Filling Cylinders with Medical Oxygen (Quebec City)

Purpose and Scope
Quick guide
Safety
  Emergencies
Before Filling
  Check Filling Area, Equipment, and Measuring Devices
  Select Cylinders
  Record Information
  Check Cylinders
    Damage and External Contamination
    Paint
    Stamped Markings
    Valves and Safety Devices
    Hammer Test
    Residual Pressure Test
    Internal Moisture Test
    Odour Test
  Record Information
Filling
  Introduction
  Purge, Vent, and Evacuate Empty Cylinders
    Purge
    Vent
    Evacuate
  Vent and Evacuate All Cylinders
    Vent
    Evacuate
  Record Information
  Start Filling
  Test for Leaks
    Test for Leaks in the Fill Line-to-Cylinder Connection
    Test for Leaks Around the Cylinder Valve and Neck
  Test for Warmth
  Adjust Target Fill Pressure
  Stop Filling
After Filling
   Stick on New Labels
   Test for Leaks
   Analyze
   Record Pressure and Temperature of Sample
   Apply Tags and Seals
   Release
Attachment

**Attachment(s):**
   - clear ringing sound
   - dull thud sound
   - Quick Guide
Purpose and Scope

Purpose

The purpose of this chapter is to explain how to fill high-pressure cylinders with medical grade oxygen (also known as Oxygen, USP) using:

• a semiautomatic system at filling station #1 for large cylinders
• a manual system at filling station #2 for small cylinders

Note: Oxygen USP is oxygen that meets the standards of the United States Pharmacopoeia, an independent, US-based group that prepares and updates standards for the ingredients used in pharmaceutical products.

Scope

This chapter is for all staff who fill high-pressure cylinders with medical-grade oxygen at the BOC filling plant in Quebec City, Canada.

Quick guide

Filling process summary

The following flowchart summarises the processes used in Quebec City for filling high-pressure cylinders with medical-grade oxygen.

Printable version of this Quick Guide.
Safety

Personal protective equipment

When filling cylinders with medical-grade oxygen you must wear, and keep clean, the following personal protective equipment (PPE):
- CSA-approved safety footwear (either shoes or boots) with toe caps to protect your toes and metatarsal guards to protect the top of your feet
- clean white gloves
- safety glasses
- overalls or long pants, and a long-sleeved shirt

You may also wear hearing protectors.

See Personal Protective Equipment (PPE) for Quebec City (when published).

Oxygen

Oxygen vigorously supports combustion. When filling with oxygen take great care that there is no oil or grease (which can burn) on:
- the filling equipment
- the cylinders or their components
- your personal protective equipment

See IND-17-08: Safe Oxygen Filling.

Emergencies

Stopping at the tank

In case of an incident such as a break in the pipe connecting the oxygen storage tank to a filling manifold, press the Stop button on the oxygen pump's control panel.

This stops filling from the oxygen storage tank.

Stopping at the manifold

In case of a minor incident at a filling manifold, such as a pigtail breaking or a safety relief valve lifting, use the control to stop filling at the manifold.

Push the Fill button on the manifold control panel at filling station #1.

Close the Fill valve on the manifold control panel at filling station #2.

Emergency plan

You should become familiar with the Quebec City plant's emergency plan. There is a copy of it in the plant office, and maps of emergency exits beside all doors from the plant.
Before Filling

Check Filling Area, Equipment, and Measuring Devices

Filling area
Check the area around the filling station. It should:

- be clean and tidy
- be clearly labelled as an area used only for filling with medical oxygen
- have clear identifying labels on pipes (e.g., oxygen) and on valves (e.g., vent, vacuum)
- have separate and clearly labelled areas for medical oxygen cylinders that have reached the same stage in the filling process (i.e., empty, filled and awaiting release, quarantined, released, or rejected)

Filling equipment
Check the following items for cracks, wear, or other kinds of damage, and for contamination with oil or other substances:

- flexible filling lines
- threads and O-rings of the pigtail connectors used with large cylinders (left photo)
- pins (right photo) of pin-index yoke connectors used with small cylinders

If any of these items are in poor condition or missing parts, replace them or have a maintenance technician replace them before filling.

See IND-17-02: Condition Monitoring of Permanent Gas-Filling Equipment.

