



LABS
(Laboratory Archival Biological Storage)

CRYOSTORAGE SYSTEM

OPERATING AND MAINTENANCE INSTRUCTION



Taylor-Wharton

Harsco

REVIEW AND UNDERSTAND ALL SAFETY PROCEDURES IN FORM # TW-10 P/N 7950-8052 BEFORE ATTEMPTING TO INSTALL, OPERATE OR PERFORM MAINTENANCE ON THIS CRYOSTORAGE SYSTEM.

DO NOT ATTEMPT TO USE OR MAINTAIN THIS UNIT UNTIL YOU READ AND UNDERSTAND THESE INSTRUCTIONS. DO NOT PERMIT UNTRAINED PERSONS TO USE OR MAINTAIN THIS UNIT. IF YOU DO NOT FULLY UNDERSTAND THESE INSTRUCTIONS, CONTACT YOUR SUPPLIER FOR FURTHER INFORMATION.

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WARNING

The following safety precautions are for your protection. Before installing, operating, or maintaining this unit read and follow all safety precautions in this section and in reference publications. Failure to observe all safety precautions can result in property damage, personal injury, or possibly death.

Safety Precautions for Liquid Nitrogen

Nitrogen is an inert, colorless, odorless, and tasteless gas making up four-fifths of the air you breathe. Liquid nitrogen is obtained by cooling air until it becomes a liquid and then removing the oxygen. Air is roughly one-fifth oxygen. Liquid nitrogen is at a temperature of -320°F (-196°C) under normal atmospheric pressure.

Extreme Cold - Cover Eyes and Exposed Skin

Accidental contact of liquid nitrogen or cold issuing gas with the skin or eyes may cause a freezing injury similar to frostbite. Handle the liquid so that it won't splash or spill. Protect your eyes and cover the skin where the possibility of contact with the liquid, cold pipes and cold equipment, or cold gas exists. Safety goggles or a face shield should be worn when operating this equipment. Insulated gloves that can be easily removed and long sleeves are recommended for arm protection. Trousers without cuffs should be worn outside boots or over the shoes to shed spilled liquid.

Keep Equipment Area Well Ventilated

Although nitrogen is non-toxic and non-flammable, it can cause asphyxiation in a confined area without adequate ventilation. Any atmosphere not containing enough oxygen for breathing can cause dizziness, unconsciousness, or even death. Nitrogen, a colorless, odorless, and tasteless gas, cannot be detected by the human senses and will be inhaled normally as if it were air. Without adequate ventilation, the expanding nitrogen will displace the normal air resulting in a non-life-supporting atmosphere.

Liquid Nitrogen System

The liquid nitrogen supply pressure at the inlet to the refrigerator should be in the range of 10 psig (0.7bar/69 kPa) to 20 psig (1.4bar/138 kPa) for optimum performance. Higher operating pressures will increase transfer losses and create excessive turbulence of the liquid in the refrigerator which can generate false signals to the liquid level controller causing the refrigerator to under-fill. In "liquid phase" storage applications, excessive turbulence can cause splashing which could result in personal injury and/or damage to the refrigerator. When installing piping or fill hose assemblies, make certain a suitable safety relief valve is installed in each section of plumbing between shut-off valves. Trapped liquefied gas will expand greatly as it warms and may burst hoses or piping causing damage or personal injury. A relief valve is installed in the refrigerator plumbing to protect the line between the customer supplied shut-off valve and the refrigerator solenoid valve.

CAUTION: When installing field fabricated piping, make certain a suitable safety valve is installed in each section of piping between shut-off valves.

For more detailed information concerning safety precautions and safe practices to be observed when handling cryogenic liquids consult CGA pamphlet P-12 "Handling Cryogenic Liquids" available from the Compressed Gas Association, 1235 Jefferson Davis Highway, Arlington, VA 22202.

Warning: Inlet pressure should not exceed 22 psig (1.5bar/152 kPa). Higher pressures could result in damage to equipment.

Dispose of Waste Liquid Nitrogen Safely

Dispose of waste liquid nitrogen out-of-doors where its cold temperature cannot damage floors or driveways and where it will evaporate rapidly. An outdoor pit filled with clean sand or gravel will evaporate liquid nitrogen safely and quickly.

Electrical

Electrical Shock Can Kill – the liquid level controllers used with these refrigerators operate from 16.5VAC. However, the external transformer does have an 110/220VAC primary. Do not attempt any service on these units without disconnecting the electrical power cord.

Note: Units are supplied with Taylor-Wharton approved controllers. If other liquid level controllers are used, please contact Taylor-Wharton before putting the refrigerator into service.

Freight Damage Precautions

Any Freight damage claims are your responsibility. Cryostorage systems are delivered to your carrier from Taylor-Wharton's dock in new condition. When you receive our product you may expect it to be in that same condition. For your own protection, take time to visually inspect each shipment in the presence of the carrier's agent before you accept delivery. If any damage is observed, make an appropriate notation on the freight bill. Then, ask the driver to sign the notation before you receive the equipment. You should decline to accept containers that show damage, which might affect serviceability.

GENERAL INFORMATION

Thank you for purchasing this product. This state of the art CRYOSTORAGE SYSTEM can control either the liquid level and/or the vapor temperature range. The features are designed to provide a safe environment for samples while at the same time tracking all relevant information associated with the freezer. This control provides a complete historical record of the environment in your freezer and therefore, the environment in which your samples have been stored.

Text Format Notation

In this owner's manual we use some special text formats to denote certain portions of the system. These are listed below:

- Menu is indicated in **ALL CAPS BOLD**.
- Actual Menu Choices are indicated in ALL CAPS.
- Start Fill and Stop Fill sensor are indicated in *ALL CAPS ITALICS*.
- Specific Menu Descriptions under a main category are listed in *Italics*.

Taylor-Wharton LABS CryoStorage Systems are designed for applications where extremely low temperature storage of biological products is required. They are also appropriate for industrial or other applications where liquid nitrogen temperatures and high capacity are needed.

The LABS style refrigerator covered by this publication is designed for, but not limited to, the laboratory environment. Each model is supplied with casters to enable limited mobility for cleaning and positioning purposes.

The standard model is also equipped with the KRYOS electronic liquid level controller that will monitor and control the supply of liquid nitrogen to the unit. The controller features a vacuum fluorescent display. The addition of a liquid nitrogen supply and inventory control racks for systematic retrieval of stored product completes the total cryostorage system.

LABS Cryostorage Specifications

Liquid nitrogen at atmospheric pressure weighs 1.78 lb./liter (0.8 kg/liter). All Taylor-Wharton Gas Equipment cryostorage systems are designed to support the full weight of liquid nitrogen and a complete stainless steel or aluminum inventory control system with boxes and specimens.

Dimensions		80K	40K	20K
External Operating Height (Top of Step to Lid opening)	in	42.5	42.5	42.5
	mm	1080	1080	1080
Step Height	in	11	11	11
	mm	279	279	279
Overall Height (Top of Control Interface)	in.	60	60	60
	mm	1524	1524	1524
Usable Height, Internal	in.	30.0	30.0	30.0
	mm	762.0	762.0	762.0
Outside Diameter	in	59.5	45.0	34.0
	mm	1511	1143	863.6
Internal Working Diameter	in	55.0	40.5	29.5
	mm	1397	1029	750
Neck Opening	in	24.5	18.0	13.0
	mm	622	457	330
Capacity				
LN2 Capacity	L	1350	606	407
Power Supply⁰	VAC	16.5	16.5	16.5
Evaporation Rate¹	L/day	15.0	9.0	8
Weight, Empty	lb	1550	920	650
	kg	703	417	295
Maximum Gross Weight²	lb.	3956	2000	1375
	kg	1794	907	624
Inventory Control System Specifications				
No 5.0 x 5.0 Racks ³		58	30	14
No. Shelves/Rack		13	13	13
No. 3.0 x 3.0 Racks ⁴		12	8	4
No. Shelves/Rack		13	13	13
Vial Capacity, 2 ml ⁵		79300	41600	19500
Blood Bag (Fenwall 4R9951)		2100	1204	560
Blood Bag (Fenwall 4R9953)		1505	820	400
Blood Bag (Fenwall 4R9955)		1050	590	290

Footnotes:

⁰ This is the power supply for the standard battery backup version. The Kryos version (No Battery) uses a 24 VAC power supply. For power outlets other than North American 110 VAC contact Taylor-Wharton Customer Service.

¹ Evaporation rate is nominal. Actual rate may be affected by the nature of the contents, atmospheric conditions, container history, and manufacturing tolerances.

² Includes the empty weight and total LN2 capacity weight.

³ 5.0 in. x 5.0 in. (127 mm x 127 mm) 100 cell box.

⁴ 3.0 in. x 3.0 in. (76 mm x 76 mm) 25 cell box.

⁵ 2 ml vial size; 12.5 mm O.D. internal thread.

KRYOS Specifications

Configurations:	Designed exclusively for all Taylor-Wharton LABS CryoStorage Systems
Power Supply:	16.5 VAC, 40 Voltamps – Standard Battery Backup Version 24 VAC, 40 Voltamps (No Battery) (For power outlets other than North American 110 VAC contact Taylor-Wharton Customer Service.)
Sensor Assembly:	Freeze-Guard Assembly – Standard 8-Thermistor Assembly– Optional 4-Thermistor Assembly – Optional
Thermocouples:	Operates with none, 1 or 2 Type T Thermocouples (1 piece standard)
Solenoid Valve:	12 VDC cryogenic solenoid valve – Standard
Control Type:	Liquid Level Control or Liquid Level Control with Temperature Control
Security:	User Access via 2-digit password Power On/Off Password Menu access Password
Alarms:	Audible Visual red LED Alarm description Remote alarm relay
Diagnostics:	Circuit diagnostics at start-up Sensor diagnostics from front panel Thermocouple diagnostics from front panel Manual Test for audible, visual and remote alarms
Temp. Calibration:	Automated calibration from the front panel
Communications:	RS-232 Serial Port for 2-way communications capable
Logging Capacity:	System Logs (4096 events) Alarm Logs (4096 events) Temperature Logs (32,768 events)
Battery:	A CR2032 coin cell battery is used to back up time/date

INSTALLATION

Unpacking and Inspection

Inspect shipping containers for external damage. All claims for damage (apparent or concealed) or partial loss of shipment must be made in writing within five (5) days from receipt of goods. If damage or loss is apparent, please notify the shipping agent immediately.

Open the shipping containers; a packing list is included with the system to simplify checking that all components, cables, accessories, and manuals were received. Please use the packing list to check off each item as the system is unpacked. Inspect for damage. Be sure to inventory all components supplied before discarding any shipping materials. If there is damage to the system during transit, be sure to file proper claims promptly with the carrier and insurance company. Please advise Taylor-Wharton of such filings. In case of parts or accessory shortages, advise Taylor-Wharton immediately. Taylor-Wharton cannot be responsible for any missing parts unless notified within 60 days of shipment.

Repackaging for Shipment

If it is necessary to return any part of the system for repair or replacement, a Material Return Authorization (MRA) number must be obtained from an authorized factory representative before returning the instrument to our service department. Contact your distributor for return authorization. When returning an instrument for service, the following information must be provided before obtaining an MRA:

- A. System model and serial number, and controller serial number
- B. User's name, company, address, and phone number
- C. Malfunction symptoms
- D. Description of System

If possible, the original packing material should be retained for reshipment. If not available, consult Taylor-Wharton for shipping and packing instructions. It is the responsibility of the shipper to assure that the goods are adequately packaged for return to the factory.

Liquid Nitrogen Supply Connection

The package included with the refrigerator includes a strainer. The liquid fill hose from a low pressure source of liquid nitrogen must be connected to the inlet through this fitting. This liquid nitrogen source must have a shut-off valve, and may be any portable liquid cylinder or a bulk supply. The liquid nitrogen supply pressure at the inlet to the refrigerator should be in the range of 10 psig (0.7 bar/69 kPa) to 20 psig (1.4 bar/38 kPa) for optimum performance. Higher operating pressures will increase transfer losses and create excessive turbulence of the liquid in the refrigerator which can generate false signals to the liquid level controller causing the refrigerator to under-fill. In "liquid phase" storage applications, excessive turbulence can cause splashing which could result in personal injury and/or damage to the refrigerator. If the liquid nitrogen supply pressure at the inlet to the refrigerator rises above the opening pressure of the relief valve on the refrigerator, liquid nitrogen will be discharged into the surrounding area which can cause a rapid and very dangerous depletion of oxygen in the atmosphere. Once this pressure relief device has opened and cooled to liquid nitrogen temperature, it will not reseal until it has warmed to near ambient temperature. THIS COULD PERMIT THE ENTIRE CONTENTS OF THE LIQUID NITROGEN SUPPLY SYSTEM TO BE DISCHARGED INTO THE IMMEDIATE AREA OF THE REFRIGERATOR(S).

WARNING: In order to prevent the relief device on the nitrogen refrigerator(s) from opening when the system is in operation, the liquid nitrogen supply system must be protected by a pressure relief device that will open when the pressure at the inlet to the refrigerator(s) is approximately 22 psig (1.5 bar/152 kPa). Never install the supply system pressure relief device onto a liquid service line.

Power Supply Connection

Connect the 16.5 Volt AC power supply to the control of the LABS cryostorage system; then plug the power supply into a surge protected 110/120 VAC outlet.

