# WATER TRIPLE POINT MAINTENANCE BATH MODEL ITL-M-18233

User Maintenance Manual/Handbook

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# CE EMC INFORMATION

This product meets the requirements of the European Directive on Electromagnetic Compatibility (EMC) 89/336/EEC as amended by EC Directive 92/31/EEC and the European Low Voltage Directive 73/25/EEC, amended by 93/68/EEC.  To ensure emission compliance please ensure that any serial communications connecting leads are fully screened.

The product meets the susceptibility requirements of EN 50082-1, criterion B.

| Symbol Identification | Publication | Description |
|---|---|---|
|  | ISO3864 | Caution (refer to manual) |
|  | IEC 417 | Caution, Hot Surface |

# ⚠ ELECTRICAL SAFETY

This equipment must be correctly earthed.

This equipment is a Class I Appliance. A protective earth is used to ensure the conductive parts cannot become live in the event of a failure of the insulation.

The protective conductor of the flexible mains cable which is coloured green/yellow MUST be connected to a suitable earth.

The blue conductor should be connected to Neutral and the Brown conductor to Live (Line).

Warning: Internal mains voltage hazard. Do not remove the panels.

There are no user serviceable parts inside. Contact your nearest Isotech agent for repair.

Voltage transients on the supply must not exceed 2.5kV.

Conductive pollution e.g. Carbon dust, must be excluded from the apparatus. EN61010 pollution degrees 2

## Environmental Ratings

| | |
|---|---|
| Operating Temperature | 5-50°C |
| Relative Humidity | 5-95%, non condensing |

# ⚠ HEALTH AND SAFETY INSTRUCTIONS

1. Read this entire manual before use.

2. Wear appropriate protective clothing.

3. Operators of this equipment should be adequately trained in the handling of hot and cold items and liquids.

4. Do not use the apparatus for jobs other than those for which it was designed, i.e. the calibration of thermometers.

5. Do not handle the apparatus when it is hot (or cold), unless wearing the appropriate protective clothing and having the necessary training.

6. Do not drill, modify or otherwise change the shape of the apparatus.

7. Do not dismantle the apparatus.

8. Do not use the apparatus outside its recommended temperature range.

9. If cased, do not return the apparatus to its carrying case until the unit has cooled.

10. There are no user serviceable parts inside. Contact your nearest Isotech agent for repair.

11. Ensure materials, especially flammable materials are kept away from hot parts of the apparatus, to prevent fire risk.

12. Ensure adequate ventilation when using oils at high temperatures.

# GUARANTEE



This instrument has been manufactured to exacting standards and is guaranteed for twelve months against electrical break-down or mechanical failure caused through defective material or workmanship, provided the failure is not the result of misuse.

In the event of failure covered by this guarantee, the instrument must be returned, carriage paid, to the supplier for examination and will be replaced or repaired at our option.

FRAGILE CERAMIC AND/OR GLASS PARTS ARE NOT COVERED BY THIS GUARANTEE INTERFERENCE WITH OR FAILURE TO PROPERLY MAINTAIN THIS INSTRUMENT MAY INVALIDATE THIS GUARANTEE

The company is always willing to give technical advice and assistance where appropriate.  Equally, because of the programme of continual development and improvement we reserve the right to amend or alter characteristics and design without prior notice.  This publication is for information only.

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# ⚠ CAUTIONARY NOTE

ISOTECH PRODUCTS ARE INTENDED FOR USE BY TECHNICALLY TRAINED AND COMPETENT PERSONNEL FAMILIAR WITH GOOD MEASUREMENT PRACTICES.

IT IS EXPECTED THAT PERSONNEL USING THIS EQUIPMENT WILL BE COMPETENT WITH THE MANAGEMENT OF APPARATUS WHICH MAY BE POWERED OR UNDER EXTREMES OF TEMPERATURE, AND ARE ABLE TO APPRECIATE THE HAZARDS WHICH MAY BE ASSOCIATED WITH, AND THE PRECAUTIONS TO BE TAKEN WITH, SUCH EQUIPMENT.

# GENERAL INFORMATION

## *SYSTEM DESCRIPTION*

The Water Triple Point Bath is designed to provide an environment in which up to four Water Triple Point Cells can be maintained for use as primary standards of temperature. The life of the ice mantle in a triple point cell is dependent upon the initial geometry of the mantle, the use of the cell and the temperature of its environment. The bath has sufficient stability to maintain a mantle for six weeks or more, provided that the cell is not thermally overloaded.

The bath contains about 34 litres of water which is agitated with air supplied by a pump located on the controller chassis. The temperature of the water is maintained at 0.010°C by four thermoelectric cooling modules. The current through the cooling modules is controlled by a proportional controller which uses a precision, high stability, thermistor probe to sense bath temperature.

The cooling system has sufficient cooling capacity to bring the bath to operating temperature from 25°C in about two days. The limited cooling capacity provides some protection for the cells in case of control failure, since the water in the bath would freeze only very slowly. Additional protection is provided by a fault detection system which is triggered if either of the cooling surfaces drops below a preset limit or by the formation of ice on the cooling surfaces of the bath. Triggering of either fault detector will, after a built-in delay, activate the fault alarm and remove power from the coolers until the system is reset by turning the power switch off and back on.

## *SPECIFICATIONS*

| | |
|---|---|
| Size: | 910mm high, 635mm wide, 710mm deep |
| Weight: | Approximately 66kg dry |

**Acceptable Ambient Conditions:**

| | |
|---|---|
| Operating: | Temperature 15°C to 26°C; relative humidity 10% to 80% |
| Storage: | Temperature -30°C to 55°C; relative humidity less than 85% |

**Power Requirements:**

115/230v AC, 50/60 Hz, 150 VA max

| | |
|---|---|
| Bath Fluid: | De-ionised water, approximately 34 litres (7½ gal) |
| Bath Temperature: | 0.010°C nominal (adjustable<br>-0.5°C to +0.5°C, approximately)<br>±2mK/month |

# OPERATING INSTRUCTIONS

## *INSTALLATION*

### Location

The typical industrial standards laboratory provides an environment suitable for the bath, which is designed to operate at an ambient temperature between 15 and 26°C, in air that is relatively free of particulate material (particularly soluble salts) and soluble or corrosive gases such as ammonia or sulphur dioxide. The clearance necessary for cooling air to circulate through the back of the cabinet is provided by the extended frame around the air filter. This frame may be placed directly against a wall as long as the lower opening is not obstructed. The cabinet is equipped with castors so that it may be moved easily; however, care must be taken to avoid splashing water out of the bath. Power requirements need no special consideration; maximum power consumption is 150VA, and interruptions of a few minutes will not affect the condition of the cells because of the large thermal inertia of the bath.

