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Guide to Operations

Galaxy R Series
170 R CO_2 Incubator

MANUAL No: CO170 R-0050
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CAUTION!

This equipment *must* be operated as described in this manual. If operational guidelines are not followed, equipment damage and personal injury *can* occur.

Please read the entire User's Guide before attempting to use this incubator.

Do not use this equipment in a hazardous atmosphere or with hazardous materials for which the equipment was not designed.

New Brunswick Scientific (NBS) is not responsible for any damage to this equipment that may result from the use of an accessory not manufactured by NBS.

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Manual Conventions

NOTE: **Notes contain essential information that deserves special attention.**

CAUTION! ***Caution* messages appear before procedures which, if caution is not observed, could result in damage to the equipment.**

WARNING! ***Warning* messages alert you to specific procedures or practices which, if not followed correctly, could result in serious personal injury.**

WARNING! **This particular *Warning* message represents a potential electric hazard.**

This particular *Warning* message, whether found in the manual or on the incubator means HOT SURFACE–and therefore represents a potential danger to touch.

CRUSH WARNING! ***Crush Warning* messages alert you to specific procedures or practices <u>regarding heavy objects</u> which, if not followed correctly, could result in serious personal injury .**

This symbol on the incubator is a reminder that it is of essential importance to read the user manual.

Every Instrument manufactured by New Brunswick Scientific (NBS) is warranted to be free from defects in material and workmanship. This apparatus, with the exception of glassware, lamps and electrodes (where supplied), is warranted for 2 years against faulty components & assembly and our obligation under this warranty is limited to repairing or replacing the instrument or part thereof which shall within 2 years following date of shipment prove to be defective after our examination. Incubator accessories are warranted for 1 year. This warranty does not extend to any NBS products which have been subjected to misuse, neglect, accident or improper installation or application; nor shall it extend to products which have been repaired or altered outside the NBS factory without prior authorization from the New Brunswick Scientific.

TABLE OF CONTENTS

1 INTRODUCTION

The Galaxy R Series CO_2 incubator, model 170 R, is microprocessor-controlled and designed to ensure accurate and reliable operation. The incubator incorporates a large, back-lit LCD display, touch-sensitive keypad and sophisticated control system that allows for easy programming, control and monitoring of the chamber conditions. The display also provides for graphical viewing of system data, on-screen messaging and help files to simplify operation and maintenance.

A direct heating system, utilising a thermal heating element, completely surrounds the incubator, providing an even temperature within the chamber. The independently and directly heated outer door is designed to ensure an even distribution of heat. This system ensures a rapid, controlled return to optimum chamber conditions after a door opening while also preventing any overshoot. The incubator's direct heat system provides for optimal use of laboratory space by allowing the most efficient internal volume for the footprint of the instrument.

A solid-state infrared sensor is used to control the level of CO_2, providing excellent reliability and remaining unaffected by humidity. The CO_2 system has a programmable automatic zero system (Auto-zero) to re-reference the sensor baseline to atmospheric CO_2 levels at regular intervals. A small pump supplies HEPA-filtered atmospheric gas to the sensor. The chamber atmosphere within the sensor is completely displaced, allowing the control system to automatically reference the sensor, after which the pump is switched off, allowing the chamber atmosphere to homogenise back into the sensor. This provides for accurate CO_2 control without disturbing the chamber environment.

An independently controlled water tray at the bottom of the incubator allows a high, uniform relative humidity while preventing condensation in other parts of the chamber. Perforated shelves are provided as standard to facilitate a much faster recovery of RH conditions in the chamber than with unperforated shelves.

The 170-liter chamber is seamless, to provide a sanitary and easy-to-clean environment, and all internal components are manufactured from polished stainless steel. The shelves (which are non-tip), shelf racks and humidity tray are easily removed without tools for thorough cleaning and are capable of being sterilized. Air circulation is achieved without the use of a fan, eliminating ductwork (a potential source of contamination), simplifying cleaning, eliminating vibration, and reducing small sample evaporation within the chamber.

The Galaxy 170 R model contains many standard features usually seen as options. It has a sealing inner door with a cam action lock to allow visualization of the cultures without compromising the internal atmosphere. This is also available as a split 4- or 8-inner-door option (to coordinate with shelves), which is ideal for critical hypoxic studies. In addition, there is a 25mm access port now standard to allow for seamless integration of independent probes or other equipment through the chamber. Lastly, NBS has included an RS232 port as standard on all Galaxy R series incubators. This port will communicate with any computer through a hyperlink access or can be used to externally datalog the incubator through NBS software.

The incubator incorporates a two-level alarm system. The chamber-monitoring alarms are programmable and will alert you if temperature or CO_2 have not recovered within a preset time after the door has been opened. If it is not required, this system can be disarmed. The system alarms occur only if a problem has developed with system components that require user intervention to rectify. The incubator also incorporates an over-temperature safety system that operates independently from the main control system.

The incubator features multiple options that can be installed to simplify maintenance and provide superior control over experimental conditions. For example, high-temperature disinfection quickly and conveniently disinfects the incubator's chamber at 120°C, without the need to remove interior components or the CO_2 sensor. A humidity tray warning system warns the user before the humidity tray runs out of water, preventing dehydration of samples. Oxygen control provides for conditions that require above- or below-ambient oxygen levels. These and other options and accessories provide for a uniquely flexible CO_2 incubator capable of meeting the most demanding requirements.

2 UNPACKING & INSTALLATION

2.1 Inspection of Boxes

After you have received your order from NBS, inspect the boxes carefully for any damage that may have occurred during shipping. Report any damage to the carrier and to your local NBS distributor immediately.

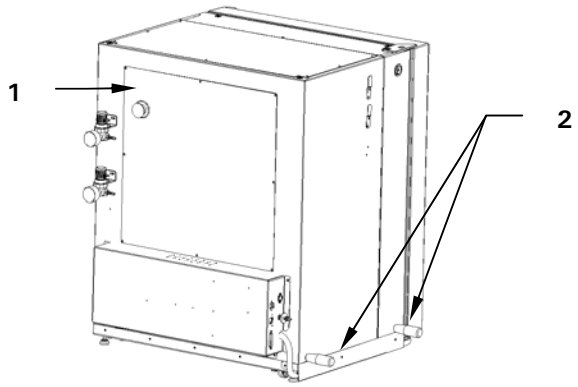
2.2 Unpacking

CRUSH WARNING!
At least four people are required to safely lift your Galaxy 170 R.

Disassemble the shipping crate and remove the protective packing. Save the packing materials for possible future use, and be sure to save this User's Guide for instruction and reference. User manuals can also be found online, in PDF format, at www.nbsc.com.

To simplify lifting the incubator, leave it on the pallet as you install the four lifting handles provided (*see Figure 1a*) by screwing them into the tapped holes on both sides. You must have at least two persons at either side to safely lift the incubator. *Supported by the lifting handles only*, lift the incubator from the delivery pallet.

Figure 1a: Removable Lifting Handles



1	Rear of incubator	2	Removable lifting handles

CAUTION!
NEVER try to lift the incubator by its door; this would cause permanent damage to the incubator.

Locate and remove the parts stored in the Humidity Tray.

If any part of your order was damaged during shipping, is missing, or fails to operate, please contact your NBS distributor.

Using your NBS packing list, verify that you have received the correct materials, and that nothing is missing.

Table 1 outlines the accessory items that are supplied with your new incubator.

Table 1: Accessories Provided

Quantity	Item	Notes
4	Screw-in Lifting Handles	Installed
4	Non-tip Shelves	Installed
2	Wire Shelf Racks	Installed
1	Humidity Tray	Installed
1	White porous CO_2 Sensor Cover	Installed
1	Black Sensor Cover*	Installed
1	Power Cord	Packed in clear accessories bag
3 meters, 9.8 feet	PVC Tubing, ~1/4-inch or 6mm bore, with an inline CO_2 HEPA-filter connected, ready for use	Packed in clear accessories bag
2	Hose Clips	Packed in clear accessories bag
1	Auto-zero HEPA Filter	Packed in clear accessories bag
2	Anti-slip Pads for adjustable feet	Packed in clear accessories bag
1	User Manual	Provided

* There is a holder on the side of the incubator to store sensor covers (*see Figure 10*).

WARNING!
Anytime you touch or handle the white CO_2 sensor cover, be sure to wear gloves, and do not later touch those gloves to your face. Discard or wash the gloves.

2.3 Utilities

In order to use the incubator, you will need:

Table 2: Utilities

Utility	Requirement
Electricity	100/120V, 50/60 Hz grounded electrical supply with minimum capacity of 10 amps
	OR
	220/240V, 50 Hz grounded electrical supply with minimum capacity of 8 amps
CO_2 gas	Cylinder with 100% CO_2 vapor withdrawal, together with a two-stage regulator for pressure control to 5 psi or 0.35 bar (see **WARNING** below)

WARNING!
For proper incubator operation, CO_2 gas pressure must not exceed 5 psi.

2.4 Location

The incubator is designed to operate at a chamber temperature of 4.0°C above ambient, and at an absolute minimum ambient temperature of 15°C if the incubator is being used at 37°C. **Maximum allowable ambient temperature is 35°C.**

NOTE:
Position the incubator allowing enough space to open the door and to access the CO_2 sample port on the left side of the incubator.

Care should be taken to avoid placing the incubator in a position that may affect its performance, such as those listed below.

DO NOT place the incubator:

- **Directly under, beside or within the air flow of heating or air-conditioning ducts, or other drafts;**
- **Directly beside heat-generating equipment such as a heater, an autoclave or an oven;**
- **Near the exhaust of heat- or cold-generating equipment (like an ultra-low temperature freezer);**
- **Near a window exposed to direct sunlight;**
- **Directly on top of any heat-generating apparatus;**
- **Without minimum ventilation clearance of 0.5 inch/10mm all around (2 inches/50mm in back if you have the cooling system option).**

CAUTION!
NEVER try to lift the incubator by its door; this would cause permanent damage to the incubator.
NEVER lean on or place objects on the open door.

Remove the incubator from the pallet as described in Section 2.2 and place the incubator in the working position, on a level surface capable of bearing its weight (approximately 200 lb/90 kg; actual in-use weight will naturally be heavier and will depend on both the options installed and the material stored in the incubator).

The incubator is designed so that one incubator can be safely stacked on top of either another Galaxy 170 R or a Galaxy 170 S using the stacking kit, which includes instructions. It is not possible to put any other type of incubator or heavy apparatus on top, as the top cover and stacking kit are designed to support only the feet of another Galaxy 170 incubator.

NOTE:
When the incubator is securely in place, remove the four lifting handles. Store them in a safe place for future use.

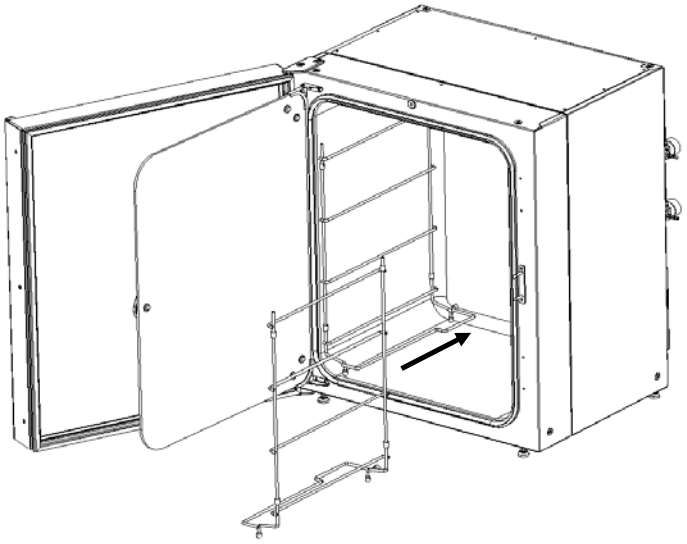
2.5 Setting Up

Place the anti-slip covers provided onto the incubator's front feet; keep them installed at all times.

Install the wire shelf racks and shelves, and level the incubator:

1. *Oriented as shown in Figure 1*, place the shelf racks inside the chamber. Each rack has three rubber feet: two stand on the floor of the chamber, and one stands against the back wall. Make sure the cushioned tubing spacers are snug against the side walls; these spacers allow clearance for the shelves.

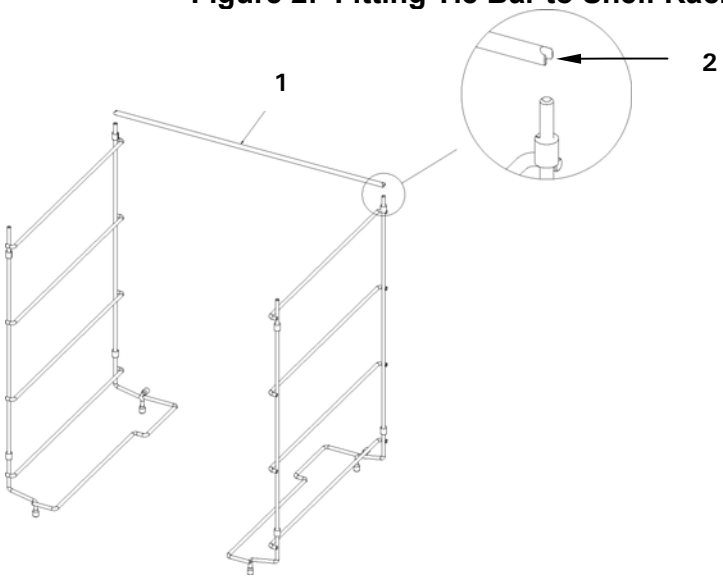
Figure 1: Inserting Shelf Racks



NOTE:
Only shelf racks for 4 shelves are shown in this manual. Shelf racks for 8 shelves are also available.

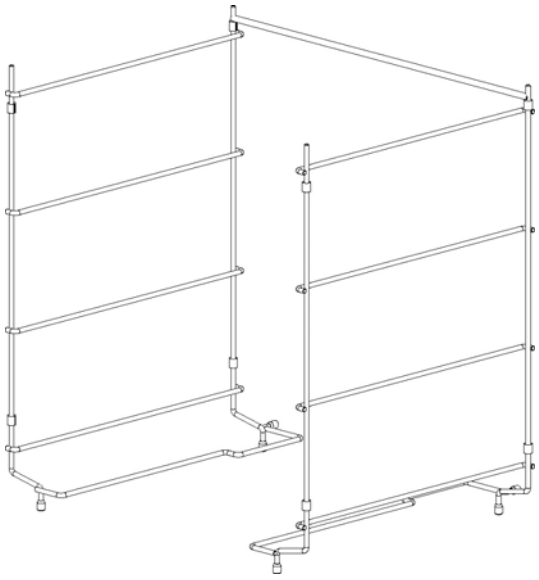
2. Install the tie rod at the back of the shelves to hold both sides together, as shown in Figures 2 & 3 on the following page. You may prefer to do this prior to inserting the racks in the chamber.

Figure 2: Fitting Tie Bar to Shelf Racks



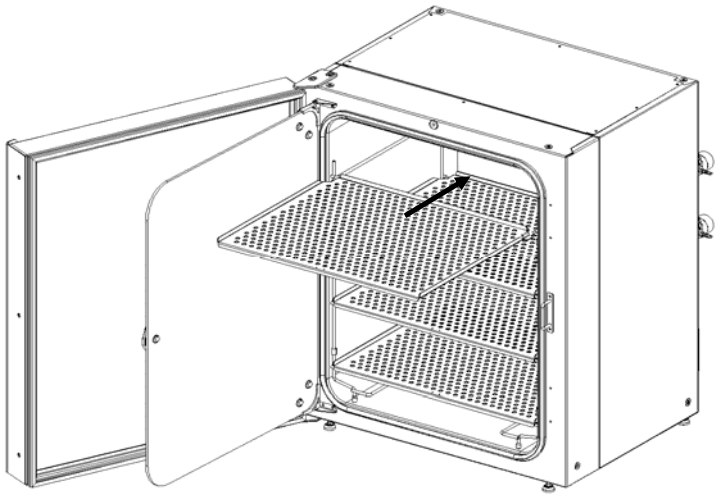
1	Tie Bar	2	Detail (2:3 scale) shows the tie bar's anti-tip groove.

