

INSTRUCTION MANUAL

Medical Device K SERIES Cryostorage System



CryoCe38K

CryoCe24K

CryoCe10K

CAUTION — SAFETY FIRST!

- FOR PROPER AND SAFE OPERATION AND USE OF THIS CRYOSTORAGE SYSTEM, IT IS ABSOLUTELY NECESSARY TO REVIEW AND UNDERSTAND THE FOLLOWING WARNINGS AND SAFETY PRECAUTIONS BEFORE ATTEMPTING TO INSTALL, OPERATE OR MAINTAIN THE CRYOSTORAGE SYSTEM.
- DO NOT ATTEMPT TO INSTALL, USE OR MAINTAIN THE CRYOSTORAGE SYSTEM UNTIL YOU READ AND UNDERSTAND THESE INSTRUCTIONS.
- DO NOT PERMIT UNTRAINED PERSONS TO INSTALL, USE OR MAINTAIN THIS CRYOSTORAGE SYSTEM.
- IF YOU DO NOT FULLY UNDERSTAND THESE INSTRUCTIONS, CONTACT WORTHINGTON INDUSTRIES OR YOUR DISTRIBUTOR FOR FURTHER INFORMATION.

NOTE: Devices may differ slightly from the image



CONTENTS

1 USER DIRECTIONS	5
2 SAFETY PRECAUTIONS	6
3 SYMBOLS	9
4 DEVICE DESCRIPTION	11
4.1 DEVICE INTENDED USE	11
4.2 DEVICE INTENDED LOCATION AND USER	11
4.3 DEVICE OVERVIEW AND KEY FEATURES	12
4.4 CRYOSTORAGE SPECIFICATIONS	14
4.5 INVENTORY CONTROL SYSTEM SPECIFICATIONS	15
5 INSTALLATION OF DEVICE	20
5.1 UNPACKING AND INSPECTION	20
5.2 CONDITIONS OF OPERATION AND STORAGE	21
5.3 LIQUID NITROGEN SUPPLY CONNECTION	22
5.4 ELECTRICAL POWER SUPPLY CONNECTION	23
5.5 FIRMWARE	23
6 OPERATION OF DEVICE	24
6.1 SELECTING CRYOPROTECTANTS	24
6.2 INITIAL FILL	24
6.3 NORMAL FILL CYCLE	25
6.4 ADDING AN INVENTORY CONTROL SYSTEM	27
7 OPERATION OF LIQUID NITROGEN LEVEL CONTROL SYSTEM	28
7.1 CONTROLLER INITIAL START UP	28
7.2 CONTROLLER SET UP	29
7.3 CONTROLLER CONFIGURATION AND CALIBRATION	37
7.4 CONTROLLER OTHER SETTINGS (ENGINEER MENU)	48
7.5 CONTROLLER IN NORMAL OPERATION	48
7.6 CONTROLLER ALARMS	49
7.7 CONTROLLER RESET	52
8 CARE AND MAINTENANCE OF DEVICE	54
8.1 GENERAL CONSIDERATIONS	54
8.2 INSPECTION AND MAINTENANCE SCHEDULE	55
8.3 CLEANING THE STRAINER	56
8.4 DEFROSTING THE CRYOSTORAGE SYSTEM	57
8.5 CLEANING AND DISINFECTING THE CRYOSTORAGE SYSTEM	58



Instruction Manual

K SERIES Cryostorage System

IM: CryoCeK
Revision: 02
Approved by: CB
Page 3 of 87

8.6 NORMAL EVAPORATION RATE (NER) TEST	59
8.7 TRANSPORT OF DEVICE	60
8.8 RETURN OF DEVICE	60
8.9 DISPOSAL OF DEVICE	60
9 WARRANTY TERMS	62
10 MANUFACTURER'S DECLARATION	63
11 ADDITIONAL TECHNICAL DATA	64
LIST OF APPENDIXES	66



TABLES AND FIGURES

Table 1 K SERIES Cryostorage System specifications	14
Table 2 K SERIES Cryostorage System Inventory Control System specifications.....	15
Table 3 K SERIES Cryostorage System admissible ambient conditions	21
Table 4 Procedure for initial start up of the controller	28
Table 5 Timers/Clock Menu's options of the controller	29
Table 6 Procedure for setting up the controller.....	30
Table 7 Configuration/Calibration Menu's options of the controller	37
Table 8 Procedure for configuration/calibration the controller.....	37
Table 9 Engineer Menu's options of the controller.....	48
Table 10 Procedure for resetting the controller	52
Table 11 Recommended inspection and maintenance schedule.....	55
Table 12 K SERIES Cryostorage System warranty terms	62
Table 13 Technical data of the K SERIES Cryostorage System.....	64
Table 14 Radiated Immunity	65
Table 15 Conducted Immunity	65
Figure 1 K SERIES CryoCe24K Standard Model	12
Figure 2 Level Controller Display (type M505CE).....	13
Figure 3 Vial storage in boxes on racks	16
Figure 4 Rack arrangements for 50 ml cassettes (7-level configuration)	17
Figure 5 Rack arrangements for 250 ml cassettes (5-level configuration)	18
Figure 6 Rack arrangements for 500 ml cassettes (5-level configuration)	19
Figure 7 Fill cycle and evaporation period time	25
Figure 8 Sensor positioning	72
Figure 9 Thermocouple positioning	73
Figure 10 Suggested Form of Thermocouple for Vapour Phase Storage	75
Figure 11 Connection for Simultaneous Filling	79
Figure 12 Connection for Sequential Filling.....	80
Figure 13 Connection for Gas Venting	81



1 USER DIRECTIONS

IMPORTANT

READ THIS INSTRUCTION MANUAL!

Failure to follow the instructions in this manual can result in injury to personnel, damage to your K SERIES Cryostorage System, or poor performance of this medical device!

THIS INSTRUCTION MANUAL IS FOR PROFESSIONAL STAFF ONLY!

Do not permit any other untrained person to install, use or maintain this K SERIES Cryostorage System.

THIS INSTRUCTION MANUAL IS AN ESSENTIAL ACCESSORY TO YOUR K SERIES CRYOSTORAGE SYSTEM.

As such it is to be kept in a suitable place near the operating location of your K SERIES Cryostorage System and should be accessible at all times to the persons involved in the use, operation and maintenance. The instruction manual should be included, if the K SERIES Cryostorage System is transferred to another location.