### General Layout

*Figure 1. Front View:*

1. Cell Access
2. Lid
3. Name Plate
4. Control Facia
5. Precool Pocket
6. Handle

*Figure 2. Rear View:*

1. Air Filter
2. Identification Plate
3. Power Entry
4. Fan Socket
5. Tank Power Socket
6. Air Adjust
7. Air Output
8. Alarm Right Sensor
9. Alarm Left Sensor
10. Controller Sensor

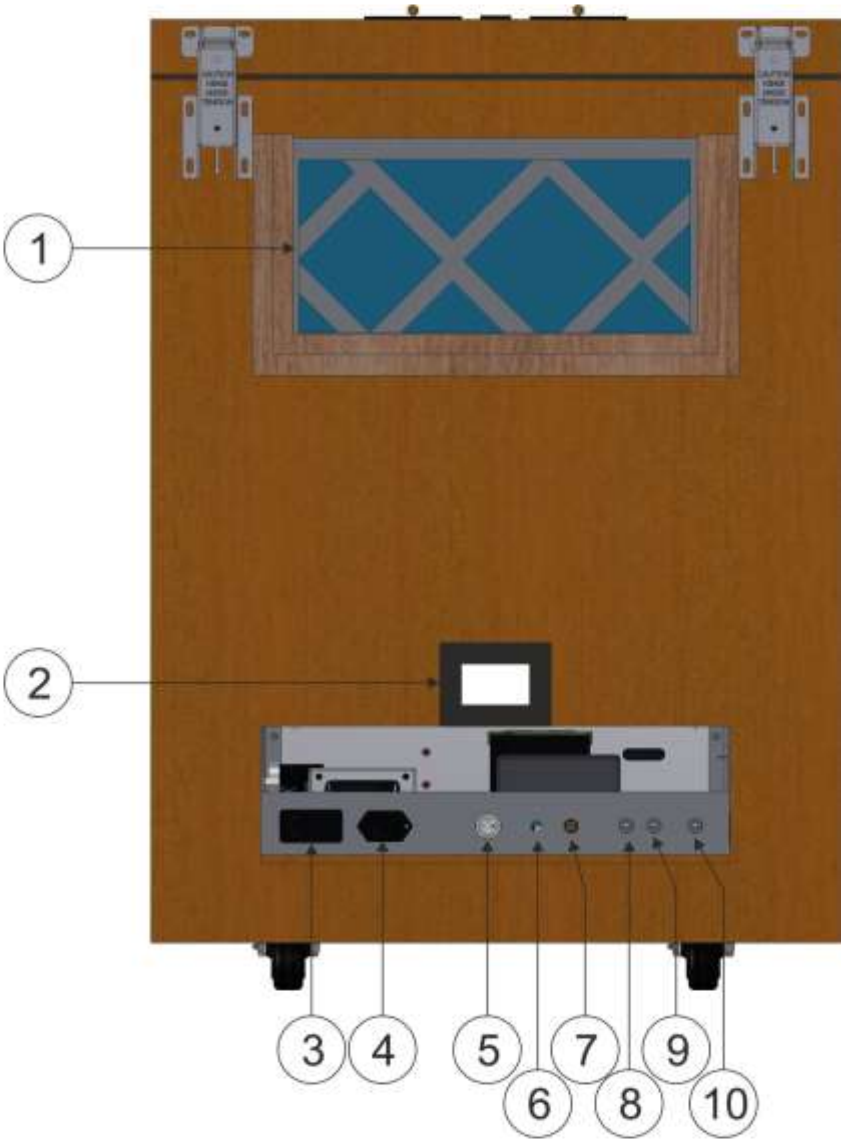
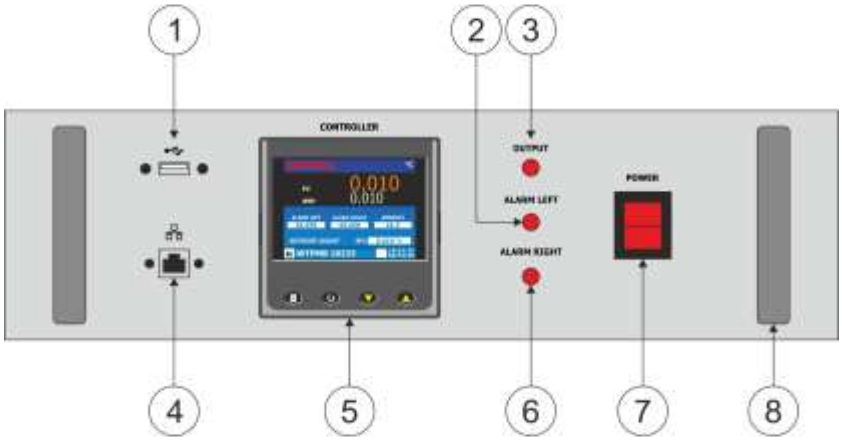



*Figure 3. Control Panel:*

1. USB Port
2. Alarm Left Beacon
3. Output Beacon
4. Ethernet
5. Controller
6. Alarm Right Beacon
7. Power Switch
8. Handles



## Start Up

1. Visually inspect the system to ensure that it has not been damaged in transit.
2. Connect the mains cable to a suitable supply socket outlet and turn the power switch on. The alarm sounder will operate momentarily while the controller boots up.
3. Fill the tank to the top of the cell holder tubes with clean, de-ionised water.
4. Monitor the water temperature. The temperature should drop about 0.6°C per hour from 20°C. Do not use ice, this will increase the risk of forming ice mantles on the sides of the tank.
5. Monitor the controller display to check for descent to temperature and when the bath is ready for use.

# *OPERATION*

Six openings are provided in the lid of the bath. The two small openings permit access to the thermometer pre-chill tubes and the four large openings permit access to the cells. The large openings should be kept closed with the split-plugs provided (these have thermometer channels so that closure may be maintained during use). The bath does not have sufficient cooling capacity to operate with the top open to ambient air.

The water level in the bath should just cover the top of the main body of the cells. Whenever the number of cells kept in the bath is changed, the water level should be adjusted to compensate. The water level and air filter should be checked weekly and maintained correctly. See Maintenance.

Some micro-organisms are capable of growing in water near 0°C. Cloudy water and/or slimy surfaces in the bath may indicate such growth. See Maintenance.

***Due to the long cool down time we recommend that the bath is left running continuously; this maximises the life of the bath.***

Internal trips and temperature alarms protect the system and running costs are very low. We do not recommend powering the bath up then down for short periods of operation.

# USING THE CONTROLLER

The controller installed on this equipment uses an advanced three loop controller with a multi-channel sensor input.