Measuring devices
Check that the measuring devices used when filling cylinders with medical oxygen are well calibrated.

See IND-28-14: Calibration of Instruments.
Step | Action
--- | ---
1 | **Pressure indicators**
   Verify that when the oxygen pump is turned off:
   - the fill pressure indicator at filling station #1 reads zero (left)
   - both fill pressure gauges at filling station #2 read zero (right)

2 | Verify that when no vacuum is being pulled:
   [i.e., when
   - the vacuum pump is turned, or
   - the vacuum button at filling station #1 is pushed off (left) and
   - the vacuum valves at filling station #2 are turned off (right)]
   the vacuum pressure gauges at filling station #1 (left) and #2 (right) read zero.

3 | For each pressure-measuring device, check that the date on which its next calibration is due has not passed.
   The due date is written on the calibration sticker stuck on each measuring device.

4 | **Thermometer**
   Thermometers are calibrated once a year. Verify that the calibration-due date of the thermometer used to measure filling temperature has not passed.
Select Cylinders

Bring cylinders to manifold

Select cylinders that:

- were previously filled with medical oxygen, and
- do not have tags identifying them as needing maintenance or having defects

Bring the selected cylinders to the oxygen manifold.

Place a total of 16 large cylinders (i.e. sizes T, K, or M) upright, 8 on each of the two sides of filling station #1 (left).

Place a total of 24 small cylinders (i.e. sizes E, D, or B) with their valves pointing down, 12 on each of the two slanted racks at filling station #2 (right).

Record Information

Begin a Production Control Report

Begin to fill out a Production Control Report (PCR) by entering the batch, lot, and SAP numbers that identify the oxygen with which you will fill the cylinders.

For the PCR for medical oxygen see MED-08-15 : Compressed Medical Oxygen.

Check Cylinders

Check cylinders, outside and inside

Visually check the outside of each cylinder to make sure that:

- there is no damage or contamination
- the paint is correct and in good shape
- stamped markings are correct
- valves and safety devices are correct

You may carry out these visual checks before or after bringing the cylinders to the manifold.

Indirectly check inside each cylinder for possible contamination by following the instructions below for:

- hammer test (on steel cylinders)
- residual pressure test
- internal moisture test
- odour tests

If a cylinder fails any of these external or internal inspections, put a tag or chalk mark on it to identify it as needing maintenance, and to identify its problem.

See IND-16-05 : Carrying Out a Cylinder Pre-fill Inspection.
Damage and External Contamination

Damage
Make sure that there are no visible signs of damage to the cylinder such as:

- bulging or swelling (the bottom of the cylinder should be flat)
- dents, digs, cuts, gouges, or cracks
- excessive corrosion or pitting
- burns or other signs of damage due to fire or heat

External contamination
Make sure that there is no grease, oil, or dirt on the cylinder.

Paint

<table>
<thead>
<tr>
<th>Step</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Verify that the cylinder is painted in the colours that BOC uses to identify cylinders containing Oxygen USP.</td>
</tr>
<tr>
<td></td>
<td>• shoulder: white</td>
</tr>
<tr>
<td></td>
<td>• body: white</td>
</tr>
<tr>
<td>2</td>
<td>Verify that the paint is in good condition.</td>
</tr>
<tr>
<td></td>
<td>See Cylinder Appearance Standards (when published).</td>
</tr>
<tr>
<td>3</td>
<td>Verify that paint has not been sprayed on the valve.</td>
</tr>
</tbody>
</table>

Stamped Markings

<table>
<thead>
<tr>
<th>Step</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Verify that the date on which the cylinder last passed a hydrostatic pressure test is clearly stamped on its shoulder.</td>
</tr>
</tbody>
</table>
2 From the date of the last hydrostatic test, determine the date when the next test is due.  

The next test is due 5 years after the last test unless the cylinder has a five-pointed star following the stamped date (as in the photo above).  

If the cylinder has this star, its next test is due 10 years after the last test.  

Example: The numbers 06 127 06 in the photo above mean that the cylinder was last tested, on the sixth month (i.e., June), at BOC’s Montreal plant (identified by 127, its Transport Canada identification number), of the year 2006 (06).  

The star means that this cylinder’s next test is due on June 1, 2016 (i.e., 10 years after June 2006).  