In this instruction manual, the following symbols are used:

Warnings and safety precautions:

This symbol indicates warnings and safety precautions which, in the context of a potentially hazardous situation, shall followed to reduce the risk of any injury to personnel, or malfunction or poor performance to the K SERIES Cryostorage System.



Important and useful information:

This symbol indicates important and useful information which, in context of a operating instruction, should followed to optimize the performance of the K SERIES Cryostorage System.





2 SAFETY PRECAUTIONS

IMPORTANT

The following safety precautions apply to the Worthington Industries K SERIES Cryostorage System:

The safety precautions in this instruction manual are for your protection:

Before operating or maintaining your K SERIES Cryostorage System, become familiar with the warnings and safety precautions.

It is the sole responsibility of the operating company to ensure refreshing trainings.

Make sure that all applicable provisions have been followed before putting your K SERIES Cryostorage System in operation.



Any damage can lead to malfunction:

Check your K SERIES Cryostorage System for faults and signs of damage before use.

If the K SERIES Cryostorage System is suspected of malfunction, take it out of operation immediately and affix appropriate warning labels to ensure that the K SERIES Cryostorage System is no longer in use until the necessary repairs have been carried out.



Extremely cold refrigerant may cause freezing injuries:

Your K SERIES Cryostorage System operates with liquid nitrogen, a cryogenic liquid that is extremely cold and will be at a temperature of $-196\text{ }^{\circ}\text{C}$ under normal atmospheric pressure.

Accidental contact of the skin or eyes with nitrogen liquid or gas may cause a freezing injury similar to frostbite.

Protect your eyes and cover your skin when handling stored samples, or when transferring liquid nitrogen; or in any other instance where the possibility of contact with cryogenic liquid, cold pipes, and cold gas may exist.

Use safety goggles or a face shield, and safety gloves, and long-sleeved clothing that can be easily removed.





IMPORTANT

The following safety precautions apply to the Worthington Industries K SERIES Cryostorage System (*continued*):

Inlet pressure should not exceed 1.5 bar / 152 kPa:



Higher pressures could result in damage to equipment and/or sufficient depletion of oxygen in the atmosphere to cause dizziness, unconsciousness, or even death.

The liquid nitrogen supply pressure at the inlet to the refrigerator should be in the range of 0.7 bar / 69 kPa to 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.

When installing piping or fill hose assemblies, make sure 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.

Keep the location well ventilated:



A confined area without adequate ventilation can result in an atmosphere that does not contain enough oxygen for breathing and will cause asphyxiation, dizziness, unconsciousness, or even death.

Although nitrogen is non-toxic and non-flammable, it is an colorless, odorless, and tasteless gas, and cannot be detected by the human senses, and will be inhaled normally as if it were air.

Ensure there is adequate ventilation where your K SERIES Cryostorage System is used and store liquid refrigerant supply containers only in a well ventilated area.

In case of First Aid: Have someone call for emergency medical services immediately and do not leave victims of asphyxia alone at all times.



IMPORTANT

The following safety precautions apply to the Worthington Industries K SERIES Cryostorage System (*continued*):

Electrical shock can kill:

Always disconnect the electrical power cord before you attempt any repair or maintenance on your K SERIES Cryostorage System.

The liquid level controller used with the refrigerator operates from 24 VAC. However, the external transformer does have a 230 VAC primary power supply. Connect the refrigerator only to the mains power supply with protective conductor.

Always make sure that the wiring and electrical installations in any given room comply with the applicable standards and regulations before using the device in the room. Take measures to ensure that any sources of magnetic induction of external origin (e.g., emission of rays or high temperatures) are kept to an absolute minimum.



Do not make any modifications:

Repairs and maintenance services to your K SERIES Cryostorage System must be carried out by service personnel instructed and authorized only by Worthington Industries.



Use only approved accessories and replacement parts:

Your K SERIES Cryostorage System is supplied with Worthington Industries approved accessories and replacement parts.

Except Printers and PCs, only devices and accessories approved by Worthington Industries may be connected to the controller or power supply.



Complete the service history log:

Arrange for the regular inspections and checks to be carried out to this instruction manual. Sign off in the service history log each time service and maintenance is finished to your K SERIES Cryostorage System.



For more detailed information concerning safety precautions and safe practices to be observed when handling cryogenic liquids refer to CGA publication P-12 "Safe Handling of Cryogenic Liquids" available from the Compressed Gas Association, www.cganet.com; and the comparable publications from the European Industrial Gases Association, www.eiga.eu.





3 SYMBOLS

IMPORTANT

The following symbols apply to the Worthington Industries K SERIES Cryostorage System:



CE mark with Notified Body number
Declares compliance with EU Directive 93/42/EEC (Medical Device Directive)



Manufacturer as defined in EU Directive 93/42/EEC
Combined with year of manufacture of medical device



Manufacturer's model reference of medical device



Manufacturer's serial number of medical device



Follow this instruction manual for important warnings and safety precautions



Danger!



Use protective gloves

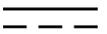


Use protective goggles



IMPORTANT

The following symbols apply to the Worthington Industries K SERIES Cryostorage System *(continued)*:

	AC voltage
	DC voltage
	Protective earth conductor
IP	Ingress protection rating
	Transport and move medical device in upright position
	Do not stack medical devices
	Fragile, handle medical device with care
	Keep medical device away from sunlight and heat
	Keep medical device dry
	Temperature limits to which the medical device can be safely exposed
	Humidity limits to which the medical device can be safely exposed
	Atmospheric pressure limits to which the medical device can be safely exposed
	Do not dispose of medical device or parts with unsorted non-recyclable waste
	The packaging materials are recyclable Do not dispose of the packaging in the household waste Dispose the packaging through waste collection or recycle where facilities are available



4 DEVICE DESCRIPTION

4.1 DEVICE INTENDED USE

The Worthington Industries K SERIES Cryostorage System is a medical device intended to use

- for cryogenic long-term storing of bags, vials and similar containers
- with biological specimens of human origin, such as cord blood, stem cell or semen
- that will eventually be investigated or introduced into the human body
- at extremely low temperatures from -100 °C to -196 °C
- supplied by liquid nitrogen as cryogenic agent under normal atmospheric pressure.

Any other use is not declared by the manufacturer!