Other features of the controller are:

- Built in data logging
- Ethernet connection
- USB host for controller updates and data export
- Bright colour display
- Dynamic optimisation of the control PID parameters

Before using the controller, please read this manual thoroughly to get the best performance from the equipment.

Certain features used in this controller require different levels of access. The Operator access requires no passcode to use. These functions include:

- Changing the setpoint
- Changing any values using the USER ACCESS PAGE (figure 7)

Other features will require the user to log in as “Supervisor” to carry out these functions. These include:

- Adjusting the PID settings
- Extracting data from the recorder function

Configuration changes to the controller require you log in as “Engineer” to perform these functions. These include:

- Change language selection
- Change °C to °F or K
- Change equipment clock and time zone

# THE ISOTECH SPLASH SCREEN AND CONTROLS

Figure 4. The **USER INTERFACE** start up screen and controls:

1. **ISOTECH** splash screen
2. **PAGE** button
3. **SCROLL** button
4. **DOWN** button
5. **UP** button

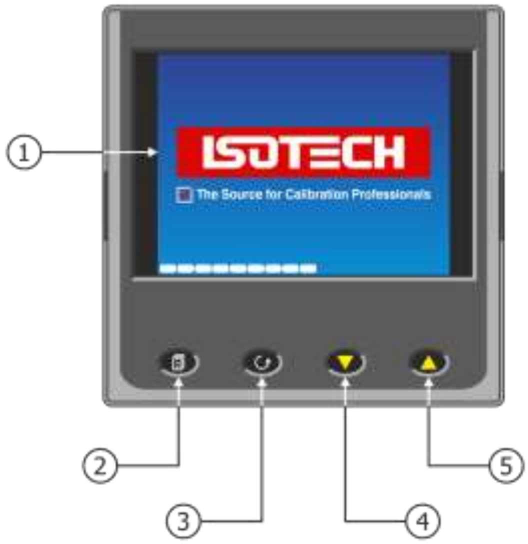
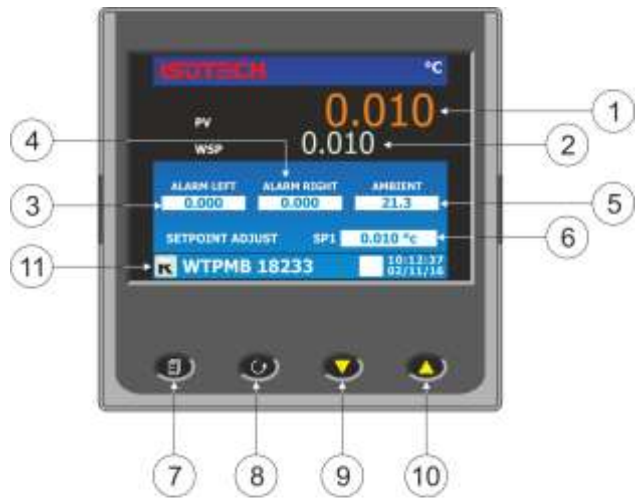



Figure 5. The **HOME** page:

1. Water temperature
2. Setpoint
3. Left alarm sensor value
4. Right alarm sensor value
5. Ambient temperature
6. Setpoint adjust box
7. **PAGE** button
8. **SCROLL** button
9. **DOWN** button
10. **UP** button



## *HOW TO LOG IN AS THE SUPERVISOR*


Figure 6

1. Press the Page button to display the Home menu
2. Scroll to LOG IN
3. Press the SCROLL button
4. Press up to scroll to SUPERVISOR in dialogue box
5. Press the SCROLL button to prompt for a passcode
6. Select code **15** from the soft keyboard
7. Press PAGE button to prompt to accept the changes
8. Select Yes and enter with SCROLL button to display the SUPERVISOR screen (figure 9)
9. When logged in as the SUPERVISOR the equipment will control in the normal way

## *HOW TO LOG IN AS THE ENGINEER*

1. Press the Page button to display the Home menu
2. Scroll to LOG IN
3. Press the SCROLL button
4. Press up to scroll to ENGINEER in dialogue box
5. Press the SCROLL button to prompt for a passcode
6. Select code 17 from the soft keyboard
7. Press PAGE button to prompt to accept the changes
8. Select Yes and enter with SCROLL button to display the ENGINEER screen (figure 9)
9. When logged in as the ENGINEER, the equipment will <u>not</u> control the temperature of the heat source

Figure 7. The **USER ACCESS** page:

1. Proportional band
2. Integral time
3. Derivative time
4. Control sensor Alarm Low value
5. Control sensor Alarm High value
6. Left side Alarm value
7. Right side Alarm value
8. Alarm Reset
9. Units
10. Fixed offset value


## *CHANGING THE SET POINT*

### To change the setpoint of the equipment

1. From the ISOTECH homepage, press the SCROLL button once, this will highlight the SETPOINT ADJUST box.
2. Press the SCROLL button once more and this will allow adjustment of the setpoint via the UP/DOWN buttons.
3. Scroll to the desired set point as described above.
4. When the temperature is set, press the SCROLL button again to enter and save the setting.
5. The equipment will now raise or lower the furnace temperature as required.

### How to  change from °C to °F or Kelvin

1. Scroll to the USER ACCESS page
2. Scroll to UNITS
3. Highlight value
4. Scroll to UNITS
5. Scroll to °C, °F or Kelvin
6. Enter the value with Page key

*# HOW TO USE THE ALARMS AND ADDITIONAL SAFETY FEATURES OF THE CONTROLLER*

This equipment has several alarm features built in to facilitate the safety of the Water Triple point cells contained within. In almost all conditions the controller will reset the set point to a safe value to ensure the integrity of the cell(s) and to prevent the freezing of the water within the cell(s). The alarm trigger values are accessible within the USER ACCESS LIST and can be adjusted by the user. ***However, care should be taken not to set the values too far and to render the safety circuit unresponsive.***

## Control sensor alarms:

For the safety of the installed Water triple point cells, there are several safety features built into the equipment. The control sensor has two discrete alarms for the protection of the water temperature inside the tank.

**Under temperature alarm** – in the event of the water in the tank dropping below the user defined value (User Access List) the controller will illuminate both the LEFT and RIGHT alarm LEDS simultaneously. If no remedial action is taken within 20 minutes, the audible sounder will begin and the controller will reset the set point to +5°C to allow the water to warm to a safe condition.
**Over temperature alarm** – in the event of the water in the tank rising in temperature in excess of the user defined value, either as a result of the lid being left open or other reasons. Both the LEFT and RIGHT alarm LEDS will illuminate simultaneously. If no remedial action is taken within 5 minutes then the audible sounder will begin and controller will reset the set point to 5°C to allow the water to warm to a safe condition.

