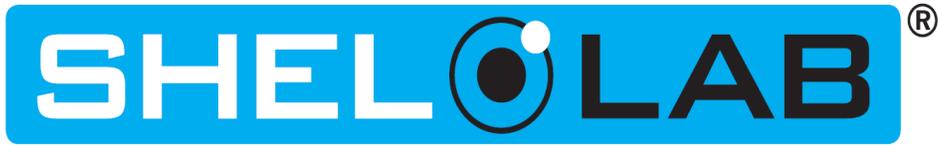


BACTROX 220 – 240 Volts



# Installation and Operation Manual

BACXTROX-2

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# **BACTROX HYPOXIA CHAMBER 220 – 240 Volts**

## **Installation and Operation Manual**

**Part Number (Manual): 4861715**

**Revision: February 1, 2016**

These units are TÜV CUE listed as climatic chambers for professional, industrial, or educational use where the preparation or testing of materials is done at an ambient air pressure range of 22.14 – 31.3 inHg (75 – 106 kPa) and no flammable, volatile, or combustible materials are being heated.

These units have been tested to the following requirements:

CAN/CSA C22.2 No. 61010-1:2012

CAN/CSA C22.2 No. 61010-2-010:2004 Reaffirmed: 2014-07

UL 61010-1:2012-05

UL 61010A-2-010:2002-03

EN 61010-1:2010

EN 61010-2-010:2014

Supplemented by: UL 61010-2-010:2015

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# INTRODUCTION

*Thank you for purchasing a Shel Lab BACTROX Hypoxia Chamber Workstation. We know that in today's competitive marketplace, customers have many choices when it comes to constant temperature equipment. We appreciate you choosing ours. Our continued reputation as a leading laboratory product manufacturer rests with your satisfaction. Sheldon Manufacturing, Inc. stands behind our products, and we will be there if you need us.*

BACTROX workstations are intended for professional, industrial, and educational applications as hypoxia workstations suitable for the cultivation of bacteria and cell cultures. They are not intended for use at hazardous or household locations. Only use this equipment within its intended spectrum of applications; any alterations or modifications void the warranty.

## GENERAL SAFETY CONSIDERATIONS

---

**Note:** Failure to follow the guidelines and instructions in this manual may create a protection impairment by disabling or interfering with the unit's safety features. This can result in injury or death.

---

Before using the BACTROX read this entire manual carefully to understand how to install, operate, and maintain the workstation in a safe manner. Keep this manual available for use by all workstation operators. Ensure that all operators are given appropriate training prior to using the BACTROX.

The BACTROX and its recommended accessories are designed and tested to meet strict safety requirements. The workstation is built to connect to a wall power source using the specific power cord type shipped with the unit.

For safe operation of your BACTROX, always follow basic safety precautions including:

- Follow all local or regional ordinances in your area regarding the use of this unit. If you have any questions about local regulations, please contact the appropriate agency.
- Use only approved accessories. Do not modify system components. Any alterations or modifications to your BACTROX can be dangerous and void your warranty.
- Always plug the BACTROX power cord into an earth grounded electrical outlet that conforms to national and local electrical codes. If the workstation is not grounded properly, parts such as knobs and controls can conduct electricity and cause serious injury.
- Avoid damaging the power cord. Do not bend it excessively, step on it, or place heavy objects on it. A damaged cord can be a shock or fire hazard. Never use a power cord if it is damaged.
- Position the workstation so the end-user can quickly unplug the unit in the event of an emergency.
- Do not attempt to move the workstation while it is in operation.

# INTRODUCTION (CONTINUED)

## *ENGINEERING IMPROVEMENTS*

Sheldon Manufacturing continually improves all of its products. As a result, engineering changes and improvements are made from time to time. Therefore, some changes, modifications, and improvements may not be covered in this manual. If your unit's operating characteristics or appearance differs from those described in this manual, please contact your Shel Lab dealer or distributor for assistance.

## *CONTACTING ASSISTANCE*

If you are unable to resolve a technical issue with the BACTROX, please contact Sheldon Technical Support. Phone hours for Sheldon Technical Support are 6 am – 4:30 pm Pacific Coast Time (west coast of the United States, UTC -8).

Please have the following information ready when calling or emailing Technical Support: the **model number** and the **serial number**. These will be found on the unit's data plate. See the [Recording Data Plate Information entry](#) on page 11, for the location of the data plate.

EMAIL: tech@shellab.com PHONE: 1-800-322-4897 extension 4 or (503) 640-3000 FAX: (503) 640-1366

Sheldon Manufacturing INC.  
P.O. Box 627  
Cornelius, OR 97113

# RECEIVING YOUR BACTROX

## INSPECT THE SHIPMENT

- When an oven leaves the factory, **safe delivery becomes the responsibility of the carrier.**
- Damage sustained during transit is not covered by the manufacturing defect warranty.

When you receive your unit, inspect it for concealed loss or damage to its interior and exterior. If you find any damage to the oven, **follow the carrier's procedure for claiming damage or loss.**

1. Carefully inspect the shipping carton for damage.
2. Report any damage to the carrier service that delivered the oven.
3. If the carton is not damaged, open the carton and remove the contents.
4. The unit should come with an Installation and Operation Manual and a Certificate of Compliance.
5. Verify that the correct number of accessories have been included.

**Arm Port Door  
Left**



**Arm Port Door  
Right**



**Gas Regulator, CO<sub>2</sub>**



**Gas Regulator,  
Nitrogen**



**3 Incubator Shelf  
Spacers**



**4 Leveling Feet\***



**Power Cord  
CEE7/7 Euro**



**2 Rubber Cuff  
Plugs**



**7 Petrie Dish Racks**



**2 Sleeve  
Assemblies**



(Size 9 Large)

**Calibration Ambient  
Air Sample Pump**



**Calibration Kit Cover**



**Cal / Data Logging  
RS232 Cable**



**Calibration RS232 to  
USB Adaptor Kit**



**Document Shelf**



\*BACTROXes shipped mounted on a stand do not include leveling feet.

6. Carefully check all packaging before discarding. Save the shipping carton until you are certain that the unit and its accessories function properly.

# RECEIVING YOUR BACTROX (CONTINUED)

## ORIENTATION

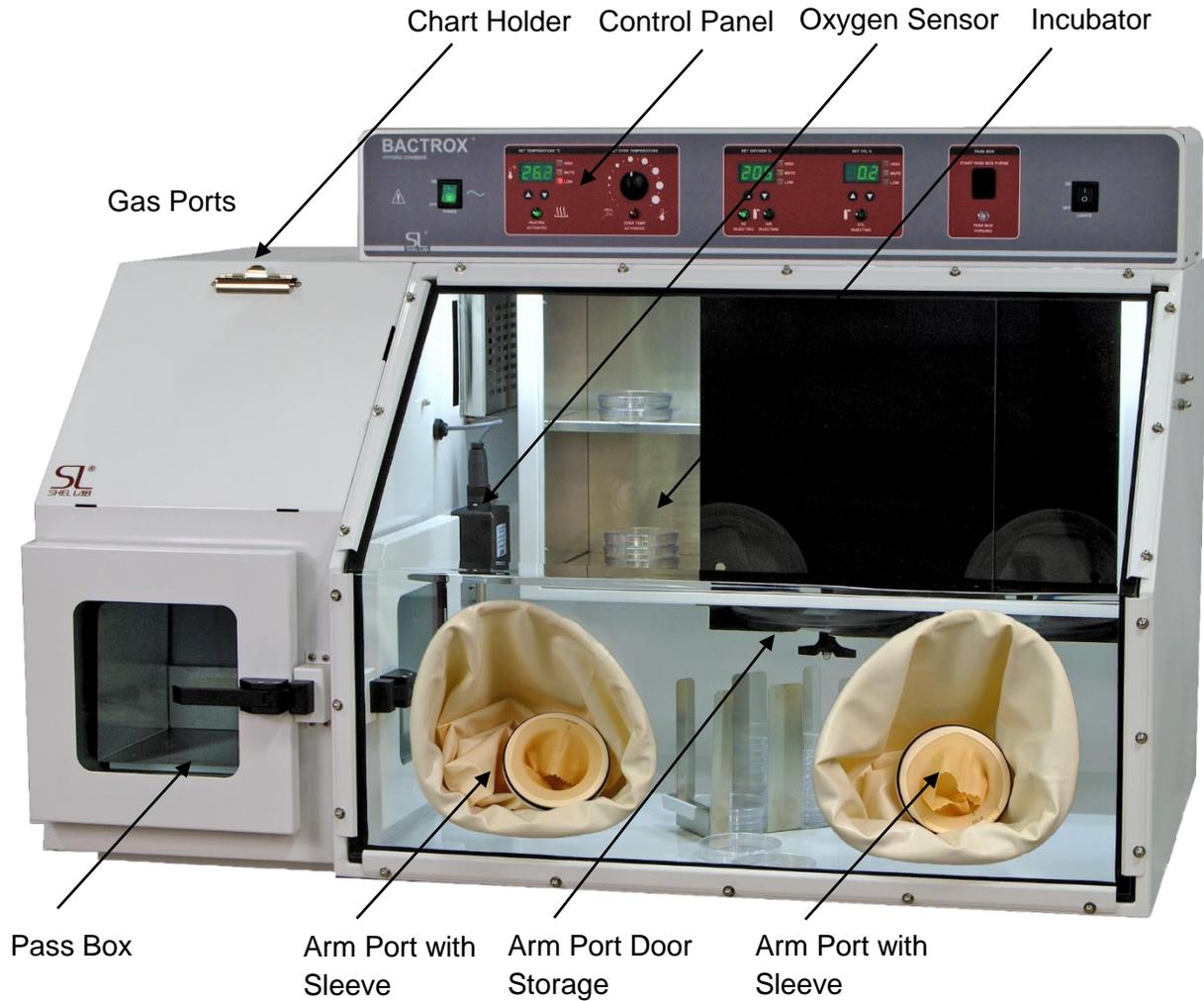


Figure 1: BACTROX-2 Exterior

# RECEIVING YOUR BACTROX (CONTINUED)

## Additional Chamber Orientation



Figure 3: O<sub>2</sub> Sensor

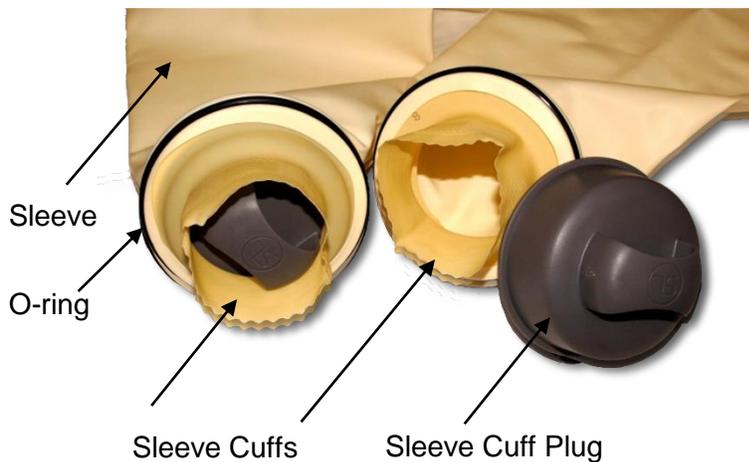


Figure 2: Sleeve Assemblies

Oxygen Sensor Assembly  
Power Outlet. Note:  
Outlet type will vary  
by voltage and nation.  
Sensor Cage

Pass Box Sliding Shelf

Figure 4: Pass Box



# RECEIVING YOUR BACTROX (CONTINUED)

## Vents – Back of the Unit



**Figure 6: Chamber Vent**

Oxygenated atmosphere is forced out of the workspace chamber through this vent. Do not plug or obstruct!

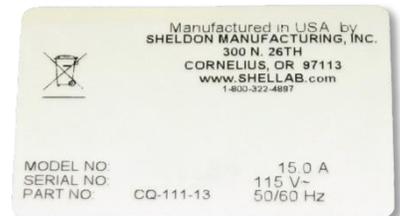


**Figure 5: Pass Box Vent**

During pass box purge cycles evacuated air is exhausted through this vent. The pass box vent should never be plugged while the unit is in operation. Remove the vent cover after installing the unit.

## RECORDING DATA PLATE INFORMATION

Locate the data plate in the workspace chamber above the inner pass box door. The data plate contains the BACTROX model number and serial number. Enter this information below for future reference.



**Figure 7: Data Plate**

### Date Plate Information

<b>Model Number</b>	
<b>Serial Number</b>	

# RECEIVING YOUR BACTROX (CONTINUED)

## CALIBRATION ITEMS

### **Calibration Gas – O<sub>2</sub> Display and Sensor**

The BACTROX oxygen sensor requires periodic calibrations to compensate for drifts in accuracy. These drifts are caused by a naturally occurring material evolution over the operational lifetime of the sensor. The BACTROX O<sub>2</sub> sensor can be calibrated to a single O<sub>2</sub> value with a matching sample. However, a dual point calibration, calibrating at a high value and then a low value, provides accuracy across a range of O<sub>2</sub> concentrations. The high-value sample may be drawn from the ambient atmosphere, after calculating its oxygen concentration (please see page 88). Since the low value for a hypoxic range must be below the atmospheric concentration, a man-made supply with a known hypoxic O<sub>2</sub> concentration is required. Single point calibrations for hypoxic values also require a manufactured sample gas.

Such reference or calibration gases are purchased in a supply cylinder, which will require its own regulator and tubing to connect to the BACTROX. Check with your gas supplier for the appropriate regulator type. Only use oxygen – nitrogen mixes for O<sub>2</sub> sensor calibrations. Do not use an O<sub>2</sub> - CO<sub>2</sub> mix for an O<sub>2</sub> calibration, even if you will be running a carbon dioxide-enriched environment.

O<sub>2</sub> sensor calibrations typically only use a small volume of gas.

Calibration mixes are sometimes known among gas suppliers as **Certified Standard Mixtures** or **Portable Calibration Gases** with a **% Oxygen**.

The BACTROX is dual-point calibrated at the factory. The low value is supplied with a certified standard gas mix purchased from Airgas with 5% O<sub>2</sub> – 95% N<sub>2</sub> balance (Airgas part number X02NI95C3006050). Airgas also provides other certified O<sub>2</sub> – N<sub>2</sub> mixes suitable for accurately calibrating the BACTROX at a variety of hypoxic values.

These include:

1% O <sub>2</sub> - 99% N <sub>2</sub>	8% O <sub>2</sub> - 92% N <sub>2</sub>
3% O <sub>2</sub> - 97% N <sub>2</sub>	10% O <sub>2</sub> - 90% N <sub>2</sub>
5% O <sub>2</sub> - 95% N <sub>2</sub>	21% O <sub>2</sub> - 79% N <sub>2</sub>

### **CO<sub>2</sub> Calibration Reference Device**

The carbon dioxide (CO<sub>2</sub>) sensor operates at significantly cooler internal temperatures than the O<sub>2</sub> sensor and does not require a calibration gas. A digital reference gas analyzer capable of detecting CO<sub>2</sub> concentrations at least of 0.1% will suffice, and must be purchased separately.

### **Incubator Temperature Reference Device**

The incubator requires a temperature reference thermometer accurate to at least 0.1°C for performing temperature display calibrations. The reference sensor must be purchased separately. For best results, use a digital reference device with a wire sensor probe to take remote readings. Remote readings may offer an hour or more of time savings during each calibration. Do not use an alcohol or mercury thermometer.

# INSTALLATION

## *INSTALLATION CHECK LIST*

Perform the following procedures in the Installation section to prepare and install the BACTROX in a laboratory or workspace location.

- ✓ **Required Ambient Conditions**, page 14
  - Verify that the room temperature, humidity level, and space available fall within the BACTROX-required ranges.
- ✓ **Check for Ambient Disruptions**, page 14
  - Check that potential locations do not expose the BACTROX to significant sources of heat or cold.
- ✓ **UV Lighting**, page 14
  - Verify that potential locations do not expose the BACTROX to UV lighting or direct sunlight
- ✓ **Power Source Requirements**, page 15
  - Verify that potential locations have power sources that match the power requirements listed on the BACTROX data plate, inside the chamber.
- ✓ Read the **Lifting and Handling** and the **Leveling** entries, page 16
  - Read how to safely move and level the unit.
- ✓ **Gas Sources and Usage**, page 17
  - Read about gas source types, requirements, and N<sub>2</sub> usage rates.
- ✓ **Install the Workstation**, page 16
  - Install the BACTROX in a location that matches the criteria listed in the previous procedures.
- ✓ **Connect to Gas Sources**, page 18
  - Connect the BACTROX to its nitrogen gas source and any CO<sub>2</sub> source.
- ✓ **Cleaning and Install Accessories**, page 19
  - Remove shipping wrapping from and clean the BACTROX interior, shelving, and accessories.
  - Place the cleaned accessories inside the workspace chamber.
- ✓ **Shelving Installation**, page 20
  - Install the shelf spacers in the workspace incubator.
- ✓ **Install Arm Port Doors** and **Install the Sleeve Assemblies**, page 22
  - Install the arm port doors in the arm ports on the front panel of the unit, then install the sleeve assemblies on the ports.
- ✓ **Remove the Pass Box Vent Cover**, page 23

# INSTALLATION (CONTINUED)

## *REQUIRED AMBIENT CONDITIONS*

This workstation is intended for use indoors at room temperatures between **15°C and 30°C (59°F and 86°F)**, at no greater than **80% Relative Humidity** (at 25°C / 77°F). Allow a minimum of 4 inches (10cm) between the workstation and walls or partitions, and 2 inches (5cm) of clearance above the top of the workstation for unobstructed airflow.

**Operating the unit outside of these conditions may adversely affect the unit temperature range and stability.**

For conditions outside of those listed above, please contact your distributor or Shel Lab representative to explore other unit options suited to your laboratory or production environment.

## *AMBIENT DISRUPTIONS*

When selecting a location to install your BACTROX, consider environmental factors that can affect the workstation temperature stability and atmospheric integrity:

- Ovens, autoclaves, and any device that produces significant radiant heat
- Heating and cooling ducts, or other sources of fast moving air currents
- High-traffic areas
- Direct sunlight

**Condensation:** Direct exposure to air conditioning vents or other sources of cold air can result in condensation or fogging on workstation acrylic glass panels, depending on humidity and other ambient conditions. Prolonged exposure to cold air flows may adversely affect the temperature performance of the incubator.

## *UV LIGHTING*

Check if your laboratory or workspace contains sources of UV lighting. Sustained exposure to direct sunlight, UVC, or UV germicidal lighting around 254nm, will cause a rapid aging of BACTROX acrylic glass panels and arm port sleeves. Periodic use of long-wave (365nm) UV hand lamps for bacterial identification should not damage the acrylic glass. See the [Maintaining the Acrylic Glass Panels](#) entry on page 57 for more details.

