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Impact of COVID-19 on Medical Gas Systems

Presented by The Medical Gas Professional Healthcare Organization

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Bulk Oxygen Concerns: What to watch for?

- The vaporizers – monitor for excess ice buildup.
- The liquid level gauges
- The pressure gauges
- Any signs of leakage or unusual icing
- At least once a day, if conditions call for it more frequently

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Bulk Oxygen Concerns: Vaporizer Ice Buildup

Normal Ice Buildup

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Bulk Oxygen Concerns: Vaporizer Ice Buildup

50% Ice Buildup (Contact Bulk Oxygen Supplier)

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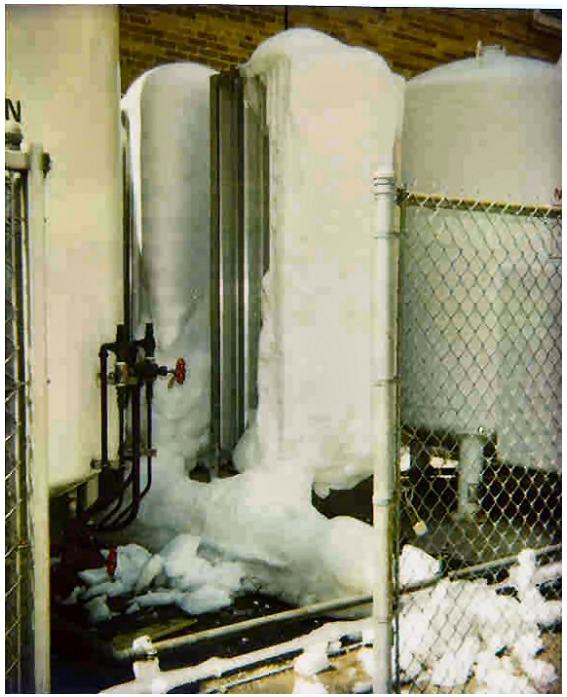

Bulk Oxygen Concerns: Vaporizer Ice Buildup

Above 50% Ice Buildup (Contact Bulk Oxygen Supplier)

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Bulk Oxygen Concerns: Watch for icing in unusual locations

- Inspecting the pressure build vaporizer should be done during the daily system inspection. If the ice on the Pressure Building coil has grown to the point where it is touching the ground, tank shell or any other component it needs to be deiced.

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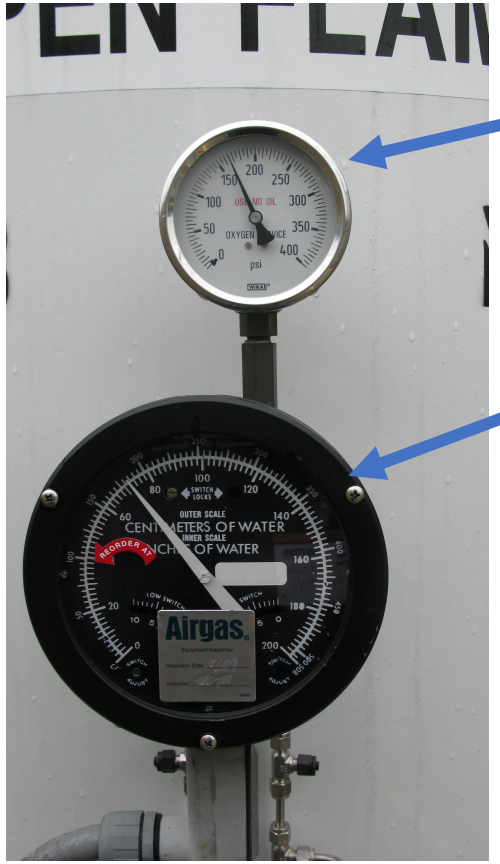
Bulk Oxygen Concerns:
Liquid Level & Tank Pressure Gauges

