



Taylor-Wharton

OPERATING AND MAINTENANCE INSTRUCTIONS

10K, 24K, 38K

CRYOSTORAGE SYSTEMS WITH KRYOS CONTROLLER

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.

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*.

Safety

Liquefied Gases

Extremely cold refrigerant – Cover Eyes and Exposed Skin – Accidental contact of the skin or eyes with any cryogenic liquid or cold gas may cause a freezing injury similar to frostbite. Protect your eyes and cover your skin when handling stored product and when transferring liquid, or in any instance where the possibility of contact with liquid, cold pipes, and cold gas may exist. Safety goggles or a face shield should be worn when transferring liquid. Long-sleeved clothing and gloves that can be easily removed are recommended for skin protection. Cryogenic liquids are extremely cold and will be at a temperature of -196°C (-320°F) under normal atmospheric pressure.

Keep Equipment Well Ventilated – Although the liquefied gas refrigerant used in this equipment is non-toxic and non-flammable, it can cause asphyxiation in a confined area without adequate ventilation. An atmosphere that does not contain enough oxygen for breathing will cause dizziness, unconsciousness, or even death. These gases cannot be detected by the senses and will be inhaled normally as if they were air. Ensure there is adequate ventilation where this equipment is used and store liquid refrigerant supply containers only in a well ventilated area

Note:
For detailed information on the handling of cryogenic liquids, refer to the Compressed Gas Association publication: P-12 "Safe Handling of Cryogenic Liquids" available from the Compressed Gas Association Inc., 1235 Jefferson Davis Highway, Arlington, VA 2202.

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 underfill. 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.

Warning: **Inlet pressure should not exceed 22 psig (1.5bar/152 kPa). Higher pressures could result in damage to equipment and/or sufficient depletion of oxygen in the atmosphere to cause dizziness, unconsciousness, or death.**

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.

Electrical

Electrical Shock Can Kill – the liquid level controllers used with these refrigerators operate from 24VAC. However, the external transformer does have a 110/220VAC primary. Do not attempt any service on these units without disconnecting the electrical power cord.

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 may affect serviceability.

GENERAL INFORMATION

Taylor-Wharton 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 10K, 24K and 38K refrigerators covered by this publication are designed for, but not limited to, the laboratory environment. The 10K and 24K feature square, modular cabinets that facilitate grouping several units together in a cryostorage area. The 38K features a cylindrical stainless steel cryochamber. All of the models will accommodate inventory control systems or provide unobstructed storage area for larger product. All models are supplied with casters to enable limited mobility for cleaning purposes.

These standard models are equipped with the KRYOS electronic liquid level controller that will monitor and control the supply of liquid nitrogen to the unit. The controller features 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.

Maximum Refrigerator Contents

Your cryostorage system has a maximum weight capacity which is stated in the specifications. This capacity exceeds the maximum amount of liquid nitrogen the refrigerator is capable of holding. Generally, as product is added to liquid phase storage, the stored product and inventory control system are heavier than the liquid nitrogen they displace. In vapor-phase storage applications, where the liquid refrigerant is found only in the bottom portion of the refrigerator, the weight of contents is determined more by the weight of the stored product.



The K-Series and Legacy 2000 CryoStorage Units

Liquid nitrogen at atmospheric pressure weighs 1.78 lb./liter (0.8 kg/liter). To ensure you are not exceeding the capacity of the cryostorage system, calculate the weight of the quantity of liquid nitrogen in your unit and subtract the result from the Total Allowable Capacity Weight found in the specifications section of this publication. All Taylor-Wharton Gas Equipment Wharton 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.

**CRYOSTORAGE
SPECIFICATIONS**

		10K	24K	38K
Dimensions				
Height ¹	in.	44.0	44.0	49.0
	mm	1118	1118	1245
Width	in.	23.1	34.0	42.0
	mm	587	864	1067
Depth ²	in.	30.5	38.0	48.0
	mm	775	965	1219
Usable Height, Internal	in.	29.0	29.0	29.0
	mm	737	737	737
Internal Diameter ³	in.	21.0	31.0	39.0
	mm	533	787	991
Capacity				
Space Volume	cu. ft	5.8	12.7	20.0
	cu. m	0.16	0.36	0.56
LN ₂ Capacity	L	165	365	590
Evaporation Rate⁴	L/day	5.0	7.0	8.0
Weight, Empty	lb.	245	405	565
	kg	111	184	256
Total Allowable Capacity Weight⁵ (including liquid refrigerant and stored product)	lb.	292	641	1008
	kg	133	291	457
Maximum Gross Weight⁶	lb.	540	1050	1575
	kg	245	476	715
Inventory Control System Specifications				
No 5 x 5 Racks ⁷		7	17	28
No. Shelves/Rack		13	13	13
No. 3.0 x 3.0 Racks ⁸		4	6	6
No. Shelves/Rack		13	13	13
Vial Capacity, 2 ml ⁹		10400	24050	38350
Blood Bag ¹⁰		175	360	560
Straw Capacity ¹¹		44000	59400	114000

Footnotes:

- ¹ Maximum required clearance (with the lid open) for the 10K is 69 in. (1753 mm); 24K is 76 in (1930 mm); and 38K is 90 in. (2286 mm).
- ² Depth with lid open for 10K is 34 in (864 mm); 24K is 48.5 in. (1232 mm); 38K is 55 in. (1397 mm).
- ³ Temperature Gradient Suppression System reduces internal diameter by approximately ¼ in. (6.4 mm). Does not apply to 10K.
- ⁴ Evaporation rate is nominal. Actual rate may be affected by the nature of the contents, atmospheric conditions, container history, and manufacturing tolerances.
- ⁵ Does not include the weight of the refrigerator itself. Refer to Maximum Refrigerator Contents section.
- ⁶ Includes the empty weight and total allowable capacity weight.
- ⁷ 5 in. x 5 in. (127 mm x 127 mm) 100 cell box.
- ⁸ 3.0 in. x 3.0 in. (76 mm x 76 mm) 25 cell box.
- ⁹ 2 ml vial size; 12.5 mm O.D. internal thread.
- ¹⁰ Fenwall 4R-5461 bag.
- ¹¹ 0.5 cc straws, 10 per goblet, 2 13 mm goblets per cane; 2

KRYOS Specifications

Configurations:	Designed exclusively for the Taylor-Wharton CryoStorage Systems (10K, 24K and 38K)
Power Supply:	24VAC, 40 VA – Standard 16.5 VAC, 40 VA with Battery Backup Option
Sensor Assembly:	4-Thermistor Assembly – Optional 8-Thermistor Assembly – Optional Freeze-Guard Assembly – Standard
Thermocouples:	Operates with none, 1 or 2 Type T Thermocouples (1 piece standard)
Solenoid Valve:	24 VAC cryogenic solenoid valve – Standard
Control Type:	Liquid Level Control or Liquid Level Control with Temperature Control
Security:	Keyless entry via 4-digit password Power On/Off Password Menu access Password
Alarms:	Activates an audible and a visual alarm. Description of the alarm condition displays on front panel. Activates remove alarm after user defined delay
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
- E. Material Return Authorization (MRA) number

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 filter and an elbow. The liquid fill hose from a low pressure source of liquid nitrogen must be connected to the inlet through these two fittings. 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 underfill. In "liquid phase" storage applications, excessive turbulence can cause splashing which could result in person 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.

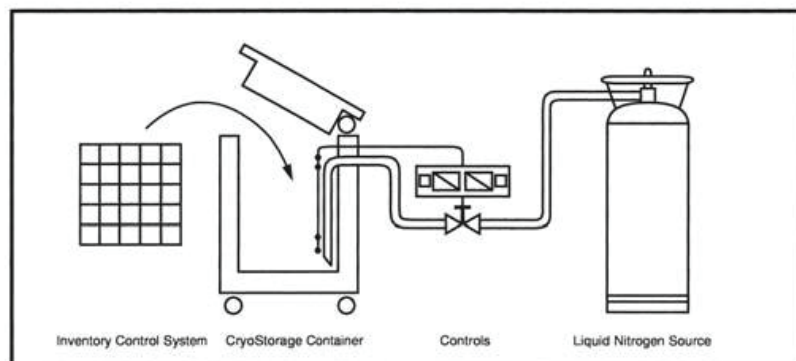


Figure 1. Taylor-Wharton CryoStorage System

Installation

KRYOS Control Field Installation

1. Unplug power from old unit
2. Close liquid nitrogen supply at valve
3. Remove 4 phillips head screws from controller face escutcheon
4. Remove 4 phillips head screws from cabinet top and 2 from old control
5. Withdraw old controller from cabinet top, noting how the controller body has been resting in guide slots
6. Unplug all jacks and wires from old controller and set aside
7. Remove 4 phillips head screws from real electrical panel
8. Unplug all connectors and wires and set panel aside
9. Remove rear plumbing access panel
10. Disconnect supply hose from solenoid valve using a 7/8 inch wrench
11. Remove old solenoid
 - two ¼ inch hex head screws
 - one compression fitting using 3/8 inch wrenches
12. Lower lid and lock hinged lid to cabinet top
13. Raise hinged lid. Cabinet top should also raise out of the way
14. Remove all wire and electrical components other than sensors and thermocouple
15. Remove old sensor tube with sensors left in place
16. Mark old sensor locations with electrical tape
17. Measure and made note of the “Start Fill”, “Stop Fill” and temperature sensors from the bottom of the sensor tube. You will need this information to set up the new controller.
18. Reverse procedure to install KRYOS control.

