Inpatient Hospice, Intermediate Care Facilities for Intellectuals with Disabilities, Long-term Care, Programs for All-Inclusive Care of the Elderly, and Religious Nonmedical Health Care Institutions facilities.
- The 2012 NFPA 99 requires medical gas and vacuum system tubing to be rigid copper tubing and does not allow for the use of corrugated medical tubing (CMT).
- In certain applications, the inability to use CMT may be considered an unreasonable hardship as the installation of CMT may be more efficient and economical.
- CMS is issuing a categorical waiver to allow the use of CMT in new and existing health care facilities based on provisions provided in the 2018 NFPA 99.

Background

CMS regulations governing Ambulatory Surgical Centers, Critical Access Hospitals, End-Stage Renal Disease, Hospitals, Inpatient Hospice, Intermediate Care Facilities for Intellectuals with Disabilities, Long-term Care, Programs for All-Inclusive Care of the Elderly, and Religious Nonmedical Health Care Institutions require compliance with the 2012 edition of the National Fire Protection Association (NFPA) Health Care Facilities Code (NFPA 99).

The 2012 NFPA 99 requires medical gas and vacuum system distribution piping to be rigid copper tubing and does not include provisions for corrugated medical tubing (CMT). CMT is flexible copper tubing that is externally coated with non-metallic fire-retardant sheath and is typically provided in lengths longer than rigid tubing, which may make it more efficient and economical to install. The 2018 NFPA 99 added new provisions that allow for the use of CMT.



Page 2 – State Survey Agency Directors

Discussion

CMS regulation allows for the waiver of specific provisions of the 2012 NFPA 99 where the application would result in unreasonable hardship upon a provider or supplier, but only if the waiver does not adversely affect the health and safety of patients or residents.

The 2012 NFPA 99 does not include provisions for the use of CMT, which may be more efficient and economical to install. This may result in unreasonable hardship upon providers and suppliers. The 2018 NFPA 99 established requirements for the installation, inspection, testing, maintenance, performance, and safe practices for CMT that provide protection from related hazards.

The inability to install CMT may cause unreasonable hardship and a minimum level of protection is achieved based on compliance with provisions in the 2018 NFPA 99, CMS is providing a categorical waiver to allow for the use of CMT in new and existing facilities in accordance with the 2018 NFPA 99, sections 5.1.10, 5.2.10, and 5.3.10.

The NFPA 99 requires the installation of CMT to be made by American Society of Safety Engineers (ASSE) 6010, *Professional Qualifications Standard for Medical Gas Systems Installers*, qualified installers who are experienced in performing such installations. In addition, inspection and testing must be performed on all new piped medical gas and vacuum systems, additions, renovations, temporary installations, or repaired systems to ensure, by a documented process and procedure, that all applicable provisions of the NFPA 99 have been adhered to and system integrity has been achieved or maintained.

Categorical Waiver Process

Providers and suppliers that want to utilize a categorical waiver must formally elect and document their decision. At the survey entrance conference, a provider/supplier that has elected to use a categorical waiver must provide the survey team with their documented decision and verification of compliance with all applicable provisions. It is not acceptable for a facility to notify surveyors of the election to use a categorical waiver after the survey team has issued a citation. The survey team will review the documentation decision to use the categorical waiver and confirm the facility is compliant with all applicable provisions. This will confirm a minimum level of protection is afforded to protect the health and safety of patients and residents, as required by regulation.

If a provider/supplier conforms to the requirements identified for the categorical waiver, it will not be required to request waiver approval from a CMS Location nor will it need to be cited for an associated deficiency in order to implement this categorical waiver.

The elected categorical waiver must be described by the surveyor under Tag K000, and the Form CMS-2786 should be marked as "Facility Meets, Based Upon, 3. Waivers". If the survey team determines that the provisions required for the categorical waiver are not being met, a deficiency must be cited under the applicable NFPA 99 waiver regulatory standard:

FACILITY MEMORY

The expertise held by a select few key staff who have gained their facility-specific knowledge through experience within that organization

- Avoid the pitfall of relying on staff *knowledge and experience* in responding and recovering from an emergency.
- Without proper documentation, *lay offs, retirement or natural attrition* can cause enormous *gaps* in transfer of *knowledge*.
- Train and learn from your Medical Gas Experts including both internal and external resources with equipment capabilities.
- Document while the info is accessible!

Strengths: Facility Knowledge

Revisit the SWAT Analysis and consult with the RFA at each level

Category 1 Operation and Management

OPERATIONS AND MANAGEMENT DOCUMENTATION

Maintenance Programs with:

- 5.1.14.2.2.1 Inventories
- 5.1.14.2.2.2 Inspection Schedules (PM's)
- 5.1.14.2.2.3 Inspection Procedures (Risk Assessment)
- 5.1.14.2.2.2 Maintenance Schedules

All have paper trails

Plan for life cycle replacements and unexpected failures.

The Joint Commission

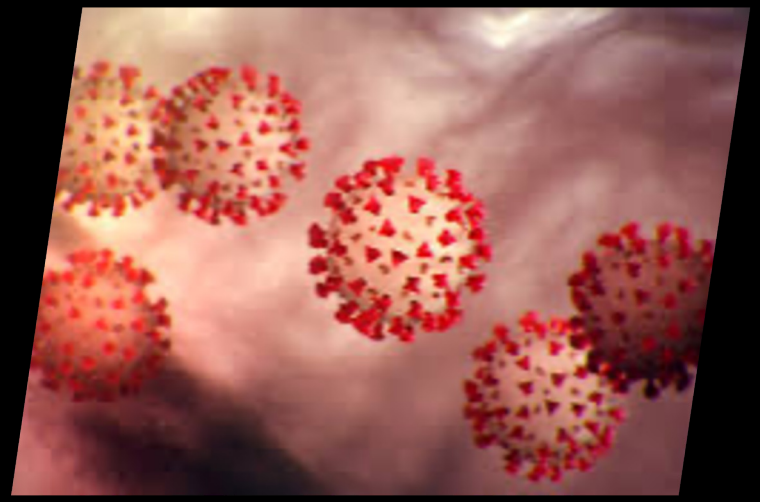
Elements of Performance for Emergency Management

- Standard EM.02.02.09 EP 07
  - For organizations that plan to offer services during an emergency: The Emergency Management Plan describes how the organization will deliver alternative means of meeting essential building utility needs and provide *continuous* services during an emergency.
  - Examples of potential utility problems might include disruption to piped medical gas systems, failure of backup generators and/or water pipe rupture.

Chapter 12: Revised Emergency Management

CMS Emergency Preparedness Rule

CMS.gov
Centers for Medicare & Medicaid Services



- To increases patient safety during emergencies.
- To establishes consistent emergency preparedness requirements across provider and supplier types.
- Establishes a more coordinated response to natural and man-made disasters.

The Joint Commission

Identifying Threats Utilizing EPP Rules

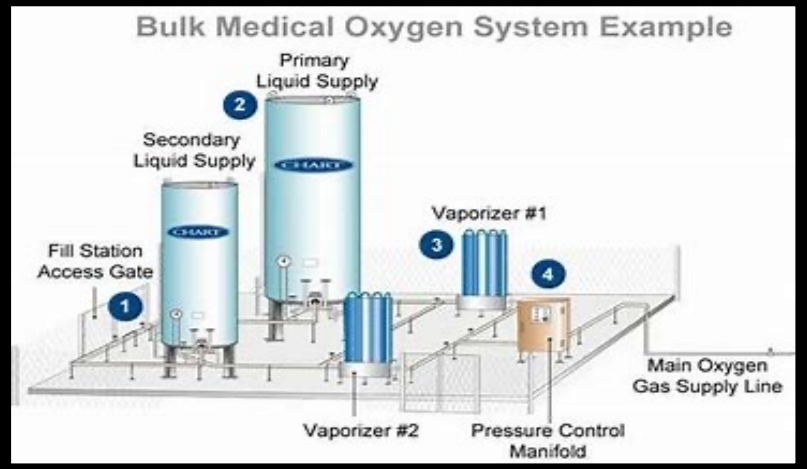
Elements of Performance for Emergency Management

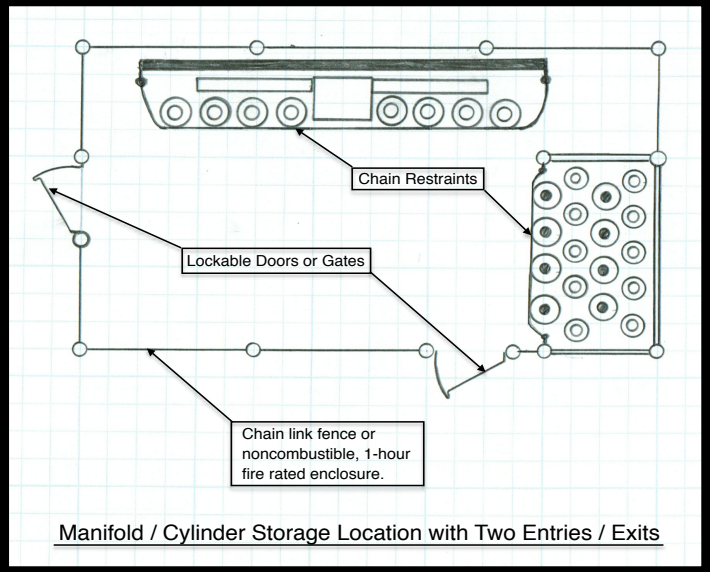
- Standard EM 03.01.03 EP 11
  - Monitor the management of staff roles and responsibilities during emergency response exercises.
- Standard EC 04.01.01 EP 11
  - Investigate and report utility failures with a focus on team-based communications.

