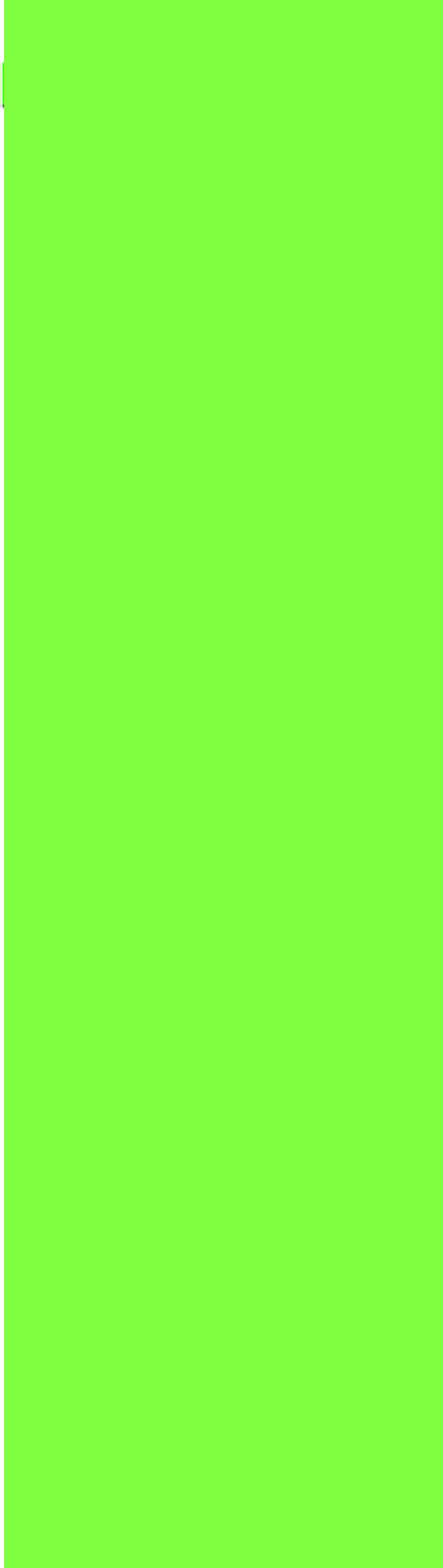




LyoDry Benchtop Pro Freeze Dryer INSTALLATION AND OPERATION MANUAL

**LyoDry Freeze Dryers &
High Vacuum Systems**

**MechaTech Systems Ltd
Thornbury UK**



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MechaTech Part No. LSB85P Operator and Maintenance Manual

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1. Introduction

1.1 Who should use this manual?

This Operator's Manual is intended for anyone trained and authorised to operate the MechaTech LyoDry Benchtop Pro Freeze Dryer

1.2 Scope of this Manual

This manual attempts to cover all the issues that an operator is likely to encounter in normal, daily operation of the system.

1.3 Disclaimer

The purpose of this manual is to provide instructions and guidance for using the LyoDry Benchtop Pro Freeze Dryer. Nothing contained in this manual constitutes a warranty of any kind in respect of the machine or of the results to be achieved by its use. The only warranties given by MechaTech Systems Ltd in respect of any machine are those expressly given by MechaTech Systems Ltd in the contract under which it sells the machine to its buyer.

The information contained in this manual is believed to be accurate as at the date of publication, but MechaTech Systems Ltd gives no guarantees in this respect. Note that it is the operating company's responsibility to ensure that it complies with such regulatory and other legal requirements as may be from time to time apply to operation of the machine.

1.4 Service and Sales Contact

General Sales and Service Contact Information:

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2. Health and Safety

2.1 Safety Warnings in this Manual

Instructions in this manual may require special precautions to ensure the safety of the personnel performing the operations.



Potential safety issues are indicated by this symbol:

Please read the safety information before performing any operation preceded by this symbol.

There are two levels of safety message: **WARNINGS** and **CAUTIONS**. The distinction between the two is as follows:



WARNING

Failure to observe this warning could result in death or serious injury.



CAUTION

Failure to observe this caution may cause minor injury, or damage to equipment.

2.2 General Safety Precautions

Do not operate the machine until you have read the safety precautions below.



WARNINGS

- Failure to follow safe installation and servicing procedures could result in death or serious injury.
- Only authorised personnel trained by MechaTech Systems Ltd and qualified by experience may perform maintenance on the LyoDry Benchtop Pro Freeze Dryer.
- Do not make changes to this equipment of any kind without prior consultation with MechaTech Systems Ltd.
- Please note that international regulations and various safety requirements strictly prohibit the modification of this equipment in any way without first being approved by a competent specialist.
- Some protective covers may not be interlocked, as it is not intended for them to be removed during normal use of the machine.
- Do not attempt to override the safety circuit of the machine in any way. The safety circuit exists to ensure that a hazardous situation cannot arise during the operation of the machine.
- The customer is responsible for fitting and using machine safeguards to protect personnel from becoming trapped or crushed by moving parts of the machine. Failure to do so may cause death or serious injury.

2.3 Health and Safety when using this equipment



WARNING

- The LyoDry Benchtop Pro is heavy. Use suitable lifting equipment to move the LyoDry Benchtop Pro or get someone to help you move it. Do not attempt to lift the LyoDry Benchtop Pro Freeze Dryer on your own.
- Observe your Health and Safety at Work information, and wear suitable Personal Protective Equipment where appropriate.



WARNING

Do not interfere with system safeguards, and make sure that you read, understand and comply with the safety instructions in this manual.

3. Installing the LyoDry Benchtop Pro

3.1 Unpack and inspect

Remove all packing materials and inspect the LyoDry Benchtop Pro. If the LyoDry Benchtop Pro is damaged, notify your supplier and the carrier in writing within three days; state the serial number of the LyoDry Benchtop Pro together with your order number and your supplier's invoice number. Retain all packing materials for inspection. Do not use the LyoDry Benchtop Pro if it is damaged. Check that your package contains the items listed in Table 1 below. If any of these items is missing, notify your supplier within three days.

Quantity	Description	Check
1	LyoDry Benchtop Pro Freeze Dryer	<input type="checkbox"/>
1	Power Cord	<input type="checkbox"/>
1	Condenser Extension Tube	<input type="checkbox"/>
1	Vacuum Pump Connection Hose	<input type="checkbox"/>
1	Nozzle Connector	<input type="checkbox"/>
1	Vacuum Pump Connection Clamp	<input type="checkbox"/>
1	Drain Tube	<input type="checkbox"/>

Table 1 – Checklist of components.

If the LyoDry Benchtop Pro is not to be used immediately, replace the protective covers. Store the LyoDry Benchtop Pro in suitable conditions.

3.2 Locate the LyoDry Benchtop Pro

The LyoDry Benchtop Pro is designed for use on a level floor. Locate the LyoDry Benchtop Pro in its required operating position, ensuring that the floor is adequate to support the equipment, within convenient access to a suitable electrical supply.

We recommend that you leave an air-gap of at least 500mm between all four sides of the LyoDry Benchtop Pro and any wall or obstruction. If you do not leave a sufficient air gap, poor cooling of the LyoDry Benchtop Pro may result in poor performance.

When you locate the LyoDry Benchtop Pro, you should also consider ease of access for maintenance and repair work, when you will need to remove the cover of the LyoDry Benchtop Pro.

3.3 Connecting the LyoDry Benchtop Pro to the electrical supply



WARNING

Failure to refit all panels prior to connecting to mains power may result in injury or death to the operator.

**WARNING**

Ensure that the electrical installation of the LyoDry Benchtop Pro conforms to your local and national safety requirements. It must be connected to a suitably fused and protected electrical supply and a suitable earth (ground) point.