Worthington Industries and the distributors of the K SERIES Cryostorage System refuse all liability when the device is not used in compliance with this instruction manual.



4.2 DEVICE INTENDED LOCATION AND USER

The Worthington Industries K SERIES Cryostorage System is a medical device intended to be used in locations in the area of professional health care facilities, such as hospitals, clinics, medical practices, medical laboratories.

The environment of professional health care does not include every arbitrary location. So this environment comprises not areas, where sensitive facilities or sources of intense electromagnetic interference are located, such as radio frequency (RF) shielded rooms for magnetic resonance imaging (MRI), areas in operation rooms with active high frequency (HF) surgical equipment, electrophysical laboratories or areas where short-wave therapy equipment is used.

For further details on the admissible ambient conditions for operating the K SERIES Cryostorage System, see section 5.2.



The Worthington Industries K SERIES Cryostorage System is a medical device intended to be used by trained professional users, such as clinicians, medical and laboratory technicians, medical and laboratory assistants and other health care professionals, experienced with cryogenic agents and cryogenic equipment.



Any other untrained person is not permitted to use the K SERIES Cryostorage System in any way!

Worthington Industries and the distributors of the K SERIES Cryostorage System refuse all liability when the user, operator or other person is not sufficiently instructed to use this K SERIES Cryostorage System, with reference to this instruction manual including





all relevant aspects for the proper operation and necessary safety precautions, and any inspections to be performed prior to each application, and maintenance to be carried out in certain intervals.

4.3 DEVICE OVERVIEW AND KEY FEATURES

The Worthington Industries K SERIES Cryostorage System is a state-of-the-art cryogenic storage system with the following key features:

- can be used in either liquid or vapor phase under normal atmospheric pressure
- uses liquid nitrogen as cryogenic agent that is non-toxic and non-flammable
- stainless steel vacuum vessel with superior vacuum performance
- wide-neck opening allows easy loading and retrieval of samples
- robust design of smooth surfaces for easy cleaning and disinfection
- thermally insulated and lockable lid
- microprocessor based controller with intuitive touch controls for:
 - liquid level and temperature monitoring, and alarms
 - logging of temperature, levels, alarms, fill activity etc.
 - remote alarm (optional)
- mounted lockable casters to enable limited mobility for cleaning purposes
- variety of racks and boxes allows a wide range of storage capacity to fit individual sample management

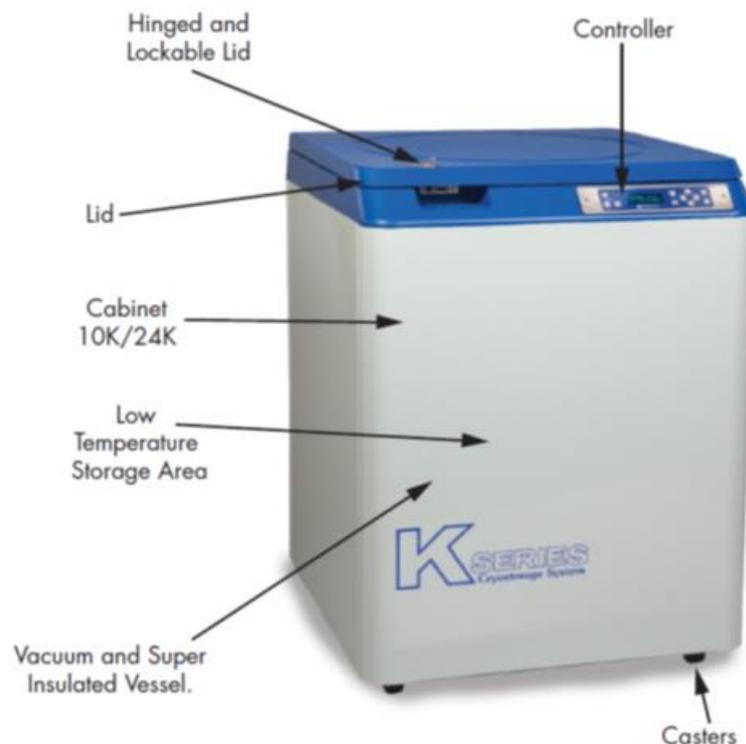


Figure 1 K SERIES CryoCe24K Standard Model



The Worthington Industries K SERIES Cryostorage System is available with the following types of level controller display:

M505CE (standard version), designed for fitting to **CryoCe10K** and **CryoCe24K**

M505CE-B (boxed version), designed for fitting to **CryoCe38K**

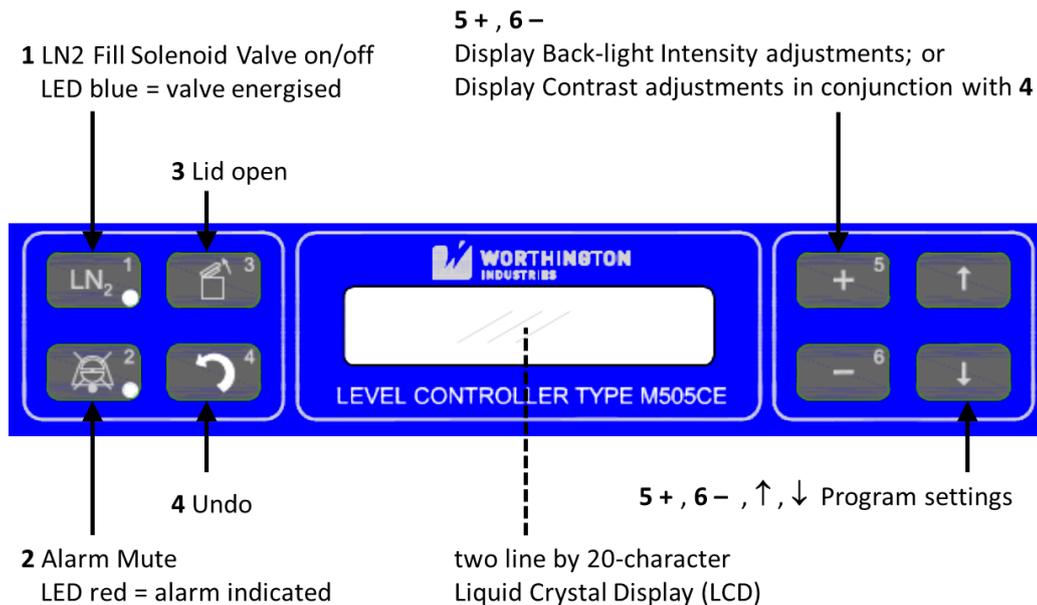


Figure 2 **Level Controller Display** (type M505CE)

NOTE Level controller displays are identical for type M505CE and M505CE-B

Use only Worthington Industries approved electronic liquid level controllers:

If other liquid level controllers are required, please contact Worthington Industries before putting your K SERIES Cryostorage System into operation.