Qty	Description	K-Series	K-Series
		10, 24	38
1	Control Panel	5140-1166	5140-1165
1	24VAC Wall Transformer	R08K-9C04	R08K-9C04
1	Thermocouple – Temp Sensor	R08K-9C51	R08K-9C51
1	Plumbing	R10K-8C64-R	R38K-8C64-R
1	Lid Switch	5140-1041	5140-1041
1	Sensor Assembly		
	• Freeze-Guard Capable	5140-1163	5149-1163
	• Sensor-T	5140-1161	5140-1161
	• 8 Thermistor (option)	5140-1164	5140-1164
	• 4 Thermistor (option)	5140-1162	5140-1162
1	Wiring Harness w/Electric Panel	5140-1167	N/A
1	Remote Alarm Plug	R06K-8C20	5140-1160
1	Operating Instructions	7950-8320	7950-8320
1	Sensor Tube-Perf. S. Steel	R23K-9C96	R23K-9C96
1	Inlet Filter	7631-1080	7631-1080

WARNING

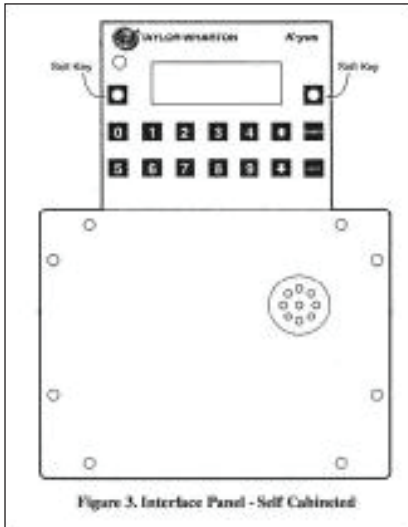
**INLET PRESSURE MUST NOT EXCEED 22 PSIG (1.5 BARL
HIGHER PRESSURES COULD RESULT IN DAMAGE
TO EQUIPMENT AND/OR DEPLETION
OF OXYGEN IN THE ATMOSPHERE TO CAUSE
DIZZINESS, UNCONSCIOUSNESS OR EVEN DEATH.**

**DO NOT REMOVE THIS LABEL
DECAL PART NO. R23K-9C42**

Figure 2. Warning Label (R23K-9C42)

Filling the Refrigerator (Initial Fill)

The 10K and 24K units using the KRYOS controller come preset from the factory to operate. For the 38K unit, refer to the **Installing the Controller** section in this manual.



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 underfill. In “liquid phase” storage applications, excessive turbulence can cause splashing which could result in personal injury and/or damage to the refrigerator.

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

Power Supply Connection

Connect the 24 Volt AC power supply to the rear of the cryostorage system; then plug the power supply into a surge protected 110/120 VAC outlet.

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

INTRODUCTION

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.

CONTROL COMPONENTS

Interface Panel

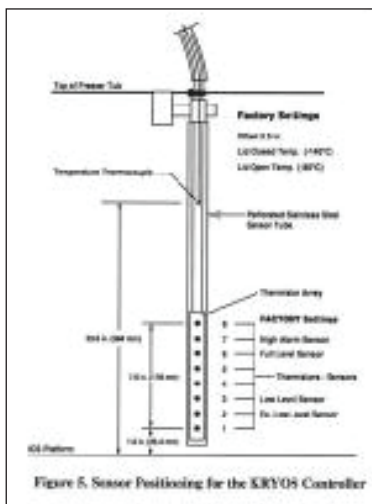
The KRYOS Interface panel, which the user will interact with, contains the vacuum fluorescent display as well as the number keypad, power button, help button and the soft-key control buttons.

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 either housed in a separate box, or located away from the Interface Panel.

Sensor Assembly

A standard 7+1 thermistor assembly, includes the Freeze-Guard over-fill sensor. Optional 4 thermistor, or 8 thermistor sensor assembly 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 lid and determines whether or not the lid is open on the freezer. This also allows the control to determine whether to activate the Quickchill or Auto Defog features.

Solenoid Valve

Is designed to work with 24 VAC solenoid valves manufactured by Valcor, ParkerHannifin, ASCO or Alcon.

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.

Wall Transformer

A 24 VAC, 40 VA wall transformer is required. The system is supplied with a transformer compatible with common household (North American) 110VAC. These wall transformers have UL approval. UL approval for the system as a whole is not required since the control operates on such a 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.

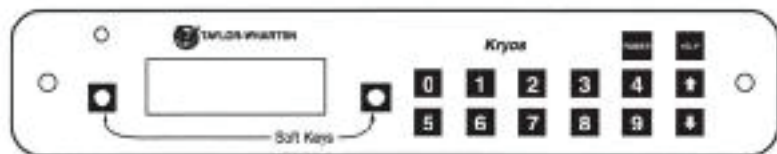


Figure 4. Interface Panel - Factory Installed - 10K or 24K

Remote Alarm

If an error condition occurs for 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 #1 in the normal condition. Continuity between pin #2 and pin #3 is provided in an error condition (See Figure 6).

OPERATION

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 at the front 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 (See Figure 5). 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 above the High Alarm sensor to measure the warmest condition in the storage chamber. The factory sensor positions will maintain a liquid level between 3 in. (76 mm) to 6 in. (152 mm). The dimensions used for the factory sensor installation are shown in Figure 5.

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.

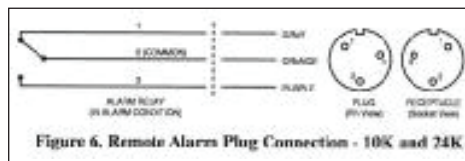


Figure 6. Remate Alarms Plug Connection - 10K and 24K

Thermocouple Positioning

The thermocouple is a separate sensor designed in conjunction with the controller temperature readout to monitor and control the temperature within the refrigerator. The thermocouple should be positioned about the High Level Alarm sensor.

NOTE:

Temperature Gradient Suppression Systems are specifically designed for use in vapor phase applications and will be of little value when liquid phase storage is used.

Temperature Gradient Suppression System

Most Taylor-Wharton CryoStorage units include a Temperature Gradient Suppression System. The Temperature Gradient Suppression System is a thermal conductor designed to conduct heat downward toward the nitrogen reservoir, and by doing so, will significantly reduce the temperature gradient between the top of the inventory control system and the nitrogen reservoir. While specific temperature profiles will vary with the use of the refrigerator and the type of inventory control system used, the Temperature Gradient Suppression System is an effective way to lower the temperature underneath the refrigerator lid without noticeably increasing liquid nitrogen consumption.

The chart below represents typical temperature gradients within a Taylor-Wharton CryoStorage System utilizing the Temperature Gradient Suppression System.

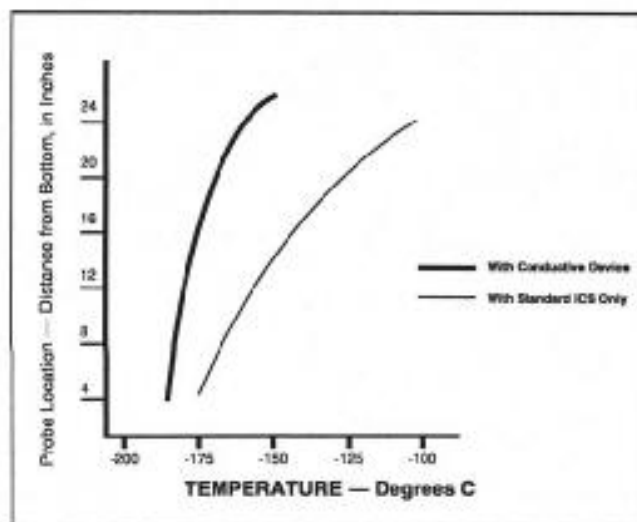


Figure 7. Temperature Gradient Suppression System Chart

Adding an Inventory Control System

The purpose of the inventory control system (ICS) 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.

If an alternate platform is supplied with your inventory control system, the liquid phase platform in the bottom of your refrigerator may need to be removed to accommodate your inventory control system platform.

Fully removing Inventory Control System racks such that frost forms on them, and then setting this frost, along with the racks back into the freezer, will deposit the frost in the bottom of the freezer. Do not let ice or debris collect in the bottom of the freezer. Schedule periodic clean out if racks no longer stand upright.