1. Make sure that the LyoDry Benchtop Pro is suitable for use with your electrical supply voltage and frequency.
2. Ensure that the main switch (item 1, figure 2) is on the '0' (off) position.
3. The LyoDry Benchtop Pro is supplied with a two-metre length of 3-core electrical supply cable and a 13A power plug. Connect the plug to the electrical supply.

3.4 Connecting the vacuum pump

3.4.1 General

**WARNING**

If you intend to freeze dry products that contain Sodium Azide, make sure that your vacuum pump and pipeline are suitable for freeze drying these products. If they are not suitable, there is a severe risk of explosion.

**CAUTION**

Exhaust gases must be ducted away from the surrounding atmosphere and suitably disposed of.

**CAUTION**

Do not obstruct any vacuum pump exhaust port (refer to manufacturer's manual before operation).

**CAUTION**

You must use a two-stage pump with the LyoDry Benchtop Pro. If you do not, the pump will have a very short working life.

Connect your vacuum pump to the vacuum pump connector on the front of the LyoDry Benchtop Pro. The connector is suitable for use with a 10 mm inside diameter pipeline.

It is recommended that an Edwards model RV5 or RV8 vacuum pump is used with the LyoDry Benchtop Pro. This pump is suitable for freeze drying products which contain sodium azides. To connect an Edwards RV5 or RV8 pump to the LyoDry Benchtop Pro, please see below.

If you do not use an Edwards vacuum pump, the pump must meet the requirements specified in Section (9). To connect another type of pump to the LyoDry Benchtop Pro, refer to the instruction manual supplied with the pump.

3.4.2 Connect an Edwards RV5 or RV8 pump to the LyoDry Benchtop Pro



WARNING

The vacuum pump supply outlet has a maximum rating of 6amps. Vacuum pumps which exceed this rating should not be connected to the supply outlet and should be supplied separately.

To connect an Edwards RV5 or RV8 pump to the LyoDry Benchtop Pro and use the following procedure.

1. Remove the vacuum pump connection kit from its packing material. As shown in Table 4, the kit contains a clamp, a one-metre vacuum hose and a nozzle connector.
2. Fit the centring-ring and inlet filter assembly to the inlet-port of the pump, and then use the clamp to secure the nozzle connector to the inlet-port.
3. Push one end of the vacuum hose onto the nozzle connector.
4. Push the free end of the vacuum hose onto the vacuum pump connector on the front of the LyoDry Benchtop Pro.
5. The LyoDry Benchtop Pro is supplied with a 1.5 metre length of 3-core electrical supply cable. Connect the cable to the vacuum pump and the LyoDry Benchtop Pro pump power outlet on the rear of the LyoDry Benchtop Pro (item 2, figure 2).

3.4.3 Pump outlet safety

Fit an oil mist filter or pipe the exhaust gases of the vacuum pump to a suitable treatment plant.

An Edwards EMF Oil Mist filter is available as an accessory and can be fitted to trap oil mist exhausted from the pump.

3.5 Test after installation

**CAUTION**

Do not attempt to use the LyoDry Benchtop Pro if it fails the installation test. If you do, poor performance may result in the loss of the product being freeze dried

**CAUTION**

Never engage the vacuum pump when water is present in the Ice Condenser. The introduction of water directly into the internal mechanism of the vacuum pump will cause significant damage to the pump.

When you have installed the LyoDry Benchtop Pro, test that it works correctly. Note that the refrigeration system uses a thermostatic expansion valve which contains a spring-loaded needle valve; the expansion valve automatically regulates the amount of refrigeration, according to the load on the refrigeration system. The needle valve is optimised for load conditions and when you test the LyoDry Benchtop Pro with the chamber empty (that is, with no product in the chamber), the temperature of the chamber can cycle between -70°C and -85°C .

Use the following procedure to test the LyoDry Benchtop Pro:

1. Switch on the electrical supply and then turn the main switch (item 1, figure 2) to the '1' (on) position.
2. Press the On/Off switch (item 7, figure 1)
3. The display (item 3, Figure 1) on the front panel should be illuminated.
4. From the Home screen select the Control Screen
5. Enter your Operator user name and password to access the Control screen.
6. From the Control screen tap the Refrigeration switch to start the compressor.
7. Check that 'COOL' is displayed. If 'DEFROST' is displayed tap the Mode switch to cool.
8. Hold an A4 size piece of paper against the grill on the left side of the LyoDry Benchtop Pro. If the paper is drawn towards the grill then the cooling fan is rotating correctly: continue at Step 10. If the fan is not rotating, continue at Step 14 below.
9. Check that the compressor operates. If it operates, you will hear a low hum: continue at Step 6. If you cannot hear the compressor, continue at Step 14 below.
10. Leave the LyoDry Benchtop Pro on for approximately 60 minutes, and then check that a temperature of -45°C or lower is shown on the temperature gauge. If the temperature is correct continue at Step 11 below. If the temperature is not correct, continue at Step 14 below.
11. Attach an empty drying accessory to the accessory flange (item1, Figure 1).
12. Turn the drain-valve fully clockwise to close it, and then switch on the electrical supply to the vacuum pump.
13. Leave the pump to operate for at least 30 minutes, then check that a pressure of

1×10^{-1} mbar or lower is shown on the pressure gauge. If the pressure is correct, the LyoDry Benchtop Pro is ready for use. If the pressure is not correct, continue at Step 14.

14. If any of the checks in Steps 3 to 10 above fail, turn the main switch to the '0' (off) position, then switch off the external electrical supply and disconnect the supply from the LyoDry Benchtop Pro. Contact your supplier for advice. Do not attempt to use the LyoDry Benchtop Pro.

4. Introduction to the LyoDry Benchtop Pro

4.1 General description

The LyoDry Benchtop Pro is the ice condenser section of a freeze drying system. It is a low-cost unit suitable for freeze drying biological and pharmaceutical preparations in a laboratory. The LyoDry Benchtop Pro only requires the attachment of a suitable vacuum pump and drying accessory to form a complete freeze drying system. The LyoDry Benchtop Pro is also suitable for use on other vacuum duties, including evaporation and distillation processes.

The LyoDry Benchtop Pro has a condenser chamber, a refrigeration system and a control system which includes temperature and pressure indication and user controls. The refrigerant used in the LyoDry Benchtop Pro is CFC free. All of the LyoDry Benchtop Pro components are all housed in a stainless steel cabinet which is designed for bench-top use. The components are described in the following sections (see figure 1 for the locations of components).

When used with suitable accessories, the LyoDry Benchtop Pro can be used to freeze dry materials in bulk trays, round-bottomed flasks, vials or ampoules. Alternatively, the LyoDry Benchtop Pro can be used as a low-temperature vapour trap (or cold trap) that may be attached to an existing evaporation facility. A number of accessories are available from MechaTech Systems; these include vacuum pumps, drying accessories and glassware.



Figure 1 – LyoDry Benchtop Pro.

1. Condenser Chamber Accessory Flange & Condenser Chamber
2. Steel Cabinet
3. Operator Interface
4. Drain Outlet
5. Vacuum Port
6. On/Off Switch
7. USB port

5. Description of LyoDry Benchtop Pro Main Components

The LyoDry Benchtop Pro has a condenser chamber, a vacuum pump, a refrigeration system and a control system which includes temperature and pressure indication and user controls. The refrigerant used in the LyoDry Benchtop Pro is CFC free. All of the LyoDry Benchtop Pro components are housed in a free-standing cabinet.

The cabinet is fitted with casters for ease of locating the required operating position. The components are described in the following sections.

These are the main components of the LyoDry Benchtop Pro system.

5.1 Vacuum and Condensing system

5.1.1 Condenser Chamber

5.1.1.1 Condenser extension tube

A condenser extension tube is supplied with the LyoDry Benchtop Pro. The extension tube can be installed inside the condenser chamber to extend the vacuum pumping pipeline further into the condenser chamber. This results in an improved distribution of ice.