4.4 CRYOSTORAGE SPECIFICATIONS

The Worthington Industries K SERIES Cryostorage System is designed for the following models:

Table 1 K SERIES Cryostorage System specifications

MODEL	CryoCe10K	CryoCe24K	CryoCe38K
Dimensions (mm)			
Height	111.8	111.8	1245
Width/Depth	587 x 775	864 x 965	1067
Internal Useable Height	737	737	737
Internal Diameter	533	787	991
LN2 Capacity (litre)	165	365	590
Evaporation Rate* (litre/day)	5.0	7.0	8.0
Empty Weight (kg)	111	184	256
Maximum Gross Weight (kg) including unit, controls and plumbing assembly, liquid nitrogen, racks, boxes, vials and samples	332	669	1037
Static Holding Time* (days)	33	52	74

*NOTE * Evaporation Rate and Static Holding Time are nominal. Actual rate may be affected by the nature of the contents, atmospheric conditions, container history and manufacturing tolerances.*

The K SERIES Cryostorage System has a maximum weight capacity which exceeds the maximum amount of liquid nitrogen the refrigerator is capable of holding.



Generally, as samples are added to liquid phase storage, the stored samples and inventory control system are heavier than the liquid nitrogen they displace. In vapor-phase storage applications, where the liquid nitrogen is found only in the bottom portion of the refrigerator, the weight of contents is determined more by the weight of the stored product.



4.5 INVENTORY CONTROL SYSTEM SPECIFICATIONS

The Worthington Industries K SERIES Cryostorage System standard models will accommodate inventory control systems or provide unobstructed storage area for larger samples:

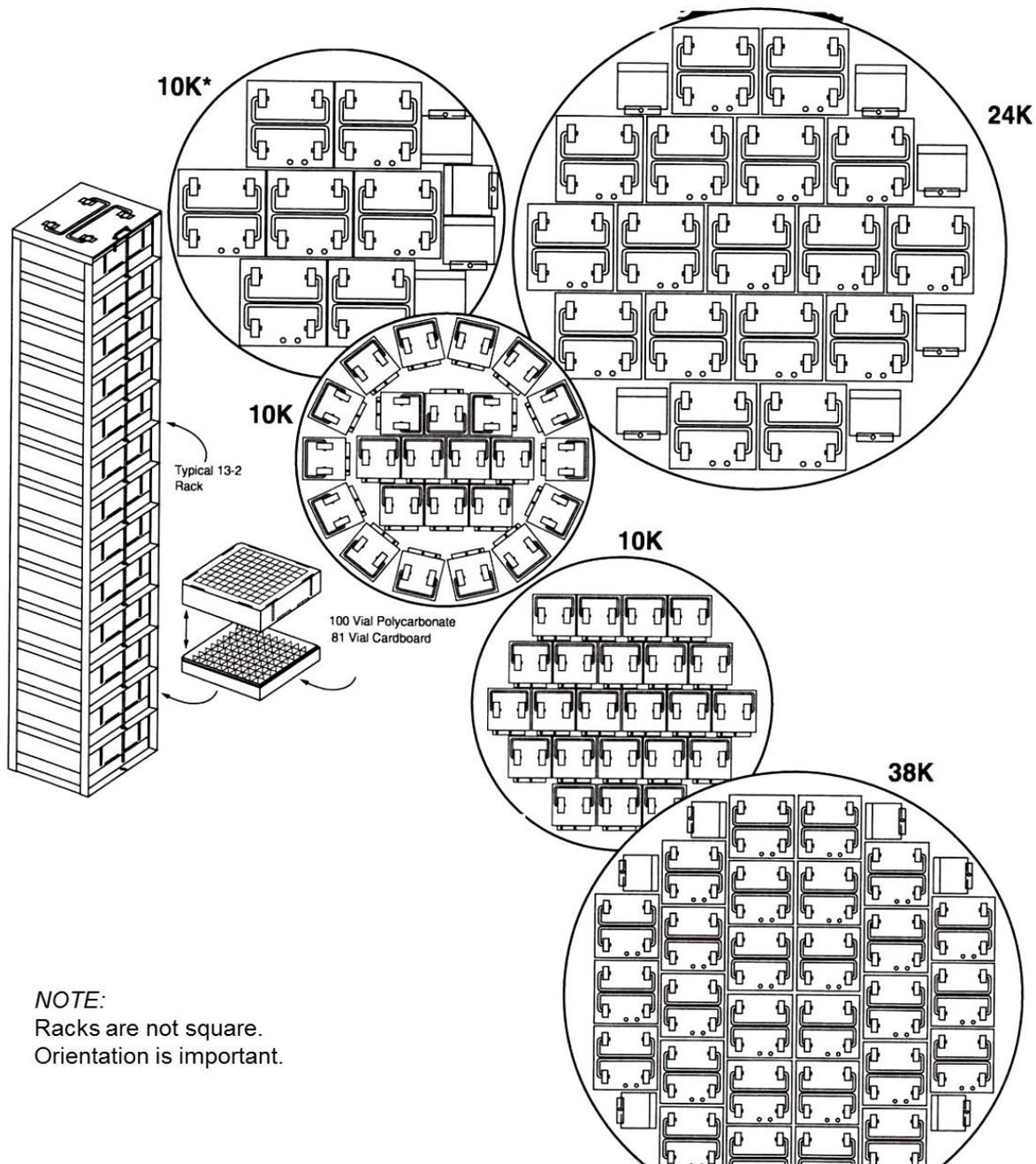
Table 2 K SERIES Cryostorage System Inventory Control System specifications

MODEL	CryoCe10K	CryoCe24K	CryoCe38K
Racks per 25 cell boxes	4	6	6
Racks per 100/81 cell boxes	7	17	28
Cell box size	5 in. x 5 in. (127 mm x 127 mm) square 3 in. x 3 in. (76 mm x 76 mm) square		
Shelves per rack	13	13	13
Vials per 2 ml (12.5 mm O.D. internal thread)	10 400	24 050	38 350
Straws per 0.5 cc (10 per goblet, 2-13 mm goblets per can)	44 000	59 400	114 000
Bags per 50 ml (7 level rack)	343	805	1 407
Bags per 250 ml (5 level rack)	235	535	870
Bags per 500 ml (5 level rack)	185	475	680

NOTE Various box and bag sizes and capacity details are available upon request.