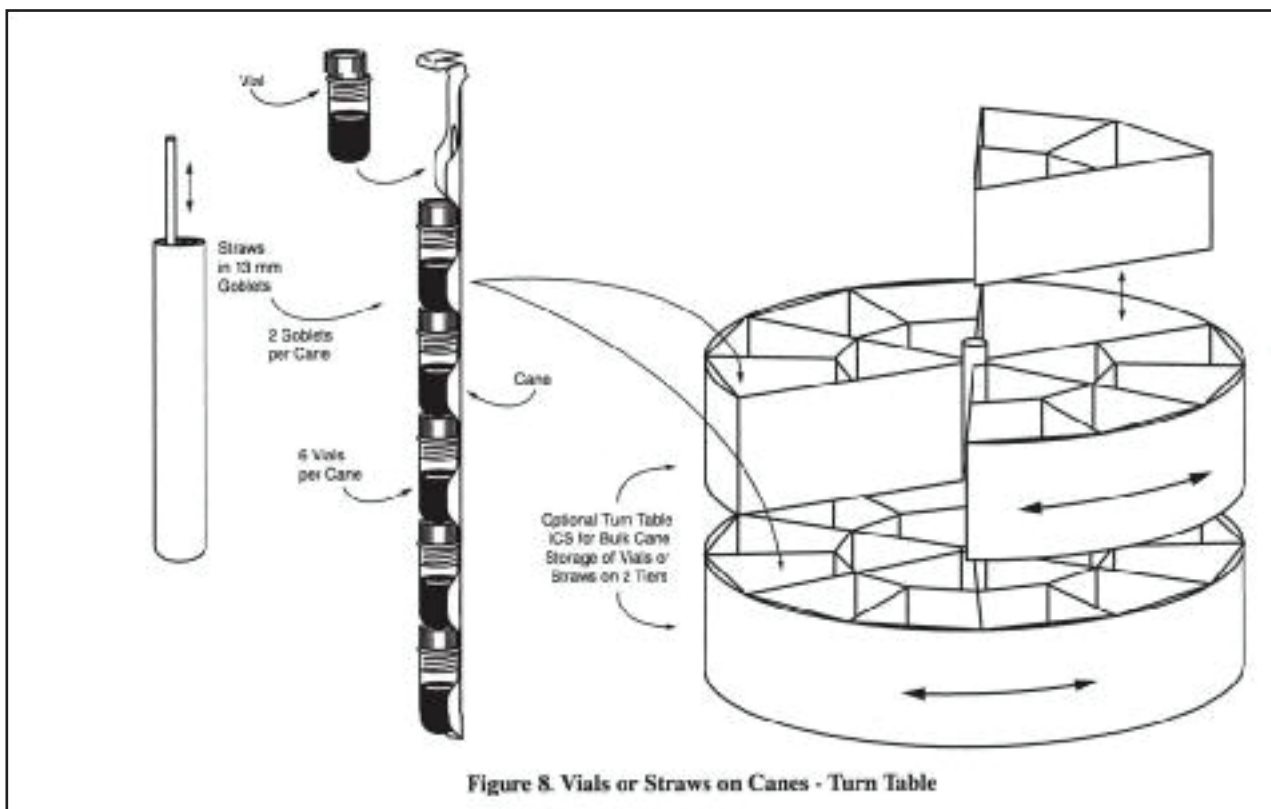
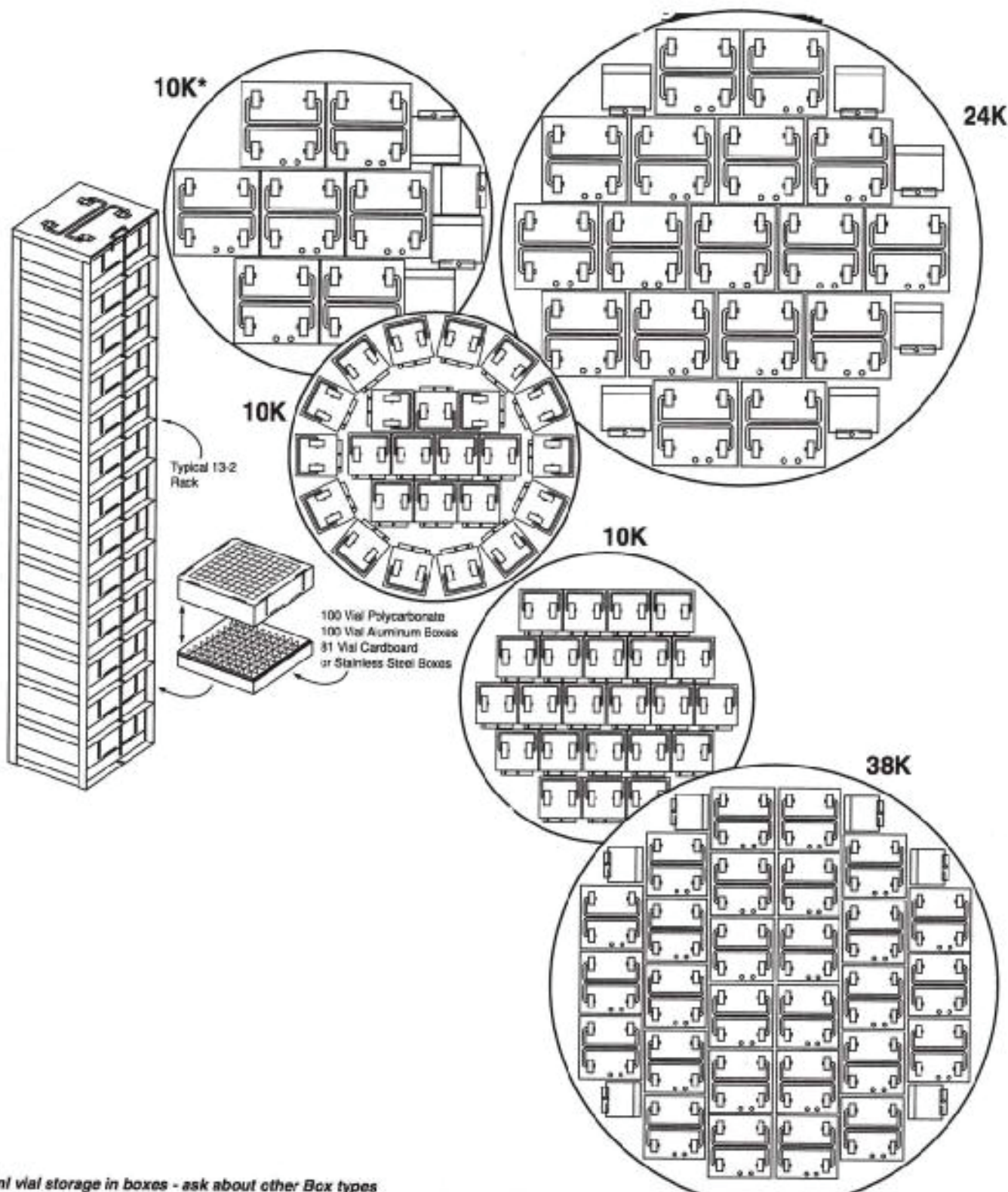