Figure 3: Shelf Rack Assembly



3. Install the shelves (*see Figure 4)*, beginning at the top. Make sure that each shelf's anti-tip groove (*see Figure 2 detail*) is properly inserted onto each of the shelf rack guides.

Figure 4: Inserting Shelves



4. Level the incubator by adjusting the feet. Place a small level on the second shelf of the incubator. Adjust the leveling feet until the incubator is level and stable. Lock the leveling feet in place by tightening the locking nuts on each foot.

5. Slide the humidity tray onto the lowest shelf rack supports, which are shaped with stops to keep the tray in place (*see Figures 5 & 6*).

Figure 5: Installing the Humidity Tray

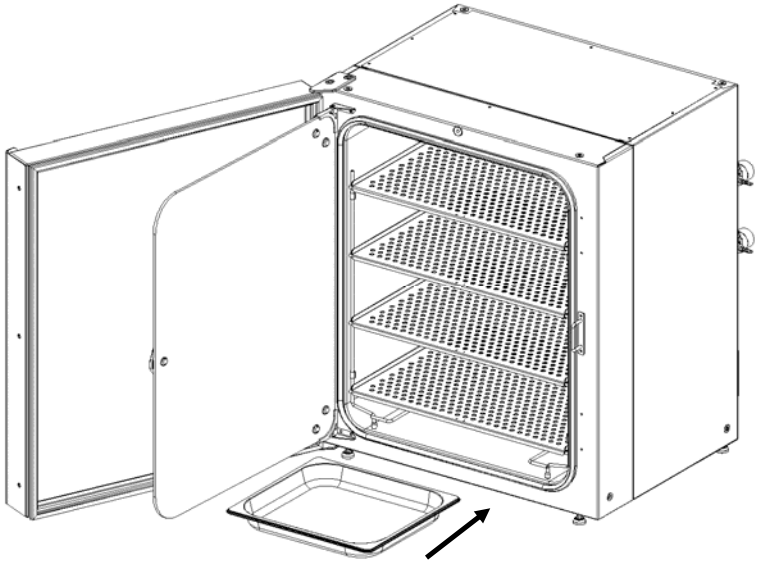
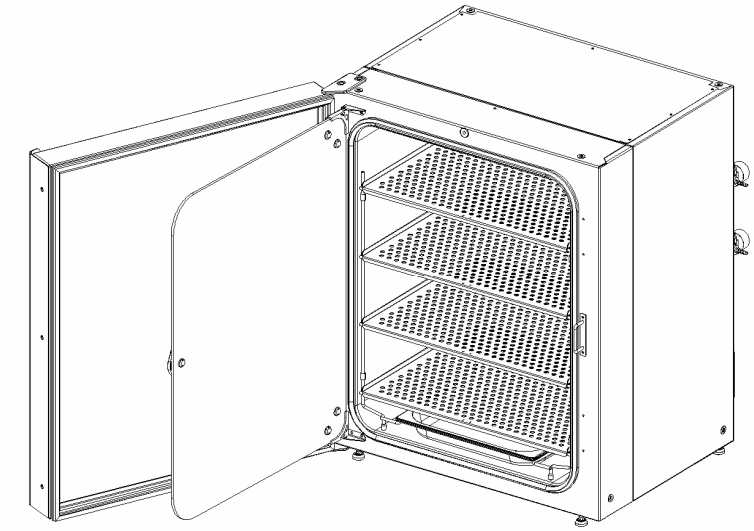


Figure 6: Humidity Tray, Installed



2.6 Making Connections

Connect the CO_2 gas supply, with reference to Figure 7 on the following page:

1. Connect the incubator to the CO_2 supply using the ~6mm plastic tubing (with installed HEPA filter) by attaching the tubing from the two-stage regulator (or in-line regulator) to the matching CO_2 inlet on right side of the equipment tray.

NOTE:

It is highly recommended that an in-line regulator be used at the incubator's gas inlets.

In-line regulators can also be mounted on the back of the incubator.

2. Use the tubing clips provided to eliminate CO_2 leaks.

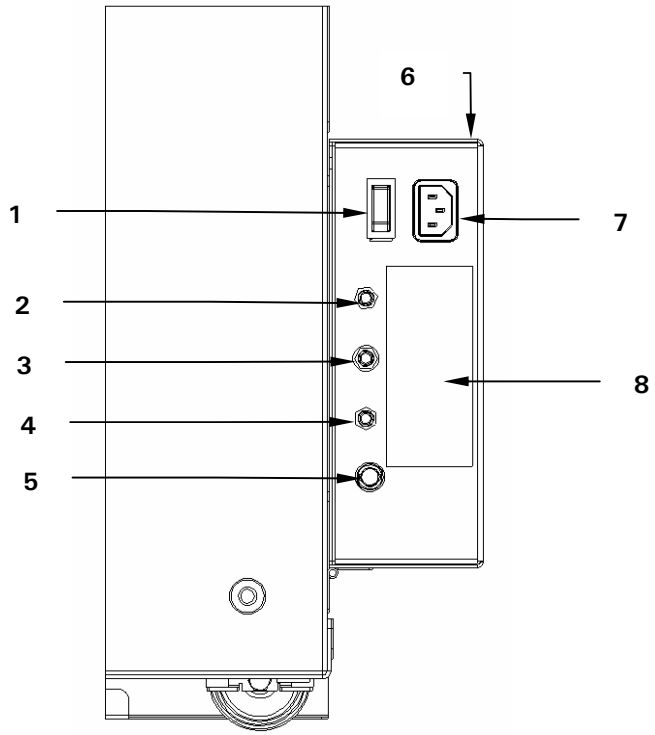
WARNING!

Slightly increased levels of CO_2 may be found in and around the operating area of the CO_2 incubator. Over time, this can have adverse effects on those exposed to such an environment. Users working in environments with elevated levels of CO_2 should take all appropriate precautions to protect their breathing.

WARNING!

Before making electrical connections, verify that your power supply voltage matches the voltage of your incubator and that the on/off switch is in the OFF position.

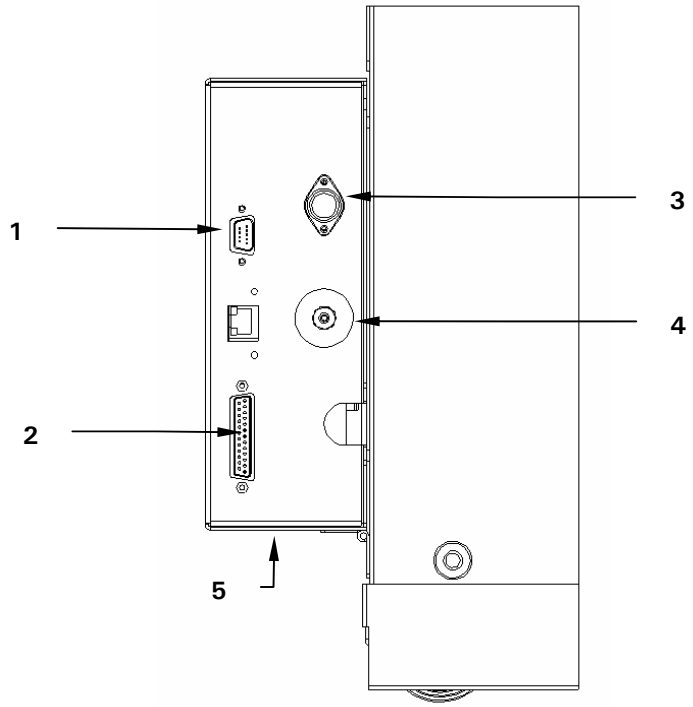
Figure 7: Making Connections



1	ON/OFF switch	5	Fuse holder
2	Optional O_2 inlet	6	Righthand side of equipment tray
3	CO_2 inlet	7	Power cord receptacle
4	Optional N_2 inlet	8	Label

Install the Auto Zero HEPA filter, press the Auto Zero HEPA filter gently into the white plastic filter socket (*see Figure 8*) on the left side of the equipment tray.

Figure 8: AutoZero HEPA Filter & Fitting



1	RS232 socket	4	AutoZero HEPA filter
2	Optional printer port location	5	Lefthand side of equipment tray
3	Optional BMS relay contact alarm socket (see Section 8.3 for details).		

WARNING!

Before making electrical connections, verify that your power supply voltage matches the voltage of your incubator and that the on/off switch is in the OFF position.

Install the power cord:

1. Insert the power cord into its receptacle on the right side (facing the incubator) of the equipment tray (*see Figure 7 on the previous page)*.

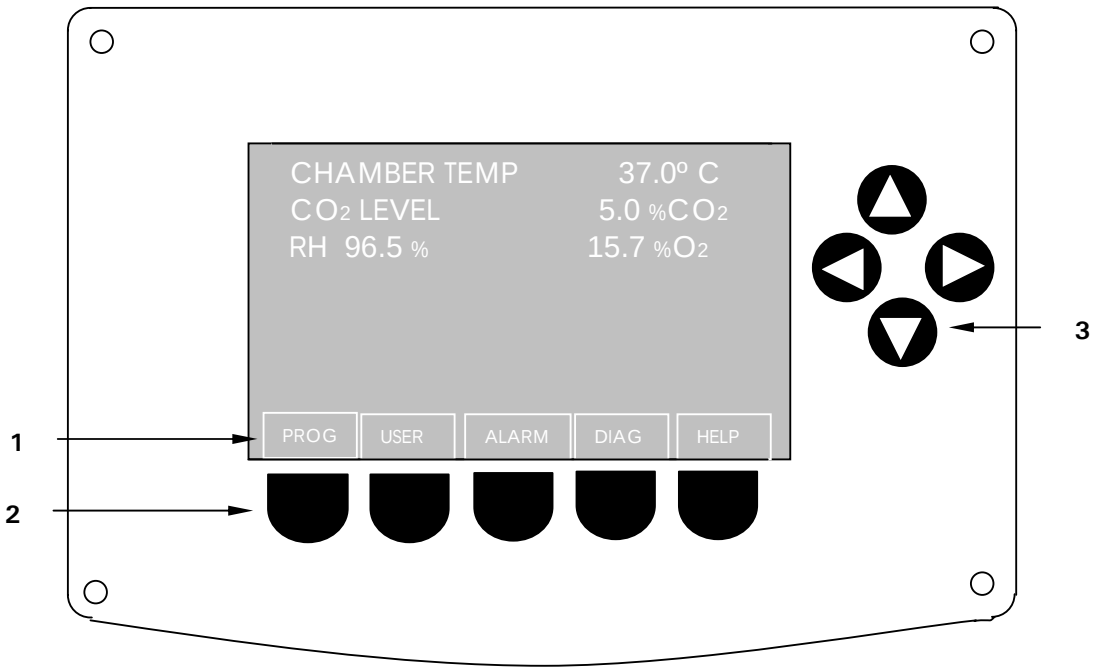
2. After verifying that your supply voltage matches the voltage specified for your incubator and that the ON/OFF switch is OFF, plug the cord into your power supply outlet.

3 OPERATION

3.1 Control Panel

The control panel consists of an LCD display, five function keys & four direction keys (*see Figure 9*):

Figure 9: Control Panel



1	Function key menu	3	Direction keys
2	Function keys		

The illustration above shows the screen in normal operation. This is also how the screen should look when you switch the incubator on.

The purpose of each Function Key is identified at the bottom of the display, above the corresponding key; the function may change from screen to screen.

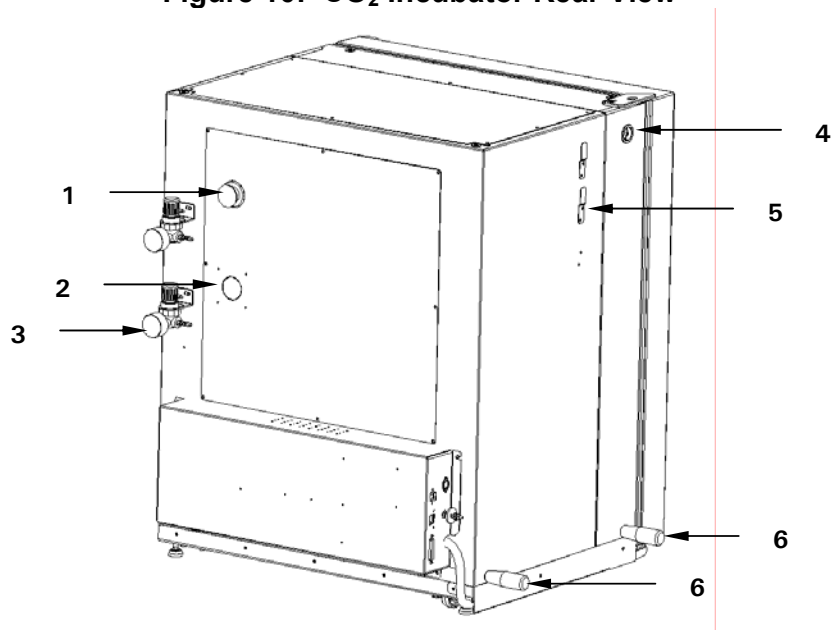
The cluster of four arrowed Direction Keys will move the cursor around the screen and adjust values.

The **HELP** file contains most of the information in this User Manual, together with more detailed troubleshooting information.

3.2 Preparing for Operation

1. Remove the black protective cover from the CO_2 sensor, taking care not to remove the white porous cover; store the black cover on the holder on the side of the equipment tray (*see Figure 10 below*). The sensor cap should be placed back on the sensor when the incubator is to be cleaned.

Figure 10: CO_2 Incubator Rear View



1	Access port	4	CO_2 sample port
2	O_2 sensor location (not shown here)	5	Sensor cover holder
3	Location for mounting in-line regulators	6	Removable lifting handles

2. Ensure that the white porous sensor cover remains in place.
3. Using the power cord provided, connect the incubator to a grounded power supply.
4. Switch the incubator ON using the on/off switch at the rear of the cabinet. The display will illuminate immediately.
5. Turn on the CO_2 gas supply with the pressure regulator set to 5 psi or 0.35 bar.
6. The chamber setpoints are pre-programmed at 37.0°C and 5% CO_2. Leave the incubator on until the programmed chamber temperature and CO_2 concentration have been reached.

NOTE:

The incubator's CO_2 valve is disabled until the incubator reaches the temperature setpoint. After the temperature setpoint is reached, the CO_2 valve is activated, allowing the incubator to reach the CO_2 setpoint.

If power is interrupted to the incubator long enough for the temperature to drop below setpoint, the CO_2 valve will be deactivated until temperature setpoint is again achieved. *(This serves to avoid spurious CO_2 readings while the incubator is below its temperature setpoint)*

7. Leave the incubator running for at least two hours (preferably overnight) to allow conditions to stabilize.

3.3 Using the Humidity Tray & Humidity Control

If humidification is required, the humidity tray should be filled with at least 1.5 liters—but no more than 2.5 liters—of warm (~ 37.0ºC) distilled water at this time.

NOTE:
The humidity tray should always be left in place, even if the incubator is not being humidified. It also serves as a spill tray.