KRYOS Control Field Installation

1. Unplug power from old unit.
2. Close liquid nitrogen supply at valve.
3. Remove 4 Phillips head screws from rear of interface display box.
4. Remove controller face from interface display box.
5. Finish face removal by disconnecting plug and ground wire.
6. Remove 2 Phillips head screws from the old control located underneath the tabletop.
7. Withdraw old controller from underneath table top, noting how the controller body has been resting on outer upper head.
8. Unplug all connectors and wires and set panel aside.
9. Disconnect supply hose from solenoid valve.
10. Remove old solenoid.
11. Remove spiral wire wrap.
12. Mark old sensor locations with electrical tape
13. Measure and make note of the "Start Fill", "Stop Fill" and temperature sensors from the bottom of the appropriate sensor tube. You will need this information to set up the new controller.
14. Remove old sensor wires.
15. Calibrate new KRYOS control to new temperature sensor.
16. Reverse procedure to install KRYOS control.

OPERATION

These instructions are for operators experienced with cryogenic equipment. Before operating the system, become familiar with the safety precautions in this manual and in reference publications. Make certain all applicable provisions set forth in the Installation Section have been followed before placing a system in operation. Study this manual thoroughly. Know the location and function of all system components.

Initial Fill

The LABS cryostorage system using the KRYOS controller, comes preset from the factory. The liquid nitrogen supply pressure at the inlet to the refrigerator should be in the range of 10 psig (0.7 bar/69 kPa) to 20 psig (1.4 bar/138 kPa) for optimum performance. Higher operating pressures will increase transfer losses and create excessive turbulence of the liquid in the refrigerator which can generate false signals to the liquid level controller causing the refrigerator to under fill. In “liquid phase” storage applications, excessive turbulence can cause splashing which could result in personal injury.

WARNING: Maintain adequate ventilation to prevent asphyxiation hazard (see Safety Precautions).

WARNING: If the fill fails to stop for any reason, quickly close the liquid supply valve to prevent overfilling until the cause of the problem can be determined.

Control Components

Interface Panel

The KRYOS Interface panel, which the user will interact with, contains the vacuum fluorescent display as well as the number keypad, power button, help button and the soft-key control buttons. (See figure 1.0 below.)

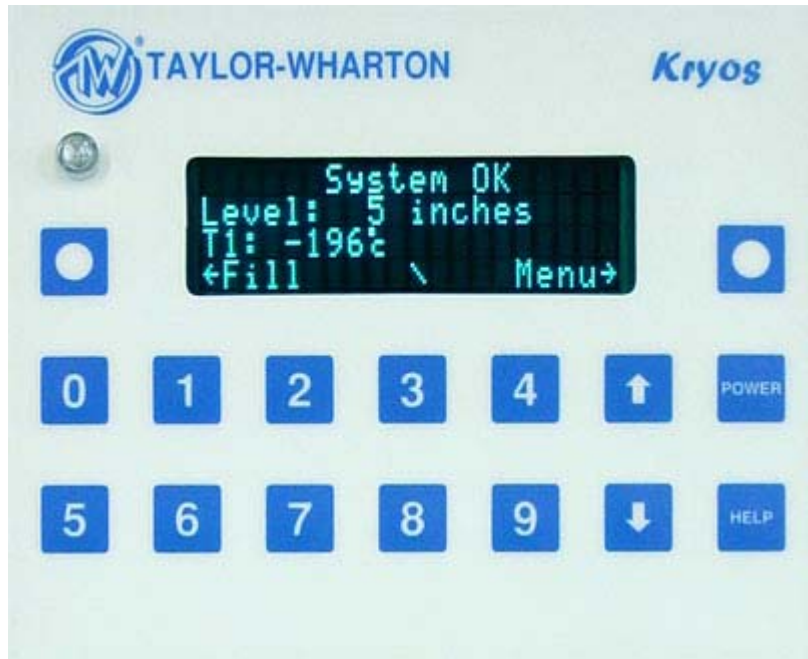


Figure 1.0 KRYOS Interface Panel

Main Control

The “brain” for the control system “talks” to the interface unit and makes all decisions regarding liquid levels, temperatures, valve opening/closing, etc. It is located away from the Interface Panel on the upper outer head. (See figure 2.0 below.)

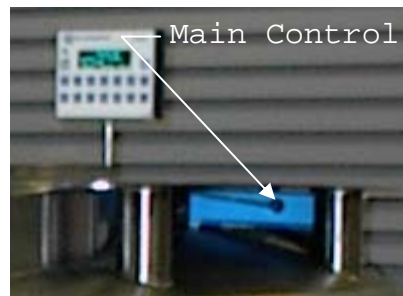


Figure 2.0 KRYOS Main Control

Sensor Assembly

A standard 7+1 thermistor assembly, includes the Freeze-Guard over-fill sensor. Optional 4-thermistor, or 8-thermistor sensor assemblies can be ordered. The 4-thermistor assembly maintains the liquid level between 2 middle sensors. The 8-thermistor assembly maintains the liquid level between the high sensor and the low sensor assigned by the user. The standard 7-thermistor assembly is similar to an 8 sensor assembly in that the user can select the START FILL and STOP FILL positions. The eighth position on this assembly is tied into an inline plumbing thermistor, which detects if the solenoid valve fails to close.

Lid Switch

Is attached to the hinge and determines whether or not the lid is open on the freezer. This also allows the control to determine whether to activate the Quickchill, Auto Defog or Lid Alarm features.

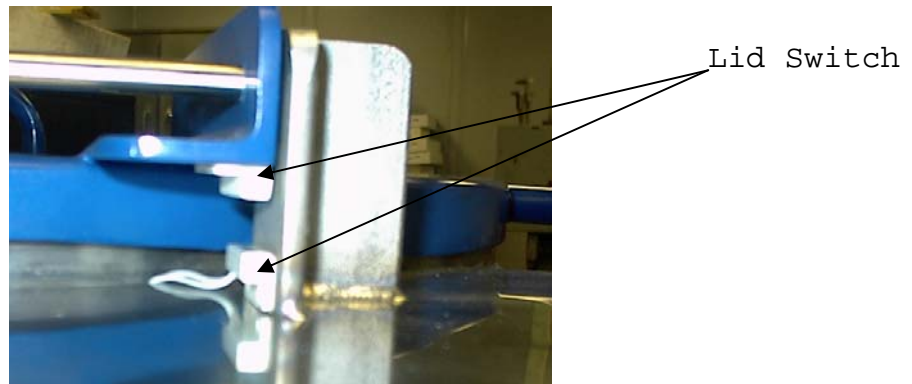


Figure 3.0 Lid Switch

Solenoid Valve

Designed to work with 12 VDC solenoid valves manufactured by Valcor, Parker-Hannifin, ASCO or Alcon. (See plumbing assembly Figure 10.0 on page 37 of this manual.)

Thermocouples

Type T thermocouples determine the temperature in the freezer. The user may choose to use NONE, 1 or 2 thermocouples with this control at any time. (The unit comes complete with one Thermocouple)

Wall Transformer

A 16.5 VAC, 40 VA wall transformer is a standard option on the LABS cryostorage system with battery backup. A 24 VAC, 40 VA wall transformer is supplied for the Kryos version (No Battery). The system is supplied with a transformer compatible with common household (North American) 110VAC. (For other power outlets contact Taylor-Wharton Customer Service.) These wall transformers have UL approval. UL approval for the system as a whole is not required since the control operates on low voltage. If your power source differs, or is subject to disruption or line surges due to other equipment on line, consult your Taylor-Wharton representative.

Battery Backup

The LABS cryostorage system with the battery backup option has a 12VDC battery installed underneath the unit's tabletop.

Remote Alarm

If an error condition occurs after a user defined period of time a remote alarm circuit can be initiated. This is accomplished by connecting a remote device to the remote alarm jack on the rear electrical panel. The 3-pin jack on the back of the unit provides continuity between pin #2 (common) and pin #3 in the normal condition. Continuity between pin #1 and pin #2 is provided in an error condition. (See Figure 4.0 below.)

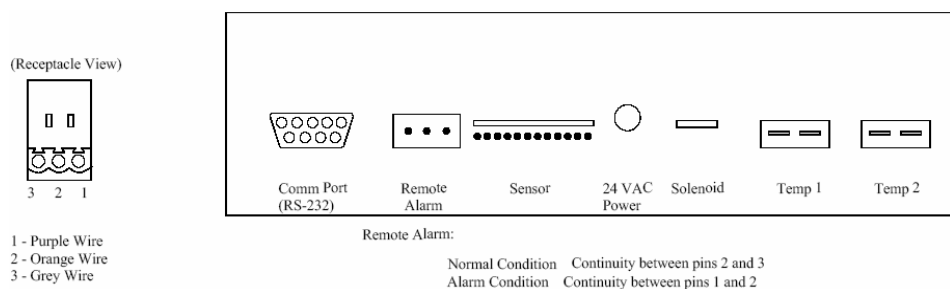


Figure 4.0 Remote Alarm Plug Connection

Operating Parameters

When materials are immersed in liquid nitrogen, they will assume the temperature of the liquid -196°C (-320°F). When material is stored in the vapor phase over the liquid, the liquid nitrogen is still a very cold refrigerant, but the refrigerator's interior temperature increases somewhat as product is stored higher over the liquid. This temperature differential is not significant in many biological storage applications, and is affected by the amount of product stored in the refrigerator, the type and size of inventory control system, and the liquid level in the unit.

The liquid level in the refrigerator is determined by the position of the sensor probes in the tube located to the right of the refrigerator. These probes are set at installation to maintain a specific liquid level. The controller operates a fill cycle that adds liquid at a low level, fills to a predetermined high level, then stops the fill. The cycle repeats when the liquid level drops to the low level sensor over time. Sensor probe assignments may be changed on the controller keypad to define new high and low levels, and these levels may be set independently to vary the liquid level differential between fills. Prior to the initial fill of the refrigerator, a determination should be made whether vapor phase or liquid phase storage will be utilized.

The sensor probe contains seven thermistors that can be preprogrammed for any liquid level application. The separate sensor in the sensor tube is the temperature thermocouple. The thermocouple is normally positioned at the top of the storage rack. The factory sensor positions will maintain a liquid level within a distance of 2 in. (50.8 mm) from the bottom of the operating tray.

Liquid Phase Storage

Liquid phase storage is normally utilized when liquid nitrogen temperatures are required to maintain stored product viability and the storage medium is adequate for storage in liquid nitrogen.

In a typical liquid phase storage system, the liquid level sensors are positioned to maintain the liquid level at or below the top level of the inventory control system. During operation, the upper levels of the inventory control system will at times become exposed as the liquid level fluctuates.

Care must be taken to ensure that the liquid level remains below the bottom of the refrigerator lid. Exposure to liquid nitrogen may result in physical damage to the lid. Additionally, operating the refrigerator with high liquid levels characteristic of liquid phase storage may result in turbulence during fill cycles. Caution must be exercised if the refrigerator lid is opened during a fill, and appropriate safety equipment should always be worn.

The LABS cryostorage system is set at the factory for vapor phase storage. To reconfigure the system's settings for liquid phase, the following steps should be used.

1. Power up the unit.
2. Remove the "Start Fill", "Stop Fill" (Thermistor) sensors.
3. Allow the unit to fill to your desired "Stop Fill" elevation.
4. Stop the fill by closing the supply line valve.
5. On the interface panel, push (**MENU**, 2, 1).
6. Insert the "Start Fill", "Stop Fill" (Thermistor) sensors until the #6 sensor changes on the display from G (gas) to L (liquid).
7. Return to the main (**MENU**).
8. Dress wires and seal with stopper.

Thermocouple Positioning

The thermocouple is a separate sensor used to monitor and control the temperature within the refrigerator. The factory-supplied thermocouple in the LABS cryostorage system is positioned to monitor the temperature 30” above the tray.

Adding an Inventory Control System

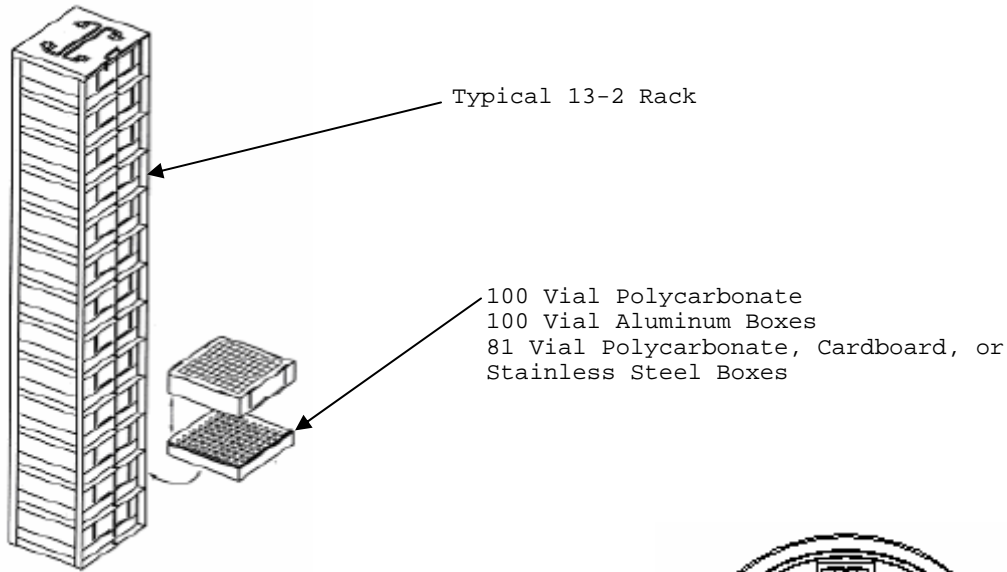
The purpose of the inventory control system is to bring order to the storage of many small samples, and to allow direct retrieval of the particular sample you need at any time. It is important to be aware that when you lift an ICS rack from the refrigerator it is in a warmer environment. Learn to locate your sample quickly to avoid unnecessary warming of your stored product. Keep ICS inserts (drawers or boxes) and dividers in good repair. Replacement inserts and dividers are available from your Taylor-Wharton distributor to keep your system as efficient as possible.