Figure 8. Vials or Straws on Canes - Turn Table

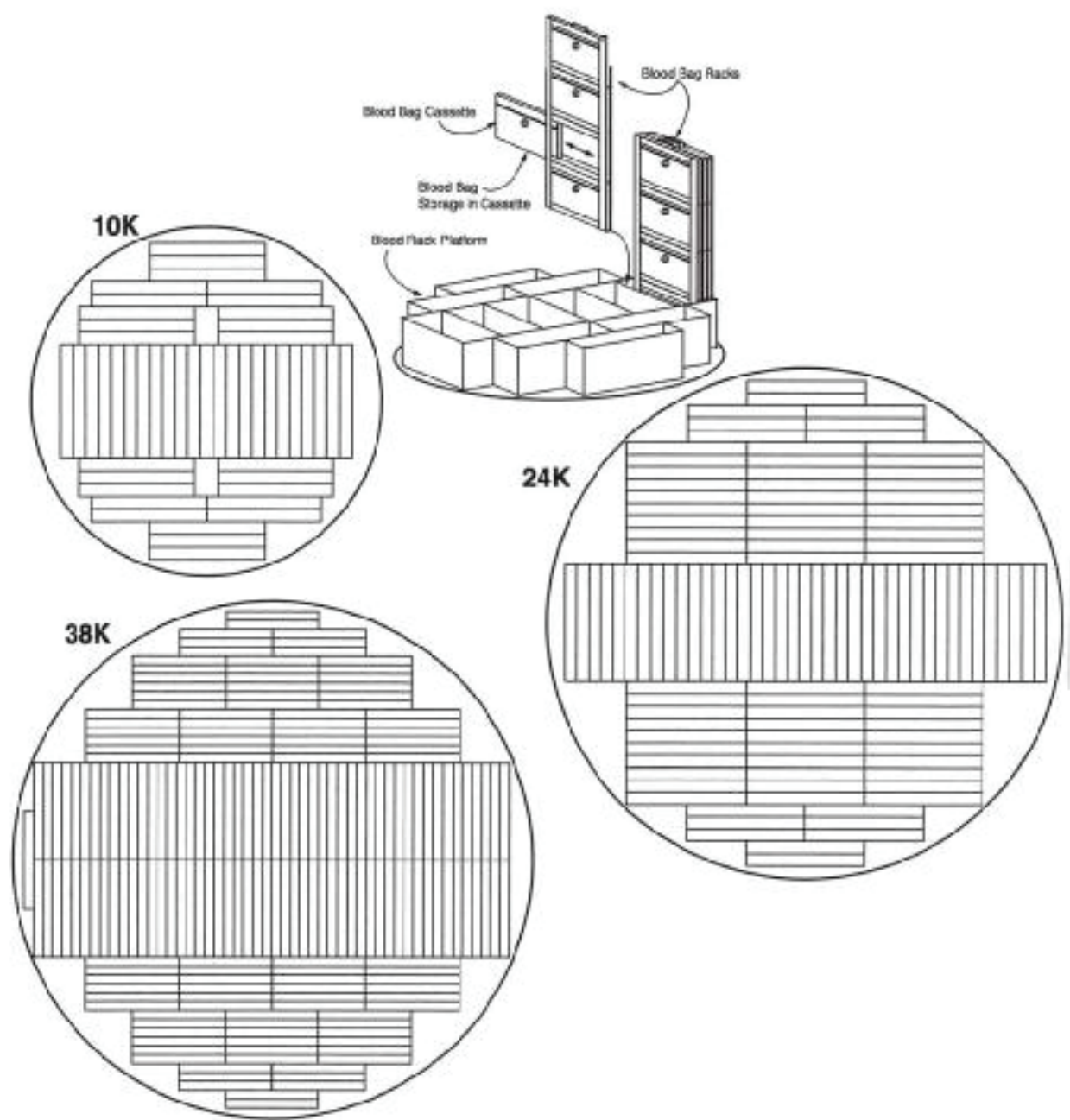


2ml vial storage in boxes - ask about other Box types

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)	BOXES -25 N-374160 (case of 36)	VIAL CAPACITY Max. allowable
10K*	7	4	91	52	10400*
24K	17	6	221	78	24050
38K	28	6	364	78	38350

*Without Temperature Gradient Suppressor

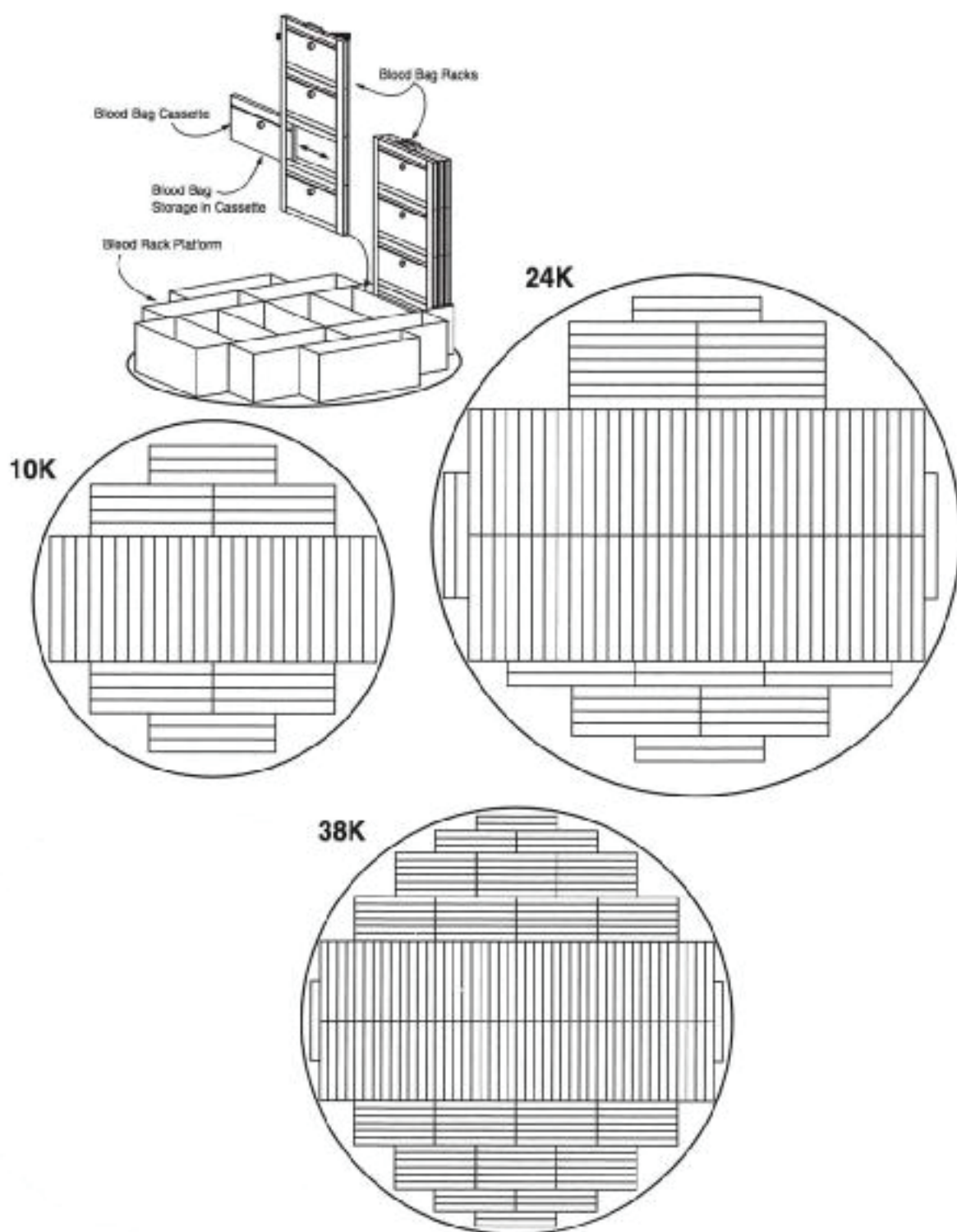
Figure 9. Vial Storage on Racks



Fenwal 4R9951 Blood Bags - ask about other Bag types

	CAPACITY	FRAMES	CASSETTES	PLATFORM
10K	343	48	343	10KBP-4R9951
24K	805	115	805	24KBP-4R9951
38K	1407	201	1407	38KBP-4R9951

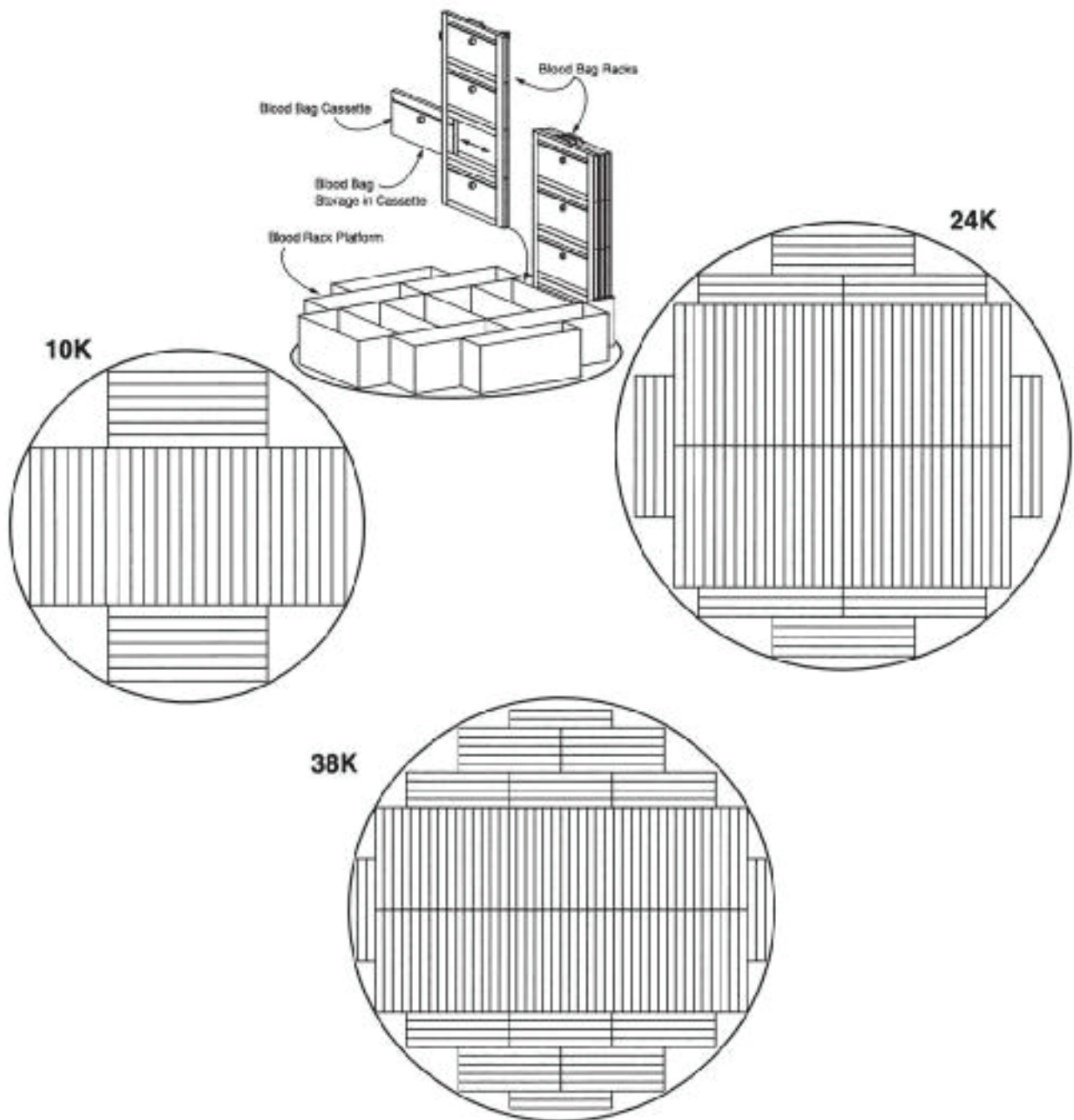
Figure 10. Fenwal 4R9951 Blood Bag Rack Arrangements