Daily Rounding Checklist Items # 1 & 2

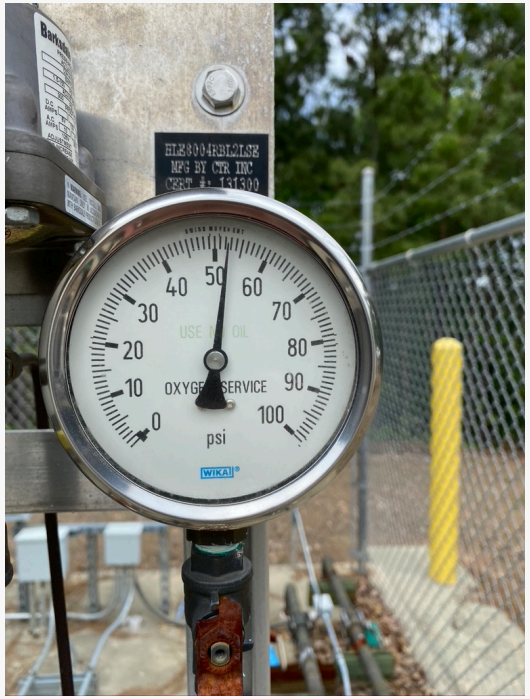


Tank Pressure Gauge

Liquid Level Gauge

Bulk Oxygen Concerns: Final Line Pressure Gauge

- Log pressure daily
- If any downward trend is noticed, then proceed with planned mitigation steps
- Do not raise line pressure if gauge and/or regulator shows signs of freezing / ice buildup



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Bulk Oxygen Concerns: Leakage

Fill Circuit

Relief Valve (icing around relief)

Liquid level gauge lines frosting

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Bulk Oxygen Deicing Procedure for Vaporizer

NOTES:

1. ICE REMOVAL MECHANISM CAN BE BY WATER PRESSURE SPRAY, STEAM OR HEATED AIR.
2. GENERALLY IT IS RECOMMENDED TO REMOVE ICE WHEN CRYOGEN CAN BE SHUT OFF OR SLOWED. ALSO, IT IS RECOMMENDED TO REMOVE FROM TOP ZONE FIRST, THEN DOWNWARD.
3. MANUAL ISOLATION VALVE SHOULD BE LOCATED OUTSIDE OF POSSIBLE ICE BALL THAT IS FORMED AT BOTTOM OF UNIT.
4. A VERTICAL 180° LOOP @ 1–2m HEIGHT, JUST UPSTREAM OF LIQUID VALVE IS ALSO RECOMMENDED.
5. PLINTHS HEIGHT FOR VAPORIZER INSTALLATION SHOULD FOLLOW RECOMMENDED GUIDELINES.
6. IT IS RECOMMENDED FOR CUSTOMER LIQUID PIPING TO RISE IN ELAVATION FROM CUSTOMER TANK TO VAPORIZER LIQUID INLET CONNECTION.

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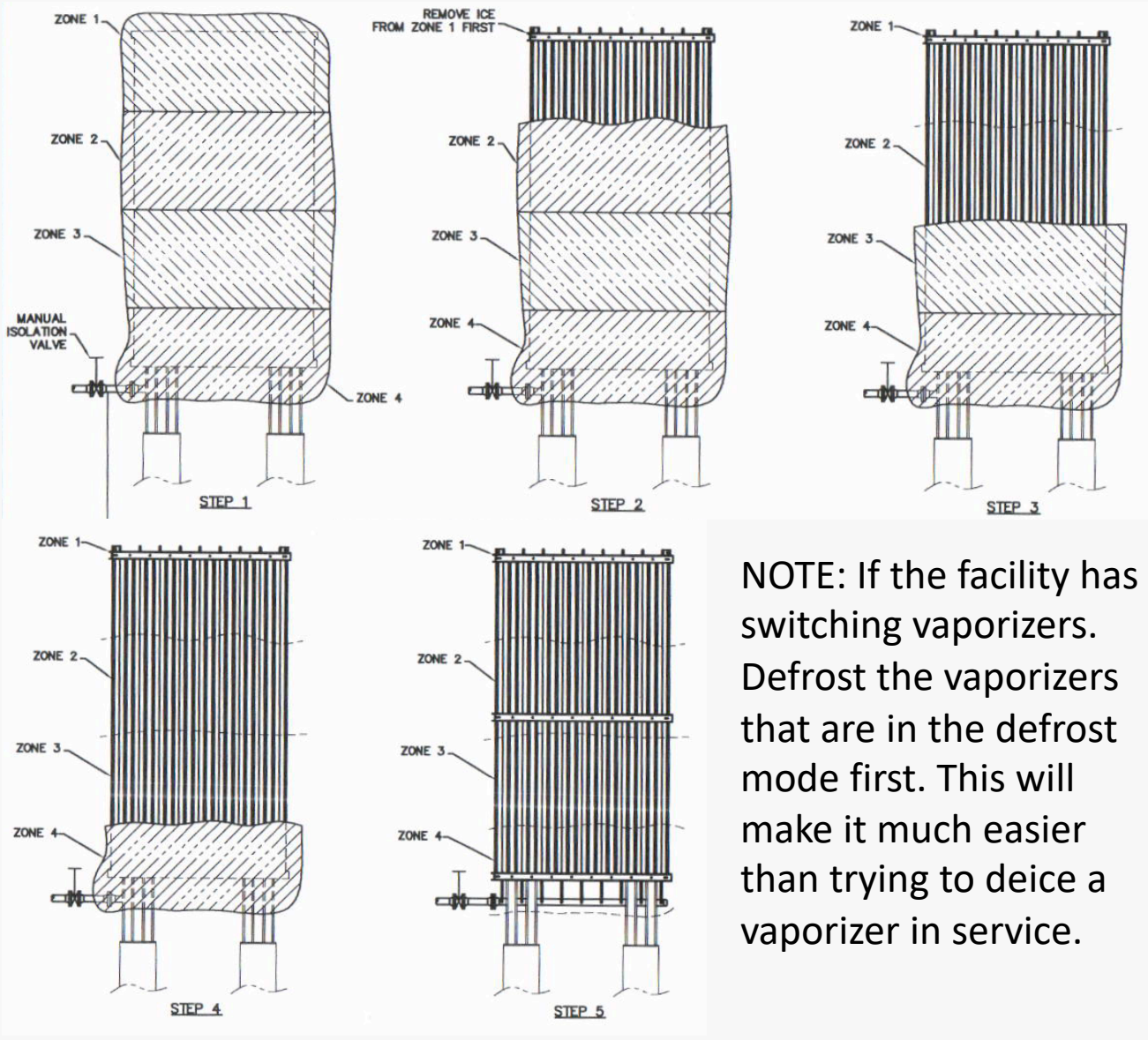
Deicing Procedure