For cell culture work, we recommend the use of copper sulphate (or a recognized biocide) in the humidity tray. Tests have shown that, in addition to inhibiting bacterial growth in the tray, this can reduce contamination on the chamber walls. Add one small teaspoonful (~0.5g) of copper sulphate to the water in the humidity tray.

For IVF and other sensitive work, we do **not** recommend the use of any biocide in the humidity tray. To reduce the possibility of contamination, every 10 to 14 days, empty the tray, clean it with a solution of 70% isopropyl alcohol and 30% distilled water, and then refill it with 1.5 liters of warm distilled water.

CAUTION!
To avoid possible damage to the CO_2 sensor, never leave water in the humidity tray while the incubator is switched off, or when a high temperature disinfection cycle is initiated (if you have this option).

The humidity level within the chamber is not adjustable. The internal chamber will reach ~95% relative humidity at 37°C using the 1.5-liter humidity tray.

3.4 Programming

3.4.1 Temperature and CO_2 Level

To set the desired operating temperature and CO_2 level:

1. Press the **PROG** function key (*see Figure 9, left-most menu button*):

2. In the **PROG** screen that appears, press the desired function key, **TEMP** or **CO_2**, then use the ◀ & ▶ direction keys to adjust the value.

NOTE:
If the incubator is supplied with the option of oxygen control, the setpoint for the oxygen level can be selected and changed like the temperature and CO_2 setpoints.

3. When the desired setpoint is displayed, press the **ENTER** function key.

4. After making adjustments (if any were made), allow the incubator to stabilize at the setpoints before continuing.

NOTE:
If a temperature >1°C below the actual chamber temperature is set, the independent over-temperature system will activate. This is indicated by a warning message on the display. When the chamber cools down, normal operation will resume. Programming a higher temperature can also deactivate the warning.

3.4.2 User Access Code

A user access code is programmable, if required. The user access code allows you to restrict access to the **PROG**, **USER**, and **ALARM** screens (where settings can be changed) to authorized persons only.

To set the User Access Code:

1. In the **PROG** screen (accessed by pressing the **PROG** function key), the user access code will be displayed as a series of four asterisks.
2. Use the left and right direction keys to move to each code position, and the up and down direction keys to select a number from 0 to 9.
3. Once the number is selected, press the **ENTER** function key to save the code.
4. After returning to the main screen, programming access will require the code to make any further programming changes.

To cancel the access code:

1. In the **PROG** screen, enter the current access code.
2. Now program **0000** as the new access code.
3. Press the **ENTER** function key to save the change.
4. The code is now cancelled and programming is no longer restricted.

NOTE:
If the access code has been misplaced, you will be unable to make changes to your incubator's settings. Contact customer service or your service representative for instructions on how to regain access to your incubator.

3.5 Referencing the CO_2 Sensor with AutoZero

Prior to using the incubator, you should manually perform a CO_2 AutoZero (*see Section 3.6.3 for an explanation of this feature*):

1. Perform a CO_2 AutoZero by pressing the **USER** function key (*see Figure 9*), selecting the **PROGRAMMABLE CO2 AUTOZERO**, and pressing the **START** key.

2. The incubator will display a countdown as the AutoZero is running.

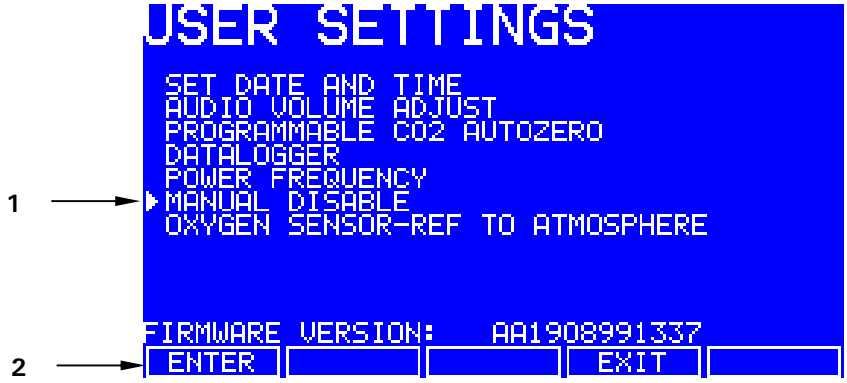
3. When the countdown is complete, the incubator is ready to use.

NOTE:
It may be necessary to open the door momentarily if, after performing an AutoZero, the CO_2 level is too high.

3.6 USER Settings

In the **USER** screen (*see Figure 11 below*), you can adjust the features called out on the screen.

Figure 11: USER SETTINGS Screen



1	Use the ▲ & ▼ direction keys to move the cursor.
2	Use the ENTER function key to select an option.

This section explains each of the **USER** screen features. There are other **USER** options that may be displayed on this screen if they are installed on your incubator. *See Section 8.1 for a list of options*.

3.6.1 DATE/TIME ADJUST

The date and time is factory-set and will only require adjustment if you are in a different time zone, or when you change your clocks to Daylight Saving Time and back again to Standard time. You may also select the style of display for the date.

A battery back-up system ensures that the correct time/date setting is never lost.

3.6.2 AUDIO VOLUME ADJUST

The audible volume can be adjusted to your own preferences.

3.6.3 PROGRAMMABLE CO_2 AUTOZERO

When you select this feature, the **PROGRAM CO_2 AUTOZERO** screen (*see Figure 12 below*) allows you to program the AutoZero frequency and time, or to run the AutoZero function manually.

The AutoZero System automatically re-references the CO_2 Sensor to atmospheric CO_2 in the following way:

1. A pump activates for two minutes, pumping HEPA-filtered atmosphere at 0.3 liters/minute into the sensor's measuring chamber. This displaces the chamber atmosphere completely from the sensor.

Figure 12: PROGRAM CO_2 AUTOZERO Screen

NOTE:
This procedure does not affect the internal chamber environment and will not affect your cell culture as it is being performed.

2. At the end of the countdown, the control system adjusts the AutoZero Factor to reference the sensor to 0.05% CO_2, which is the approximate atmospheric level.

3. The pump switches off and the chamber atmosphere diffuses back into the sensor's measuring chamber. This takes three minutes, after which the normal CO_2 control system takes over.

4. The result of the AutoZero (listed as **A/Z** on some screens) is sent to the **DATALOGGER ALARM EVENTS** screen so that a record of the results will be kept.

The frequency of AutoZeroing can be set in steps between once a day and once every 28 days, which is the default setting. If not required, it can be disabled (*see Section 3.6.6*).

The default time setting is 7:00 am. This can be altered to suit your requirements. We do recommend that you only change the time setting shortly before you start to use the incubator.

NOTE:
The AutoZero will only occur if the temperature is at setpoint. If the temperature is not at setpoint, the system will postpone AutoZero until the setpoint is achieved.

If the AutoZero function is to be run manually, simply press the **START** function key, within the **PROGRAM CO_2 AUTOZERO** window.

3.6.4 DATALOGGER

See Section 3.7 for detailed information.

3.6.5 POWER FREQUENCY

You can adjust the power frequency to either 50 or 60 Hz to match the local electrical supply. Use the ◀ or ▶ direction key until the correct frequency is displayed, then press the **ENTER** function key.

3.6.6 DISABLE

This feature allows you to inform the control system to ignore certain sensors if their function is not required. The standard item on this menu is the **CO_2 PRESSURE SWITCH** (for Auto Zeroing). Additional Disable Options appear on this screen according to the options installed on your incubator. *See Section 8.1 for available options.*

To disable a feature, scroll to **OFF** using the ◀ & ▶ direction keys, then press the **ENTER** function key.

3.6.7 DISINFECTION (optional)

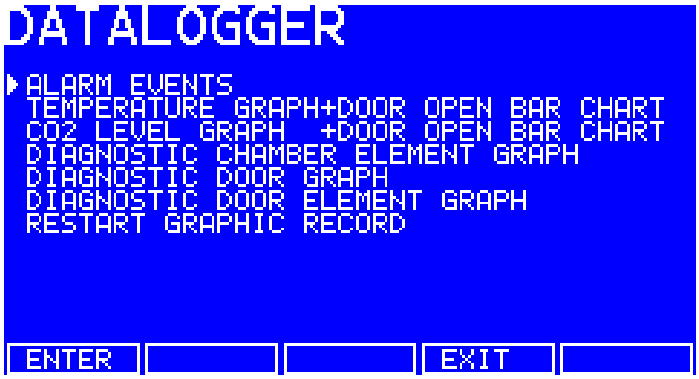
If the incubator is supplied with the High Temperature Disinfection option, the menu item **DISINFECTION** will be displayed. This feature activates the disinfection cycle of the incubator.

The disinfection cycle heats the inner chamber to 120°C, holds that temperature for 4 hours, then cools the chamber to the selected temperature setpoint. All of the interior components (with the exception of the O_2 sensors, if present) can be left in place during the cycle to ensure that everything within the chamber is disinfected prior to resumption of activity. *For a full explanation of this feature, see Section 8.5.1.*

3.7 DATALOGGER Screen

The **DATALOGGER** Screen (*see Figure 13 on the following page*) displays the following information:

Figure 13: DATALOGGER Screen



This section explains these features.

3.7.1 ALARM EVENTS

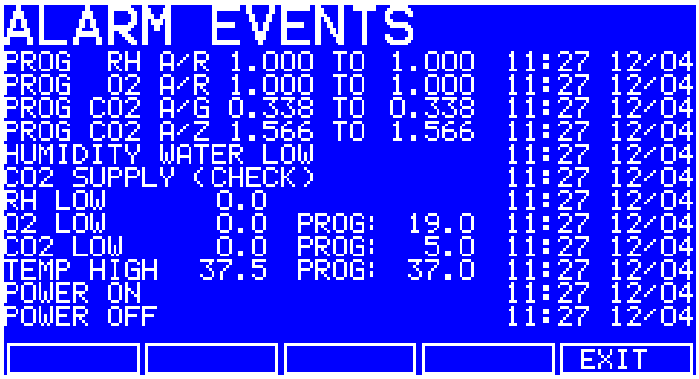
The following alarm events are recorded in the order in which they occurred, with the most recent event displayed at the top:

- Power ON/OFF
- Chamber Temperature High/Low (programmed value)
- CO_2 Level High/Low (programmed value)
- CO_2 Supply Failure
- All System Alarms
- CO_2 Auto-Zero (A/Z) Adjustments
- CO_2 Auto Gain (A/G) Adjustments (*reserved for use by authorized service technicians only*)
- Oxygen and Relative Humidity (R/H) Alarms (where these options are installed)

The capacity is 99 events, after which the earliest event is overwritten and a later event is added.

The date and the time are also recorded for each event, as shown in Figure 14 on the following page:

Figure 14: ALARM EVENTS Screen



To scroll the screen back, press the ▼ direction key. Press ▲ to go back to the first screen.

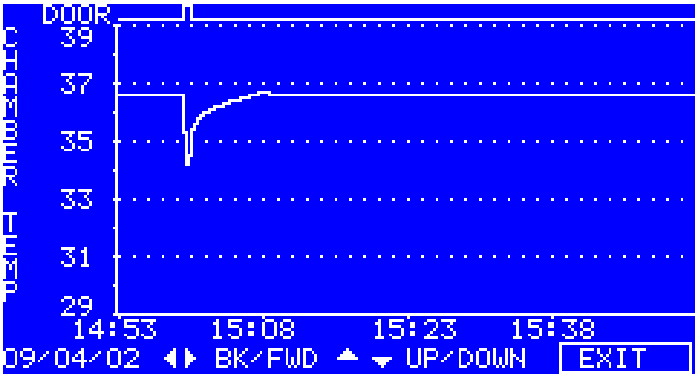
3.7.2 TEMPERATURE GRAPH + DOOR OPEN BAR CHART

When you select this from the **DATALOGGER** screen, the Door Open bar chart is shown at the top of the screen to associate it with a temperature disturbance (*note the correlation in Figure 15 on the following page*). A temperature reading is recorded every 18 seconds while the temperature is outside the specification of ±0.1°C and each reading is shown as a single pixel.

When the temperature has settled within specification, the recording is compressed to one pixel representing **ten** 18-second readings (as long as the temperature remains in specification). This allows up to ten hours of readings to be displayed on one screen. When the temperature moves outside specification, for instance if the door is opened, the graph reverts to individual 18-second readings until temperature is within specification again.

When the data is compressed or decompressed, *a light dotted line* is displayed vertically on the screen to signify that the time axis is changing from 18-second to 10 x 18-second increments or vice versa. *A heavy dotted line* is displayed when the incubator is switched on.

Figure 15: TEMPERATURE GRAPH + DOOR OPEN BAR CHART Screen



Compressing data allows memory space to be maximized. Once the memory space has been filled, the earliest events are overwritten as they are replaced by the latest recording. Graphical recording can be extended, however, to a number of years if your incubator is equipped with an RS-232 port, by connecting the port to a PC loaded with *GalaxyLog* Software (*see Section 8.13 for more information*).

3.7.3 CO_2 GRAPH + DOOR OPEN BAR CHART

These graphs record in a way similar to the Chamber Temperature graphs. The specification for CO_2 is ± 0.1%.

NOTE:
Both CO_2 and temperature graphs share the same time axis. If the time axis changes to accommodate data in one graph, it will also change in the other.

3.7.4 DIAGNOSTIC CHAMBER ELEMENT GRAPH

This graph records chamber element temperature over time to assist troubleshooting.

3.7.5 DIAGNOSTIC DOOR GRAPH

This graph records the door's inner surface temperature over time to assist troubleshooting.

3.7.6 DIAGNOSTIC DOOR ELEMENT GRAPH

This graph records door element temperature over time to assist troubleshooting.

3.7.7 RESTART GRAPHIC RECORD

This feature removes the current graph and begins a new one. The data cannot be recovered once it is deleted.

3.8 CHAMBER ALARMS Menu Screen

The **CHAMBER ALARMS** programming screen (*Figure 16*) allows the various alarm options to be selected and modified. Press the ▲ or ▼ direction key to move around the options and the ◀ or ▶ direction key to adjust values. The temperature and CO2 High and Low Alarm setpoints automatically adjust to within ± 0.5 of the temperature and CO_2 setpoints. The alarm setpoints can also be manually adjusted.

Figure 16: CHAMBER ALARMS Screen

To arm the Chamber Alarms after a selectable delay:

1. Choose the option **ARM ALARMS WHEN AT SETPOINT:**
2. Select **NO** for both **TEMP** and **CO2** (*as shown in Figure 16 above*)
3. Choose the option **DELAY IN ARMING AFTER DOOR OPEN**: and select the desired delay (15 minutes in the sample screen above) to allow for temperature and CO_2 recovery after the door has been opened.

Alternatively, the alarm system can be set to rearm only after the original temperature and CO_2 setpoints have been achieved:

1. Choose the option **ARM ALARMS WHEN AT SETPOINT:**
2. Select **YES** for both **TEMP** and **CO2**.
3. When **YES** is selected for this function, the **DELAY IN ARMING AFTER DOOR OPEN** is ignored.

A **DOOR OPEN ALARM:** can be adjusted, choosing from seven preset durations (45 seconds in Figure 16) to warn of an improperly closed door.

The **AUDIBLE** and **VISUAL** alarms can be adjusted from **OFF** to **ON** (which means the alarm will be on continuously until it is acknowledged) in seven preset time increments.

In the **OFF** position, any Chamber Alarms that occur will be displayed on the screen without flashing and with the audible alarm inhibited.