3 If the date on which its next hydrostatic pressure test is due has passed, move the cylinder to the hydrostatic test area.  

4 Verify that DOT (US Department of Transport) and TC (Transport Canada) specification marks are clearly stamped on the cylinder.  

As seen in the photo below left, the code (TC-3AA2015) includes the service pressure (2015 psi). (This code is also written TC-3AAM154, where the rated service pressure, 154 bars, is in metric pressure units.)  

The plus sign following the stamped date (photo, below right) means that the actual maximum allowable service pressure is 10% more than the stamped pressure. Thus this cylinder’s maximum allowable service pressure is 2217 psi.  

5 Verify that the serial number and the owner's name (e.g. BOC Canada) are clearly stamped on the cylinder shoulder.

Valves and Safety Devices

Make sure that:  

1 Both the valve (left) and the rupture disc (right) are of appropriate size for the pressure to which the cylinder will be filled.  

(See the table of cylinder data below.)  

2 The valve is not bent or damaged.  

3 The valve is free of water, oil, dirt, grit, paint, or other contaminants.  

4 The valve outlet threads are not obviously worn or damaged.
Make sure that:

5. The valve hand wheel is securely attached, complete, free of sharp edges, and not
   broken or damaged.

6. The valve guard (also known as the cylinder valve protection cap) screws securely
down on the neck ring threads, and is not cracked, bent, broken or otherwise damaged.

7. The bursting disc (or other safety device) is not blocked or damaged, has no
   mechanical defect, and does not show any signs of having been tampered with.

8. The safety devices show no corrosion.

9. The safety valve discharge port is not plugged.

<table>
<thead>
<tr>
<th>BOC name</th>
<th>Specification mark DOT/TC</th>
<th>Allowable pressure (rated + 10%) in psi</th>
<th>Target fill pressure at 70°F (psi)</th>
<th>Valve type</th>
<th>Rupture disk burst pressure in psi</th>
</tr>
</thead>
<tbody>
<tr>
<td>large</td>
<td>T DOT 3AA2400 TC 3AAM183</td>
<td>2640</td>
<td>2640</td>
<td>CGA 540</td>
<td>4000</td>
</tr>
<tr>
<td>large</td>
<td>K, M DOT 3AA2015 TC 3AAM154</td>
<td>2217</td>
<td>2217</td>
<td>CGA 540</td>
<td>3360</td>
</tr>
<tr>
<td>small</td>
<td>C, D, E DOT 3AA2015 TC 3AAM154</td>
<td>2015</td>
<td>2000</td>
<td>CGA 870</td>
<td>3360</td>
</tr>
</tbody>
</table>

Hammer Test

Hammer (dead ring) test

Tap each large steel cylinder lightly at mid-height with a ½-pound ball-peen hammer or with a tool
of similar weight. (Do not perform this test on aluminum cylinders, which do not ring clearly.)

A bell-like clear ringing sound (see attachment) that dies away slowly indicates that the interior of
the cylinder is undamaged, clean, and dry and hence safe to fill.

A dull thud sound (see attachment) that dies away quickly indicates that there is liquid or
corrosion in the cylinder. If you hear such a sound, tag the cylinder to identify the problem and to
identify it as needing maintenance.

Residual Pressure Test

<table>
<thead>
<tr>
<th>Step</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step</td>
<td>Action</td>
</tr>
<tr>
<td>------</td>
<td>--------</td>
</tr>
<tr>
<td>1</td>
<td>Slowly open each cylinder valve, and verify that the valve stem (spindle) does not feel either very stiff or too free.</td>
</tr>
<tr>
<td>2</td>
<td>Check that there is residual pressure in each cylinder.</td>
</tr>
<tr>
<td>2a</td>
<td>If gas does come out of the cylinder, and you can hear it flowing or feel its pressure, go to Odour Test (Page 12).</td>
</tr>
<tr>
<td>2b</td>
<td>If there is no residual pressure in a cylinder, go to Internal Moisture Test (Page 12).</td>
</tr>
</tbody>
</table>

**Internal Moisture Test**

**Internal moisture test**

This test is to make sure that there is no foreign liquid inside a cylinder.

If you are testing a small cylinder, follow the steps below.

For more information, and for instructions on how to test large cylinders, see *IND-16-05: Carrying out a Cylinder Pre-Fill Inspection*.