# INSTALLATION (CONTINUED)

## POWER SOURCE REQUIREMENTS

When selecting a location for the BACTROX-2, check that **each** of the following requirements are satisfied:

- The wall power source for the unit must match the voltage and ampere requirements listed on the unit data plate.
  - These units are intended for 220 – 240V AC 50/60 Hz applications at 2 amps
- **Supplied voltage must not vary more than 10% from the data plate rating.** Damage to the unit may result if supplied voltage varies more than 10%.
- The wall power source must be protective earth grounded.
- Use a separate circuit to prevent loss of the unit due to overloading or circuit failure.
- **The recommended wall circuit breakers for these units are 15 amps.**
- The wall power source must conform to all national and local electrical codes.

The unit must be positioned so that all end-users can quickly unplug the BACTRON in the event of an emergency.

- The unit comes with a 230 – 250VAC 8ft (2.5m) CEE7 power cord. Always use this cord or an identical replacement.



These units come provided with 2 **Type T 4 5x20mm fuses**, with one in the power cord plug inlet on the back of the unit, and the other in an adjacent fuse holder. The unit must be fused in order to operate.

## LOW OXYGEN AMBIENT CONDITIONS

Low oxygen work area environments can be created by the operation of several hypoxia chambers or CO<sub>2</sub> incubators in an enclosed area with inadequate ventilation. Leakage from units may lead to lowered oxygen levels as CO<sub>2</sub>, N<sub>2</sub>, and other laboratory gasses crowd out oxygen.

The highest level of O<sub>2</sub> concentration achievable by the BACTROX is equal to the ambient (room) concentration. A low oxygen workspace environment around the BACTROX may have the following adverse effects:

- It can hinder the ability of the BACTROX to meet a user selected O<sub>2</sub> set point
- It can interfere with an O<sub>2</sub> sensor calibration when using an ambient air sample

# INSTALLATION (CONTINUED)

## *CONDENSATE RECEPTACLE*

The BACTROX comes with an integral Peltier effect chiller for capturing excess humidity on an internal cold plate. The condensate is then collected in a small reservoir that drains through a plastic tube into the workspace chamber. An open container, such as a beaker or flask, must be placed beneath the drain tube and drained regularly.

## *LIFTING AND HANDLING*

The unit is heavy, and care should be taken to use appropriate lifting devices that are sufficiently rated for these loads. Follow these guidelines when lifting and handling the BACTROX workstation:

- Lift the unit only from its bottom surface.
- Doors, handles, and knobs are not adequate for lifting or stabilization.
- Restrain the unit completely while lifting or transporting so it cannot tip.
- Remove all moving parts, such as shelf spacers and trays, and secure all doors in the closed position during transfer to prevent shifting and damage.

To prevent damage when moving the unit, turn each of the four leveling feet completely clockwise.

## *LEVELING*

The BACTROX must be level and stable for safe operation. Each BACTROX ships with four leveling feet. Insert one leveling foot into each of the four holes in the bottom corners of the workstation. Adjust the foot at each corner until the workstation stands level and solid without rocking. To raise a foot, turn it in a counterclockwise direction; to lower a foot, turn it in a clockwise direction.

## *INSTALL THE WORKSTATION*

Install the unit in a workspace location that meets the criteria specified in the previous entries in the Installation section.

Do not connect the unit to its power source at this time.

# INSTALLATION (CONTINUED)



**Warning:** Never introduce hydrogen in any quantity into the BACTROX. Hydrogen will destroy the oxygen-sensing zirconium dioxide sensor and the BACTROX's ability to regulate oxygen levels. Use of hydrogen in a BACTROX voids the warranty.

## *GAS SOURCES AND USAGE*

The BACTROX achieves a hypoxic atmosphere (1 – 20% O<sub>2</sub> concentration) by using injections of nitrogen. These injections force oxygenated atmosphere out through a vent valve located on the back wall of the chamber, lower right side.

Before installing a BACTROX, contact your site safety officer and review your institutional safety protocols for handling, storing, securing, and using compressed gasses. Follow all local ordinances and national regulations regarding compressed gases in your research or production environment.

**Note:** Always use medical grade gas supply sources. Use of non-medical grade gases risk introducing contaminants into the chamber, may damage workstation components, and will void the unit's warranty.

### ***Gas source considerations:***

- A cylinder or wall source of medical grade nitrogen (N<sub>2</sub>) is the primary injection gas for creating a hypoxic environment.
- For setting up a carbon dioxide-enriched chamber environment Sheldon Manufacturing recommends using a cylinder or wall source of medical grade carbon dioxide gas (CO<sub>2</sub>) in addition to nitrogen.
- Always use a two-stage gas pressure regulator to ensure consistent metering for all gasses. Some single-stage regulators have two (2) gauges. Make certain your regulator is a two-stage regulator.
- The BACTROX uses injections of air drawn from the laboratory environment when required to raise the concentration of oxygen inside the workspace chamber.

### ***Usage Rates***

- The BACTROX requires approximately 400lbs of N<sub>2</sub> to purge the workspace chamber down to a 1% O<sub>2</sub> concentration.
- N<sub>2</sub> usage rates during normal operations vary considerably. Among the major factors driving usage are the O<sub>2</sub> set point (the lower the set point, the higher the rate of use) and if CO<sub>2</sub> is being added to the chamber atmosphere.
- Accessing and working in the workspace chamber significantly increases the consumption rate of N<sub>2</sub>. Proper entry and exit techniques, along with proper movement technique while in the chamber, are essential for reducing N<sub>2</sub> usage. Proper techniques are covered in the Operation section of this manual (page 43).

# INSTALLATION (CONTINUED)

## CONNECT TO GAS SOURCES

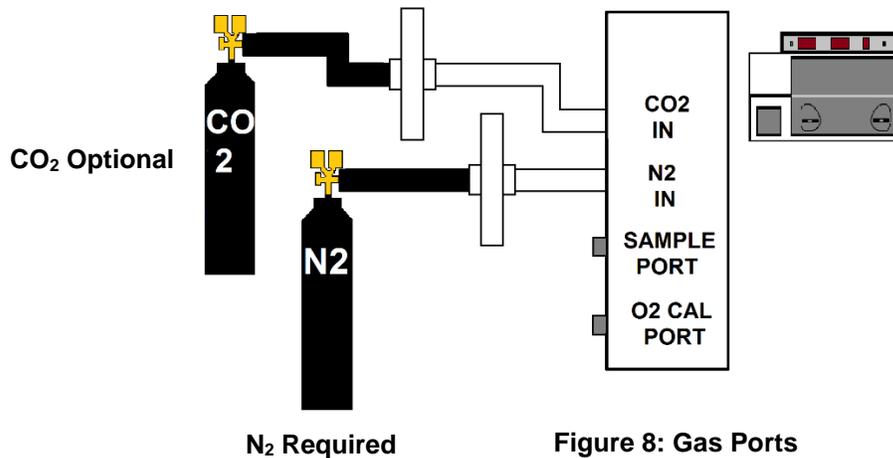


Figure 8: Gas Ports

Always match the correct type of gas regulator to the correct gas type. Example: A CO<sub>2</sub> regulator should always be used for CO<sub>2</sub> gas applications.

1. Install the dual stage gas regulators on the gas-supply cylinders to be used for your application.
2. Set the supply gas regulators at **15 – 20 PSI**.
  - a. Do not exceed 20 PSI!

PSI	Megapascals	Kilopascals	Bar
15 - 20 PSI	0.103 – 0.138 Mpa	103.42 – 137.89 Kpa	1.03 – 1.38 bar

3. Connect the nitrogen (N<sub>2</sub>) gas regulator or wall source to the N<sub>2</sub> IN port.
  - a. The nitrogen and carbon dioxide regulators provided with the BACTROX each comes with ¼ inch OD tubing to connect to the BACTROX.
4. If using CO<sub>2</sub> in addition to nitrogen, connect the CO<sub>2</sub> regulator or wall source to the CO<sub>2</sub> IN port.
5. **Do not open** the gas valves at this time.
  - a. Gas will be supplied to the BACTROX when establishing a hypoxic atmosphere, as part of the Preparation for Use procedure in the Operation section.

# INSTALLATION (CONTINUED)

## INITIAL CLEANING

Disinfect the workstation to the standards of your laboratory or production environment protocol prior to placing the unit into operation. The BACTROX was disinfected at the factory prior to shipment. However, Sheldon Manufacturing cannot guarantee that the BACTROX was not exposed to contaminants en route, or that the factory procedure matches the standards of your institutional protocols. See the [Cleaning](#) procedure in the User Maintenance section on page 56 for more information about cleaning and disinfecting the BACTROX. Also see step 2 of the Install Components procedure below.

## DEIONIZED AND DISTILLED WATER

**Note:** Do not use deionized water for cleaning or humidifying your BACTROX.

While DI water is useful in a variety of laboratory applications, it is an aggressive solvent that attacks most metals. Use of DI water for cleaning or humidification in a Shel Lab incubator voids the unit warranty. Sheldon Manufacturing recommends the use of distilled water in the resistance range of 50K Ohm/cm to 1M Ohm/cm, or a conductivity range of 20.0 uS/cm to 1.0 uS/cm, for cleaning and humidifying applications.

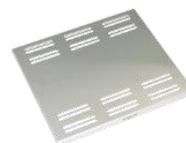
## INSTALL ACCESSORIES

Place the following components in the workstation:

1. Remove all protective wrappings from accessories, shelving, and the workstation.
2. Clean, disinfect, and place the following items in the workspace chamber:
  - a. Arm port doors through pass box. The doors may be stored in the hanging slots on the bottom of the workspace incubator during the setup.
  - b. The calibration O<sub>2</sub> sensor cover plate through arm ports or pass box.
  - c. The incubator bottom shelf spacers through pass box.
  - d. The petri dish racks through arm ports. These can be placed on the top shelf of the workspace chamber incubator during the setup.
  - e. A glass flask or beaker placed under the plastic condensation drain tube on the left side of the chamber.
  - f. Any equipment or containers that will be used in the workspace chamber. Doing so now saves time and nitrogen by eliminating pass box purge cycles. If possible, containers should be placed in the chamber loose lidded or open to allow oxygen to be evacuated during hypoxic atmosphere setup. Sealed containers act as reservoirs of oxygen.



**Figure 9: Arm Port Doors**



**Figure 10: Incubator Shelf Spacers**



**Figure 11: Petri Dish Racks**

# INSTALLATION (CONTINUED)

## *SHELVING INSTALLATION*

Install the three (3) metal bottom spacers included with the BACTROX on the bottom shelf of the workspace chamber incubator. These spacers shield sample containers from direct contact with the warm surfaces of the incubator and ensure uniform heat dissipation.

1. Set the spacers on the bottom shelf of the workspace chamber incubator, side by side, with the "SPACER" label facing out.
2. **Do not load samples at this time.**
3. Leave both doors of the workspace chamber incubator slightly open to prepare the unit for establishing a hypoxic atmosphere. Failure to leave the doors open during the setup will create reservoirs of ambient oxygen atmosphere.
  - a. **Leave the doors approximately 1 cm (0.5 inches) open.** Opening the doors all the way at the start of the purge will cause the incubator to significantly overshoot its set point when the doors are finally closed.

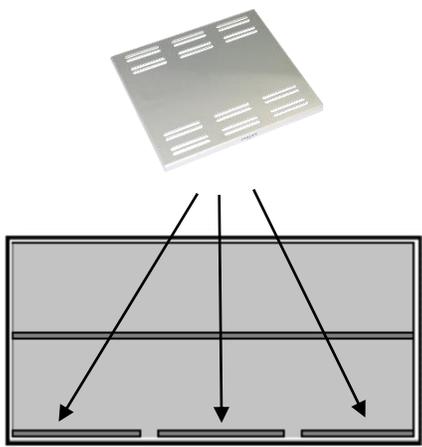


Figure 13: Incubator Shelf Spacers

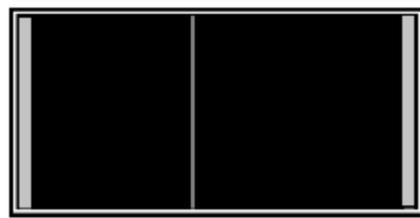


Figure 12: Incubator Doors Slightly Open

# INSTALLATION (CONTINUED)



## *INSTALL THE ARM PORT DOORS*

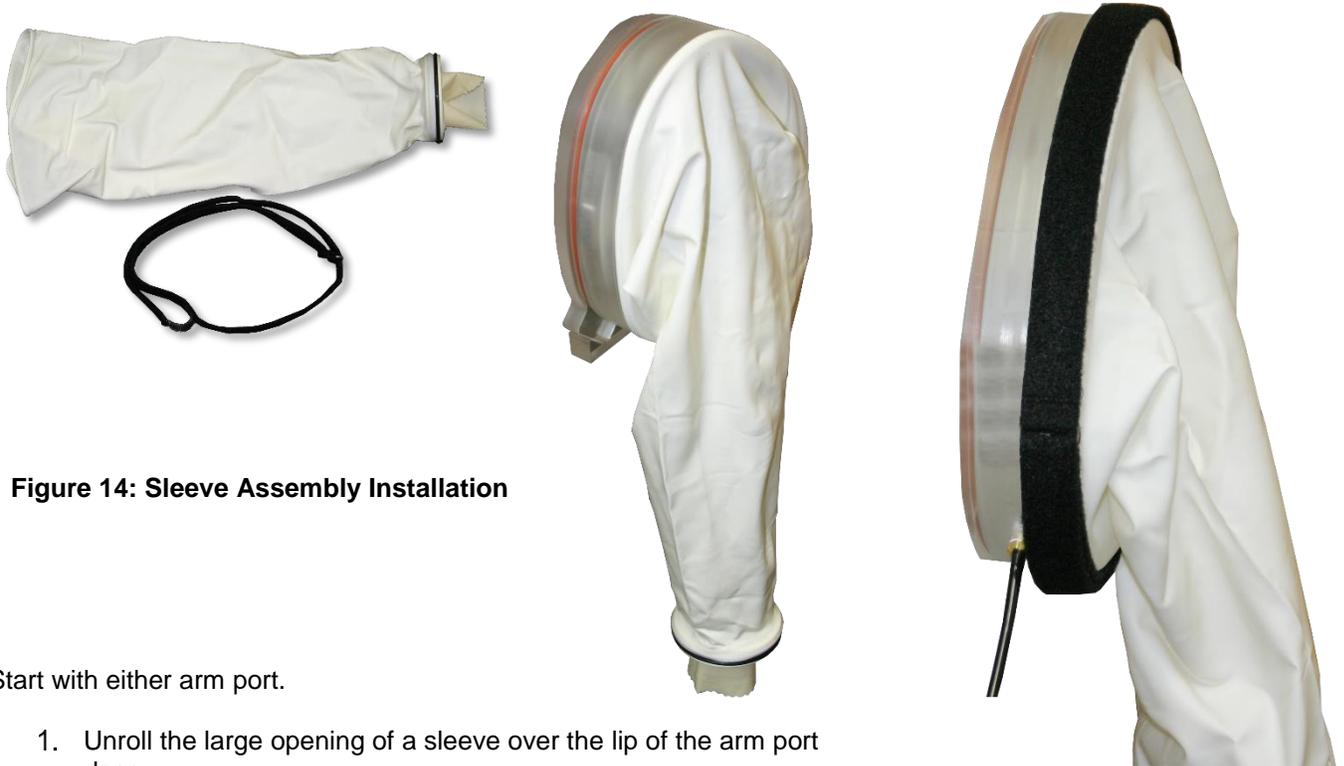
Install the arm port doors in the arm ports to seal the chamber. The arm port doors should already be inside the workspace chamber.

1. Turn each silver locking bar to a roughly 45° position. 
2. Install each door bottom first, inserting the tabs into the slots on the arm ports.
3. Tilt the door cover up so that it sits securely in the arm port.
4. Turn the locking bar to the horizontal position: 
5. Secure the door by turning the black arm port doorknob clockwise
  - a. Use wrist strength only, until the knob grabs and feels snug.
  - b. Tightening too much may compromise the integrity of the door

# INSTALLATION (CONTINUED)

## ATTACH THE SLEEVE ASSEMBLIES

Attach and secure both sleeve assemblies to the arm ports. This allows access to the chamber through the ports without introducing external atmosphere.



**Figure 14: Sleeve Assembly Installation**

Start with either arm port.

1. Unroll the large opening of a sleeve over the lip of the arm port door.
  - a. Place the ring on the large end of the sleeve inside the groove on the arm port.
  - b. Make sure none of the sleeve material is trapped or pinched between the ring and the seating groove.
2. Secure the sleeve to the arm port using the 48 inch (121cm) self-gripping strap included with the sleeve.
  - a. Exercise caution when placing the strap next to the arm port gas lines.
3. Repeat the process for the 2<sup>nd</sup> sleeve and arm port.
4. Insert both sleeve plugs.

Sleeves may be left attached to the BACTROX when not in use.



**Figure 15: Insert Sleeve Plugs**

# INSTALLATION (CONTINUED)

## *PASS BOX VENT COVER*

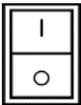
Remove the rubber cover from the pass box vent, located on the back of the BACTROX on the lower right corner.



**Figure 16: Pass Box Vent**

# GRAPHIC SYMBOLS

The unit is provided with multiple graphic symbols located on its exterior and interior surfaces. The symbols identify hazards and the functions of the adjustable components, as well as important notes found in the user manual.

Symbol	Definition
	Indicates that you should consult your user manual for further instructions. Indique que l'opérateur doit consulter le manuel d'utilisation pour y trouver les instructions complémentaires.
	Indicates Temperature Repère température
	Indicates the Over Temperature Limit system Indique le système de dépassement de température
	Indicates AC Power Repère le courant alternative
	Indicates I/ON and O/OFF I repère de la position MARCHÉ de l'interrupteur d'alimentation O repère de la position ARRÊT de l'interrupteur d'alimentation
	Indicates protective earth ground Repère terre électrique
	Indicates UP and DOWN respectively Touches de déplacements respectifs vers le HAUT et le BA
	Indicates Manually Adjustable Indique un bouton réglable manuellement
	Indicates Potential Shock Hazard Signale danger électrique

# GRAPHIC SYMBOLS (CONTINUED)

Symbol	Definition
	Indicates the unit should be recycled (Not disposed of in land-fill) Indique l'appareil doit être recyclé (Ne pas jeter dans une décharge)
	Indicates an injection of gas Indique un flux de gazeux
	Indicates the incubator heater is active L'élément chauffant est la production de chaleur

# CONTROL PANEL OVERVIEW



Figure 17: Control Panel

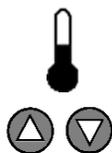


## Power Switch

The power switch controls all power to the BACTROX and its systems. The switch will illuminate when in the ON ( I ) position, along with all three of the green digital displays



Figure 18: Incubator & OTL Controls



## Incubator Temperature Control and Display

Marked SET TEMPERATURE °C, this display shows the current air temperature of the workspace incubator accurate to within  $\pm 0.1^{\circ}\text{C}$ . The arrow buttons can be used to adjust the temperature set point, mute a temperature deviation alarm, or place the unit in its calibration mode and enter a display value correction.



The green pilot light located beneath the label HEATING ACTIVATED illuminates whenever the workspace incubator heating elements are powered and warming the incubator.