We recommend that you fit the extension tube inside the condenser chamber whenever a load capacity of 2 litre (or more) condensate will be collected.

5.1.2 Condensate Drain System

The use of the controls and connections are described in Table 2 and Table 3.

Control/Connection	Use
Touch Screen Interface	The Touch Screen Interface is used to fully operate and monitor the LyoDry Benchtop Pro. The pressure reading shows the pressure in the condenser chamber. The temperature reading shows the temperature in the condenser chamber.
Data retrieval port	Use this to retrieve logged data files to a USB memory stick
Ethernet port	Used for factory configuration
Vacuum pump connector	Use this to connect your vacuum pump to the LyoDry Benchtop Pro.

Drain-outlet	This outlet is used to drain water from the LyoDry Benchtop Pro during defrosting of the condenser chamber and cooling-coil. The outlet is also used to admit air into the vacuum system.
--------------	---

Table 2 – Front Controls and Connections.

Control/Connection	Use
Power inlet	To connect the LyoDry Benchtop Pro to an external power supply. Switch power on and off.
Auxiliary power	To connect your vacuum pump. This will enable the pump to be operated directly from the LyoDry Benchtop Pro.

Table 3 – Rear Controls and Connections.

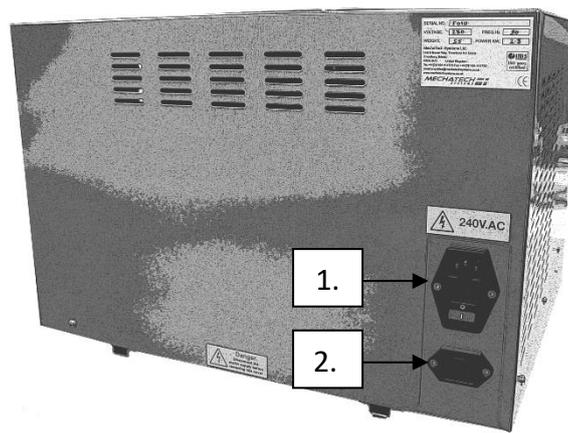


Figure 2 – LyoDry Benchtop Pro Rear connections.

1. Power inlet with switch
2. Auxiliary vacuum pump power

6. Applications

6.1 Introduction

If you want to use the LyoDry Benchtop Pro as a freeze dryer, you must connect it to a two-stage vacuum pump and fit a drying accessory. When you use the LyoDry Benchtop Pro as part of a freeze drying system, we recommend that you keep accurate records of all operating parameters (that is: load, drying times, and so forth). This data will help you to determine the optimum cycle for efficient operation with various products.

Some factors which affect the freeze drying process are described in the following sections.

6.2 The freezing process

You must pre-freeze the product to be freeze-dried before you place it in (or on) the drying accessory. The thickness of the ice (and hence the product) will affect the length of time needed to dry a given sample. In general, the thickness should be less than 10mm. A range of product containers is available from MechaTech Systems. These include the containers shown in Table 4.

Container	Method of freezing
Bulk tray	Use a cabinet freezer to freeze the bulk tray. The maximum recommended depth is 10 mm.
Vials	Use a cabinet freezer to freeze the vials. The maximum recommended depth of fill is 10 mm.
Ampoules	Pre-freeze in a cabinet or use a spin-freeze accessory to dry the ampoules.
Flasks	Use a pre-freeze bath to shell-freeze to a maximum thickness of 10 mm.

Table 4 – Product containers

6.3 The drying process

When the LyoDry Benchtop Pro condenser temperature is less than -45 °C, as shown on the Main screen, the vacuum pump can be switched on. The pressure in the condenser chamber then starts to drop, producing the conditions necessary for freeze drying to occur. The pressure gauge will show the pressure in the condenser chamber.

The time required to dry a product varies and is determined by a number of factors; these include the type of product, its mass and thickness, the type of container used, the temperatures of the product and the condenser and the system performance.

Freeze drying requires an input of heat energy to the product to change the ice into water vapour. When using the LyoDry Benchtop Pro, this energy may be absorbed solely from the surroundings or, alternatively, a heated accessory may be used to supplement this heat input. If you use a heated accessory, the accessory should not be switched on until the pressure in the condenser chamber has fallen to 1 mbar or lower.

When you decide on the quantity of heat input required, or when you try to optimise the drying cycle for a particular product, it is important to observe the physical appearance of the product whenever possible during the drying process. If the product has been correctly frozen, it will usually appear to be uniform in colour and Benchtop Pro. If the product is uneven in colour, or if signs of boiling are visible, then the product may have been incorrectly frozen or may have undergone some physical change, possible from the application of too much heat.

A wide range of factors has to be considered when trying to optimise the drying cycle for a given product. To assist in this optimisation, we therefore recommend that you take note of the rate of change of both temperature and pressure within the condenser chamber during the freeze drying process.

6.4 Vapour trapping

When the LyoDry Benchtop Pro is used as a vapour trap, its function is significantly different to that when it is used in freeze drying applications. In vapour trapping applications, the LyoDry Benchtop Pro acts solely to protect the rotary pump; in freeze drying applications, it actually pumps the water vapour from the product.

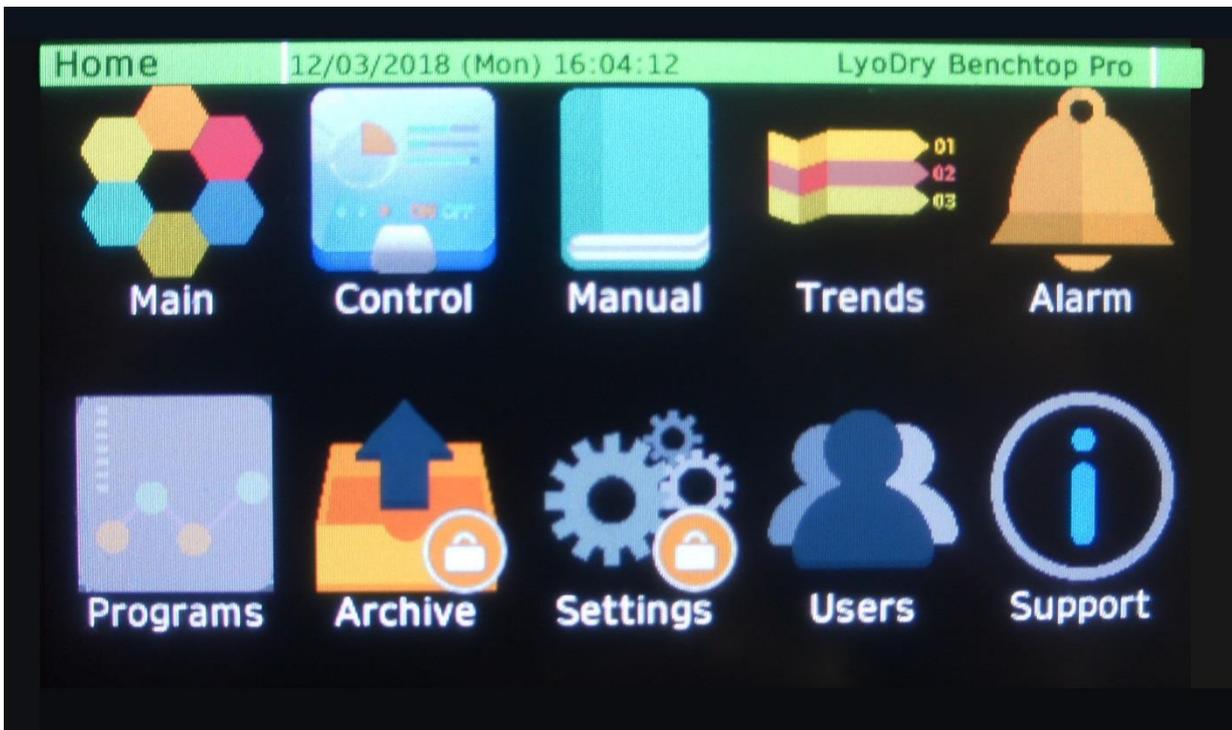
In vapour trapping applications, it is often necessary to limit the vapour flow from the system to the LyoDry Benchtop Pro by fitting a restrictor between the vapour source and the LyoDry Benchtop Pro. The size of the restrictor depends on the system.