A few things to remember…

Chapter 5: Design and Construction

All outdoor locations require 2 forms of egress 5.1.3.3.2 (3)





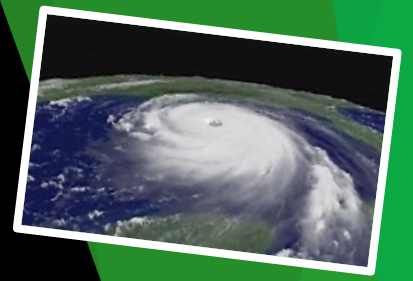
Manifold / Cylinder Storage Location with Two Entries / Exits

2018 Change: 5.1.3.3.2 (4) If greater than 200 ft², you must provide a minimum of two entry/exit.

RISK ASSESSMENT

What are the worst-case scenarios?

Look for them…



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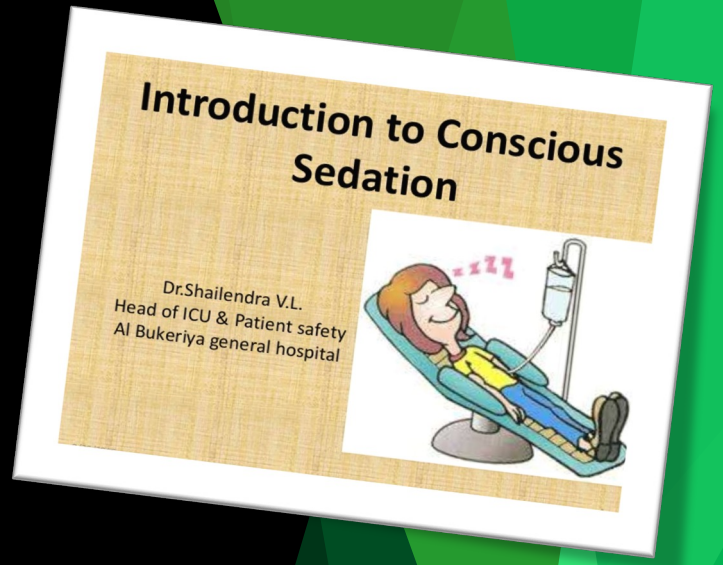
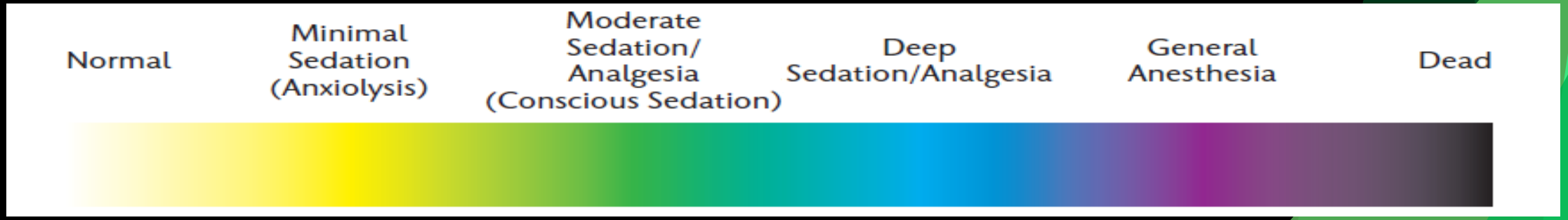
NFPA 99 Risk Assessment…… Risk Schematic

				NFPA 99 2012 Risk Assessment		Chapter 5							Chapter 6				Chapter 7				Chapter 8										Chapter 9			Chapter 10		Chapter 11		12	
						Gas & Vacuum Systems							Electrical Systems				IT & Communications				Plumbing										HVAC			Electrical Equipment		Gas Equipmemt		EM	
Building Code	Building Name	Floor Code	Room Code	Room Description	Room Class Type Description	Oxygen	Medical Air	Nitrous Oxide	Nitrogen	Medical/Surgical Vaccuum	Instrument Air	HeliOx	Normal Power	Critical	Life Safety	Equipment	Data Transfer	Phone	Nurse Call	Cable	Potable Water-Cold	Potable Water-Hot	Non-Potable Water	Water Heating	Water Cooling	Steam	Non-Med.Compressed Air	Waste Water	Storm Water	Heating	Cooling	Ventilation	Elecrial Equipment	(See Equipment Tab	Cylinder sources	Cylinder Storage	Emergency Management	Notes
2002	White	B	W0B001	Electrical Equipment Room	Mechanical Room-Electr	4	4	4	4	4	4	4	4	4	2	2	2	2	2	4	4	4	4	4	4	4	4	4	4	4	4			4	4	3	
2002	White	B	W0B002	Private Corridor	Circulation	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4			4	4	4	
2002	White	B	W0B002A	Stairs	Circulation	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4			4	4	2	
2002	White	B	W0B003	Mechanical Equipment Area	Mechanical Room-Electr	4	4	4	4	4	4	4	4	4	2	2	2	2	2	4	4	4	4	4	4	4	4	4	4	4	4			4	4	3	
2002	White	B	W0B004	Central Storage	Storage	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4			4	4	4	
2002	White	B	W0B005	Central Storage	Storage	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4			4	4	4	
2002	White	B	W0B006	Public Corridor	Circulation	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4			4	4	4	
2002	White	B	W0B007	Public Corridor	Circulation	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4			4	4	4	
2002	White	B	W0B008	Electrical Closet	Mechanical Room-Electr	4	4	4	4	4	4	4	4	4	2	2	2	2	2	4	4	4	4	4	4	4	4	4	4	4	4			4	4	3	
2002	White	B	W0B009	Central Storage	Support Facilities	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4			4	4	4	
2002	White	B	W0B010	Shaft	Structural Area	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4			4	4	4	

Chapter 4: Risk Assessment - Levels of Sedation

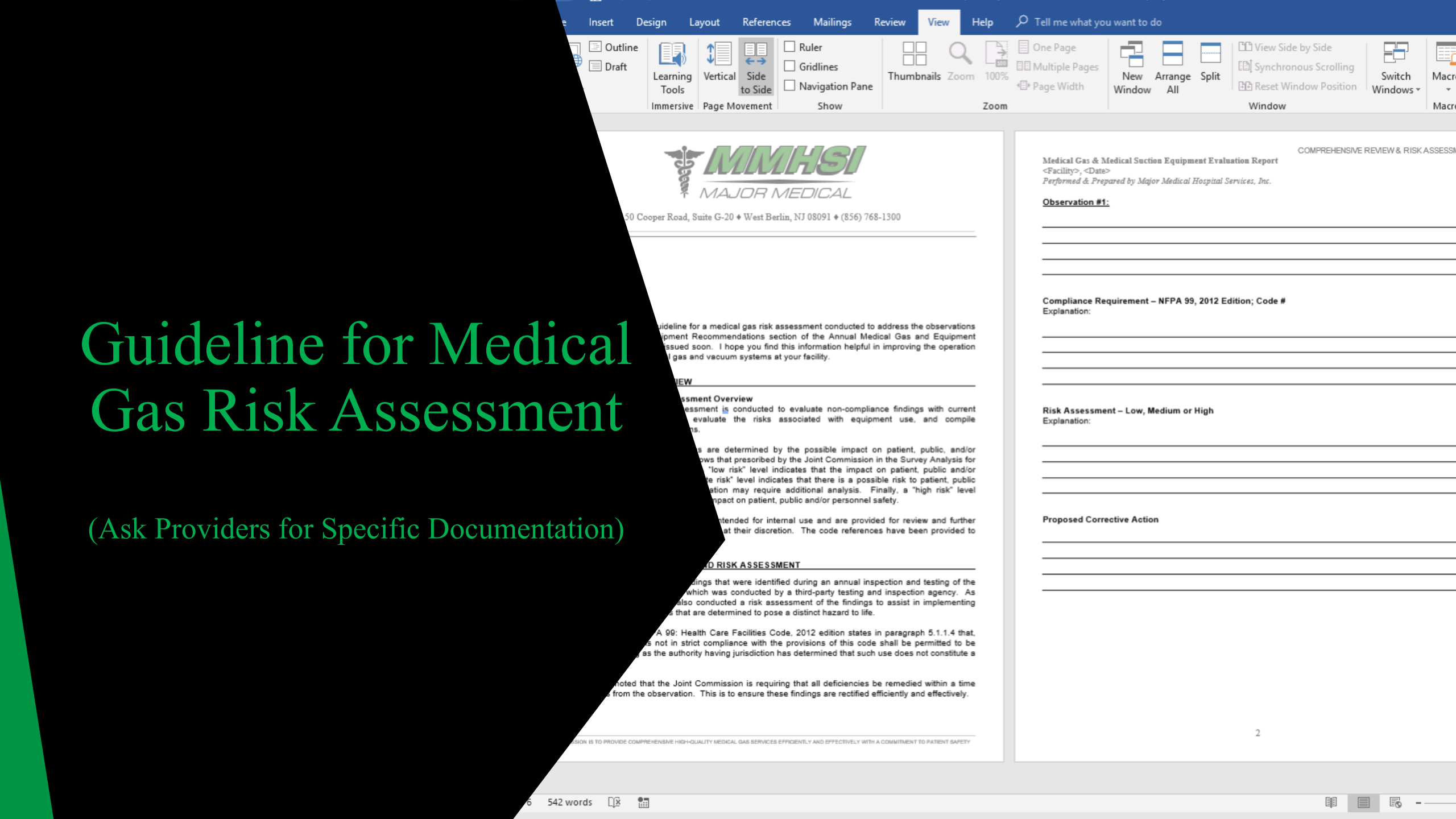
- The scope of necessary safety precautions will be determined by a risk assessment of levels of anesthesia (Ex: use of ZVB & Area Alarms).
- It is the responsibility of the facility's "governing body" to determine through a *documented* process the maximum level of sedation to be used in a given location.
  - Results of this assessment determine use of
  - Zone Valves & Area Alarms.