NOTE: If the facility has switching vaporizers. Defrost the vaporizers that are in the defrost mode first. This will make it much easier than trying to deice a vaporizer in service.

Bulk Oxygen Concerns: Mitigating Low Line Pressure

- Leaving both Final Line Regulators Open
- Raising Final Line Regulator Pressure
- Increase air circulation around vaporizers (e.g. fans, etc)

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Bulk Oxygen Mitigating Low Line Pressure: Procedure for Raising Final Line Pressure

<u>NOTE 1: this adjustment procedure is only to use if the supplier isn't available</u>

1. Adjust one regulator with the other valved off
2. Set both regulators to the same pressure
3. 1/4 turn clockwise every 5 min (1-2 psi change)
4. Don't exceed 60 or 65 psi
5. Monitor pressure closely after adjustments

NOTE 2: do not adjust the regulator if there is any sign of frost on the piping leading to the regulator assembly! The diaphragm could be brittle from the low temperature gas and could fail when being adjusted.

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How many ventilators can I install within my facility?

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Breakdown the request:

What specific zone(s) or area(s) will these ventilators be placed into?	Does the facility know how many ventilators they have access to?	What are the specs of the ventilators that will be in use?

Get as much help as possible from RT department at the facility:

What have they seen as the max “constant” inspiratory flow rates?	What has the % O2 setting been on the patients with these max flow rates?	What have been the average breaths per minutes of these patients?

Ask if there are as-built drawings available for review of the piping system that will be serving the zone(s) or area(s) where the additional ventilator load will be going.

How many ventilators can I install within my facility?

Other resources

- Beacon Medaes MedGas Insights Issue 8
- Kaiser Permanente Document
- PB 840 Ventilator Calculator
- Run actual flow tests in zone(s) where additional ventilators are expected to be put into use

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How many ventilators can be supplied from a 1/2” medical air and oxygen zone valve?

- Dependent on the overall piping system as well as source equipment
- One document lists 212 LPM
- Another document lists 260 LPM
- Actual flow tests can show you a snapshot

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½” oxygen zone valve flow test

Zone serves an 8 bed unit on the 5th floor

Zone is served by a 1” service line

Procedure:

- Connected a flow meter in all 8 rooms
- Set flow to 110-120 LPM on each flow meter
- Total CONTINUOUS flow in zone approximately 880-960 LPM
- Starting pressure – 49.5 PSIG
- Pressure drop in zone to 41-42 PSIG
- Pressure drop in adjacent zone to 44 PSIG
- Length of test was approximately 12 minutes

Other Respiratory Devices to consider

Detail 2.1 below from Beacon Medaes *MedGas Insights* Issue 8a April 2020

Detail 2.1 Estimates for Gas Consumption by device (usually one per patient)				
Therapy Device	*Total gas*	*FiO_2*	*O_2 Consumption*	*Medical Air Consumption*
Masks / standard nasal cannula	8 *l*pm	30%	0.9	7.1
Reservoir masks and venturi masks	15 *l*pm	30 -50%	1.7 - 5.5	13.3 - 9.4
Standard invasive ventilation (e.g. ICU vents) (except oscillating vents)	12 *l*pm	50%	4.4	7.6
Noninvasive high flow (e.g. HFNC)	50 *l*pm	60%	24.7	25.3
High frequency oscillating ventilators	80 *l*pm	50%	50.6	29.4
Noninvasive other devices	120 *l*pm	60%	59.3	60.7

How much flow of medical air and oxygen does a ventilator use?