7. How the LyoDry Benchtop Pro is controlled

7.1 Operator Interface:

The Operator Interface is a touch screen used to control and monitor the LyoDry Benchtop Pro.

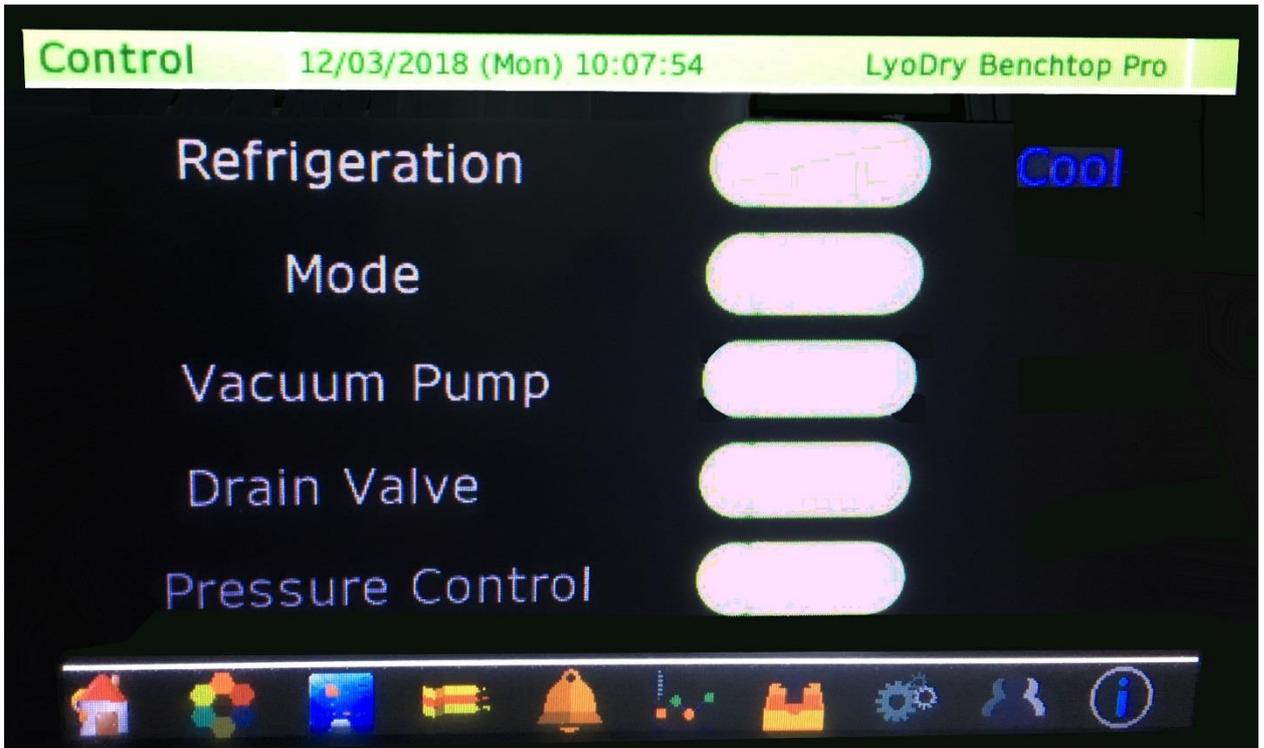
An overview of the main screens follows.



This is the **Home** screen

This is the top level Menu screen that appears after the power up sequence.

There are touch icons buttons located on the Home screen. These icons are used to navigate through the screens. These icons are repeated along the bottom of the other screens.



This is the **Control** screen

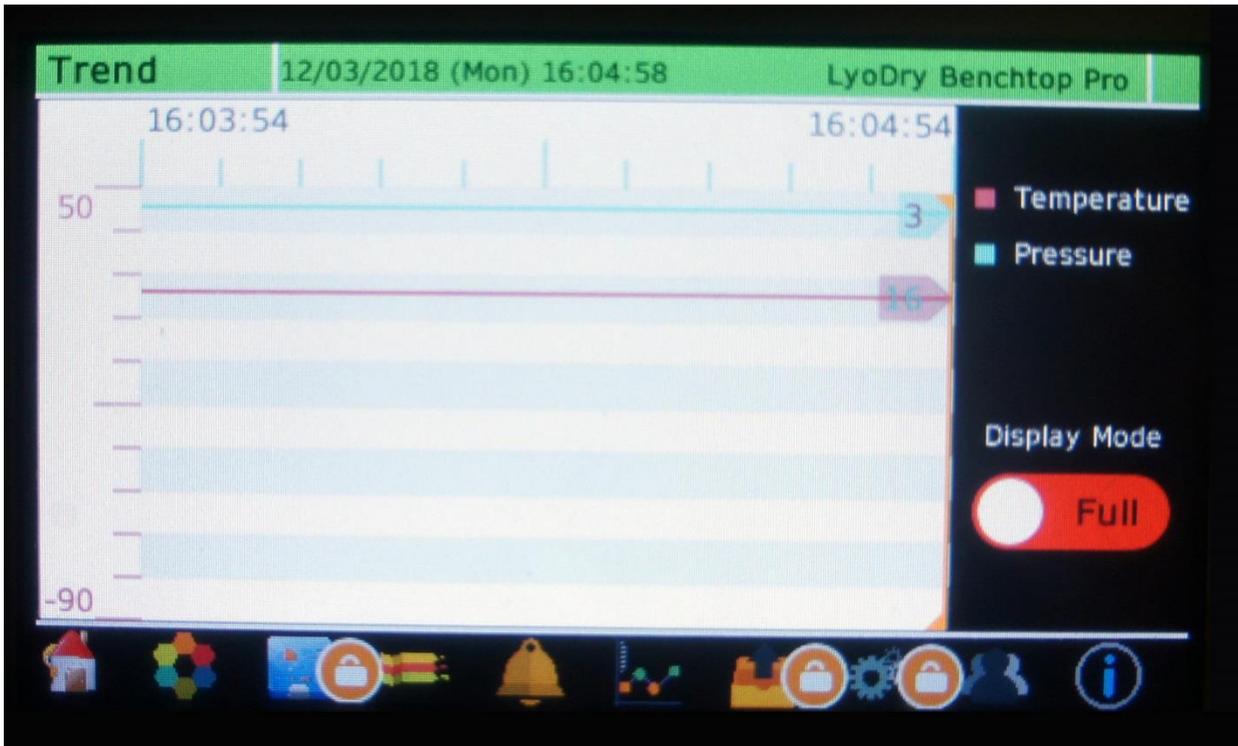
Tap the switches to operate each item



This is the **Overview** screen

The pressure setpoint can be adjusted within this screen by tapping the up and down arrows

Note: Pressure Control must be selected within the Control screen to activate the setpoint.