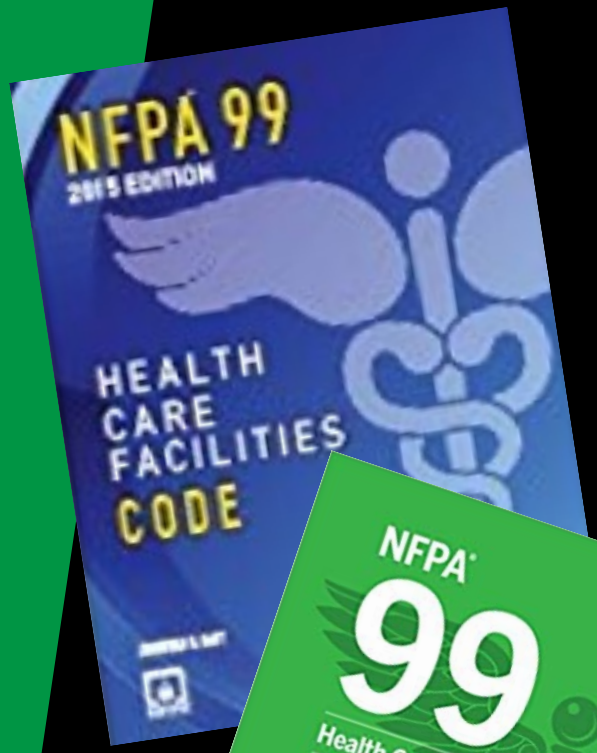
Guideline for Medical Gas Risk Assessment

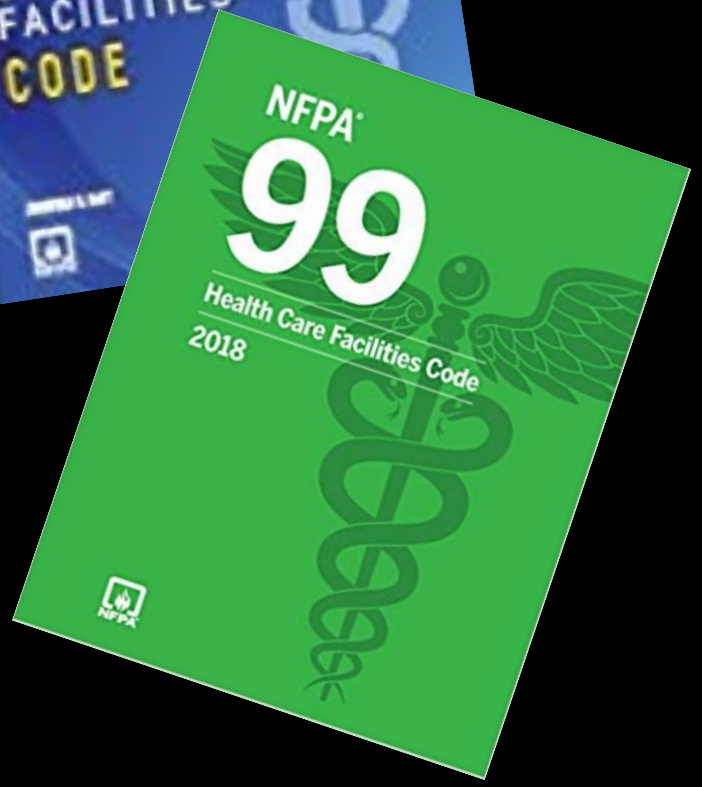
(Ask Providers for Specific Documentation)



Questions regarding pandemic response or design?

Medical Gas
NFPA 99 Changes





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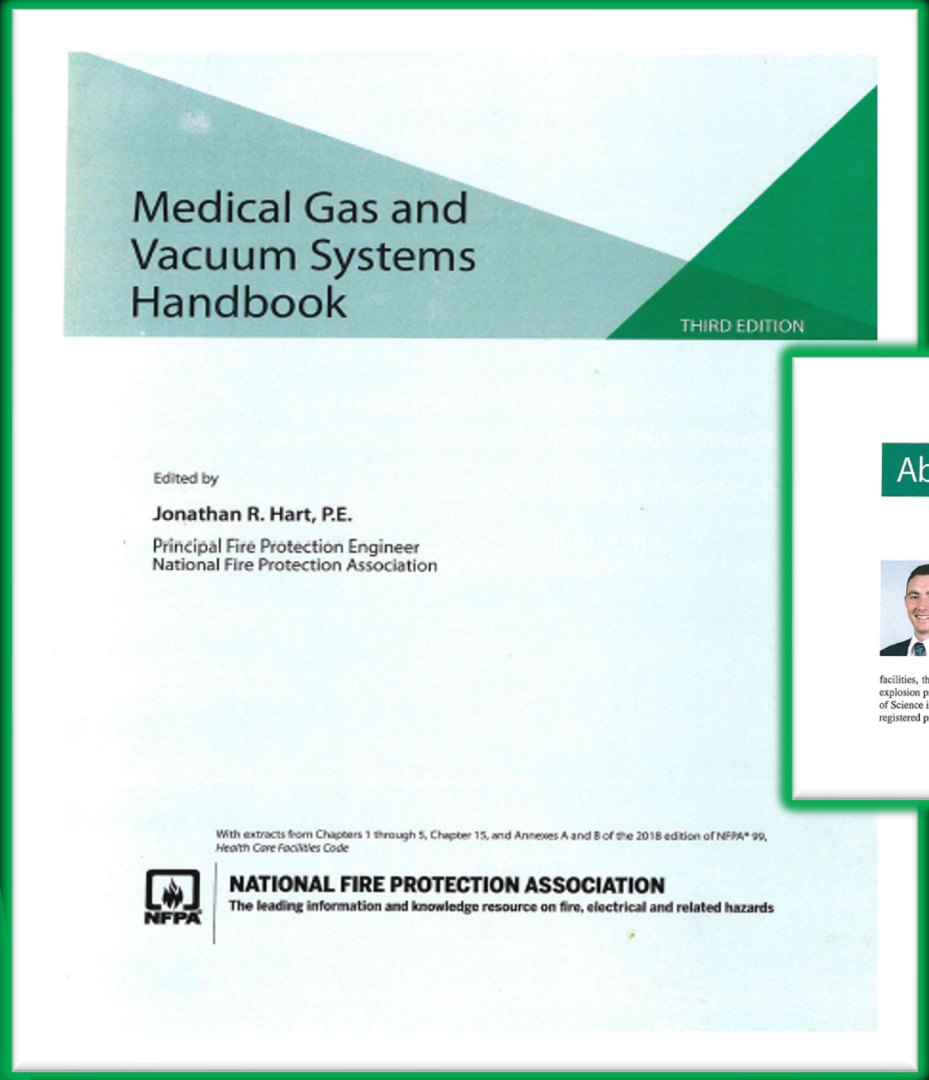
Summary of Technical Changes 2018 -2021



PDF File Available for Preview at: https://www.techstreet.com/mss/products/preview/2003553