Always wear gloves when handling ICS racks or stored product, as they are very cold – read the precautions in the Safety section of these instructions, and in Taylor-Wharton publication TW-10 “Handle With Care”, for more detail on handling product stored in liquid nitrogen.

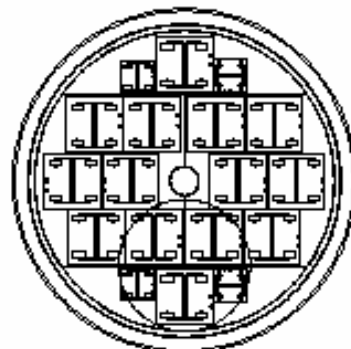
When removing ICS racks to retrieve product, protect the labels, plastic, and electronic areas of the refrigerator from liquid nitrogen that may spill from the rack inserts. These parts of the refrigerator are subject to damage from the extreme low temperature of the refrigerant.

Do not let ice or debris collect in the bottom of the freezer. Schedule periodic clean out if racks no longer stand upright.

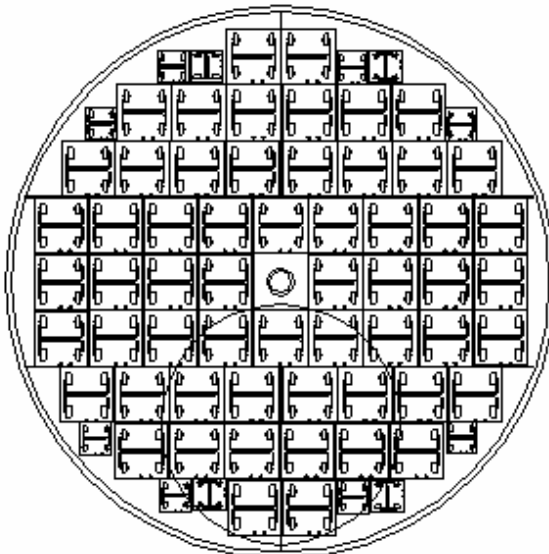
Inventory Control System Layouts (LABS Cryostorage System)



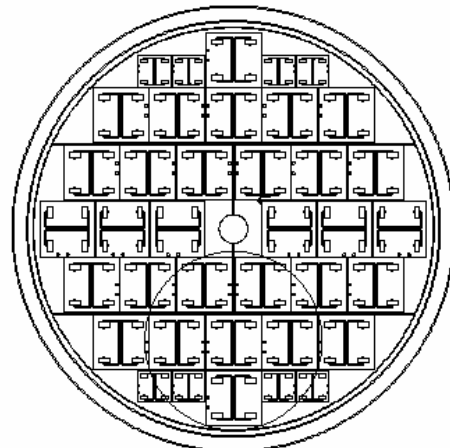
NOTE:
RACKS ARE NOT SQUARE.
ORIENTATION IS IMPORTANT.



LABS-20K



LABS-80K

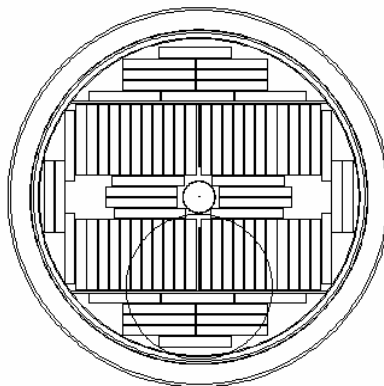
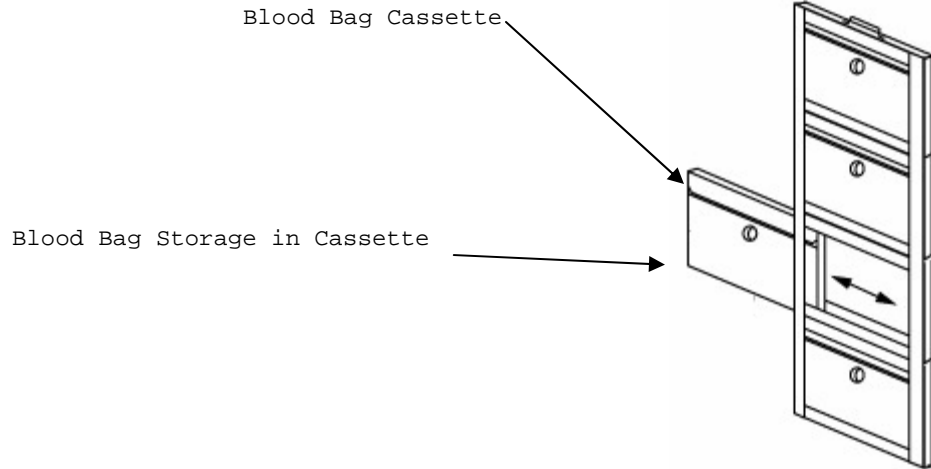


LABS-40K

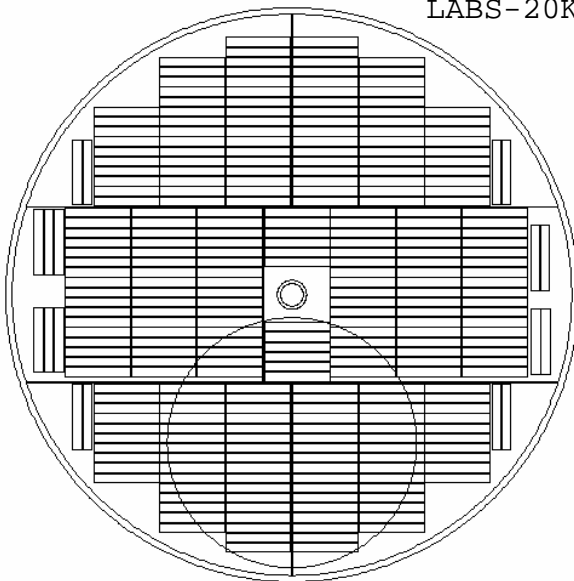
2ml vial storage – ask about other Box types

Part Number	Racks 13 x 2 x 100 R23K-8C35	Racks 13 x 2 x 25 R10K-9C44	BOXES-100 N-374187-92 (Case of 24 Polycarbonate)	BOXES-25 N-374180 (Case of 36 Polycarbonate)	VIAL CAPACITY Max. allowable
LABS-80K	58	12	754	156	79300
LABS-40K	30	8	390	104	41600
LABS-20K	14	4	182	52	19500

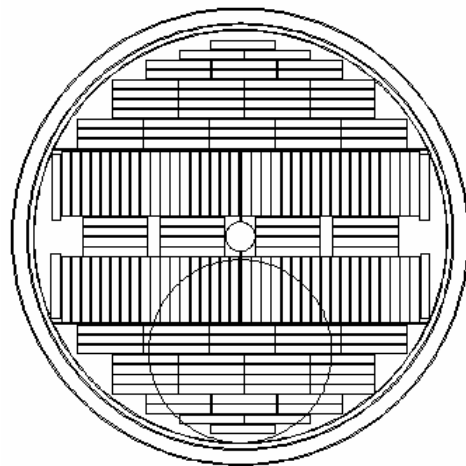
Figure 5.0 Vial Storage on Racks



LABS-20K



LABS-80K

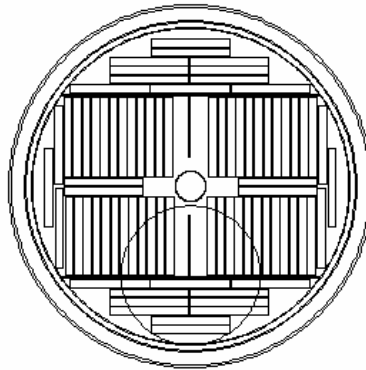
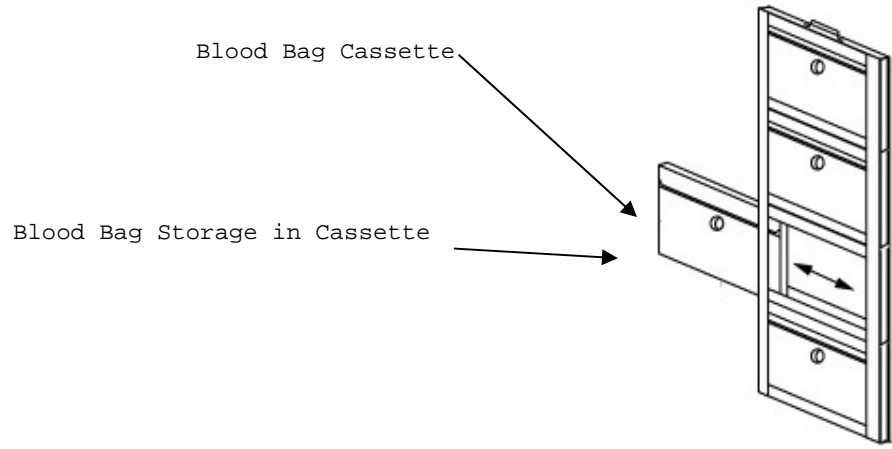


LABS-40K

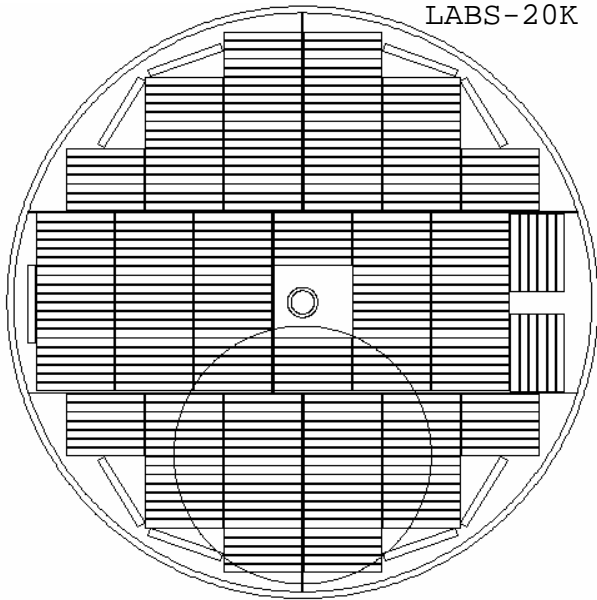
Fenwal 4R9951 Blood Bags – ask about other Bag types

PART NUMBER	CAPACITY	FRAMES	CASSETTES
LABS-80K	2100	300	2100
LABS-40K	1204	172	1204
LABS-20K	560	80	560

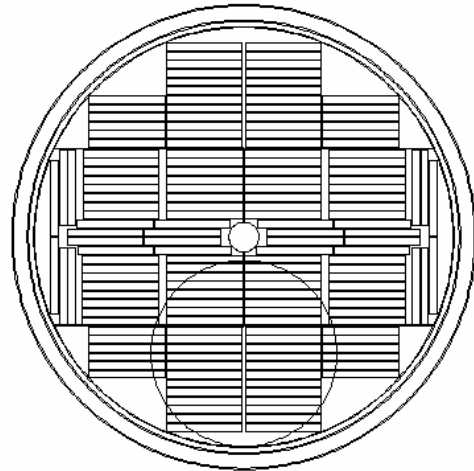
Figure 6.0 Fenwal 4R59951 Blood Bag Rack Arrangements



LABS-20K



LABS-80K

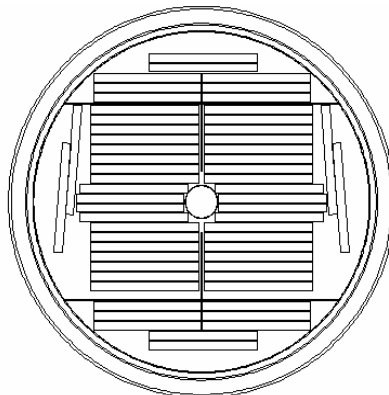
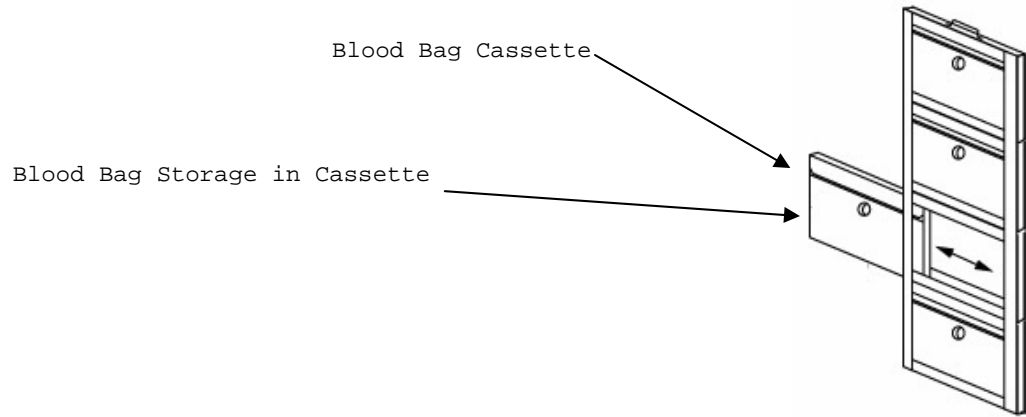