This is the **Trend** screen

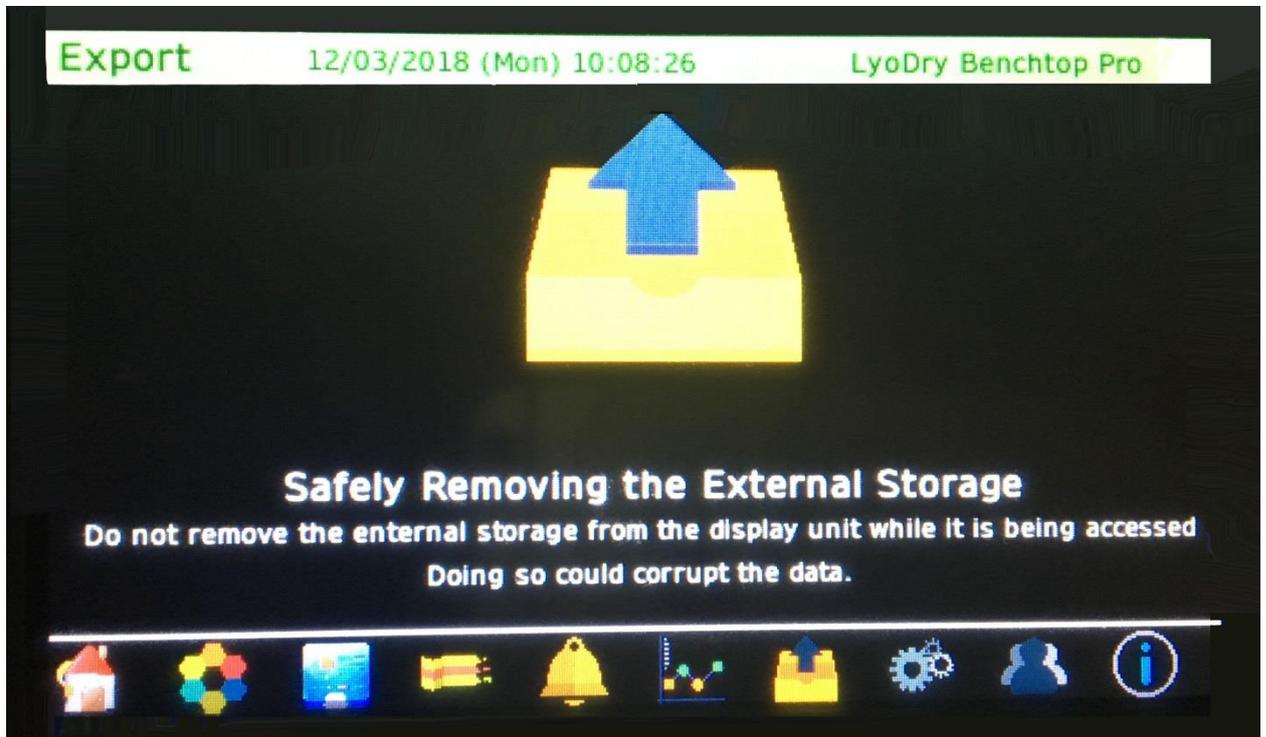
Within the Trend screen, the Display Mode switch can be used to scroll toggle between display modes.

The screenshot shows the 'Alarms' screen for 'LyoDry Benchtop Pro' on 12/03/2018 at 16:05:31. The table below is empty and has the following columns: Date, Time, AlarmMessage, AlarmStatus, and Active. The Active count is 0. An 'ACK' button is located at the bottom right of the table area. The bottom navigation bar is identical to the Trend screen.

Date	Time	AlarmMessage	AlarmStatus	Active
				0

This is the **Alarms** screen

The temperature and pressure levels during the process are key to a successful freeze dried product and are therefore monitored continuously during the cycle. Should either the temperature or pressure rise above the permitted level then there will be an alarm. The alarm message will be displayed until the parameter has recovered to normal levels or the alarm is subsequently acknowledged.



This is the **Export** screen

Data is stored continually in the system's internal battery backed memory.

Selecting the Export screen from the Home screen allows a user, with a high enough access level, to archive the recorder history, to a 'memory stick' plugged into the USB port at the front of the unit (item 7, figure 1). The archived data remains in the flash memory of the instrument.

Tap the icon to start achieving process.

**CAUTION**

The Memory stick must not be removed while archiving is in progress, as to do so may irreparably damage the file system of the memory stick, rendering it unusable.

8. Running a Drying Process

8.1 How to run a Drying Cycle

**WARNING**

If you intend to freeze dry products which contain sodium azide, make sure that your vacuum pump and pipeline are suitable for freezing these products. If they are not suitable, there is a severe risk of explosion.

Sodium azide is sometimes used as a stabilizing agent in freeze drying processes. Sodium azide is toxic and, when dry, is highly explosive.

If you freeze dry a product that contains Sodium azide, a chemical reaction can occur in the presence of heavy metals such as copper, lead, zinc and cadmium. The result of this reaction is the formation of metallic azides which are highly unstable and explosive.

The LyoDry Benchtop Pro contains no heavy metals and is suitable for freeze drying products which contain Sodium azide. The Edwards RV5 and RV8 pumps are also suitable for this purpose.

However, if you do not use an Edwards's pump, your vacuum pump and vacuum pipeline may not be suitable for freeze drying products containing Sodium azide. Check with your vacuum pump's manufacturer to determine its suitability if you intend to freeze dry products containing Sodium azide.

8.2 Sequence of operation

Operation of the LyoDry Benchtop Pro can involve a number of different steps:

- Prepare the LyoDry Benchtop Pro
- Fit the product container and any other necessary accessory
- Load the products
- Pre-cool the LyoDry Benchtop Pro
- Dry the product
- Shut down

Before you freeze a product, you must always prepare the LyoDry Benchtop Pro as described. Always dry the product and shut down the LyoDry Benchtop Pro as described.

However, the order in which the remaining three steps are carried out depends on the type of product container or other accessory you use and the type of product to be freeze dried. In some circumstances you will need to pre-cool the LyoDry Benchtop Pro with the accessory-flange open to atmosphere; in other circumstances, you fit the product container, then pre-cool the LyoDry Benchtop Pro and then load the product to be freeze dried.

If the correct sequence of operations to follow is not clear to you, refer to the instruction manual supplied with the product container or other accessory which you will use.

8.3 Prepare the LyoDry Benchtop Pro



CAUTION

Use only mild detergents to clean the condenser chamber, accessories and connecting pipeline. Some of the MechaTech Systems accessories are made from acrylic materials and must not be cleaned with organic solvents.

Before you use the LyoDry Benchtop Pro, and between freeze-drying cycles, prepare the LyoDry Benchtop Pro, as follows:

1. Switch on the electrical supply and then press the power switch (item 1, figure 2) to the '1' (on) position.
2. Press the On/Off switch (item 6, figure 1)
3. The display (item 3, Figure 1) on the front panel should be illuminated.
4. From the Home screen select the Control Screen
5. Enter your Operator user name and password to access the Control screen.
6. From the Control screen tap the Drain Valve switch to open it.
7. When the chamber is completely drained, turn off the drain-valve.
8. If acidic or corrosive products have been processed, flush through the condenser chamber and drain-line with clean water.
9. Make sure that the condenser chamber is dry.
10. Make sure that the LyoDry Benchtop Pro is clean, particularly the accessory-flange. If the flange is not clean, you will not get a good vacuum seal and the performance of the LyoDry Benchtop Pro will be poor.
11. Check the vacuum connection on the front of the LyoDry Benchtop Pro. Check the connection at the vacuum pump.
12. If a load of more than 2 litres of ice will be condensed in the LyoDry Benchtop Pro, we recommend that you fit the condenser extension tube: fit the extension tube in the condenser chamber, so that the short end of the tube fits over the vacuum pumping pipe, and so that the end of the tube points directly downwards towards the bottom centre of the condenser chamber.

If you do not fit the extension tube, the vacuum pump connection may become blocked with ice; this may cause a loss of vacuum and the product may melt.

13. Select a suitable drying accessory for the product. Wipe clean the sealing-ring of the accessory and check the sealing-ring for damage; if it is damaged, fit a new sealing-ring.