NFPA 99 2018: Summary of Changes

Chapter 3 - Definitions
- ❑ Defining & Clarifying Terms

Chapter 4 - Fundamentals
- ❑ Fundamentals of Risk Assessment

Chapter 5 – Gas & Vacuum Systems
- ❑ Outdoor/indoor locations for central supply
- ❑ Storage of Medical Gas Cylinders
- ❑ Controls for Line Pressure
- ❑ Auxiliary Source Connection
- ❑ Oxygen Concentrator Supply Units
- ❑ Cryogenic Fluid Central Supply Systems
- ❑ Operating, Area and Local Alarms and Signals
- ❑ Vacuum Filtration
- ❑ Manufactured Assemblies/ Corrugated Medical Tubing
- ❑ System Inspection
- ❑ Source Equipment Labelling
- ❑ Bulk System Verification

Chapter 11 – Gas Equipment
- ❑ Performance and maintenance of gas equipment in ***new and existing*** healthcare facilities
- ❑ Cylinder Storage and Protection

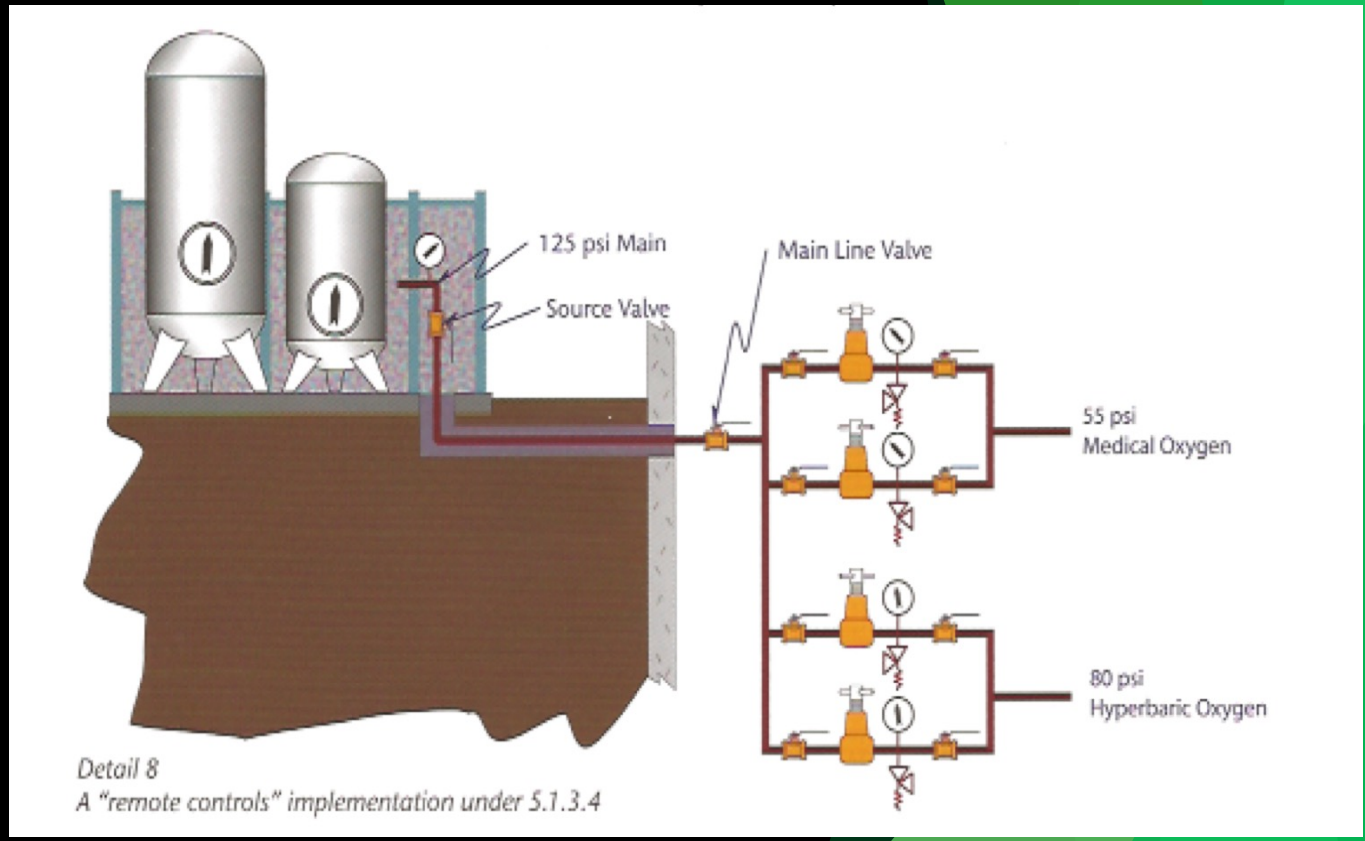
Chapter 12 – Emergency Management
- ❑ Pandemic/ COVID Response

Chapter 15 - Dental Gas and Vacuum Systems
- ❑ Removed from chapter 5 and moved to its own chapter

Chapter 5: Central Supply System Location

"Remote" Control Equipment (i.e. Regulators, valves, and gauges) for Central Supply Systems

Control Equipment is allowed to be remote from the source equipment with this new provision (5.1.3.4).



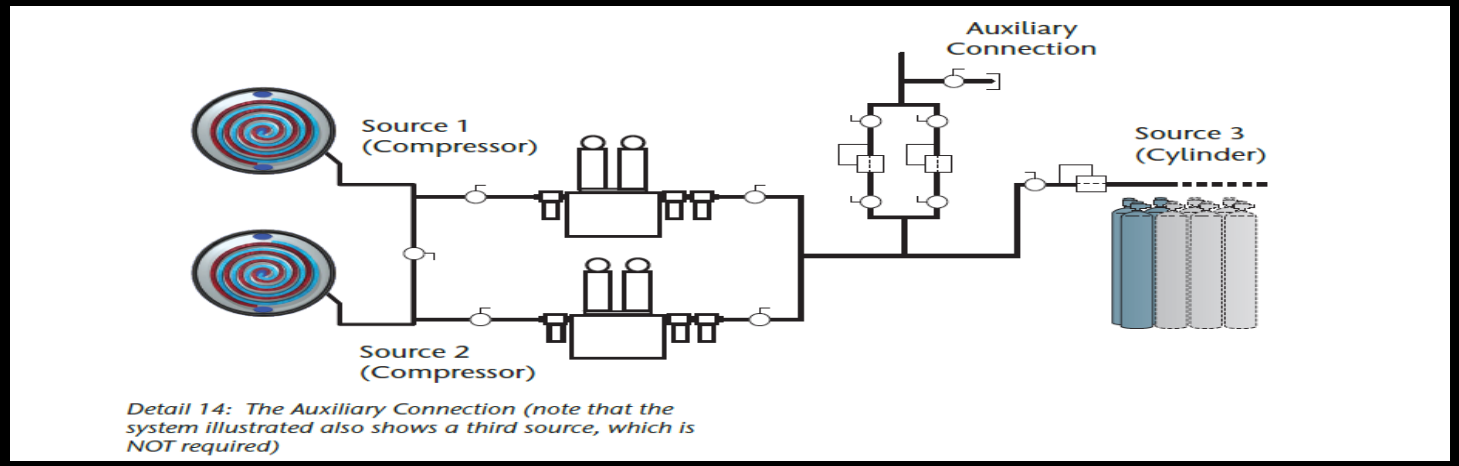
Detail 8
A "remote controls" implementation under 5.1.3.4

Chapter 5: Auxiliary Line Connections

2015 - 5.1.3.5.7 Auxiliary Source Connection. All source systems shall be provided with an auxiliary source connection point of the same size as the main line, which shall be located immediately on the patient side of the source valve.

2018 - 5.1.3.5.7 Auxiliary Source Connection. Only for Cryogenic fluid central supply systems ***(Personal Opinion – all source equipment should have an auxiliary connection)***

- **5.1.3.5.7.1** The connection shall consist of a tee, a valve, and a removable plug or cap.
- **5.1.3.5.7.2** The auxiliary source connection valve shall be normally closed and secured.