LABS-40K

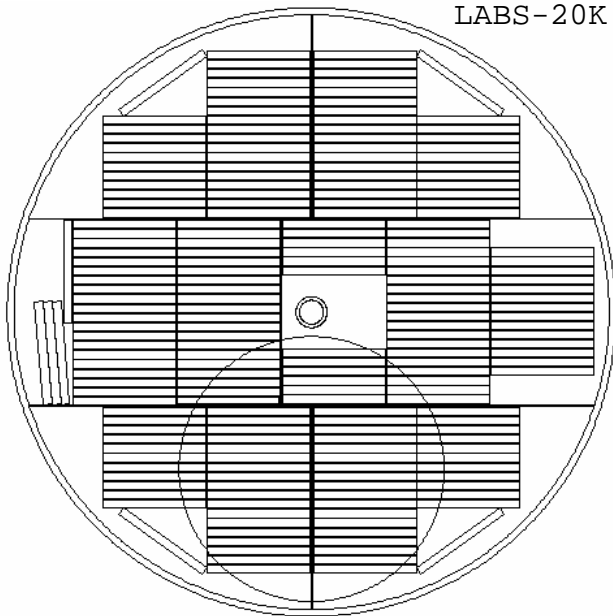
Fenwal 4R9953 Blood Bags – ask about other Bag types

PART NUMBER	CAPACITY	FRAMES	CASSETTES
LABS-80K	1505	301	1505
LABS-40K	820	164	820
LABS-20K	400	80	400

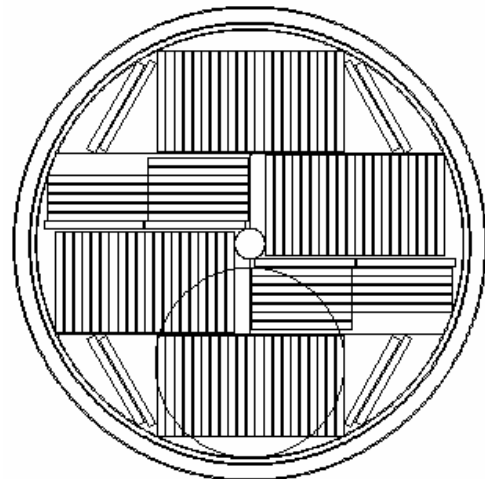
Figure 7.0 Fenwal 4R59953 Blood Bag Rack Arrangements



LABS-20K



LABS-80K



LABS-40K

Fenwal 4R5462 – 9955 Blood Bags – ask about other Bag types

PART NUMBER	CAPACITY	FRAMES	CASSETTES
LABS-80K	1050	210	1050
LABS-40K	590	118	590
LABS-20K	290	58	290

Figure 8.0 Fenwal 4R5462 – 9955 Blood Bag Rack Arrangements

Control Operation

This section of the operating manual is for Taylor-Wharton approved equipment that uses the KRYOS controller.

Introduction

The KRYOS temperature and LN2 level controller is designed for easy operation and uninterrupted, reliable service. This controller will maintain the selected temperature and liquid level range of LN2 in your refrigerator as well as provide audible and visual alarms for any alarm conditions that may occur. An “*alarm*” is any off-normal condition, such as a sensor short or open circuit, a temperature outside of the limit set by the user, or any other condition that would cause the controller to enter the *ALARM* mode. “*Events*” are lid openings and closings, solenoid valve openings and closing, and operation of the controller’s relay for remote alarm indication. “*Data*” refers to periodic alarm and event logging available at the “*Data Output*” connection.

The KRYOS controller should require no additional attention to control temperature and maintain liquid level if an adequate supply source of liquid nitrogen is maintained. If your protocol calls for you to “top-off” the cryostorage system at the end of a workday or workweek, press the FILL button. The unit will fill to the upper allowable liquid level and stop automatically. You may choose to manually stop the fill by pressing the STOP button at anytime during the fill.

Normal Fill Cycle

When the refrigerator is filled and the controller is operating, the LOW LEVEL and LOW ALARM sensors are immersed in liquid nitrogen. Their resistance values are interpreted by the controller as “in liquid”. At the same time, the FULL LEVEL and the HIGH ALARM sensors are above the liquid pool, sending the controller an “above liquid” signal. As liquid nitrogen evaporates, the liquid level in the refrigerator drops slowly until the LOW LEVEL sensor is above the liquid and sends a different signal to the controller. After a delay sufficient to ensure the signal, the controller interprets this condition as low liquid and opens the fill solenoid, admitting more liquid nitrogen from the supply source.

The refrigerator will fill slowly. The fill continues until the STOP FILL sensor sends the controller a signal that it is now in liquid. The controller will close the liquid supply solenoid to stop the fill. As liquid evaporates, the display will indicate the liquid is at a normal level as the cycle begins again.

The KRYOS temperature and liquid level controller is designed to support a remote alarm. Connections are provided on the back of the controller chassis.

Power

The control can be turned on and off by pressing the Power button followed by “42”, as instructed on the display panel. The two-step shutdown is a precaution against accidental shutdown. Shutdown can also be password protected to prevent users from turning the system on and off under the security section of this manual.

Main Display Screen

The main display screen consists of 4 lines of information.

Line 1: Displays the current status of the control. It indicates if all systems are normal or if any errors have been detected. Error messages disappear when the error is corrected.

Line 2: Displays the level sensing in the control. If the 7-thermistor or 8-thermistor assembly is being used, the control will indicate actual liquid level in the freezer. If a 4-thermistor assembly is being used, the control will indicate LOW if the liquid level is below sensor #2, NORMAL if the liquid level is between sensor #2 and sensor #3, and HIGH if the liquid level is above sensor #3. In addition, LOW LEVEL ALARM is indicated when the liquid level is below sensor #1 and HIGH LEVEL ALARM is indicated when liquid level is above sensor #4.

Line 3: Displays the temperature indicated by thermocouple #1 and #2. If either thermocouple is disabled by the user through the menu system, it is no longer displayed on the front panel. If both thermocouples are disabled by the user, line 3 is blank.

Line 4: Used to annotate (or label) the soft-key buttons and to provide information about the valve and the lid status. In the center of the line, a rotating “baton” provides a visual indication that the control is running and functioning properly.

The Menu System

Pressing the Soft Key labeled MENU on the front right side of the control will access the menu system. Choose a menu option by pressing the appropriate number of your menu choice. If more menu choices are available than will fit on 1 screen (more than 4 choices in this menu section), the left-hand soft-key button will give the “More” choice. Pressing this button will give the user the additional menu choices. A shortcut is available to get to the proper menu choice by pressing the appropriate number button. The menu choice need not be visible on the screen to select it.

When the menu is accessed, all control functions cease until the control returns to the main status screen. Therefore, if a fill is occurring and the menu is accessed, the solenoid valve will close until the menu system is exited and the control is again displaying the main screen. If the menu system is accessed but not interacted with for 3 minutes, it will automatically revert to the main screen and all functions will resume.

Please note that the menu system can vary slightly depending on the configuration of the control. Menu choices will be included or excluded depending on the selected features in the control. This is illustrated in the menu system when the 4-sensor or the 8-sensor probe assembly is being used. The START FILL and STOP FILL sensor must be physically set when the 4-sensor probe is in use, so the START FILL level and STOP FILL level menu items are not displayed. When the control is operated with the 8-sensor assembly, the user can assign the START FILL and STOP FILL levels with the control key pad without physical intervention to the sensors in the storage chamber unless you want to change from vapor phase storage to liquid phase storage. (See Menu Table 1.0 on page 21 of this manual.)

Table 1.0 Menu System

1. Temperature	4.4 Temperature Logs
1.1 Thermocouple Select	4.4.1 Thermocouple #1 Log Rate
1.2 Calibrate Temperature	4.4.2 Thermocouple #2 Log Rate
1.3 Test Temperature System	4.5 Erase Logs
2. Level Sensing	4.5.1 Erase System Logs
2.1 Test Level Sensors	4.5.2 Erase Error Logs
2.2 Set Sensor Offset	4.5.3 Erase Temperature Log #1
2.3 Sensor Positions	4.5.4 Erase Temperature Log #2
2.3.1 Start Set Point	5. Security
2.3.2 Stop Set Point	5.1 Power-On Password
2.4 Sensor Type	5.2 Menu Password
2.5 Inch/Metric	6. User Options
3. Alarms	6.1 RS-232 Settings
3.1 High-Temp Alarm #1	6.1.1 Disable RS-232
3.2 High-Temp Alarm #2	6.1.2 Set up RS-232
3.3 System Alarms	6.1.2.1 Toggle
3.3.1 LN2 Supply Alarm	Handshaking
3.3.2 Sensor Error Alarm	6.1.2.2 19200 Baud (Sets
3.3.3 Remote Alarm Timer	the baud rate)
3.3.4 Lid Open Too Long	6.2 Control Options
3.3.5 Thermocouple Alarm	6.2.1 Date & Time
3.4 Test Alarms	6.2.2 Lid/Defog Settings
3.4.1 Test Audible	6.2.2.1 Defog Timer
3.4.2 Test Visual	6.2.2.2 Lid Switch Setup
3.4.3 Test Remote	6.2.2.3 Auto Defog
4. Logging	6.2.2.4 Quick-Chill
4.1 Dump Logs	6.2.3 Control By Temperature
4.1.1 Dump System Logs	6.2.3.1 Disable
4.1.2 Dump Error Logs	Temperature
4.1.3 Dump Temp Log #1	Control
4.1.4 Dump Temp Log #2	6.2.3.2 Temperature
4.2 Error Logs	Control settings
4.2.1 Sensor Error Logging	6.2.3.2.1 Control
4.2.2 Low Supply Logging	Temperature
4.2.3 Remote Alarm Logging	6.2.3.2.2 Control
4.2.4 Open Thermocouple logging	Range
4.2.5 High Temperature	6.2.4 Freeze-Guard Options
Alarm Logging #1	6.2.4.1 Valve Open
4.2.6 High Temperature	Duration
Alarm Logging #2	6.2.4.2 Frozen Valve
4.3 System Logs	Sensor
4.3.1 Fill Logging	6.2.4.3 Valve De-icing
4.3.2 Lid Action	6.3 Display Brightness
Logging	6.4 About this Control
4.3.3 User Access Logs	

Help Screens

The Help button provides help to the user at any point in the menu system. The help message is displayed and the user is then prompted to press a button to return to the menu system.

Temperature

Thermocouple Select

The chamber temperature is monitored with 1 or 2 Type T thermocouples. The thermocouple is placed in the chamber to monitor temperature level with the top rack. Factory installation includes one thermocouple inside of the thermocouple tube at an elevation to match the height of standard racks. A second Type T thermocouple may be added to monitor another location inside the chamber. Both thermocouples can be activated/deactivated through the menu system. (MENU, 1, 1)

Calibrate Temperature

KRYOS provides easy calibration of the thermocouples. To calibrate, the user should enter the menu system (MENU, 1,2). Remove the thermocouple from the thermocouple tube and dip thermocouple #1 into an ice water bath. The fourth line of the control display will indicate "Wait" and will give a reading on the proximity of the temperature to 0°C. When the temperature reaches equilibrium the control will indicate "OK" and the user can press the left soft-key button. Dry the thermocouple thoroughly. Next, the control will prompt you to dip thermocouple #1 into LN2. Wait while the control reaches equilibrium at -196°C (-320°F). When it does, the control will again indicate "OK" and the user can again press the left soft-key button. The control is now calibrated. The thermocouple is now ready to be repositioned inside the thermocouple tube. Please note that both thermocouples are calibrated by going through this process with Thermocouple #1.

Test Temperature System

The temperature circuitry can be checked at any time through the menu system (MENU, 1,3). This check will tell if the thermocouples are working or if they are "open" (broken or unplugged). If a thermocouple is not connected to the control it will check as "open." If a thermocouple is "Disabled" through the menu system, it will not show up on the check.

Level Sensing

The level sensing in the system is determined through the use of thermistor-based sensor assemblies. Thermistors are thermal resistors whose resistances change as temperature changes. Their use in liquid level control is a time-tested method to provide accurate results. The KRYOS uses a 7-, 8- or a 4-thermistor assembly to measure liquid level in the freezer. The 4-sensor assembly provides general information about liquid level (high, normal, and low alarm) while the 7- and 8-thermistor assemblies provide liquid level readings accurate to within one inch. When the LN2 level drops below the *START FILL* sensor, the control opens the solenoid valve to commence the fill process. This process continues until the LN2 level reaches the *STOP FILL* sensor. When the control "senses" that the LN2 has reached the upper level, it flashes "Check" on the display while the KRYOS insures that it has not received false signals and then allows the fill to stop. The fill process can be halted at any time before it reaches the *STOP FILL* sensor by manually pressing the *STOP FILLING* button.

Test Level Sensors

The sensor assembly can be tested through the menu system as well (MENU, 2, 1). The sensor diagnostics indicates the sensor number and the status (whether in liquid or gas) of that sensor. If the control is set for an eight-thermistor or Freeze-Guard sensor it will indicate 8 sensors in the diagnostics. Likewise, if it is set for a four-sensor assembly, it will indicate 4 sensors. The status is indicated with either an "O" for open, a "G" for gas or an "L" for liquid. This is an easy means to tell if sensors are in or out of liquid or if a new sensor assembly is needed (open sensors).

Sensor Type

The sensor type can be set through the menu system (**MENU**, 2, 4). The sensor type selection should match the sensor type that is being used in the system. This is a 4-sensor, a 7-sensor (Freeze-Guard) or an 8-sensor array. If the sensor assembly is unplugged and the main control is still on, the display will indicate that a sensor error has occurred. In addition the level indicated would be 8" on an 8-sensor assembly, 7" on a Freeze-Guard assembly or "High Alarm" on a 4-sensor assembly. This occurs because the control cannot differentiate between a very high resistance (when a thermistor is in LN2) and an infinite resistance (when an open circuit appears in the level sensing circuitry).