The accessory sealing-ring should not need lubricating, but if it is excessively dry, apply a light wipe of high vacuum grease.

8.4 Fit the product container and other accessories

A drying accessory may be connected to the LyoDry Benchtop Pro accessory flange. Accessories have a rubber sealing-ring to seal the accessory to the LyoDry Benchtop Pro accessory flange. Once positioned, the weight of the accessory is sufficient to produce an airtight seal under vacuum conditions.

8.5 Pre-cool the LyoDry Benchtop Pro



WARNING

Do not touch any part of the condenser chamber during or immediately after the cooling process. The condenser chamber is at a very low temperature and can cause tissue damage.

Note: if you cool the LyoDry Benchtop Pro with no product in the chamber, the condenser temperature will cycle between approximately -70°C and -85°C .

Pre-cool the LyoDry Benchtop Pro condenser chamber as follows:

1. From the Control screen tap the Refrigeration switch to start the compressor.
2. Check that 'COOL' is displayed. If 'DEFROST' is displayed tap the Mode switch to cool.
3. Wait until the temperature shown on the display should read -45°C or lower. This may take 60 minutes.
4. The temperature shown on the display should read -45°C or lower.

8.6 Dry the product



CAUTION

Use gas-ballast on the vacuum pump when drying. If you do not, water may condense in the pump.

1. On RV5 or RV8 pumps, turn the gas-ballast control to position '1': refer to the pump instruction manual. On other pumps, open the gas-ballast valve: refer to the pump instruction manual.

2. If the vacuum pump is electrically connected to the LyoDry Benchtop Pro vacuum pump power outlet (Figure 2), from the Control Screen tap the Vacuum Pump switch to turn it on. If the vacuum pump is connected to a separate supply, switch on the pump according to the manufacturer's instructions.

Take note of the following when freeze drying products:

- Only switch on a heated accessory when the pressure is 1 mbar or less.
- When a load is first applied to the LyoDry Benchtop Pro, the temperature may rise for a few minutes. This is because the evaporation rate from the product is initially high. If the temperature does not fall to -45 °C or below within a few minutes, the LyoDry Benchtop Pro is overloaded. Reduce the amount of product in the freeze drying system to prevent the product from melting or, when you use the LyoDry Benchtop Pro as a vapour trap, restrict the flow of vapour to the LyoDry Benchtop Pro.
- If you wish to dry a number of flasks, first attach one flask, then evacuate the flask until the pressure (shown on the pressure gauge) falls to 1 mbar or less. Then attach and evacuate the remaining flasks in the same way.

If you use this procedure, you can identify any flasks that leak. This procedure also prevents rapid pressure increases, which might cause flasks to fall off of the drying accessory.

- If there appears to be a leak, check that the drain-valve is fully closed and that all seals are clean. If the LyoDry Benchtop Pro continues to leak, contact your supplier.

8.7 Removing the product



CAUTION

If you use a manifold assembly, do not admit air into the LyoDry Benchtop Pro through the drain-valve until all flasks have been removed, otherwise the flasks may fall off the manifolds.

Look at the pressure shown on the pressure gauge and the appearance of the product and consult data gathered from previous freeze drying operations to determine when the freeze drying process has finished. Note that the pressure shown on the display will fall significantly when vapour is no longer being released from the product.

Once the process has finished, shut down the LyoDry Benchtop Pro as follows:

1. If you use a manifold accessory, use the manifold valves to vent each flask in turn. Remove and seal each flask.
2. If the Vacuum Pump is electrically connected to the LyoDry Benchtop Pro vacuum pump power outlet (Figure 2), from the Control Screen tap the Vacuum Pump switch to turn it off. If the vacuum pump is connected to a separate supply, switch off the pump according to the manufacturer's instructions.

8.8 Defrost the LyoDry Benchtop Pro



WARNING

Do not touch any part of the condenser chamber during or immediately after the cooling process. The condenser chamber is at a very low temperature and can cause tissue damage.



WARNING

Do not pour water at a temperature greater than 50 °C into the ice condenser when it is cold. This may result in a dangerous rise in pressure in the refrigeration system.

The LyoDry Benchtop Pro has a hot gas defrosting feature.

Place the drain hose in a suitable container to collect the melted condensate.

1. From the Control Screen tap the Drain Valve switch to open it.
2. From the Control screen tap the Mode switch to select DEFROST.
3. Wait until all the ice has defrosted and finished draining out of the drain hose. If all the ice has melted and there is no water flowing out of the drain hose tap the Drain Valve switch to close it.
4. From the Control screen tap the Mode switch to select DEFROST.
5. From the Control screen tap the Refrigeration switch to turn off the compressor.

During defrosting you can also pour warm water into the ice condenser to speed up the defrosting process. This method is useful if you wish to use the LyoDry Benchtop Pro again immediately. Use water at a maximum temperature of 50 °C. Do not fill the chamber above the level of the vacuum pipeline.

6. Prepare the LyoDry Benchtop Pro for the next operational cycle as described starting from section 8.3 or shutdown the LyoDry Benchtop Pro as described in section 8.10.

8.9 Operation with no load

If you operate the LyoDry Benchtop Pro with no load for several hours, the internal components of the LyoDry Benchtop Pro get very cold. Atmospheric water vapour will then condense onto the cold surfaces and may drip out of the bottom of the LyoDry Benchtop Pro. You may therefore see puddles of water under the LyoDry Benchtop Pro, which give the impression that water is leaking from the condenser chamber.

If you see water dripping out of the LyoDry Benchtop Pro, inspect the condenser chamber: if there is ice in the chamber, the water is probably not leaking from the chamber, but is dripping from the cold surfaces inside the LyoDry Benchtop Pro. Always check this carefully before you contact your supplier for advice.

To avoid this problem, we recommend that you shut-down the LyoDry Benchtop Pro if you will not use it for three or four hours. This is particularly important if the use of the LyoDry Benchtop Pro is in a high humidity environment.

8.10 Shutdown

1. Press the On/Off switch (item 6, figure 1)
2. Switch off the electrical supply and then press the power switch (Figure 2) to the '0' (off) position.

9. Maintenance



WARNING

Obey the safety instructions below and take note of the appropriate precautions. If you do not you can cause injury to people and damage to equipment.



WARNING

The LyoDry Benchtop Pro may be contaminated with the process chemicals that have been pumped during operation. If so, ensure that the LyoDry Benchtop Pro is decontaminated before maintenance and that you take adequate precautions to protect people from the effects of dangerous substances if contamination has occurred.

9.1 Introduction

Note: you must obey the maintenance procedures defined in the instruction manuals supplied with your accessories and vacuum pump.

Note: there are no user-serviceable parts inside the LyoDry Benchtop Pro refrigeration system.

The following sections describe possible problems and their possible solutions and are intended as a guide to the user and to qualified service engineers. Some of the solutions can be carried out by the user, but others (which are clearly identified) must be carried out only by approved MechaTech Systems service engineers.

9.2 Precautions

- Switch off the LyoDry Benchtop Pro, isolate it from the electrical supply and defrost it before you start maintenance.
- Do not touch any part of the condenser chamber during or immediately after the cooling process. The condenser chamber is at a very low temperature and can cause tissue damage.
- Do not pour water at a temperature greater than 50 °C into the condenser chamber when it is cold. If you do, this may result in a dangerous pressure rise in the refrigeration system.
- Ensure that you do fault finding in a well-ventilated area.
- After you have rectified a fault, ensure that the electrical installation of the LyoDry Benchtop Pro conforms to your local and national safety requirements. It must be connected to a suitable fused and protected electrical supply and a suitable earth (ground) point.

9.3 Cleaning



CAUTION

External surfaces of the LyoDry Benchtop Pro should be cleaned using warm soapy water. Care must be taken with solvent-based cleaning fluids as they may remove important information from the product labels.