## Set Over Temperature

This graduated dial sets the temperature limit for the incubator Over Temperature Limit system. The OTL System prevents unchecked heating of the incubator in the event of a failure of the main controller. For more details, please see the explanation of the [Over Temperature Limit System](#) on page 33 in the Operation section Theory of Operation.



Marked OVER TEMP ACTIVATED, the light illuminates when the OTL System is routing power away from the incubator heating elements.

# CONTROL PANEL OVERVIEW (CONTINUED)



Figure 19: O<sub>2</sub> and CO<sub>2</sub> Controls

## Set OXYGEN %

The SET OXYGEN % display shows the oxygen concentration in the workspace chamber as a percentage of the chamber atmosphere between 0 and 25%. The control **UP / DOWN** arrow pad is used to input an O<sub>2</sub> concentration set point for the workspace chamber atmosphere between 0.5 and 20%, and to enter calibration offsets. The display is also provided with LED deviation alarms and an audible buzzer alarm. These alarms activate in the event of a deviation in the O<sub>2</sub> concentration of  $\pm 1\%$  from the O<sub>2</sub> set point. The yellow LED marked MUTE illuminates whenever an audible O<sub>2</sub> deviation alarm is being muted. There is a 15-minute delay for the activation of the low deviation buzzer alarm.



## N<sub>2</sub> Injecting / Air Injecting

The green N<sub>2</sub> light illuminates when the unit is injecting nitrogen drawn from the N<sub>2</sub> IN port into the workspace chamber. The Air Injecting light activates when outside air is being injected to raise the oxygen concentration in the chamber to match the user-selected O<sub>2</sub> set point. The N<sub>2</sub> solenoid operation is normally accompanied by a clicking sound. The air pump creates a slight buzzing.



## SET CO<sub>2</sub>%

Labeled SET CO<sub>2</sub>, this panel includes a green digital LED display connected to an infrared sensor probe. The probe measures the concentration of CO<sub>2</sub> in the workspace chamber as a percentage of the chamber's atmosphere. The control's **UP / DOWN** arrow pad is used to input a CO<sub>2</sub> concentration set point for the workspace chamber atmosphere, and to enter calibration offsets. The display is also provided with LED deviation alarms and an audible buzzer alarm. These alarms activate in the event of a deviation in CO<sub>2</sub> concentration of  $\pm 1\%$  from the CO<sub>2</sub> set point. The yellow LED marked MUTE illuminates whenever an audible CO<sub>2</sub> deviation alarm is being muted. There is a 15-minute delay for the activation of the low deviation buzzer alarm.



## CO<sub>2</sub> Injecting Light

Marked CO<sub>2</sub> INJECTING, this pilot light illuminates whenever the CO<sub>2</sub> solenoid is injecting CO<sub>2</sub> into the workspace chamber from the CO<sub>2</sub> In port. CO<sub>2</sub> solenoid operation is normally accompanied by a clicking sound.





Figure 20: Bass Box Switch and Chamber Light

## Start Pass Box Purge



The START PASS BOX PURGE button initiates an approximately 45-second long cycle of the pass box chamber. The cycle purges oxygenated atmosphere by injecting nitrogen into the box chamber and forcing oxygenated atmosphere out through a vent on the back of the unit.

## Pass Box Purging



This clear light illuminates for the duration of a pass box purge cycle.

## Lights



The LIGHTS switch turns the workspace chamber lights on and off.

# CONTROL PANEL OVERVIEW (CONTINUED)

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## *THEORY OF OPERATION*

The BAXTROX detects the concentration of oxygen in the chamber atmosphere using the black and silver O<sub>2</sub> sensor located on the left chamber wall. The O<sub>2</sub> sensor operates with an internal temperature of 700°C to produce mobile oxygen ions through disassociation. The volume heated to temperature is very small. The ions are drawn into sensor cavities separated by porous sheets of platinum-coated zirconium dioxide that act as an electrolyte. The controller determines the partial pressure of oxygen by measuring the voltage potential differential between ions separated by the zirconium sheets. That measurement is then compared with reference differentials that were saved in the controller memory during the previous O<sub>2</sub> sensor calibration. The controller derives the O<sub>2</sub> concentration from the measured partial pressure of oxygen (PPO).

### ***Achieving and Maintaining Hypoxic Conditions***

The BACTROX achieves low-oxygen conditions through injections of non-oxygen gases. These force oxygenated atmosphere out through a vent located on the chamber back wall. Nitrogen (N<sub>2</sub>) is the primary gas for such injections, though users also have the option of adding carbon dioxide to create an atmosphere enriched with a 1 – 20% CO<sub>2</sub> concentration. In the event O<sub>2</sub> levels fall below the user-programed set point, the BACTROX injects oxygenated atmosphere drawn from the surrounding laboratory air.

Maintenance of the O<sub>2</sub> and CO<sub>2</sub> set points is a dynamic competition of N<sub>2</sub> and air injections, as well as CO<sub>2</sub> injections. When the workstation is sitting sealed and undisturbed N<sub>2</sub> injections will take place approximately every 4 – 6 seconds. The N<sub>2</sub> and CO<sub>2</sub> gas solenoids produce audible clicking sounds when injecting. The air pump produces an audible buzz when injecting ambient atmosphere.

The N<sub>2</sub> and CO<sub>2</sub> gas solenoids produce audible clicking sounds when injecting. The air pump produces an audible buzz when injecting ambient atmosphere.

Pass box operations or a user working with arms in the chamber will displace some hypoxic atmosphere, and result in increased N<sub>2</sub> and CO<sub>2</sub> usage. Proper arm port entry and exit techniques, minimized pass box usage, and slow, deliberate movements while working in the chamber can significantly reduce the displacement of hypoxic atmosphere.

The BACTROX-2 microprocessor controller employs proportional-integral-derivative analytical feedback-loop functions when measuring and controlling gas levels. PID-controlled gas injection lengths are proportional to the difference between the measured chamber gas concentrations and the current set points. The frequency of injections is derived from the rate of change in the difference. Gas injections slow as the chamber atmosphere nears the set points to avoid overshoots.

# OPERATION (CONTINUED)

## ***Sensing Oxygen***

The BACTROX-2 detects the concentration of oxygen in the chamber atmosphere using the black and silver O<sub>2</sub> sensor located on the left chamber wall. The O<sub>2</sub> sensor operates with an internal temperature of 700°C to produce mobile oxygen ions through disassociation. The volume heated to temperature is very small. The ions are drawn into sensor cavities separated by porous sheets of platinum-coated zirconium dioxide that act as an electrolyte. The controller determines the partial pressure of oxygen by measuring the voltage potential differential between ions separated by the zirconium sheets. That measurement is then compared with reference differentials that were saved in the controller memory during the previous O<sub>2</sub> sensor calibration. The controller derives the O<sub>2</sub> concentration from the measured partial pressure of oxygen (PPO).

**The sensor must be allowed five minutes to warm up to its operating temperature in order to provide an accurate oxygen concentration measurement.**

Each BACTROX-2 is shipped with the sensor calibrated for a two point curve using an N<sub>2</sub> – O<sub>2</sub> reference mixture of 5% O<sub>2</sub> – 95% N<sub>2</sub> for the low end. An ambient air sample with a calculated concentration is used for the high end.

The O<sub>2</sub> sensor comes set with an output range of 0 – 25% O<sub>2</sub> concentration. Control panel display readings above 25% are indicative that the sensor and O<sub>2</sub> display are out of calibration. The unit controller has an effective operating range of 0.5 – 20%. Sheldon Manufacturing cannot guarantee a stable oxygen concentration at settings above 20%. In part due to the variability of ambient oxygen to draw on, as well as significantly increased wear on the air motor pump when running near continually to maintain an ambient atmosphere in a sealed chamber containing metabolically active samples.

## ***Sensing Carbon Dioxide***

The BACTROX-2 monitors CO<sub>2</sub> levels with an infrared sensor. The sensor operates on the principle that a band of infrared light is absorbed by CO<sub>2</sub>. The higher the CO<sub>2</sub> concentration in the chamber atmosphere, the more of that band of infrared is absorbed. This means that sensor is only sensitive to CO<sub>2</sub>, so measurement accuracy is consistent, regardless of the presence of other gasses in the incubator. The addition of CO<sub>2</sub> to the chamber atmosphere is purely optional and dependent on your laboratory protocol and application requirements.

# OPERATION (CONTINUED)

## ***Accessing the Workstation***

Items such as media containers and laboratory equipment can be introduced to or removed from the hypoxic workspace through the pass box. The pass box runs a user-initiated 45-second nitrogen purge that forces oxygenated room atmosphere out of the pass box chamber through a valve on the back of the unit.

Users can access and work glove-free in the workspace chamber by donning the sleeve assemblies attached to the front panel arm ports, and entering through the ports. Effective use of the sleeve assemblies requires bare skin contact between the widest part of the user's forearms and the cuff ring of the sleeve assembly. Smooth, small items held in hand may be introduced into the workspace chamber through the sleeve assemblies.

The sleeve assemblies are compatible with exam gloves for handling pathogenic samples inside the workspace.

## ***Incubator***

The BACTROX-2 microprocessor controller monitors and controls the incubator temperature using a solid state thermometer probe attached to the incubator body, along with two heating elements. As with gas injections, heating is monitored and controlled by the microprocessor controller using PID feedback loops. PID-controlled heating is proportional to the difference between the measured incubator temperature and the user-programmed temperature set point. The rate of heating pulses is derived from the rate of change in the difference. The integrator function slows the rate of heating slows as the measured chamber temperature nears the set point to avoid overshooting.

The BACTROX-2 incubator relies on natural heat radiation for cooling.

The PID analytics allow the controller to optimize heating rates for the local temperature conditions. If the BACTROX-2 is moved to a new location with a significant temperature difference from its previous surroundings, it may require 24 hours of incubator run time for the controller to fully adapt to the new thermal environment. For example, a BACTROX-2 that has optimized to use more power for heating in a cool environment may generate overshoots for a day after being moved to a warmer location.

This is why the incubator should be run at its application set point for 24 hours prior to performing a temperature calibration when the unit has been moved to a new location. Additionally, accelerated heat loss from leaving the incubator doors open for long periods (an hour or more) can trick the controller into behaving as though it is operating in a cool environment.

Optimization helps maintain a high degree of temperature stability and reduce overall power usage during normal operating conditions.

## ***The Over Temperature Limit System (OTL)***

When set, the OTL system prevents runaway heating in the event of a failure of the microprocessor controller board or its thermometer probe. It does so by depowering the heating elements whenever the temperature in the incubation chamber exceeds the OTL setting. Typically the OTL is set approximately 1°C above the incubator set point. Because of its nature as a mechanical cutoff system and its lack of PID analytics, the OTL cannot deliver the same degree of temperature stability and measurement precision as the digital display and microprocessor board. The OTL System should only be used as a means of heating regulation for the incubator until a failed controller board or its thermometer probe can be repaired or replaced.

## ***Com Port Data and Logging Outputs***

The BACTROX-2 comes with an RS232 data port and generates three outputs once per minute as a logline describing the oxygen, CO<sub>2</sub>, and temperature levels. These outputs can be logged using a computer or building management system connected to the RS232 port. Please see the [Data Output and Logging](#) entry on page 48 for a more detailed description.

## ***Condensation Management***

Petri plates and other open or breathable containers loaded with samples can generate significant humidity as well as condensation in the workspace chamber if unchecked. To control humidity levels the BACTROX is provided with a Peltier effect condensate chiller located behind a circulation fan on the upper left side of the workspace chamber. Chamber humidity is trapped on the chiller's cold plate in the form of condensation. The condensate is then channeled into a drain tube that empties into a receptacle placed in the workspace chamber by the end-user. The receptacle must be regularly drained. The condensate chiller and its circulation fan eliminate the need to use chemical desiccants to control humidity level. Desiccants can dry out culture media while leaving significant condensate untouched. Under normal operating conditions the chiller can handle media evaporation from up to 300 plates.

The condensate chiller is active whenever the BACTROX-2 is powered.

# OPERATION (CONTINUED)

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**Note:** Preparing the BACTROX-2 for use requires approximately three hours of work. However, Sheldon Manufacturing recommends allowing 24 hours for the chamber incubator to heat and stabilize and for the hypoxic atmosphere to stabilize, prior to loading samples in the workstation.

---

## *PREPARING THE BACTROX*

Verify that the following procedures were completed during the workstation installation:

- [Connect to the Gas Supply](#) page 18
- [Install Components](#) page 19
- [Shelving Installation](#) page 20
- [Install the Arm Port Doors](#) page 21
- [Install the Sleeve Assemblies](#) page 22

Perform the following procedures to prepare the unit for use:

- ✓ [Power the BACTROX](#) page 35
- ✓ [Verify O<sub>2</sub> Sensor Accuracy](#) (Optional) page 36
- ✓ [Establish a Hypoxic Atmosphere](#) page 39
- ✓ [Setting the Incubator Temperature](#) page 42
- ✓ Read [Chamber Entry](#) page 43
- ✓ Read [Chamber Movement Techniques](#) page 43
- ✓ Read [Exit the Chamber](#) page 44
- ✓ Read [Operation of the Pass Box](#) page 45
- ✓ [Set the Over Temperature Limit](#) page 46
- ✓ [Load the Workstation](#) page 47

**Audible gas and temperature deviation buzzer alarms may sound** during the setup while the BACTROX-2 is establishing a hypoxic chamber atmosphere and the incubator is warming up. **To mute these alarms**, press the up or down arrow on each control that a red deviation indicator is illuminated on. Hold the button until the yellow MUTE indicator illuminates. All active alarms must be muted before the buzzer will shut off. There is a 15-minute delay for the activation of audible low deviation alarms.

## *POWER THE BACTROX*

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**Note:** Before plugging in the BACTROX, verify that the wall power supply and workstation electrical requirements have been checked for compatibility (see the Installation section, page 15).

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1. Plug the female end of the power cord into the inlet on the back of the workstation.
2. Plug the male end of the power cord into the earth-grounded outlet.
3. Turn the power switch ON ( I ) to verify that the workstation will power up.
4. The following lights and displays should illuminate. If they do not, consult Technical Support:
  - a. The Green power switch.
  - b. All three green digital displays on the main control panel.
5. The three displays will initially show fluctuating gas and temperature levels. It will take approximately five minutes for the gas sensor probes come up to operating temperature.



# OPERATION (CONTINUED)

## VERIFY O<sub>2</sub> SENSOR ACCURACY

**Optional:** The BACTROX is shipped with the oxygen sensor factory calibrated on a two-point curve at approximately 20.7% and at 5% at near sea level. An onsite verification of the calibrated sensor accuracy can be performed prior to establishing a hypoxic atmosphere if required by your laboratory, study, or production protocol. **Sheldon Manufacturing strongly recommends performing a verification if you are preparing your BACTROX for use at altitudes above 2000 feet (600 meters).** Altitude-related pressure differences can result in offset errors of 0.1% or greater in the display output.

A fast verification can be performed using one of two methods:

- **Reference Gas Verification.** Attach a bottle of calibration reference gas to the O<sub>2</sub> CAL PORT. After 5 minutes of inflow verify that the O<sub>2</sub> display matches the oxygen concentration of the calibration gas.
  - See next page for the procedure.
- **Atmosphere sample.** Open the arm port doors and pass box, calculate the current ambient O<sub>2</sub> concentration. Verify that the O<sub>2</sub> display matches the ambient concentration, after 5 minutes of run time.
  - See page 38 for the procedure.

## Set O<sub>2</sub> to OFF

Before using either method, set the O<sub>2</sub> display to Off. This preserves the tuning of the controller's PID analytic feedback loops and prevents the BACTROX from attempting to continually inject nitrogen during the procedure.

Set O <sub>2</sub> to Off		
 OR 	1. Press either one of the O <sub>2</sub> control arrow keys and then release. <ul style="list-style-type: none"><li>a. The display will briefly flash the letters "SP", then switch from bright to dim, and blink on and off.</li></ul>	SET O <sub>2</sub> % 
   Wait 5 Seconds	2. Press and hold the down arrow key. <ul style="list-style-type: none"><li>a. Hold the key until the displayed percentage reaches 0, and then switches to "OFF".</li><li>b. After you have adjusted the display to Off, wait five seconds.</li><li>c. The display will cease flashing, brighten, and show the ambient level of O<sub>2</sub> in the chamber. The control is now set to Off, and the BACTROX-2 will not attempt to inject N<sub>2</sub>.</li></ul>	SET O <sub>2</sub> %   SET CO <sub>2</sub> % 

# OPERATION (CONTINUED)

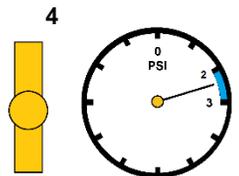
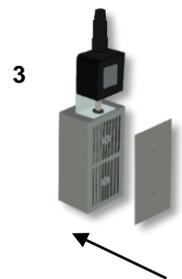
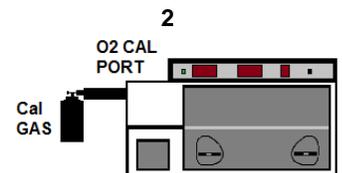
## Verification Using Calibration Reference Gas Sample

Allow the BACTROX to run for at least 5 minutes prior to conducting the Verify O<sub>2</sub> Sensor Accuracy procedure. This is the time required for the sensor to heat up to its operational temperature and output an accurate O<sub>2</sub> concentration reading.

1. Leave the O<sub>2</sub> set point set to OFF.
2. Attach the calibration gas cylinder to the BACTROX O<sub>2</sub> Cal Port.
3. Attach the calibration kit sensor cover to the O<sub>2</sub> sensor in the workspace chamber.
4. Set the calibration gas cylinder regulator to between **2 and 3 psi**.
5. Start a gas flow from the supply cylinder to the sealed O<sub>2</sub> sensor space.
6. Wait 5 minutes to achieve a sufficient concentration of calibration gas in the O<sub>2</sub> sensor space.
7. Verify that the Set Oxygen % display matches the O<sub>2</sub> concentration of the calibration gas.

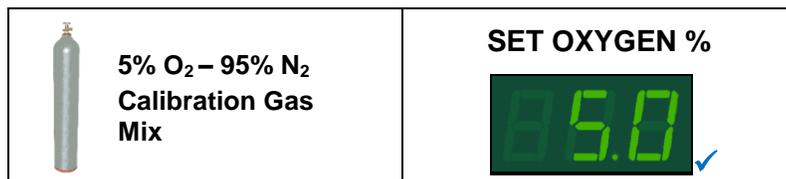


Wait 5 Minutes

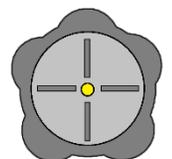


Calibration Gas Regulator

### Example



8. Return the unit to normal operation.
  - a. Stop the Cal Gas flow to the BACTROX
  - b. Disconnect the Cal Gas cylinder from the BACTROX
  - c. Reattach the O<sub>2</sub> Cal port cover
  - d. Remove the calibration kit cover from the O<sub>2</sub> sensor before continuing the Setup.