Detail 14: The Auxiliary Connection (note that the system illustrated also shows a third source, which is NOT required)

Chapter 5: System Inspection

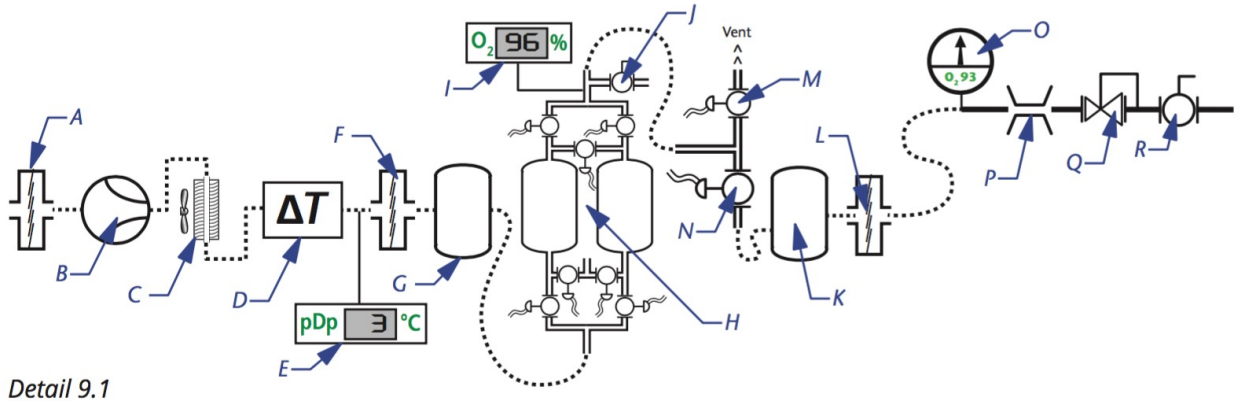
5.1.14.2.3.1 Inspection & Testing Operations

REMINDER

- 5.1.6.1 (5) Flow test is required (by manufacturer)
- 5.1.6.2 Changes provide clarity on the specific testing requirements of pressure loss
- 5.1.6.5 Manufacturer must certify hose burst pressure
- 5.1.6.9 Hoses must be thouroughly labeled & dated
  - Helps maintenance people know when maintenance or replacement is needed
- Installer/Manufacturer should provide this documentation for verifier

Chapter 5: Oxygen Concentrator Supply Units (5.1.3.5.11)

- Valved sample port and vent (to outside) are required
- "Outlet" valve to isolate all components from the pipeline required to be both manual and automatic
  - Manual to isolate source if needed for maintenance
  - Automatic if oxygen concentration drops too low (contaminated sieve bed)

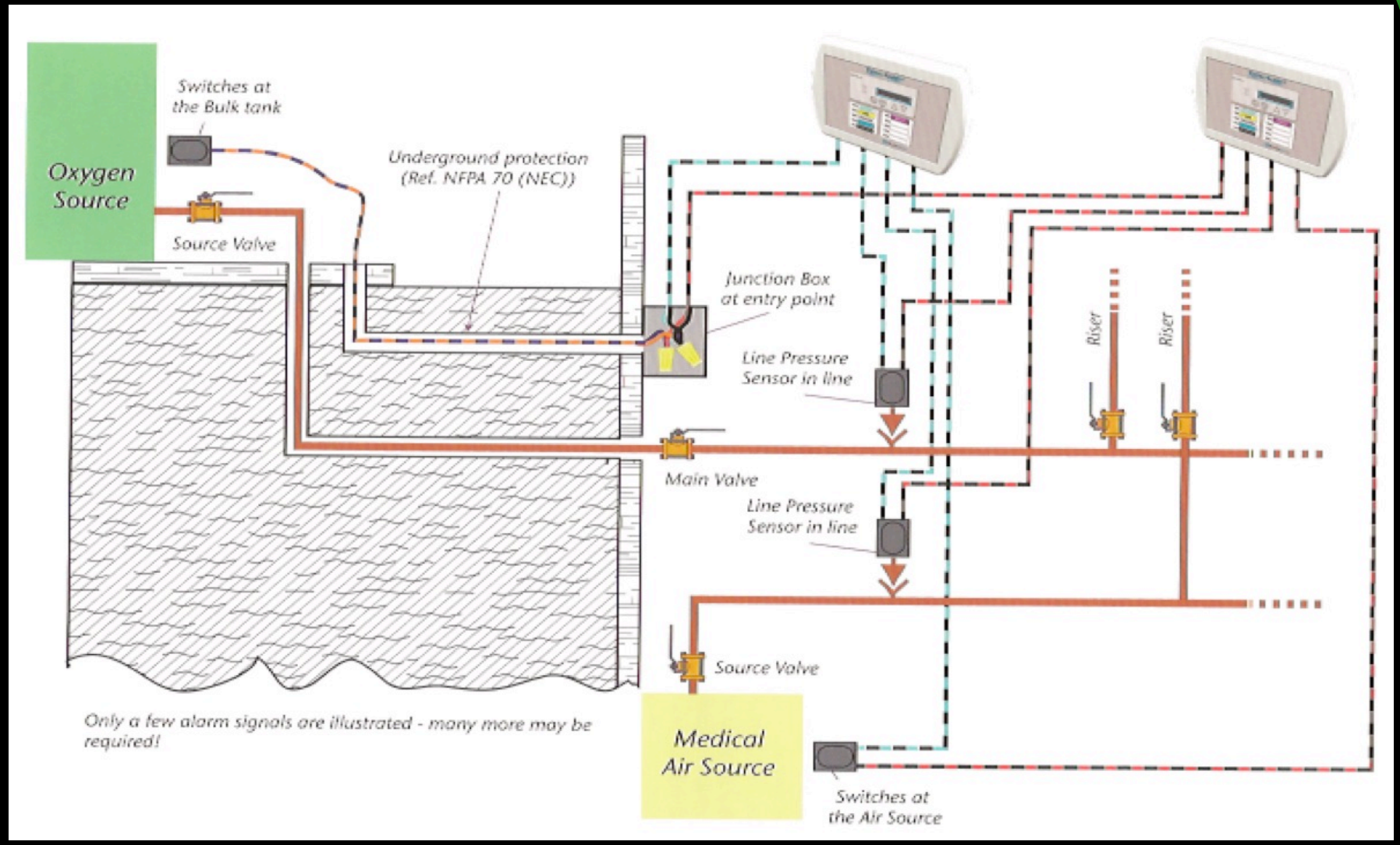


Detail 9.1
Elements of a Typical Pressure Swing Absorber supply source
(Note: only elements with citations are required by NFPA 99. Other arrangements are possible)
(A) Concentrator Inlet filter 5.1.3.5.11.6; (B) Air Compressor; (C) Compressor aftercooler; (D) Dryer; (E) Dew point monitor; (F) Filter; (G) Receiver; (H) Concentrator; (I) Oxygen concentration monitor 5.1.3.5.11.13; (J) Sampling port 5.1.3.5.11.9; (K) Oxygen vessel; (L) Final filter 5.1.3.5.11.10; (M) Purge valve 5.1.3.5.11.8; (N) Automatic valve 5.1.3.5.11.12 and 5.1.3.9.2 (4); (O) Pressure Gauge; (P) Control orifice; (Q) Pressure regulator or check valve 5.1.3.5.11.11 and 5.1.3.9.2 (4); (R) Supply source isolation valve 5.1.3.5.11.12.

Chapter 5: Oxygen Concentrator Supply Units (5.1.3.5.11)

Normal air is about 21% oxygen and 79% nitrogen

- Molecular sieve removes the nitrogen
- A vent, blower, or pump is used to remove the nitrogen and recycle the sieve.
- Sieve bed also removes particulates/contaminants
  - Filter required downstream, to remove stray particulate
  - Intake air requirements not as stringent as medical air



5.1.9.2.3.6
Underground master alarm wiring single set of wires is permitted, in regard to emerging technologies and otherwise.

Summary of 2021 Changes

- 5.1.3.10 Cryogenic Fluid Central Supply Systems
  - ➢ Multiple Changes
- 5.1.10.2.3.2 Labelling for both Vacuum and WAGD
- 5.1.11 Labelling, Identification and Operating Pressure
  - ➢ Multiple Changes
- 5.1.13 Category 1 Medical Support Gas
  - ➢ Multiple Changes
- 5.1.14 Category 1 Operations and Management
  - ➢ Very Important - Multiple Changes

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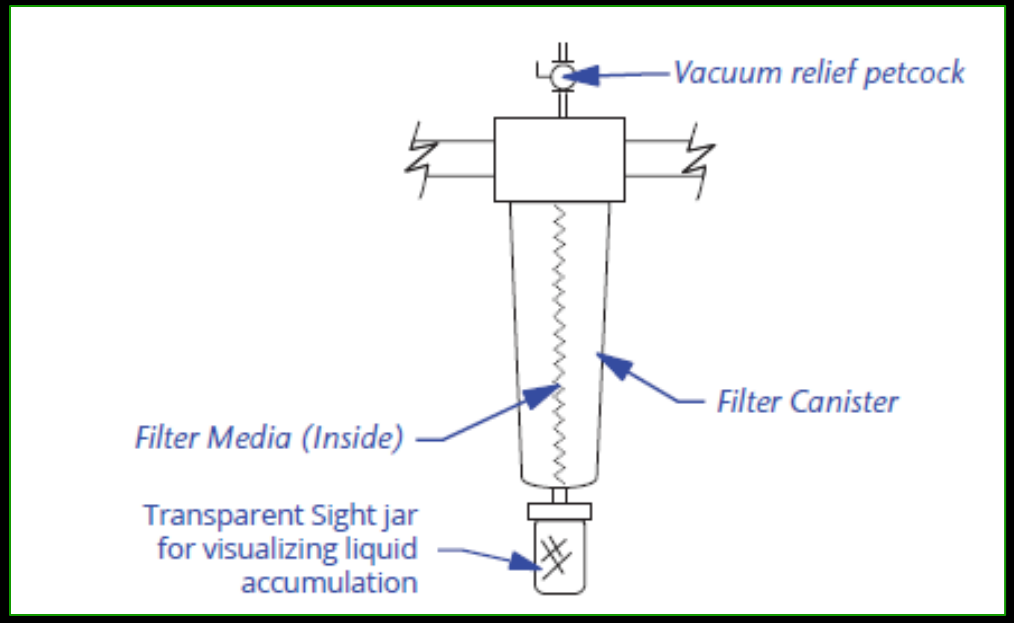
Chapter 5: Vacuum Filtration 5.1.3.7.4 (1-10)