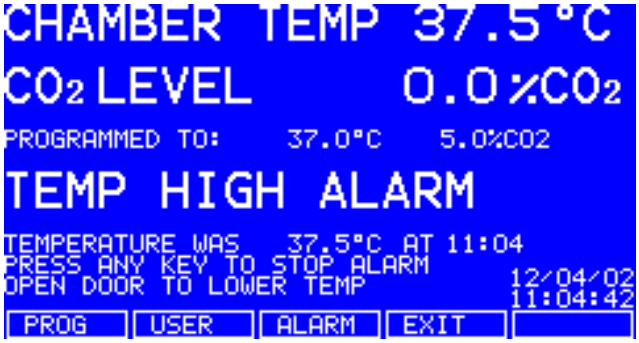
Section 3.8.1, *Chamber Alarm System Function*, and Figure 18 explain in detail how the Chamber Alarms operate.

3.8.1 Chamber Alarm System Function

When the incubator is switched **ON**, or after the temperature and CO_2 levels have been reprogrammed, the alarm system is inactive until the setpoint values (± 0.1) are achieved, after which the alarm system is armed. As setpoint is achieved, the CO_2 and temperature alarms are individually armed.

If temperature and/or CO_2 levels deviate more than the programmed setpoints, the display flashes, the audible alarm sounds and a message appears on the screen (*see Figure 17*). You can acknowledge the alarm by pressing any key.

Figure 17: CHAMBER ALARM Message



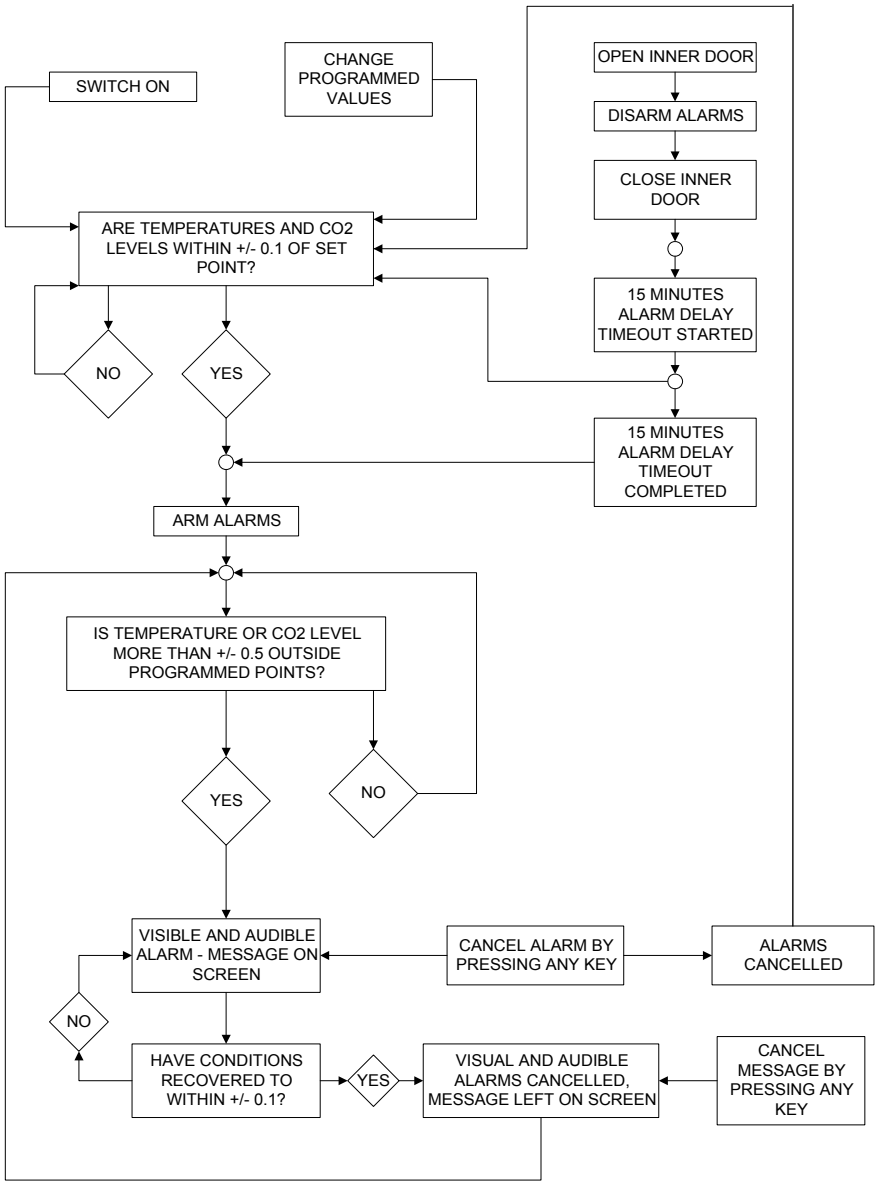
After setpoints have been achieved for the first time, when the inner door is opened, the alarm system is disabled; on closing the door, if selected, a **programmable alarm delay** starts:

- If chamber conditions recover within the programmed alarm delay time, the alarm system is immediately re-armed. After the delay, the alarm system is armed and if the temperature and CO_2 are outside the alarm high & low settings, the alarm will be activated.

- If an alarm occurs and the chamber subsequently recovers, the alarm stops and the system is re-armed. Details of the alarm event are stored in the datalogger.

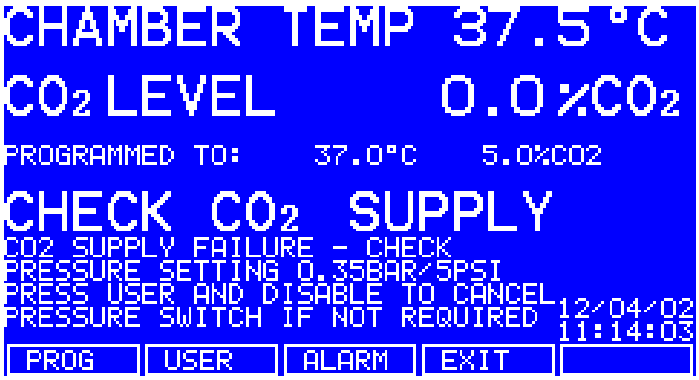
Figure 18 (*on the following page*) is a flow chart representing the chamber alarm system.

Figure 18: Chamber Alarm System Flow Chart



If the CO_2 valve is opened and no pressure is detected, an alarm occurs and a warning message appears on the screen, alerting you to **CHECK CO_2 SUPPLY**: (*see Figure 19 on the following page*).

Figure 19: CHAMBER ALARM to Check CO_2 Supply



As you can see *in Figure 19 above*, instructions are provided in the **ALARM** screen to deal with the situation that triggered the alarm.

3.9 DIAGNOSTIC *Menu Screen*

The diagnostics screen (*Figure 20 below)* contains technical information regarding the status of many of the system components found on the incubator. This screen is mainly for technical service use, and can be used to troubleshoot the incubator systems before service is scheduled. This information allows technical support to optimize the service support required, and to shorten service time.

Figure 20: DIAGNOSTICS Screen

3.10 HELP MENU *Screen*

The **HELP MENU** screen (*Figure 21 on the following page)* provides user-selectable categories of abbreviated information found in the user manual. All the major systems are covered in the help menu, including help on installing the incubator. If the user manual is misplaced, information about the CO_2 incubator and its functions can always be found on-screen.

Figure 21: HELP MENU Screen

3.11 RS232 Interface

The RS232 interface port provides a connection for the incubator to a personal computer or terminal. This allows the incubator to be programmed remotely and the incubator's operating status to be viewed on a remote screen.

In addition to the incubator and this port, you will need the following:

- A PC or terminal, capable of RS232 communication, with one serial com port free for this connection.
- A null-modem screened cable of suitable length (see **NOTE** below). To ensure reliable communication, the cable should not exceed 49 feet/15 meters in length. One end must have a 9-pin female D connector, to connect to the incubator's RS232 port, and the other end must have either a 9-pin or 25-pin female D connector, whichever mates to your PC or terminal.

NOTE:
The computer should be connected to a power supply outlet as close as possible to the incubator, to avoid grounding problems.

- Suitable communications software, such as Terminal (included with MS Windows® 3.1/3.11) or HyperTerminal (included with Windows® NT, 95, 98, ME, 2000 and XP). The incubator requires the following settings in the communications software:

Baud Rate	19200 bits/second
Data Bits	8
Parity	None
Stop Bits	1
Flow Control	Hardware (some cables may require it to be "None")

For details on using the RS232 interface, see Section 8.4.

4 ROUTINE MAINTENANCE

4.1 General Notes

To ensure that chamber conditions remain as stable as possible, be sure to minimize the length of time that the door is open. When you open the door, wipe off any small drops of condensate that may have formed on the inner seal. This will avoid a build-up of condensation.

If you are using the humidity tray for humidification, be sure to follow the indications provided *in Section 3.3*.

NOTE:
There is no need to remove the top panel for normal maintenance or servicing, so if you have two incubators stacked, the upper incubator does not have to be moved when you are servicing the lower incubator.

4.2 Daily Checks

1. Check that the temperature and CO_2 levels are reading within specification.

2. Check the reserve pressure in the CO_2 cylinder (normally 725 psi or 50 bar when full). The design of the incubator ensures very low consumption of CO_2: during normal working conditions, a typical large cylinder should last approximately 12 months (frequent door openings will deplete the supply more rapidly). If there is a significant drop at the cylinder pressure of 725 psi or 50 bar, it means that the cylinder is almost empty and should be replaced. Ensuring that there are no leaks at any of the connections will ensure a greater lifetime to the CO_2 supply and will help avoid accidentally running out of CO_2.

3. Any spills in the chamber should be cleaned immediately to protect the stainless steel surfaces.

4. Check the **DATALOGGER** screen for any alarms or events that may have occurred overnight.

4.3 Weekly Checks

Refill the humidity tray (never exceed the maximum volume of 2.5 liters). The use of warm water (~ 37.0°C) will ensure a rapid return to optimum chamber conditions.

4.4 Monthly Check

Remember that we recommend routine replacement of the water in the humidity tray, and that you clean the tray at the same time.

If required, you can take a sample of the gas inside the chamber using the CO_2 sample port, and check it using a CO_2 gas analyzer (*see Section 4.5*).

4.5 CO_2 Sampling with Analyzer

The CO_2 sample port is located on the lefthand side of the incubator, near the top (*see Figure 10*).

If you conduct a sampling, please ensure the following:

- Turn off the CO_2 gas by re-programming the setpoint for CO_2 to 0.0% to prevent CO_2 from being injected into the chamber and giving a false reading.
- A flow rate ≤ 0.5 liters/minute is used to take a sample.
- The door is kept closed to minimize heat loss.
- Remember to reset the CO_2 setpoint to the desired level after sampling.

We recommend that you perform a CO_2 AutoZero prior to sampling (*see Section 3.5*).

NOTE:
Displayed chamber CO_2 level will drop during sampling, but it will recover once the sampling is complete. This is merely a sensor characteristic; the CO_2 level in the chamber is actually not affected.

We also recommend that you AutoZero the CO_2 system at least once every 28 days to ensure that CO_2 level is correct.

4.6 Routine Checks of the O_2 Control Option

Be sure to conduct the reference to atmospheric oxygen procedure on a monthly basis to ensure that long-term drift in output from the sensor will be corrected, and to determine when the sensor requires replacement.

Under normal humidity conditions (95-99% RH), the sensor is unaffected. If for any reason (such as a large spill inside the chamber or the incubator being switched off while fully humidified) liquid condenses around the sensor, the result may be restriction of gas flow and a low sensor signal. Should such condensation appear on the chamber walls, normal operation can be easily restored by removing the humidity tray, drying the chamber completely, and then running the incubator at 37°C for one hour. This will dry out the sensor. After the hour has elapsed, the humidity tray can be reinstalled and the incubator humidified again.

Change the hydrophobic filter **each time** you clean the incubator, to avoid contamination or clogging over time.

5 SERVICE

5.1 Fuse Replacement

To replace a fuse, you will need an ordinary flat-bladed (5mm maximum) screwdriver.

1. Using the flat-bladed screwdriver, rotate the fuse holder (*see Figure 7 for location*) counter-clockwise until the fuse holder springs out.
2. Remove the spent fuse.
3. Install a new fuse: make sure it is of the same type.
4. Orient the fuse holder back in the side panel and, using the screwdriver as before, secure it in place.

6 CLEANING & DISINFECTING

6.1 Cleaning

1. Routinely clean the exterior of the incubator by wiping it over with a soft cloth, moistened with soapy water.

2. Rinse the soap from the cloth in clean water, and wipe the exterior surfaces again.

CAUTION!

Be sure to use only approved cleaning fluids and materials. Solvents, chloride-based cleaning substances and abrasive materials, among others, may cause permanent damage to the product surfaces. Also be sure to wipe all surfaces dry, leaving them free from any foreign particulates or fluids which could cause subsequent surface damage. (See the CAUTIONs in Section 6.2).

6.2 Disinfecting

The recommended disinfecting agent for use with the incubator is a solution of 70% isopropanol (isopropyl alcohol) and 30% distilled water. Be sure to follow appropriate safety regulations while you are using this solution:

WARNING!

- **As a routine precaution, wear protective gloves.**
- **Be sure to adequately ventilate the work area as you are disinfecting, to avoid the formation of potentially explosive alcohol vapors.**
- **Protect all electrical connections from contact with the alcohol solution.**

To best protect yourself, your incubator and your work area, follow these instructions:

1. **Program 0.0% CO_2 and switch off the incubator. Unplug the incubator from the power supply.**

2. Dampen a clean cloth with the alcohol solution and wipe down all external surfaces, taking care to keep the alcohol solution from coming into contact with any electrical outlets or assemblies.

3. Remove all of the shelves, the humidity tray and the shelf racks.

4. Place the black protective cover over the CO_2 sensor. Also protect any additional sensors, such as Oxygen or Humidity, with the cover(s) supplied.

CAUTION!

It is very important to ensure that no liquid is spilled onto the white porous CO_2 sensor cover at the rear of the chamber. Failure to use the protective cover(s) could result in damage to the sensor(s) and may affect your warranty.

5. You can clean the humidity tray by rinsing it in sterile water, wiping it down with the alcohol solution, and then rinsing it again with sterile water.

6. Wipe down the inside of the chamber with the alcohol/water solution, and leave it to dry completely.

CAUTION!

***Never* use any of the following substances to clean the stainless steel, or damage will result: Sodium Azide, Aqua Regia, Iodine, Ferric Chloride or Sulphuric Acid.**

7. Wipe the internal components of the chamber twice with the alcohol/water solution. Wipe off excess liquid and leave it to dry completely.

8. Reassemble the shelf racks, shelves and humidity tray before switching the incubator on. Wipe the inner door seal with the alcohol solution, rinse and leave it to dry.

9. Ensure the protective cover(s) are removed from all sensor(s) and replaced in the holder for safekeeping. **Be very careful, as you remove the black CO_2 sensor cover, not to accidentally remove the white porous sensor cover. This must remain in place.**

10. Refill the humidity tray (*as explained in Section 3.3*). When you reinstall it, ensure that the humidity tray is pushed fully back.

11. Leave the incubator on for at least two hours (preferably overnight) to allow conditions to stabilize.

12. When the incubator has stabilized, carry out an AutoZero and reprogram the desired CO_2 level. It may be necessary to open the glass door briefly if, after performing an AutoZero, the CO_2 level is too high.

6.3 High Temperature Disinfection

If your incubator is supplied with the High Temperature Disinfection option, follow the guidelines outlined in Section 8.5 for correctly and safely operating this option.