Start Gas Flow

If the verification does not produce an acceptable match between the calibration gas sample and the BACTROX Set Oxygen % display, continue and complete the Preparing the BACTROX process. A full calibration procedure can be performed after to correct any errors in the accuracy of measurement or display output. Please see the [O<sub>2</sub> Sensor Calibration Procedure](#) on page 59 in the User Maintenance section.



Wait 5 Minutes

**Note:** An O<sub>2</sub> set point will be entered during the [Establish a Hypoxic Atmosphere procedure](#) on page 39.

# OPERATION (CONTINUED)



Wait 5 Minutes

## Verification Using Ambient Atmosphere Sample

Allow the BACTROX to run for at least 5 minutes prior to conducting the Verify O<sub>2</sub> Sensor Accuracy procedure. This is the time required for the sensor to heat up to its operational temperature and output an accurate O<sub>2</sub> concentration reading.



Wait 5 Minutes

1. Open the arm ports and both pass box doors to expose the chamber to the room atmosphere.
2. Wait at least 5 minutes to ensure that the O<sub>2</sub> level of the chamber matches that of the ambient atmosphere.
3. Calculate the concentration of O<sub>2</sub> in the ambient atmosphere. See the [Calculating the O<sub>2</sub> Concentration Appendix](#) on page 88 for how to derive the current O<sub>2</sub> concentration of the ambient air.
4. Verify that your calculated ambient concentration matches the concentration shown on the Set Oxygen % Display.

### Example

<ol style="list-style-type: none"><li>1. <math>WVP = \left(\frac{H_{rel}}{100}\right) \cdot WVP_{max}</math></li><li>2. <math>PPO_2 = (BP - WVP)</math></li><li>3. <math>O_2\% = \left(\frac{PPO_2}{BP}\right) 100</math></li><li>4. = <b>20.7% O<sub>2</sub></b></li></ol>	<p><b>SET OXYGEN %</b></p> 
---	--

5. Reseal the arm ports, close and latch both arm port doors.

If the verification does not produce an acceptable match between the calculated value of the ambient sample and the Set Oxygen % display, continue and complete the Preparing the BACTROX process. A full calibration procedure can be performed after to correct any offset errors in the accuracy of measurement or display output. Please see the [O<sub>2</sub> Sensor Calibration Procedure](#) on page 59 in the User Maintenance section.

---

**Note:** An O<sub>2</sub> set point will be entered during the [Establish a Hypoxic Atmosphere procedure](#) on page 39.

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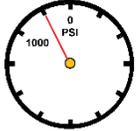
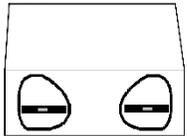
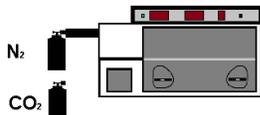
End of procedure

# OPERATION (CONTINUED)

## ESTABLISH A HYPOXIC ATMOSPHERE

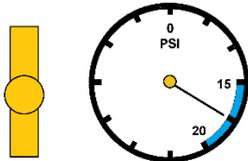
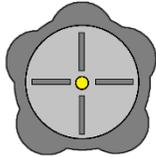
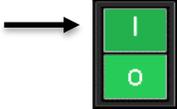
Carry out the following steps to purge the ambient atmosphere from the workstation and establish a hypoxic environment.

This procedure requires 1 to 3 hours to complete depending on experiencing at using the BACTROX-2, and the gas concentrations to be achieved. Under normal conditions, 1.5 to 2 hours are required to achieve an O<sub>2</sub> concentration of 1%. It may take up to 4.5 hours to achieve a 5% CO<sub>2</sub> concentration in the chamber. Normally **400lbs of N<sub>2</sub> tank pressure are required for a purge**, though this will be reduced if CO<sub>2</sub> is also being introduced to establish a carbon dioxide-enriched environment.

Establish Hypoxic Atmosphere	
<ol style="list-style-type: none"> <li>Record the supply readings on the gauges of the gas sources. This is done to start a record of gas usage.</li> </ol>	 <p>Supply Reading</p>
<ol style="list-style-type: none"> <li>Verify that both incubator doors are slightly open to avoid leaving a reservoir of fully aerobic atmosphere. See the <a href="#">Shelving Installation Procedure</a> on page 20.</li> </ol>	
<ol style="list-style-type: none"> <li>Verify the arm port doors are closed and sealed and / or sleeves with sleeve plugs have been installed.</li> </ol>	 <p>Arm Ports Secured</p>
<ol style="list-style-type: none"> <li>Verify that all gas supply sources are connected to the BACTROX-2.               <ol style="list-style-type: none"> <li>See the <a href="#">Connecting to the Gas Sources</a> procedure on page 18 in the Installation section.</li> </ol> </li> </ol>	

Procedure continued on next page

# OPERATION (CONTINUED)

Establish Hypoxic Atmosphere (Continued)	
<p>5. If not already set, set the N<sub>2</sub> regulator or source control to flow between 15 and 20 PSI.</p> <p>a. <b>Optional:</b> Set the CO<sub>2</sub> regulator or source control to flow 15 to 20 psi if you will be setting up a CO<sub>2</sub> enriched environment.</p> <p>b. <b>Do not exceed 20 PSI for either supply source!</b></p>	<p>N<sub>2</sub> and CO<sub>2</sub></p> 
<p>6. Open the gas supply valves all the way to supply nitrogen to the BACTROX-2.</p> <p>a. Optional: Do the same for the CO<sub>2</sub> regulator or in-house source.</p>	 <p>N<sub>2</sub> CO<sub>2</sub></p>
<p>7. Turn on the BACTROX-2, if it is not already powered up.</p>	
<p>8. <b>Set the oxygen set point</b> to your application set point using the <b>Up</b> and <b>Down</b> arrows of the SET OXYGEN % control.</p> <p>a. Press either of the arrow keys and then release.</p> <p>b. The display will briefly flash the letters “SP” for set point, then switch from bright to dim and blink on and off. This is the adjustable set point.</p> <p>c. Use the up and down keys to adjust the set point to your required O<sub>2</sub> concentration.</p> <p>d. After adjusting the display to your application or process set point, wait 5 seconds. The display will cease flashing, and brighten. The set point has now been entered into the BACTROX-2, and the workstation will now begin injecting N<sub>2</sub> to create a hypoxic atmosphere.</p> <p> OR </p> <p> Wait 5 Seconds</p>	<p>SET OXYGEN %</p>  <p>SET OXYGEN %</p>  <p><b>Note:</b> 15% is an arbitrary example value.</p>

Procedure continued on next page

# OPERATION (CONTINUED)

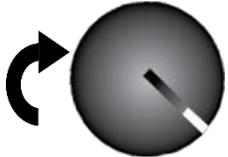
Establish Hypoxic Atmosphere (Continued)	
<p>9. <b>Optional:</b> If you will be using a carbon dioxide-enriched atmosphere, <b>set the CO<sub>2</sub> set point</b> using the up and down arrows of the SET CO<sub>2</sub> % control.</p> <p>   OR              </p> <p>   Wait 5 Seconds         </p> <ol style="list-style-type: none"> <li>Press either of the arrow on the keys and then release.</li> <li>The display will briefly flash the letters "SP", then switch from bright to dim and blink on and off.</li> <li>Use the up and down keys to adjust the set point to the CO<sub>2</sub> concentration you will be using for your application.</li> <li>After adjusting the display to your application or process set point, wait five seconds. The display will cease flashing, and brighten. The set point has now been entered into the BACTROX, and the workstation will now begin injecting CO<sub>2</sub> to establish a carbon dioxide-enriched atmosphere.</li> </ol>	<p>SET CO<sub>2</sub> %</p>  <p>SET CO<sub>2</sub> %</p>  <p><b>Note:</b> 5% is an arbitrary example value</p>
<p>10. Do not enter the workspace chamber or use the pass box while the BACTROX is purging the chamber atmosphere.</p>	
<p>11. <b>Optional:</b> Set the incubator temperature set point.</p> <ol style="list-style-type: none"> <li>While waiting for the oxygen purge to complete, you may set the temperature set point of the workspace incubator to your application's required temperature.</li> <li>Please see the Setting the Incubator Temperature procedure on the next page.</li> </ol>	<p><b>Optional</b></p> <p><b>Setting the Incubator Temperature</b></p> <p>Page 42</p>
<p>12. End states. <b>A hypoxic atmosphere has been achieved when:</b></p> <ol style="list-style-type: none"> <li>The SET OXYGEN % display has stabilized for 1 hour without any changes at or near your O<sub>2</sub> set point. Under normal conditions 1.5 to 2 hours are required to drop down to a concentration of 1% from ambient.</li> </ol> <p style="text-align: center;"><b>Optional</b></p> <ol style="list-style-type: none"> <li>And the SET CO<sub>2</sub> % display has stabilized without any changes for 1 hour at or near your CO<sub>2</sub> set point. Under normal conditions, 45 minutes are required to achieve a 1% concentration. It may take significantly longer to reach the CO<sub>2</sub> concentration than the O<sub>2</sub> concentration.</li> </ol>	

End of procedure

# OPERATION (CONTINUED)

## SET THE INCUBATOR TEMPERATURE

Set the incubator temperature to your application set point.

Set Temperature	
<ol style="list-style-type: none"> <li>1. Turn the <b>Over Temperature Limit</b> control dial clockwise to the maximum position indicated by the largest dot, if it is not already set to max.               <ol style="list-style-type: none"> <li>a. This prevents the Over Temperature Limit system from interfering with the Set the Temperature Set Point procedure.</li> </ol> </li> </ol>	
<div style="display: flex; align-items: center;">  <div style="margin: 0 5px;">OR</div>  </div> <ol style="list-style-type: none"> <li>2. Press either the <b>Up</b> or <b>Down</b> key on the <b>Set Temperature</b> control panel to activate the temperature set point mode.               <ol style="list-style-type: none"> <li>a. The temperature display will briefly flash the letters “SP” to indicate a Set Point is about to be displayed.</li> <li>b. The Set Temperature digital display will then show the flashing adjustable temperature set point.</li> </ol> </li> </ol>	<p style="text-align: center;">Set Temperature °C</p> 
<div style="display: flex; align-items: center;">  <div style="margin: 0 5px;">OR</div>  </div> <ol style="list-style-type: none"> <li>3. Use the <b>Up</b> or the <b>Down arrow key</b> to adjust the set point.               <ol style="list-style-type: none"> <li>a. If neither key is pressed within 5 seconds, the Set Temperature display will stop flashing. It will then return to displaying the current air temperature of the incubator chamber.</li> </ol> </li> </ol>	<p style="text-align: center;">Set Temperature °C</p> 
<div style="display: flex; align-items: center;">  <div style="margin-left: 5px;">Wait 5 Seconds</div> </div> <ol style="list-style-type: none"> <li>4. Wait 5 seconds after entering your set point.               <ol style="list-style-type: none"> <li>a. The display will stop flashing, and the set point is now saved in the controller.</li> <li>b. The incubator will now automatically heat or passively cool to match your set point.</li> <li>c. The display will revert to showing the current chamber air temperature.</li> </ol> </li> </ol>	<p style="text-align: center;">Set Temperature °C</p> 
<ol style="list-style-type: none"> <li>5. Wait 24 hours for the incubator temperature to stabilize, then <b>set the Over Temperature Limit system</b>. See page 46.</li> </ol> <p><b>Note:</b> Sheldon manufacturing recommends waiting 24 hours for the incubator temperature to stabilize prior to loading samples</p>	

End of Procedure

# OPERATION (CONTINUED)

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**Note:** Familiarize yourself with the chamber entry procedure and movement techniques prior to accessing a hypoxic chamber.

---

## CHAMBER ENTRY

Perform these steps to access the workspace chamber without drawing in ambient atmosphere from outside the BACTROX-2. See the [Exiting the Chamber procedure](#) on page 44 for how to withdraw your arms from the chamber and sleeve assembly without compromising the hypoxic atmosphere.

1. Remove watches, bracelets, large rings, and any sharp objects that might damage the cuffs or sleeves.
2. Remove the sleeve plugs if installed.
3. Place your hands in the sleeve assemblies so that the cuff rings are secure around the bare skin of the widest part of your forearms.
  - a. The BACTROX-2 comes with size 9 cuffs. Size 6 cuffs are available for users with smaller forearms; size 8 for midsized users. Please see the [Parts List](#) on page 85.
4. Loosen both arm port door knobs by two or three turns if installed.
5. Rotate the locking bars to a roughly 45° diagonal: 
6. Slowly push one door into the chamber, then the second. The Arm port doors can be hung in the arm port door holders on the bottom of the workspace chamber incubator.

## CHAMBER MOVEMENT TECHNIQUES

Gas usage increases when users are working in the workspace chamber.

Reaching into the chamber through the arm ports creates pressure as the user's arms displace hypoxic atmosphere. This generates mechanical resistance and may force some hypoxic atmosphere out through the filtered exhaust vent. Exhausting prevents damage to the BACTROX from overpressure.

Use the following techniques to reduce displacement and gas usage while working in the chamber.

1. Avoid making fast or large movements while working in the chamber.
2. Use a swimming motion, withdrawing one arm partly into the arm port while reaching in with the other.
  - a. Placing both arms in the chamber at the same time displaces a larger volume of hypoxic atmosphere.

# OPERATION (CONTINUED)

**Note:** Familiarize yourself with the chamber exit procedure prior to accessing a hypoxic chamber.

## *EXIT THE CHAMBER*

The following steps are used to exit the chamber without pulling in ambient atmosphere.

1. Check that the interior pass box door is closed and secured to avoid drawing oxygenated atmosphere through the pass box.
2. Remove the arm port doors one at a time from the hanging stowage slots beneath the incubator.
3. Place each door on the chamber floor by its corresponding port.
4. Grasp one door by the silver locking bar, and **slowly** withdraw your arm holding the door.
  - a. Insert the tabs on the door into the slots of the arm port assembly. T
  - b. Tilt the door toward you so that it sits securely in the port.
  - c. Rotate the locking bar from the diagonal to horizontal position.
5. Tighten the arm port door knob until it starts to grab, using wrist strength only.
6. Repeat steps 4 – 5 for the second door.
7. Withdraw one hand from its cuff and exit the sleeve.
8. Withdraw your other hand from the second sleeve.
9. Optional: Install the sleeve plugs.



**Figure 21: Securing the Arm Port Doors**

# OPERATION (CONTINUED)

## OPERATING THE PASS BOX

### Introducing Items

1. Make sure the inner pass box door is closed and secured.
2. Open the outer pass box door.
3. Load the pass box sliding shelf with items to be introduced in the workspace chamber.
4. Close and secure the outer door.
5. Press and immediately release **Start Pass Box Purge switch**. Do not hold down the switch.
6. The purge cycle runs for 45 seconds.
  - a. N<sub>2</sub> is injected into the pass box, and oxygenated atmosphere evacuated through a vent on the back of the BACTROX-2.
  - b. The clear PASS BOX PURGING light will flash throughout the cycle.
7. Once the purge cycle is complete you may open in the inner pass box door and pull the sliding shelf into the workspace chamber.



Figure 22: Pass Box

**Best Practice.** Stow the sliding shelf in the pass box, and close the inner pass box door once the shelf has been unloaded. This protects accidental exposure of the workspace chamber to fully aerobic atmosphere if the outer pass box door is opened while the inner door is still open.

**Aborting:** To abort a pass box purge cycle, press and hold the **START PASS BOX PURGE switch** for **five (5) seconds**. The purging light will cease flashing and turn off. The cycle is now terminated.

### Removing Items

1. Make sure the outer pass box door is closed and secured.
2. Open the inner pass box door.
3. Pull the pass box sliding shelf into the chamber and load with items to be removed.
4. Return the shelf to the pass box. Close and secure the inner door.
5. Press and immediately release START PASS BOX PURGE switch. Do not hold down the switch.
6. The purge cycle runs for 45 seconds.
  - a. The clear PASS BOX PURGING light will flash throughout the cycle.
7. Once the purge cycle is complete you may open in the outer pass box door and unload the pass box shelf.

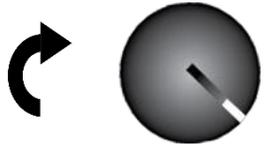
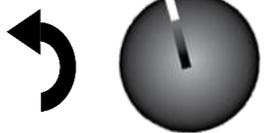
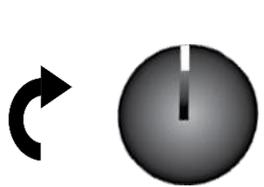
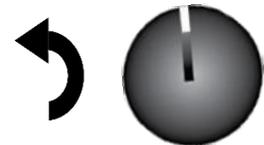


# OPERATION (CONTINUED)

**Note:** Test the OTL system at least once per year for functionality.

## SET THE OVER TEMPERATURE LIMIT

The incubator must be operating at your incubation application temperature, and must be stable for at least 1 hour prior to setting the OTL. Perform the following steps to set up the **Over Temperature Limit** heating cutoff system for use:

Set OTL	Example
1. Turn the <b>Set Over Temperature Limit</b> control dial clockwise to the maximum position, if it is not already set to maximum.	
2. Turn the dial counterclockwise until the red Over Temperature Limit Activated light illuminates.	
3. Slowly turn the dial clockwise until the Over Temperature Limit Activated light turns off. Stop turning the control. a. The Over Temperature Limit is now set approximately 1°C above the current incubator air temperature.	
4. <b>Optional:</b> You may turn the dial slightly to the left to bracket in closer to the set point temperature. This sets the OTL cutoff threshold nearer to the current incubator air temperature.	
5. Leave the OTL dial set just above the activation point.	

If the OTL is sporadically activating, you may turn the dial very slightly to the right (clockwise).

If the OTL continues activating, check for ambient sources of heat or cold that may be adversely impacting the unit temperature stability. Check if any powered accessories in the workspace chamber are generating heat. If you can find no sources of external or internal temperature fluctuations, contact Tech Support or your distributor for assistance.

*End of Procedure*

# OPERATION (CONTINUED)

## *LOAD THE WORKSTATION*

Sheldon Manufacturing recommends waiting 24 hours after establishing a hypoxic atmosphere and entering an initial incubator temperature set point before loading samples into the unit.

See page 45 for how to operate the pass box when introducing and removing items from the chamber.

The pass box sliding shelf can hold and transport up to 252 plates. Place samples and their media containers on the shelves inside the incubator as evenly spaced as possible. Proper spacing allows for atmosphere circulation and a higher degree of temperature uniformity. If heat-sensitive microorganisms are being cultivated it may be necessary to place an empty Petri plate at the bottom of each stack.

**This concludes the Preparing the BACTROX-2 portion of the Operation section**

## *GAS CONSERVATION METHODS*

1. Minimize the number of times per day the pass box is purged and opened.
2. Introduce small individual items, such as sealed microplates or transport tubes, into the workspace chamber through the sleeve assemblies.

## *ACTIVATED CARBON SCRUBBER AND REJUVENATION CYCLE*

Activated carbon scrubber media may be placed in the workspace chamber to absorb volatile fatty acids (VFAs) or volatile sulfur compounds (VSCs) produced by sample cultivation. This helps keep the workstation interior clean and may help reduce VCS odors. See the [Accessories section](#) on page 86 for scrubber media and a volatile compounds scrubber fan.

