Build Health International

Comparison of Oxygen Delivery Methods

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This document was developed by Build Health International to support global medical oxygen infrastructure planning, site preparation, operation, maintenance, and sustainability. Additional technical resources are available at www.bhioxygen.org.

This document compares the three medical oxygen delivery methods: individual oxygen cylinders, cylinder supply manifolds, and direct piping

Characteristics	Individual Oxygen Cylinders	Cylinder Supply Manifolds	Direct Piping
Description	Individual cylinders (restrained for safety) at patient bedside *See Figures 1a and 1b.*	Wall-mounted oxygen outlets supplied by a medical gas pipeline system (MGPS) from cylinder supply manifolds to the patient bedside. *See Figures 2a and 2b.*	Wall-mounted oxygen outlets supplied by a medical gas pipeline system (MGPS) directly from the oxygen plant to the patient bedside. *See Figures 3a and 3b.*
Flexibility	**High** - Cylinders can be easily moved and used at other facilities. The booster can be turned on only when cylinder filling is needed.	**Moderate** - Cylinders can be easily moved and used at other facilities. Supply manifolds can be configured in any area of the hospital, but once established cannot be easily or inexpensively modified.	**Low** - Modifying pipelines is difficult and costly. Operationally, the plant is either on or off, with no flexibility to respond to demand. The plant can be turned off and MGPS can be supplied by a back-up manifold, if needed.
Initial Costs	**Moderate** - High pressure booster compressor(s), filling manifold, cylinder inventory, cylinder hand carts, regulators, valves	**High** - High pressure booster compressor(s), cylinder inventory, filling manifold, supply manifold(s), cylinder hand carts, regulators, valves, copper piping (often hundreds of meters), outlets, bed head units, valves, regulators, alarms, trenching, installation labor	**Moderate** - Copper piping (often hundreds of meters), backup manifold, outlets, bed head units, valves, regulators, alarms, trenching, installation labor
Construction Complexity	**Low** - High pressure booster compressors and filling manifolds may ship assembled with the PSA plant in containers or require light installation support	**High** - MGPS requires specialized construction techniques and materials	**High** - MGPS requires specialized construction techniques and materials
Maintenance Complexity	**Moderate** - High pressure booster compressors require frequent, specialized maintenance. Maintenance may be needed every 2000 hours of operation. Operator training to perform maintenance is required.	**High** - High pressure booster compressors require frequent, specialized maintenance. Maintenance may be needed every 2000 hours of operation. Operator training to perform maintenance is required. While infrequent, additional time is required for checking for leaks, monitoring area alarms and manifolds, and infrequent outlet maintenance.	**Low** - MGPS requires limited ongoing maintenance. Includes checking for leaks, monitoring area alarms and manifolds, and infrequent outlet maintenance.

Characteristics	Individual Oxygen Cylinders	Cylinder Supply Manifolds	Direct Piping
Recurring Costs	**High** - High pressure booster compressor maintenance; cylinder inspections; cylinder, valve, and regulator replacements; and additional electrical costs from running the booster compressor	**High** - High pressure booster compressor maintenance; cylinder inspections; cylinder, valve, and regulator replacement; and inspection and repair of leaks for MGPS. Inexpensive periodic maintenance for outlets, such as replacing o-rings, and electrical costs from running the booster compressor..	**Low** - Inspection and repair of leaks for MGPS. Inexpensive periodic maintenance for outlets, such as replacing o-rings.
Safety Risk	**High -** Oxygen cylinders are present in wards near untrained patients and visitors. Requires transportation of cylinders across the hospital and filling to high pressures.	**Moderate -** Requires transportation of cylinders across the hospital and filling to high pressures, but cylinders are kept away from patients and visitors.	**Low -** Oxygen flows at relatively low pressures through pipelines out of the reach from patients and visitors
Staffing Requirements	**High** - Changing oxygen cylinders at the filling manifold, transporting cylinders to bedsides, transporting cylinders to other health facilities	**High** - Changing oxygen cylinders at all manifolds, transporting cylinders to and from manifolds, and delivering cylinders to other health facilities.	**Low** - No additional staff required to manage oxygen delivery via MGPS; staff only needed to monitor the oxygen plant
Other Considerations	• Cylinders require a secure, safe storage space with cylinder racking and designated areas for empty and full cylinders. *See Figure 4.* • Cylinders require an inventory management and tracking system • Cylinders require adequate pathways (including ramps and elevators) from the plant to patient wards and bedsides	• Cylinders require a secure, safe storage space with cylinder racking and designated areas for empty and full cylinders. *See Figure 4.* • Cylinders require an inventory management and tracking system • Cylinders require adequate pathways (including ramps) from the plant to each supply manifold • MGPS runs above or below ground. Buried piping networks are more secure, but typically more costly to install and more difficult to repair or modify. *See Figure 5.*	• MGPS runs above or below ground. Buried piping networks are more secure, but typically more costly to install and more difficult to repair or modify. *See Figure 5.* • Especially long piping networks must be designed to limit excessive pressure drops within the system

