Spare Parts & Consumables for Oxygen Plants: Considerations, Procurement, and Management

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Build Health International developed this document for the Global Fund's Project BOXER.

1. Overview

This document is designed to support health facilities in effectively procuring and managing spare parts and consumables for oxygen plants. It outlines critical considerations for identifying required parts, planning procurement based on usage, managing budgets, and maintaining proper storage and inventory. As a practical, action-focused resource, this guidance aims to ensure consistent, uninterrupted plant operations. This document is not exhaustive and should be adapted to fit local implementation models and operational needs.

2. Introduction

Spare parts and consumables are both items used in routine maintenance and repair, but they differ in their function and how they are used.

- **Spare parts** are extra components kept on hand to replace broken or worn-out parts of equipment, such as belts or bearings.
- **Consumables** are items that are used up or depleted during operation and need frequent replacement, like oil or filters.

Since both types of items are required to be purchased in advance and stored for use during preventative maintenance, "spare parts" is often used to refer to both spare parts and consumables. Most BHI resource documents use the term "spare parts" to refer to both spare parts and consumables.

Many oxygen plant components need to be replaced at specified intervals due to wear and tear. Manufacturers provide predetermined schedules for part replacement, having designed their equipment with this maintenance in mind. Spare parts are also essential for various repairs within the oxygen plant. To effectively plan for the use and procurement of spare parts and consumables, it is important to consider your plant's operating plan, projected running hours, and the manufacturer's recommended service intervals.

3. Service Intervals

Each piece of equipment in an oxygen plant has its own service intervals which are outlined in the manufacturer's manual. These manuals detail which components need to be replaced and at what running hour intervals. For example, consider the booster compressor in an oxygen plant. A sample maintenance schedule for this equipment is shown in Table 1. Tables like this are specific to the model installed in your plant and *cannot* be applied to other similar components.

Table 1: Example booster compressor maintenance schedule

Scheduled maintenance	
Booster Compressor Component	**Interval (hours)**
Filter Cleaning	3000
Crankcase Lubricating Oil	3000
Drive belt adjustment	8000
Electric Motor Lubrication	As required
Pressure relief valves	8000
Gas Piping Leak Check	1000
Compressor Valves	4500
1st stage piston ring replacement	4500
2nd stage piston ring replacement	3000
3rd stage piston ring replacement	1500
Cylinder Liners	As required
Piston rod oil seals	As required

Even when looking at just three components within the air compressor, it can be seen that each has a different service interval. Although these components are all part of the same machine, they require service at different times.

- The oil filter service kit is needed every 2,000 hours.
- The oil separator requires service every 4,000 hours.
- The thermostatic valve needs servicing every 8,000 hours.

It is important to follow the manufacturer's minimum recommended service intervals. However, there may be situations where maintenance is required earlier than the manufacturer recommended interval. For example, in dusty environments, filters may clog faster, causing a drop in performance and requiring premature replacement. Conversely, for equipment that runs infrequently, manufacturers may include time-based clauses such as "service every 4,000 hours or once per year, whichever comes first."

Spare parts planning begins with a solid understanding of your operating plan. Keeping track of all the components that require service can quickly become complicated. Not only do parts within a single machine have different intervals, but each piece of equipment in the oxygen plant will also accumulate running hours at different rates. To stay organized, make use of a preventative maintenance log and daily checklist. BHI has developed a standard preventative maintenance log and daily checklist, however the supplier may provide specific log templates for their equipment. These tools help plant operators track the running hours of individual components and estimate how many days remain before service is due.

4. Running Hours and Operating Plan

The operating plan of an oxygen plant significantly affects the need for spare parts, as it determines the running hours of various equipment.

Running hours refer to the total number of hours a machine has operated over its lifetime. Spare parts are typically needed based on running hours rather than months or days. Tracking equipment use by hours is more accurate, as different plants operate for varying durations each day. Plants with operating plans that require equipment to run longer each day will reach service intervals sooner. The list below illustrates this using a 2,000-hour service interval as an example:

- A plant running 24 hours per day will reach 2,000 hours in 83 days
- A plant running 12 hours per day will reach 2,000 hours in 167 days
- A plant running 8 hours per day will reach 2,000 hours in 250 days

Hospitals can operate their oxygen plants in a variety of ways, leading to a wide range of possible running hours. For instance, a booster compressor may operate for just 1 hour per day, 24 hours per day, or anywhere in between. The more it runs, the faster it accumulates running hours, increasing the frequency of required maintenance. The running hours on the air compressor, oxygen generator, and booster compressor will *not b*e the same as the components are designed to briefly shut off when not in use. As operating hours increase, so does the frequency of maintenance—and the need for spare parts.