1. The recommended use is 250 grams (one packet) placed in a 500ml beaker inside the chamber. Place another 250 grams into a second 500ml beaker.
2. On day 2 replace the first beaker of charcoal scrubber with the second.
3. On day 3 reactivate the first beaker of charcoal scrubber by heating at a minimum of 160°C for at least 2 hours.
  - a. Place the reactivated scrubber in the chamber. Remove and reactivate the second scrubber.
  - b. For best effect, reactivate the scrubber by heating overnight.
4. Repeat this cycle for 6 months. Discard both scrubbers after six months and replace.

# OPERATION (CONTINUED)

## ATTACHING EQUIPMENT TO THE CHAMBER ACCESSORY OUTLETS

BACTROX-2 workstations are provided with a 1 amp accessory outlet located inside the workspace chamber, on the left wall. The power switch on the main control panel controls power to the outlet. The outlet can power equipment such as magnetic stirrers or a volatile compounds scrubber fan. Do not attach equipment drawing more than one (1) amp.

Accessory equipment may produce additional heat in the workspace chamber. This can affect the temperature range of the incubator. Monitor the incubator performance when using powered accessories inside the workspace chamber.

## HUMIDIFYING THE INCUBATOR

Placing only a small number of Petri dishes or other open media containers in the BACTROX for several weeks may lead to excessive drying of sample media. A small open container, such as a flask of 500ml of distilled water set on each shelf of the incubator, can help to slow sample drying.

## DATA OUTPUTS AND LOGGING

Each BACTROX hypoxia workstation is provided with an RS232 DB9 com port, an RS232 cable, and an RS232 to USB Type A adaptor. While the com port and cable are primarily intended for use in calibrating the oxygen sensor, the com port may also be used for data logging. Once per minute the BACTROX will send three outputs through the com port describing the current **temperature** (°C), **oxygen** (O<sub>2</sub>), and **carbon dioxide** (CO<sub>2</sub>) levels in the workspace chamber.

Use of the cable and com port requires downloading and installing the free, open source ([BSD license](#)) Tera Term terminal emulator on a laptop or other device. Tera Term can be downloaded from the [Tera Term development](#) project site (SourceForge.JP) at:

<http://en.sourceforge.jp/projects/ttssh2/releases/>

### Using the RS232 to USB adaptor

RS232 uses a communications protocol different from that of USB, and the adapter requires its own driver to convert between the two protocols. These drivers are available for free download on the adapter manufacture's website. Chose one compatible with your computer operating system.

<http://www.iogear.com/support/dm/driver/GUC232A>

The BACTROX will not be able to communicate with a computer via the USB adapter without a driver.

See pages 62 – 63 in the O<sub>2</sub> Calibration procedure for instructions on how to connect the BACTROX to a logging computer and how to initiate the logging process.

#### Logging Channels:

C1 = Current  
Temperature

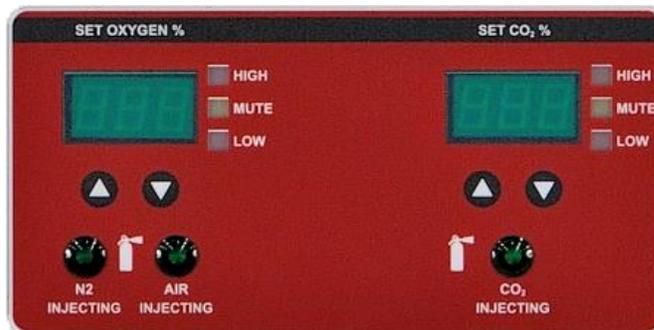
C3 = Current  
Oxygen

C4 = Current  
CO<sub>2</sub>

# OPERATION (CONTINUED)

## ADJUST THE GAS SET POINTS

This procedure works for changing either the O<sub>2</sub> or CO<sub>2</sub> set point.



Adjust Gas Set Point	Example
<div style="display: flex; align-items: center;">  <div style="margin-left: 10px;"> <p>1. Briefly press either of the arrow keys on the control for the gas you wish to adjust, then release.</p> <p>a. The gas display will briefly flash the letters "SP" for set point.</p> <p>b. This display will then switch from bright to dim and blink on and off. This is the adjustable set point.</p> </div> </div> <p><b>Note:</b> After 5 seconds of inactivity the display will exit the set point mode, saving the last shown value as the new set point.</p>	<div style="text-align: center;">  <p><b>Set Point</b></p>  <p><b>Current Set Point</b></p> </div>
<div style="display: flex; align-items: center;">  <div style="margin-left: 10px;"> <p>2. Use the up and down keys to adjust the set point to your required gas concentration.</p> </div> </div>	<div style="text-align: center;">  <p><b>New Set Point</b></p> </div>
<div style="display: flex; align-items: center;">  <div style="margin-left: 10px;"> <p>3. Wait 5 seconds after adjusting the display to your new application or process set point.</p> <p>a. The display will cease flashing, then brighten.</p> <p>b. The set point has now been entered into the BACTROX, and the workstation will now begin to adjust to the new set point.</p> </div> </div> <p>Wait 5 Seconds</p>	<div style="text-align: center;">  <p><b>Chamber Adjusting</b></p> </div>

End of Procedure

# OPERATION (CONTINUED)

## MUTE THE AUDIBLE O<sub>2</sub> / CO<sub>2</sub> ALARMS

Visual O<sub>2</sub> or CO<sub>2</sub> deviation alarm indicators illuminate if gas levels deviate 1% above or below the current set points. An audible alarm for each gas type will sound immediately for high deviations. This delay prevents the alarm from sounding in the event a chamber entry creates a short-lived drop in gas concentration.



Figure 23:  
Muted  
Alarms

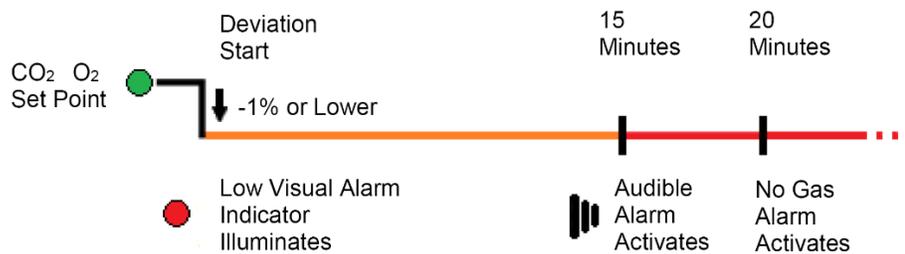
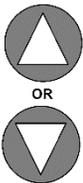


Figure 24: Gas Alarms Timeline

To mute:



1. Press and hold the **Up** or the **Down** arrow button for 1 second on the control with the illuminated alarm indicator.
  - a. The alarm will cease sounding and the yellow Mute indicator light will illuminate.

The alarm will stay muted for the duration of the **current** temperature deviation. Another deviation of 1% will reactivate the audible alarm.

# OPERATION (CONTINUED)

## PRESSURE UNIT CONVERSION

**Conversion table for pressure units**

	kPa	MPa	kgf/cm <sup>2</sup>	bar	psi	mmHg (Torr)	inHg	atm
1 kPa	1	$1 \times 10^{-3}$	$1.01972 \times 10^{-2}$	$1 \times 10^{-2}$	$1.45038 \times 10^{-1}$	7.50062	0.2953	$9.86923 \times 10^{-3}$
1 MPa	$1 \times 10^3$	1	$1.01972 \times 10$	$1 \times 10$	$1.45038 \times 10^2$	$7.50062 \times 10^3$	$0.2953 \times 10^3$	9.86923
1 kgf/cm <sup>2</sup>	$9.80665 \times 10$	$9.80665 \times 10^{-2}$	1	$9.80665 \times 10^{-1}$	$1.42234 \times 10$	$7.35559 \times 10^2$	$2.8959 \times 10$	$9.67841 \times 10^{-1}$
1 bar	$1 \times 10^2$	$1 \times 10^{-1}$	1.01972	1	$1.45038 \times 10$	$7.50062 \times 10^2$	$2.953 \times 10$	$9.86923 \times 10^{-1}$
1 psi	6.89473	$6.89473 \times 10^{-3}$	$7.03065 \times 10^{-2}$	$6.89473 \times 10^{-2}$	1	$5.17147 \times 10$	2.036	$6.80457 \times 10^{-2}$
1 mmHg (1 Torr)	$1.33322 \times 10^{-1}$	$1.33322 \times 10^{-4}$	$1.35951 \times 10^{-3}$	$1.33322 \times 10^{-3}$	$1.93368 \times 10^{-2}$	1	$3.9370 \times 10^{-2}$	$1.31579 \times 10^{-3}$
1 inHg	3.3864	$3.3864 \times 10^{-3}$	$3.4531 \times 10^{-2}$	$3.3864 \times 10^{-2}$	0.4912	$2.5400 \times 10$	1	$3.342 \times 10^{-2}$
1 atm	$1.01325 \times 10^2$	$1.01325 \times 10^{-1}$	1.03323	1.01325	$1.46960 \times 10$	$7.60000 \times 10^2$	$2.9921 \times 10$	1

**Figure 25: Pressure Measurement Unit Conversions**

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# USER MAINTENANCE

## Chamber Quality Control Check Sheet

Month:	Incubator Temperature	Condensate Drained	N <sub>2</sub> Cylinder Pressure Reading	CO <sub>2</sub> Cylinder Pressure Reading	
Date:					
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
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31					

You may copy this sheet for institutional use

# USER MAINTENANCE (CONTINUED)

## DAILY MAINTENANCE

1. Record the gas cylinder reading(s) to track usage.
2. Change the gas cylinder(s) if low.
3. Remove and drain the condensate collection container as needed.
4. Visually inspect that the pass box gaskets are properly seated.
5. Check the cuffs on the sleeve system for holes, tears, and other signs of wear that may compromise integrity. Replace if necessary.
6. Check the incubator temperature to ensure that the setting is correct.
7. Change or reactivate the charcoal scrubber, if installed. Please see the [Activated Charcoal Scrubber and Rejuvenation Cycle](#) on page 47 in the Operation section.
8. Clean and disinfect the workspace chamber in accordance with your laboratory or production protocols, or regulatory requirements.

## DOOR GASKET MAINTENANCE AND USAGE

BACTROX door gaskets are wear items. Replace when the gasket shows obvious signs of wear or damage such as dryness, brittleness, cracks, or tears. Heavy institutional users may wish to keep a pair of spare door gaskets on hand (Part Number 3450507).

Spilling sample media on door gaskets or the interior surfaces of pass box doors may cause the gaskets to stick to the doors. This can compromise the atmospheric integrity of the pass box when door openings pull sticky gaskets of their mounts. Gaskets can be cleaned with dish soap and warm water, if compatible with your laboratory protocol.

## SLEEVES MAINTENANCE AND USAGE

Sleeves may be washed with dish soap and warm water between uses. Disinfection should be carried out per lab protocols. Institutions with several users for each BACTROX may wish to keep a pair of sleeves in small, medium, and large sizes on hand. Or keep a pair of sleeves for each user.

The sleeve cuffs are subject to the most wear on the sleeve assemblies. Sheldon Manufacturing recommends keeping a stock of replacements on hand. See the [replacement parts list](#) (bottom of the list) on page 85 for sizes and part numbers of latex and nitrile cuffs. Make sure that the cuff matches the size of the sleeve assembly it will be attached to.

Sleeves or cuffs should be replaced when brittleness, dryness, or cracks are present.

Figure 25: Sleeve Cuff Replacement

## REPLACING THE SLEEVE CUFFS

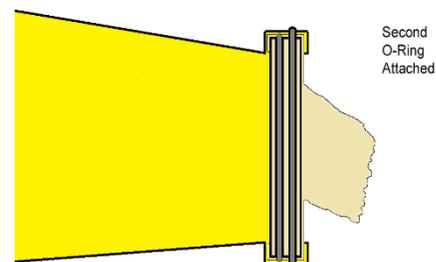
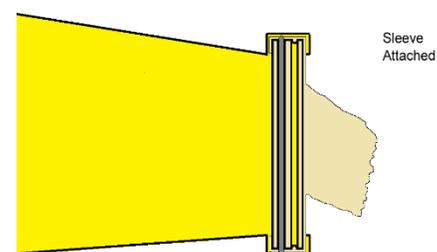
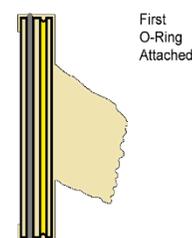
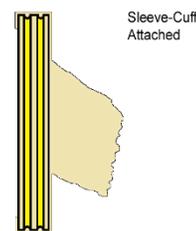
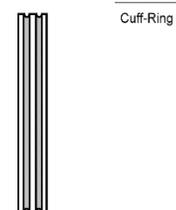
Remove the sleeve cuff by performing the following.

1. Remove the black O-ring located on the outside of the sleeve assembly, around the cuff. Gently roll the ring off to avoid damaging it or the sleeve.
2. Slowly and gently remove the sleeve-cuff and its sleeve cuff-ring from the sleeve.
3. Roll off the second black O-ring, which holds the sleeve-cuff to the cuff-ring.
4. Remove the old sleeve-cuff from the cuff-ring and discard. Inspect the cuff-ring. Replace the cuff-ring if there are cracks, dryness, brittleness, or a loss of flexibility.
5. Inspect the black O-rings. Replace if cracks, dryness, brittleness, or a loss of flexibility are present.
6. Inspect the sleeve. Replace if cracks, dryness, or brittleness are present.

Replace the sleeve-cuff.

1. Pull a new sleeve-cuff on over the cuff-ring.
2. Pull an O-ring onto the cuff-ring, over the sleeve-cuff. Fit the ring into the groove opposite the fringed side of the cuff.
3. Pull the lip of the sleeve over the cuff and cuff-ring. The fringed end of the cuff should be left outside the sleeve.
4. Roll on the second O-ring. Fit the O-ring into the unoccupied groove on the outside of the sleeve and sleeve cuff.

End of procedure



# USER MAINTENANCE (CONTINUED)



**Warning:** Prior to any maintenance or cleaning of this unit, disconnect the power cord from the power supply.

**Avertissement:** Avant d'effectuer toute maintenance ou entretien de cet appareil, débrancher le cordon secteur de la source d'alimentation.

## CLEANING AND DISINFECTING

If a hazardous material or substance has spilled in the incubator, immediately initiate your site's Hazardous Material Spill Containment protocol. Contact your local Site Safety Officer and follow instructions per the site policy and procedures.

The unit should be cleaned and disinfected prior to first use. Periodic cleaning and disinfection are required to prevent microbiological contamination.

Do not use spray on cleaners or disinfectants. These can leak through openings and coat electrical components. Do not use cleaners or disinfectants that contain solvents capable of harming paint coatings or stainless steel surfaces. **Do not use chlorine-based bleaches or abrasives; these will damage the chamber liner.** Consult with the manufacturer or their agent if you have any doubts about the compatibility of decontamination or cleaning agents with the parts of the equipment or with material contained in it.

Never spray the oxygen sensor or chamber power outlets. Do not attempt to clean or disinfect the interior of the O<sub>2</sub> sensor box cage. The high operating temperature of the sensor precludes microbiological contamination. Wipe down sensor and cage exterior surface with a lightly dampened cloth.



**Warning:** Never clean the unit with alcohol or flammable cleaners.

**Avertissement:** Ne jamais nettoyer l'appareil à l'alcool ou avec des nettoyeurs inflammables.

## Cleaning

1. Remove all items (shelves, racks, and any additional items) from the incubator when possible.
2. Clean the workstation's interior with a mild soap and water solution, including all corners.
3. Clean all removable accessories including arm port doors, gaskets, and sleeve assemblies with a mild soap and water solution.
4. Rinse with distilled water and wipe dry with a soft cloth. **Do not use deionized water.** See the [Distilled and Deionized Water](#) paragraph on page 19 in the Operation section.
5. Take special care when cleaning around the oxygen sensor and chamber power outlets to prevent damage.
6. **Do not use chloride-based cleaners** except Zephiran benzalkonium chloride solution. Other types may have adverse effects on microbiological samples.
7. Wipe down the interior surfaces with Zephiran. Do not wipe up, allow the Zephiran to evaporate.

# USER MAINTENANCE (CONTINUED)

## *Disinfecting*

Disinfect the workspace chamber, pass box, and incubator on a regular basis. Perform the following steps to disinfect the workstation:

1. Turn the unit off. Carry out your laboratory disinfection protocol.
2. If possible, remove all interior accessories (shelf spacers, dish racks, and other non-attached items) from the incubator when disinfecting. Disinfect all corners, the incubator interior, and the pass box. Take special care when disinfecting around the pass box door and arm port door gaskets so as not to impair a positive seal.
3. Disinfect the unit using commercially available disinfectants that are non-corrosive, non-abrasive, and suitable for use on stainless steel surfaces. Contact your local Site Safety Officer for detailed information on the disinfectants compatible hypoxia applications.
4. **Do not use overtly volatile disinfecting agents.** Chlorines, amphylys, and quaternary ammonias will evaporate into the chamber environment. Over time the concentration in the chamber atmosphere will continue to increase, potentially leading to inhibited growth or metabolic symptoms in sample populations.
5. After completion of your institutional protocol, allow all disinfectants to evaporate completely. Wipe down all surfaces, except the acrylic glass panels, with distilled water and Zephiran until the unit no longer has a volatile odor. Use nonabrasive wipes.

## *MAINTAINING THE ACRYLIC GLASS PANELS*

Sheldon Manufacturing recommends using Novus brand acrylic glass cleaner and Novus scratch remover for cleaning and maintaining BACTROX-2 acrylic glass surfaces. Please see the [Accessories section](#) on page 85. Alcohol or alcohol-based solvents and other aggressive solvents should never be used to clean the BACTROX-2, and may damage the acrylic glass panels.

**Never expose the BACTROX-2 to sustained UV light.** Prolonged exposure to UV will result in rapid aging of the acrylic glass, leaving it vulnerable to compression forces, and generating cracks across all exposed areas. UV light will also quickly age sleeve assemblies, turning the sleeves yellow and result in a quick loss of elasticity.

Disable or redirect laboratory UV lighting away from the BACTROX-2. The BACTROX-2 should not be exposed to direct sunlight. Verify that your laboratory or workspace environment does not use UV lighting at night. This type of light is usually referred to as short-wave UVC or germicidal UV light and operates at roughly 254nm.

Damage from prolonged or high-intensity UV exposure is not covered under the manufacturing defects warranty.

Periodic use of long-wave (365nm) UV hand lamps used for bacterial identification should not damage the acrylic glass.

# USER MAINTENANCE (CONTINUED)

## CONDENSATION AND THE DEW POINT

**Relative humidity inside the BACTROX-2 should never exceed 80% at 25°C.** Exceeding this threshold will likely result in condensation on incubator and workspace surfaces.

Condensation will appear wherever the humidity level in the chamber reaches the dew point. The dew point is the level of humidity at which the air cannot hold more water vapor. The warmer the air, the more water vapor it can hold.