<table>
<thead>
<tr>
<th>Step</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Inject about 30 psig of Nitrogen, USP into a small cylinder held valve-down on its slanted rank.</td>
</tr>
<tr>
<td>2</td>
<td>Close the cylinder valve.</td>
</tr>
<tr>
<td>3</td>
<td>After at least five minutes, open the cylinder valve and allow the stream of gas to blow against a stainless steel mirror.</td>
</tr>
<tr>
<td>3a</td>
<td>If you see or hear no signs of contamination with a foreign liquid:</td>
</tr>
<tr>
<td></td>
<td>• mark the cylinder so that you will remember that it is empty and will have to be purged (see <strong>Purge, Vent, and Evacuate Empty Cylinders (Page 15)</strong>)</td>
</tr>
<tr>
<td></td>
<td>• go to Odour Test (Page 12)</td>
</tr>
<tr>
<td>3b</td>
<td>If you do see condensation on the mirror, or hear a spitting sound, tag the cylinder to identify it as being contaminated with a foreign liquid and needing maintenance.</td>
</tr>
</tbody>
</table>

**Odour Test**

<table>
<thead>
<tr>
<th>Step</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Slightly open each cylinder valve.</td>
</tr>
<tr>
<td>2</td>
<td>Fan some gas towards your nose with your cupped hand. Sniff the gas.</td>
</tr>
</tbody>
</table>
### Remove Old Labels and Tags

**Remove old labels and tags**

Remove medical tags and bar-coded lot labels (left).

Remove product-identification labels (right) if they are torn, unreadable, or if they cover stamped information.

**Tip:** It's easier to remove labels from warm cylinders than from cold ones. If the cylinders are cold, wait for them to warm up (until after filling, if necessary) before removing labels.

### Record Information

**Record checks and results**

As soon as you have completed the above checks and tests enter the results in the Production Control Record.

### Filling

### Introduction
Introduction

Before being filled with oxygen for medical use, any cylinders that had no residual gas, including new or revalved cylinders, **must** first be purged with oxygen, vented, and evacuated.

All cylinders **must** then be vented and evacuated to a pressure of -27 inHg or less.

To vent, evacuate, purge, and fill large cylinders use the controls at filling station #1.

Step 1 Action

1. If the cryogenic oxygen pump is not already running, start it.

   See Operating the Cryogenic Pump (when published).
Step | Action
--- | ---
2 | Make sure that the vent, vacuum, and fill controls are:
   - pushed off at filling station #1 (left)
   - turned off at filling station #2 (right).

3 | Using pigtail connectors, connect all the large cylinders to be filled at the two racks at filling station #1 (left).
Using pin-index yoke connection adapters, connect all small cylinders to be filled at filling station #2 (right)

*Note:* Take care not to cross-thread any connectors.

4 | Are you filling any cylinders that:
   - have a *1er REMPLISSAGE* (First Fill) label (i.e., are new or revalved)?
   - had open valves?

4a | Yes. If you are filling some of these kinds of cylinder go to *Purge, Vent, and Evacuate Empty Cylinders (Page 15).*

4b | No. If you are not filling any such cylinders, go directly to *Vent and Evacuate All Cylinders (Page 18).*

---

**Purge, Vent, and Evacuate Empty Cylinders**

*First Fill* cylinders

Following the instructions below, *Purge (Page 16), Vent (Page 16), and Evacuate (Page 17)* all the connected cylinders.
Then *Vent and Evacuate All Cylinders (Page 18)* a second time.
Purge

Step  Action
1  Fully open the cylinder valves on all connected cylinders.
   **Note:** Open valves slowly, using a BOC-approved tool.
   Be systematic in going from one cylinder to the next so that you do not skip a cylinder.
   1a If a valve stem (a spindle) feels either very stiff or too free, attach a tag to the faulty cylinder identifying the problem and identifying the cylinder as needing maintenance, and replace it on the filling rack with another cylinder.
2  **Purge**
   Start filling by:
   - pulling the fill button on at filling station #1 (left)
   - turning the fill controls on at filling station #2 (right)

3  When the fill pressure (indicated by the fill pressure indicator at the filling station #1, and by the fill pressure gauges at filling station #2) has reached about 100 psi (which will only take seconds), stop filling by:
   - pushing the fill button off at filling station #1 (left)
   - turning the fill controls off at filling station #2 (right)