## Left and Right side alarms for under temperature protection:

The heat is conducted from the water by means of the thermoelectric heat pumps on the sides of the tank assembly. Inside the assembly are built two temperature sensors, one on the left and one on the right. These are for safety in the event of the sides of the tank drop in temperature beyond the freezing point of the water and create ice mantles on the side of the tank.

If the temperature drops below the user defined value (USER ACCESS LIST) then the corresponding side LED alarm will illuminate. If no remedial action is taken within 20 minutes then the audible sounder will begin and the controller will reset the set point to 5°C.

## In the event of an alarm condition:

In the event of an alarm condition and remedial action is taken within the given time, i.e. the sounder cannot be heard but the LEDs are illuminated. Under these circumstances the equipment will reset automatically and the function will carry on as normal.

If the sounder has begun and the controller has reset the temperature, this means that the user will need to ensure the reason for the trigger has been resolved and the bath is safe. Please ensure there is no ice mantle on the side plates of the tank and that the Water Triple point cells are safe with no ice bridge present within the cell.

## What happens next:

When the bath is deemed safe for a reset, scroll to the USER ACCESS page.

Press Scroll button to access the list and scroll down to ALARM RESET. Highlight the value and scroll to YES and enter the value. The alarm will now be reset, the sounder will switch off and the controller will reset the set point to the last known value.

## How to apply a fixed offset to the control sensor to compensate for temperature errors:

In the event of that the controller display value is in error to the actual temperature of the water inside the tank, there is an OFFSET feature to enable the adjustment of the value to correct for this.

To apply an offset value to the Controller display value, scroll to the USER ACCESS page. Access the list and scroll to the OFFSET feature. Open the setting and a soft keyboard will open. Enter the correct correction value and enter the value with the page button. Exit from the page back to the HOME page and the correction will now be visible.

## If the bath becomes unstable:

This bath will control the water inside the tank within a very small stability band of better than +/- 0.002°C. In the event of the bath becoming unstable, there are the controller PID settings promoted to the USER ACCESS PAGE (Proportional band, Integral Time and Derivative time) to allow the adjustment of the stability band.

**Please note: An understanding of PID temperature control is required to adjust these settings. Any adjustment is made entirely at the user risk.**

## Ambient temperature indicator:

The controller display has an ambient temperature value. This displays the ambient temperature within the controller case. This is particularly useful for diagnostic purposes in the event of control stability issues or alarm "nuisance" tripping. Due to the very stable nature of the temperature control, the bath is sensitive to rapid changes in environmental temperature and this feature allows the recording of the ambient to ensure easy diagnostics in the future.

## *HOW TO CHANGE THE DATE AND TIME OR THE LANGUAGE OF THE EQUIPMENT:*

The Date and time of the equipment can be changed to suit local time. This can also incorporate the any daylight saving time in the time zone of your country or region. The display language of some of the display screens can also be change to suit the local language.

The options for this are:

- English
- French
- German
- Italian
- Spanish

Note: Only the Supervisor and Engineer menus will read in the alternative language. The Isotech Home screen will still read in English when this feature is used.

## *TO CHANGE THE DATE AND TIME OR LANGUAGE:*

- To access these features you will need to log in as the Engineer.
- When logged in, scroll to the INSTRUMENT tab on the Engineer homepage
- Press the SCROLL button to enter
- Scroll to CLOCK and enter by pressing SCROLL button
- Alternatively scroll to LOCALE and enter by pressing SCROLL button
- Adjust as necessary and exit engineer mode

## THE NETWORK INTERFACE:

Access to the NETWORK interface is available when logged in as the ENGINEER. This will allow adjustment to various network parameters, should they need to be adjusted.

This menu allows writeable access to:

- IP type (FIXED or DYMAMIC)
- IP address
- Subnet Mask
- Gateway

and Read only access to:

- MAC address
- Client identifier

## TO ACCESS THE NETWORK INTERFACE:

1. Log in as the ENGINEER
2. From the ENGINEER page scroll to NETWORK tab and enter with the SCROLL button
3. Scroll to INTERFACE and enter with the scroll button
4. Scroll to and adjust desired parameter using the pop out soft keyboard

## DATA LOGGING:

The equipment will always record data for all four channels UNLESS the equipment is in ENGINEERING mode. This is indicated by the green R in the bottom left had side of the ISOTECH homepage.

The data can either be extracted via the USB socket on the front panel or to a PC by means of the FTP protocol (Remote Archiving) using REVIEW software, see page 31 for details.

To back up the data via USB stick on the control panel use the following procedure:

1. Log in as the SUPERVISOR
2. Plug a suitable USB memory stick to the socket on the control panel (Figure 1, item 6)
3. Ensure the controller has accepted the memory stick by the icon in the lower left of the ISOTECH homepage (figure 3)
4. Press the page button to scroll to the SUPERVISOR menu
5. Scroll to DEMAND ARCHIVING
6. Scroll to ARCHIVE TO and enter, select USB from the options and enter
7. Scroll to ARCHIVE and select from:
   a) Bring to date
   b) All
   c) Last month
   d) Last week
   e) Last day
   f) Last hour
   g) None

8. When the selection is entered by pressing the SCROLL button, the transfer will begin (this may take several minutes depending on the selection made)
9. When the transfer is complete, remove the USB stick and exit SUPERVISOR mode

The data will be stored in a folder called HISTORY.

## *FTP SERVER ARCHIVING:*

This allows the archiving of recorder files to a remote computer via the RJ45 type connector on the front panel, either directly or via a network.

In order to carry out a successful transfer:

1. Details of the remote host must be entered in the Network Archive area of configuration
2. The remote computer must be set up as an FTP server. Help from the user's IT department may be necessary in order to achieve this.
3. The remote computer must also be set up to respond to 'pings'. This is because the instrument pings the host whilst establishing connection, if it does not receive a response the archive attempt fails.
4. When accessing files using Microsoft® Internet Explorer, the address (URL) field can be in one of two formats:
5. ftp://<instrument IP address>. This allows a user to log in as the anonymous user if the recorder has any account with the user name set to 'anonymous' with a blank password.
   ftp://<user name>:<password>@<instrument IP address> to log in as a specific user.

For IE5 users, Microsoft® Internet Explorer displays, by default, history files only. To quit the history folder, either uncheck the Tools/Internet Options/Advanced/Browsing/'Enable folder view for FTP sites' option, or check the Tools/Internet Options/Advanced/Browsing/'Use Web based FTP' option.