Alarms and Error Conditions

The KRYOS control tracks many different conditions in the freezer and therefore, has a full complement of alarms associated with these different conditions. As alarms occur, they cause an audible beep as well as a flashing red light. A remote alarm relay is also triggered following a user-designated period of time, after the error condition occurs, if it is not corrected. In addition, the error condition is displayed on the top line until the error condition is corrected. When an error does occur, the audible alarm may be muted by pressing the designated button. The audible alarm will then be silent until activated by a new error condition. The red light will continue to flash until all errors are corrected. The remote alarm will be activated if the power is interrupted.

The High Temperature Alarm for Thermocouple #1 can be set through the menu system (**MENU**, 3, 1). This alarm is activated if the temperature rises above the designated temperature. The alarm temperature can range from 0°C to -190°C. It can also be disabled.

The High Temperature Alarm for Thermocouple #2 can be set through the menu system (**MENU**, 3, 2). This alarm is activated if the temperature rises above the designated temperature. The alarm temperature can range from 0°C to -190°C and it can also be disabled.

System Alarms

The Low LN2 Supply Alarm can be set through the menu system (**MENU**, 3, 3, 1). This alarm is activated if the solenoid valve is not closed within a designated time period after a fill starts. The solenoid valve can be closed either automatically (the LN2 level reaches the *STOP FILL* sensor) or manually (the stop fill button is pressed) to stop the timer which activates this alarm. The possible choices for this alarm are None, 15, 30, 45, 60 minutes, 2 or 3 hours. This alarm does not correct itself until the fill is stopped (the solenoid closes).

The Sensor Error Alarm can be set through the menu system (**MENU**, 3, 3, 2). This alarm is activated if the control detects a sensor error such as an open sensor. The possible choices are ENABLE or DISABLE. An open sensor can be confirmed through the *TEST LEVEL SENSORS* option in the menu system (**MENU**, 2,1).

The Remote Alarm Timer can be set through the menu system (**MENU**, 3, 3, 3). This is the amount of time allowed to pass before the remote alarm relay is triggered if an error condition is not corrected. The possible choices are None, Immediate, 30 minutes, 60 minutes or 2 hours.

The Lid Open Too Long Alarm can be set through the menu system (**MENU**, 3, 3, 4). This is the amount of time the lid can be open before it triggers an alarm condition. The possible choices are None, 1, 2, 5 or 10 minutes.

The Thermocouple Alarm can be set through the menu system (**MENU**, 3, 3, 5). This alarm is activated if either thermocouple experiences an open circuit. The possible choices are ENABLE or DISABLE.

Test Alarms

The audible, visual and remote alarms can be tested at any time by the user through the menu system (**MENU**, 3, 4). Follow the instructions on the display to hear the audible “chirping” indicator of an alarm or to see the red LED flash or to trigger an immediate relay closure of the remote alarm.

Logging

The on board memory logging function is one of the most powerful and useful features of the KRYOS control. It provides a historical record for not only your freezer but also a complete record of the environment in which specimens were stored. Four separate logs are kept in the control:

1. System log – System logs are events that occur in the system such as lid opening/closing, LN2 filling Quick-Chill, Defog, etc.
2. Error log - Error logs are off-normal conditions detected by the system.
3. Temperature #1 log and Temperature #2 log - The two temperature logs are simply records of the temperatures recorded by the two thermocouples in the system.

The system and the error log each hold 4096 events while the combined temperature logs hold an additional 32,765 temperature events. All the logs are kept in non-volatile memory, meaning that the information is saved regardless of whether the control has power.

When an event (system, error or temperature) occurs, the control does two things with the data:

1. It enters the beginning or the conclusion of an event in the internal memory of the controller.
2. It sends the event data out the serial port of the freezer.

The control consolidates the events in the internal log (combining “start event” / ”conclude event” information to provide one event with duration), however, when the data is sent out the serial port no consolidation of data occurs.

As an example, a fill would provide one log entry in the internal log of the control, indicated as follows: **Fill occurred on 9/28/98 @ 8:07 for 24 minutes**. The same data coming out of the serial port would cause two entries in a computer or printer and would be indicated as follows:

```
Fill Started on 9/28/98 @ 8:07
... (elapsed time)
Fill occurred on 9/28/98 @ 8:07 for 24 minutes
```

Menu Access causes the control to make some decisions on logging an event and they are handled in the following manner: Temperature is immediately logged (if it is enabled) and then a fresh time period is started when the Menu system is exited. System and error logs are placed in a suspended state until the control exits the menu system and timing is started again. Duration of system and error logs then are total time of the event less any time that the user was in the menu system.

When logs are dumped to the serial port, the oldest events are sent first. The control operates on the FIFO (First In First Out) method. If the maximum number of entries is reached, the oldest are lost to make way for the newest entries.

Dump Logs

Dump SYSTEM LOGS is accessible through the menu system of the control (**MENU**, 4, 1, 1). This option sends data from the system logs out the serial port of the freezer. When this option is chosen, the display reports how many system logs are stored. While the data is being sent to the serial port, it can be paused or completely cancelled through the menu system.

DUMP ERROR LOGS is accessible through the menu system of the control (**MENU**, 4, 1, 2). This option sends data from the error logs to the serial port of the freezer. When this option is chosen, the display reports how many error logs are in the system. While the data is being sent out the serial port, it can be paused or completely cancelled through the menu system.

DUMP TEMP LOG #1 and *TEMP LOG #2* are accessible through the menu system of the control (**MENU**, 4, 1, 3 or **MENU**, 4, 1, 4). This option sends data from the temperature logs to the serial port of the freezer. When this option is chosen, the display reports how many temperature logs are in the system. While the data is being sent out the serial port, it can be paused or completely cancelled through the menu system.

Error Logs

SENS. ERR. LOGGING is accessible through the menu system of the control (**MENU**, 4, 2, 1). This menu choice turns on/off the logging of all sensor errors. The choices are ENABLE or DISABLE. Records data in the error log.

LOW SUPPLY LOGGING is accessible through the menu system of the control (**MENU**, 4, 2, 2). This menu choice turns on/off the logging of the low LN2 supply error. The choices are ENABLE or DISABLE. Records data in the error log.

REMOTE ALARM LOGGING is accessible through the menu system of the control (**MENU**, 4, 2, 3). The menu choice turns on/off the logging of the remote alarm activation. The choices are ENABLE OR DISABLE. Records data in the error log.

OPEN THERMOCOUPLE LOGGING is accessible through the menu system of the control (**MENU**, 4, 2, 4). This menu choice turns on/off the logging of the thermocouple open alarm. The choices are ENABLE and DISABLE. Records data in the error log.

HIGH TEMP #1 LOG is accessible through the menu system of the control (**MENU**, 4, 2, 5). This menu choice turns on/off the logging of the high temperature alarm for Thermocouple #1. The choices are ENABLE and DISABLE. Records data in the error log.

HIGH TEMP #2 LOG is accessible through the menu system of the control (**MENU**, 4, 2, 6). This menu choice turns on/off the logging of the high temperature alarm for Thermocouple #2. The choices are ENABLE and DISABLE. Records data in the error log.

System Logs

FILL LOGGING is accessible through the menu system of the control (**MENU**, 4, 3, 1). This menu choice turns on/off the logging of tank filling operations. The choices are ENABLE or DISABLE. Records data in the system log.

LID ACTION LOGGING is accessible through the menu system of the control (**MENU**, 4, 3, 2). This menu choice turns on/off the logging of lid openings and closings. The choices are ENABLE or DISABLE. Records data in the system log.

USER ACCESS LOGGING is accessible through the menu system of the control (**MENU**, 4, 3, 3). This menu choice turns on/off the logging of user access codes, which are requested when the lid is opened. Records data in the system log.

Temperature Logs

Temperature Logging Rates for thermocouple #1 (*T/C #1 LOGGING*) and thermocouple #2 (*T/C #2 LOGGING*) are accessible through the menu system of the control (**MENU**, 4, 4, 1 or **MENU**, 4, 4, 2). This menu choice adjusts the rate at which temperatures are logged for the two thermocouples. The possible choices are Disabled, 15, 30 minutes, 1, 2, 4, 6, 12 or 24 hours. Records data in the temperature logs.

Erase Logs

ERASE LOGS is accessible through the menu system of the control (**MENU**, 4, 5). This menu choice erases any of the four logs found in the control. **Please note that once a log has been erased, it is gone forever.**

ERASE SYSTEM LOGS (**MENU**, 4, 5, 1).

ERASE ERROR LOGS (**MENU**, 4, 5, 2).

ERASE TEMPERATURE LOG #1 (**MENU**, 4, 5, 3).

ERASE TEMPERATURE LOG #2 (**MENU**, 4, 5, 4).

Security

KRYOS security features restrict access to certain key features such as power and the menu system.

The *POWER-ON PASSWORD* can be set through the menu system of the control (**MENU**, 5, 1). The power-on password requires entry of a 4-digit password before turning on or turning off the control. Follow the directions on the display to set a new password or disable a password. Codes 0000 & 9999 are invalid choices. Code 9999 is used to access a procedure to clear passwords should they be forgotten.

The *MENU PASSWORD* can be set through the menu system of the control (**MENU**, 5, 2). The menu password requires entry of a 4-digit password before allowing access to the menu system to change any control settings. Follow the directions on the display to set a new password or to disable a password. Codes 0000 & 9999 are invalid choices. A code of 9999 is used to access a procedure to clear passwords should they be forgotten.

User Options

The user options menu choice covers all other control settings not already covered. These include serial port settings, date and time settings, Lid Settings, Defog, Quick-Chill, Temperature Control, Valve Freeze-Guard, Display brightness and Control Information.

Lid Switch Setup

LID SWITCH SETUP can be accessed through the menu system of the control (**MENU** 6, 2, 2, 2). This option enables or disables the lid switch.

Manual Defog

DEFOG TIMER can be changed through the menu system of the control (**MENU**, 6, 2, 2, 1). This is the time interval that the valve is opened when the user manually presses the defog button. The possible choices are disabled through 90 seconds.

Auto Defog

The *AUTO DEFOG* (**MENU**, 6, 2, 2, 3) feature provides a burst of gaseous N₂ to the freezer to clear the fog when the lid is opened. This is activated through the lid switch. If the lid switch is deactivated this feature will be disabled. The choices for auto defog time are disabled through 90 seconds.

Quick-Chill

The *QUICK-CHILL* (**MENU**, 6, 2, 2, 4) feature provides a burst of N₂ gas to the freezer to lower the temperature each time the lid has been opened and then closed. This is activated through the lid switch. If the lid switch is deactivated this feature will be disabled. The choices for quick-chill time are disabled through 90-second purge of gaseous nitrogen.

Control By Temperature

CONTROL BY TEMP can be set through the menu system of the control (**MENU**, 6, 2, 3). By enabling this option KRYOS will control by temperature around Thermocouple #1. The Temperature Control menu choices are only available if Thermocouple #1 is enabled.

Temperature Control Settings

TEMP CTRL SETTINGS can be set through the menu system of the control (**MENU**, 6, 2, 3, 2, 1). The user can set the temperature that must be maintained in the freezer around Thermocouple #1. The set-point can be set from -180° to -100°C.

Control Temperature

KRYOS can also *provide a vapor chamber temperature control* for specimens that must be stored in a particular vapor temperature range. The temperature control function operates in addition to the level control function. The level control always takes precedence. If the liquid level of LN₂ is maintained between the START FILL sensor and the STOP FILL sensor, the control attempts to maintain a selected temperature around Thermocouple #1.

Menu Password

When the menu password is active, it is possible to review all of the control settings without having the password. When a password is activated and the user presses the menu key, two choices are available:

- 1) *MENU (PASSWORD REQ)*
- 2) *CONTROL SETTINGS*

By selecting choice #2 the user can go through the menu system and see all of the settings in the control but in this mode, the user cannot change any settings. If either the power-on or the menu passwords are forgotten, the user can reset the password by typing in 9999 when asked for the password. The KRYOS will display an 8-digit number. Call your distributor or Taylor-Wharton with the 8-digit number to obtain a unique 8-digit number to type into the control. When this number is entered, all passwords are cleared.

Serial Communications and RS-232 Settings

The KRYOS control system is designed with a 2-way serial communication feature. RS-232 (**MENU**, 6, 1) allows the user to configure the serial port to “talk” with other Data Terminal Equipment (DTE). The control can send data through its serial port to a computer, a printer or a modem. System logs, error logs or temperature logs are always available for download. In addition to downloading data, the control can accept commands through the serial port. Control settings can be viewed or changed at any time. Also remote diagnostics can be performed.

If the RS-232 is enabled the handshaking can be turned on and off. This feature allows two devices to communicate when sending data. Also the baud rate can be set for the following speeds: 300, 1200, 2400, 4800, 9600 or 19200 baud.

Time and Date Set

TIME AND DATE SET can be changed through the menu system. (**MENU**, 6, 2, 1). The date and time will be set at the factory to Central Time, USA.

User Access Logs

The *USER ACCESS LOGS* (**MENU**, 4, 3) track all personnel who enter the freezer by asking for an identification number when the lid is opened. When this feature is enabled, the control asks for an identification number any time the lid is opened. An entry is then recorded in the log indicating the time, date and identification of the person entering the freezer. The user has 30 seconds to enter an ID code (the 30 seconds is counted down on the screen). If an ID is not entered within the 30-second time frame, the log indicates that an unidentified user accessed the freezer. Identification numbers range from 00 to 99.