The following images show the different rack arrangements for the K SERIES Cryostorage System:



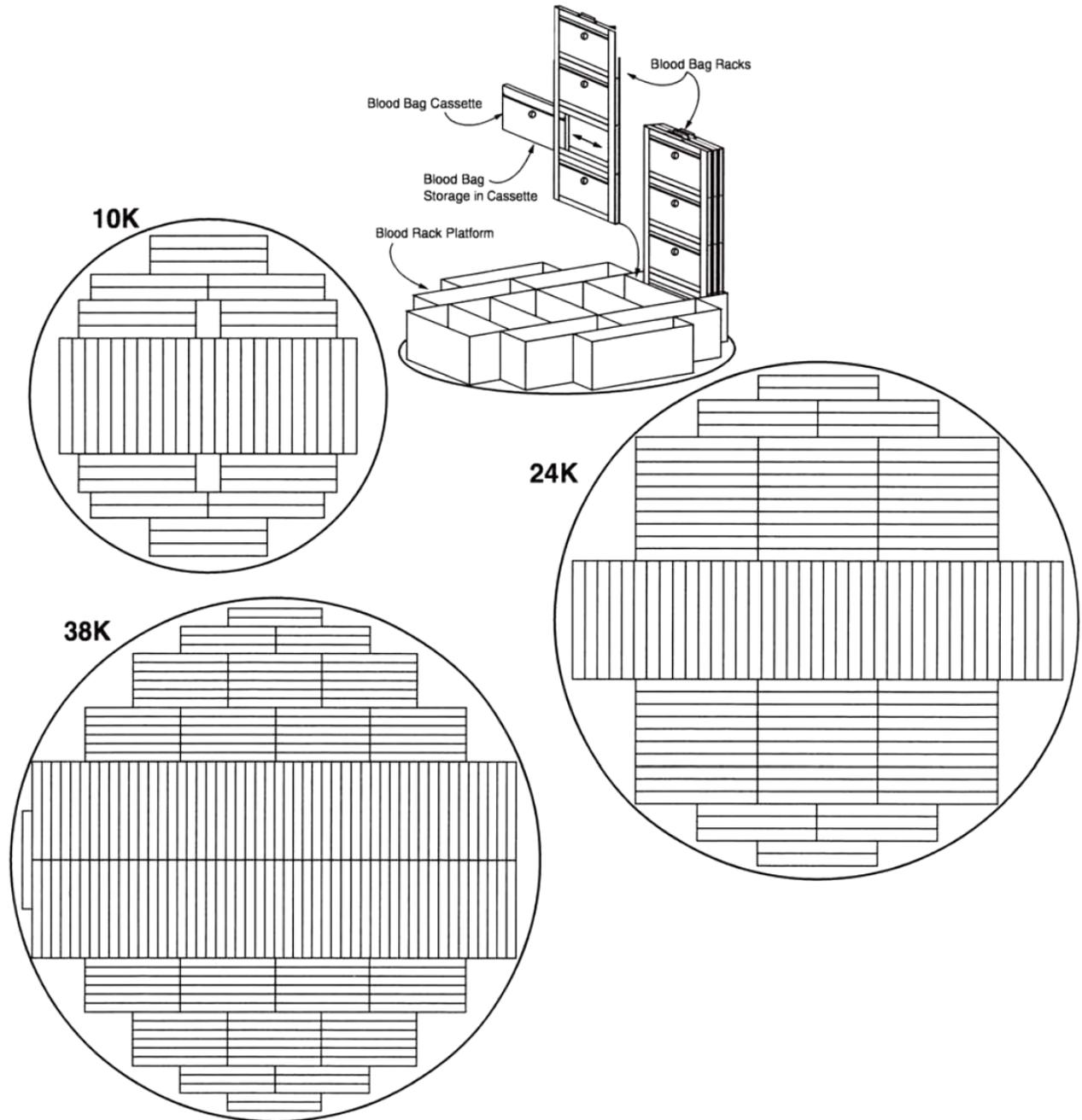
NOTE:
 Racks are not square.
 Orientation is important.

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-374180 (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