As the level of humidity rises in the chamber, condensation will first appear on surfaces that are cooler than the air temperature. Near the dew point, condensation will form on any item or exposed surface that is even slightly cooler than the air. When the dew point is reached, condensation forms on nearly all exposed surfaces.

Mild condensation can be present in BACTROX-2 units fully loaded or loaded to near capacity with open media plates, depending on ambient temperature and humidity. Cold air blowing on the exterior of the BACTROX-2 may also help to cause condensation in the workspace chamber by chilling the acrylic glass panels and metal bulkheads.

Managing excessive condensation at humidity levels that overwhelm the BACTROX-2 condensate controller depends on either lowering the humidity level in the chamber or increasing its air temperature.

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**Note:** Note: Rising or falling air pressure from the weather will adjust the dew point up and down in small increments. If the relative humidity in the BACTROX is already near the dew point, barometric fluctuations may push it across the dew point threshold.

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If excessive condensation is forming in the BACTROX-2 chamber, check the following:

- Check to see if condensate from the condensate controller is draining through the drain tube in the left wall and into the collection vessel.
- Remove or cap open containers of water or media. Empty the condensate controller catch vessel frequently.
- Does the number of media containers in the BACTROX-2 exceed its rating? The workstation can hold 300 plates. Reduce the number of sample containers.
- Does the ambient humidity in the room exceed the stated operating range of 80% relative humidity? If so, lower the humidity.
- Is the BACTROX-2 exposed to an external flow of cold air such as, an air-conditioning vent or a door to a cooler hallway or adjacent room? Block or divert the air, or move the incubator.
- Verify that the circulation fan over the Peltier condensate controller on the left wall of the chamber is operating. The fan circulates air over condenser controller's cold plate.

## ELECTRICAL COMPONENTS

Electrical components do not require maintenance. If the BACTROX-2 electrical systems fail to operate as specified, please contact your distributor or Technical Support for assistance.

# USER MAINTENANCE (CONTINUED)

**Note:** The O<sub>2</sub> sensor requires five minutes to warm up to its operating temperature in order to provide an accurate O<sub>2</sub> measurement. It will begin heating as soon as the BACTROX is turned on.

## CALIBRATE THE O<sub>2</sub> SENSOR AND DISPLAY

The oxygen calibration procedures verify the accuracy of the O<sub>2</sub> display and correct for any measurement errors. Errors accrue due to gradual material changes in the O<sub>2</sub> sensor because of a high internal operating temperature and exposure to ionized oxygen as well as other heated gasses. Additionally, the sensor derives the O<sub>2</sub> concentration from the measured partial pressure of oxygen (PPO), so its measurements are sensitive to altitude and barometric pressure.

Each BACTROX is shipped from the factory calibrated at near sea level for a two-point curve using an N<sub>2</sub> – O<sub>2</sub> reference mixture of 5% O<sub>2</sub> for the low value and a near sea level ambient air sample of around 20.7% O<sub>2</sub> for the high value.

### Recommended O<sub>2</sub> Calibrations

- When preparing the unit for use at altitudes higher than 2000 feet (600 meters).
- As required by your laboratory, study, or production protocol, or regulatory compliance schedule.

### Chamber O<sub>2</sub> Deviations During Calibrations

The O<sub>2</sub> controller is set to Off during calibration procedures. This means no N<sub>2</sub> or air injections take place. The oxygen concentration in the chamber may drift from the set point. Use proper entry and exit procedures when using the BACTROX arm ports to minimize disruptions to the hypoxic atmosphere during a calibration.

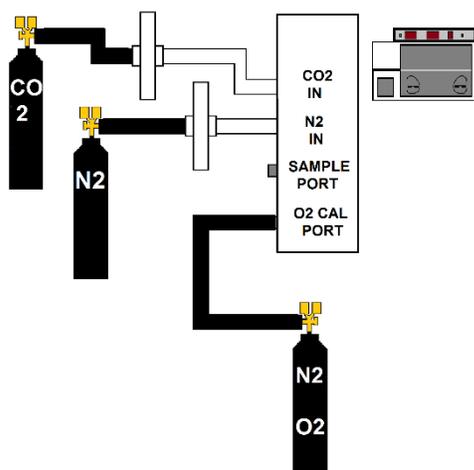


Figure 27: Mixed Reference Gas Cylinder

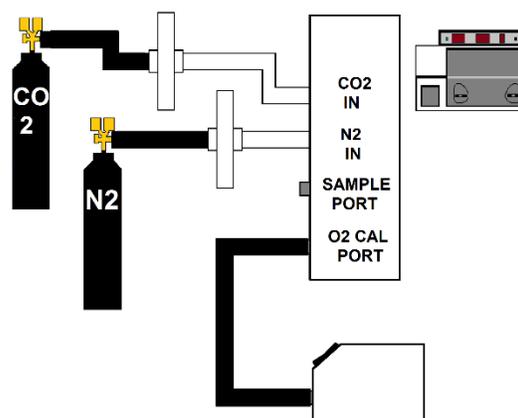


Figure 26: Ambient Air Sample Pump

# USER MAINTENANCE (CONTINUED)

## Sample Types

Two air sample types may be used for calibrations.

- A reference mixed gas cylinder with a known O<sub>2</sub> concentration
- An ambient air sample with a calculated O<sub>2</sub> concentration

**Reference gasses** are typically a dry gas (no humidity) mix of nitrogen and a precise oxygen concentration. Reference gas mixes may be used for all calibration types.

The BACTROX-2 may also be calibrated to an **ambient air sample** drawn from the laboratory environment. To use an ambient air sample, it is necessary to calculate the oxygen concentration value of the air using the current temperature, humidity, and barometric pressure. The temperature and humidity should be obtained using sensors inside the laboratory environment in the immediate vicinity of the BACTROX-2. The current barometric pressure may be obtained from a local meteorological service or online source **unless** the BACTROX-2 is located in an overpressure or negative pressure environment. In an artificial pressure environment, the air pressure must be measured in the same room as the BACTROX-2.

Please see the [Calculating the O<sub>2</sub> Concentration procedure](#) on page 88 for the formulas used to calculate the current ambient O<sub>2</sub> concentration. The ambient sample should be obtained by attaching the **air pump** provided with the BACTROX-2 O<sub>2</sub> calibration kit to the BACTROX-2 calibration port.



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## Calibration Types

The BACTROX-2 can be calibrated in one of two modes:

- Single Point Calibration
- Dual Point Calibration

**Single Point Calibration:** The single point calibration procedure produces a calibration offset adjustment to match the sensor and its display to the calibration sample.

If a difference is detected between the sensor reading and the known or calculated value of the gas sample, an offset adjustment is entered into the BACTROX controller. **The single point calibration and should only be used in applications in which having an absolute linear curve throughout your range of chamber O<sub>2</sub> concentrations is not an issue.** This may mean that a single point O<sub>2</sub> calibration is only valid for a single O<sub>2</sub> chamber concentration for your study.

Required for the single point calibration procedure:

- An ambient air sample or an reference gas cylinder
- The O<sub>2</sub> calibration kit provided with the BACTROX-2

# USER MAINTENANCE (CONTINUED)

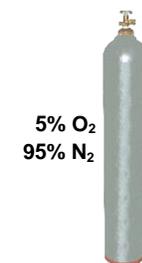
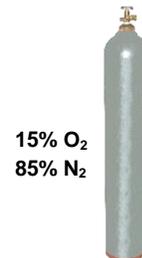
**Note:** The effective O<sub>2</sub> concentration operating range of the BACTROX is 1 – 20%

**Note:** The links and sites listed below are provided as conveniences. Sheldon Manufacturing makes no warrant as to the safety of third party sites, their contents, or the reliability or support of software products contained therein.

**Dual Point Calibration:** The dual point calibration procedure calibrates the sensor to an **upper calibration value point** and a **low calibration value point** to produce an adjusted linear curve across a range of potential chamber O<sub>2</sub> concentrations. The upper calibration may be made using either ambient laboratory atmosphere or a reference gas mix, and should never exceed 20.7%. **The low value is always calibrated using a hypoxic reference gas cylinder.**

Required for the dual point calibration procedure:

- An ambient air sample **or** an oxygen reference cylinder for the upper calibration point.
- An oxygen reference mixture for low the calibration point.
- A computer connected to the BACTROX-2 using the RS232 cable provided with the unit (includes USB adaptor).
- A software driver for the USB adaptor compatible with your computer's operating system. RS232 uses a communications protocol different from that of USB, and the adapter requires its own driver to convert between the two protocols. These drivers are available for free download on the adapter manufacture's website:
  - <http://www.iogear.com/support/dm/driver/GUC232A>
- Open source Tera Term terminal-emulation software loaded on the computer (see below).
- The O<sub>2</sub> calibration kit provided with the BACTROX-2.



## Dual Point O<sub>2</sub> Calibration Procedure

**Note:** Make sure the calibration kit cover plate is inside the workspace chamber prior to starting this procedure.

Prior to starting this procedure install a terminal emulator on the computer, you will be using for the calibration and data logging. There are several free, open source emulators available online. Sheldon Manufacturing uses Tera Term when performing dual point calibrations and data logging at the factory. Tera Term is a free ([BSD license](#)) software application that can be downloaded from the [Tera Term development](#) project site (SourceForge.JP) at: <http://en.sourceforge.jp/projects/ttssh2/releases/>

*Procedure continued on next page*

# USER MAINTENANCE (CONTINUED)

## Calibrating the O<sub>2</sub> Sensor

1. If you will be using an ambient air sample for the upper-value calibration, calculate the current O<sub>2</sub> concentration of the ambient laboratory atmosphere.

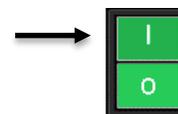
- a.  $WVP = \left(\frac{H_{rel}}{100}\right) \cdot WVP_{max}$
- b.  $PPO_2 = (BP - WVP) \cdot \left(\frac{20.95}{100}\right)$
- c.  $O_2\% = \left(\frac{PPO_2}{BP}\right) 100$

Please see the [Calculating the O<sub>2</sub> Concentration procedure](#) on page 88

2. Verify that the BACTROX-2 has been powered for more than five minutes.
  - a. Calibrating with an O<sub>2</sub> sensor that has not warmed up fully will lead to an inaccurate calibration.



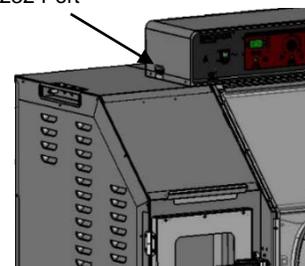
> 5 Minutes



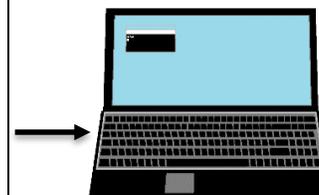
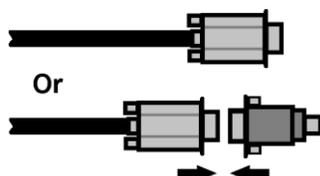
3. Connect the RS232 DB9 cable to the port on the left side of the BACTROX-2 control panel box.



RS232 Port



4. Connect the RS232 DB9 cable to your computer.
  - a. Use the USB adaptor included with the calibration kit if necessary. Remember to download and install the free driver if using the adaptor.



# USER MAINTENANCE (CONTINUED)

## Calibrating the O<sub>2</sub> Sensor (Continued)

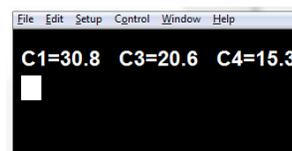
5. Open the terminal emulator on your computer.
  - a. For Tera Term, select the serial button in the lower left corner of the **New Connection** window.
  - b. If you know the communication port used by your computer, select it in the Port dro-down menu on the lower right side of the New Connection window.
  - c. If you do not know the com port, **select COM1**. The correct port may be determined by process of elimination. See next step (6).
  - d. **Click OK**.



6. Connection: If using Tera Term, the emulator should start logging data from the BACTROX-2 once every minute if the correct com port was chosen. If the emulator is not logging the data, perform the following steps.



- a. Verify that a USB to Serial Adapter driver has been installed if you are using the RS232 to USB Adaptor
- b. Close Tera Term.
- c. Re-open Tera Term.
- d. Select a different com port.

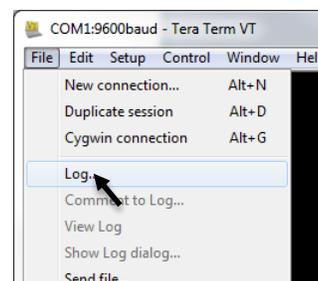


### Logging Channels:

C1 = Current Temperature  
C3 = Current Oxygen  
C4 = Current CO<sub>2</sub>

**Note:** The output logging channels and the calibration input channels are completely separate channels, with a separate numbering system.

7. Saving O<sub>2</sub> log data (optional). To save log data from the BACTROX-2 during the calibration, perform the following steps.
  - a. Click on the Tera Term File tab.
  - b. Click on the “Log” option.
  - c. Create a file on your computer to save the log data in.
  - d. Click OK after naming the file.
  - e. Data will now be saved.



Procedure continued on next page

# USER MAINTENANCE (CONTINUED)

## Calibrating the O<sub>2</sub> Sensor (Continued)



OR



Wait 5 Seconds

8. Set the O<sub>2</sub> set point to OFF. This prevents the BACTROX-2 controller from attempting to adjust the chamber O<sub>2</sub> concentration while the O<sub>2</sub> sensor is isolated from the workspace environment. It also disables the O<sub>2</sub> deviation alarms during the calibration process.

- Press and release either **Set Oxygen % arrow button**. The display will briefly flash the letters SP.
- When the display dims and flashes an adjustable set point, press and hold the down arrow button until the display reads "Off".
- Wait five (5) seconds for the display to stop flashing.

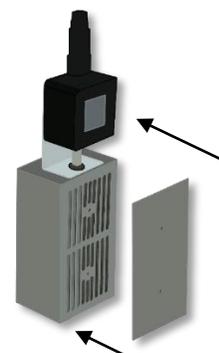
SET OXYGEN %



SET OXYGEN %



9. Install the O<sub>2</sub> calibration kit sensor cover plate on the oxygen sensor cage.
- Tighten the plate thumb screws until finger tight.
  - This isolates the O<sub>2</sub> sensor and allows a sufficient concentration of calibration sample gas to build up around the sensor head.



## Upper Value Calibration

10. Attach the upper calibration gas sample to the O<sub>2</sub> CAL PORT.



- If you are using **ambient air** for the upper calibration sample, plug the oxygen calibration pump included with the BACTROX-2 into a suitable wall power source. Attach the calibration kit tubing to the pump and then to the O<sub>2</sub> CAL PORT on the BACTROX-2. Push the pump power switch to the (I) on position. The pilot light on the pump will illuminate, and air will be pumped into the O<sub>2</sub> sensor box.

Or

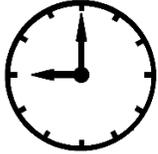
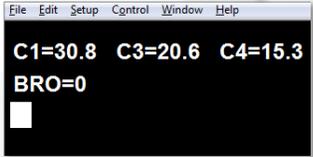


- If you are using a **reference gas mixture** for the upper calibration sample, connect the gas cylinder regulator to the O<sub>2</sub> CAL Port on BACTROX-2. Use the tubing provided with the oxygen calibration kit. Set the cylinder regulator to 3 PSI. **Never set the regulator to higher than 3 PSI!** Open the regulator control valve to establish a flow of gas to the sensor.



Procedure continued on next page

# USER MAINTENANCE (CONTINUED)

Calibrating the O <sub>2</sub> Sensor (Continued)	
<p>11. Wait 5 minutes for a sufficient upper calibration O<sub>2</sub> sample concentration to build up in the sealed sensor box.</p>	 <p>Wait 5 Minutes</p>
<p>12. Access the BACTROX-2 calibration channels using the terminal emulator software on your computer after 5 minutes have elapsed.</p>  <ol style="list-style-type: none"> <li>Type <b>BRO=0</b> in the emulator window and press <b>Enter</b>.</li> <li>You now have access to the calibration channels.</li> </ol> <p><b>Note:</b> The BACTROX-2 will automatically revert out of the calibration channels every three minutes to prevent accidental calibration adjustments from being made.</p>	
<p><b>Note:</b> <i>The 20.7% shown to the right is an arbitrary example value.</i></p> <p>13. Check the green SET OXYGEN % display on the BACTROX-2.</p> <ol style="list-style-type: none"> <li>If BACTROX-2 O<sub>2</sub> display matches the O<sub>2</sub> concentration of your upper calibration sample, the upper value is now calibrated. Advance to step 16.</li> </ol> <p style="text-align: center;"><b>Or</b></p> <p>14. If there is a difference between the O<sub>2</sub> display reading and the concentration of your sample, and that difference exceeds the range allowed by your laboratory protocol, enter an upper calibration adjustment. <b>See next step.</b></p>	<p style="text-align: center;"><b>Upper Sample O<sub>2</sub>% = 20.7%</b></p> <p style="text-align: center;">SET OXYGEN %</p>  <p style="text-align: center;"><b>Or</b></p> <p style="text-align: center;">SET OXYGEN %</p> 

Procedure continued on next page

# USER MAINTENANCE (CONTINUED)

## Calibrating the O<sub>2</sub> Sensor (Continued)

15. Enter an upper calibration adjustment to match the Set Oxygen % display to the upper calibration gas sample value.



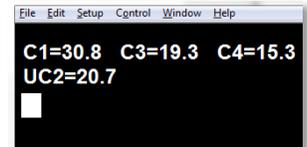
a. Enter the air or reference gas concentration into the BACTROX-2 by typing **UC2=sample value** in the emulator window. For example, if your air sample or reference gas has an O<sub>2</sub> concentration of 20.7%, type **UC2=20**, and press **Enter**.

b. The BACTROX-2 display should now match the O<sub>2</sub> concentration of your sample.

**Note:** UC2 indicates the upper calibration value for oxygen  
LC2 indicates the low calibration value for oxygen

Upper Sample O<sub>2</sub>% =  
20.7%

SET OXYGEN %



SET OXYGEN %



16. Turn off and unplug the calibration kit air pump, or close the valve of the reference gas cylinder. Set the cylinder regulator to 0. Disconnect the pump or cylinder from the O<sub>2</sub> Cal Port.