Characteristics	Individual Oxygen Cylinders	Cylinder Supply Manifolds	Direct Piping
Advantages	Cylinders can be brought to any locations, including to: ● Wards with no piping ● Wards far from the oxygen plant ● Other health facilities in the region	● Wards with supply manifolds have a centralized oxygen supply. This is safer and typically a more consistent oxygen supply to patients when compared to individual cylinders ● Allows sprawling hospital campuses to install piping in individual buildings without the need for long runs to the oxygen plant ● Cylinders can be brought to any locations, including to: ○ Wards with no piping ○ Wards far from the oxygen plant ○ Other health facilities in the region	● Provides continuous and reliable oxygen delivery whenever the oxygen plant and backup manifold are functioning ● Low staffing requirement ● Increased safety by reducing oxygen pressure vessels in patient areas ● Low maintenance costs
Disadvantages	● **Supply:** Poor individual cylinder management can result in gaps in oxygen supply to patients ● **Costs:** High recurring costs and staffing requirements ● **Safety:** Oxygen pressure vessels in patient areas increases safety risks ● **Safety:** More staff members handling oxygen pressure vessels increases safety risks ● **Maintenance:** Complex maintenance requirements for booster compressors	● **Costs:** High initial and recurring costs ● **Staffing:** High staffing requirement ● **Maintenance:** Complex maintenance requirements for booster compressors ● **Supply:** Oxygen disruptions possible during pipeline repair	● **Cost:** High initial investment ● **Cost:** Inflexible and costly to modify ● **Supply:** Difficult or impossible to implement for sprawling hospital campuses due to lengths of piping runs required ● **Supply:** Oxygen disruptions possible during pipeline repair

Combining Oxygen Delivery Methods
Facilities may benefit from combining multiple oxygen supply methods—for instance, installing direct piping to wards near the PSA plant, using supply manifolds for wards farther away, and providing individual cylinders to peripheral facilities. Further, direct piping systems should always include a backup manifold as well, which can continue providing oxygen while the PSA plant is offline – either during power outages or planned maintenance. In this way, the manifold acts as a reliable safeguard, ensuring uninterrupted oxygen delivery to the wards through the piping network.

Figure 1a: Individual cylinders at patient bedside (restrained for safety)

Figure 1b: Individual cylinder at patient bedside (restrained for safety)

Figure 2a: Cylinder supply manifold and storage restrained with chains

Figure 2b: Cylinder supply manifold restrained with chains

Figure 3a: Wall-mounted oxygen outlet (supplied by cylinder manifold or MGPS direct from the oxygen plant)

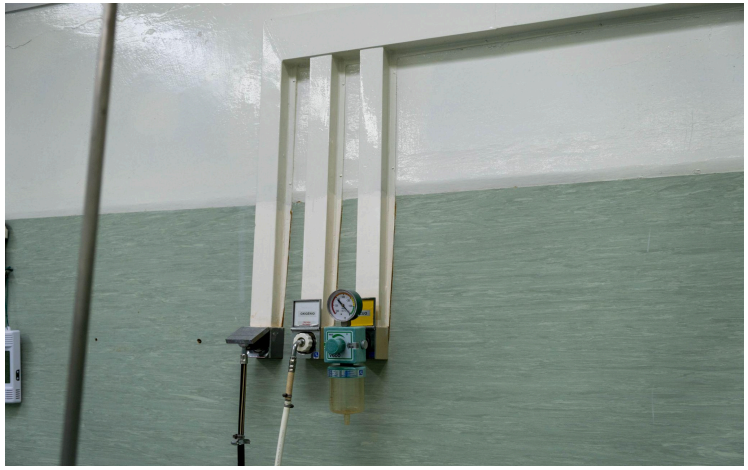

Figure 3b: Wall-mounted oxygen outlet (supplied by cylinder manifold or MGPS direct from the oxygen plant)

Figure 4a: Cylinder storage area with racks and chains (no cylinders pictured)

Figure 4b: Example of cylinder racking, the safest method of cylinder storage

*Figure 5a: MGPS running above ground**

Figure 5b: Digging trenching for underground MGPS

** Copper is corrosion resistant and does require extra protection from environmental degradation. Piping may be painted for aesthetic reasons or to mark the type of gas carried by the pipe. Conduit or trunking is typically added in areas where protection from physical damage is needed (for example, where a cart or vehicle may contact the pipe).*