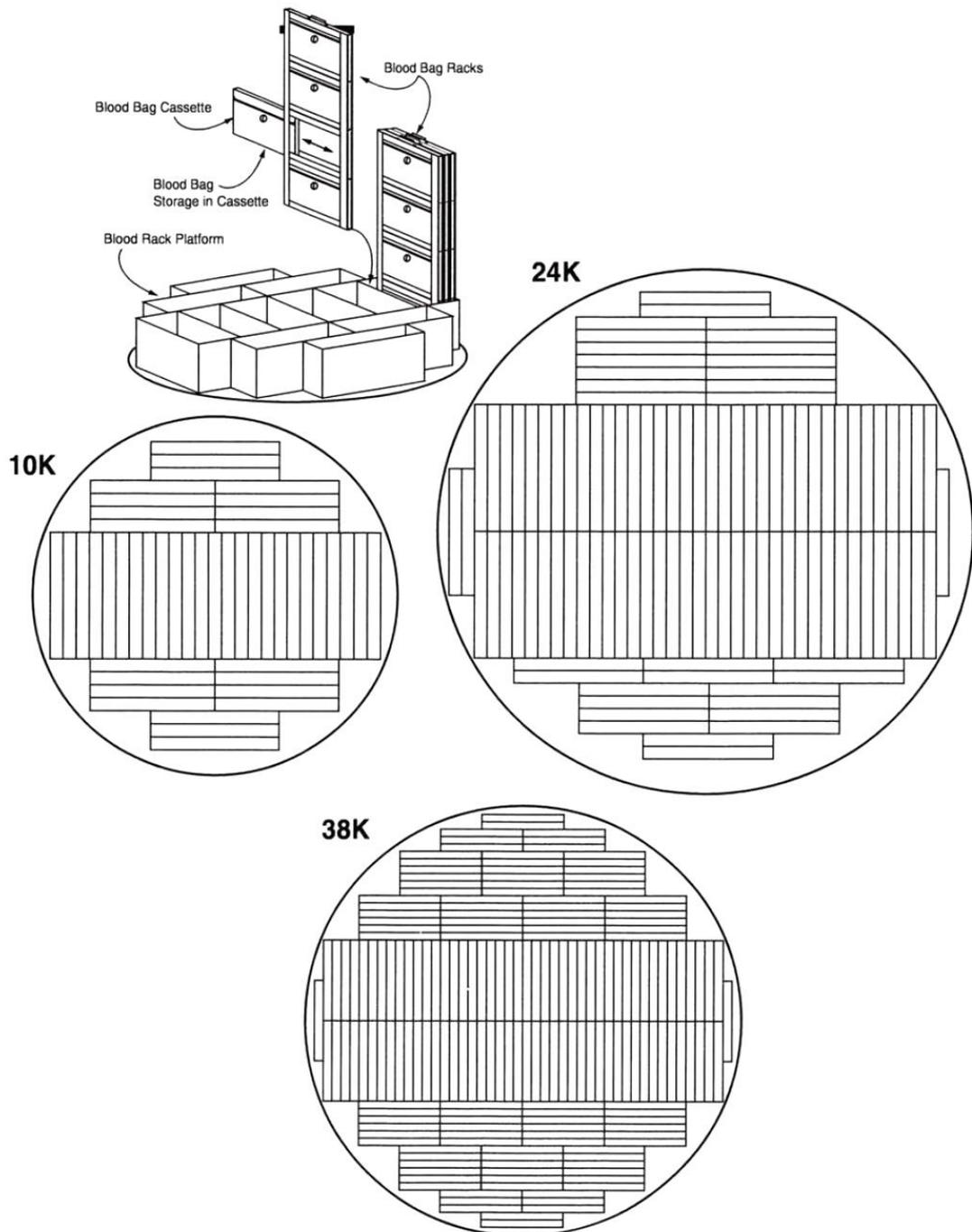
Figure 3 Vial storage in boxes on racks



Fenwal 4R9951 Blood Bags - ask about other Bag types

	CAPACITY	FRAMES	CASSETTES
10K	343	49	343
24K	805	115	805
38K	1407	201	1407

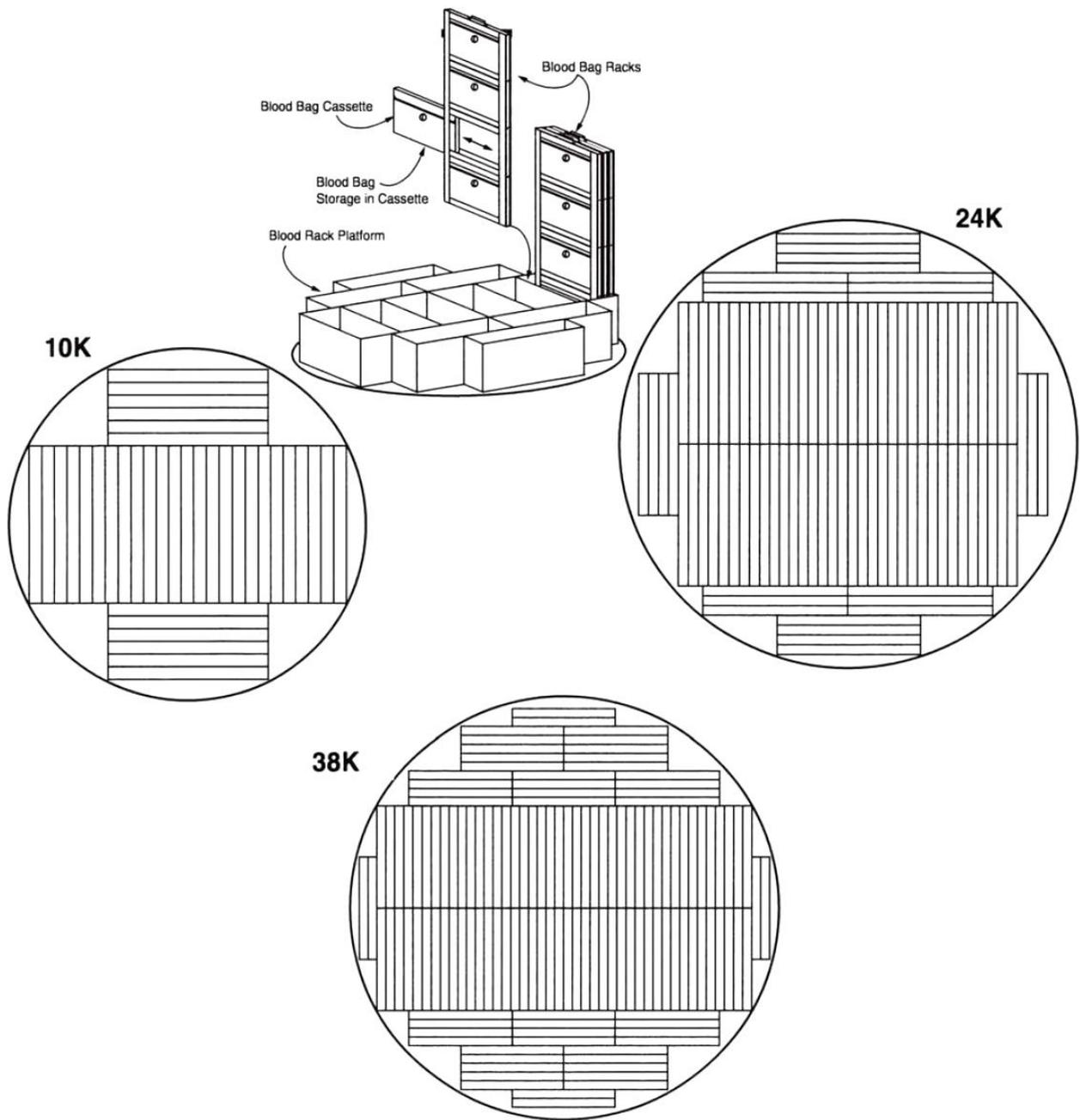
Figure 4 Rack arrangements for 50 ml cassettes (7-level configuration)



Fenwal 4R5461-9953 Blood Bags - ask about other Bag types

	CAPACITY	FRAMES	CASSETTES
10K	235	47	235
24K	535	107	535
38K	870	174	870

Figure 5 Rack arrangements for 250 ml cassettes (5-level configuration)



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

	CAPACITY	FRAMES	CASSETTES
10K	185	37	185
24K	475	95	475
38K	680	136	680

Figure 6 Rack arrangements for 500 ml cassettes (5-level configuration)



5 INSTALLATION OF DEVICE

Installation as well as all associated inspections should only be performed by qualified persons:



These persons are qualified due to their special education and their practical experiences, in particular with regard to the relevant legislation and standards, to recognize the potential impact and hazards and to assess the necessary measures.