Vent

Step  Action
Step 1  Action

Open the manifold vent valves by:

- pulling the vent button on at filling station #1 (left)
- turning the vent controls on at filling station #2 (right)

Step 2  Action

When you can no longer hear residual gas leaving any of the cylinders, (i.e., when the pressure in all cylinders has dropped to atmospheric pressure), close the manifold vents by:

- pushing the vent button off at filling station #1 (left)
- turning the vent controls off at filling station #2 (right)

Evacuate

Step 1  Action

Turn the vacuum pump on by pressing its Start button.

Step 2  Action

Open the manifold vacuum valve by:

- pulling the vacuum button on at filling station #1 (left)
- turning the vacuum controls on at filling station #2 (right)
Step 3
After the vacuum pressure gauge indicates that the vacuum pressure has dropped to -27 inHg, close the vacuum valve by:

- pushing the vacuum button off at filling station #1 (left)
- turning the vacuum control off at filling station #2 (right)

4
After 1 minute, check the vacuum pressure gauge again.

4a
If the vacuum pressure stays at -27 inHg and you have only evacuated the connected cylinders once, go to *Vent and Evacuate All Cylinders (Page 18)*.

*Note:* The static vacuum test that you have just performed verifies that the pressure is equal in all connected cylinders and that there are no leaks in the connections.

4b
If the vacuum pressure stays at -27 inHg and you have evacuated the connected cylinders twice, go to *Record Information (Page 18)*.

4c
If the vacuum pressure reading climbs up (from -27 inHg to -26 inHg, for instance), listen and look for leaks. If you find any loose connections, tighten them. If the leaking persists, stop the vacuum pump and inform your supervisor.

**Vent and Evacuate All Cylinders**

**Vent**

<table>
<thead>
<tr>
<th>Step</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Follow the instructions in <em>Vent (Page 16)</em>, above.</td>
</tr>
</tbody>
</table>

**Evacuate**

<table>
<thead>
<tr>
<th>Step</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>If it is not already on, turn the vacuum pump on by pressing its Start button.</td>
</tr>
<tr>
<td>2</td>
<td>Follow the instructions in <em>Evacuate (Page 17)</em>, above.</td>
</tr>
<tr>
<td>3</td>
<td>Turn the vacuum pump off.</td>
</tr>
</tbody>
</table>

**Record Information**

| Record | |
|--------| Record details of any purging and venting and evacuating on the Production Control record. |
Start Filling

Step  Action
1. If you are filling at filling station #1, set the allowable pressure for the connected cylinders as the target fill pressure by pressing the Up Arrow or Down Arrow on the pressure indicator.

   Note: The allowable pressures to which cylinders at 70°F may be filled are listed in the table of cylinder data above. You can also determine them from the stamped markings (see Stamped Markings (Page 9), step 4.

2. If you are filling at filling station #2, open the fill valves.

Test for Leaks

Test for leaks You must test for leaks early in the filling procedure.

After filling you must Test for Leaks (Page 25) again around the cylinder valve and neck using leak-detection fluid.

Test for Leaks in the Fill Line-to-Cylinder Connection

Step  Action
1. Before the fill pressure has reached 500 psi check for minor leaks in the connection between the fill line and the cylinder valve. Do not use leak-detection fluid on this connection. Look for frost forming and listen for the whistling sound of escaping gas.

2. If you detect such a leak tighten the filling connections by hand to try to stop the leak.

2a. If this fixes the leak, go to Test for Leaks Around the Cylinder Valve and Neck (Page 20).

2b. If the leak cannot be fixed by hand-tightening the connection:
   - stop filling
   - vent the manifold and all connected cylinders
   - tag the leaking cylinder to identify it as leaking and needing maintenance
   - replace the leaking cylinder
   - go back to Start Filling (Page 19)
Test for Leaks Around the Cylinder Valve and Neck

Step  Action
1  Using the BOC-approved leak-detection liquid provided at the filling station, check for leaks around:
   • the threads with which the valve is screwed into the neck of the cylinder
   • the safety relief device
   • the valve stem to which the hand wheel is connected

Spray a narrow spray of leak-detector liquid on these cylinder valve parts. Avoid spraying fluid on the valve outlet and the attached fill connector. Look for bubbles, which indicate leaks.