# MAINTENANCE

## *ROUTINE MAINTENANCE*

Full power is required for about 48 hours to cool the bath from ambient to operating temperature. The controller will normally apply full power for several minutes if water is added to the bath, or if any warm object is placed into the bath. Ice formation on the cooling surfaces will cause the controller to apply full power as the water releases its heat of fusion, eventually resulting in an under-temperature fault as the thermal resistance of the ice layer increases. Failure of the cooling fans or total obstruction of the cooling air will result in a full power condition, which would eventually open one or both of the thermal fuses on the cooling module heat sinks as the bath temperature increases towards ambient.

Check the water level and the air filter weekly. Replace the air filter with a standard 8" x 16" fibreglass "furnace" filter if its clean area is less than 70% of original. A spare is supplied as standard with the bath when new.

Cloudy water and/or slimy surfaces may indicate growth of micro-organisms. The bath may be disinfected by adding about 0.5 litre of household bleach (5% sodium hypochlorite), and leaving it in the bath for a few hours, then changing the water in the bath. Since the bleach is corrosive, all metal surfaces, including the lining of the access holes, should be rinsed with de-ionised water after disinfecting.

## *CALIBRATION*

Calibration of cells is not required since the water triple point temperature is a constant of nature. However, proper adjustment of the bath will optimise the life of the ice mantles in the cells. (See Appendix B for a procedure to verify the integrity of the cell).

# THEORY OF OPERATION

## *REFRIGERATION*

Refrigeration is provided by four thermoelectric modules. These modules are sandwich structures of ceramic, copper and semiconductor material. They use the Peltier effect of the semiconductor material (bismuth telluride) to produce a current-dependent heat pumping action. Each thermoelectric module is mounted between a heat sink and an aluminium block. Two of these assemblies are mounted to an aluminium plate attached to the lower part of each side of the stainless steel tank. The cooled area of each side is about 230 by 280mm (9" x 11"). The tank is embedded in moulded foam insulation which has been formed to provide air channels over the heat sinks and across the bottom to the fans located near the centre of the horizontal panel that supports the tank assembly. The cooler circuit has two thermal fuses in series with the four modules to protect the system in case of fan failure. Each fuse is mounted on one heat sink on each side of the tank assembly. Current through the thermo-electric modules is regulated by the controller circuitry.

Three precision thermistor probes monitor the temperature of the tank and the water. Two of these probes are inserted into wells from the rear of the tank assembly. (They are accessible through the air filter opening and monitor the tank wall temperature at the tops of the cooling plates). These probes are connected to the fault detector circuits. The other probe is the main control probe and is mounted to the top panel of the tank assembly such that it extends down into the water in the bath.

## *REPAIR PROCEDURES*

Troubleshooting and repair procedures are generally straightforward for an experienced technician. Isotech personnel are available to answer any question that might arise. The following information might, however, prove useful.

## *CONTROLLER REMOVAL*

The control assembly houses the system power supply, the controller and fault detector circuits and the stirring air pump. Remove the controller from the cabinet as follows:

1. Make sure power is disconnected.
2. Make sure the three probe cables at the right-hand end of the controller rear panel are labelled to match the panel labels.
3. Disconnect the two fan power plugs, two "Cinch" connectors, air hose and three probe connectors from the rear panel of the controller.
4. Remove the four screws holding the control front panel to the cabinet.
5. From the rear of the cabinet, lift the rear of the controller slightly upwards and replace the controller forwards until the front panel projects from the cabinet opening.
6. Remove the controller from the front of the cabinet.

## *AIR PUMP REPLACEMENT*

1. Make sure that power is disconnected and remove the controller from the cabinet as described above.
2. Remove four nuts holding the pump plate shock mount brackets to the chassis studs.
3. Replace the defective pump.
4. Remount the pump assembly, and re-install the controller in the cabinet.
5. Test pump operation, and adjust the flow control (R5) for the lowest air flow rate that reliably maintains air flow through all of the holes in both stirring tubes.

## *LINE VOLTAGE CONVERSION*

1. Make sure that power is disconnected, and remove the controller from the cabinet as described above.
2. Remove the clear plastic insulator at the right rear of the controller.
3. To convert from 115V to 230V, remove the two jumpers between terminals 1 and 2, and between terminals 4 and 5 from the terminal strip, and install one jumper from terminal 2 to 4. Replace the 1½ A fuse with a 750mA fuse, and change the labelling.

   To convert from 230V to 115V, remove the jumper between terminals 2 to 4 from the terminal strip, and install two jumpers one between terminals 1 and 2, and the other between terminals 4 and 5. Replace the 750mA amp fuse with a 1½ A fuse, change the labelling, and change the mains cable and/or plug as required.
4. Replace the clear plastic insulator.

## *TANK ASSEMBLY REMOVAL*

The only individually replaceable parts on the tank assembly are the sensors and the thermal fuses that protect the cooling modules in cases of fan failure. The tank assembly may be removed as follows:

1. Make sure that the power supply is disconnected.
2. Remove the lid, **(CAUTION: SPRING LOADED HINGES)**. With the lid in the closed position, remove the three screws holding the lower section of each hinge to the cabinet.
3. Remove the water from the tank. (A small submersible pump is convenient)
4. Remove the access panel (held by two screws) directly above the lower opening at the rear of the cabinet.
5. Disconnect the 3 pin connector, air hose and three probe cables from the rear panel of the controller and assure that they are not tangled or snagged.
6. Remove first the cushioning strips and then 16 brass wood-screws holding the top panel of the tank assembly to the cabinet.
7. Secure the cabinet so that it cannot move, and push the tank assembly to one side until the opposite edge of the top panel can be grasped. Lift the tank assembly vertically upwards by the side edges of the top panel.

   **NOTE:** Do not lift by the corners of the panel, as the bond between the panel and the insulation might be damaged.

## *THERMAL FUSE REPLACEMENT*

Thermal fuses are attached to the top of one heat sink on each side of the tank assembly.

1. Remove the tank assembly from the cabinet as described above.
2. Test each thermal fuse with an ohmmeter. The normal resistance is only a few milliohms.
3. Unsolder the connections at each end of the defective thermal fuse.
4. Carefully cut the silicone rubber that holds the thermal fuse to the heat sink. Be careful to avoid damage to the insulation behind the thermal fuse.
5. Ensure that the replacement 60 C thermal fuse is wrapped with a layer of thin Kapton or Mylar tape to insulate it electrically from the heat sink.
6. Place two solid copper alligator clips on each lead of the thermal fuse, one adjacent to the body, and the other about 6mm (¼") away (these serve as heat sinks during soldering).
7. Quickly solder the connections to the new fuse.