5. Budgeting

Hospital management may assume that if the plant is functioning well, spare parts are unnecessary in the annual budget, but this is a risky misconception. Failing to stock the necessary spare parts can lead to critical equipment failure. A non-functional oxygen plant can result in:

- Loss of the hospital's primary oxygen source for patients
- Unplanned emergency spending on commercial oxygen deliveries
- Higher repair costs compared to the cost of preventive spare parts

While spare parts may seem expensive, the cost of repairing a broken plant—and the potential risk to patient care—is significantly higher.

Understanding the operating plan, running hours, and service intervals are essential for estimating the quantity of spare parts needed. Hospital managers should plan ahead by ordering spare parts to cover two years of operation at a time. Example budget calculations for parts for two years are shown in Appendix A. The table in Appendix A can be copied and adapted to estimate the spare parts costs for any oxygen plant.

Having the right spare part on hand when a repair is needed can get an oxygen plant back up and running within 1–2 hours. In contrast, if the part must be ordered, the plant could be down for 1–2 months or longer—potentially disrupting patient care and increasing operational costs. To ensure accuracy, develop a list of required parts for that time period and share it with the manufacturer to confirm that nothing has been overlooked.

6. Procurement

It is common to purchase several years' worth of spare parts during each procurement cycle. When ordering spare parts, keep in mind that lead times can range from several weeks to several months—especially for specialized components. These delivery times must be factored into your preventive maintenance planning to avoid disruptions in plant operation. Good spare parts management is essential to keeping an oxygen plant operating reliably. Because many spare parts are replaced only after long intervals—such as every few months—and are often not available locally, ordering and shipping times must be factored into maintenance planning.

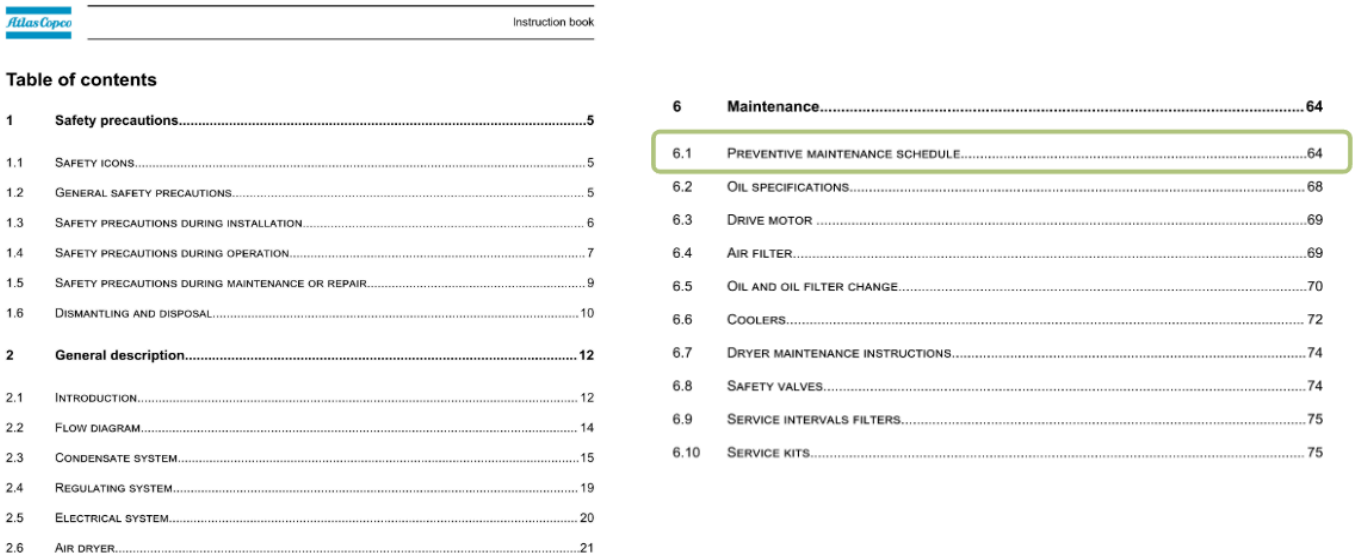
It is essential that the spare parts match the existing system components. **Always reference the serial number on the machine when ordering parts**. For example, when ordering spare air filters always include the serial number of the air compressor in the request as well. While manufacturers may retain the same model number over time, internal components may change. Using the serial number helps ensure that you receive the correct parts for your specific unit and avoids costly delays due to incorrect shipments.

