

Briefing Note: Oxygen Plant Staffing

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1. Introduction

Hiring qualified staff to operate an oxygen plant is a critical part of ensuring the plant's long-term success. It is important to hire the right candidates and the right number of candidates to run the oxygen plant effectively. In this document, Build Health International (BHI) explores considerations for the number of oxygen plant operators to hire for an oxygen plant. This document also contains example qualifications for an oxygen plant operator and their possible supervisors.

2. Considerations for Staffing Oxygen Plants

There are four key variables to consider when determining the number of oxygen plant operators to hire for an oxygen plant. Those variables are:

1. Type of plant (cylinder-filling, direct piping only, or a combination of the two).
2. Operating plan (For example, how many hours the plant will run, will both sides of a duplex plant operate at all times, when will the cylinder-filling compressor be turned on, etc.).
3. Size of the plant.
4. Frequency of cylinder manifold changeovers.

1. Types of Plant

There are three types of plants: piping only, cylinder-filling only, or both piping and cylinder-filling. Staffing considerations for these plant types are shown in the table below.

	Piping Only	Cylinder-Filling Only	Piping & Cylinder-Filling
Number of Operators	One operator at all times is required.	More than one operator is often needed, operators are not needed when the oxygen plant is turned off.	One operator at all times is required.
Reason for Number of Operators	To ensure constant oxygen to patients. Plant runs for 24 hours, 7 days per week.	Operators must move filled and empty cylinders, but only when the plant is running. A cylinder-filling plant does not need to run 24 hours per day, 7 days per week.	Staffing will depend on plant size and % piping versus cylinders.
Shift Requirements	Shifts will be required to supervise the plant at all times.	One shift may suffice	Shifts will be required to supervise the plant at all times. The number of staff on each shift will vary based on the operating plan for the cylinder-filling.

2. Operating Plan

The operating plan of an oxygen plant is defined as the plan for running the oxygen-generating equipment that will meet the needs of the health facilities supported, and should consider the following:

- Where an oxygen pipeline is connected directly to an oxygen plant and relies on the plant for oxygen at all hours, the oxygen plant will need to operate 24 hours per day, 7 days per week.
- Oxygen plants that exclusively fill cylinders can operate for as many hours as it takes to fill the cylinders needed (4 hours, 8 hours, 12 hours, etc.).
- Some oxygen plants rely on the whole capacity of the plant to pipe during the day, and then fill cylinders at night when the oxygen demand to the pipeline is lower.
- Some oxygen plants fill cylinders and pipes during the day, then the oxygen plant is turned off at night when cylinders begin to feed the piping system.
- Some oxygen plants are duplex plants but only operate on one side of the duplex during normal operating conditions. The second side of the duplex can be turned on in times of high oxygen demand, such as COVID-19 surges.

In summary, there are countless ways to operate an oxygen plant and every installation is different. If a partner helped to size an oxygen plant, it's likely designed with a specific operating plan in mind. In cases where there are questions about the operating plan of an oxygen plant that was sized with input from a partner, BHI recommends coordinating with that partner to confirm the intended operating plan.

3. Oxygen Plant Size

A larger oxygen plant will generate more oxygen than a smaller oxygen plant. Where cylinders are involved, this means that a higher quantity of oxygen cylinder can be filled. For example:

- A cylinder-filling oxygen plant that fills 20 cylinders per day will need less staff than an oxygen plant that fills 150 cylinders per day.
- The more cylinders filled by the oxygen plant, the more staff is needed to manage and distribute them.

4. Filling Manifold Changeovers

Oxygen plants that fill cylinders, either exclusively or in parallel with direct piping, use cylinder manifolds to connect individual cylinders to a source of high pressure oxygen. A cylinder-filling manifold will have a set number of spots for cylinders to connect to the high pressure flow. The number of cylinders that can be connected to the manifold and the size of the cylinder-filling compressor influence how often cylinders must be changed over (i.e., when filled cylinders are removed and empty cylinders are connected to be filled). There are two sides to a cylinder manifold, which allows oxygen plant staff to change out one half of the cylinders while the other half of the cylinders continues to provide oxygen. The table below shows an example of two set ups, both with the same cylinder-filling compressor size but with different filling manifold size. It shows that a larger cylinder filling manifold needs less frequent changeovers.

	Option 1	Option 2
Plant size	30 Nm ³ /h cylinder-filling compressor	30 Nm ³ /h cylinder-filling compressor
Cylinder filling manifold size	Filling manifold of 2 x 2 cylinders = 4 cylinders	Filling manifold of 2 x 20 cylinders = 40 cylinders
Frequency of changeovers	Changeover one side of the manifold (2 cylinders) every 30 minutes	Changeover one side of the manifold (20 cylinders) every 5 hours

The more often the cylinders must be changed over in the filling manifold, the more staff is required to manage the filled and empty cylinders. Larger cylinder manifolds generally require less staff.

3. Recommended Job Descriptions & Staffing Qualifications

Below are details about the job descriptions and qualifications recommended for oxygen plant operators and supervising engineers. The arrangement envisioned for the two roles in this document is that of a regional or national supervising engineer who oversees several oxygen plants and operators. In some contexts, the oxygen plants may have dedicated biomedical engineers or biomedical engineers that are the oxygen plant operator. In all arrangements, steps should be taken to ensure that the daily checklists of the oxygen plant operators are checked by a qualified engineer.