Detail 2.2 below from Beacon Medaes *MedGas Insights* Issue 8a April 2020

Detail 2.2 Medical air to Oxygen Ratio	
FiO_2	*Air*
20.9	∞
30	7.7
40	3.2
50	1.7
60	1
70	0.62
80	.35
90	.15
100	0

Example Table: 45 LPM total flow

Oxygen LPM	Med Air LPM
0	45
5.2	39.8
10.7	34.3
16.7	28.3
22.5	22.5
27.8	17.2
33.3	11.7
39.1	5.9
45	0

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Do all ventilators use both medical air and oxygen?

- No, all “ventilators” do not use oxygen & medical air. For this reason it is very important to get a complete list of the respiratory equipment that facilities will be using to combat a surge in COVID-19 patients
- Try to learn what other treatment options, other than ventilators, that respiratory might be using to treat patients

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Ventilator Stats

Oxygen Only	Oxygen & Med Air
Philips Respironics BiPAP V60 • Max Flow 175 LPM • Low 40, High 87	GE Carescape R860 • Max Flow 160 LPM • Low 35, High 94
Respironics Esprit • Max Flow 300 LPM • Low 40, High 90	Carefusion Avea • Low 20, High 80
Allied Healthcare AutoVent 3000 • Flow listed between 16-48 LPM • Low 40, High 60	Carefusion LTV1200 • Low 40, High 80
Allied Healthcare EPV200 • Spec says an oxygen D cylinder will last 65 minutes • Low 40, High 87	Tecme Advance • Low 41, High 87
Respironics Vision BiPAP • Max Flow 120 LPM • Low 50, High 100	Drager Evita XL • Max flow 120 LPM • Low 39, High 87
Trilogy Ventilator • Max Flow 200 LPM • Low 40, High 87	Maquet Servo I • Low 29, High 94
Newport HT70 Transport Ventilator • Max Flow 100 LPM • Low 35, High 90	PB 840 • Flow to 200 LPM • Low 35, High 100

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How many ventilators can my existing medical air compressor supply?

Factors to consider:

- Age and condition of system
- Refer to manufacturer of systems for capacities
- Use the following formula to help calculate air consumption in SCFM (note: ensure the dryers are not purging and no timed auto drains activate while gathering data)

$$\frac{.55 \times \text{Size of Receiver (in gallons)} \times \Delta P \text{ (difference in the lead unit on / off setting)}}{\text{Run time of compressor from start to stop}}$$

EXAMPLE (note: variables listed in **blue**):

- Receiver Size – **120 Gallon**
- Lead unit on setting – **80 PSIG**
- Lead unit off setting – **100 PSIG**
- Run time of compressor to go from 80 to 100 PSIG – **75 seconds**