Control Range

CONTROL RANGE can be accessed through the menu system of the control (**MENU**, 6, 2, 3, 2, 2). KRYOS maintains a temperature range around the user-selected temperature. A tighter range maintains a temperature very close to the selected temperature at the cost of greater LN2 usage. A broad range provides more temperature variability but the LN2 usage is less. The range can be varied from +1° to +15°C above and below the selected temperature. The total range therefore, is between 2°C (1° below and 1° above the selected temperature) and 30°C (15° below and 15° above the selected temperature). When the KRYOS is attempting to control by temperature, it flashes “*T.Recov*” (Temperature Recovery) in the center of the bottom line.

Freeze-Guard Options

Ice crystals introduced through the supply line are the primary cause of an overflow. Freeze-Guard is a process designed to reduce the risk of an overflow. Freeze-Guard consists of two options to reduce the risk of a frozen valve: 1) The maximum valve open duration can be set by the user. (*VALVE OPEN DURATION*) 2) The valve can be rapidly turned on and off trying to free it up (*VALVE DE-ICING*). Option 2 occurs if either the Freeze-Guard sensor detects that the valve is not fully closed. The special “Freeze-Guard” sensor assembly includes a plumbing “T” with an in-line thermistor which is placed in the plumbing directly downstream from the solenoid valve. KRYOS monitors the “Freeze-Guard” thermistor and detects if the flow of LN2 is stopped when the valve has been commanded to close.

Valve Monitoring

If KRYOS detects that a flow of LN2 is occurring even when the solenoid valve is supposedly closed, an error message will appear on the screen indicating “*Valve Stuck Open.*” To confirm, the control waits for 10 seconds after it determines that the valve should be closed before it will indicate that the valve is stuck open.

Valve Open Duration

Valve Open Duration can be accessed through the menu system (**MENU**, 6, 2, 4, 1). This allows the user to set the maximum amount of time, which the valve will stay open at any one time. If a fill operation exceeds the valve open duration time set by the user, the valve closes for 15 seconds and then opens again for another cycle. This 15 second rest period allows the solenoid valve to warm. The allowable settings are Disabled and 1-15 minutes.

Valve De-icing

Valve De-Icing can be accessed through the menu system (**MENU**, 6, 2, 4, 2). This feature can be turned on or off. If enabled, the control will try to free up the valve by rapidly turning it on and off. This feature is triggered when the Freeze-Guard sensor detects a stuck valve condition. KRYOS will attempt to free up the valve by De-icing 5 times with a two-minute delay between tries.

Splash-Guard

Splash Guard is a process to reduce or eliminate false signals detected by the thermistor sensor assembly. In particular this reduces sporadic valve operation when the sensor assembly is splashed with LN2. When a fill operation has completed because the level has reached the STOP FILL sensor, the display will flash “Check” and the control will check the validity of the signals received from the sensor assembly. The splash-guard check occurs for 20 seconds and the bottom line of the display indicates this by flashing “Check”.

Display Brightness

DISPLAY BRIGHTNESS can be set through the menu system of the control (**MENU**, 6, 3). This option changes the intensity of the display. The possible choices are 25%, 50%, 75% and 100%.

About this Control

ABOUT THIS CONTROL can be accessed in the menu system (**MENU**, 6, 4). This option provides information about the control. In particular it tells the serial number of the control and the software version that the control is running.

Control On Battery Backup Version

This controller is similar to the AC Kryos Controller. The menu system and all features are identical. The only operational difference is if a power failure occurs, the control goes into battery backup mode. The Kryos control operates on 24 VAC power. As an option, however, the control can also operate on battery power to provide up to 72 hours of continuous service without AC power. The system is designed for full operational service during a power failure, including full solenoid valve operation. The battery backup system can be ordered from Taylor-Wharton and should be factory installed.

Differences between the regular Kryos and the battery backed Kryos:

Please see the chart below for the differences between the two systems.

	Regular Kryos	Battery Backed Kryos
SOLENOID VALVE	24 VAC solenoid	12 VDC solenoid
Wall Transformer	24 VAC/ 40 Voltamps output	16.5 VAC/ 40 Voltamps output
Battery	None	17amp-hour
Battery Extension Cable	None	Connects battery to control board
Software	V4.0	V4.0
Control Board (1)	Black 2-pin solenoid valve plug	Red 2-pin solenoid valve plug & Red 3-pin battery plug.

- (1) The control board for the battery backup is quite different than the control board for the regular Kryos in that a number of parts are either removed or changed. The best way to tell if the control is a battery backed unit or a regular unit is to look at the valve connector.

Operation

The software is designed such that if power is lost and a battery-backed control is in place, the control detects the loss of power and continues to operate from the battery. If power is lost, a "Battery Backup" message appears on the display, the alarm beeper sounds and the red LED starts to flash. After a short period of time (approximately 10 seconds) the display will go dark to conserve power, however the red LED will continue to flash and the beeper will continue to sound until it is muted. The display can be brought back at any time by pressing any button on the front panel.

The control will continue to monitor the system, record logs and operate the valve until the battery runs too low. Original specifications required that the battery run, fully operational, for at least 72 hours. Battery backup mode is treated by the control as an alarm condition. This means that the remote alarm will be triggered after a period of time as defined by the user.

Note: We strongly recommend that all Cryo-Storage systems be connected to a redundant alarm, a building alarm system or a dialer. This insures that someone is notified if an error condition persists.

The DC solenoid valve requires that the battery be connected for the system to work properly. If the battery is disconnected or completely discharged the valve operation and the control operation may be affected. In particular, if the control is calling for a fill, the solenoid will be called to open. Opening the solenoid takes a substantial inflow current, which the solenoid may “steal” from the control if it cannot get sufficient power from the battery. This in turn will “fool” the control into believing that a power failure has occurred, which will cause the control to reset and the valve to close. This will occur over and over again. If a battery-backed control keeps turning itself on and then off, try recharging the battery by following the steps below.

Battery Charging: The Kryos control has a circuit that trickle charges the battery. This provides a fully charged battery for the times when it is needed yet keeps it from being damaged by overcharging. If the battery should become discharged, the following steps should be followed to charge it.

Turn the control off using the Power button on the front panel of the Kryos. Even though the control is turned off, the battery will still be recharged.

Check all connections to the Kryos, especially the harness plug, the wall transformer and the battery extension cable. The wall transformer should be plugged into the wall.

Wait for 30-60 minutes. After this time period, the battery should have enough power to run the control and continue charging the battery.

Battery Life

The life of the battery will vary according to many factors including use and storage temperature. The lead-acid batteries have an expected life of 3 to 5 years. For full functionality of your Cryo-Storage system we recommend that the lead-acid battery be changed every 3 years.

INTERFACE SOFTWARE

Optional software (CRYOCOM) is available which allows a computer system to communicate with KRYOS through the serial port on the freezer. The software provides the capability to download the logs, review control settings, change control settings and perform system functions such as open/close the solenoid valve, mute the alarm, etc. Contact Taylor-Wharton for details. Please have your Cryostorage System serial number, KRYOS serial number and version number as it appears in *ABOUT THIS CONTROL (MENU, 6, 4)*.

The Kryos control is also compatible with the SQR-1 Sequence that provides sequence filling at multiple freezer locations.

MAINTENANCE

Strainer Cleaning Instructions

The container will not fill properly if the strainer is clogged with ice or dirt. To clean the strainer, first close the supply valve to the refrigerator. Vent the fill line of all pressure. Remove and warm the strainer to ambient temperature. Purge the strainer from both directions with dry nitrogen gas or dry oil-free air. Rinse the strainer with alcohol and purge it again with dry nitrogen gas or dry oil-free air to clear contaminants. If the cleaning process doesn't clear the blockage, replace with a new filter (P/N 7631-1080).

Defrosting Your LAB-Series CryoStorage System

All liquid nitrogen storage systems are subject to ice and frost buildup over time. Regular preventive maintenance programs should be instituted to remove ice and frost from the sensor and fill tubes and from the refrigerator lid. Ice and frost buildup in the sensor tube may result in false readings being relayed to the controller from the sensors. Ice can form a thermal barrier around a level sensor, rendering it insensitive to the temperature differences between vapor and liquid. Sensors and thermocouples should be carefully removed regularly and inspected for ice and frost buildup.

Ice and frost buildup in the fill tube may block the flow of liquid nitrogen into the refrigerator during fill. This blockage can result in the liquid level dropping to dangerously low levels, and may result in the Low Alarm sensor being activated. In addition, a fill line blockage may cause the Low LN2 Supply Alarm to be activated. If the fill line becomes blocked, it must be warmed until the ice blockage is cleared. Ice blockage would typically form in the fill tube at the point at which water will form ice. This location may be just inside the storage chamber, near the top. Warm the fill line with a hair dryer or other safe low heat source with the solenoid in the open position. If this is not successful in 2 minutes, the refrigerator should be allowed to thaw to room temperature, and purge with dry nitrogen to remove all traces of moisture within the storage chamber before re-filling.

Excessive ice and frost buildup may occur on the refrigerator lid if the lid is left open or the liquid level is too close to the underside of the lid. To defrost the lid, open the lid to the fully open position. Clean the ice and frost from the underside of the lid by allowing it to thaw slightly and wiping with a clean, lint-free cloth. *Care must be taken to insulate the inventory control system from high temperatures, which may affect the viability of the stored product.*

If it is determined that defrosting is necessary the following procedure must be followed. Cryogenic freezers of these types must be carefully warmed to ambient temperatures to avoid the ingress of water. As long as liquid nitrogen is present in the unit, the evaporation of the liquid nitrogen provides slightly positive gas pressure in the unit, preventing the entrance of moisture laden air. When all of the liquid nitrogen has evaporated but the unit temperature is still below the dew point of the surrounding atmosphere, condensation will start to collect in the unit. When frost and condensation collect in the unit, staining of the carousel or damage to the level sensors will occur. If one of these units is to be taken out of service for any reason the following steps must be performed to avoid damaging the unit.

1. Disconnect power and liquid nitrogen source.
2. Remove all stored product and inventory control system components.
3. A source of nitrogen gas must be found and used to purge the unit as the temperature rises to ambient. The purge gas can be installed on the thermocouple tube, sensor tube, or fill line after the appropriate components have been removed. The purge gas may also simply be delivered to the unit through a bent metal tube under the lid. A flow rate of 5 to 10 SCFM is sufficient to prevent water from collecting inside the unit. This flow of purge gas will also speed the warming of the unit to ambient temperature.

Cleaning Your Taylor-Wharton CryoStorage System

The cryogenic vessel of all LABS CryoStorage Systems may need to be cleaned, and sterilized if the type of stored product is changed or the unit is taken out of service. The vessel must be defrosted, cleaned, and sterilized regardless of the type of stored product, prior to return to Taylor-Wharton for repair or maintenance.

Prior to cleaning, the unit must be warmed and defrosted following the defrosting procedure described above.

To clean and sterilize your defrosted LABS CryoStorage System, Spray the entire inner vessel surface with ample amounts of an approved disinfectant. Allow surface contact to be maintained for a minimum of five minutes. Rinse the inner vessel with water, remove all water and debris through the access opening located in the carousels bottom tray, and vacuum or towel dry the surface. Spray the inner vessel surface with a 70% alcohol to water solution and maintain surface contact for fifteen minutes. Rinse the inner vessel surface with water and vacuum or towel dry excess water. Final dry the inner container, sensor line, and fill line using a nitrogen gas purge.

WARNING: Never use chlorine-based disinfectants to clean a LABS CryoStorage System.

Normal Evaporation Rate (NER) Test

Nitrogen consumption is an accumulation of all system components and user introduced evaporation. The storage chamber is a double walled, vacuum insulated vessel and contributes to the daily consumption of liquid nitrogen. The liquid nitrogen supply vessel and transfer hose also contribute greatly to the daily consumption rate. Choosing to control the vapor temperature, combined with the liquid level and temperature specified, will affect the overall nitrogen consumption. In addition to these variables, opening the lid to retrieve product, and adding new product into the storage chamber will play a role in the accumulative liquid nitrogen consumption.

If the nitrogen consumption of your CryoStorage system seems excessive, it may be appropriate to perform an estimated Normal Evaporation Rate (NER) test on the CryoStorage chamber. To perform an NER test:

1. Fill the CryoStorage unit to the “High Level” sensor.
2. Measure the liquid nitrogen level with a plastic or wooden measuring rod.

WARNING: Never use hollow rods or tubes as dipsticks. When a warm tube is inserted into liquid nitrogen, liquid will spout from the top of the tube and may cause personal injury.

3. Close and lock the lid of the LABS CryoStorage System for forty-eight (48 hours).
4. Open the LABS CryoStorage System and measure the liquid nitrogen level. Typically, liquid nitrogen levels will drop approximately 3/8 in. (9.53 mm) per day. If your measurement indicates a drop in excess of 3/4 in. (19 mm) per day, please contact your Taylor-Wharton distributor or Taylor-Wharton for further information. Please have your serial number, this manual and service history available.

WARNING: The source power supply at 110/120VAC can cause a lethal electrical shock. Unplug the power cord before proceeding with any repairs.

The KRYOS has been designed for easy setup and maintenance. All connectors on the controller are uniquely identified snap-on plugs. The thermocouple, sensor assembly, solenoid valve, power, remote alarm, temperature recorder and data lines can be connected or disconnected in seconds.