1a If you detect no leaks, go to Test for Warmth (Page 20).
1b If you detect a leak in a cylinder:
   • close the cylinder valve to isolate it from the manifold
   • continue filling the other connected cylinders
   • when the fill is complete, vent the leaking cylinder
   • tag the cylinder to identify it as leaking and needing maintenance

Test for Warmth

Test for warmth  You can tell whether a cylinder is filling by a heat check. As a cylinder fills the pressure inside it and its temperature increases.

Step  Action
1 When the fill pressure approaches 1000 psig begin checking that the cylinders are indeed filling by touching each one with your bare hand.
1a If a cylinder feels warm, then it is filling correctly. Go to Adjust Target Fill Pressure (Page 21).
1b If a cylinder feels cold, then it is not filling. Try to close the cylinder valve.
1c If the valve is already closed:
- tag the cylinder to identify it as being empty
- continue filling the other cylinders
- you may include the tagged empty cylinder in the next batch to be filled

**Note:** Do not open a closed cylinder valve after filling has started. Because its valve was closed, this cylinder was not properly evacuated and thus may be contaminated. Opening a valve after the fill has started may start a fire.

1d If the valve is open but the cylinder is not filling:
- close the valve
- tag the cylinder to identify is as having a blocked valve
- continue filling the other cylinders
- put the faulty cylinder in the area for defective cylinders

1e If a cylinder feels very warm or if you hear a muffled explosion then internal ignition has occurred.
- stop filling immediately.
- notify your supervisor.
- tag the cylinder in which the fire occurred and the other connected cylinders, to identify the problem and to identify them as needing maintenance

### Adjust Target Fill Pressure

<table>
<thead>
<tr>
<th>Step</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>As the pressure approaches the target fill pressure measure the temperature of the cylinder that is closest to the filling station control panel by placing the thermometer or probe at a point halfway between the cylinder's waist and its shoulder.</td>
</tr>
</tbody>
</table>
Step 2  
On the chart of oxygen pressure and temperature (posted beside the filling station, and published in \textit{MED-08-15 : Compressed Medical Oxygen}) look up the target pressure to which the cylinders are to be filled.

In the example illustrated below, a temperature of 74ºF measured on a cylinder whose maximum allowable service pressure is 2640 psi gives a target fill pressure of 2670 psi.

\textbf{Temperature and Pressure Chart}

<table>
<thead>
<tr>
<th>Temp °F</th>
<th>Oxygen Pressure (PSIG)</th>
<th>Temp °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>(20)</td>
<td></td>
<td>(21.1)</td>
</tr>
<tr>
<td>50</td>
<td>1800</td>
<td>10</td>
</tr>
<tr>
<td>52</td>
<td>1810</td>
<td>11.1</td>
</tr>
<tr>
<td>54</td>
<td>1820</td>
<td>12.2</td>
</tr>
<tr>
<td>56</td>
<td>1830</td>
<td>13.3</td>
</tr>
<tr>
<td>58</td>
<td>1840</td>
<td>14.4</td>
</tr>
<tr>
<td>60</td>
<td>1850</td>
<td>15.6</td>
</tr>
<tr>
<td>62</td>
<td>1860</td>
<td>16.7</td>
</tr>
<tr>
<td>64</td>
<td>1870</td>
<td>17.8</td>
</tr>
<tr>
<td>66</td>
<td>1880</td>
<td>18.9</td>
</tr>
<tr>
<td>68</td>
<td>1890</td>
<td>20</td>
</tr>
<tr>
<td>70</td>
<td>1900</td>
<td>21.1</td>
</tr>
<tr>
<td>72</td>
<td>1910</td>
<td>22.2</td>
</tr>
<tr>
<td>74</td>
<td>1920</td>
<td>23.3</td>
</tr>
</tbody>
</table>

3  
Set the revised target pressure

3a  
**Filling station #1**

Use the Up Arrow or Down Arrow buttons on the pressure indicator/controller to adjust the setting to the revised target fill pressure.

Once the fill pressure reaches the set target, filling will stop automatically.

3b  
**Filling station #2**

When the fill pressure has reached the revised target fill pressure, stop filling by turning the fill valves off.