$$\frac{.55 \times 120 \times 20}{75} = 17.6 \text{ SCFM}$$

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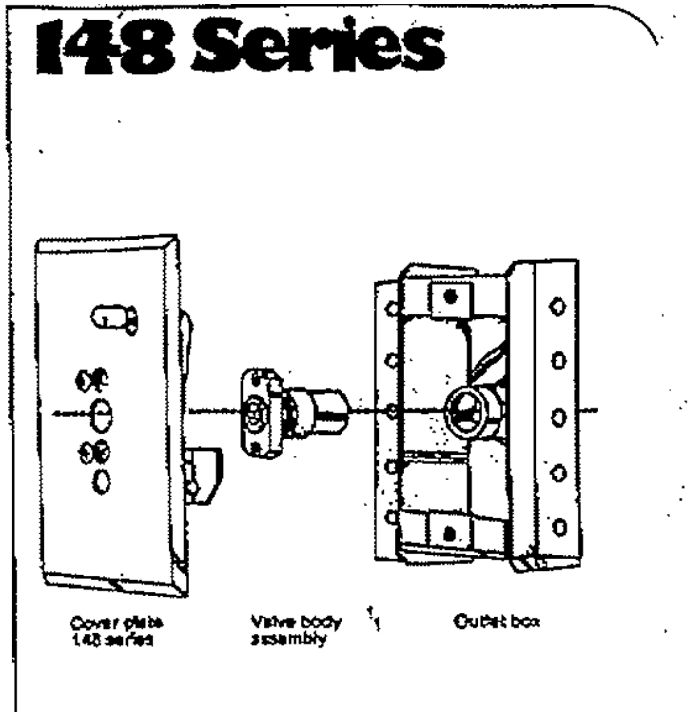
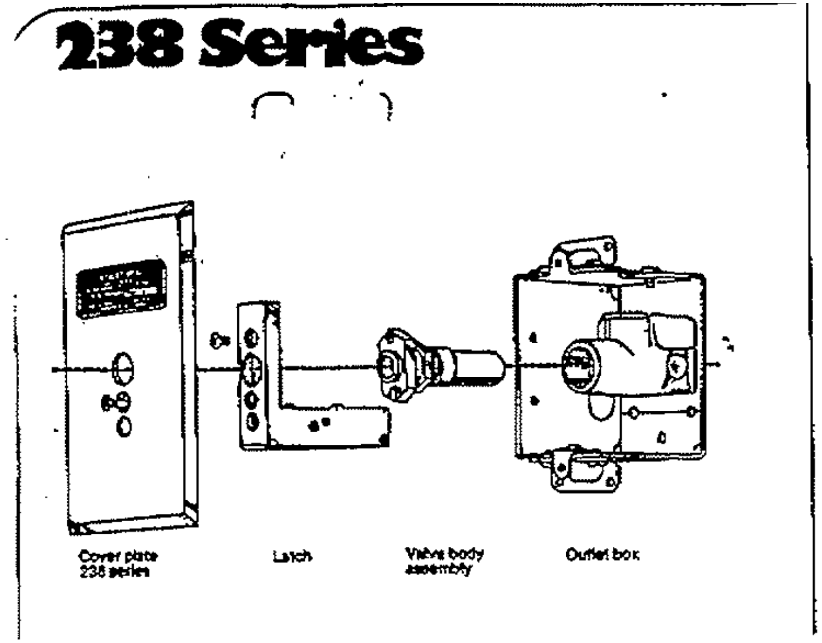
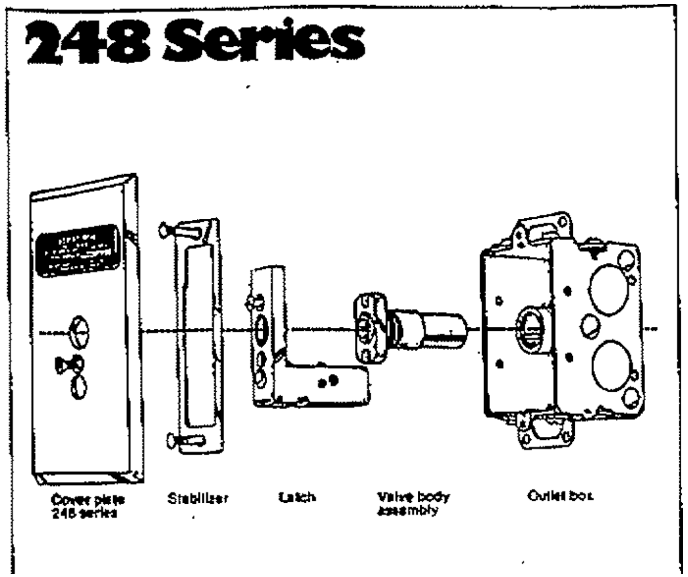
Ventilators going into alarm when connected to older outlets

- Chemetron, NCG:
  - Series # 146, 148, 236, 238, 246, 248







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Ventilators going into alarm when connected to older outlets

- Ohmeda, Ohio Medical:
  - Series # Diamond 1.