Spare parts can be purchased either directly from the manufacturer or through an authorized distributor. Do not purchase spare parts from an unauthorized supplier. Purchasing from unauthorized suppliers may void your warranty because these parts may not be authentic and these parts may not last as long as they should or not perform as they should. There's two approaches to submitting a procurement request:

1. The operators compile a list of needed spare parts over a certain time frame using their equipment manuals, service interval frequencies, and current running hours. This list can then be sent to the supplier for review.
    a. Each piece of equipment (e.g. air compressor, oxygen generator, booster compressor) has its own manual and service schedule.

b. Figures 2 and 3, below, show an example of how to locate a service schedule using an Atlas Copco GA75+ manual published in July 2022. Figure 1 demonstrates using the Table of Contents to locate the section with the maintenance schedule. Table 2 shows an excerpt of the schedule that can be found in Section 6.1 of the manual.

Figure 1: Example air compressor manual table of contents (only English screenshot available at this time)



Instruction book

Table of contents

Table 2: Excerpt of air compressor service schedule

	A-service every 4000 running hours	B-service every 8000 running hours	D-service every 24000 running hours
Change the air filter	x	x	x
Change the electric cabinet filter mats	x	x	x
Change the drain(s) filter mesh	x	x	x
Change the oil	x	x	x
Change the oil filter	x	x	x
Change the oil separator element		x	x

c. Estimate the service interval timing. Service intervals are often determined by operating hours not months or years. If this is the case it is important to calculate the annual operating hours based on the operating plan of the plant. Please note the operating hours on different equipment will likely not match. See an example below, in Table 3.

Table 3: Example service interval frequency calculations

Equipment	Operating Plan	Annual Running Hours
Air compressor and oxygen generator	Run 24 hours per day, 365 days per year	8760
Booster compressor	Run 8 hours per day, 5 days per week, 52 weeks per year	2080

d. Based on the manuals' service schedules and the calculated number of service intervals per year, calculate the number of each spare part that will be needed. Use historical cost data for

each spare part to calculate the cost or reach out to the supplier with the plant name plate information and a request a quote for the quantities and types of spare parts you have identified

2. The operators email the supplier the current number of running hours on the plant and request to have spare parts for the next X hours of operation. The supplier will then perform the calculations and send the appropriate number of spare parts.

The first option gives the operators more control and visibility into what is being ordered, but it requires more effort and technical knowledge. The second option reduces the workload on the operators and relies on the supplier's expertise, but it may result in less transparency and higher dependency on the supplier. From BHI's experience, the suppliers may not send the correct filters if the number and type of filters are not explicitly included in the plant equipment information that is shared with suppliers

7. Storage and Inventory

7.1 Typical spare parts management approaches
While there is no single standard for managing spare parts, a few common systems are used:

1. **On-Site Storage:** All spare parts are stored at the hospital or facility where the oxygen plant is located. Make sure to store parts in a secure, indoor location such as a closet or office space—not inside the oxygen plant container or plant room. Storing parts in the plant room, especially in cardboard boxes, can pose fire risks, create accessibility issues, and lead to disorganization.
2. **Centralized Storage:** Spare parts are stored and managed by a central entity, such as the Ministry of Health, at a facility like a Central Medical Storage warehouse. Parts are distributed to facilities as needed for scheduled maintenance.
3. **Supplier-Managed Storage:** The supplier retains custody of the spare parts, even though they have been purchased by the plant owner. The supplier brings the required parts during preventive maintenance visits. These parts may be stored with a local partner or at the supplier's factory.

In practice, spare parts management may be a combination of these approaches. For example, a plant owner may purchase five years' worth of spare parts. One year's worth could be stored on-site at the hospital for immediate use, while the supplier holds the remaining four years' worth and provides them during scheduled service visits.

7.2 Example spare parts management for on-site storage
If the facility already has a strong existing equipment or asset management system, it may make sense to include the oxygen spare parts within this system for streamlined tracking and planning. If there is no existing system, establish a spare parts management system to ensure efficient plant operation. Below is an example of one way to manage spare parts:

1. Create a **spare parts stock list** to be managed by the plant administrator. See example stock list in Appendix C (an excel version is also available here). This spreadsheet should include a list of every spare part and consumable item required for the plant with a corresponding code/part number, the manufacturer, the vendor, the unit price, a lead time, and the minimum acceptable quantity that should be in stock at all times for each critical item so that replacements can be ordered as soon as the inventory reaches the minimum threshold (or warning level, as indicated on the example stock card in Appendix B).
2. Establish a **spare parts stock card system** to be managed by the plant operators (ideally one). This is a system to manage the daily in and out of stock from the store room. An example spare parts stock card is shown in Appendix B (a printable version is also available here).
3. Create an **inventory and parts ordering system** to be managed by the plant administrator. This can be monthly, quarterly, or yearly, depending on consumption of spare parts.