7 SPECIFICATIONS

Table 3: Specifications

Galaxy 170 R Incubator Specifications	
Temperature Management **(see important NOTE on the following page)**	▪ Digital programming via microprocessor control in 0.1°C increments. Measurement of chamber and door temperature via 6 RT* matched thermistors (sensitivity 0.01°C) ▪ Adjustable independent control of door heater ▪ "Out of Limits" temperature protection system independent of microprocessor control.
Range	4°C above ambient temperature to 50°C
Control	± 0.1°C
Stability	± 0.1°C at 37°C
Uniformity	≤± 0.3°C at ambient 20 - 25°C
Recovery Rate	Please refer to recovery graph
NOTE:	If ambient temperature is close to the programmed value, control settings may need adjusting. Please consult NBS for instructions.
CO_2 Control	Solid-state infrared CO_2 sensor operating independent of humidity. Programmable, fully automatic zeroing function.
Range:	0.2 - 20%
Control:	± 0.1%
Stability:	± 0.2% at 5% CO_2
Uniformity:	± 0.1%
Recovery Rate:	Please refer to recovery graph
Gas Connections:	6mm tubing
Required Gas Pressure:	5 psi / 0.35 bar
Relative Humidity	Removable stainless steel humidity tray
Reservoir Capacity:	2.5 liters
Humidity Control:	Normal: 95% at 37°C
Shelves	Polished stainless steel, perforated (standard).
Dimensions (WxD)	520 x 426mm (20.5 x 16.8 inches)
Number of Shelves:	4 standard; up to 8 shelves with multiple position option
Alarm Systems	Two-level alarm system giving programmable audio/visual warnings with options for remote communication. Level 1 signals system failures, level 2 is programmable and monitors chamber conditions.
Dimensions	
Chamber (HxWxD):	693 x 540 x 444mm (27.3 x 21.3 x 17.5 inches)
Chamber Volume:	174 liters
External (HxWxD):	848 x 685 x 677mm (33.4 x 27 x 26.7 inches)
External, Crated (HxWxD):	1100 x 830 x 830mm (43 x 33 x 33 inches), pallet included

*RT = Resistance Temperature curve

...continued...

Galaxy 170 R Incubator Specifications		
Weight	Crated: 115kg (253.5 lbs) Uncrated: 90kg (198.4 lbs), with standard features	
Grounded Electrical Supply		
	Voltage	**Power**
	100V – 120V 50/60 Hz	1300 W
	220V – 240V 50/60 Hz	1600 W
Energy to maintain 37°C:	< 0.1 kWh	
Storage Temperature	10 - 50°C	
Fuses	**120V**	**230V**
	10A	8A

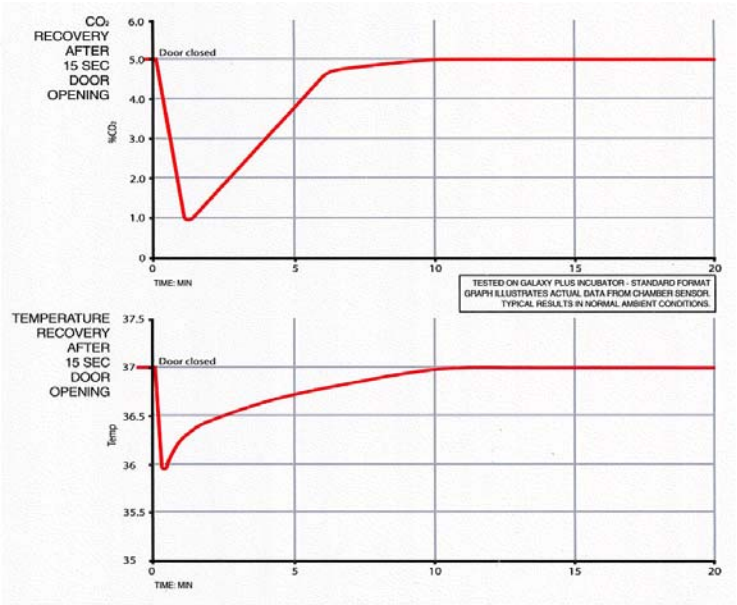
NOTE:

Maximum operating ambient temperature is 35°C.

Factory calibration of the incubator is carried out at 37°C, 5.0% CO_2 and 90 to 95% RH, in an ambient temperature of 20-25°C with no heat-generating apparatus inside the chamber.

Software calibration adjustments may be required to optimize performance if the incubator is being used well outside these operating conditions. Performance specifications may also be affected.

For advice on calibration adjustments and relevant performance specifications, contact NBS. Please be prepared with the model and serial number of your incubator and the complete details of your operating conditions.



8 OPTIONS & ACCESSORIES

8.1 Available Options

Some option combinations are not possible, others may incur extra cost. Please inquire before ordering.

Options	NBS Part Number	Field Retrofitable?
Cooling System	P0628-6810	No
BMS Relay	P0628-5540	Yes
High Temperature Disinfection	CO170 R-1000	No
O_2 Control, 1-19%	CO170 R-0200	No
O_2 Control, 0.1-19%	P0628-5410	No
O_2 Control, 1-195%	P0628-5400	No
IP66 Power Receptacle	P0628-5612	No
Copper Chamber	P0628-5612	No
4 Split Inner Glass Door	P0628-6780	Yes
8 Split Inner Glass Door	P0628-6781	Yes
Humidity Package	P0628-6820	No

8.2 Cooling System Option

The cooling system option allows the incubator to be used in one of three possible modes, as explained in Table 5 on the following page. This option consists of a heat exchanger assembly, fitted to the rear wall of the chamber, with a circulation fan.

Inside the incubator chamber, the interior cooling fins and fan are enclosed by a removable cover, with slots for airflow to the fan and the shelves. To cool the chamber, the fan on the heat exchanger assembly circulates chamber air across the cooling fins of the heat exchanger.

Outside the chamber, the rear of the heat exchanger assembly has an external cooling fan to cool the exchanger's hot fins by blowing ambient air across them.

The three modes of operation accessible in the **USER** menu under **COOL OPTIONS** are explained in Table 4:

Table 4: Cooling System Modes of Operation

Mode	Description
NORMAL	For working at 37°C in average ambient temperatures of 20-30°C. In this mode, the fans and heat exchanger assembly are switched off and the heating system operates as standard, without using the cooling option.
AMBIENT	For working at ambient temperature, therefore maintaining the chamber temperature within a close range of the outside air. In this mode, the fans & heat exchanger and the heating system are switched on to balance each other.
COOL	For working continuously from 1-10°C below ambient temperature. In this mode, the cooling system operates as AMBIENT, with the heating system switched off.

Before running the incubator with the cooling system option, make sure the heat exchanger assembly cover is in place, and make sure that the humidity tray is pushed fully back to keep deflector plate condensation from running down the rear of the tray, onto the chamber base.

The heat exchanger cover can be removed for cleaning: remove it from the four keyhole studs that hold it in place by gently lifting the cover out of the keyhold slots and then lifting it away toward you, taking care not to force it as damage to the inner components could result. Be sure to reinstall the cover with the same care before running the incubator again.

8.2.1 Troubleshooting the Cooling System

The thermo-electric module which governs the cooling system is self-contained and does not require any specific maintenance during the life of the incubator. If, however, the cooling system fails to perform according to expectation, consult the following Troubleshooting Guide:

Table 5: Cooling System Troubleshooting Guide

Step	Description
1	Check that the incubator has been set to the desired cooling mode. For the cooling system to operate at all, either COOL or AMBIENT must be selected.
2	Check that the circulation fans are operating. If either fan (inside the chamber or outside at the rear of the incubator) is not rotating when COOL or AMBIENT mode is engaged, and there are no obvious obstructions, contact your authorized service engineer for assistance.
3	If the temperature inside the chamber drops below 5°C while the cooling system is operating, frost may form on the heat sink fins, reducing airflow and adversely affecting performance. Raise the temperature in the chamber to no less than 5°C to avoid frost.
4	Check that the rear fan inlet and outlets are not blocked and that there is sufficient clearance (2 inches/50mm) between the rear of the incubator and the nearest possible obstruction, such as furniture or a wall.

8.3 BMS Relay Contact Alarm Option

The BMS (Building Management System) Relay Contact Alarm allows a signal from a central alarm system to be switched ON or OFF to indicate an alarm condition at the incubator.
The following alarms would activate the system: over-temperature, under-temperature, system failure, CO_2 high and CO_2 low.

As an integral option, the alarm can be programmed to indicate when the power fails (perhaps due to an electrical fault) or is switched off. If the power failure warning is active, the relay contacts will be reversed (pin 4, which is normally open, becomes normally closed and pin 6, which is normally closed, becomes normally open). The alarm will also respond to other types of alarm, depending on the options installed on the incubator.

The system is connected at the rear of the incubator via a standard 6-pin DIN socket (*see Figure 10 for location & Figure 22 for a detailed look*). The matching plug is provided, when the option is installed.

Figure 22: BMS Relay Contact Alarm Socket

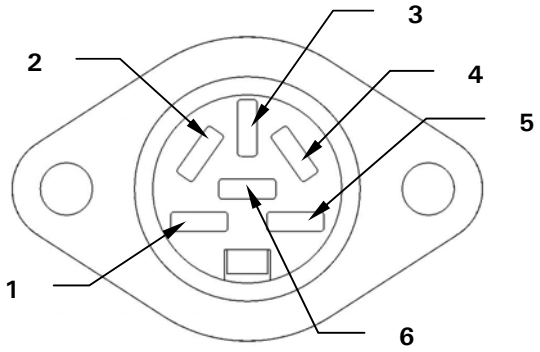


Table 6: BMS Relay Contact Alarm Socket Pin Designation

Pin	Designation	
1	24VDC unregulated	To power external equipment such as a remote buzzer or light (100mA maximum current available).*
2	0V	
3	5VDC	Via 10KΩ pull-up resistor, for a logic signal to directly control an auxiliary control system.*
4	Normally closed	To access the relay contacts. Contact limits are 3 Amps @ 24V DC and 3 Amps @ 34 VAC.
5	Common	
6	Normally open	

*Cable length should not exceed 3 meters (9.8 ft) to comply with EMC requirements.

The default setting for the alarm system is ON. To deactivate the relay using the incubator keypad:

1. Press **USER**.
2. Select **BMS ALARM RELAY**.
3. Select **MAKE ALARM RELAY ACTIVE YES/NO**.
4. Toggle to **NO** and then press **ENTER**.

The default setting for the power failure warning is ON. To make the alarm system ignore any power outage (intentional or not):

1. Press **USER**.
2. Select **BMS ALARM RELAY**.
3. Select **MAKE ALARM RELAY ACTIVE AT POWER SWITCH OFF/FAILURE YES/NO**.
4. Toggle to **NO** and then press **ENTER**.

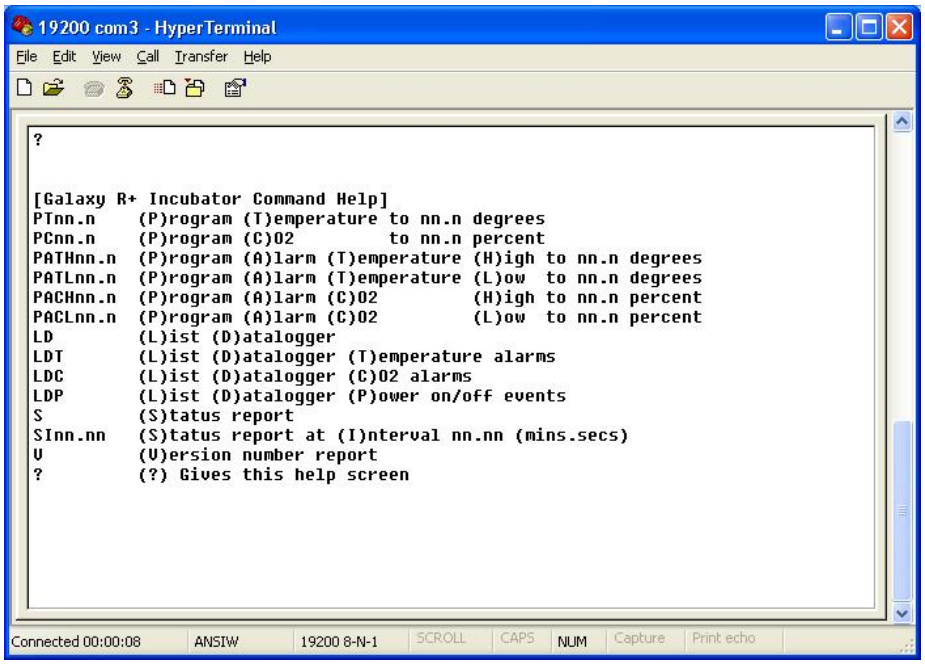
8.4 RS232 Interface

As indicated in Section 3.11, the RS232 interface port provides a connection for the incubator to a personal computer or terminal. This allows the incubator to be programmed remotely and the incubator's operating status to be viewed on a remote screen.

NOTE:
The computer should be connected to a power supply outlet as close as possible to the incubator, to avoid grounding problems.

To use the RS232 interface:

1. Connect the null-modem cable to the RS232 port at the rear of the incubator (*see Figure 8*).
2. Connect the other end of the cable to *either* the 25-pin male D serial com port *or* the 9-pin male D serial com port on the PC or terminal.
3. Turn on the computer and start the communications software.
4. Select an unused serial port to enable communications between the incubator and the PC or terminal. *If you know which port to use, continue to Step 5 and then skip to Step 7. If not, continue to Steps 5 & 6.*
5. Using the communications software, select the unused port (COM1, COM2, COM3, etc.) then press the ↵ **Enter** key on the PC/terminal keyboard. If you have successfully chosen an unused port, the message **Type '?' for help** should appear on the computer screen.
6. If you see any other message, or nothing happens, select the next port and press the ↵ **Enter** key again. If you still do not see the expected message, change the Flow Control setting from **Hardware** to **None**, then try again.
7. When the connection between the incubator and PC/terminal has been successfully established, and the message indicated in Step 5 appears, type (as prompted by the message onscreen) a **?** in the communications software, then press the ↵ **Enter** key.
8. The menu shown on the following page should now appear on the computer screen:



This menu allows the incubator temperature, CO_2 and alarm setpoints to be programmed remotely. A running status report can be generated at user-defined intervals, and all reports can be sent to a printer. *For details on these features, consult the documentation supplied with your communications software.*

Remote Programming: all commands beginning with P can be used to program the incubator from the remote computer. These commands are not case sensitive: lower case or upper case letters work exactly the same way. The following are examples of how each of the above commands might be used:

PTnn.n	(P)rogram new (T)emperature setpoint. Type **PT37.5**, then press ↵ **Enter** to reprogram the incubator's temperature setpoint to 37.5°C.
PCnn.n	(P)rogram new (C)O_2 level. Type **PC04.0**, then press ↵ **Enter** to reprogram the incubator's CO_2 level to 4%.
PATHnn.n	(P)rogram new (A)larm (T)emperature (H)igh setpoint. Type **PATH38.0**, then press ↵ **Enter** to reprogram the incubator's high temperature alarm setpoint to 38.0°C.
PATLnn.n	(P)rogram new (A)larm (T)emperature (L)ow setpoint. Type **PATL36.0**, then press ↵ **Enter** to reprogram the incubator's low temperature alarm setpoint to 36.0°C.
PACHnn.n	(P)rogram new (A)larm (C)O_2 level (H)igh setpoint. Type **PACH05.5**, then press ↵ **Enter** to reprogram the incubator's high CO_2 level alarm setpoint to 5.5%.
PACLnn.n	(P)rogram new (A)larm (C)O_2 (L)ow setpoint. Type **PACL04.5**, then press ↵ **Enter** to reprogram the incubator's low CO_2 level alarm setpoint to 4.5%.