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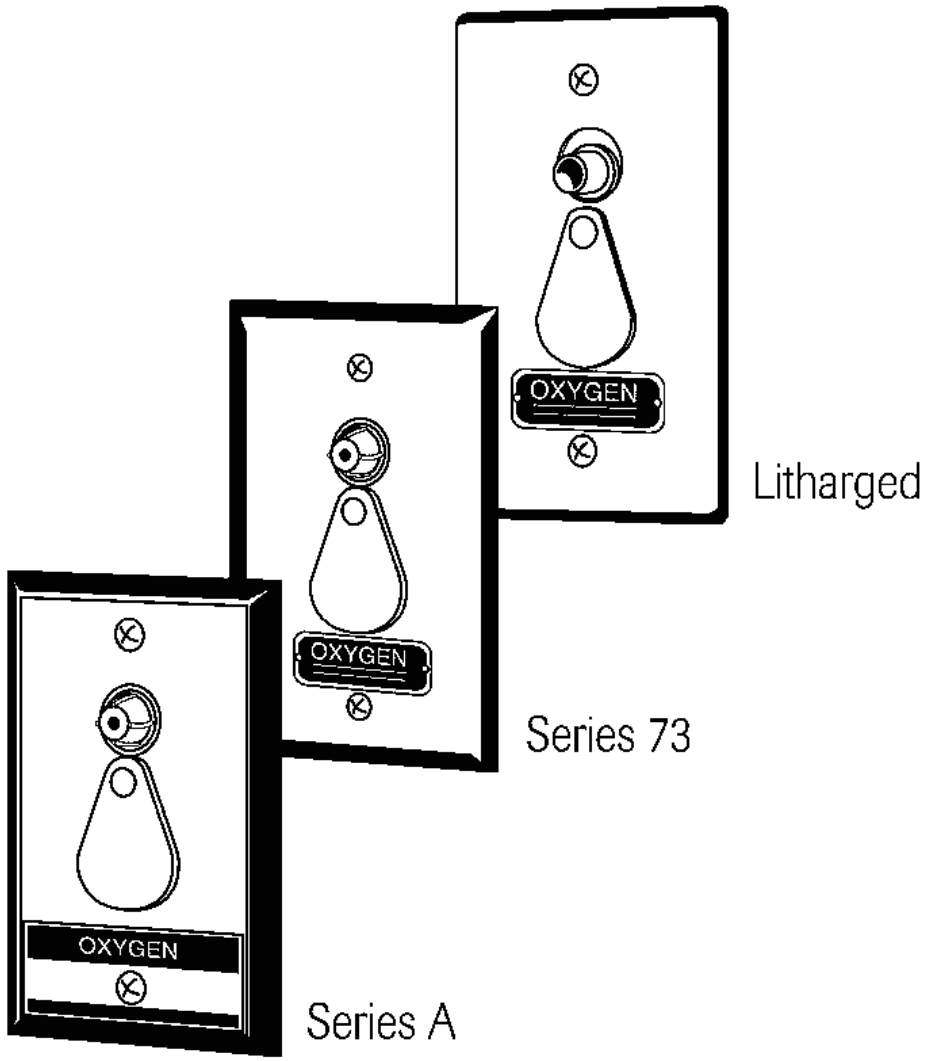
Ventilators going into alarm when connected to older outlets

- Puritan-Bennett:
  - Series # Series A, Series 73, & Litharged



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So what about annual medical gas testing requirements?

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Up to the facility

Up to company – health & safety of employees

CMS Waiver 1135 found here - https://www.cms.gov/Medicare/Provider-Enrollment-and-Certification/SurveyCertEmergPrep/Downloads/1135-Waivers-At-A-Glance.pdf

What can we do to ensure our medical gas systems can accommodate the increase in ventilator patients?

There are a few ways that the capacity of medical gas systems can be increased or supplemented to deal with the additional ventilator usage required by patients with Covid-19.

These can be broken into (4) categories:

- Increase existing system capacity
- Supplement existing systems to deal with a surge in usage
- Back feed areas of the hospital as needed to accommodate overconsumption
- Install separate supply systems for temporary surge areas

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The Impact on the Increase in Ventilator Usage on the Existing Medical Gas Systems

There has been much discussion on the increased use of oxygen due to the use of ventilators to treat patients with the Covid-19 virus. It has been reported that these infected patients on ventilators have been using 80-100% oxygen due to the nature of the virus affecting the respiratory system. So, the oxygen systems are the primary focus of the information provided, but medical air may also become a concern as patients are weened off ventilators, which would increase the demand for medical air. Therefore, we have addressed medical air as well.

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Increasing the Capacity of Our Existing OXYGEN System

There are a few ways to increase capacity on the oxygen system. They include:

- Increasing the system operating pressure. Typically, oxygen systems operate at about 50 psig with an alarm set point of 60 psig. This pressure and alarm set point can be increased up to 60 psig to help with increased demand on the oxygen system.
  - Increasing the operating pressure should only be done on a temporary basis.
  - The increase in pressure may lead to an increase in the icing of vaporizers. These should be monitored closely.