Procedure continued on next page

# USER MAINTENANCE (CONTINUED)

## Low-Value Calibration

Calibrating the O <sub>2</sub> Sensor (Continued)	
 <p>17. Attach your low-value reference gas mixture to the O<sub>2</sub> Cal Port. <b>Do not use ambient air for the low-value sample.</b></p> <ol style="list-style-type: none"><li>Set the cylinder regulator to 3 PSI. <b>Do not set the regulator to higher than 3 PSI!</b></li><li>Open the regulator control valve to establish a flow of gas to the sensor.</li></ol>	
<p>18. Wait 5 five minutes for the low-value reference mix to purge the sensor box and establish a sufficient concentration.</p>	 <p>Wait 5 Minutes</p>
<p><b>Note:</b> The 5% shown to the right is an arbitrary example value. The O<sub>2</sub> value of your low-value gas mix should be chosen on the basis of your study or laboratory protocol requirements.</p> <p>19. Check the SET OXYGEN % display on the BACTROX-2.</p> <ol style="list-style-type: none"><li>If the display matches the O<sub>2</sub> concentration of the low calibration gas mix, the BACTROX-2 low calibration value is now calibrated. <b>Advance to step 21.</b></li></ol> <p style="text-align: center;">Or</p> <ol style="list-style-type: none"><li>If there is a difference between the display and the reference gas concentration and that difference exceeds the acceptable range of your laboratory or study protocol, enter a low calibration adjustment. <b>See next step.</b></li></ol>	<p><b>Lower Sample O<sub>2</sub>% = 5.0%</b></p> <p>SET OXYGEN %</p>  <p>Or</p> <p>SET OXYGEN %</p> 

Procedure continued on next page

# USER MAINTENANCE (CONTINUED)

## Calibrating the O<sub>2</sub> Sensor (Continued)

20. Enter a low calibration adjustment to match the O<sub>2</sub> sensor and display to the sample concentration value.

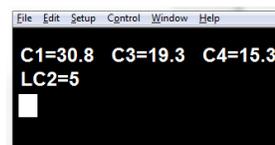


- Type **BRO=0** in the Tera Term window and press **Enter** to ensure that you are still accessing the calibration channels.
- Enter the low calibration gas O<sub>2</sub> concentration by typing **LC2=sample value** in the Tera Term window. For example, if the low calibration reference gas has an O<sub>2</sub> concentration of 5%, type **LC2=5** and hit **Enter**.
- The BACTROX-2 display should now match the O<sub>2</sub> concentration value of the low calibration reference gas.

**Note:** LC2 indicates the low calibration value for oxygen

Lower Sample O<sub>2</sub>%  
= 5.0%

SET OXYGEN %



SET OXYGEN %



## Verify Calibration Across Full Range

21. Verify that the sensor is accurate across the full range of the established O<sub>2</sub> curve by rechecking the high calibration accuracy.



Wait 5 Minutes

- Close the valve and set the regulator of the low reference gas cylinder to zero (0). Disconnect the low cylinder from the calibration gas port.
- Re-attach your upper calibration sample to the O<sub>2</sub> Cal Port. Plug in and turn on the calibration kit air pump. **Or**, set the upper reference cylinder regulator to 3 PSI, and open the regulator control valve to establish a flow of gas to the sensor.
- Wait five 5 minutes for the upper calibration sample gas to purge the sensor box and build up a sufficient concentration. Failure to wait for the full 5 minutes will result in an inaccurate calibration.

Low Value



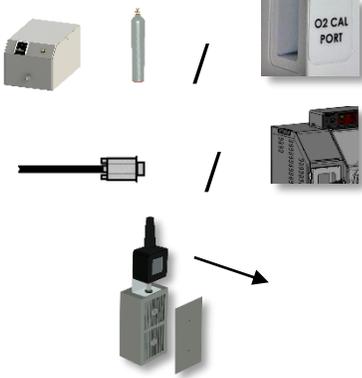
Upper Value

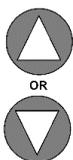


Procedure continued on next page

# USER MAINTENANCE (CONTINUED)

## Verification of Range Continued

Calibrating the O <sub>2</sub> Sensor (Continued)	
<p>22. If the BACTROX-2 display matches the O<sub>2</sub> concentration of the upper calibration sample, the dual point calibration is accurate across the range of the curve. Advance to step 23.</p> <ol style="list-style-type: none"> <li>If the O<sub>2</sub> concentration does not match the concentration of the air or reference gas sample, <b>repeat steps 11 – 21</b> starting on page 65. Recalculate the ambient air O<sub>2</sub> concentration if you are using ambient air for the high calibration.</li> <li>Contact Sheldon Manufacturing Technical Support for assistance if the high value does not match the ambient air or reference gas concentration after three attempts.</li> </ol>	<p>Upper Sample O<sub>2</sub>% = 20.7%</p> <p>SET OXYGEN %</p>  <p>Or</p> <p>SET OXYGEN %</p>  <p>Repeat steps 10 – 21</p>
<p>23. Return the unit to normal operation after a successful calibration.</p> <ol style="list-style-type: none"> <li>Disconnect the calibration air pump or high calibration gas cylinder.</li> <li>Reattach the O<sub>2</sub> Cal Port cover cap.</li> <li>Disconnect the RS232 cable unless you wish to continue logging data from the BACTROX-2.</li> <li><b>Remove the calibration kit cover plate from the oxygen sensor!</b> Failure to do so will result in inaccurate O<sub>2</sub> readings.</li> <li><b>Set the O<sub>2</sub> concentration</b> set point (page 40) for your application using the Set Oxygen % arrow keys.</li> <li>The oxygen concentration in the workspace chamber may have fallen or risen during the calibration procedure. Monitor the BACTROX-2 and make sure it achieves the set point. Gas injection lights will illuminate as the unit matches and stabilizes at the set point.</li> </ol>	 <p>SET OXYGEN %</p>  <p>↓</p> <p><b>Your Application O<sub>2</sub>% Set Point</b></p>



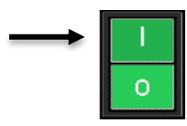
End of dual point calibration

# USER MAINTENANCE (CONTINUED)

## Single Point O<sub>2</sub> Calibration

A single point calibration is valid for a narrow range centered on the calibration sample value. For example, if the unit is calibrated using a reference gas with 10% O<sub>2</sub>, the calibration is valid for a narrow band around 10%. Sheldon Manufacturing recommends using a calibration reference gas with an O<sub>2</sub> concentration that matches your application set point.

**Note:** Make sure the calibration kit cover plate is inside the workspace chamber prior to starting this process.

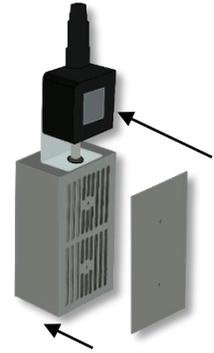
Calibrating the O <sub>2</sub> Sensor	
<ol style="list-style-type: none"><li>Verify that the BACTROX-2 has been powered for more than five minutes.<ol style="list-style-type: none"><li>Calibrating with an O<sub>2</sub> sensor that has not warmed up fully will lead to an inaccurate calibration.</li></ol></li></ol>	 <p>&gt; 5 Minutes</p> 
<ol style="list-style-type: none"><li>Set the O<sub>2</sub> set point to OFF. This prevents the BACTROX-2 controller from attempting to adjust the chamber O<sub>2</sub> concentration while the O<sub>2</sub> sensor is isolated from the workspace environment. It also disables the O<sub>2</sub> deviation alarms during the calibration process.<ol style="list-style-type: none"><li>Press and release either <b>Set Oxygen % arrow button</b>. The display will briefly flash the letters SP.</li><li>When the green Oxygen % display dims and flashes an adjustable set point, press and hold the down arrow button until the display reads "Off".</li><li>Wait five (5) seconds for the display to stop flashing.</li></ol></li></ol>	<p>SET OXYGEN %</p>  <p>↓</p> <p>SET OXYGEN %</p> 

Procedure continued on next page

# USER MAINTENANCE (CONTINUED)

## Single Point O<sub>2</sub> Sensor (Continued)

3. Install the O<sub>2</sub> calibration kit sensor cover plate on the oxygen sensor cage.
  - a. Tighten the plate thumb screws until finger tight.
  - b. This isolates the O<sub>2</sub> sensor and allows a sufficient concentration of calibration sample gas to build up around the sensor head.



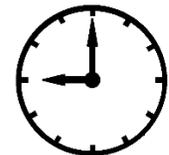
4. Attach the calibration gas sample to the O<sub>2</sub> CAL PORT.



- a. Connect the gas cylinder to the O<sub>2</sub> CAL Port on BACTROX-2.
- b. Use the tubing provided with the oxygen calibration kit. Set the cylinder regulator to 3 PSI.
- c. **Never set the regulator to higher than 3 PSI!** Open the regulator control valve to establish a flow of gas to the sensor.



5. Wait five (5) minutes for a sufficient sample concentration to build up in the sealed sensor box.



Wait 5 Minutes

Procedure continued on next page

# USER MAINTENANCE (CONTINUED)

Single Point O <sub>2</sub> Sensor (Continued)	
<p><b>Note:</b> The 15% O<sub>2</sub> sample value and 13.4% display are arbitrary example values.</p> <p>6. Check the green SET OXYGEN % display.</p> <ul style="list-style-type: none"> <li>a. If display matches the O<sub>2</sub> concentration of your calibration reference, the BACTROX-2 is now calibrated for O<sub>2</sub>. Advance to step 9.</li> </ul> <p style="text-align: center;"><b>Or</b></p> <ul style="list-style-type: none"> <li>b. If there is a difference between the display reading and the concentration of your sample, and that difference exceeds the range allowed by your laboratory protocol, enter a calibration offset. <b>See next step.</b></li> </ul>	<p style="text-align: center;"><b>Sample O<sub>2</sub>% = 15%</b></p> <p style="text-align: center;">SET OXYGEN %</p> <div style="text-align: center;">  </div> <p style="text-align: center;">Or</p> <p style="text-align: center;">SET OXYGEN %</p> <div style="text-align: center;">  </div>
<p>7. Place the display in its calibration mode.</p> <div style="display: flex; align-items: center;">  <div style="margin-left: 10px;">AND</div>  </div> <ul style="list-style-type: none"> <li>a. Press and hold both the <b>UP and DOWN</b> Set O<sub>2</sub> arrow buttons simultaneously for approximately 5 seconds.</li> <li>b. Release the buttons when the display shows the letters "CO". The display will begin flashing the <b>current O<sub>2</sub> display value</b>.</li> </ul> <p><b>Note:</b> If an arrow key is not pressed for five seconds, the display will cease flashing, and store the last displayed value as the new current O<sub>2</sub> value.</p>	<p style="text-align: center;"><b>Sample O<sub>2</sub>% = 15%</b></p> <p style="text-align: center;">SET OXYGEN %</p> <div style="text-align: center;">  </div>
<div style="display: flex; align-items: center;">  <div style="margin-left: 10px;">AND</div>  </div> <p>8. Use the <b>Up</b> or <b>Down</b> arrows to adjust the current O<sub>2</sub> display value until it matches the reference gas O<sub>2</sub> concentration.</p>	<p style="text-align: center;">SET OXYGEN %</p> <div style="text-align: center;">  </div>
<p>9. After matching the display to the reference device, wait 5 seconds.</p> <div style="display: flex; align-items: center;">  <div style="margin-left: 10px;">Wait 5 Seconds</div> </div> <ul style="list-style-type: none"> <li>a. The display will cease flashing and store the corrected display value.</li> <li>b. The workstation will begin injecting O<sub>2</sub> or allow the current gas concentration to decay in order to achieve the set point with the corrected display value.</li> </ul>	<p style="text-align: center;">SET OXYGEN %</p> <div style="text-align: center;">  </div>

# USER MAINTENANCE (CONTINUED)

## Single Point O<sub>2</sub> Sensor (Continued)

10. Allow the BACTROX to sit for at last 1 hour undisturbed to stabilize **after it has achieved the corrected O<sub>2</sub> set point.**



Wait 1 Hour

- a. Failure to wait until the unit is fully stabilized will result in an inaccurate reading and calibration.

SET OXYGEN %



11. If the BACTROX-2 display matches the O<sub>2</sub> concentration of the reference gas, the O<sub>2</sub> sensor and display are now calibrated. Advance to step 10.

Or

- a. If the O<sub>2</sub> concentration does not match the concentration of the reference gas sample, **repeat steps 6 - 10** starting on page 72 .
- b. Contact Sheldon Manufacturing Technical Support for assistance if the display value does not match your sample concentration after three attempts.

Sample O<sub>2</sub>% = %

SET OXYGEN %



Or

SET OXYGEN %



Repeat steps 6 – 11

12. Return the unit to normal operation after a successful calibration.

- a. Disconnect the calibration air pump or reference gas cylinder.
- b. Reattach the O<sub>2</sub> Cal Port cover cap.
- c. Remove the calibration kit cover plate from the oxygen sensor.
- d. **Set the O<sub>2</sub> concentration** set point (see page 40) for your application using the Set Oxygen % arrow keys.
- e. The oxygen concentration in the workspace chamber may have fallen or risen during the calibration procedure. Monitor the BACTROX-2 and make sure it returns to the set point. Gas injection lights will illuminate as the unit matches and stabilizes at the set point.



OR



SET OXYGEN %



Your Application O<sub>2</sub>% Set Point

End of procedure

# USER MAINTENANCE (CONTINUED)

## CALIBRATE THE CO<sub>2</sub> DISPLAY

**Note:** Performing a CO<sub>2</sub> display calibration requires a gas reference device. Please see the [Reference Sensor Devices entry](#) on page 12 for the device requirements.

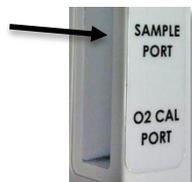
CO<sub>2</sub> calibrations are performed to match the incubator CO<sub>2</sub> display to the actual gas concentration in the workspace chamber. The actual concentration is supplied by a calibrated reference sensor device. Calibrations compensate for drifts in the unit microprocessor controller, as well as those caused by the natural material evolution of the IR CO<sub>2</sub> sensor when continually exposed the chamber atmosphere. Calibrate as often as required by your laboratory or production protocol, or regulatory compliance schedule.

### CO<sub>2</sub> Supply

The incubator must be powered, the CO<sub>2</sub> set point set, and the BACTROX supplied with CO<sub>2</sub> for at least eight hours prior to the calibration.

### Temperature

The chamber temperature impacts the chamber CO<sub>2</sub> concentration, due to its influence on gas diffusion. CO<sub>2</sub> calibrations must be performed with the incubator fully heated and stable at your operational temperature set point. A CO<sub>2</sub> display calibration may be performed during a temperature calibration **as long as pass box or armor port doors are not opened during either procedure.**



### Probes

Connect a digital CO<sub>2</sub> analyzer to the sample tube to the sample port, located on the left side of the incubator near the top.

### Stability

Prior to a calibration, the chamber must operate at its CO<sub>2</sub> set point for **at least 1 hour with no fluctuations** of  $\pm 0.1\%$  or greater in order to be considered stabilized. Failure to wait for stabilization will result in an inaccurate calibration and incubator display reading.

**Figure 28:**  
**CO<sub>2</sub> Sample Port**

For best results, allow the unit to operate undisturbed for 8 hours supplied to achieve temperature and gas stability (for example, overnight).

# USER MAINTENANCE (CONTINUED)

Calibrate the CO <sub>2</sub> Display	
<p>1. Once the BACTROX CO<sub>2</sub> concentration has stabilized with no fluctuations of 0.1% or greater, compare the gas reference device and BACTROX CO<sub>2</sub> display readings.</p> <ol style="list-style-type: none"> <li>If the readings are the same, or the difference between the two (2) falls within the acceptable range of your protocol, the display is accurately showing the chamber CO<sub>2</sub> concentration. <b>The CO<sub>2</sub> calibration procedure is now complete.</b></li> <li>If there is a difference between the two readings that falls outside the acceptable range of your protocol see the next step.</li> </ol>	<p>Reference Device</p>  <p>Set CO<sub>2</sub></p> 
<p>2. A display calibration adjustment must be entered to match the incubator CO<sub>2</sub> display to the reference device.</p>	<p>Reference Device</p>  <p>Set CO<sub>2</sub></p> 
<p>3. Place the display in its CO<sub>2</sub> calibration mode.</p>  <p>AND</p>  <ol style="list-style-type: none"> <li>Press and hold both the <b>UP and DOWN</b> Set CO<sub>2</sub> arrow buttons simultaneously for approximately 5 seconds.</li> <li>Release the buttons when the display shows the letters “CP”. The display will begin flashing the <b>current CO<sub>2</sub> display value</b>.</li> </ol> <p><b>Note:</b> If an arrow key is not pressed for five seconds, the display will cease flashing, and store the last displayed value as the new current chamber CO<sub>2</sub> value.</p>	<p>Set CO<sub>2</sub></p> 

*Procedure continued on next page*

# USER MAINTENANCE (CONTINUED)

Calibrate the CO <sub>2</sub> Display (Continued)	
<div style="display: flex; align-items: center;">  <span style="margin: 0 5px;">OR</span>  </div> <p>4. Use the <b>Up</b> or <b>Down</b> arrows to adjust the current CO<sub>2</sub> display value until it matches the reference device CO<sub>2</sub> reading.</p>	<p>Reference Device</p>  <p>Set CO<sub>2</sub></p> 
 <p>Wait 5 Seconds</p> <p>5. After matching the display to the reference device, wait 5 seconds.</p> <p>a. The display will cease flashing and store the corrected display value.</p> <p>b. The workstation will begin injecting CO<sub>2</sub> or allow the current gas concentration to decay in order to achieve the set point with the corrected display value.</p>	<p>Set CO<sub>2</sub></p> 
 <p>Wait 1 Hour</p> <p>6. Allow the BACTROX to sit for at least 1 hour undisturbed to stabilize <b>after it has achieved the corrected CO<sub>2</sub> set point</b>.</p> <p>a. Failure to wait until the unit is fully stabilized will result in an inaccurate reading and calibration.</p>	<p>Set CO<sub>2</sub></p> 
<p>7. Compare the reference device reading with the BACTROX CO<sub>2</sub> display again.</p> <p>a. If the reference device and the CO<sub>2</sub> display readings are the same or the difference now falls within the range of your protocol, <b>the incubator is now calibrated for CO<sub>2</sub></b>.</p> <p>b. Or see next step.</p>	<p>Reference Device</p>  <p>Set CO<sub>2</sub></p> 

Procedure continued on next page

# USER MAINTENANCE (CONTINUED)

CO <sub>2</sub> Calibration (Continued)	
<p>8. If the two readings are not the same, and the difference falls outside the acceptable range of your protocol, repeat steps 3 – 7 up to two more times.</p> <p>a. Three calibration attempts may be required to successfully calibrate units that are more than <math>\pm 2\%</math> out of calibration.</p>	<p>Reference Device</p>  <p>Set CO<sub>2</sub></p> 
<p>9. If the CO<sub>2</sub> readings of the display and the reference device still fall outside your protocol after three calibration attempts, contact your distributor or <a href="#">Sheldon Technical Support</a> for assistance.</p> <p>a. Three calibration attempts may be required to successfully calibrate units that are more than <math>\pm 2\%</math> out of calibration.</p>	

End of procedure

# USER MAINTENANCE (CONTINUED)

## CALIBRATE THE TEMPERATURE DISPLAY

**Note:** Performing a temperature display calibration requires a temperature reference device. Please see the **Reference Sensor Devices** entry on page 12 for device requirements.

Temperature calibrations are performed to match the temperature display to the actual air temperature inside the incubation chamber. The actual air temperature is supplied by a calibrated reference sensor device. Calibrations compensate for drifts in the unit microprocessor controller as well as those caused by the natural material evolution of the sensor probe in the humidified and heated chamber space. Calibrate as often as required by your laboratory or production protocol, or regulatory compliance schedule.