4  
Check the pressure that the fill pressure indicator (at filling station #1) or gauge (at filling station #2) now indicates.

4a  
If this (known as the static pressure) is equal to the target fill pressure go to \textit{Stop Filling (Page 23)}. 
Step | Action
--- | ---
4b | If the static pressure is more than 10 psi less than the target fill pressure, top up the cylinders to the desired target pressure by:
   - pulling the fill button on at filling station #1
   - turning the fill controls on at filling station #2
4c | If the static pressure is more than 10 psi above the target fill pressure, Vent (Page 16) the cylinders until they reach the desired target pressure.

Stop Filling

Step | Action
--- | ---
1 | Close all the cylinder valves, using a BOC-approved tool. Do not overtighten. Be systematic in going from one cylinder to the next so that you do not skip a cylinder.
   1a | If you find a cylinder with a closed valve, identify it for refill.
2 | Verify that the pressure indicator or gauge now indicates the target fill pressure.
   2a | If the pressure indicator or gauge reads less than the target fill pressure:
      - look for and fix whatever is causing the difference in pressures, which may be a leak in the system or a malfunction of the pressure controller
      - start the fill process again (go to Start Filling (Page 19)) to top-up the cylinders to the correct target fill pressure
3 | As soon as you have completed step 2, record the final fill pressure and temperature in the Production Control Record.
4 | Vent the manifold and fill lines by:
   - pulling the vent button on at filling station #1 (left)
   - turning the vent controls on at filling station #2 (right)
5 | When all residual product has vented, stop venting by:
   - pushing the vent button off at filling station #1 (left)
   - turning the vent controls off at filling station #2 (right)
<table>
<thead>
<tr>
<th>Step</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>5a</td>
<td>If the pressure shown by the pressure indicator at filling station #1 or by the fill pressure gauge on filling station #2 drops to and remains at zero, go to step 6.</td>
</tr>
<tr>
<td>5b</td>
<td>If the pressure does not drop to zero, check all cylinder valves. If you find any cylinders with valves that were left open, close their valves and mark the cylinders &quot;MT&quot; for refill.</td>
</tr>
<tr>
<td>5c</td>
<td>If the pressure remains above zero, inform your supervisor. Do not disconnect the cylinders until it is safe to do so.</td>
</tr>
<tr>
<td>6</td>
<td>Once the pressure in the manifold has dropped to zero, disconnect the cylinders from the fill lines.</td>
</tr>
<tr>
<td>7</td>
<td>Quarantine all the filled cylinders by placing a quarantine sign at the manifold.</td>
</tr>
<tr>
<td>7a</td>
<td>If there is another batch of cylinders to be filled, complete the steps below to Release (Page 28) the cylinders you have just filled, then start Filling (Page 13) the next batch.</td>
</tr>
<tr>
<td>7b</td>
<td>If there are no more cylinders to be filled, turn off the cryogenic oxygen pump.</td>
</tr>
</tbody>
</table>

### After Filling

**Stick on New Labels**

<table>
<thead>
<tr>
<th>Stick on new labels</th>
<th>You may apply new labels and tags earlier.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>For instructions on how to apply labels see CMT-14-02 : About Labelling Containers.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Stick a new product label, if required, to the shoulder of each cylinder.</td>
</tr>
</tbody>
</table>

**Note:** The product-identification label is also known as the TDG/WHMIS label because it carries information and symbols in accordance with regulations on Transport of Dangerous Goods (TDG) and the Workplace Hazardous Materials Information System (WHMIS).
Step 2  
Prepare and stick on to the shoulder of each cylinder a label with a bar code identifying the lot number.

Test for Leaks

Test for leaks  
*Test for Leaks Around the Cylinder Valve and Neck (Page 20)* again by spraying approved leak-detector fluid around the valve parts of both large and small cylinders and looking for bubbling.

Remove small cylinders from the cylinder rack. Place these cylinders vertically. As well as checking their valves, check their necks for cracks.

Tag any cylinders in which you find leaks to identify them as leaking and needing maintenance.

Analyze

Test purity of lot  
Before the cylinders you filled may be released for distribution, you **must** sample their contents, show that it is at least 99.2% pure oxygen, and get the person responsible for quality control (QC designee) to complete and sign the production control report.