   **NOTE:** Slow soldering, or the absence of heat-sinks, can cause the fuse to melt.
8. Bend the leads of the fuse so that it is positioned against the top edge of the heat sink, and cement it in place with non-corrosive, single part, silicone rubber (Dow Corning RTV 3145 or equivalent).
9. Check the cooler circuit with an ohmmeter (resistance should be about 8 ohms) before re-assembling the bath.

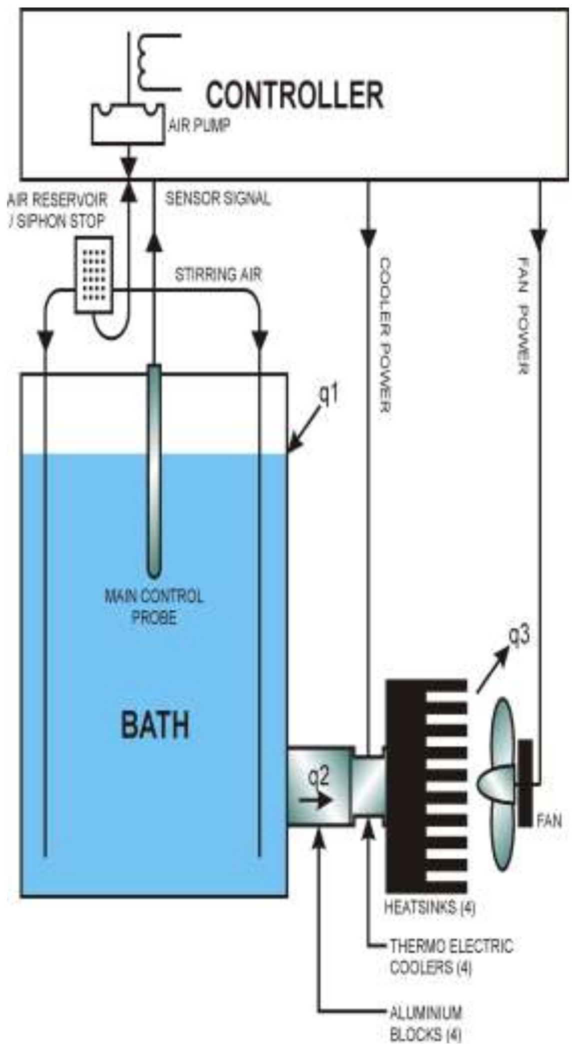
## *FAN REPLACEMENT*

To replace either of the two fans:

1. Remove the controller from the cabinet as described above.
2. Remove four thumb-screws holding the fan support to the top of the controller compartment and remove the support with fan attached.
3. Detach the fan from the support (4 screws).
4. Mount the new fan to the support and re-attach the assembly to the top panel of the controller compartment.

## Refrigeration Diagram

Figure 8.




q1 = Rate of heat flow from ambient to the bath.
q2 = Heat flow from the bath to the four thermo electric coolers.

(This is the same rate of heat flow as q1, but at about 0°C).

q3 = Heat flow from the heat sinks to ambient. (This is equal to q2 + P, where P is the electrical power used to drive the thermo electric heat pumps).

# APPENDIX A: AN INTRODUCTION TO THE WATER TRIPLE POINT

The International Temperature Scale of 1990 (ITS 90), the scale most used in science and industry, is defined by a series of fixed points. Defining fixed points are two-phase or three-phase equilibria of ideally pure materials to which temperature values are assigned. These values are derived from fundamental methods of thermometry and are considered to be exact by definition. Two-phase equilibria may be solid-liquid, liquid-vapour, or solid-vapour. All are pressure-dependent, at least to some extent, with those involving the vapour phase having much larger pressure coefficients than solid-liquid equilibria. Equilibria in which all three phases are present (triple points) define fixed temperatures, the pressure is, in each case, uniquely defined by the simultaneous existence of all three phases of one material in the absence of other influences (the vapour pressure of the material in the containing vessel will be negligible as will be its dissolution in the thermometric material).

Of all defining fixed points, the triple point of water (the equilibrium point of liquid and solid water under its vapour pressure) is the most important for both theoretical and practical reasons.

1. The triple point of water is the single defining point of the Kelvin Thermodynamic Temperature Scale (KTTS) on which ITS-90 is based and is the accepted reference temperature for SPRT characteristics.
2. The triple point of water is, at present, the most accurately realisable of the defining fixed points. Properly used, it is not difficult to realise the temperature of the triple point, 0.01°C, with an accuracy of ±0.0001°C. (To put this in context, it is difficult to prepare and use an ice bath with accuracy of better than 0.002°C).
3. Computer-interpolated calibration printouts which accompany an SPRT provide tables of temperature versus the ratio of resistance of the thermometer at that temperature to its resistance at the triple point of water:

   $W(t°C) = R(t°C)/R(0.01°C)$

   For measurements of the highest precision, proper technique for use of an SPRT is as follows:-

   a) Measure the thermometer resistance at temperature required.
   b) Measure the thermometer resistance at the water triple point.
   c) Calculate the ratio by dividing (a) by (b).
   d) Find the temperature in the table corresponding to this ratio.
4. The water triple point is relatively inexpensive to acquire, and the equilibrium can be maintained for long periods with a minimum of effort.
5. The water triple point is an excellent check and quality assurance control on SPRT's and other thermometers. If a thermometer resistance remains constant at the water triple point, it is probably in calibration at all temperatures within its range.

We at Isothermal Technology Limited, Southport, manufacture a range of Water Triple Point Cells which are designated as A11 (11mm bore) with McCleod gauge and B12 (with 12mm bore).

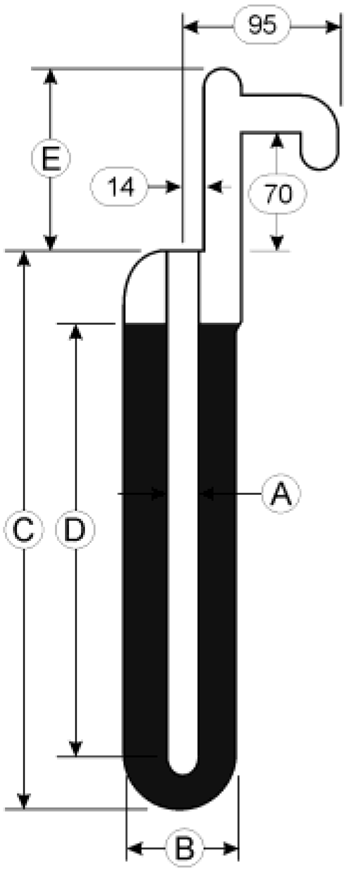
The illustration overleaf shows the configuration and dimensions of cells available from Jarrett-Isotech.