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Increasing the Capacity of Our Existing OXYGEN System

There are a few ways to increase capacity on the oxygen system. They include:

- Installing a supplemental temporary supply system to add additional capacity to the oxygen system. This can be connected to the Emergency Oxygen Supply Connection (EOSC) or the Auxiliary Source Connection at the Bulk Oxygen Tank Pad.
- Another option for temporary supply is using the hyperbaric oxygen supply system (if separate from the main supply system). This can be connected to the Auxiliary Source Connection using flexible connectors on the bulk oxygen pad.

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Increasing the Capacity of Our Existing MEDICAL AIR Systems

There are a few ways to increase capacity on the medical air systems. They include:

- Many facilities have multiple medical air systems. These system can be interconnected via a “bypass” piping. This will allow to two system to work together to help minimize disruptions due to a surge in ventilator use.
- Another option is to allow the “lag” compressor to run as needed. This is typically an alarm condition and would not be acceptable during normal operation. Medical air systems are designed to have a 100% redundant compressor in case one of the primary compressors fails.
    - **NOTE: If this condition is allowed on a temporary basis, the user should be aware the backup/ redundancy may not be realized in the event of a compressor failure.**

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Supplementing the Capacity of Our Existing OXYGEN System

There are a few ways to supplement capacity on the oxygen system. They are similar to some of the ways we can “increase” capacity discussed previously.

- Installing a supplemental temporary supply system to act as a backup/supplement to the oxygen system. This will help prevent large pressure swings that can occur when nearing system capacity. This can be connected to the (EOSC) or the Auxiliary Source Connection (typically located at the bulk oxygen system).
- Another option for temporary supply is using the hyperbaric oxygen supply system (if separate from the main supply system). This can be connected to the Auxiliary Source Connection using flexible connectors.

Back Feeding Areas of the Hospital to Accommodate Overconsumption of the Medical Gas Systems

During planned shutdowns for medical gas systems, we often back feed areas of the hospital to allow for the shutdowns and continue to use the piped medical gas systems and wall outlets. This technique can be used to deal with over consumption as well.

- Back feeding areas includes a separate temporary supply of the medical gas connected to a “zone” or area of the hospital that has been isolated from the primary supply. The temporary supply is used instead of the primary supply, but allows the clinical staff to continue to use the wall outlets like they are used to.
    - Note: These back feeds should be used with a backup supply like the code requires. The back feed procedures can be found in the ASSE 6000 Professional Qualification Standard.

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Installing Temporary Supply Systems to Accommodate Temporary Patient Care Areas

With temporary patient areas being constructed, there has been an increased need of temporary supply systems to serve these “surge” areas. We have seen separate patient tents, converted conference rooms, and repurposing of other areas of the hospital for use during the “surge” to increase capacity.

- Temporary supply systems should be installed when connection to the primary hospital system is not possible. These temporary systems will generally be much different than the traditional medical gas supply systems in the hospital. They may not have the same redundancies, monitoring, or function of the hospital systems. This needs to be considered if used. These temporary supplies can consist of high pressure cylinders, portable liquid tanks / dewars, oxygen generators, or other portable supply systems.

Note: Installing temporary supply systems can be tricky because there is some concern as to how code / regulatory compliance is considered in the installation and use of these systems. This is addressed in the next few slides.

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Can I use other areas of the hospital for ventilator patients?

Background: There are many areas of the hospital that are not considered critical care areas (Category 1 Spaces – NFPA 99 term). These are areas that would not typically be used to treat critical care patients. However, these areas are now being considered due to the lack of ICU bed spaces. There are a few considerations for temporarily converting these areas for use with critical care patients.

- These areas may not have been designed for use with critical care equipment (i.e. ventilators).
- There are design standards that we follow for design of these systems. The design standards are very different for critical care and noncritical care areas.
- Specifically, those include flow rate calculations (critical care areas have a much higher flow rate design), as well as, design “diversity”, which addresses the expected usage of the system as a percentage of available (again, critical care designed at 100% diversity, whereas patient rooms may only have a 10% diversity).

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Do I need area alarms in zones that will now be used to supply ventilators?

Background: Critical care areas (Category 1 Spaces – NFPA 99 term) are required to be monitored by an alarm system. However, many other noncritical areas are not required to have this monitoring. There are a few considerations for temporarily converting these areas for use with critical care patients.

- If the patient areas being used do not have an area alarm panel, a temporary alarm panel can be installed to monitor the systems while being used for critical care.
- We have also implemented an Interim Life Safety Measure for this purpose as well. The ILSM could include frequent periodic monitoring of the system to ensure it is operating properly during the temporary use.