5.1 UNPACKING AND INSPECTION

The Worthington Industries K SERIES Cryostorage System is delivered in new condition.

For your own protection, take time to visually inspect each shipment for external damage.

- Open the shipping containers
- 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

All claims for damage (apparent or concealed) or partial loss of shipment must be made in writing within 5 (five) days from receipt of goods.



If damage or loss is apparent, please notify the shipping agent immediately.

In case of parts or accessory shortages, advise Worthington Industries immediately.

Worthington Industries and the distributor cannot be responsible for any missing parts unless notified within 10 (ten) days of receipt of shipment.



5.2 CONDITIONS OF OPERATION AND STORAGE

The Worthington Industries K SERIES Cryostorage System is designed to operate under the following conditions:

Table 3 K SERIES Cryostorage System admissible ambient conditions

Temperature for operation:	0 °C to +40 °C
Temperature for transport and storage:	-10 °C to +50 °C
Relative air humidity for operation:	20 % to 80 %, non-condensing
Relative air humidity for transport and storage:	10 % to 90 %, non-condensing
Atmospheric pressure:	700 hPa to 1060 hPa
Altitude:	up to 2 000 m

Do not operate the K SERIES Cryostorage System in oxygen-deficient atmospheres or in potentially flammable environment.



Install the Cryostorage System in a level, well-ventilated in-door area free from vibration or excessive dust, and not in direct sunlight or near radiators or other sources of heat.

Allow enough clearance so that the lid can fully be opened.

Provide sufficient ventilation so as to avoid persistent condensation.

Deviation from the admissible ambient conditions may lead to malfunction of the K SERIES Cryostorage System!



This K SERIES Cryostorage System has no Radio Transmitter (Intentional Radiator) functions, and does not intentionally apply or receive Radio Frequency (RF) energy for its function.



Other medical equipment or electrical systems can produce electromagnetic emissions and therefore can interfere with the functionality of the K SERIES liquid level controller system.



Care should be taken when operating the K SERIES Cryostorage System adjacent to or stacked with other equipment. If adjacent or stacked use is necessary, the K SERIES liquid level controller system should initially be observed to verify normal operation in the configuration in which it will be used.

NOTE For detailed information see the EMC test results in section 11



5.3 LIQUID NITROGEN SUPPLY CONNECTION

IMPORTANT

The following safety precautions apply to the Worthington Industries K SERIES Cryostorage System:

The liquid nitrogen source must have a shut-off valve, and may be any portable liquid cylinder or a bulk supply.



Never install the supply system pressure relief device onto a liquid service line.

When installing piping or fill hose assemblies, make sure 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.

Inlet pressure should not exceed 1.5 bar/152 kPa!



Higher liquid nitrogen supply pressure at the inlet to the refrigerator opens the relief valve on the refrigerator.

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 RAPIDLY INTO THE IMMEDIATE AREA OF THE REFRIGERATOR.

This could result in damage to equipment and/or sufficient depletion of oxygen in the atmosphere to cause dizziness, unconsciousness, or death.

The liquid nitrogen supply pressure at the inlet to the refrigerator should be in the range of 0.7 bar/69 kPa to 1.4 bar/138 kPa for optimum performance.



The Worthington Industries K SERIES Cryostorage System includes a strainer.

The liquid fill hose from a low pressure source of liquid nitrogen must be connected to the inlet through this fitting.



Ensure the strainer's arrow is oriented with the flow of the liquid.



5.4 ELECTRICAL POWER SUPPLY CONNECTION

IMPORTANT

The following safety precautions apply to the Worthington Industries K SERIES Cryostorage System:

To avoid the risk of electric shock, connect this K SERIES Cryostorage System only to a supply network with protective earth conductor.



Worthington Industries and the distributors of the K SERIES Cryostorage System refuse all liability when the device is used in locations where the electrical installations do not meet the national standards and local electrical codes, or where a power supply is not guaranteed for the respective duration of use of the K SERIES Cryostorage System.

Connect the 24 Volt AC power supply to the K SERIES Cryostorage System and plug the power supply into a surge-protected 230 Volt AC outlet.

Position the K SERIES Cryostorage System so, that the mains plug is easily accessible to the user or service personnel at any time.



The mains plug is the only device used to connect and disconnect the power supply from the refrigerator.

Incorrect electrical power supply connection can cause severe personal injury or damage to the device.



Worthington Industries and the distributors of the K SERIES Cryostorage System refuse all liability when the device is used in locations where the electrical installations do not meet the national standards and local electrical codes, or where a power supply is not guaranteed for the respective duration of use of the K SERIES Cryostorage System.

5.5 FIRMWARE

The Worthington Industries K SERIES Cryostorage System is equipped with the liquid nitrogen level controller system (M505CE or M505CE-B) preloaded with a firmware ready to run.

If it is necessary to update to a newer version of the firmware this can be done using the PC Cable (M519CE) or the USB-PC Cable (M549CE) to connect a PC with the socket on the level controller front panel (M505CE) or rear panel (M505CE-B).



The latest firmware version may be obtained by email.

Contact Worthington Industries or your distributor for details of the current version and/or to obtain an firmware update. Update instructions will be sent with all updates.



6 OPERATION OF DEVICE

6.1 SELECTING CRYOPROTECTANTS

The Worthington Industries K SERIES Cryostorage System is designed to operate with liquid nitrogen at extremely low temperatures from -100 °C to -196 °C under normal atmospheric pressure.

The cryoprotectant selected for long-term storage of cells can have profound implications for future experimental results:



Different cell types have different permeability for different types of cryoprotective molecules. This difference affects the rate at which a cell shrinks and swells before freezing, during freezing, and during thaw cycles.