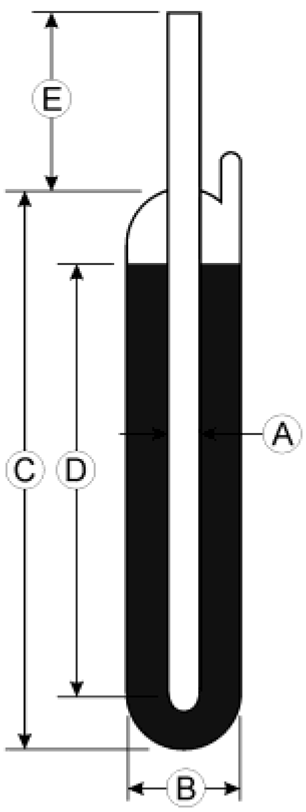
The Isotech Water Triple Point Bath, as furnished, will accommodate A-11 (11mm bore) and A-13 (13mm bore) cells; the cell holding tubes will accommodate B11/65; B13/65 and B16/65 cells with modification of the top bushing and bottom plug. Please call Isotech for information on special cell holders.

# PHYSICAL FEATURES

**Type A cells** were designed by Dr. H. F. Stimson at NBS. A tubular glass extension at the top of the cell serves as a convenient handle for lifting and carrying the cell, as a hook for supporting it in an ice bath, and as an indicator of partial pressure of air in the cell.

**Type B cells** were designed at NRC of Canada. The thermometer well extends 100mm above the top of the cell. Heat transfer to the ice mantle may be essentially eliminated by keeping these cells packed in ice to the top of the well extension, or by immersing them sufficiently in a Water Triple Point Maintenance Bath.




| | *Nominal Dimensions in mm* | | | | | |
|---|---|---|---|---|---|---|
| **Model** | **A** | **B** | **C** | **D** | **E** | **Comments** |
| A11-50-270 | 11 | 50 | 350 | 270 | 100 | Highly recommended (1) (2) |
| A13-50-270 | 13 | 50 | 350 | 270 | 100 | Large re-entrant tube |
| B8-30-130 | 8 | 30 | 160 | 130 | 0 | Was D8, Ideal for Isocal-6, NPL type 16 |
| B12-40-210 | 12 | 40 | 290 | 210 | 75 | Replacement NPL type 32 |
| B12-46-210 | 12 | 46 | 290 | 210 | 75 | Fits Oceanus, Hydra, was C12 |
| B11-50-270 | 11 | 50 | 350 | 270 | 100 | Highly recommended (1) (2) |
| B11-65-270 | 11 | 65 | 350 | 270 | 100 | NRCC's favourite Cell (2) |
| B13-65-270 | 13 | 65 | 350 | 270 | 100 | Large re-entrant tube |
| B16-65-270 | 16 | 65 | 350 | 270 | 100 | Larger re-entrant tube |

# PERFORMANCE

## Accuracy

The equilibrium of the Jarrett Triple Point of Water Cell is guaranteed to be within +0.000,00 and -0.000,04°C of the triple-point of pure water which has a natural isotopic composition.

## Reproducibility

The equilibrium temperature of a cell will repeat to within ±0.000,02°C of the mean equilibrium temperature.

## Stability

After equilibrium is reached, the temperature of the inner melt of an ice mantle will remain constant to within ±0.000,01°C for as long as the mantle can be preserved (up to 90 days in some instances).

## Life

Soluble impurities in glass slowly diffuse to the surface, are dissolved in the water of a Triple Point of Water Cell and eventually cause a lowering of equilibrium temperature. The glass used in Jarrett cells is subjected to an accelerated ageing process before filling, which increases the effective life of the cell. No detectable change in equilibrium temperature should be expected for the first 8 to 10 years of life. The equilibrium temperature of cells over 12 years old, may lower by 0.0001°C or more.

*(1) Isotopic Analysis is available.*

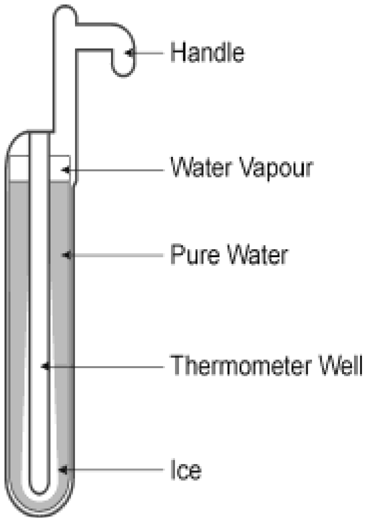
*(2) Available in Quartz Glass.*

*(3) Any Cell described can be supplied with a UKAS Certificate.*

*(4) A range of apparatus is available to create and maintain the cells.*

# APPENDIX B: TRIPLE POINT CELL OPERATION

Figure 9. The illustration below shows a water triple point cell (Jarrett Type A).




The ice mantle may be frozen in one of several ways. The procedure for the most common of these ways is as follows:

1. Pre-chill the cell in a bath of ice and water or in the Isotech Triple Point Bath.

   **NOTE:** The large thermal mass of a cell, coupled with the limited cooling capacity of the bath, will produce a significant disturbance in bath temperature when a cell is cooled from ambient temperature in the bath. Therefore, if the bath contains an operating cell, the cell to be frozen should be cooled to about 4°C in an ordinary refrigerator before putting it into the bath. If a room-temperature cell is put directly into the bath, the thickness of the mantle at the bottom of an operating cell may be reduced by about 1mm.

2. Carefully invert the cell to drain the thermometer well.

   **CAUTION - Tilt the cell very carefully through the horizontal; the flowing of water from one end of the cell to the other will cause vapour bubbles to collapse and reform. The collapse of vapour bubbles produces a sharp clicking sound, and the glass can be broken if the water is moving rapidly.**

3. Fill the thermometer well with alcohol and drain it again to remove the remaining water.
4. Put several drops of alcohol into the well (so that it contains about 1ml). (The alcohol serves as a heat transfer fluid during the freezing of the mantle).
5. There are various techniques for coating the ice mantle in the cell; Isotech recommends the use of the heatpipe apparatus model 452 which uses either solid carbon dioxide or liquid nitrogen. Ask for details.
6. Whichever method you decide to use, continue to form the ice mantle until sufficiently thick, usually 4 to 10mm. The ice mantle may be made as thick as desired, with the caution that, because of the circular cross-section of the cell and the refractive index of water, the mantle appears larger than its actual size, and incremental growth of a thick mantle is difficult to observe. If the mantle grows so that it impacts the inside diameter of the outer tube, the glass may be broken. The actual size of the mantle may be observed by gently inverting the cell.
7. During the process of freezing the mantle, care should be taken to see that an ice bridge does not form between the thermometer well and the outer tube at the top of the water column. Such a bridge can break the glass. If a bridge begins to form, warm the water locally by holding it with the hand to melt the ice bridge.