Fenwal 4R5461-8953 Blood Bags - ask about other Bag types

	CAPACITY	FRAMES	CASSETTES	PLATFORM
10K	235	47	235	10KBP-4R9953
24K	535	107	535	24KBP-4R9953
38K	870	174	870	38KBP-4R9953

Figure 11. Fenwal 4R5461-9953 Blood Bag Rack Arrangements



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

	CAPACITY	FRAMES	CASSETTES	PLATFORM
10K	185	37	185	10KBP-4R9955
24K	475	85	475	24KBP-4R9955
38K	680	136	680	38KBP-4R9955

Figure 12. 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. For models that use the Mark IL controller refer to operating manual TW-303, P/N 7950-8303, for the Mark 3 controller refer to operating manual TW-291, P/N 7950-8291, for the Mark 2L controller refer to operating manual TW-290, P/N 7950-8290.

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 source supply of liquid nitrogen is maintained. If your protocol calls for you to “top-off” the cryostorage system at the end of a work day or work week, 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 FILLING 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 FUL LEVEL and the HIGH LARM 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 bottom of the controller chassis for the 38K and on the back of the refrigerator for the 10K and 24K. See Figure 13.

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. No pressure or time calculations are used to measure the liquid level (as on other controllers). 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. 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 3 choices in this menu section), the left-hand soft-key button will give the "More" choice. User may select inches or centimeter level reading (menu 2,5) in either 7 or 8 thermistor mode. 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

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 - 1.1 Thermocouple Select
 - 1.2 Calibrate Temperature
 - 1.3 Test Temperature System
 - 2. Level Sensing
 - 2.1 Test Level Sensors
 - 2.2 Sensor Positions
 - 2.3 Sensor Positions
 - 2.3.1 Start Fill
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 - 2.4 Sensor Type
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 - 3. Alarms
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 - 5. Security
 - 5.1 Power-On Password
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-

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.

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 thermocouples should be placed in the chamber to monitor temperature in the

warmest part of the chamber (worst case temperature). Factory installation includes one thermocouple inside of the sensor 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 sensor 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 self calibrates to -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 will then indicate that the temperature has been calibrated. The thermocouple is now ready to be repositioned inside the sensor tube. Be sure that the thermocouple elevation is well below the lid when closed. 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 4 thermistor assembly to measure liquid level in the freezer. The 4 sensor assembly provides general information about liquid level (high alarm, high, normal, and low alarm) while the 7 and 8 thermistor assemblies provide liquid level readings accurate to the nearest 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).

Set Sensors Offset

A sensor offset can be set through the menu system of the control (**MENU**, 2, 2) . The offset is used if the sensor assembly is raised off the floor of the freezer and the user wants to read the actual liquid level on the display. An example of this would be a *STOP FILL* setting of 23" and a *START FILL* setting of 20". The 8 thermistor sensor assembly would be set so that the bottom of the sensor assembly is raised 18" off the floor of the freezer. The level would then read from 18" to 26".

The low level alarm would be set at 19" since the *START FILL* is 20" and the high level alarm would be 24" since the *STOP FILL* is 23." In normal operation, the liquid level would read between 20" and 23." The offset would be set to 18." The control determines the liquid level by adding the offset to the number of thermistors in LN₂. The offset can be set from 0 to 40".

Sensor Positions

The *START FILL* and *STOP FILL* sensor positions can be set through the menu system of the control (**MENU**, 2, 3). *START FILL* and *STOP FILL* need to be set if an 8 thermistor sensor or the Freeze-Guard sensor is being used. If an offset is being used, it is added to the sensor position to indicate the correct level of the sensor from the floor of the freezer. The *STOP FILL* sensor must always be higher than the *START FILL* sensor. Therefore, if *START FILL* is being increased where it would pass the *STOP FILL* point, the *STOP FILL* is also increased so that it is always 1" higher than *START FILL*. The converse is true for the *STOP FILL* when it is being decreased. A four thermistor sensor assembly requires that the *START FILL* and *STOP FILL* sensors be physically located at the correct position. Because of this the menu selection for setting the *START FILL* and *STOP FILL* becomes inaccessible when the 4 thermistor sensor is being used.

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. Multiple errors will be shown in sequence.

When an error does occur, you may MUTE the audible alarm 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. It can not be disabled without disconnecting the power supply. The remote alarm will be activated if the power supply 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 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).

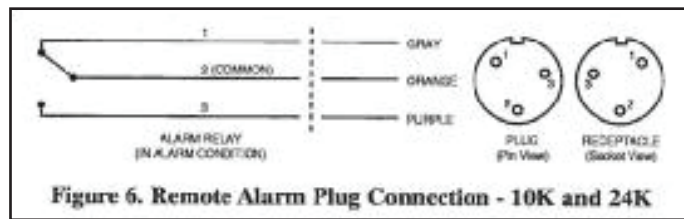


Figure 6. Remote Alarm Plug Connection - 10K and 24K

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 opened 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, 4. Temperature #2 log. The two temperature logs are simply records of the temperatures recorded by the two thermocouples in the system.

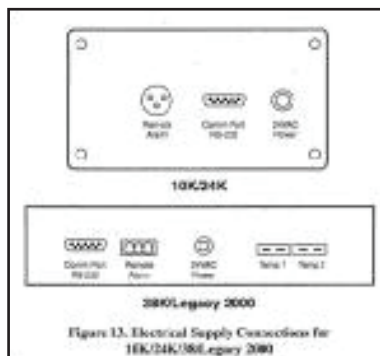


Figure 13. Electrical Supply Connections for 10K/24K/30K Legacy 2000

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 to 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 to the serial port of the freezer. When this option is chosen, the display reports how many system logs are in the system. 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 to 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 to 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.

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.

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.

THERMOCOUPLE OPEN 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.

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.

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.

System Logs

TANK 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.

LID OPENING/CLOSING 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.

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.

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.

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. Password 9999 is an invalid choice since this is used to access the procedure to clear the password if it is 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. Password 9999 is an invalid choice since this is used to access the procedure to clear the password if it is forgotten.

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 (PASSWD 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. 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, the passwords will be cleared and full access to the control is restored.

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.

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. The following speeds can be chosen: 300, 1200, 2400, 4800, 9600 or 19200 baud. For an explanation of remotely detectable alarm conditions, see the “ALARMS” section of this manual.

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 (Central Time, USA), however, different time zones will need to adjust this according to their time zone. A coin cell battery backs up the date and time on the control.

User Access Logs

The *USER ACCESS LOGS* (**MENU**, 4,3) track all personnel who enter the freezer by asking for an identification number. Identification numbers range from 00 to 99. 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 seconds time frame, the log indicates that an unidentified user accessed the freezer.

Defog Timer Set

DEFOG TIMER SET 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.

Manual Defog

The *DEFOG TIMER* (**MENU**, 6, 2,2,1) feature provides a burst of LN₂ to the freezer to clear the fog when the user presses the defog button from the front panel. The choices for this feature are Disabled through 90 seconds.

Lid Switch Setup

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

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 are disabled through 90 seconds.

Auto Defog Timer Set

AUTO DEFOG TIMER SET can be changed through the menu system of the control (**MENU**, 6,2,2,3). This option sets the time interval that the valve is opened on an auto defog (when the lid is opened). The possible choices are Disabled through 90 sec-onds.