See:
- *IND-08-15 : Compressed Medical Oxygen* for medical oxygen specifications
- *ANA-08-06 : Servomex Portable Oxygen Analyzer - Model 570* for instructions on measuring oxygen content

Step 1  
Select a sample cylinder, bring it to the medical analysis station, and record its serial number in the Production Control Record.

2  
**Zero calibration.** Connect a cylinder of zero gas (nitrogen grade 4.8 or better, i.e., at least 99.998% pure) to the Servomex Oxygen Analyzer, and let pure nitrogen flow through the instrument.

See *ANA-08-06 : Servomex Portable Oxygen Analyzer - Model 570A*.

2a  
If the analyzer does not display a reading of 00.0, use a screwdriver to turn the zero-adjust screw (located on the left-hand side of the instrument) to set a zero reading.
<table>
<thead>
<tr>
<th>Step</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td><strong>Span calibration.</strong> Connect a cylinder of span gas (certified to be more than 99.2% oxygen with the balance being nitrogen) to the Servomex oxygen analyser. Let this gas flow through the instrument.</td>
</tr>
<tr>
<td>3a</td>
<td>If the analyzer does not display a reading of the certified oxygen concentration of the span gas (e.g., 99.2), use the span calibration adjustment knob (located on the front of the instrument) to set the correct reading.</td>
</tr>
<tr>
<td>4</td>
<td>Recheck the zero reading (step 2).</td>
</tr>
<tr>
<td>5</td>
<td>Record any adjustments in the Production Control Report.</td>
</tr>
<tr>
<td>6</td>
<td>Connect the sample cylinder to the analyzer. Let some gas flow from at a pressure no greater than 10 psi through the oxygen analyser.</td>
</tr>
<tr>
<td>6a</td>
<td>If the analyser indicates that your sample has an oxygen concentration of 99.2% or more, and thus meets the specifications for medical-grade oxygen, continue to step 5.</td>
</tr>
</tbody>
</table>
| 6b   | If your first sample does not meet these specifications, go back to step 4 and analyse the oxygen content of three more samples drawn from the same cylinder.  
If all three samples meet specifications, continue to step 7.  
If any of the three samples do not meet specifications, go to step 8. |
| 7    | Check the odour of your sample. |
| 7a   | If you detect no odour, continue to step 9. |
| 7b   | If you detect an odour go to step 8. |
| 8    | If your sample does not meet specifications or has an odour:  
• tell your supervisor  
• tag all the cylinders in the lot you filled as being Out of Specification  
• notify the SHEQ Compliance Manager  
See **IMS-12-10 : Handling and Reporting Internal Non-Conformance in North America.** |
| 9    | Record all the results of the purity tests in the Production Control Record. |

**Record Pressure and Temperature of Sample**
Record pressure and temperature

Measure the pressure and temperature of the sample cylinder and record these measurements in the Production Control Record.

If the pressure in the sample cylinder is more than 10 psi below the target pressure, top up the pressure in all cylinders by reconnecting them to the manifold and restarting the fill process by going back to *Start Filling (Page 19)*.

If the pressure in the sample cylinder is more than 10 psi above the target pressure, reduce the pressure in all cylinders to the target pressure by slightly opening their valves.

Apply Tags and Seals

<table>
<thead>
<tr>
<th>Step</th>
<th>Action</th>
</tr>
</thead>
</table>
| 1    | For each cylinder filled, prepare a medical tag by entering data on:  
|      | • net contents (i.e., the volume of gas that the cylinder contains)  
|      | • the lot number identifying the gas that the cylinder contains  
|      | For data on the volume of gas that cylinders contain see the chart of content by cylinder size in *MED-08-15: Compressed Medical Oxygen*. |
| 2    | Attach a medical tag, prepared as in step 1, to each cylinder you filled. |
| 3    | On large cylinders, roll the medical tag to allow the protector cap to fit over it, and then screw down this cap. |
| 4    | On small cylinders, attach a tamper-evident seal to the valve. |
Release

Once the person who is authorised to perform quality control (the QC designee) has reviewed the lot of filled cylinders and signed the Production Control Report to indicate approval, remove the cylinders from quarantine. This releases them for distribution.

Attachment

The following document is attached to this chapter:

*Quick Guide (see attachment)*