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HEALTH FACILITY MEDICAL OXYGEN SYSTEMS
BEST PRACTICES DURING COVID-19 PANDEMIC

Introduction

The following is intended to be used as a guide for use and maintenance of medical oxygen systems used for patient care in California healthcare facilities during COVID-19. The demand on existing oxygen systems is being overtaxed during the pandemic due to the patient population and their specific needs for treatment. This document is intended to provide applicable best practices observed by the Office of Statewide Health Planning and Development (OSHPD).

The types of oxygen systems are similar but do have their differences. Facilities must work with their oxygen supplier/vendors for processes best suited to their equipment and contact them if there are additional questions.

Audience

The intended audience for this guide is hospital facility engineering and maintenance staff but also includes any staff that has decision or authority over the use of the medical oxygen system.

Objectives of this Guide

- Provide for safe and effective manipulation of existing med gas oxygen systems during the pandemic.
- Identifies clear guidelines for Hospital Facility Engineers and Design Engineers to follow when redesigning, maintaining or augmenting their existing systems to accommodate high-flow bulk medical oxygen to the facility.
- Describes best practices and standards for ensuring maintenance and proper use of bulk medical oxygen systems.
- Provides guidance on what has been working as well as what not to do.

What do we mean by Best Practices?

The term best practices, with respect to high-flow oxygen (O_2), refers to strategies that are based on current evidence-based research providing effective and efficient delivery strategies of bulk medical oxygen systems. These best practices will address maintenance and service to ensure maximum oxygen flow of existing systems.

Background

Medical oxygen gas systems in hospitals have typically been designed with diversity factors as listed in the California Plumbing Code, Chapter 13, “Health Care Facilities and Medical Gas and Medical Vacuum Systems”. OSHPD does not adopt this chapter, but it provides some design guidance that many engineers and system designers use. Table 1310.2.1(1) in the chapter lists diversity factors that suggest a system can be designed under the assumption that patient medical spaces will not all require the flow of medical oxygen at all times. For example: Medical facilities with 26 or more outlets have a listed diversity factor of 50%. During a pandemic, where a majority of patient treatment rooms will have patients requiring medical oxygen at the same time, this assumption can be problematic.

Many healthcare providers have established their own diversity factors which are commonly 100% for operating rooms, 50% for ICU's, and 10% to 25% for patient rooms. It should be noted that building code is a minimum and should not be considered a design guide.

As many of the existing systems are used to provide more oxygen than they were designed for, the equipment cannot always keep up with the demand during this pandemic. This results in evaporators and connected piping forming a large covering of ice, system pressures dropping, etc. The conversion of liquid oxygen to gas phase is endothermic and evaporators need to be sized to evaporate the total required oxygen flow. If they are not sized sufficiently, large amounts of ice develop on the outside and heat transfer is reduced. The evaporators are typically the weakest link in the chain of system components. The size of the gas transfer piping is probably often the second weakest link as it was often designed with the referenced diversity factors, resulting in excessive pressure loss in the flow of the medical gas from source to the patient.

It should also be noted that ventilators (around 20 LPM) require less oxygen flow than nasal canula and high-flow BiPAP machines (each about 40 LPM). This may seem counterintuitive to some practitioners.

Figure 1
Ice on Oxygen Evaporator Piping

Guidance

The following are some best practices and notes for medical oxygen system operation in the COVID-19 pandemic:

- **<u>If ice is forming on the outside of the evaporator equipment</u>**, flowing water may be used to reduce the ice accumulating on the outside of the equipment via forced convection. One method for addressing this is with the installation of shower heads over the equipment. Care must be taken to not create a hazard by the water from this method. It should not be allowed to flow over walkways or create any other hazards. Fans may also be used to assist in deicing if done in a safe manner (see Do's and Don'ts below).