The lid switch must be enabled to use this feature.

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 are disabled through 90 second purge of gas-eous nitrogen.

Quick-Chill Timer Set

QUICK CHILL TIMER SET can be changed through the menu system of the control (**MENU** 6,2,2,4). This option sets the time interval that the valve is opened on a quick chill (when the lid is closed). The possible choices are disabled through 90 seconds. The lid switch must be enabled to use this feature.

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 Thermo-couple #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 setpoint 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.

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 tempera-ure. 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 is 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 or if the control goes into a High Alarm. 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 com-manded 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 and gives the FreezeGuard sensor the opportunity to predict an impending overflow before it actually overfills. The allowable settings are Disabled and 1-15 minutes.

Valve De-icing

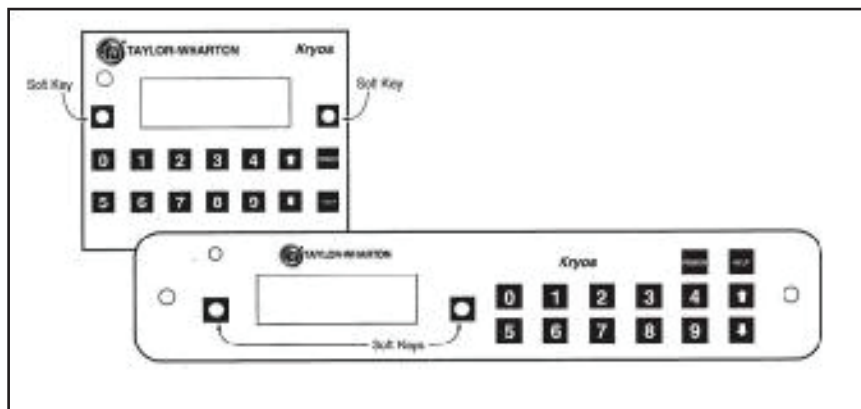
Valve De-Icing can be accessed through the menu system (**MENU**, 6,2,4,2). This feature can be turned on or off. If enabled, the control will try to free up the valve by rapidly turning it on and off. This feature is triggered when the Freeze-Guard sensor detects a stuck valve or when the control detects a High Alarm 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 assem-bly. 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%.



Control Interface Panel

INTERFACE SOFTWARE

About this Control

ABOUT THIS CONTROL can be found 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.

Optional software 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).

MAINTENANCE

Filter Cleaning Instructions

The container will not fill properly if the filter is clogged with ice or dirt. To clean the filter, first close the supply valve to the refrigerator. Vent the fill line of all pressure. Remove and warm the filter to ambient temperature. Purge the filter from both directions with dry nitrogen gas or dry oil-free air. Rinse the filter 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).

NOTE:

Ice or frost in the sensor tube may restrict the movement of sensor probes in the tube. Do not pull excessively on the sensor wiring while attempting to change sensor position. It may be necessary to remove the sensor tube from the container and allow it to thaw before the sensors can be repositioned

Defrosting Your K-Series Cryo-Storage 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 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, remove the fill tube from the refrigerator, allow to thaw to room temperature, and purge with dry nitrogen or oil-free dry air to remove all traces of moisture before re-installation.

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.*

Excessive ice and frost buildup on the lid may occur if the lid is misaligned or the insulative gasket material is damaged. Should this occur, please contact your Taylor-Wharton distributor for assistance.

Cleaning Your Taylor-Wharton CryoStorage System

The cryogenic vessel of all K-Series 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 cleaned and sterilized, regardless of the type of stored product, prior to return to Taylor-Wharton for repair or maintenance¹

To clean and sterilize your K-Series CryoStorage System, first turn the unit off. Disconnect the power source and the liquid nitrogen source. Remove all stored product and inventory control system components. Allow the residual liquid nitrogen to evaporate and the cryogenic vessel to warm to ambient temperature. Increasing air flow with a room fan or blower will expedite the evaporation.

Spray the entire inner vessel surface with ample amounts of an approved disinfectant.² Allow surface contact to be maintained for a minimum of five minutes. Rinse the inner vessel with water, remove all water and debris, and 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 towel dry.

WARNING: Never use chlorine-based disinfectants to clean a 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 dip-sticks. 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 CryoStorage System for forty-eight (48 hours.)
4. Open the CryoStorage System and measure the liquid nitrogen level. Typically, liquid nitrogen levels will drop approximately 1 in. (25.4mm) per day. If your measurement indicates a drop in excess of 2.0 in. (51 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. For the 10K and 24K, the controller is connected to the back electrical panel with a wire cable with the appropriate snap-on connectors.

Removing/Installing the Controller 10K/24K Units

Remove the cabinet top, follow the steps illustrated in Figure 14. Remove two (2) screws from the controller and lift it from the refrigerator far enough to detach its electrical connection wiring. Remove four (4) screws from the top of the refrigerator and lift the cabinet top to gain access to the area between the cabinet and the insulated inner vessel. On the 10K and 24K, the cabinet top may only be raised as shown because of the lid hinges. Do not remove the hinged lid. After the cabinet top is loosened and propped up, the electrical connection wiring may be detached to allow access to its back panel connection. At the completion of maintenance or repairs, reattach the electrical connection wiring to the controller.

To install the controller, install the electrical supply connections panel to the back of the refrigerator. Feed the wiring harness from the electrical supply connections panel to the front of the refrigerator and through the opening to where the controller will be mounted. Attach the electrical supply connections to the controller board. Be sure to follow all of the installation procedures for the thermocouple, sensor probes and solenoid valve before you reattach the cabinet top. Reattach the cabinet top with the (4) four screws that were taken out to remove the cabinet top. Carefully lower the controller into the cabinet. Attach the controller to the cabinet top with the (2) two supplied screws. Be sure that all of the necessary installation procedures have been completed before you start to fill the refrigerator. To start filling, refer to Filling the Refrigerator (Initial Fill) section of this manual.

38K

Unscrew the two (2) screws that attach the controller to the container. Remove the controller. Disconnect the thermocouple, sensor probes and solenoid valve leads from the controller board. After maintenance or repairs have been made to the controller refer to the procedure outlined for your refrigerator in Removing/Installing the Controller section.

To install the controller, connect the thermocouple, sensor probes and solenoid valve leads to the bottom of the controller box.

Locate the two (2) sets of mounting holes on the refrigerator. When facing the container, these holes will be located at the 10 o'clock and 2 o'clock positions. Remove the two (2) screws in the position that has been chosen. Mount the controller to the outside of container using these two (2) screws. Be sure to follow all of the necessary installation procedures for the thermocouple, sensor probes and solenoid valve before you start to fill the refrigerator. To start filling refer to Filling the Refrigerator (Initial Fill) section of this manual.

Removing/Installing the Thermocouple

Remove the controller using the procedures outlined for your particular refrigerator model in Removing the Controller section. Disconnect only the thermocouple lead connection from the controller board. Gently pull the thermocouple from the sensor tube.

To install a thermocouple, feed the thermocouple lead into the sensor tube to an elevation in the storage chamber you want to monitor. Connect the thermocouple to the controller board. At the completion of maintenance or repairs, install the controller using the procedure outlined for your refrigerator model in the Removing/Installing the Controller section.

NOTE:

Ice or frost in the sensor tube may restrict the movement of sensor probes in the tube. Do not pull excessively on the sensor wiring while attempting to remove sensors. It may be necessary to remove the sensor tube from the container and allowed it to thaw before the sensors can be removed.

Removing/Installing the Sensor Probes

Remove the controller using the procedures outlined for your particular refrigerator model in Removing/Installing the Controller section. Disconnect the sensor probe lead connection from the controller board. Carefully remove the sensor tube plug from the sensor tube and remove the sensor leads from the plug.

Making Adjustments to the KRYOS Sensor Assembly

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

- Low Level Alarm = 2 (Always 1" below the start fill)
- Start Fill Sensor = 3
- Stop Fill Sensor = 6
- High Level Alarm = 7 (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.

- Determine the range of LN₂ level in the refrigerator (i.e. Start Fill = 9; Stop Fill = 12)
- Determine the appropriate offset by subtracting 2 from the Start Fill. (i.e. Offset = 9 - 2 = 7)

- Set the sensor assembly so that the very bottom of the assembly matches the desired offset. This can be done as follows:
- Push the sensor down the sensor tube until it touches the bottom of the refrigerator.
- Mark the sensor wire where it emerges from the top of the sensor tube.
- Using the marked wire as a reference, pull the sensor up the same distance as the offset setting.

The sensor assembly is now in the correct location.

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”).
- Go 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

Remove the controller using the procedures outlined for your particular refrigerator model in the Removing/Installing the Controller section. Disconnect only the solenoid valve lead connection from the controller board. Remove the back plumbing cover of the refrigerator to gain access to the plumbing and solenoid valve.

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. At the completion of maintenance or repairs, install the controller using the procedure outlined for your refrigerator model in the Removing/ Installing the Controller section.