- Vacuum filtration is required at system source
- Filters efficient to HEPA
- Sight Glass adequate to see any contaminants



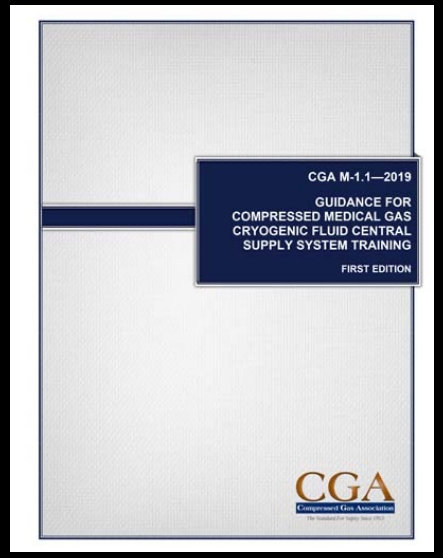
Chapter 5: Downward Facing Outlets/Inlet 5.1.5.17

To avoid inadvertent, disconnect of downward facing hoses or other high stress applications (i.e., ceiling outlet), DISS outlets will now be required.

Chapter 5: Bulk System Verification (5.1.12.4.1.4)

- **Reminder: All "bulk systems" are now called "cryogenic fluid central supply systems"**

- **Testing / verification of these systems requires an *ASSE 6035 Bulk Medical Gas Systems Verifier* certification, in accordance with CGA M-1 requirements.**



Chapter 5: Qualifications and Permit to Work Systems

5.1.14.1 – 2.2

New - 2021

5.1.14.1 ***General*** - The Responsible Facility Authority (RFA) shall have primary responsibilities for the implementation of medical gas and vacuum systems including WAGD and support gas.

(1) Advising on section 1.3 and risk assessments in accordance with 4.2 and interpretations of sections 5.1 through 5.3 as applied to facility.
(2) Writing and upkeep of portions of the healthcare facility emergency plan effecting piped medical gas and vacuum systems' quality, quantity and continuity of supply.
(3) Ensuring emergency plan specifically addresses unusual or exceptional requirements for patient and staff safety arising from elements of design and construction of the building.
(4) Developing and enforcing permit to work rules pertaining to medical gas and vacuum systems during repair, modification and construction.
(5) Review and acceptance of test results in accordance with 5.1.12.
(6) Maintenance of facility records on piped med gas vacuum systems, installation and operations.

Chapter 5: Qualifications and Permit to Work Systems

5.1.14 (.1 – 2.2)

New

5.1.14.1.3 Qualifications

5.1.14.1.3.1 The person(s) designated as the Responsible Facility Authority (RFA) shall be qualified to interpret, implement and advise on this code.

5.1.14.1.3.2 Appropriate qualifications shall be demonstrated by any of the following: completion of an educational program acceptable to the hospital's governing body, ASSE 6010, ASSE 6020, ASSE 6030 or ASSE 6040.

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Certification Requirements (5.1.14.2.2.5) Qualifications

- A technician's training must be "documented" but the requirement to be "certified" has been removed.

- Competence on ALL facility equipment is required to obtain certification.

Chapter 5: Qualifications and Permit to Work Systems

5.1.14.1.3 – 5.1.14.2 (continued)

5.1.14.2 Permit to Work Systems

5.11.14.2.1 The RFA plan shall include process to include at least all of the following:

1. The effected clinical staff and administration is communicated with prior to work on piped medical gas and vacuum systems
2. Alternate supply or adjustments are in place
3. All work performed by competent and credentialed individual
4. Procedures of shutdown and restoration are communicated to all involved in working on or with the systems
5. Safety procedures are in place and observed
6. Code observed in execution of maintenance repair and construction
7. Effected portions of systems tested in accordance with code and demonstrate acceptability for patient use

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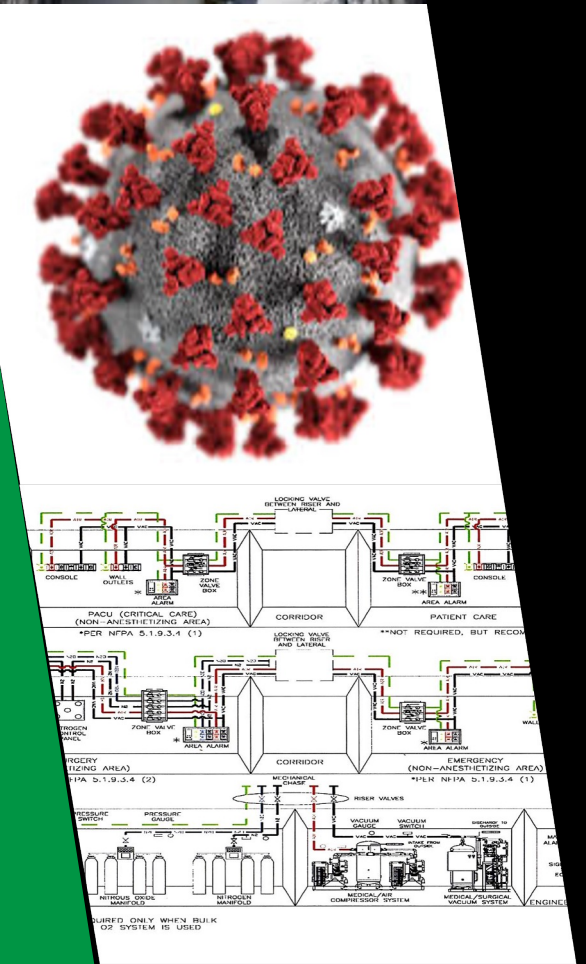
Summary

COVID Affects on Medical Gas

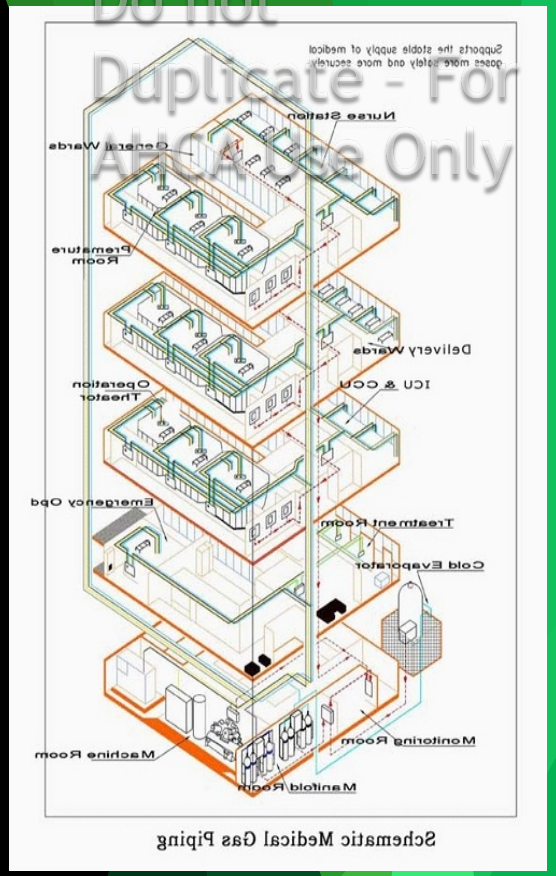


Look for…

- Patient Safety and Clinical Support Ventilator or Oxygen Therapy uses
- Bulk System Icing
- Pipe sizes feeding COVID locations (ZVB) provides estimates for Flow and Pressure to Different Areas of the Building
- Facility Memory (location of medical gas components)
- Updated Drawings and Labelling (Service Valves, etc.)
- Risk Assessments (What Risks will there be)
- Medical gas storage and air exchanges for those locations
- ?