Figure 2
Sprinklers Used for Deicing

- **<u>If medical oxygen systems are experiencing low pressure</u>**, the facility may increase O_2 mainline pressure from the typical 52-53 psi. This provides some additional flow. It may require an adjustment to the area and master alarm settings and to ventilators with high pressure alarms. Set valves on both mainline O_2 pressure regulators to increase flow. Liquid oxygen equipment typically has duplex regulators with usually only one valve on. Be sure not to overstress the existing medical gas distribution piping by increasing the system pressure.
- **<u>If pressure and capacity is low</u>**, use emergency oxygen supply connection (EOSC) to allow additional "push" of O_2 into building – especially effective if the LOX pad is remote from facility or if the LOX pad must supply multiple sites on a distributed campus. Requires dewars/high pressure cylinders be manifolded together with regulator to adjust pressure. This bolsters the flow and pressure because the supply is closer to use site. Be sure not to overstress the existing medical gas distribution piping by increasing the system pressure.
- **<u>To prevent loss of oxygen supply</u>**, keep LOX vessel at increased level before reordering. Typically, facilities allow LOX vessels to go down to the 30% level. Instead, keep the vessel no lower than 50% full. Check gauges visually. Do not rely on automatic telemetry systems.

- **<u>To reduce load to the facility medical oxygen system</u>**, use stand-alone H-cylinders with regulators available for use at patient bedside, or manifold several cylinders together in a “spider web” arrangement allowing service to multiple beds from one supply location.

Figure 3
Cylinder Manifold – Make Sure to Restrain Tank

- **<u>To safely reactivate portions of a facility that have previously been removed from service</u>**, reactivate with a current med gas verification to ensure that no contamination has entered a dead-leg pipeline.
- **<u>To ensure that the supply chain is not adversely impacted</u>**, please return your empty oxygen supply containers promptly.

Figure 4
Promptly Return Empty Tanks to Suppliers

Do's

- Provide water and spill containment beneath evaporators.

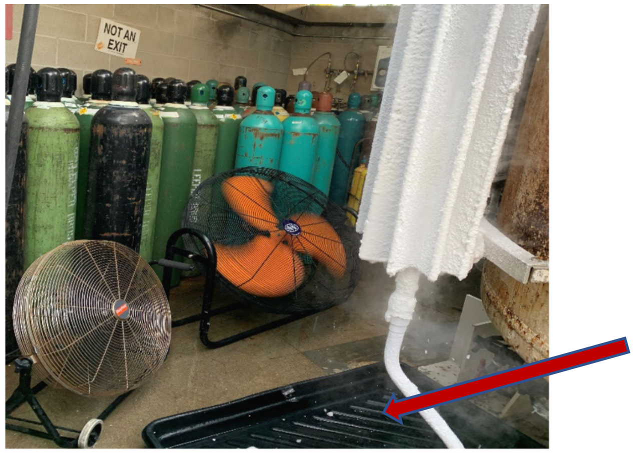


Figure 5
Provide Water and Spill Containment Below Evaporator

Figure 6
Industrial Fans May Be Used

Temporary O_2 tanks on trailers must be properly anchored. See **Mobile Units Used for Temporary Oxygen Tanks** below and **CAN 2-108**, **Temporary Systems, Utilities and Equipment.**

Don’ts

- Do not leave tanks unrestrained.
- Do not let cords lay in wet areas.
- Do not block air flow around evaporators with mounts and tanks.
- Do not have emergency liquid oxygen connections over asphalt.