In each case, the change is confirmed by a message from the incubator (e.g., **Program Temperature 37.5°C OK**, or **Program Alarm Temperature High 38.0°C OK**, etc.).

Status Commands: all commands beginning with S can be used to interrogate the incubator from the remote computer, and to display the current status of the incubator. As with the program commands, these commands are not case sensitive: lower case or upper case letters work exactly the same way. The following are examples of how each of the Status commands might be used:

S	(S)tatus report. Type **S**, then press the ↵ **Enter** key to display a current status report, which may look like this: **Temperature: Actual 37.0°C Setpoint 37.0°C** **CO2: Actual 05.0% Setpoint 05.0%**
SInn.nn	(S)tatus report at (I)nterval of n minutes, n seconds. Type **SI60.0**, then press the ↵ **Enter** key to display a current status report (as shown above) every hour. A confirmation message will appear: **Status report at interval 60.0 will be given** **Press "Enter" or "ESC" to stop reports**

Other Commands: As with the Program and Status commands, the V (Version number report) and ? (Help) commands are not case sensitive. To use these two commands:

V	Type **V**, then press the ↵ **Enter** key to generate a report on the current firmware version.
?	Type **?**, then press the ↵ **Enter** key to return to the initial help screen.

Alarm/Event Messages: a number of messages are preset to appear on the computer screen to inform you of either an alarm condition or a certain event. The following table recaps those messages:

Type of Message	Message
Alarm	TEMPERATURE LOW
Alarm	TEMPERATURE HIGH
Alarm	CO2 LOW
Alarm	CO2 HIGH
Alarm	TEMPERATURE SENSOR FAILURE
Alarm (AutoZero)	PROG CO2 A/Z SYSTEM INOPERATIVE
AutoZero Event	PROG CO2 A/Z COMPLETED OK
Door Event	DOOR OPENED
Door Event	DOOR CLOSED

After displaying any of the above messages, a status report message relative to the alarm or event will be displayed, e.g.:

[DOOR EVENT] DOOR OPENED
Temperature: Actual 37.0°C Setpoint 37.0°C
CO2: Actual 00.1% Setpoint 05.0%

8.5 High Temperature Disinfection

The High Temperature Disinfection option is designed to heat the internal chamber to 120°C, maintain that temperature for 4 hours, and then allow the chamber to cool down to 37°C or the programmed temperature (if different from 37°C) when normal control takes over. The cycle is designed to disinfect all internal surfaces and components, with the exception of the Oxygen control sensor where supplied.

8.5.1 Using High Temperature Disinfection

1. The incubator should be cleaned, disinfected chemically and dried thoroughly before starting the cycle (follow the instructions for Cleaning in Section 6).

2. The black protective cover must be removed before starting a cycle (the white porous cover can remain in place). The shelves, shelf racks, humidity tray and silicone rubber feet and sleeves should all be in place during the cycle. *The incubator MUST be clean and dry, and the humidity tray MUST be empty, clean and dry, to continue.* If it is not, permanent damage can occur to the incubator that may void your warranty.

3. To start the cycle, press the **USER** menu button, select **DISINFECTION** and press **START**. The incubator will then prompt: **IS CHAMBER CLEAN & DRY?** Answer **YES** if it is clean and dry. The cycle will start automatically, unless the incubator is fitted with Oxygen Control, in which case the incubator will also prompt: **IS O2 SENSOR REMOVED?** Make sure that the O_2 sensor has been removed and answer **YES** to begin the cycle. *See Section 8.5.2 for the O_2 sensor removal/reinstallation procedure.*

WARNING!
During the High Temperature Disinfection cycle, the outer surfaces of the incubator will get hot and should not be touched.

4. To cancel the cycle, press **CANCEL**. The incubator will cool down to the programmed level where normal control takes over.

NOTE:
In the unlikely event of a scheduled AutoZero beginning just prior to a disinfection cycle, the AutoZero will abort until the cycle is complete. A user initiated AutoZero will also abort but will not resume after completion of the disinfection cycle.

5. If the incubator door is opened during a disinfection cycle, the process will continue as normal but will cause a failure message if the temperature falls as a result during the heating phase and especially during the disinfection phase.

See important WARNING on the following page.

WARNING!

The door should NOT be opened during the cycle due to the hazardous high temperatures involved: serious burns could occur.

NOTE:

The chamber walls and CO_2 sensor all achieve temperatures of between 120 - 150°C, particularly in areas that are inaccessible to chemical disinfection. Certain areas of the glass door and inner door seal surface temperatures will be ± 5° of 120°C.

6. After completion of the process, one of the following status messages will be displayed. If the cycle:

   - was completed successfully, **DISINFECTION COMPLETED OK** is shown.
   - was cancelled by the user, **DISINFECTION WAS ABORTED** is shown.
   - failed for any reason, **DISINFECTION FAILED [CODE: XX]** is shown. The codes are listed in Table 7a and they are explained in Table 7b on the following page. If this happens, please note the failure code and contact your service representative for advice.

Table 7a: Disinfection Failure Codes & Descriptions

Failure Code	Failure Code Description *(see Table 5b below)*
01	**Z**
02	**W**
03	**W, Z**
04	**X**
05	**X, Z**
06	**W, X**
07	**W, X, Z**
08	**Y**
09	**Y, Z**
0A	**W, Y**
0B	**W, Y, Z**
0C	**X, Y**
0D	**X, Y, Z**
0E	**W, X, Y**
0F	**W, X, Y, Z**

Table 7b: Disinfection Failure Code Explanations

Failure Code Description	Explanation
W	Temperature drop during warm-up period: indicates the temperature fell more than 2°C during the heating phase over a 60-second period.
X	Temperature drop during 4-hour period: indicates the temperature fell below 118.0°C during the disinfection phase.
Y	Temperature increase during cool-down phase: indicates the temperature rose by more than 2°C during the cooling phase over a 60-second period.
Z	Cancel key pressed.

NOTE:
If the incubator power is cycled OFF then ON during a disinfection cycle due to a power outage, the incubator will power up as normal. This condition will be indicated by the absence of a completed disinfection status message (DISINFECTION COMPLETED OK).

If the chamber temperature is above the setpoint or the element temperature is greater than a factory-preset control point, cooldown will be entered until these conditions are satisfied.

NOTE:
It is recommended that the AutoZero function be run following each disinfection cycle.

8.5.2 High Temperature Disinfection Option with Oxygen Control

The Oxygen Sensor is an electrochemical device that will be destroyed by the high temperature used to disinfect the incubator if left in place. For this reason, the Oxygen Sensor *must* be removed from the incubator prior to a High Temperature Disinfection Cycle. The sensor can be accessed from the rear panel of the incubator.

Detailed removal and installation instructions are provided in Section 8.6.7.

CAUTION!
The incubator should be positioned to allow access to the back of the incubator for removal of the Oxygen Sensor prior to starting a High Temperature Disinfection cycle.

8.6 O_2 Control (1-19%)

This oxygen control option is designed to cover the **1-19% range** by adding nitrogen to bring the level below ambient. *If you have the **0.1-19%** oxygen control option, skip ahead to Section 8.7; or if you have the **1-95%** oxygen control option, skip to Section 8.8.*

8.6.1 Setting Up the N_2 Tank

Before you set up your oxygen control, be sure you have the proper equipment for your nitrogen supply:

- 2 cylinders of nitrogen, regulation size W
- 1 two-stage pressure regulator
- 1 Inline pressure regulator
- 6mm PVC tubing
- tubing clips

Set up the nitrogen tanks as follows:

1. Inspect them to be sure there are no leaks or other damage.
2. Check that the two-stage pressure regulator valve and the inline pressure regulator valve are closed by trying to turn their knobs in a counter-clockwise direction; the knobs should be at the stop point.
3. Place the inline pressure regulator close to the incubator.
4. Securely attach the two-stage pressure regulator to the nitrogen tank's outlet and to the inline pressure regulator's inlet with tubing, securing both ends with clips.
5. Connect the inline pressure regulator's outlet to the incubator's N_2 inlet on the right side of the equipment tray at the rear of the incubator (*see Figure 7*); secure both ends with clips.
6. Proceed as indicated in Section 8.6.2.

NOTE:
To add an automatic gas cylinder changeover instrument: with the incubator turned off, connect its inlet to the two-stage pressure regulator's outlet, and the changeover instrument's outlet to the inline pressure regulator's inlet with tubing, securing the ends with tubing clips.

8.6.2 Setting Up Oxygen Control

1. Remove the black plastic protective cover from the hydrophobic filter cap (*making sure that the hydrophobic filter cap is not removed with it*), located in the rear wall of the incubator chamber. Retain the cover for use when you clean the chamber.

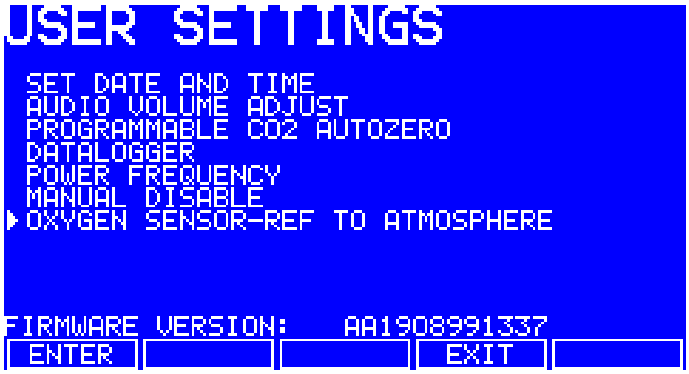
2. Open the nitrogen gas supply from the tank. Set the N_2 tank's outlet pressure gauge to 1.5 bar.

3. Set the nitrogen regulator to 1 bar (14.5 psi). The nitrogen will be fed into the incubator through a HEPA filter that is already installed in the gas line. The gas flow rate is approximately 20 liters/minute.

NOTE:
If the programmed O_2 level is close to the ambient oxygen, it may be necessary to reduce the cylinder pressure below 1 bar to stop the oxygen level from undershooting the programmed value.

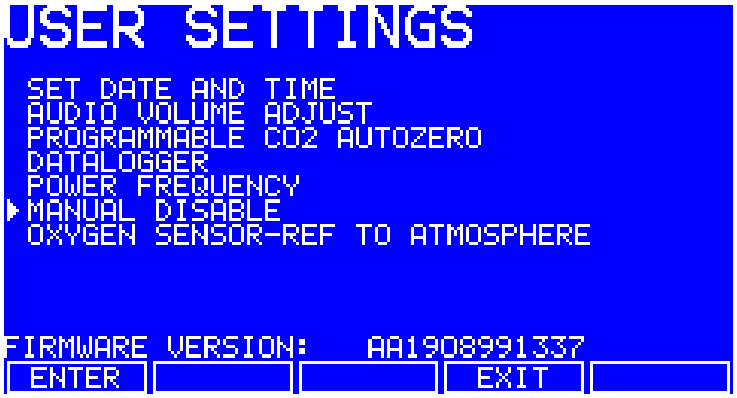
4. After the incubator has been humidified and left overnight to stabilize, select the **USER** menu; then, using the ▲ or ▼ direction key, select **OXYGEN SENSOR-REF TO ATMOSPHERE** (*see Figure 23*) and follow the onscreen instructions to automatically calibrate the oxygen sensor to atmospheric oxygen levels. The oxygen reading is automatically adjusted to 19.7%, which is the true reading taking into account the relative humidity level.

Figure 23: Selecting OXYGEN SENSOR-REF TO ATMOSPHERE



5. Enable the oxygen control: (a) press the **USER** function key, (b) using the ▲ or ▼ direction key, select **MANUAL DISABLE** (*see Figure 24*), (c) press the **ENTER** function key, (d) select **ENABLE** for Oxygen Control using the ◀ or ▶ direction key, then (e) press the **ENTER** function key.

Figure 24: USER SETTINGS Screen



6. Navigate to the **PROG** screen to set the required Oxygen level.

7. The Alarm levels are automatically set to ± 0.5% above or below the programmed value, but you can modify them in the **ALARM** screen. Re-arming the alarm can be delayed until the programmed value is achieved: select the relevant option in the **ALARM** screen.

NOTE:
At low oxygen levels, the CO_2 and O_2 levels may not have fully recovered within the Alarm limits after the 15-minute "Delay in arming after door opening." This time period can be increased (in the ALARM screen) to suit individual circumstances.

8. By controlling the Duty Cycle of the N_2 valve, Oxygen Control can be tailored to achieve programmed Oxygen and Carbon Dioxide levels at approximately the same time.

8.6.3 Operating Guidelines

We recommend that you repeat the **OXYGEN SENSOR-REF TO ATMOSPHERE** procedure (*see Step 3 in Section 8.6.1 and further details in Section 8.6.4*) once a month to ensure that any long-term drift in sensor output will be corrected. Be sure to do it at the chamber operating temperature.

When you are cleaning the chamber, be very careful not to wet the oxygen sensor or CO_2 sensor. Never use solvents on the sensor membrane; rather, be sure to cap the hydrophobic filter before you clean. In fact, it is good practice to replace the filter each time you clean the incubator chamber, to avoid the possibility of filter contamination.

Under normal relative humidity conditions (95-99%), the oxygen sensor's performance should not be affected. If, however, liquid condenses around the sensor, gas flow may become restricted, giving the sensor a low signal. This may occur if there is a large liquid spill inside the chamber or if the incubator is turned off while it is fully humidified. Should such condensation appear, normal operation can be restored by:

- removing the humidity tray,
- drying the chamber completely,
- and then running the incubator at 37°C for one hour.

This will dry out the sensor(s). The humidity tray can then be reinstalled and the incubator can be safely re-humidified.

8.6.4 Referencing to Atmosphere

The oxygen sensor is a self-powered electrochemical cell that has a finite life dependent on the ambient oxygen level. A typical lifespan is 1-2 years at atmospheric levels. During the sensor's lifespan, the signal produced will slowly degrade until it is ultimately unusable. For this reason, we recommend that you reference the sensor to atmospheric oxygen levels on a monthly basis.

The **OXYGEN SENSOR-REF TO ATMOSPHERE** procedure has three possible outcomes. The first is that the procedure was completely successful, and no further action need be taken until the following month's test. The second and third outcomes are presented in detail in Sections 8.6.5 (*Replace Sensor Soon*) and 8.6.6 (*Replace Sensor Now*).

See Section 8.6.7 for instructions on removing and replacing the sensor.

8.6.5 Replace Sensor Soon

If the referencing procedure was successful but the sensor is nearing the end of its working life, the following message will appear in the display:

O_2 REFERENCE OK BUT SENSOR REQUIRES REPLACEMENT SHORTLY

PRESS ENTER TO PROCEED

When you press the **ENTER** function key, the message will change to this:

O_2 SENSOR

THE RESULT OF THE O_2 REFERENCE PROCESS SHOWS THAT THE SIGNAL FROM THE O_2 SENSOR HAS REDUCED INDICATING IT IS APPROACHING THE END OF ITS LIFE.

REPEAT THE REFERENCE PROCEDURE TO CONFIRM THIS RESULT.

PRESS ENTER TO PROCEED.

Press the **ENTER** function key.

8.6.6 Replace Sensor Now

If the referencing procedure failed, Oxygen Control will be disabled—but the incubator will function perfectly in all other ways—until a new sensor is installed and corrected references to the atmosphere. The following message will appear in the display:

O_2 REFERENCE FAILED

PRESS ENTER TO PROCEED

When you press the **ENTER** function key, the message will change to this:

O_2 SENSOR

THE RESULT OF THE O_2 REFERENCE PROCESS SHOWS THAT THE SIGNAL FROM THE O_2 SENSOR HAS REDUCED BELOW AN ACCEPTABLE LEVEL AND HAS REACHED THE END OF ITS LIFE.