KNOWING YOUR FACILITY

Pandemic Response:
What We Learned from Medical Gas Overuse

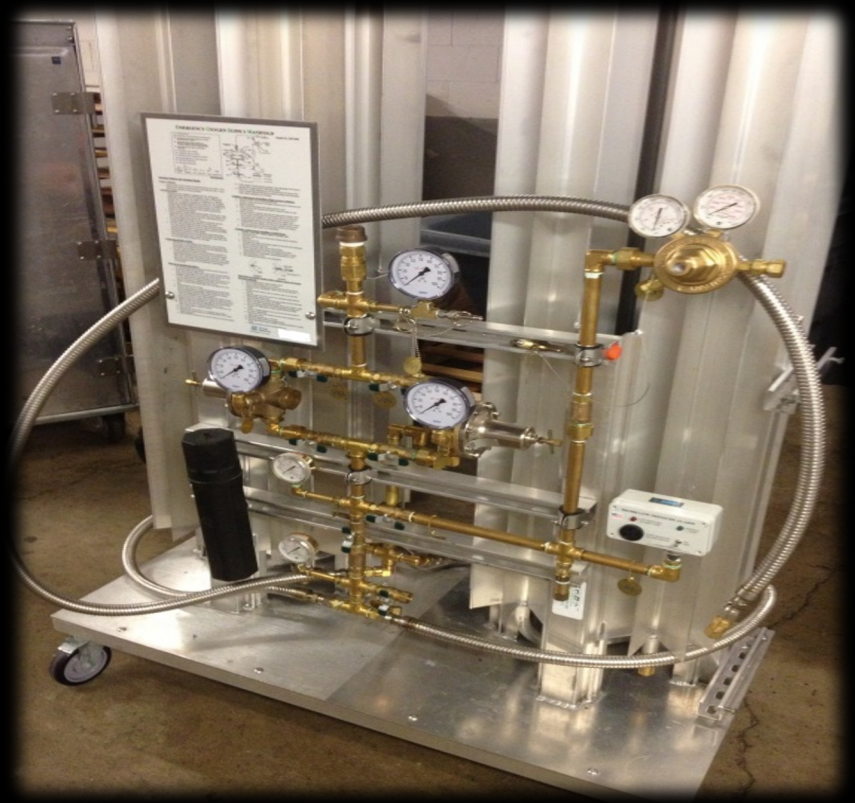


Schematic Medical Gas Piping

- **Medical Gas System Capabilities**
- **Ventilator Usage**
- **Infrastructure (Can it Handle It)**
- **How your bulk supply handles the usage**
- **Obsolescence of Systems**
- **New Facility Design**
- **Identifying Future Needs**
- **Utilize your Industry Experts**
- **Consider current or future codes for design of new systems**

Example: If You Have a 500 Bed Facility,
Can you Use 500 Vents or More?

Alternative Oxygen Supply



Emergency
Oxygen
Supply
Manifolds

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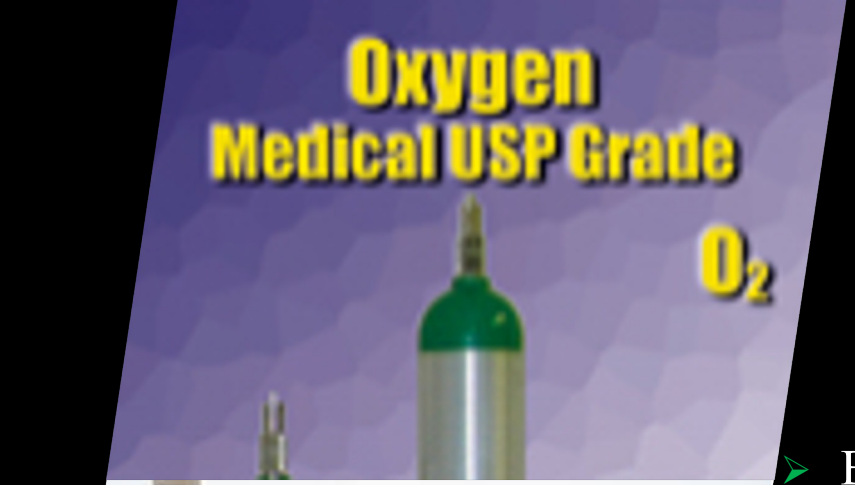

What are Typical Solutions?

- Bring cylinders to patients or transport multiple tanks with headers/regulators/carts for back feeding.

  (Always keeping safety in mind when transporting)

- Call the Bulk Supplier to bring an Oxygen Trailer/Truck with Vaporizers to site. Make sure area is cleared for truck (How long will that take and other contingencies?).

- Communicate with your Medical Gas Company & Suppliers to acquire enough rental supplies, cylinders/headers regulator/hoses, on hand for catastrophes.
- Or just a thought, utilizing resources within network and other local facilities.

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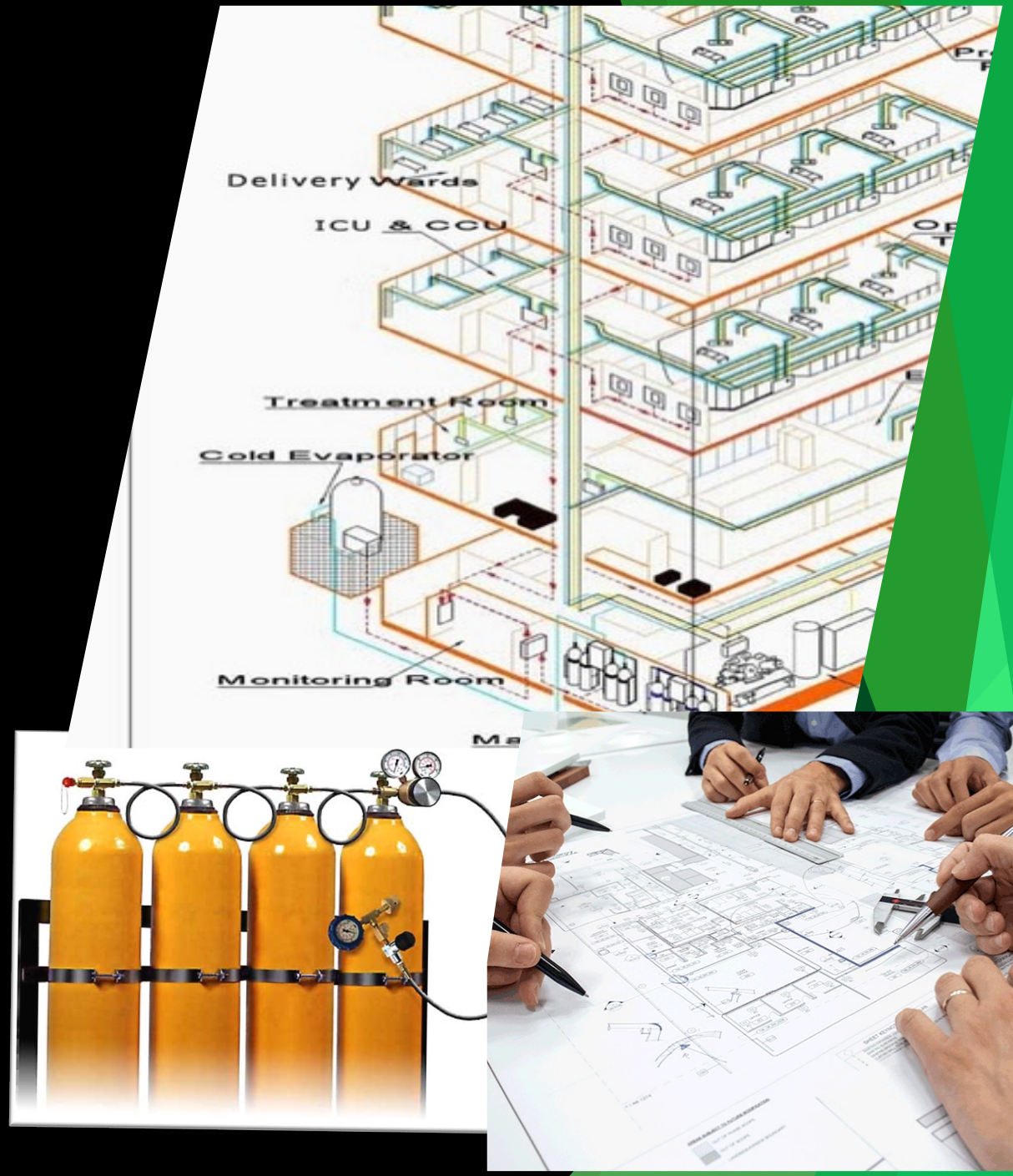
Forward thinking Designing Medical gases for the future