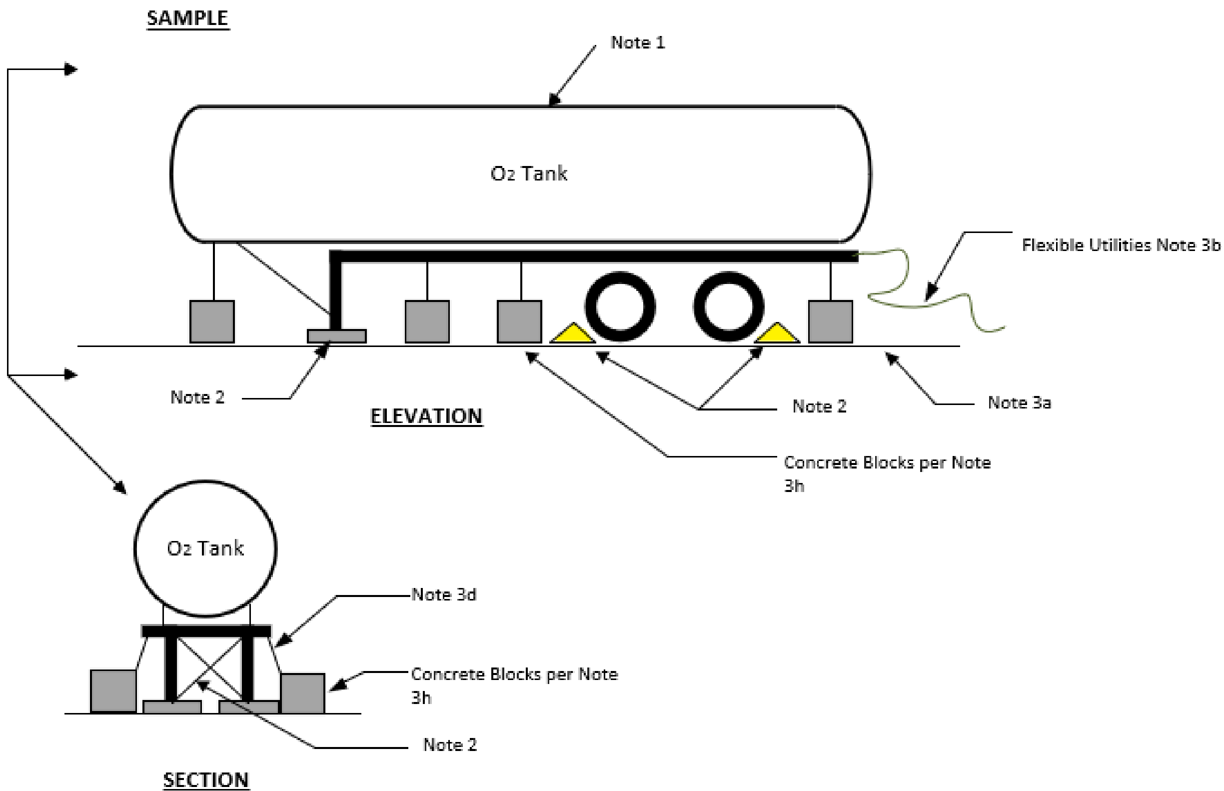
Figure 7
Do Not Let Cords Lay in Wet Areas

Figure 8
Do Not Mount Evaporator Too Close to Other Objects that May Prevent Air Circulation

Figure 9
Emergency Liquid Oxygen Connections Shall Not Be Over Asphalt

Mobile Units Used for Temporary Oxygen Tanks

1. Trailer design shall comply with State and National design standards for highways.
2. Trailer is assumed to consist of wheels in the back of trailer blocked to resist rolling, and two steel support legs in front connected to rubber or concrete pads capable of limiting punching shear of bearing surface when overturning loads are applied. Legs shall be braced and/or strengthened as necessary to resist forces as calculated in c. below.
3. Trailer tethered anchorage shall be designed to resist overturning and sliding forces from wind or seismic as follows:
    a. Trailer shall be parked on an engineered concrete or asphalt surface that is relatively flat for 10 feet around trailer.
    b. Utility connections are flexible allowing for 10 feet of movement.
    c. Seismic horizontal and vertical demands may be based on CBC Section 1617A.1.18 at ASD force level using 50% Fp for temporary installations per CAN 2-108 up to 180-day max*. *Extensions may be granted.
    d. Wind Load horizontal and vertical demands may be based on ASCE 7-10 Chapter 29.5 (Other structure) at ASD force level using Risk Category II map. Demand/Capacity to be <= 1.0.
    e. Sliding may be resisted using friction between (1) trailer tires (rubber) and asphalt or concrete (parking lot surface), and (2) jack stands and asphalt or concrete.
    f. Friction between any combination of rubber, concrete and asphalt may be used to resist sliding using a static coefficient of friction equal to 0.5.
    g. Friction resisting force may be calculated by multiplying the static coefficient of friction by the operating weight of trailer plus the least weight of counterweights on one side of the trailer.
    h. Overturning may be resisted utilizing counterweights such as concrete blocks. Connections shall not be slack wires.
    i. Provide spill containment if any liquid oxygen connections are over asphalt.



Resources and Questions
For additional information on the risk to hospital gas systems, see [Additional Ventilators May Pose a Risk to Hospital Gas Systems - AARC]().

If there are further questions, contact your oxygen supplier or vendor.