CAUTION

Do not pour water at a temperature greater than 50°C into the condenser chamber when it is cold. If you do, this may result in a dangerous pressure rise in the refrigeration system.

9.3.1 Cleaning the Operator Interface screen

Clean the Operator Interface screen as and when required.



CAUTION

- To prevent possible damage to the Nanodac screen, make sure you use a lint-free cloth, moistened if necessary with a weak detergent solution. Do NOT use aggressive cleaning materials such as isopropyl alcohol because they damage the Nanodac screen.
- DO NOT USE ABRASIVE CLEANERS OR INDUSTRIAL SOLVENTS. These may damage the unit beyond repair. This is NOT covered by warranty or hardware maintenance contracts.

1. Have all your cleaning materials ready – a clean, soft, lint-free cloth and weak detergent solution.
2. You can clean the screen when the system is powered ON or OFF.
3. Gently clean the screen. We recommend that you allow it to dry before resuming use, to avoid leaving marks on the surface.

9.3.2 Cleaning the Condenser chamber

**WARNING**

The Condenser may be contaminated with the process chemicals that have been pumped during operation. If so, follow your specific decontamination procedures before attempting to clean the chamber and take adequate precautions to protect people from the effects of dangerous substances if contamination has occurred.

Clean the Condenser chamber as and when required.

1. Have all your cleaning materials ready – a clean, soft, lint-free cloth and weak detergent solution.
2. Gloves should be worn when working with chemicals.
3. Ensure that the condenser is at atmospheric pressure and ambient temperature.
4. To access the chamber open the condenser door by turning all four handles in turn ant-clockwise until the handle 'springs out'.
5. The door can now be opened by pulling on one of the two handles on the right hand side of the door.
6. Check that the surface temperature is within safe limits to touch.
7. Gently clean the internal surface by reaching inside. Do not attempt to put your head into the chamber
8. To close the door after cleaning, swing the door flush against the sealing flange and turn all four handles, in turn, clock-wise until they are hand tight. Ensure that the door is not loose.

**WARNING**

Ensure that the electrical supply is isolated before starting any maintenance work.

9.4 Calibration

It is recommended that the vacuum and temperature gauges fitted to this unit are calibration at least every 12 months. The time interval between services must to be reviewed by the customer during the units operating life.

9.5 Safety



WARNING

Obey the safety instruction given below and take note of appropriate precautions. If you do not, you can cause injury to people and damage to equipment.

9.6 Precautions

- Switch off the LyoDry Benchtop Pro, isolate it from the electrical supply and defrost it before you start maintenance.
- Do not touch any part of the condenser chamber during or immediately after the cooling process. The condenser chamber is at a very low temperature and can cause tissue damage.
- Do not pour water at a temperature greater than 50 °C into the condenser chamber when it is cold. If you do, this may result in a dangerous pressure rise in the refrigeration system.
- Ensure that you do fault finding in a well-ventilated area.
- After you have rectified a fault, ensure that the electrical installation of the LyoDry Benchtop Pro conforms to your local and national safety requirements. It must be connected to a suitable fused and protected electrical supply and a suitable earth (ground) point.

9.7 Electrical faults

If an electrical fault is suspected, use Table 5 to identify the possible causes and actions to cure the fault. The 'By' column of the table identifies whether the checks and actions can be done by a user (a 'U' entry in the column), or whether they must be done by a qualified service engineer (an 'SE' entry in the column).

If the fault persists after you complete the recommended action, contact your supplier before you use the LyoDry Benchtop Pro again.

Symptom	Check	Action	By
The external electrical supply is on but the display is off and there is no electrical supply to any components.	Has the fuse in the main switch failed?	If so, identify and rectify the cause of the problem, then replace the fuse. If the fuse fails repeatedly, check the electrical system and rectify any fault found.	U SE
	Has the external fuse in the electrical supply failed?	If so, identify and rectify the cause of the problem, then replace the fuse. If the fuse fails repeatedly, check the electrical system and rectify any fault found.	U SE
The display is on, the Refrigeration in 'COOL' mode but the compressor does not start.	Has the thermal magnetic circuit-breaker tripped?	If so, identify and rectify the cause of the problem, then reset the circuit breaker. If the circuit-breaker trips repeatedly, check the electrical system and rectify any fault found.	U SE
	Is the electrical supply voltage too low?	Use an alternative electrical supply and/or remove any extension cables which can cause small voltage drops.	
	Is there a loose connection?	Inspect the electrical system and repair any loose connection. If there are no loose connections, the compressor may be faulty.	
The compressor starts but only operates for a short time before it stops.	Have the motor windings failed?	Check the windings and replace the compressor is necessary.	SE
The temperature shown on the display does not change or error is displayed.	Is the plug disconnected from or loosely connected to the rear of the display?	Inspect the electrical system and repair any fault found.	SE
	Has the thermocouple failed?	Check and replace the thermocouple.	SE
Incorrect temperatures are shown on the display.	Does the thermocouple need to be calibrated?	Calibrate the thermocouple.	SE
	Is the incorrect type of thermocouple fitted?	Check and replace the thermocouple, if necessary.	SE
The pressure shown on the display does not change or error is displayed.	Does the gauge need to be calibrated?	Calibrate the pressure gauge.	U
	Is the plug disconnected from or loosely connected to the rear of the display?	Inspect the electrical system and repair any fault found.	SE
	Is the gauge head faulty?	Replace the Pirani gauge head.	SE

Table 5 – Electrical Fault Finding

9.7.1 Remove the top cover and the electrical box

**WARNING**

Disconnect the LyoDry Benchtop Pro from the electrical supply before you remove the top cover. If you do not, you may accidentally touch live electrical components.

To access electrical connections on the compressor and the fan, remove the top cover, then remove the terminal-box cover on the compressor.

To repair faults in the electrical box, you must first remove the electrical box from the LyoDry Benchtop Pro. After you have completed any repairs, refit the electrical box and cover.

1. Switch off the external electrical supply and isolate it from the LyoDry Benchtop Pro.
2. Remove the 'O' Ring from the accessory flange, then undo and remove the six screws which secure the top cover.
3. Lift the rear of the cover, then pull the cover back to remove it from the base of the LyoDry Benchtop Pro and place the cover on the bench next to the base; if necessary, disconnect the earth (ground) wire from the top cover.
4. Undo and remove the two screws securing the electrical box.
5. Pull the electrical box forwards and out of the LyoDry Benchtop Pro.
6. Remove the four screws which secure the cover on the electrical box and remove the cover.

9.7.2 Refit the electrical box and cover

**WARNING**

Ensure that the earth (ground) cable is correctly fitted to the top cover. If you do not, there will be a risk of electric shock when you switch on the LyoDry Benchtop Pro.

1. Refit the cover to the electrical box and secure with the four screws.
2. Refit the electrical box into the front of the LyoDry Benchtop Pro and secure with the two screws.
3. If necessary, reconnect the earth (ground) wire to the top cover.
4. Tilt the cover upwards, fit the top front edge of the cover under the top lip of the LyoDry Benchtop Pro, and then lower the rear of the cover.
5. Refit the six screws to secure the top cover in place.
6. Refit the 'O' Ring to the accessory flange.

9.7.3 Reset the thermal magnetic breaker

Use the following procedure to reset the thermal magnetic circuit-breaker if it has tripped. Only reset the circuit-breaker once you have identified and rectified the source of the trip.

1. Carry out the procedure in **9.7.2** above
2. Press the reset button to reset the thermal magnetic circuit-breaker.
3. Carry out the procedure in **9.7.3** above
4. Refit the top cover.