Stock List

- The stock list should include every item stored in the spare parts store room. This may also include tools and consumables. Each item should have a code/number for easy identification. This number will match the stock card, shelf labels, and monthly inventory spreadsheet.

    - Often, spare parts come in service kits. There are two ways to track service kits on stock lists and on stock cards: as one item (a kit), or individual items (each individual item in the kit has a stock card/is listed on the stock list). Ideally, these items should be tracked individually because if only some items in a kit are used, there can be confusion about what is available and what needs to be ordered. If you decide to track a kit as one item with one stock card, it is advisable to give each item in the kit its own individual stock card once an individual item has been removed from the original kit, and the full kit is no longer intact.
- It may be helpful to separate these items by family (spare parts, consumables, tools, misc). Often store rooms include more than just spare parts, but also cleaning products, tools, and other items to maintain the plant and plant house infrastructure.
- The following should be included for each item:
    - Unit and unit price
    - Category:
        - "Crit." for critical items: Items that need particular attention and eventually a bigger stock, due to frequency of use and how critical it is for the functioning of the plant. These items require a minimum stock level (warning level).
        - "Norm." for normal items
        - "Low" for low turnover: Items for which a minimum stock is needed rather than an average monthly consumption due to low frequency of use.
    - Average consumption: The frequency (monthly, yearly, etc) utilized of consumption will be determined by how frequently the plant is run.
    - Minimum stock level needed: If an item is critical to the function of the PSA plant, it may be necessary to ensure there is always a certain number of those items in stock at all times. Therefore, you can implement a minimum stock amount so that as soon as that number is reached, the administration is prompted to order additional quantities to ensure the stock is never depleted.
    - Manufacturer: This is critical as plant suppliers often require that parts are procured from specific manufacturers to maintain a valid warranty.
    - Vendor: Where the item is purchased
    - Lead time: How long will it take to receive an item once it is ordered? This may impact your minimum stock quantities to ensure your store does not run out of stock before it is needed.
    - Shelf Life: Note the typical shelf life of an item, such as 6 months or two years, before it expires and can no longer be used. PSA plant spare parts and consumables typically have a very long shelf life, however expired items should be removed from stock during monthly physical inventories.

Stock Card System

- A designated plant operator should be responsible for the spare parts inventory and store.
- Every item in stock should have a part code/number for easy identification. This code should be written on the shelf where the item is, on the stock card, on the stock list, and on any inventory tracking documents.
- Stock cards are physical cards/paper for each item that is utilized to track items coming in and out of the store room. When items are added to the stock, the card is filled out with the date, quantity in, and signature of the staff member. When items are taken from the stock, the card is filled out with the date, quantity out, purpose (e.g, 2000 hour service), and signature of staff member. See example stock card in Appendix B.
    - See bullet #2 under the Stock List section above for guidance on how to track service kits in your stock
- All stock cards should be kept in a filing system (even when it is full and a new one is created), as they will assist in determining the monthly and yearly consumption of each item. This will assist in budget planning and spare part management.
- Once a month, the staff responsible for the spare parts should conduct a physical inventory of the stock. This means physically counting each item in stock and comparing that to the stock card to ensure they match.
    - Record the inventory results directly on the log card, writing “INVENTORY” in the Origin/Destination column is and filling out the Stock column

- During inventory, remove any items that have expired and update the stock card accordingly, noting the reason for removal from stock.
- If the physical inventory and stock card do not match, the store keeper should investigate the issue.
- As requested, the responsible person for the spare parts store should report stock card inventory numbers as requested to the plant administrator. Additionally, they should report when items reach their warning level (minimum stock quantity) so that additional parts can be ordered before the stock is depleted.

Inventory and Parts Ordering System
Each health facility has their own processes and procedures for procurement so no example spreadsheet template has been provided here. However, it is critical that the plant administrator establish a system for the plant operators to regularly report spare parts inventories and make orders for spare parts.

8. Best Practices

1. Assign responsibility
   Designate a specific person to be responsible for spare parts management. This individual should develop a list of required spare parts based on the plant's operating plan and the manufacturer's minimum recommended service intervals.

2. Maintain appropriate storage conditions
   - Ensure spare parts storage meets supplier requirements (humidity ranges, temperature ranges, shelf life, etc).