Making Adjustments to the LABS KRYOS Sensor Assembly

The factory settings for the LABS control system are as follows:

- Low Level Alarm = 2 (Always 1” below the start fill)
- Start Fill Sensor = 3 (1 5/8” below the carousel tray)
- Stop Fill Sensor = 5 (Just below the carousel tray)
- High Level Alarm = 6 (Always 1” above the stop fill)

The sensor assembly is pushed to the bottom of the refrigerator as delivered from the factory. If adjustments need to be made, the following procedure will simplify the process.

The Kryos Control installed on the Taylor-Wharton LABS80K refrigerator operates with software version 9.0 (regular operation) or 9.0B (battery backup). This control software has been specially designed to match the design characteristics of the LABS 80K refrigerator. The differences between the versions are in the table below

Table: Software version differences

	Kryos V4.0	Kryos V9.0 & Kryos V9.0B
Level Readings	1" increments (linear)	Level Range (nonlinear)
Default Start Fill / Stop Fill	3" / 6"	3" / 5"
Default Auto Defog	15 seconds	20 seconds
Offset Value	Adjustable (allows the sensor assembly to be raised)	Preset (sensor assembly located at factory setting)
Units of measure	English / Metric	English

Version 9.0/9.0B Level Reading

The sensor tube on the LABS 80K refrigerator is installed through the annular space (vacuum) and takes a curve near the bottom. The sensor assembly accommodates this curve. Version V9.0/V9.0 software computes the non-linearity of the sensor assembly position. This software version displays the following readings on the Kryos display.

- Thermistor #1 uncovered; Kryos will display "<2.8 in."
- Thermistor #1 covered; Kryos will display "2.8 / 3.0 in."
- Thermistor #2 covered; Kryos will display "3.0 / 3.3 in."
- Thermistor #3 covered; Kryos will display "3.3 / 4.0 in."
- Thermistor #4 covered; Kryos will display "4.0 / 5.0 in."
- Thermistor #5 covered; Kryos will display "5.0 / 6.0 in."
- Thermistor #6 covered; Kryos will display "6.0 / 7.0 in."
- Thermistor #7 covered; Kryos will display "> 7.0 in."

Other Changes

- The offset has been removed in this version of software to handle the non-linearity of the sensor when installed in the refrigerator.
- Metric readings have been removed in this version of the software.

Recommendations for a Liquid Storage Application

If the LABS 80K will be used to store the product in Liquid Nitrogen, two options are available:

1. Version 4.0 software can be installed into the Kryos to provide the offset. This allows the control to recognize that the sensor has been raised off the floor of the refrigerator so that the correct level readings can be displayed. (P/N: EPROM-Kryos40)
2. The optional 4-thermistor sensor can be purchased from Taylor-Wharton to work with the Kryos control (works in either version of the software). This sensor allows the user to physically place the start fill and stop fill sensor at the appropriate level locations in the refrigerator. The Kryos then displays the level as High, Normal or Low (P/N: 5140-1163-4T)

To make adjustments to a sensor assembly in a refrigerator filled with LN₂, the following procedure can be used:

- Measure the LN₂ liquid level in the refrigerator.
- Take this measured level and subtract the offset to determine how many sensors should be in liquid.
- Go to "Test Level Sensor" through the KRYOS menu (MENU, 2, 1). "L" means a sensor is in liquid while "G" means a sensor is in gas.

- Move the sensor up or down so that the appropriate numbers of sensors are in liquid (read “L”).
- Get back to the KRYOS main screen and the level indicated should match the physically measured reading.

The Sensor Offset, the Start Fill and the Stop Fill can all be set through the KRYOS menu system (MENU, 2).

Removing/Installing the Solenoid Valve

Disconnect only the solenoid valve lead connection from the back of controller board.

To remove the solenoid valve, loosen the compression fitting that connects the plumbing tubing to fill tube. Unscrew the two (2) mounting screws that hold the solenoid valve to the solenoid bracket. Then remove the solenoid valve and its associated plumbing. Disconnect the plumbing from the inlet and outlet side of the solenoid valve.

To install a new solenoid valve, attach the connecting plumbing to the inlet and outlet connections of the valve using Teflon tape. Attach the compression fitting to the fill tube first and then connect the compression fitting to the elbow that is connected to the outlet side of the solenoid valve. Position the solenoid valve onto the solenoid valve bracket and tighten the two (2) mounting screws. Attach the solenoid valve lead connection to the controller board.

NOTE:

After disconnecting the solenoid valve leads do not pull on wire. The wires are tied and spiral wrapped together.

Controller Electrical Tests

If a controller is removed from the refrigerator for service, the liquid refrigerant level must be maintained manually to protect stored product. The fill solenoid valve will be inoperative with the controller removed. A flexible fill line terminated with a phase separator may be used periodically through the open refrigerator lid to conduct manual fill operations until automatic operation is restored.

Sensor Probes. The sensor probes used to detect liquid level by Taylor-Wharton controllers are temperature-sensitive resistors called “thermistors.” Their resistance to electrical current flow changes greatly with their temperature. The resistance of a typical thermistor used in these controllers varies with its temperature as follows:

- At Room Temperature 2 ohms to 10 ohms
- In Cold Nitrogen Gas..... 8 K ohms to 18 K ohms
- In Liquid Nitrogen 18 K ohms to 35K ohms

Controller Logic. The liquid level controllers read the values of the sensors as indications of liquid level. The function of a sensor, and its value, are interpreted by solid-state logic circuitry to set normal operating, fill, fill termination, and alarm conditions. In addition, the refrigerator temperature is monitored and an alarm is triggered if the temperature raises above a pre-determined point. The following values will be interpreted by a controller as cause for a logic change – either an alarm, or in some cases, a fill or fill termination action.

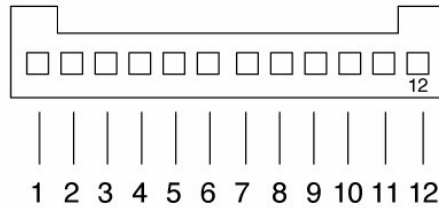
From cold gas to liquid Resistance greater than 22K ohms.

From liquid to cold gas Resistance less than 16K ohms.

Defective Sensor Resistance greater than 50K ohms, or less than 5 ohms.

Sensor Plug Schematic

SENSOR ASSEMBLIES - 12 PIN MOLEX PLUG



PIN #	STANDARD FREEZE-GUARD 7 LEVEL +1*	OPTIONAL 8 LEVEL SENSOR	OPTIONAL 4 LEVEL SENSOR
1	bk FG	Bk C	empty
2	bk FG	Gr	empty
3	Ye	Ye	empty
4	BL	Pu	empty
5	Rd	Rd	empty
6	BK C	empty	empty
7	empty	empty	Or C
8	Gy	Bl	Wh H AL
9	Or	Or	Ye SpF
10	Pu	Gy	Bk StF
11	Wh	Wh	Rd LA
12	Br C	Br C	Br C

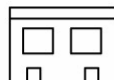
- HAL = High Level Alarm
- SpF = Stop Fill
- LA = Low Alarm
- FG = Freeze Guard
- NO = Normally Open
- C = Common
- StF = Start Fill
- NC = Normally Closed
- RA = Remote Alarm
- Or = Orange
- Wh = White
- Ye = Yellow
- Bk = Black
- Rd = Red
- Bl = Blue
- Pu = Purple
- Br = Brown
- Gy = Grey
- Gr = Green



FREEZE-GUARD SENSOR



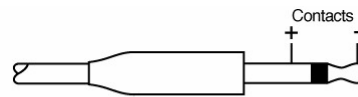
THERMOCOUPLE 1 OR 2
Check Continuity



SOLENOID VALVE
Check Continuity and Energize with 24VAC



LID SWITCH
Check Continuity Operate Switch



WALL TRANSFORMER POWER SUPPLY
24VAC

Figure 9.0 Pin View Schematics

LABS Plumbing Assembly

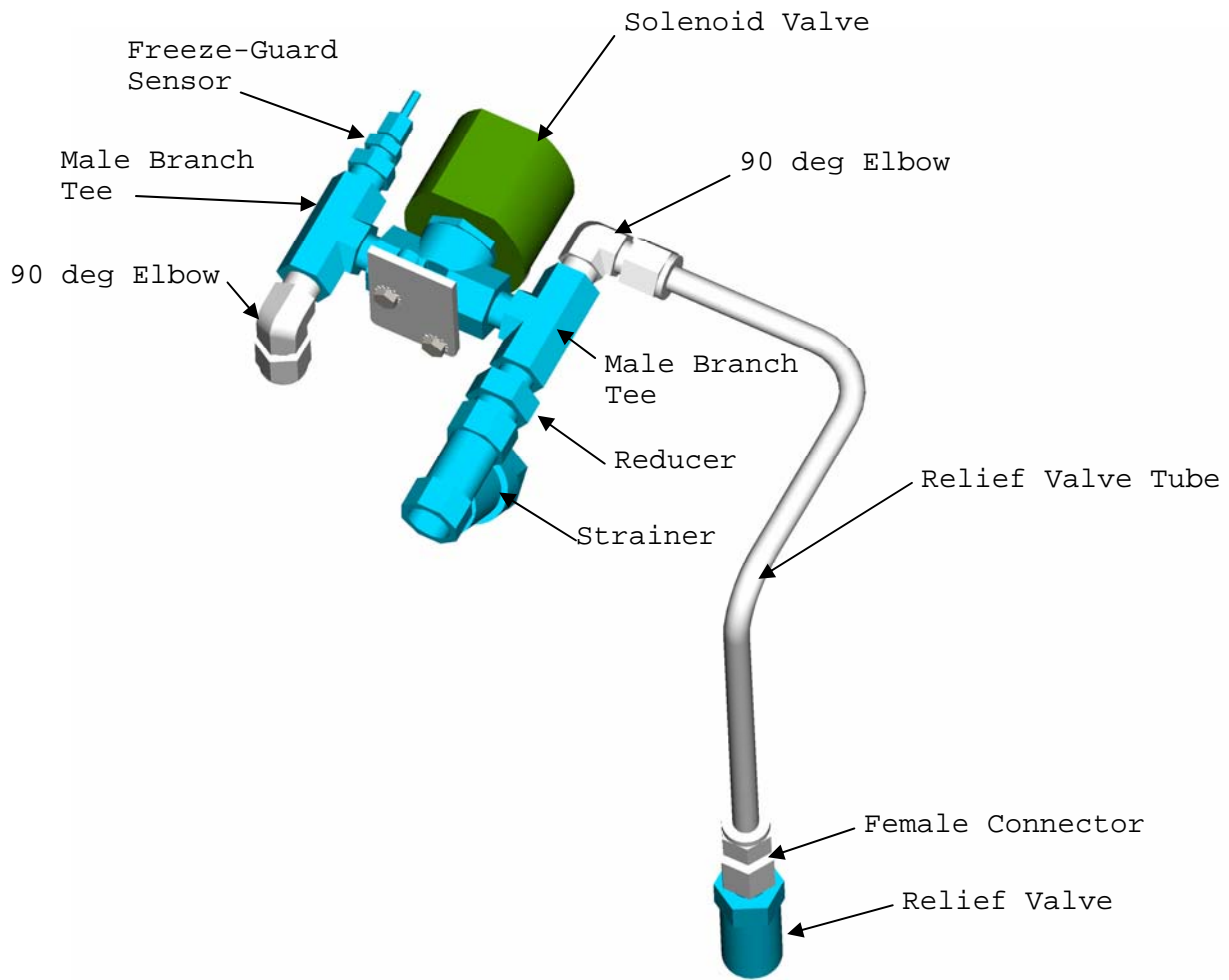


Figure 10.0 Plumbing Assembly

TROUBLESHOOTING

Symptoms

The key to troubleshooting your LABS CryoStorage system is to determine which component in the system is the source of the problem. Determine if the problem is occurring in any of the following subsystems: Supply Vessel, Transfer Line, Power Source, Temperature, Level Sensing, Security, Lid Switch, Solenoid Valve, Control Display, Alarm System, Communications. After determining which sub-system is having the problem, isolate the problem further by performing sub-system tests. Once the problem is isolated and defined, it will be easier to solve.

Controller Will Not Turn ON

1. Press POWER button. If display is blank and dark go to next step.
2. Check all connections. Start with jacks at the foot of the controller. Pay special attention to jacks labeled "POWER". Wall transformer must be plugged into an outlet providing AC voltage between 100 and 130 to deliver AC voltage 21 to 30 to the back of the freezer.

Indicates High Liquid Level

1. Determine actual liquid level using a dipstick. Select **MENU**, **LEVEL SENSING**, **TEST LEVEL SENSORS**. An "L" or "G" will indicate individual thermistor status. "L" meaning that the thermistor is submerged in liquid and "G" indicates that the thermistor is in cold Gas. Determine the pressure, and remaining liquid level in the supply cylinder (15 to 22 psi). A fill solenoid valve that freezes (or sticks) open will typically empty the supply cylinder. Replace solenoid valve if it has failed even once.
2. Liquid level is sensed by thermistors located in a sensor tube. If the sensor tube is blocked or iced at the top, the liquid level in the sensor tube may not rise and fall at the same rate as the liquid level in the freezing chamber. Make sure the sensor tube is not obstructed.
3. The pool of LN2 can become turbulent during a fill. Bubbling and splashing can be amplified by the rack arrangement. The deeper the pool, the more turbulent the surface of the pool will be during a fill. The turbulence of the pool surface can splash on the X-High thermistor and cause a false high alarm. Reduce the splashing.
4. Confirm that sensor assembly is responding to changing liquid level with a dip-test.
 - Mark the sensor assembly at top of tube to assure re-assembly.
 - Close liquid supply valve at source.
 - Remove sensor assembly from sensor tube. **DO NOT FORCE**. Fill solenoid valve should open and **LOW LEVEL** alarm should be activated.
 - Select **MENU**, **LEVEL SENSING**, **TEST LEVEL SENSORS**. An "L" or "G" will indicate individual thermistor status (L = Liquid and G = Gas).
 - Dip each thermistor in succession into LN2 Observe the controller display noting that each thermistor changes from "G" to "L" as each is submerged. Response time may vary.
 - Return to the main menu and submerge the **START FILL THERMISTOR IN LIQUID**. NOTE that the low level alarm ceases, fill solenoid valve is still open. Control is flashing **FILLING**.
 - Manually press **STOP** button and note that the fill solenoid valve closes.
 - Press **FILL** button to re-open fill solenoid valve.
- Continue to lower the sensor until the **STOP FILL** thermistor is immersed in the LN2 . The fill should stop after a confirming (**CHECK**) **SPLASH GUARD** period.