REPEAT THE REFERENCE PROCEDURE TO CONFIRM THIS RESULT.

PRESS NEXT TO PROCEED.

When you press the **NEXT** function key, the message will change to this:

O_2 SENSOR

OXYGEN CONTROL HAS BEEN DISABLED AS A RESULT BUT THE INCUBATOR IS OTHERWISE FULLY OPERATIONAL.

PRESS PREV TO VIEW PREVIOUS SCREEN.
PRESS EXIT TO EXIT.

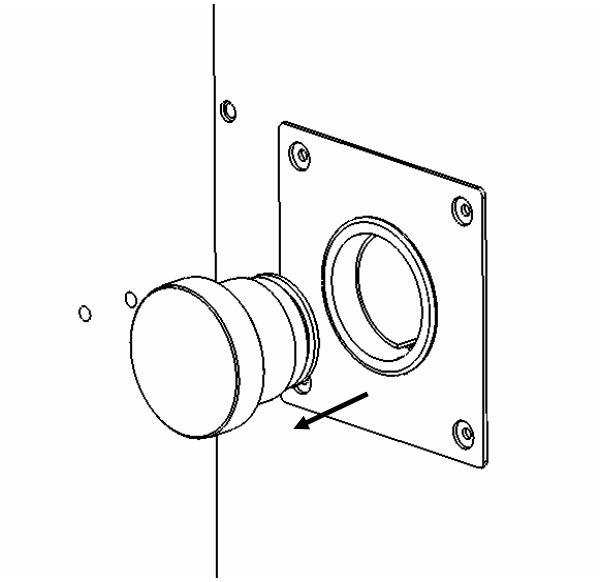
When you press the **EXIT** function key, you will return to the **USER** screen and normal operation.

8.6.7 Removing & Replacing O_2 Sensor

To remove and replace the oxygen sensor, you will need the sensor removal tool provided (*see Figure 26 on the following page*):

1. Pull the rear access cover (*see Figure 25*) off the rear outside wall of the incubator to gain access to the oxygen sensor.

Figure 25: Oxygen Sensor Rear Access Cover

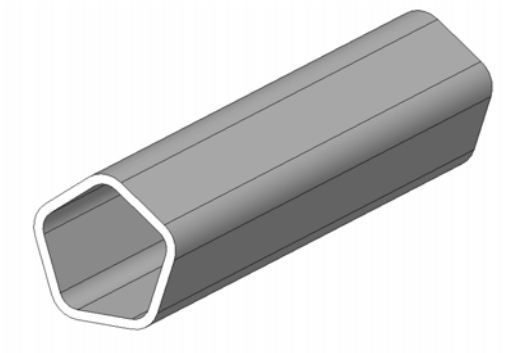


2. Reach inside and disconnect the sensor by unplugging the connector: *be sure to grasp the white connector body, not the wire leads!*

> ***WARNING!***
> **Never pull on the wire leads; disconnect the white connector body.**

3. Using the sensor removal tool (*see Figure 26*), unscrew the oxygen sensor by turning it counter-clockwise. *Because the oxygen sensor contains lead, be sure to dispose of it according to local regulations.*

Figure 26: Oxygen Sensor Removal Tool



4. Using the sensor removal tool, install the new oxygen sensor by turning it clockwise until it is finger-tight. *Do not use excessive force or any metal tool*.
5. Reconnect the sensor by plugging the white connector body back in.
6. Make sure that the sensor wires are inside the metal sensor tube to protect them from damage, then press the rear access cover snugly back in place.
7. After replacing the sensor, humidify the incubator and allow it to stabilize overnight.
8. Calibrate the sensor with reference to the atmospheric oxygen level (*see Section 8.6.4*).

8.6.8 Replacing the Filter Disc

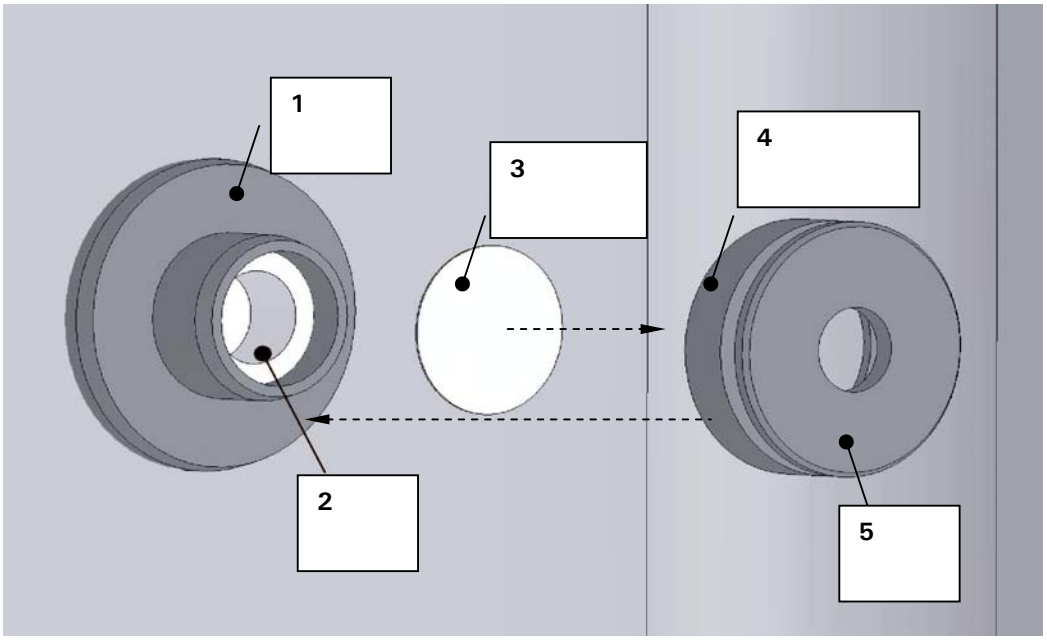
The hydrophobic filter installed on your Oxygen Control system helps prevent condensation from reaching the sensor (*see Figure 27*).

To replace the hydrophobic filter disc (membrane), with reference to Figure 27:

1. Carefully pull the complete hydrophobic filter holder away from the oxygen sensor holder on the rear wall of the chamber.

2. With a fingertip or a 10-11mm (½-inch) rod, from the rear of the filter holder, *gently* push the filter membrane disc and the filter cap out of the holder.
3. Clean and dry the filter holder and cap.
4. Wearing gloves to avoid contaminating the filter disc, gently place the new filter membrane disc into the filter holder recess. The filter disc works in both directions, so there is no right or wrong side.

Figure 27: Hydrophobic Filter & Holder Assembly (exploded view)



1	Oxygen sensor holder	4	Hydrophobic filter holder
2	Oxygen sensor	5	Hydrophobic filter cap
3	Hydrophobic filter disc		

5. Make sure the O-rings (between the cap & filter holder and between the filter holder & oxygen sensor holder) are undamaged and securely in place.
6. Gently press the filter cap back in.
7. Press fit the filter assembly back onto the oxygen sensor holder.

8.6.9 Troubleshooting the Oxygen Sensor

If the oxygen sensor fails suddenly, it is very likely that the sensor inlet membrane has become blocked by condensation. This can be seen on the **DATALOGGER** screen as a sudden drop from the programmed value to nearly zero.

To dry the membrane:

1. Remove the hydrophobic filter holder assembly (*see Figure 25*) by unscrewing it (counter-clockwise).

2. Program the incubator for a temperature of at least 37°C (or higher if you normally operate the incubator at a higher temperature).
3. Close the door and allow the temperature to recover.
4. Reopen the door for 15 seconds to release any build-up of humidity.
5. Repeat steps 3 and 4 every 30 minutes or so, keeping an eye on the **DATALOGGER** O_2 Graph. The oxygen level should rather suddenly recover after a few hours.
6. Leave the incubator for a few more hours to be sure that the sensor membrane has thoroughly dried out.
7. Replace the hydrophobic filter disc following the instructions in Section 8.6.8.
8. Re-humidify the incubator.
9. After 2 or 3 hours, carry out an **OXYGEN SENSOR-REF TO ATMOSPHERE** procedure. When the referencing has been successfully completed, the incubator is ready for use.

8.6.10 Specifications

The Oxygen Control option has the following characteristics:

Sensor Type	Self-powered, diffusion-limited, electrochemical cell with temperature compensation.
Zero Signal in Nitrogen	< 50 µV
Temperature Compensation	± 2% of signal variation from 0-40°C
Relative Humidity Range	0-99%, non-condensing
Operating Temperature Range	-20°C to +50°C
Resolution	0.01% Oxygen
Expected Operating Life	1-2 years in ambient oxygen
Hydrophobic Filter Operating Life	No data available on the filter lifespan but we are confident to expect it will last at least 6 months.
Nitrogen Input Rate	20 l/min at 1 bar (14.5 psi)
Typical Oxygen Reduction Rates	3 minutes to 16% 4 minutes to 11% 8 minutes to 6%

8.7 O_2 Control (0.1-19%)

This oxygen control option uses the controlled addition of nitrogen to reduce the oxygen level below ambient. *If you have the **1-19%** oxygen control option, go back to Section 8.6; or if you have the **1-95%** oxygen control option, skip ahead to Section 8.8.*

8.7.1 Setting Up the N_2 Tank

Before you set up your oxygen control, be sure you have the proper equipment for your nitrogen supply:

- 2 cylinders of nitrogen, regulation size W
- 1 two-stage pressure regulator
- 1 Inline pressure regulator
- 6mm PVC tubing
- tubing clips

Set up the nitrogen tanks as follows:

1. Inspect them to be sure there are no leaks or other damage.
2. Check that the two-stage pressure regulator valve and the inline pressure regulator valve are closed by trying to turn their knobs in a counter-clockwise direction; the knobs should be at the stop point.
3. Place the inline pressure regulator close to the incubator.
4. Securely attach the two-stage pressure regulator to the nitrogen tank's outlet and to the inline pressure regulator's inlet with tubing, securing both ends with clips.
5. Connect the inline pressure regulator's outlet to the incubator's N_2 inlet on the right side of the equipment tray at the rear of the incubator (*see Figure 7*); secure both ends with clips.
6. Proceed as indicated in Section 8.7.2.

NOTE:
To add an automatic gas cylinder changeover instrument: with the incubator turned off, connect its inlet to the two-stage pressure regulator's outlet, and the changeover instrument's outlet to the inline pressure regulator's inlet with tubing, securing the ends with tubing clips.

8.7.2 Setting Up O_2 Control

Oxygen control is tailored such that both the O_2 and the CO_2 levels are achieved at approximately the same time, via control of the N_2 valve's duty cycle (but only within the range of 0.1-19% O_2).

1. Remove the black plastic protective cover (*making sure that the hydrophobic filter cap is not removed with it*) from the port inside the chamber. Retain the cover for use when you clean the chamber.

2. Open the nitrogen gas supply from the tank and set the N_2 tank's outlet pressure gauge to 1.5 bar.

3. Set the nitrogen regulator to 1 bar (14.5 psi). The nitrogen will be fed into the incubator through a HEPA filter that is already installed in the gas line. The gas flow rate is approximately 20 liters/minute.

NOTE:
If the programmed O_2 level is close to the ambient oxygen, it may be necessary to reduce the cylinder pressure below 1 bar to stop the oxygen level from undershooting the programmed value.

NOTE:
When working at 0.1% O_2, set the CO_2 pressure to 0.2 bar (2.9 psi).

Be sure to humidify the incubator and leave it overnight to stabilize before proceeding further.

To automatically calibrate the sensor to atmospheric oxygen levels, select **OXYGEN SENSOR – REF TO ATMOSPHERE** in the **USER** menu, and then follow the onscreen instructions.

The oxygen reading is automatically adjusted to 19.7%, which is the true reading taking into account the Relative Humidity in the chamber.

8.7.3 Enabling or Disabling O_2 Control

To enable oxygen control:
1. Select the **USER** screen by pressing the **USER** function key.
2. Use the direction keys to select **MANUAL DISABLE**.
3. Press the **ENTER** function key, then use the direction keys to select **ON** for Oxygen Control.
4. Press the **ENTER** function key again.

Program the required oxygen level in the **PROG** screen, following the onscreen instructions.

To disable oxygen control, follow the pattern used to enable it, but this time select **USER**, **MANUAL DISABLE**, **ENTER**, **OFF** and then **ENTER** again.

8.7.4 Alarms

The alarm levels are set automatically to ± 0.5% above and below the programmed value, but these points can be altered in the **ALARM** screen. In addition, the rearming of the alarm can be delayed until the Programmed Value is achieved by selecting the relevant option in the **ALARM** screen.

For example, it is possible at low oxygen levels that the CO_2 and O_2 levels might not fully recover within the Alarm Limits after the 15-minute **DELAY IN ARMING AFTER DOOR OPENING** period has elapsed, so this time period can be increased in the **ALARM** screen to suit individual circumstances.

8.7.5 Referencing to Atmosphere

To reference the oxygen sensor to atmospheric oxygen levels, see Section 8.6.4.

8.7.6 Programming Desired O_2 Level

Program the required oxygen level in the **PROG** screen, following the onscreen instructions.

If you are running an O_2 level programmed between 0.1-0.9%, you should know that the control system is set to operate in the following way to minimize N_2 consumption after the glass door has been opened:

- The N_2 valve is switched on continuously until the O_2 level is within 0.1% of setpoint.

- The CO_2 valve is then switched on to allow the CO_2 level to reach setpoint. If the O_2 level is above setpoint 15 minutes after the N_2 valve has been switched off, it is switched back on for 40 seconds and the CO_2 valve is switched on for 20 seconds. The CO_2 valve will then pulse until setpoint is reached.
- The process described above will repeat itself until the O_2 setpoint is reached.
- The same process will also repeat if the O_2 level rises above setpoint, and if the O_2 level should rise toward 0.2% above setpoint, the N_2 valve will open again continuously until the O_2 level returns to setpoint.
- The CO_2 AutoZero, which would normally take place after a CO_2 alarm, will be cancelled to avoid the introduction of additional O_2 into the chamber. For the same reason, we recommend canceling the programmed CO_2 AutoZero.

8.7.7 Precautions

Under normal humidity conditions (95-99% RH), the sensor is unaffected. If for any reason (such as a large spill inside the chamber or the incubator being switched off while fully humidified) liquid condenses around the sensor, the result may be restriction of gas flow and a low sensor signal. Should such condensation appear on the chamber walls, normal operation can be easily restored by removing the humidity tray, drying the chamber completely, and then running the incubator at 37°C for one hour. This will dry out the sensor. After the hour has elapsed, the humidity tray can be reinstalled and the incubator humidified again.

8.8 O_2 Control (1-95%)

This oxygen control option uses the controlled addition of oxygen to increase the level above ambient and the controlled addition of nitrogen to reduce the oxygen level below ambient. *If you have the **1-19%** oxygen control option, go back to Section 8.6; or for the **0.1-19%** oxygen control option, go back to Section 8.7.*

WARNING!

High oxygen levels inside the chamber require additional safety precautions:

- **Setting the oxygen to levels >24% can greatly increase the chance of fire and explosion. Operators planning to set oxygen at 24-95% should therefore take all appropriate precautions to minimize the risk. NBS does not recommend using external (heat-generating) equipment inside the chamber when oxygen conditions will be >24%.**
- **Before opening the incubator door, make sure no flames (Bunsen burner, etc.) are in the vicinty.**
- **Avoid the presence of other combustible gases (hydrogen, methane, etc.)**
- **Ensure that all solenoid valves and pressure regulators & gauges controlling the gas supply are grease-free for use with oxygen.**

If your incubator is operating in the 3-95% range of O_2 control, only the N_2 valve will operate for setpoints below 19%; both the N2 and O2 valves will operate for setpoints between 19 and 80%; and for setpoints above 80%, only the O2 valve will operate.