   ***Isotech assumes no responsibility for the breakage of cells due to excess ice.***

8. When the well is free of dry ice, remove as much of the alcohol as possible, and place the cell in the Isotech Triple Point Bath. At this time, an inner melt may be formed as described below; however, the temperature of the cell may be as much as 0.0005 Kelvin below 0.01°C, due to stress in the newly formed ice mantle. A rest in the bath of 24 hours will relieve this stress and realise the correct temperature.

During use, whilst the frozen cell is maintained in the bath, it is prudent practice to examine the cell at intervals of several days to assure that (1) no ice bridge is formed and (2) the mantle is not even growing close to the inside of the outer wall of the cell.

The water triple point equilibrium can be maintained in the Isotech bath for long periods of time, depending upon the frequency of use and the heat added to the cell by inserted thermometers.
The ice mantle may be conveniently viewed by holding the cell at an angle in the open central portion of the bath so that the water in the bath compensates for refraction at the cell's cylindrical surface.

To measure a thermometer at the water triple point, the following is recommended:

1. Remove a cell from the bath.
2. Initially free the ice mantle by inserting a room temperature glass, quartz or aluminium rod, or a thermometer, for a few seconds. The purpose is to melt a film of water, the "inner melt", between the outside of the thermometer well and the ice mantle. When an axial twist of the cell causes the mantle to spin freely, the cell is ready for use.

   **CAUTION - On no account attempt to axially twist the cell unless the mantle is first freed or this can rupture the re-entrant tube of the cell.**

   Return the cell to the bath.
3. To prolong the equilibrium as long as possible, it is suggested that any thermometer be pre-chilled before being inserted into the cell. Pre-chill tubes are provided in the Isotech bath for this purpose.
4. During all measurements, and during the entire time the cell is maintained in the bath, the water level should be such that the thermometer well is full of bath water (Type A cell).
5. For those thermometers whose stems can act as pipes for radiant energy, particularly SPRT's with quartz tubes, there is some evidence that minor errors in temperature can be caused by the conductance of radiant energy into the cell. A source of such energy can be laboratory ceiling lights. It is good practice to cover the head of the thermometer and the cover of the bath with an opaque black cloth during measurements.
6. The temperature 0.01°C is defined at the liquid-vapour interface. This is not the location of the thermometer sensing element. Whilst the cell temperature is independent of ambient pressure, it requires correction for the hydrostatic head of the internal water. This correction is $-0.73 \times 10^{-6}$°C for every mm of water column height.

Since the temperature of the cell is defined by its equilibrium, it is not subject to calibration, NBS traceability, or such considerations. The integrity of the cell may be established absolutely as follows. (Note that these instructions refer to a chilled cell whether or not an ice mantle is frozen in it. The phenomena will be less noticeable in a room-temperature cell).

1. Gently invert the cell. As the water column strikes the opposite end, un-cushioned by air, a distinct clicking noise will be heard. This ensures that the cell is free of air. The pressure of water vapour at the water triple point is about 4.6mm Hg.
2. Gently invert the cell so as to capture the bubble of water vapour in the handle. Continue to invert. The bubble will be compressed by the water and will shrink to the size of a small pea or less.

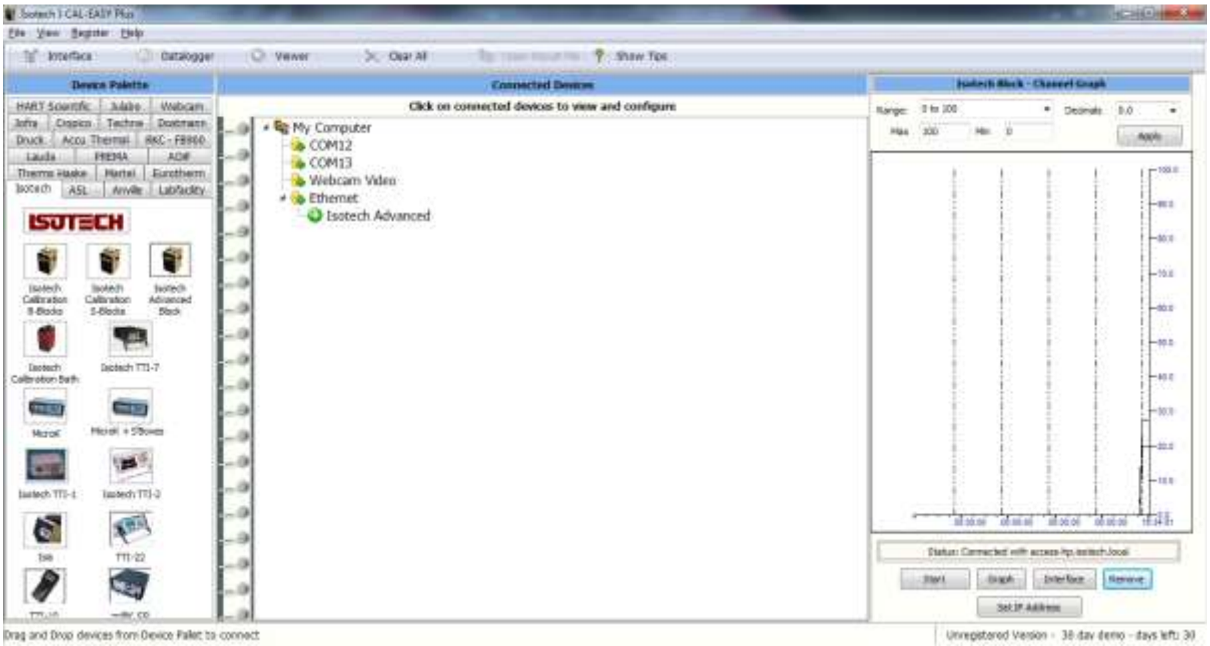
If these tests can be met, the cell is qualified.  If not, there is probably a minute crack in the glass which has admitted air.

Transportation of water triple point cells is a matter for extreme care.  It is preferable to hand carry them in the upright position.  The impact of rapid motion of the water column along the cylindrical axis has been known to break cells.  In any transportation, it is obvious that the cell must be protected from freezing.

# ISOTECH I-CAL EASY

This application allows logging of data from the ADVANCED model. Additionally if a license is purchased it allows for fully automatic calibration including certificate printing and the calculation of coefficients.

Refer to the Isotech I-Cal EASY handbook and help system for more details



# PROGRAM EDITOR

This allows set point programs to be created on a PC and uploaded to the ADVANCED model

Installation instructions are included with the download