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Dealing with the Code / Regulatory Requirements During COVID-19

The area alarm discussion in the previous slide leads to a much larger issue regarding compliance. Do these systems and "emergency operations" discussed need to meet the code and/or regulatory requirements?

- The # 1 priority is keeping patients safe and preventing death!
- CMS/Accrediting Organizations (AOs), such as The Joint Commission have "relaxed" many of their requirements for ongoing operations.
- CMS has issued a waiver for some Medicare / Medicaid requirements (Waiver 1135)
- AOs have suspended some of their onsite survey activities.

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Dealing with the Code / Regulatory Requirements During COVID-19

The question is what do I need to worry about regarding the code requirements (Specifically, NFPA 99 Code)

- NFPA 99 has a few statements in the "Application" section of the code that provides for some guidance in dealing with these types of situations. They are as follows:

The health care organization shall ensure that policies are established and maintained that permit the attending physician to satisfy the emergency needs of any patient that supersede the requirements of this code.

Each such special use shall be clearly documented and reviewed to attempt to have future similar needs met within the requirements of this code.

Finally, the Authority Having Jurisdiction shall be permitted to grant exceptions to the code.

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Dealing with the Code / Regulatory Requirements During COVID-19

If the “Responsible Hospital Authority” is acting as the Authority Having Jurisdiction (AHJ), which is often the case during emergency operations, they can grant exceptions to the code. Especially, if the code requirement creates a burden such that it will compromise patient safety during the emergency.

- No code requirement can be “waived” arbitrarily for these emergency operations. The process that I believe should be followed is that every requirement that is being considered as “unnecessary” would need to have that exception to the code approved and documented by the AHJ OR the Responsible Hospital Authority.

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Dealing with the Code / Regulatory Requirements During COVID-19

- This is essentially an exemption from the code requirements in an emergency situation if needed to keep patients safe. There should be a documentation and approval process for any systems that are noncompliant.
- Code experts can play an integral role in this process by identifying requirements that may be burdensome and unnecessary. Then, those items would be addressed by the AHJ per the process above.

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What role are verifiers being asked to play in these makeshift / temporary facilities?

This goes back to the compliance question just addressed.

- Per NFPA 99, in order for systems to be used for patients, whether they are temporary or not, they must be verified / certified for patient use.
- If the Responsible Hospital Authority of AHJ deems this requirement to be unnecessary or overly burdensome, it should be documented.
- The responsibility ultimately remains with the hospital and this is addressed in the NFPA 99 requirements.
- The code states that before systems are initially put into use, the facility authority shall be responsible for ascertaining that the gas/vacuum delivered at the outlet/inlet. Acceptance of the verifier's final report shall be permitted to satisfy this requirement.
- In other words, the hospital accepts responsibility if the system isn't verified according the code requirements.

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Recommendations for Maximizing Medical Gas System Usage

Piping and System Concerns

- Pick areas of the facility that have the largest pipe size available, especially for oxygen and medical air.
- Consider distance from bulk oxygen or medical air source, pick areas nearer to source if possible
- Set main line pressures for oxygen and medical air to 55 PSIG
- Locate EOSC for facility and ensure it is in good working order, connect a cylinder and test the feed line if there is no documentation stating the last time it has been used / tested

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Recommendations for Maximizing Medical Gas System Usage

Ventilator Concerns

- Ask Respiratory if they know
- Beacon Medaes document
- Kaiser Permanente document
- Consider if the ventilator(s) need just oxygen or oxygen and medical air to operate

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Recommendations for Maximizing Medical Gas System Usage

Backup Plans

- What is the plan if the medical air system has a failure?
  - Is there a second system connected via cross mains?
  - Temporary medical air system availability
  - Cylinders (not a great long term option)
- Are there any locations inside the facility that might serve as spaces that supplemental oxygen and / or medical air cylinders could be staged and connected?
- If the EOSC must be utilized what will be connected? Ensure necessary fittings and hoses are available if the need arises to utilize the EOSC

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Recommendations for Maximizing Medical Gas System Usage

Daily rounding tasks

- Status of bulk oxygen vaporizers and other associated equipment, level of ice buildup
- Main line gauge reading at source
- Pressure readings inside zones with heaviest usage
- Medical air compressor check – track the following:
  - How many compressors are running at a time?
  - How long does a compressor run when it comes online?
  - How long does the system rest when no compressors are running?

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STAY SAFE!

We will get through this together!!!

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