NOTE:
If you plan to maintain O_2 levels of 80-95%, be sure to read Section 8.8.4.

8.8.1 Setting Up the N_2 Tank

Before you set up your oxygen control, be sure you have the proper equipment for your nitrogen supply:

- 2 cylinders of nitrogen, regulation size W
- 1 two-stage pressure regulator
- 1 Inline pressure regulator
- 6mm PVC tubing
- tubing clips

Set up the nitrogen tanks as follows:

1. Inspect them to be sure there are no leaks or other damage.
2. Check that the two-stage pressure regulator valve and the inline pressure regulator valve are closed by trying to turn their knobs in a counter-clockwise direction; the knobs should be at the stop point.
3. Place the inline pressure regulator close to the incubator.
4. Securely attach the two-stage pressure regulator to the nitrogen tank's outlet and to the inline pressure regulator's inlet with tubing, securing both ends with clips.
5. Connect the inline pressure regulator's outlet to the incubator's N_2 inlet on the right side of the equipment tray at the rear of the incubator (*see Figure 7*); secure both ends with clips.
6. Proceed as indicated in Section 8.8.2.

NOTE:
To add an automatic gas cylinder changeover instrument: with the incubator turned off, connect its inlet to the two-stage pressure regulator's outlet, and the changeover instrument's outlet to the inline pressure regulator's inlet with tubing, securing the ends with tubing clips.

8.8.2 Setting Up O_2 Control

Oxygen control is tailored such that both the O_2 and the CO_2 levels are achieved at approximately the same time, via control of the O_2 or N_2 valve's duty cycle.

1. Remove the black plastic protective cover (*making sure that the hydrophobic filter cap is not removed with it*) from the port inside the chamber. Retain the cover for use when you clean the chamber.

2. Open the nitrogen gas supply from the tank and set the N_2 tank's outlet pressure gauge to 1.5 bar.

3. Set the nitrogen regulator to 1 bar (14.5 psi)—*but be sure to read the* **NOTE** *below*. The nitrogen will be fed into the incubator through a HEPA filter that is already installed in the gas line. The gas flow rate is approximately 20 liters/minute.

4. Install the oxygen cylinder in the same manner as outlined for the nitrogen cylinder installation in Section 8.8.1, using the incubator's O_2 inlet, of course. For this application, you will need another two-stage pressure regulator and another inline pressure regulator.

NOTE:
If the programmed O_2 level is close to the ambient oxygen, it may be necessary to reduce the cylinder pressure below 1 bar to stop the oxygen level from undershooting the programmed value.

Be sure to humidify the incubator and leave it overnight to stabilize before proceeding further.

To automatically calibrate the sensor to atmospheric oxygen levels, select **OXYGEN SENSOR – REF TO ATMOSPHERE** in the **USER** menu, and then follow the onscreen instructions.

The oxygen reading is automatically adjusted to 19.7%, which is the true reading taking into account the Relative Humidity in the chamber.

8.8.3 Enabling or Disabling O_2 Control

To enable oxygen control:
1. Select the **USER** screen by pressing the **USER** function key.
2. Use the direction keys to select **MANUAL DISABLE**.
3. Press the **ENTER** function key, then use the direction keys to select **ON** for Oxygen Control.
4. Press the **ENTER** function key again.

Program the required oxygen level in the **PROG** screen, following the onscreen instructions.

To disable oxygen control, follow the pattern used to enable it, but this time select **USER**, **MANUAL DISABLE**, **ENTER**, **OFF** and then **ENTER** again.

8.8.4 Important Notes for O_2 Levels >80%

If you are running the incubator with a dry chamber and no CO_2, the recommended maximum O2 level is 95%. In addition, open samples inside the chamber can cause RH to increase, and the O2 sensor may require recalibration to work properly in a completely dry atmosphere.

For a *humidified* chamber with no CO_2, the recommended maximum O_2 level is 92%, while for a *humidified* chamber *with 5%* CO_2, we recommend no more than 87% O_2.

When the incubator is running at normal humidity level (i.e., 95% RH), there is approximately 6% (by volume) water vapor present in the chamber. If 5% CO_2 is also present, the maximum achievable level of O_2—without using excessive quantities of oxygen—is approximately 87%.
Oxygen direct from a cylinder has a dewpoint temperature of < -45°C, corresponding to 0.06% water vapor. As it enters the incubator, therefore, its temperature is very low and even as it is warmed, its RH level is very low. Both of these factors affect the performance of the O_2 detector. To minimize these effects, O_2 is fed continuously until it arrives at 0.4% below setpoint. To allow the detector signal to recover and the RH level to build, there is a 3-minute delay. If O_2 is still required, it is fed in for 10 seconds, with an additional 3-minute delay until setpoint is achieved.

As the humidity level rises, the O_2 content in the chamber will diminish. The use of O_2 will rise considerably as the setpoint approaches the sum contents of water wapor and CO_2 in the chamber. In the short term, it is possible to achieve higher levels of O_2, but as humidity rises and O_2 content is pushed down, there will be a continuous demand for O_2 and RH will remain too low. At the same time, as O_2 is pumped in, the CO_2 level will also diminish, causing the system to add CO_2, which in turn causes the O_2 level to drop again.

If the O_2 setpoint is too high, the incubator can consume some 2,500 liters of O_2 per day—which does not include the extra oxygen consumed each time the door is opened (about 500 liters).

8.8.5 Alarms

The alarm levels are set automatically to ± 0.5% above and below the programmed value, but these points can be altered in the **ALARM** screen. In addition, the rearming of the alarm can be delayed until the Programmed Value is achieved by selecting the relevant option in the **ALARM** screen.

For example, it is possible at low oxygen levels that the CO_2 and O_2 levels might not fully recover within the Alarm Limits after the 15-minute **DELAY IN ARMING AFTER DOOR OPENING** period has elapsed, so this time period can be increased in the **ALARM** screen to suit individual circumstances.

8.8.6 Referencing to Atmosphere

NOTE:
It is highly recommended to reference the sensor to atmospheric oxygen at least once per month.

See Section 8.6.4 for details on this important procedure.

8.8.7 Programming Desired O_2 Level

Program the required oxygen level in the **PROG** screen, following the onscreen instructions.

8.8.8 Other Precautions

Under normal humidity conditions (95-99% RH), the sensor is unaffected. If for any reason (such as a large spill inside the chamber or the incubator being switched off while fully humidified) liquid condenses around the sensor, the result may be restriction of gas flow and a low sensor signal. Should such condensation appear on the chamber walls, normal operation can be easily restored by removing the humidity tray, drying the chamber completely, and then running the incubator at 37°C for one hour. This will dry out the sensor. After the hour has elapsed, the humidity tray can be reinstalled and the incubator humidified again.

For routine service checks of the sensor, see also Section 8.6.9.

8.8.9 Specifications

See Section 8.6.10.

8.9 O_2 Sensor Replacement

When the O_2 sensor needs to be replaced, see Section 8.6.7 for instructions.

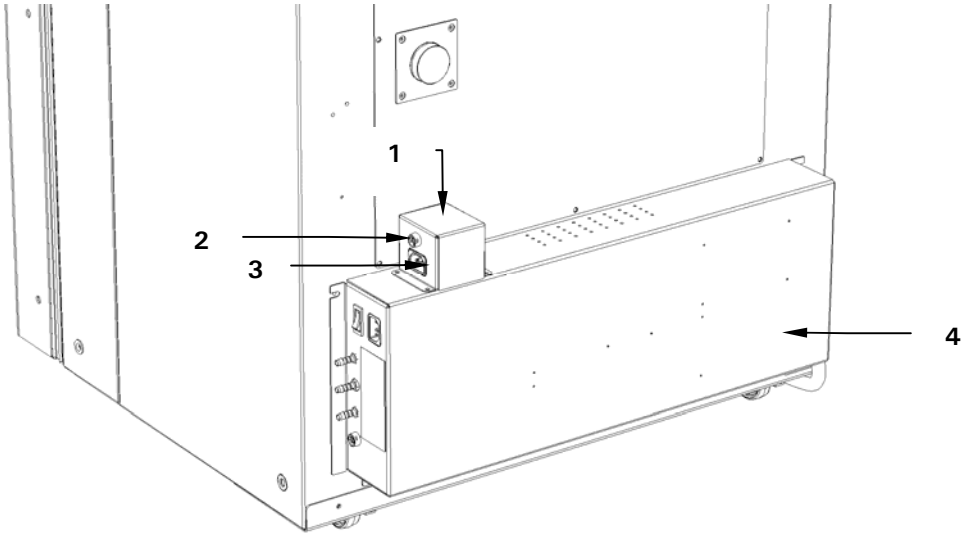
8.10 IP66 Sealed Electrical Outlet Socket

WARNING!
Both the incubator and the IP66 enclosure must be plugged into an electrical supply protected by an RCD device. Any device chosen must be a "self-resetting" type which will automatically reconnect power to the incubator as soon as power is restored after a power failure.

The IP66 Sealed Electrical Outlet Socket is designed to provide a safe and convenient means of using electrically powered equipment within the incubator chamber. The IP66 socket is powered on a completely separate circuit and therefore has its own plug, lead and fuse.

The socket (*Figure 29*) is located on the back wall of the chamber, on the righthand side between the second and third shelf. The socket is powered by an independent power inlet located above the equipment box at the rear of the incubator (*see Figure 28 below*). The socket also has an independent fuse which is rated at 4 Amps. There is a dedicated switch for this socket, illuminated green when it is on; the switch is located on the left front of the incubator.

Figure 28: IP66 Enclosure



1	IP66 enclosure	3	IP66 power inlet
2	IP66 fuse holder	4	Equipment box

CAUTION!

Working with electrical power inside a humid environment (where the incubator is humidified) can be hazardous. The following precautions should be observed:

- **The instrument or equipment, and its external connections, to be used inside the chamber should be specified as suitable for use in a humid environment, and at 37°C (see also "Using Powered Equipment within the Chamber"). If in doubt, consult with the manufacturer of the equipment.**
- **Always ensure the connections are properly and securely made.**
- **Be sure to switch OFF the green illuminated switch on the front left of the incubator before connecting or disconnecting equipment inside the chamber.**

…continued…

- **The Sealing Cap must *always* be in place when the socket is not in use.**
- **Both the incubator and the IP66 enclosure *must* be plugged into an electrical supply protected by an RCD device. Any device chosen must be a self-resetting type which will automatically reconnect power to the incubator as soon as power is restored following a power failure.**

NOTE:
If the incubator is to be used humidified, the normal RH level is ~ 95%, so any electrically powered equipment or device to be used inside the chamber must be designed for use in a humid atmosphere. Consult the manufacturer of the equipment to ensure that it is suitable.

To minimize the thermal gradient within the chamber, the device should be placed on the bottom shelf. The heat dissipated by the equipment should be as low as possible to minimize thermal disturbance to the chamber. Some shakers, stirrers etc., have been specifically designed to give a low heat output for use in incubators. The maximum heat that can be dissipated within the chamber is variable, depending on the difference between the ambient and programmed temperatures. If the heat dissipated is too great, the chamber will tend to overheat. If this happens, the control parameters can be adjusted to compensate.

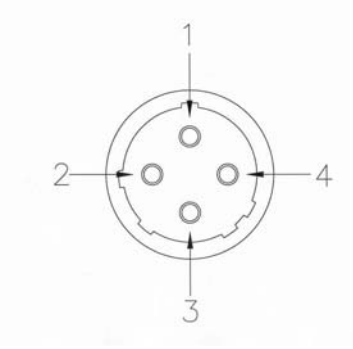
NOTE:
Any heat-generating equipment used inside the chamber will naturally affect the temperature performance of the incubator. For this reason, if you plan to use equipment which may generate heat in the chamber, we recommend equipping the incubator with the optional cooling system (*see Section 8.2*).

Factory testing can be carried out with the specific apparatus to ensure that the control conditions can be met.

To connect to the socket (*see Figure 29 on the following page*) inside the chamber, a power cable with a matching IP66 plug is supplied. This power cable should be fitted by a qualified person to the equipment or device to be used inside the chamber. If the cable cannot be fitted, contact your distributor, giving details of the connectors required, so they can supply a suitable lead.

CAUTION!
The Electrical Socket and the matching plug are both sealed to IP66 and are capable of being heated to 120°C during the High Temperature Disinfection cycle, but the electrical cable is *NOT* rated for use at 120°C. Therefore, the equipment or device and the connecting cable should be removed from the chamber, and the Sealing Cap replaced on the socket prior to starting a High Temperature Disinfection cycle.

Figure 29: IP66 Socket



Pin Connections:

1 Live
2 Neutral
3 Ground
4 Not in use at this time

8.11 Copper Inner Chamber

Copper naturally changes color. This incubator had a bright finish when it was manufactured. The dull finish that you see is a result of oxidation of the copper surface: it is the properties of this oxidation that create the important anti-microbial surface.

8.12 Other Options

Four and eight inner glass door options are available, to match the shelves you choose to install, which help to reduce the loss of CO_2, temperature and humidity conditions when the chamber door is opened.

8.13 Available Accessories

Accessories	NBS Part Number
Two Stage CO_2 Regulator	P0628-5010
Two Stage N_2 Regulator	P0628-7220
CO_2 Supply Line HEPA Filter	P0628-5020
CO_2 In-line Pressure Regulator	P0628-5030
CO_2 Cylinder Auto-Changeover Controller	P0628-5000
Auto-Zero HEPA Filter	P0628-5060
CO_2 Gas Analzyer Kit	P0628-5040
Spare CO_2 Gas Analyzer Tubes	P0628-5050
Electronic CO_2 Gas Analyzer	P0628-6150
Electronic CO_2/O_2 Gas Analyzer	P0628-6631
Electronic CO_2/O_2/Humidity/Temp Analyzer	P0628-6632
Additional Shelf, Perforated	P0628-6251
Additional Shelf, Non-Perforated	P0628-6241
Additional Humidity Pan	P0628-6260
Stacking Kit and Stand	P0628-6270
Stacking Kit with Casotrs	P0628-6490
Spare CO_2 Sensor	P0628-5700
Spare O_2 Sensor	P0628-5790

9 CE CERTIFICATION

New Brunswick
an eppendorf company

CE CONFORMITY CERTIFICATION

DECLARATION OF CONFORMITY

RS Biotech Laboratory Equipment Limited
1 Drummond Crescent,
Riverside Business Park,
Irvine, Ayrshire, KA11 5AN,
Scotland, UK

Declare that the Galaxy 170 R CO_2 incubator to which this declaration relates is in conformity to the following standards:

EN 61010-1: 2001
Safety requirements for electrical equipment for measurement, control, and laboratory use.
Part 1: General requirements.
Class 1, Installation Category II, Pollution Degree 2

EN 61010-2-010: 2003
Safety requirements for electrical equipment for measurement, control, and laboratory use
Part 2-010: Particular requirements for laboratory equipment for the heating of material.

EN 61326-1: 2006
Electrical equipment for measurement, control and laboratory use - EMC requirements.

Following the provision of:

2006/95/EC The Low Voltage Directive
and its amending directives
2004/108/EC The Electromagnetic Compatibility Directive
and its amending directives

This equipment should not be used in a residential area.

Mike King

Managing Director of UK Operations

27th March 2009

10 DRAWINGS & TABLES

10.1 Index of Drawings

10.2 Index of Tables

11 INDEX

P

R

S

T

U

W