3. Understand the spare parts management process
   Ensure the responsible person is familiar with how spare parts are managed within your system, including:
   - Who approves the spare parts budget
   - Who obtains price quotes from suppliers
   - Who places the orders
   - Where the spare parts are shipped
   - How the parts are stored and tracked
   - Consider any spare parts responsibilities of the supplier

4. Know your procurement channels
   Understand how spare parts are sourced:
   - Is the manufacturer the only supplier?
   - Are there local authorized distributors available?
   - What is the lead time for each item?

5. Maintain an active inventory
   Track spare parts inventory closely to ensure critical components are always in stock. Maintain a minimum acceptable quantity for each item and reorder promptly when inventory falls to that level.

6. Save money and save lives
   Plan ahead, manage your spare parts effectively, and include them in your annual budget to ensure your oxygen plant remains fully operational when it's needed most.

9. Resources

Guides/Templates:
- PATH Procurement Guide

Free Online Courses:
- Great Learning: Inventory Management Course
- Warehouse Management: Inventory, Stock and Supply Chains

Appendix A - Example Spare Parts Budgeting Table

Use the tables below to calculate the operating hours for a PSA plant component (air compressor, oxygen generator, booster compressor, etc.) and estimate spare parts quantities needed based on the operating hours and relevant service intervals. The example shown below is for an air compressor (note: not all schedule items and spare parts are included in the example).

Hours per day (1-24)		Days per week (1-7)		Weeks per year (1-52)		Number of years		Component operating hours in 2 years
16	x	7	x	52	x	2	=	11648

Component operating hours in 2 years		Service interval		Number of intervals *(round down)*
11648 hours	÷	4000 hours	=	2
11648 hours	÷	8000 hours	=	1
11648 hours	÷	24000 hours	=	0

Schedule Item	4000 hours	8000 hours	24000 hours	Part	Unit Cost		Quantity Needed		Total Part Costs
Change the air filter	x	x	x	Air filter	$551	x	2	=	$1102
Change the oil		x	x	Roto-Xtend oil (30L)	$1,422	x	1	=	$1422
Change the oil filter		x	x	Oil filter	$250	x	1	=	$250
Change the oil separator element		x	x	Oil separator element	$800	x	1	=	$800
Overhaul the thermostatic valve		x	x	Thermostatic valve kit	$182	x	1	=	$182
Overhaul the condensate drain(s)		x	x	Drain overhaul kit	$89	x	1	=	$89
Change the motor top bearing			x	Motor top bearing	$1,214	x	0	=	$0
							Total Cost for 2 Years of Spare Parts		**$3845**

Appendix B - Example Stock Card for Spare Parts

Note: A printable version of this document is located here.

Spare Part Description: *Include the name of the item*	
Part Code/Number: *Each item should have a code. The code can be displayed on the shelf to assist in finding it more easily.*	**Warning Level:** *This should be the lowest number the stock should get before more need to be ordered to avoid depletion.*
Unit of Distribution: *Piece, box, etc.*	**Comments:**
Packaging: *Include any helpful notes on how the item is packaged, such as if it is in a small blue box.*	

Date	Origin / Destination	IN	OUT	STOCK	Expiry Dates	Signature	Notes
Stock transferred from previous card. *When you run out of space on a stock card, you will need to transfer the last total stock number to another card. Remember to save old stock cards for reference.*							
	If the item is leaving stock (OUT), note where it is going (e.g, 2000 hour booster maintenance) *If the item is entering the stock (IN), note where it is coming from (e.g., July 2025 spare parts order from NOVAIR)*	*Number of the item being put into stock*	*Number of the item coming out of the stock*	*This should be the total number of the item now in stock (considering what was put in or taken out)*	*If the product has an expiration date, note it here. There may be different expiration dates based on when the items were received - note them all.* *Example:* *4 - Sept 2028* *10 - Oct 2029*	*The person who fills out the stock card should sign their name for tracking purposes.*	

Appendix C - Example Stock List

Note: A printable version of this document is located here.

Code	Description	Unit	Unit Price	Cat.	Average XX Consumption	Minimum Stock Level Needed	Manufacturer	Vendor	Lead Time	Typical Shelf Life	Notes
Spare Parts											
					To determine frequency that consumption should be tracked based on how frequently the plant is run. "XX" to be replaced by the interval selected.	*This should be the lowest number the stock should get before more need to be ordered to avoid depletion.*			*Lead time is the total duration from the initiation of an order to its final delivery. This will assist in ensuring items are ordered well enough in advance so that stock is not depleted before it arrives.*	*This is the period a product remains suitable for its intended use. Typically, manufacturers will provide an expiration date on the item, if there is one. Note here the duration (e.g, 1 year, 2 years) specified by the supplier before a product expires and can no longer be used.*	
Consumables											
Tools											
Misc											