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.

NOTE:

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

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.



Figure 14. Removing the Cabinet Top of the 10K or 24K

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

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

In addition to the above, an alarm condition may be triggered by an exceedingly long fill mode.

The key to troubleshooting your 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.

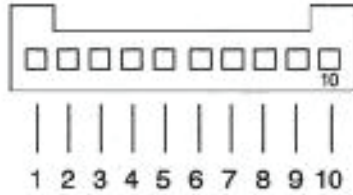
Controller Will Not Turn ON

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 dip stick. 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. Confirm that Relief Valve has a pressure rating of 100psi.
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.

HARNES ASSEMBLY - 10K AND 24K

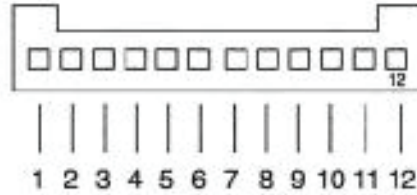


Pin 1	= Gr/Wh	= RA NO
Pin 2	= Wh/Bk	= RA C
Pin 3	= Gr/Bk	= RA NC
Pin 4	= Gr	= 24VAC
Pin 5	= Wh	= 24VAC
Pin 6	= Bk	= SI G
Pin 7	= Bl	= SI TX
Pin 8	= Bl/Bk	= SI RTS
Pin 9	= Rd	= SI RX
Pin 10	= Bl/Wh	= SI CTS

SI G = Serial Interface, Ground
SI TX = Serial Interface, TX
SI RTS = Serial Interface, RTS
SI RX = Serial Interface, RX
SI CTS = Serial Interface, CTS

All Thermistor ranges
 - At Room Temp 2 to 10 ohms
 - In Cold Gas 8K to 18K ohms
 - In Liquid Nitrogen 18K to 35K ohms

SENSOR ASSEMBLIES - 12 PIN MOLEX PLUG



PIN #	STANDARD FREEZE-GUARD 7 LEVEL +T*	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 SIF
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
SIF = 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

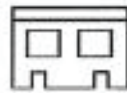


FREEZE-GUARD SENSOR

* Confirm that Freeze-Guard thermistor is attached down line of the 12 pin Molex plug.



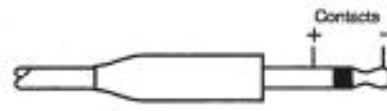
THERMOCOUPLE 1 OR 2
Check Continuity



SOLENOID VALVE
Check Continuity and Energize with 24VAC



LID SWITCH
Check Continuity Operate Switch



WALL TRANSFORMER POWER SUPPLY
24VAC

Figure 15. Pin View Schematics

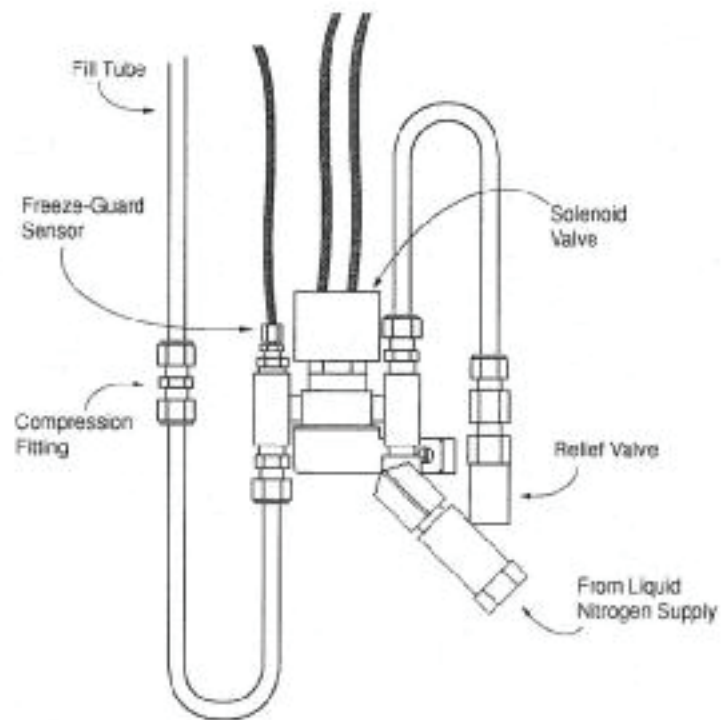


Figure 16. 10K and 24K Plumbing Assembly

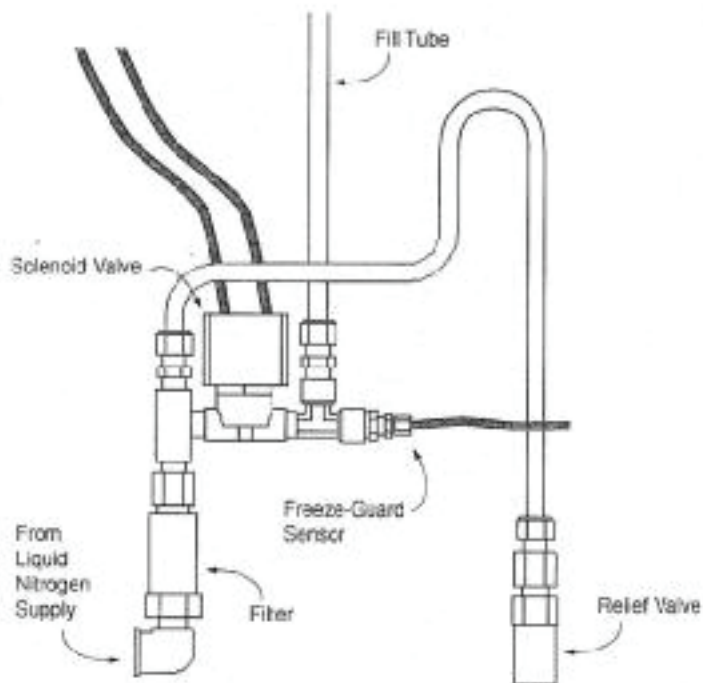


Figure 17. 38K and Legacy 2000 Plumbing Assembly

TROUBLESHOOTING

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. The joint at the cabinet top to cabinet side is often the pinch point from previous service calls.
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 15, Pin View Schematics.

- Thermocouple is not repairable. Replace from stock.

Temperature reading 10 to 20 degrees warm.

1. Make sure sensor tube is breathing. If Ice build up is a problem in a humid environment or if you have a clear polycarbonate sensor tube, the thermocouple may be attached to the outside of the sensor tube with nylon wire ties. Tuck thermocouple out of harms way on side or back of sensortube. Do not attach thermocouple to fill tube.

- 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, FREEZEQUARD 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

1. 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 Blanks During a Fill

This phenomenon can happen if cold vent gases are spilling into the controller face, or into the cabinet onto the controller back.

1. Check the seal between the blue lid and the beige cabinet top. The black gasket should direct vent gases out the back of the lid and away from the controller.
 - Adjust lid hinges and/or replace gasket.

2. Check seal between top of tub and beige cabinet top. The black gasket should prevent venting under the cabinet top.
3. Check seal around sensor wires. Tape or spray foam this gap if needed.

Message “Please Wait”

A circuit board malfunction has occurred. Call your authorized Taylor-Wharton agent for assistance.

Display = “Check”

The word CHECK will flash during periods of Splash-Guard protection. See page 18 for more information.

Lid Open Alarm

A lid switch is located on the left rear 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 “C” 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

1. 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.

1. To activate or adjust times: Select 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 within the confines of the eight 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).

1. 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 6 inches, with an OFFSET of zero. If you want to establish a START at 15 and STOP at 18, raise the sensor assembly 12 inches (18 minus 6) 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 up to a 15 inch fill. It may be necessary to stop the fill manually and allow the supply vessel time to regain enough pressure to complete this exceptionally long 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 #2 Alarm	-100° C
Hi Temp #2 Alarm	-100° C
Level Control:	
OFFSET	0 inches
START FILL Sensor	3 inches
STOP FILL Sensor	6 inches
Sensor Assembly	Freeze-Guard

System:

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

Temperature Control:

Temperature Control	Disabled
Temperature	-150° C
Temperature Range	+2° C

Alarms:

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

Freeze-Guard:

Valve Open Duration	Disabled
Valve De-icing	Enabled

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

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.