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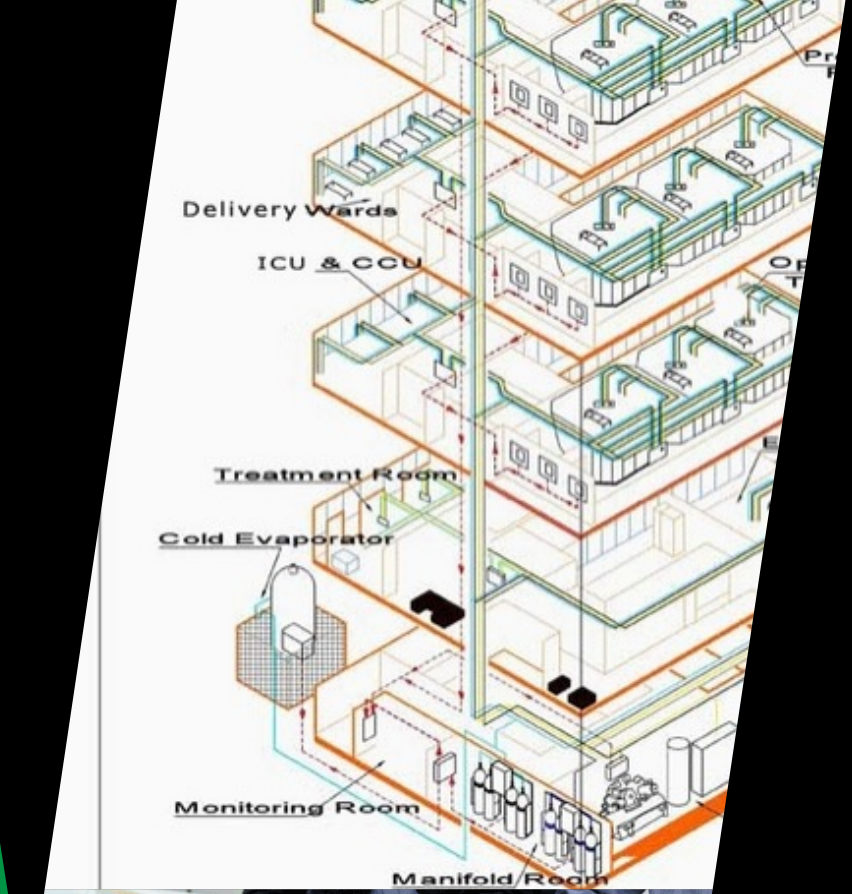

Future Design Specifications for Medical Gasses

- New and existing building renovations
- Engineers, architects, get them involved early
- Support staff or third-party medical gas experts involved
- Pipe sizing for specific areas for pandemic preparedness
- Labelling to current pipeline accuracy
- Documentation and drawing reviews for “as- builts” on any new renovations
- Alleviate stress to infrastructure of the medical gas systems
- Pipe Size Evaluations are important

  (size to 1.5 capacity?)
- Source auxiliary connections throughout facility

Knowing and Utilizing Inventories & PM's Will help with your Risk Assessment and Emergency Preparedness Program.

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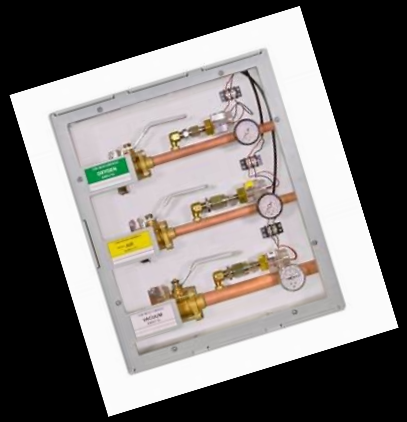
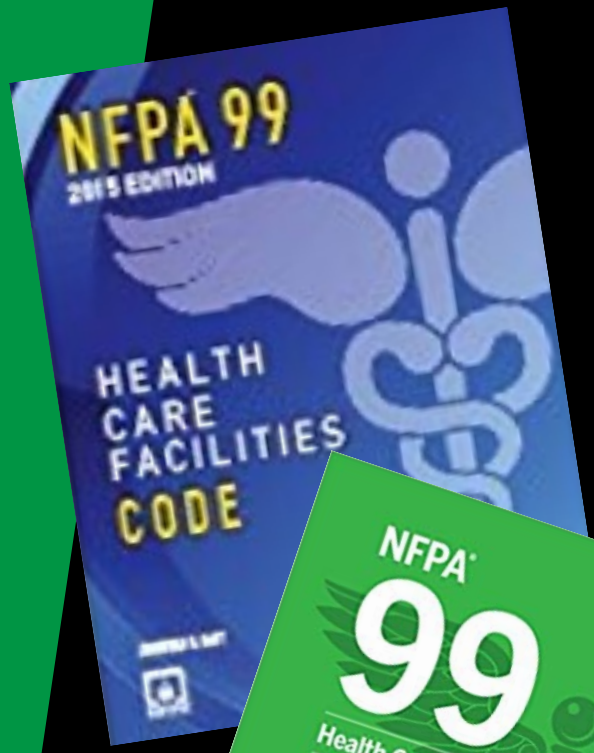
Maintenance Programs

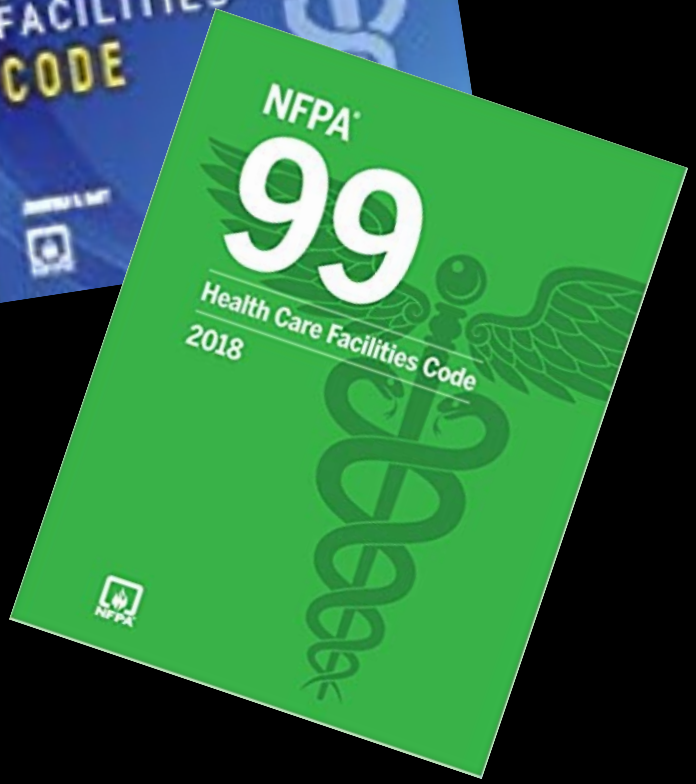
- 5.1.14.2.2.1 **Inventories**
- 5.1.14.2.2.2 **Inspection Schedules (PM's)**
- 5.1.14.2.2.3 **Inspection Procedures (Risk Assessment)**
- 5.1.14.2.2.2 **Maintenance Schedules**

Organizational Facility Memory Documented



Medical Gas Utilities Management: NFPA 99 Changes





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NFPA 99 2018: Summary of Changes

Chapter 3 - Definitions
- ❑ Defining & Clarifying Terms

Chapter 4 - Fundamentals
- ❑ Fundamentals of Risk Assessment

Chapter 5 – Gas & Vacuum Systems
- ❑ Outdoor/indoor locations for central supply
- ❑ Storage of Medical Gas Cylinders
- ❑ Controls for Line Pressure
- ❑ Auxiliary Source Connection
- ❑ Oxygen Concentrator Supply Units
- ❑ Cryogenic Fluid Central Supply Systems
- ❑ Operating, Area and Local Alarms and Signals
- ❑ Vacuum Filtration
- ❑ Manufactured Assemblies/ Corrugated Medical Tubing
- ❑ System Inspection
- ❑ Source Equipment Labelling
- ❑ Bulk System Verification

Chapter 11 – Gas Equipment
- ❑ Performance and maintenance of gas equipment in ***new and existing*** healthcare facilities
- ❑ Cylinder Storage and Protection

Chapter 12 – Emergency Management
- ❑ Pandemic/ COVID Response

Chapter 15 - Dental Gas and Vacuum Systems
- ❑ Removed from chapter 5 and moved to its own chapter

Summary of 2021 Changes

- 5.1.3.10 Cryogenic Fluid Central Supply Systems
  - ➢ Multiple Changes
- 5.1.10.2.3.2 Labelling for both Vacuum and WAGD
- 5.1.11 Labelling, Identification and Operating Pressure
  - ➢ Multiple Changes
- 5.1.13 Category 1 Medical Support Gas
  - ➢ Multiple Changes
- 5.1.14 Category 1 Operations and Management
  - ➢ Very Important - Multiple Changes

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NFPA 99 2021

Qualifications and Permit to Work Systems

THANK YOU SO MUCH FOR YOUR TIME!!!

Please contact our office for additional information.

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