- Simulate an over fill by lowering the next thermistor into the LN2 . HIGH LEVEL alarm should sound with 10 seconds.
- Re-install sensor assembly and thermocouple into sensor tube as before. Open supply valve on LN2 supply.

Indicates Low LN2 Supply

When the START FILL thermistor is uncovered, the controller calls for the fill solenoid valve to open. If the STOP FILL thermistor is not covered with LN2 in the pre-determined amount of time, the controller is programmed to interpret this as a LN2 supply shortage.

1. Check contents gauge and pressure gauge of supply cylinder. Both liquid contents and pressure (15 to 22 psi) are required to complete a fill.
2. Confirm that no other transfer hose or apparatus is attached to the supply cylinder. Either could compromise adequate tank pressure required to complete a fill in 30 minutes.
 - Check the distance that the LN2 must travel to reach the freezer. Observe the time it takes for Liquid LN2 to reach the Freezer through the usual piping conditions (Pipe-Temperature at start fill). Liquid should be entering the chamber within 4 minutes under normal (usual) line temperature conditions.
 - Distances over 6 feet without a gas by-pass are discouraged due to excessive boil off. Un-insulated fill line for the last 4 feet are encouraged to drive down vapor temperatures in the freezing chamber during each fill.
 - A “Keep-Cold” or a “Keep-Full” device are almost always needed on an LN2 pipeline, whether the pipe is Vacuum Jacketed or Foam Insulated.
3. Confirm that the solenoid valve is open when a fill is called for.
 - If no flow is detected, the solenoid valve is not getting the signal to open, or it is opening and there is a blockage in the line. Check the connections on the leads near the solenoid itself, as well as the connector at the controller.
 - Confirm that the wires have not been pinched, creating a short circuit.
4. If a longer fill time is desired, change the setting by selecting: **MENU, SYSTEM ALARMS, LN2 SUPPLY ALARM.**

Indicates Open Sensor

1. Normally, this message is associated with a loose plug or connector. Check the connection at the foot of the controller labeled SENSORS.
2. If the problem persists, the sensor assembly may need to be replaced. To determine this select: MENU, LEVEL SENSING, TEST LEVEL SENSORS. An “L”, “G”, or “O” (open) will indicate individual thermistor status. If you still suspect the controller, confirm the sensor integrity using an ohm meter. Refer to Figure 9 Pin View Schematics.
 - Thermocouple is not repairable. Replace from stock.

Temperature reading 10 to 20 degrees warm.

- Prepare an ice water slurry with crushed ice and tap water. Dip or pour LN2 into a styrofoam cup to prepare an LN2 bath. Calibrate the controller. Select **MENU, TEMPERATURE, CALIBRATE TEMPERATURE.** Follow the on-screen instructions. Hold the thermocouple in each bath until the control completes its self-calibration.
- Make sure the thermocouple is clean and dry before and after each bath.
- Reposition the thermocouple at the elevation the customer wants to monitor or control.

Fill Solenoid Cycles On and Off

KRYOS features a Freeze-Guard function whereby the valve open duration is limited, allowed to shut for a short warm-up and then opened again. To confirm or change the valve open duration:

- Select **MENU**, **USER OPTIONS**, **CONTROL OPTIONS**, **FREEZE-GUARD OPTIONS**, **VALVE OPEN DURATION**.

If the controller detects that the valve is stuck in the open position (i.e., continues to fill after the valve is de-energized), it will attempt to De-Ice the valve by causing a rapid cycling of the valve in an attempt to dislodge the blockage.

- To activate or de-activate this feature: Select **MENU**, **USER OPTIONS**, **CONTROL OPTIONS**, **FREEZEGUARD OPTIONS**, **VALVE DE-ICING**.

Repeated cycling of the solenoid valve could be attributable to moisture invasion on the controller circuit board.

1. Check gasket seals.
2. Access control board and allow time to fully dry.

Fill Solenoid Makes Humming Noise

Turn fill valve on and off using the control panel. If humming continues, it should continue to operate reliably. If the noise is excessive, replace solenoid valve.

Transformer Makes Humming Noise

This noise is a normal byproduct of most block transformers. The transformer has a non-renewable internal fuse to protect the transformer output. If the noise is excessive, replace the transformer.

Display = “Check”

The word CHECK will flash during periods of Splash-Guard protection. See page 29 for more information.

Lid Open Alarm

A lid switch is located on the front hinge. The switch lever should actuate when the hinge is opened and again when it is shut.

1. Confirm that the two spade connectors are connected to the back of the switch. They should be attached to the “G” and the “N/C” connections.
2. The switch can be bumped or moved during shipment. Adjust switch up until closed hinge will actuate switch lever.

QCF (Quick Chill Feature) Will Not Operate

See LID OPEN ALARM

To activate or adjust times: Select **MENU**, **USER OPTIONS**, **CONTROL OPTIONS**, **LID/DEFOG SETTINGS**, **QUICK CHILL**.

Defog Feature Will Not Operate

See LID OPEN ALARM.

To activate or adjust times: Select **MENU**, **USER OPTIONS**, **CONTROL OPTIONS**, **LID/DEFOG SETTINGS**, **AUTO DE-FOG**.

Push Buttons Will Not Respond

1. Check all ribbon cable connectors on back of display panel.
2. Moisture may have migrated into the sealed faceplate. Call Taylor-Wharton for a Return Authorization.

Liquid Level Readout is Incorrect

Liquid level is determined by a seven-thermistor assembly inside a protective sensor tube. The user may adjust the desired **START FILL** elevations and **STOP FILL** elevations for the pool of nitrogen with the confines of the four inches. The **EX-LOW LEVEL ALARM** is automatically assigned to the thermistor below the **START FILL** assignment, and the **EX-HIGH LEVEL ALARM** automatically reserves the thermistor above the **STOP FILL** thermistor assignment. For this reason **START FILL** cannot be assigned to thermistor number 1. Similarly, **STOP FILL** cannot be assigned to thermistor number 7. The factory installs this seven thermistor assembly all the way to the floor of the sensor tube, which positions thermistor number 1 one inch above the floor (i.e.; the first thermistor is offset from the floor zero inches).

If you would like to stop the fill at a depth greater than seven inches from the floor, the sensor assembly must physically be raised inside the sensor tube. The distance that it has been raised becomes the new **OFFSET** and the controller must be notified of this offset from the floor. The factory settings are **START FILL** at 3 inches and **STOP FILL** at 5 inches, with an **OFFSET** of zero. If you want to establish a **START** at 15 and **STOP** at 17, raise the sensor assembly 12 inches (17 minus 5) and set the controller **OFFSET** to 12 by: Selecting **MENU**, **LEVEL SENSING**, **SET SENSOR OFFSET**. The unit should begin filling. The **EX-LOW LEVEL** sensor has been subjected to the gaseous condition and should sound an alarm (O.K. to MUTE). Note that in this scenario, you have directed your LN2 supply to accomplish a 15 inch fill level. It may be necessary to stop the fill manually and allow the supply vessel time to regain enough pressure to complete this exceptionally long initial fill.

Power Failure Alarm

If power is interrupted, a note of the time and duration will be recorded in the log. No local alarm will be sounded unless a high temperature is detected after power resumes. The Remote Alarm will be triggered anytime the power is interrupted.

Factory Settings

To restore factory settings at any time KRYOS can be re-initialized. Please note that a re-initialization clears all logs and passwords and resets settings to those listed in the table below. To reset factory settings in the control, go to the menu choice ABOUT THIS CONTROL. (MENU, 6, 4) and while looking at this screen type in 1973. The control will lead you through the process required to reset the factory settings.

Temperature:

Thermocouple #1 Enabled
 Thermocouple #2 Disabled
 Hi Temp #1 Alarm -100° C
 Hi Temp #2 Alarm Disabled

Level Control:

OFFSET 0 inches
 START FILL Sensor 3 inches
 STOP FILL Sensor 5 inches
 Sensor Assembly Freeze-Guard

System:

RS-232 Enabled
 Handshaking CTS/RTS
 Baud Rate 19200
 Date & Time USA Central Time
 Brightness 100%
 Lid Switch Enabled
 Auto Defog Timer 20 seconds
 Quick-chill 15 seconds

Temperature Control:

Temperature Control Disabled
 Temperature °C
 Temperature Range ±°C

Alarms:

LN2 Supply Alarm 30 minutes
 Sensor Error Enabled
 Remote Alarm 30 minutes
 Lid Open Too Long 10 minutes
 Thermocouple Open Alarm Enabled

Logging:

Sensor Error Log Enabled
 Low LN2 Enabled
 Supply Log Enabled
 Remote Alarm Log Enabled
 Open Thermocouple Enabled
 Hi Temp #1 Log Enabled
 Hi Temp #2 Log Disabled
 Fill Logging Enabled
 Lid Open/Closed Log Enabled
 User Access Log Disabled
 Thermocouple #1 Rate Log Enabled
 Thermocouple #2 Rate Log Disabled

Freeze-Guard:

Valve Open Duration Disabled
 Valve De-icing Enabled

REPLACEMENT PARTS

Refrigerator Parts (LABS)

80K/40K/20K

Lid Assembly.....	LA80-9C85/LA40-9C85/LA20-9C85
Caster,	7300-8040
Decal, Warning.....	R23K-9C42
Decal, Warning.....	R10K-9C42
Inventory Rack 25 Vials [13 shelves tall for 2 in (51mm.) boxes] (ea.).....	R10K-9C44
Inventory Rack 100 Vials [13 shelves tall for 2 in (51mm.) boxes] (ea.)	R23K-8C35

Level Controller Electrical/Mechanical Parts

80K/40K/20K

Controller KRYOS	5140-1159 (80K/40K)
Controller KRYOS (Battery Backup).....	5140-1158
Freeze Guard Sensor Assembly	5140-1161
Sensor Assembly 7 Sensor	5140-1163
8 Thermistor (option).....	5140-1164
4 Thermistor (option).....	5140-1162
Remote Alarm Plug.....	5140-1160
Transformer 24VAC	R08K-9C04(80K/40K)
Transformer 16.5VAC.....	5140-1170
Battery, 12 Volt, 18Amp Hour.....	5140-1185
Battery Cable.....	5140-1182
Thermocouple Assembly.....	R08K-9C51
Lid Switch.....	5140-1195
Plumbing Assy. 16.5 VAC.....	LA80-8C65 (80K)
	LA40-8C65 (40K/20K)
Solenoid Valve 16.5 VAC (DC).....	6999-9024
Plumbing Assy. 24 VAC.....	LA80-8C64 (80K)
	LA40-8C64 (40K)
Solenoid Valve 24 VAC (AC).....	6999-9021 (80K/40K)
Relief Valve 100 psig (6.9 bar/690kPa) ¼ in. NPT.....	6913-9077
Strainer.....	7631-1080

Fill in top section at installation. Copy this form each time service is required.
 Fill bottom section with service notes to keep a complete log of each freezer service and maintenance history.

End User company Name _____ LOG NO _____
 Service Contract Name/Company _____
 Service Contract Phone Number/Fax _____
 LABS-series Model/Serial Number _____
 KRYOS Serial Number _____
 Control Version Number _____
 In-service Date _____

Describe Conditions – Actual	Describe Conditions – Controller Reading
Liquid Level – via Dipstick _____	Liquid Level – Per Controller _____
Level Sensor Type ___ FG ___ 8T ___ 4T	Liquid Level Setting ___ HIGH ___ LOW
Lid ___ Open ___ Closed	Lid ___ Open ___ Closed
Filling ___ Yes ___ No	Filling ___ Yes ___ No
Temperature _____	Temperature _____
LN2 Supply _____ ltr _____ psi	Supply Alarm ___ On ___ Off
Note: Ice Build-up ___ a little ___ a lot	Remote Alarm ___ On ___ Off
Note: Gasket condition ___ Seals ___ Leaks	Audible Alarm ___ On ___ Off
Display Lights ___ On ___ Off	Temp. control setpoint @ _____ degrees

Taylor-Wharton Technical Services. Phone 800-898-2657 Fax 251-408-2209

Service History Log (note date and log number on each service entry)

Date: _____
 Date: _____
 Date: _____
 Date: _____
 Date: _____
 Date: _____
 Date: _____
 Date: _____
 Date: _____
 Date: _____

1 All Taylor-Wharton CryoStorage Systems must be cleaned and sterilized prior to return to Taylor-Wharton for repair or maintenance and must be accompanied by a written statement to this effect. Any LABS-Service CryoStorage System received without this statement will be returned to the sender, freight collect. Contact Customer Service at 800-898-2657 for information.



Taylor-Wharton

Gas & Fluid Control Group

Harsco

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In U.S. and Canada:
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