Describe Conditions – Actual

Liquid Level – via Dipstick _____
Level Sensor Type ____ FG ____ 8T ____ 4T
Lid ____ Open ____ Closed
Filling ____ Yes ____ No
Temperature _____
LN2 Supply _____ ltr _____ psi
Note: Ice Build-up ____ a little ____ a lot
Note: Gasket condition ____ Seals ____ Leaks
Display Lights ____ On ____ Off

REPLACEMENT PARTS

Refrigerator Parts (10K/24K)	10K	24K
Cabinet, Back, Panel	R10K-9C35	R23K-9C35
Cabinet, Front, Panel	R10K-9C33	R23K-9C33
Cabinet, Side, Panel	R10K-9C34	R23K-9C34
Cabinet, Top, Panel (old style 24K w/12 o'clock Fill Tube = R23K-9C10)	R10K-9C11	R24K-9C12
Gasket Kit	R10K-9C60	R10K-9C60
Lid Assembly (24K for lids prior to PD = R23K-9C85R)	R10K-9C86	R23K-9C85
Back Cover, Plumbing	R06K-9C32	R06K-9C32
Caster, (Four Required)	7300-9020	7300-9020
Fill Tube Assembly (prior to PD fill tube for 24K = R23K-9C66)	R10K-9C66	R24K-9C66
Sensor Tube, Perforated, Stainless Steel (field cut to length w/ tube cutter)	R23K-9C96	R23K-9C96
Pneumatic Spring, Stroke 20# Force for 10K, 40# force for 24K	8958-0130	8958-0140
Hinge, Top Section	R10K-9C52	R10K-9C52
Hinge, Bottom Section	R17K-9C53	R17K-9C53
Decal, Lid Warning	R10K-9C42	R17K-9C42
Decal, Warning	R23K-9C42	R23K-9C42
Temperature Gradient Suppression System (reduces rack capacity ñ 10K)	R10K-9C84	R20K-8C71
Temperature Gradient Suppressor Straps	N/A	R20K-8C72
Inventory Control System (ICS) Platform	R10K-9C05	R17K-9C05
Inventory Rack 25 Vials [13 shelves tall for 2 in (51mm.) boxes] (ea.)	R10K-9C44	R10K-9C44
Inventory Rack 100 Vials [13 shelves tall for 2 in (51mm.) boxes] (ea.)	R23K-8C35	R23K-8C35
Refrigerator Parts (38K)		
Lid Assembly	R27K-9C00	
Caster, (Five Required)	7301-2032 (3 reg.), 7301-2031 (2 reg.)	
FillTubeAssembly	R40K-9C36	
Sensor Tube, Perforated, Stainless Steel	R23K-9C96	
Pneumatic Spring, 6 in. (152 mm.) Stroke 90# Force	8958-0135	
Decal, Lid	R08K-9C63	
Decal, Warning	R23K-9C42	
Decal, Warning	R10K-9C42	
Temperature Gradient Suppression System	R33K-8C71	
Temperature Gradient Suppressor Straps	R33K-8C72	
Inventory Control System Platform	R27K-8C00	
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	10K/24K	38K
Control Panel KRYOS	5140-1166	5140-1165
Sensor Assembly KRYOS (Freeze-Guard Capable)	5140-1163	5140-1163
• Sensor Assembly – Plumbing, Freeze Guard	5140-1161	5140-1161
• 8 Thermistor (option)	5140-1164	5140-1164
• 4 Thermistor (option)	5140-1162	5140-1162
Remote Alarm Plug	R06K-8C20	R06K-8C20
Transformer KRYOS	R08K-9C04	R08K-9C04
Electrical Panel Assembly	5140-1167	N/A
Thermocouple Assembly	R08K-9C51	R08K-9C51
Lid Switch	5140-1195	5140-1195
Cable Lid Switch	R20K-9C66	R20K-9C66
Plumbing Assy. KRYOS 24 VAC	R10K-8C64-R	R38K-8C64-R
Solenoid Valve 24 VAC	6999-9021	6999-9021
Relief Valve 100 psig (6.9 bar/690kPa) ¼ in. NPT	6913-9077	6913-9077
Filter Assembly	7631-1080	7631-1080

	Fully Auto -MOWDEN	MARK 1 -GE	MARK 2 -PCR	MARK 2LT -PCR	MARK 3 -GE	KRYOS -PCR
CONTROLLER	5140-1128	5140-1145	5140-1131	R08K-9C00	5140-1143	5140-1166
SENSOR ASSEMBLY	R06K-9C44	5140-1147	R08K-9C49	R08K-9C01	5140-1137	5140-1163
THERMOCOUPLE	R06K-9C46	N/A	R08K-9C51	R08K-9C51	R08K-9C51	R08K-9C51
REMOTE ALARM PLUG	R06K-8C20	R06K-8C20	NOTE 1	R06K-8C20	R06K-8C20	R06K-8C20
SENSOR TUBE ¹	R23K-9C96	R23K-9C96	R23K-9C96	R23K-9C96	R23K-9C96	R23K-9C96
SENSOR TUBE PLUG	R10K-9C69	R10K-9C69	R10K-9C69	R10K-9C69	R10K-9C69	R10K-9C69
TRANSFORMER	N/A	5140-1146	N/A	R08K-9C04	5140-1139	R08K-9C04
ELECTRIC PANEL	R06K-9C25	5140-1148	R08K-9C47	R08K-9C02	5140-1142	5140-1167
LID SWITCH	N/A	5140-1195	N/A	5140-1195	5140-1195	5140-1195
CABLE, LID SWITCH	N/A	R23K-9C71	N/A	R23K-9C71	R23K-9C71	N/A
PLUMBING ASSEMBLY	N/A	R23K-8C61	R17K-8C61	R23K-8C62	R24K-8C52	R10K-8C64-R
-SOLENOID VALVE ²	R06K-9C61	6999-9021	R08K-9C48	6999-9021	6999-9021	6999-9021
-RELIEF VALVE, 100 psi	6913-9077	6913-9077	6913-9077	6913-9077	6913-9077	6913-9077
FILTER ASSEMBLY	7631-1080	7631-1080	7631-1080	7631-1080	7631-1080	7631-1080
TEMP. GRADIENT SUP.	R10K-9C84	R10K-9C84	R10K-9C84	R10K-9C84	R10K-9C84	R10K-9C84
TGS STRAPS*	R06K-9C20	R06K-9C20	R06K-9C20	R06K-9C20	R06K-9C20	N/A ³

Note 1 – Radio Shack Park Number 274-001 Microphone jack.

*No straps on 10K or 18K

	Fully Auto -MOWDEN	MARK 1 -GE	MARK 2 -PCR	MARK 2LT -PCR	MARK 3 -GE	KRYOS -PCR
CONTROLLER	5140-1128	5140-1145	5140-1131	R08K-9C00	5140-1143	5140-1166
THERMOCOUPLE	R06K-9C46	N/A	R08K-9C51	R08K-9C51	R08K-9C51	R08K-9C51
SENSOR ASSEMBLY	R06K-9C44	5140-1147	R08K-9C49	R08K-9C01	5140-1137	5140-1163
REMOTE ALARM PLUG	R06K-8C20	R06K-8C20	NOTE 1	R06K-8C20	R06K-8C20	R06K-8C20
SENSOR TUBE1	R23K-9C96	R23K-9C96	R23K-9C96	R23K-9C96	R23K-9C96	R23K-9C96
SENSOR TUBE PLUG	R10K-9C69	R10K-9C69	R10K-9C69	R10K-9C69	R10K-9C69	R10K-9C69
TRANSFORMER	N/A	5140-1146	N/A	R08K-9C04	5140-1139	R08K-9C04
ELECTRIC PANEL	R06K-9C25	5140-1148	R08K-9C47	R08K-9C02	5140-1142	5140-1167
LID SWITCH	N/A	5140-1195	N/A	5140-1195	5140-1195	5140-1195
CABLE, LID SWITCH	N/A	R23K-9C71	N/A	R23K-9C71	R23K-9C71	N/A
PLUMBING ASSEMBLY	N/A	R23K-8C61	R17K-8C61	R23K-8C62	R24K-8C52	R10K-8C64-R
-SOLENOID VALVE ²	R06K-9C61	6999-9021	R08K-9C48	6999-9021	6999-9021	6999-9021
-RELIEF VALVE, 100 psi	6913-9077	6913-9077	6913-9077	6913-9077	6913-9077	6913-9077
FILTER ASSEMBLY	7631-1080	7631-1080	7631-1080	7631-1080	7631-1080	7631-1080
TEMP. GRADIENT SUP. ³	R20K-8C70	R20K-8C70	R20K-8C70	R20K-8C70	R20K-8C70	R20K-8C70

Note 1 – Radio Shack Park Number 274-001 Microphone jack.

¹ May require field cut-to-length

² May require electrical bolt-end-connectors for 18 gauge wire.

³ Includes TGS straps

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 Contact Name/Company _____
 Service Contract Phone Number/Fax _____
 K-Series Model/Serial Number _____
 KRYOS Serial Number _____
 Control Version Number _____
 In-Service Date _____

	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: 251-408-4515

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 K-Service CryoStorage System received without this statement will be returned to the sender, freight collect. Contact Customer Service at (251) 443-8680 for information.

² For cleaning and sterilizing of the K-Series CryoStorage Systems, Taylor-Wharton recommends EXSPOR™ Cold Sterilant, manufactured by Alcide Corp., 8561 154th Ave, NE, Redmond, WA. (206-882-2555).