9.8 Refrigeration faults

9.8.1 Repeat the installation test

If you suspect that there is a fault in the refrigeration system in the LyoDry Benchtop Pro, then:

1. Defrost the chamber.
2. Repeat the installation tests. Note the results at each step and then contact MechaTech Systems.

9.8.2 Fault diagnosis

Some possible causes of refrigeration faults, together with suggested actions to cure the faults, are shown in Table 6. The 'By' column of the table identifies whether the checks and actions can be done by a user (a 'U' entry in the column), or whether they must be done by a qualified service engineer (an 'SE' entry in the column).

If other symptoms occur, or the cause of the fault cannot be identified, contact your supplier for advice.

9.8.3 Refrigerant leaks

The refrigerant used in the LyoDry Benchtop Pro is heavier than air and is an asphyxiant by the displacement of oxygen. If a refrigerant leak is suspected, place the LyoDry Benchtop Pro in a well-ventilated area. Do not allow naked flames or smoking near the LyoDry Benchtop Pro, as products of combustion of the refrigerant include dangerous fluorides and chlorides.

If refrigerant vapour is inhaled, summon medical help immediately. Take the victim to a well-ventilated, uncontaminated area; if the victim's breathing is weak or has stopped, apply artificial ventilation, preferably using an oxygen resuscitator. Do not use adrenalin or other cardiac stimulants.

Refrigerant in contact with skin or eyes can cause cold burns. If contact has taken place, seek medical help immediately and carry out the following: remove clothing from the affected area; carefully irrigate the affected area with tepid water for at least 15 minutes; apply a sterile dressing and treat the wound as you would a heat burn.

9.8.4 Leak test the refrigeration system

Leak test the refrigeration system with a halogen leak detector, which is sensitive to all refrigerants. Before you start leak tests, check the operation of the leak tester with refrigerant from the cylinder which you will use to recharge the LyoDry Benchtop Pro.

The refrigerant used in the LyoDry Benchtop Pro is heavier than air, so you must check the highest joints in the system first.

9.8.5 Component replacement

Note: The refrigeration system should be left open to atmosphere for as short a time as possible.

Only replace a component when you are sure that it is the cause of the fault. Components (particularly compressors) are often replaced unnecessarily and it is therefore recommended that you recheck your findings before you replace a component.

Use the following procedure to replace a component in the refrigeration system.

1. Recover the refrigerant from the system.
2. Remove the faulty component. You must use suitable pipe cutters if you cut a pipe. If heat has to be applied to a joint, pass an inert gas through the system while you heat the joint, and again while you cool the joint.
3. Replace the component.
4. When repairs on the refrigeration system have been completed, replace the filter-dryer as that is likely to have been contaminated.
5. Dehydrate the system and recharge the LyoDry Benchtop Pro with refrigerant. Before the unit is completely recharged, check that any new or repaired joints do not leak.

Symptom	Check	Action	By
The compressor does not start.	Is there an electrical fault?	Refer to electrical faults section and rectify any fault found.	SE
The compressor starts but the temperature does not reach -70°C or less after 90 minutes.	Is there sufficient ventilation?	If not, relocate the LyoDry Benchtop Pro. There must be no restrictions to air-flow to the sides and rear of the LyoDry Benchtop Pro.	U
	Is there a leak in the refrigeration system?	Find the leak, then repair the leak and recharge the system with refrigerant	SE
The compressor starts but the temperature does not reduce.	Is the thermocouple faulty?	Check the gauge and the thermocouple and replace if necessary.	SE

Symptom	Check	Action	By
	Is there a leak in the refrigeration system?	Find the leak, then repair the leak and recharge the system with refrigerant.	SE
The temperature rises to above -45 °C during drying and does not fall to below -45 °C again within a few minutes.	Is the load on the LyoDry Benchtop Pro too high?	Reduce the amount of product being freeze dried or restrict the vapour load to the LyoDry Benchtop Pro.	U

Table 6 – Refrigeration fault finding

9.8.6 Recharge with refrigerant

If you need to recharge the LyoDry Benchtop Pro due to a refrigerant leak, locate and repair the leak before you start to recharge the refrigeration system.

Use the correct type and quantity of refrigerant to recharge the refrigeration system.

10. Storage and disposal

10.1 Storage

Use the following procedure to store the LyoDry Benchtop Pro

- Power down the LyoDry Benchtop Pro as described in Section 8.10
- Disconnect the LyoDry Benchtop Pro from all the services
- Place and secure protective covers over the inlet and outlet interfaces
- Store the LyoDry Benchtop Pro in cool, dry conditions until required for use. When required, prepare and install the LyoDry Benchtop Pro as described in Section 3

10.2 Disposal

Dispose of the LyoDry Benchtop Pro and any components from it safely in accordance with all local and national safety and environmental requirements.

Particular care must be taken with components which have been contaminated with dangerous process substances.

Do not incinerate fluoroelastomer seals and O-rings.

11. Spares and accessories

11.1 Spares

Description	Part No	Supplier
Edwards APG100-XM, NW16	D026-01-000	 MechaTech Systems Ltd Unit 9 Brunel Way Thornbury Bristol BS35 3UR +44 (0)1454 414723 enquiries@mechatechsystems.co.uk www.mechatechsystems.co.uk
Temperature sensor	LSTC	
Edwards RV5 vacuum pump	A653-01-903	
Edwards EMF10 outlet mist filter	A462-26-000	
Edwards clean application oil return kit	A504-19-000	
Ultragrade 19 vacuum pump oil, 4 litres	H110-25-013	
Dow Corning silicone high vacuum grease, 50g tube	HVGREASE	
Acrylic drying chamber 350mm x 435mm, lid and 2 x L-gaskets	LSDC	
6-tray drying rack assembly, SS (for use inside acrylic chamber)	LSD6	
Heated tray drying accessory	LSAD6H	
14" L-gasket for acrylic chamber	L-GASKET14	

Table 7: Spare Parts and Accessories

11.2 Accessories

Refer to the third party documentation for the available accessories for a particular part of the LyoDry Benchtop Pro.

12. Technical Specifications

12.1 System Specification

LyoDry Benchtop Pro	TECHNICAL SPECIFICATION
Part number and model	LSB85P LyoDry Benchtop Pro
Maximum condenser chamber capacity	5 litres
Ice removal capacity (in 12 hours)	1.2kg (2.6 lbs)
Ice removal capacity (in 24 hours)	2.3kg (5.1 lbs)
Maximum ice capacity	4.5kg (9.9 lbs)
Operating temperature	~ -85°C
Temperature display range	+50°C to -100 °C
Pressure display range	0.01 mbar to 1000 mbar
Refrigeration compressor type	1/4 hp + 3/8 hp reciprocating
Dimensions (H x W x D)	350 x 550 x 680 mm
Weight	77kg (170 lbs)
Power requirements	LSB85P-230: 220/240VAC/50 Hz, 10.0 A LSB85P-115: 110/120VAC/60 Hz, 16.0 A

Table 8: Technical Specification

12.2 Vacuum pump requirements

Note 1: your vacuum pump must have a gas-ballast facility to prevent water build up in the pump.

Note 2: the pump power output is limited to 3.5 Amp.

For freeze drying, your vacuum pump must meet the following specification;

Vacuum Pump	TECHNICAL SPECIFICATION
Type of pump	Two-stage, oil-sealed rotary pump
Ultimate pressure	0.01 to 0.03 mbar
Pumping speed	3 m ³ /h or greater
Recommended pump	Edwards RV pump

Table 9: Vacuum pump requirements

12.3 Technical Support

12.3.1 Contacting Technical Support

If you suspect a problem with the LyoDry Benchtop Pro unit, you should first contact your local supervisor or Maintenance Engineer. If they cannot resolve the issue, then please contact MechaTech Systems Ltd.

General Sales and Service Contact Information:

MechaTech Systems Ltd
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Thornbury, Bristol BS35 3UR UK
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