### Humidity

Always calibrate for temperature with the chamber humidified.

### Probes

Reference device sensing probes may be run through either finger hole in the incubator doors. Probes may also be introduced through the chamber door space. Use non-stick, non-marking tape to secure the wires and probe heads, and seal any gaps in the doorspace created by a probe wire.

Place the sensor probe of the temperature reference device inside as close as possible to the geometric center of the chamber. A thermocouple sensor probe sleeve may be taped to the shelving, as long as the exposed copper end is 2 inches (5cm) away from the shelf (see Figure 29). An exposed sensor probe in direct contact with the shelving may experience heat sinking, which can result in an inaccurate temperature reading.

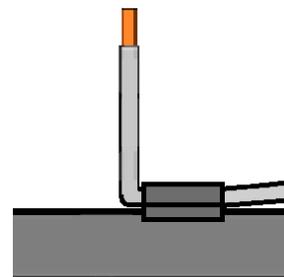


Figure 29: Probe End 2 inches (5cm) From Shelf Surface

### Stability

Prior to a calibration, the incubator should operate undisturbed at its application temperature set point for 8 hours in order to stabilize. A common practice is to introduce and place the temperature sensor probe in the incubator, allow the unit to operate and stabilize overnight, and then conduct the calibration the next day.



The incubator is considered stabilized when it has operated for **1 hour** with no fluctuations  $\pm 0.1^{\circ}\text{C}$  or greater. Failure to wait for stabilization will result in an inaccurate calibration.

*Continued on next page*

# USER MAINTENANCE (CONTINUED)

Temperature Calibration	
<p>1. Once the incubator temperature has stabilized, compare the reference device and BCTROX temperature display readings.</p> <ol style="list-style-type: none"> <li>If the readings are the same, or the difference between the two (2) falls within the acceptable range of your protocol, the display is accurately showing the test space chamber air temperature. <b>The Temperature Calibration procedure is now complete.</b></li> <li>If a difference falls outside of your protocol range, advance to step 2.</li> </ol>	<p>Reference Device</p>  <p>Set Temperature °C</p> 
<p>2. A display calibration adjustment must be entered to match the display to the reference device. See next step.</p>	<p>Reference Device</p>  <p>Set Temperature °C</p> 
<p>3. Place the display in its temperature calibration mode.</p>  <p>AND</p>  <ol style="list-style-type: none"> <li>Press and hold both the <b>UP and DOWN</b> temperature arrow buttons simultaneously for approximately 5 seconds.</li> <li>Release the buttons when the temperature display shows the letters "CP". The display will begin flashing the <b>current temperature display value</b>.</li> </ol> <p><b>Note:</b> If an arrow key is not pressed for five seconds, the display will cease flashing, and store the last displayed value as the new current chamber temperature value.</p>	<p>Set Temperature °C</p> 

Continued on next page

# USER MAINTENANCE (CONTINUED)

Temperature Calibration (Continued)		
 <p>OR</p>  <p>4. Use the <b>Up</b> or <b>Down</b> arrows to adjust the current display temperature value until it matches the reference device temperature reading.</p>	<p>Reference Device</p>  <p>Set Temperature°C</p> 	
<p>5. After correcting for the difference, wait 5 seconds.</p>  <p>Wait 5 Seconds</p> <p>a. The temperature display will cease flashing and store the corrected chamber display value.</p> <p>The incubator will now begin heating or passively cooling in order to reach the set point with the corrected display value.</p>	<p>Set Temperature°C</p>  <p>Adjusting to Set Point</p>	
 <p>Wait 1 Hour</p> <p>6. Allow the BACTROX sit for at last one 1 hour undisturbed to stabilize <b>after the incubator has achieved the corrected temperature set point.</b></p> <p>a. Failure to wait until the incubator is fully stabilized will result in an inaccurate reading.</p>	<p>Set Temperature°C</p> 	
<p>7. Compare the reference device reading with the chamber temperature display again.</p> <p>a. If the reference device and the chamber temperature display readings are the same or the difference falls within the range of your protocol, <b>the incubator is now calibrated for temperature.</b></p> <p>b. See the next step if the readings fail to match or fall outside of your protocol range.</p>	<p>Reference Device</p>  <p>Set Temperature°C</p> 	

Continued on next page

# USER MAINTENANCE (CONTINUED)

Temperature Calibration (Continued)	
<p>8. If the two readings are not the same, and the difference still falls outside the acceptable range of your protocol, repeat steps 3 – 7 up to two more times.</p> <p>a. Three calibration attempts may be required to successfully calibrate units that are more than <math>\pm 2^{\circ}\text{C}</math> out of calibration.</p>	<p>Reference Device</p>  <p>Set Temperature<math>^{\circ}\text{C}</math></p> 
<p>9. If the temperature readings of the chamber and the reference device still fall outside your protocol after three calibration attempts, contact your distributor or <a href="#">Sheldon Technical Support</a> for assistance.</p>	

End of procedure

# UNIT SPECIFICATIONS

The BACTROX-2 is a 220 - 240 volt workstation. Please refer to the BACTROX data plate for individual electrical specifications.

Technical data specified applies to units with standard equipment at an ambient temperature of 25°C (77°F) and a voltage fluctuation of ±10%. The temperatures specified are determined in accordance to factory standard following DIN 12880 respecting the recommended wall clearances of 10% of the height, width, and depth of the inner chamber. All indications are average values, typical for units produced in the series. We reserve the right to alter technical specifications at all times.

## *WEIGHT*

Shipping Weight	Unit Weight
480lbs / 218kg	247 / 112kg

## *WORKSTATION DIMENSIONS*

### By Inches

Exterior W × D × H	Workspace Chamber W × D × H
48.7 x 31.3 x 32.5 inches	33 x 28.5 x 25.2 inches

### By Centimeters

Exterior W × D × H	Workspace Chamber W × D × H
124 x 79.5 x 82.5 cm	83.8 x 72.4 x 64 cm

## *STAND DIMENSIONS*

*Optional Stand Available for Purchase*

Inches W × D × H	Centimeters W × D × H
49 x 30 x 30 inches	124.5 x 76.2 x 76.2cm

# UNIT SPECIFICATIONS (CONTINUED)

## PASS BOX CAPACITY

### Interior Dimensions

Inches W × D × H	Centimeters W × D × H
9 x 10.7 x 9 inches	23 x 27.5 x 23 cm

### Pass Box Volume

Cubic Feet	Liters
0.5	14

### Total Plate Capacity

Plates
300

## WORKSPACE CAPACITY

### Workspace Chamber Volume

Cubic Feet	Liters
13.7	388

### Workspace Incubator Volume

Cubic Feet	Liters
1.7	48

### Workspace Chamber Incubator Interior

Inches W × D × H	Centimeters W × D × H
27.5 x 8 x 13.5	70 x 20 x 34

# UNIT SPECIFICATIONS (CONTINUED)

## *INCUBATOR TEMPERATURE*

Range	Uniformity
Ambient +8°C to 60°C	±0.35°C @ 37°C

## *GAS RANGES*

O <sub>2</sub> Concentration	CO <sub>2</sub> Concentration
0.5 – 20%	1 – 20%

## *POWER*

Model	AC Voltage	Amperage	Frequency
BACTROX-2	220 - 240	2	50/60 Hz

# PARTS LIST

Description	Parts Number
Pass Box Door Gasket 9 x 9 burgundy	3450507
Arm Port Door Left	9521253
Arm Port Door Right	9521254
Arm Port Door O-Ring	6000509
Fuse 4A 5 X 20 Type T Slow Blow (Requires 2)	3300537
Leveling Foot	2700506
Petrie Dish Rack 2 x 11 inches (5 X 28cm)	5110729
Power Cord CEE7/7 10A	1800515
Rubber Sleeve Cuff Plugs	7200502
Shelf Spacer	5680502
Sleeve Pair 10 inches (25 cm)	3600521
Sleeve Assembly Size 8 Medium (2 cuffs, 2 cuff-rings, 4 0-rings, 2 sleeves, 2 straps)	9990738M
Sleeve Assembly) Size 9 Large (2 cuffs, 2 cuff-rings, 4 0-rings, 2 sleeves, 2 straps)	9990738L
Sleeve Assembly) Size 6.5 Extra Small (2 cuffs, 2 cuff-rings, 4 0-rings, 2 sleeves, 2 straps)	9990738XS
Sleeve Cuff-Ring 4 Inches (interior diameter)	6400590
Sleeve Cuff-Ring Black O-ring	6000504
Sleeve Cuff-Ring 3.5 Inches (interior diameter) Small	6400619
Sleeve Cuff-Ring Red O-ring	6000503
Sleeve Cuffs Latex (for sleeve assembly) size 7	3600500
Sleeve Cuffs Latex (for sleeve assembly) size 8	3600501
Sleeve Cuffs Latex (for sleeve assembly) size 9	3600502
Sleeve Cuffs Nitrile (for sleeve assembly) size 7	3600513
Sleeve Cuffs Nitrile (for sleeve assembly) size 8	3600514
Sleeve Cuffs Nitrile (for sleeve assembly) size 9	3600515

## ORDERING PARTS AND CONSUMABLES

If you have the Part Number for an item, you may order it directly from Sheldon Manufacturing by calling 1-800-322-4897 extension 3. If you are uncertain that you have the correct Part Number, or if you need that specific item, please contact Sheldon Technical Support for help at 1-800-322-4897 extension 4 or (503) 640-3000. Please have the **model number** and **serial number** of the BACTROX ready, as Tech Support will need this information to match your workstation with its correct part.

# ACCESSORIES

Shel Lab offers the following BACTROX accessories for sale. Please see our website for prices.

## Activated Carbon Media (2 lbs / 0.9 kgs)

For scrubbing hydrogen sulfides, fatty acids, and some toxic or corrosive compounds from the workstation atmosphere.

Part Number 1060500



## Activated Carbon, Volatile Compounds Scrubber Fan

Holds activated carbon scrubber media. Significantly speeds the removal of sulfides, fatty acids, and toxic or corrosive compounds.

Part Number 9490581 (For 220 - 230 volt units)



## Acrylic Glass Cleaner (2oz / 59.2ml)

Novus brand acrylic glass cleaner.

Part Number 1060503



## Acrylic Glass Scratch Remover (2oz / 59.2ml)

Helps remove visible scratches and nicks from acrylic glass.

Part Number 1060504

Part Number 1060500.



## Compressed Gas Cylinder Switcher, Automatic

Allows two gas cylinders to be connected to one gas port, and automatically switches from the first to the second cylinder when the first is empty.

Part Number 2002-B2E



# ACCESSORIES (CONTINUED)

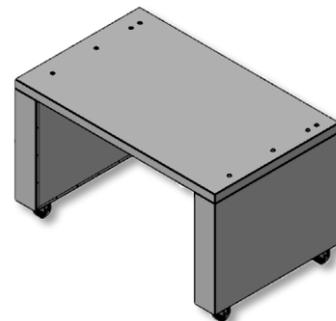
## **BACTROX: BAC1 STAND**

A rolling stand with cabinet for the BACTROX

30 inches high, 49 inches wide, 30 inches depth

(76.2cm high by 124.5 cm wide by 76.2cm depth)

Part Number BAC1 STAND (9000510)



## **Lukas Fiber Optic Micro Lite Illumination System**

A fiber optic, adjustable brightness, halogen light box and guide. Provides a stable light for use with BACTROX workstations and stereo microscopes.

Part Number 4650503



## **UV Viewing Lamp**

A handheld UV lamp for use with BACTROX workstations.

Parts Number 9490507



## **Zephiran Benzalkonium Chloride Chamber Cleaner**

1 Gallon, 0.133%.

Part Number 1060501



# APPENDIX

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**Note:** It is not necessary to calculate the O<sub>2</sub> concentration of the laboratory atmosphere if you will be using O<sub>2</sub> reference gas mixes for calibration. Calculating the ambient O<sub>2</sub>% is only required when calibrating to an ambient atmosphere sample.

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## *CALCULATING THE O<sub>2</sub> CONCENTRATION*

To determine the oxygen concentration of the ambient laboratory atmosphere, it is necessary to find the partial pressure of the oxygen (PPO) in the atmosphere. To calculate the PPO, it's first necessary to calculate the water vapor pressure (WVP) and then subtract it from the current barometric pressure.

### Calculations

1. Water Vapor Pressure in millibars (mbar)
2. Partial Pressure O<sub>2</sub> in millibars (mbar)
3. O<sub>2</sub> Concentration (%)

### **1) Water Vapor Pressure (WVP) in mbars**

$$WVP = \left( \frac{H_{rel}}{100} \right) \cdot WVP_{max}$$

Calculating the Water Vapor Pressure requires:

- **Relative Humidity (H<sub>rel</sub>)** of the laboratory ambient atmosphere
  - The relative humidity of the laboratory atmosphere can be obtained using a variety of commercially available handheld or desktop sensors. The sensor should provide a relative humidity value accurate to ±1%.
- **Temperature** of the laboratory atmosphere
  - Temperature is used to look up the Water Vapor Pressure Max (WVP<sub>max</sub>). The thermometer device should measure the temperature of the airspace near the BACTROX. **Do not use** the room's climate control thermostat setting or display reading for this value. Both may vary significantly from the air temperature around the BACTROX.
- **Water Vapor Pressure Maximum (WVP<sub>max</sub>)**
  - Please see the WVP<sub>max</sub> table on the next page to find Water Vapor Pressure Max for your current air temperature.

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**Note:** Never use a relative humidity value taken from outside the room the BACTROX is located in. Use of relative humidity from another room or a weather report will result in an inaccurate O<sub>2</sub> sensor calibration.

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# APPENDIX (CONTINUED)

## Water Vapor Pressure Max ( $WVP_{max}$ )<sup>1</sup>

Temperature (C°)	$WVP_{max}$ (mbar)
15	17.06
16	18.19
17	19.38
18	20.65
19	21.98
20	23.39
21	24.88
22	26.45
23	28.10
24	29.85
25	31.69
26	33.62
27	35.66
28	37.81
29	40.07
30	42.44

## 2) Calculating the $PPO_2$ in mbars

After calculating the WVP value, calculate the Partial Pressure Oxygen for the laboratory environment.

$$PPO_2 = (BP - WVP) \cdot \left(\frac{20.95}{100}\right)$$

Calculating the  $PPO_2$  requires:

- **Water Vapor Pressure**
  - The WVP value calculated in step 1 on the previous page
- **Barometric Pressure (BP) in millibars (mbars)**
  - The current Barometric Pressure for your area can be obtained from a local metrological station or online weather service. If the BACTROX is located in an overpressure or negative pressure laboratory environment, it will be necessary to obtain a barometric pressure sensor to determine the BP value for the room.

<sup>1</sup> Courtesy of NOAA ([http://www.srh.noaa.gov/epz/?n=wxcalc\\_vaporpressure](http://www.srh.noaa.gov/epz/?n=wxcalc_vaporpressure))

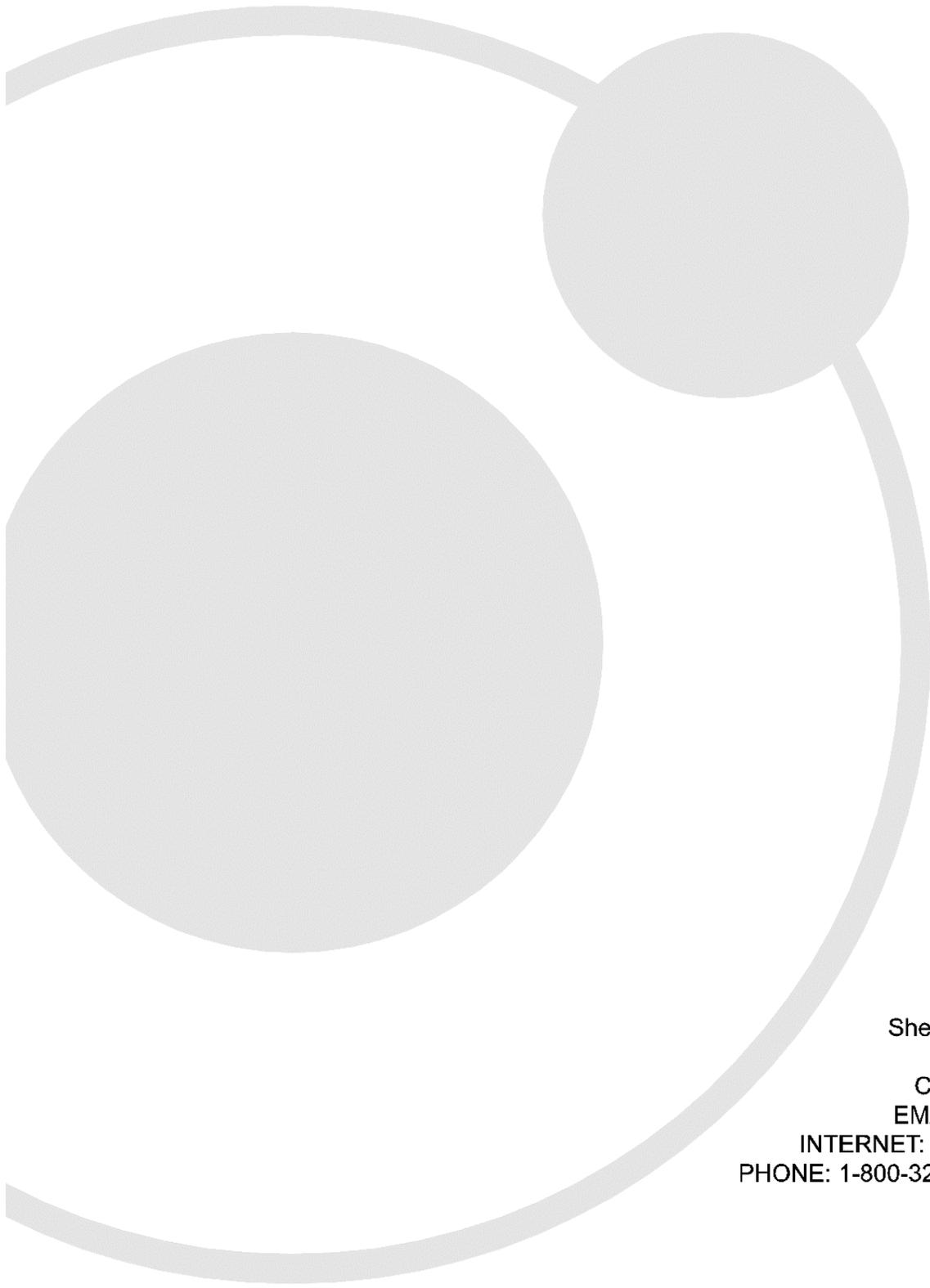
### 3) Calculating the O<sub>2</sub> Concentration (%)

$$O_2\% = \left( \frac{PPO_2}{BP} \right) 100$$

Calculating the O<sub>2</sub> concentration requires:

- **PPO<sub>2</sub>**
  - The Partial Pressure Oxygen value calculated in step 2 on the previous page.
- **Barometric Pressure (BP) in millibars (mbars)**
  - The same value previously used to calculate the PPO<sub>2</sub> value.





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