Two Oxygen Plant Roles:

1. **Oxygen Plant Operator:** This person can be a biomedical technician, electrician, existing maintenance staff, or someone with 2-3 years experience in medical equipment. They are hospital-specific and handle daily operations of the oxygen plant.
2. **Supervising Engineer:** This person should be an engineer with a degree from a four-year university that supervises high level oxygen plant operations at several hospitals. This role is typically filled by a biomedical engineer, but can also be performed by a well trained mechanical or electrical engineer. They are a regional or national level position and provide high-level support to the oxygen plants throughout the region/country.

Recommended Job Description: Oxygen Plant Operator

- Accurately completes the daily maintenance checklist for the oxygen plant.
- Cleans and makes minor repairs to equipment, like replacing defective valves.
- Observes safety guidelines for operating and managing the oxygen plant equipment.
- Reads log sheets to determine product demand and status, or to detect malfunctions.
- Manages oxygen cylinders, including changing manifolds over and storing cylinders safely.
- Collaborates with other operators to solve equipment problems.
- Requests repair and maintenance work be performed when necessary.
- Manages the spare parts and oxygen tools inventory, including keeping certain tools oxygen safe.
- Keeps the oxygen plant room neat and tidy.

Recommended Qualifications: Oxygen Plant Operator

- 2-3 years of experience with electrical or mechanical systems, electronics, hospital maintenance, biomedical experience, experience with medical equipment, industrial oxygen.
- Knowledge of pneumatic systems.
- Strong understanding of mechanical systems.
- Ability to learn how to correlate functions of an oxygen plant to daily checklist readings.
- Physical ability to move cylinders and work with hand tools.
- Willingness to learn.
- Easily adaptable.
- Strong communication skills (to coordinate with hospital staff on the delivery side, communicate with regional biomedical engineer about any problems).

Recommended Job Description: Supervising Engineer

- Manages the service contract.

- Liaises with suppliers.
- Budgets for and orders spare parts.
- Reviews daily reports, maintenance logs, repair logs from plant operators.
- Supervises plant operators/technicians, periodic visits to hospitals to check-in on the plant operators and oxygen plants (regional travel).
- Conducts more advanced or complex oxygen plant maintenance.

Recommended Qualifications: Supervising Engineer

- Degree from a four-year university in biomedical engineering, mechanical engineering, or related field.
- 1-3 years of experience with oxygen plants, industrial oxygen, compressors, or similar mechanical or biomedical equipment
- Trained up to an intermediate level on the oxygen plant (replace oil, replace filters).
- Ability to repair electric infrastructure preferred.

4. Supporting Oxygen Plant Staff

Oxygen plant operators are critical members of the healthcare system. The individuals hired to maintain oxygen plants are responsible for the ongoing operation and maintenance of expensive and critical pieces of biomedical equipment. It is important that oxygen plant operators and supervising engineers dedicated to oxygen plants have the tools and support needed to be successful.

Training

To prepare for an oxygen plant and keep it running smoothly, many training sessions may be needed. It is essential to train oxygen plant staff and repeat training at times of transition. A lack of training can lead to improper oxygen plant operation or nonfunctional oxygen plants. Below are a few types of trainings to consider for oxygen plant staff:

- **Oxygen Plant Operator Training:** A hybrid classroom and practical training to instruct oxygen plant operators in daily maintenance and troubleshooting of oxygen plants.
- **Management Training:** A classroom training to introduce oxygen plants and their operating requirements to hospital management and administrators.
- **Training of Trainers:** A hybrid classroom and practical training to teach engineers how to train Oxygen Plant Operators in daily maintenance and troubleshooting of oxygen plants.
- **Refresher Training:** Oxygen plant operator training sessions that are repeated after time has passed or new oxygen plant operators have been hired.
- **Post-service Agreement Training:** Training sessions that occur when service agreements have terminated; the responsibilities of the oxygen plant operator and supervising engineer increase after service contracts end.

In addition to providing oxygen plant staff with the knowledge and confidence to operate the oxygen plant, there are other benefits to training staff. Training sessions give oxygen plant operators access to those in similar roles, often resulting in the creation of a network of plant operators that share stories and lessons learned over messaging apps like WhatsApp. Management training increases understanding and encourages more productive dialogue with oxygen plant staff. BHI strongly recommends that resources are dedicated to training oxygen plant staff and hospital management.

Tools

Oxygen plants require specialized tools for maintenance. In order to perform their responsibilities correctly, oxygen plant staff must be provided with the proper tools for the oxygen plant. A lack of proper tools can lead to damage to the oxygen plant and risk to oxygen plant staff.

Personal Protective Equipment

Oxygen plants operate at high pressures, contain high concentrations of oxygen, produce loud noises, and have high power consumption requirements. It is critical to provide oxygen plant staff the correct personal protective equipment for working with pressurized vessels, electricity, loud noise, and flammable materials. Oxygen plant staff will be able to perform their roles more effectively if they are provided with adequate protection.

Communication Channels to Administrators

The personnel operating an oxygen plant are tasked to ensure the availability of medical oxygen for relevant patients. In order to do their jobs effectively, oxygen plant staff must have clear communication channels within hospital administration. When spare parts or maintenance is required for the oxygen plant, the oxygen plant staff should have the support of hospital administrators to fund the steps necessary to keep the oxygen plant operating. A good working relationship between oxygen plant staff and administrators can help to keep the oxygen plant running smoothly; it is much better to perform preventative maintenance than repair an oxygen plant if it falls into disrepair due to a lack of maintenance. Preventative maintenance is less expensive and keeps oxygen flowing.

Fair Compensation

Oxygen plant staff play a vital role in the care of patients. Oxygen plant staff should be fairly compensated for their work to encourage quality work.