This can have a dramatic impact on cell viability.

Thus, you need to pay close consideration to the type and concentration of the cryoprotectant being used. A careful analysis of literature regarding standard operating procedures for your cell type and small scale experimentation can save the frustration and cost of having to repeat lengthy experimentation as a result of poor cryopreservation conditions.

Worthington Industries and the distributors do not assume any responsibility for the selection of appropriate cryoprotectants to be used with your K SERIES Cryostorage System!



Due to the large number of influencing factors, this remains to the sole responsibility of the professional users operating the K SERIES Cryostorage System.

6.2 INITIAL FILL

IMPORTANT

The following safety precautions apply to the Worthington Industries K SERIES Cryostorage System:

Inlet pressure should not exceed 1.5 bar/152 kPa!

Higher liquid nitrogen supply pressure at the inlet to the refrigerator opens the relief valve on the refrigerator.





IMPORTANT

The following safety precautions apply to the Worthington Industries K SERIES Cryostorage System (*continued*):

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 RAPIDLY INTO THE IMMEDIATE AREA OF THE REFRIGERATOR.

This could result in damage to equipment and/or sufficient depletion of oxygen in the atmosphere to cause dizziness, unconsciousness, or death.

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.



Liquid phase or vapor phase storage:

Prior to the initial fill of your K SERIES Cryostorage System, you should determine whether the liquid phase or the vapor phase cryostorage will be utilized.



6.3 NORMAL FILL CYCLE

The cooling effect required for the cryogenic storage of the samples is maintained by continuous evaporation of the liquid nitrogen. The necessary evaporation heat is removed from the environment by heat transfer. Over a certain evaporation period time the liquid nitrogen level in your K SERIES Cryostorage System drops permanently:

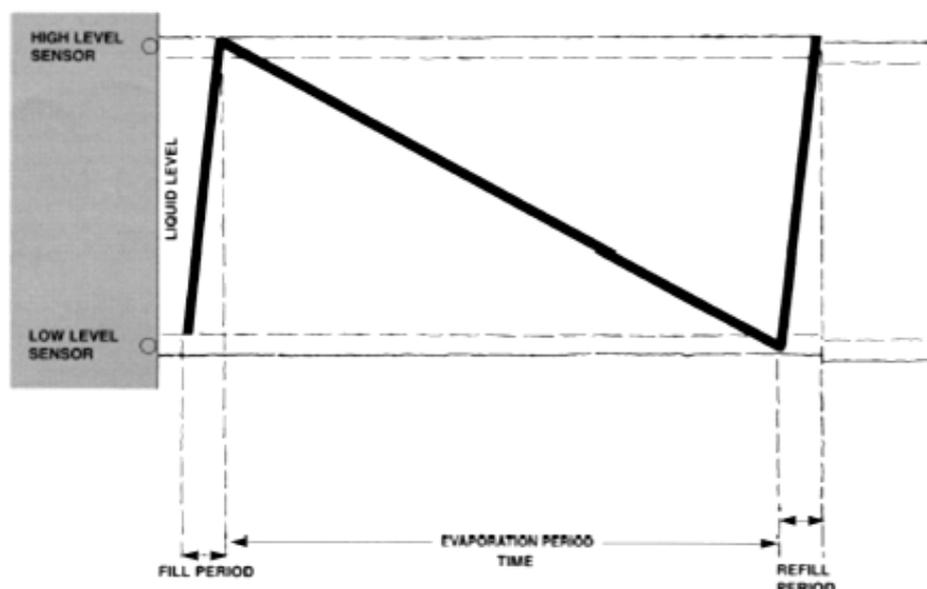


Figure 7 **Fill cycle and evaporation period time**



The liquid level in the cryostorage area is determined by the position of the sensors in the sensor tube located at the front of the refrigerator.

The liquid level controller operates a fill cycle that adds liquid nitrogen at a low level, fills the refrigerator slowly to a preset high level, then the controller will close the liquid supply solenoid valve to stop the fill. This cycle repeats when the liquid level drops to the low level sensor over the evaporation period time.

The sensor contains four thermistors that can be preprogrammed for any liquid level application.

A separate sensor in the sensor tube is the temperature thermocouple used to monitor and/or control the temperature within the cryostorage area. This thermocouple is normally positioned above the high alarm sensor to measure the warmest condition in the storage area at the top of the inventory control system.

Do not make any physical intervention to the sensors:

Sensor and thermocouple positioning to your K SERIES Cryostorage System shall be carried out only by trained professionals or persons or service centers instructed and authorized by Worthington Industries.



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

When samples are immersed in liquid nitrogen, they will assume the temperature of the liquid $-196\text{ }^{\circ}\text{C}$.

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.

Exposure to liquid nitrogen may result in physical damage to the lid:

Care must be taken to ensure that the liquid level remains below the bottom of the refrigerator lid.



In the vapor phase storage the samples are stored over the liquid, where the liquid nitrogen is still a very cold refrigerant, but the refrigerator's interior temperature increases somewhat as samples are stored higher over the liquid.

Sample transfers can cause fluctuations in temperature:

This temperature fluctuations are not significant in many medicinal and biological storage applications, and is affected by the amount of product stored in the refrigerator, the type and size of the inventory control system, and the liquid level in the unit.





Always protect your eyes and cover your skin when opening the lid:

Use safety goggles or a face shield, and safety gloves, and long-sleeved clothing that can be easily removed.

Operating the refrigerator with high liquid levels characteristic of liquid phase storage may result in turbulence during fill cycles.



6.4 ADDING AN INVENTORY CONTROL SYSTEM

IMPORTANT

The following safety precautions apply to the Worthington Industries K SERIES Cryostorage System:

Protect your eyes and cover your skin when handling stored samples:

Always wear safety goggles or a face shield, and safety gloves, and long-sleeved clothing that can be easily removed when handling the inventory control system racks or stored samples, as they are very cold.

When removing racks to retrieve samples, protect the labels, non-metallic, 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.



The purpose of the inventory control system is to bring order to the storage of many small samples, and to allow direct retrieval of the particular sample you need at any time.

Use only suitable inventory control systems:

The Worthington Industries K SERIES Cryostorage System standard models will accommodate inventory control systems specified in section 4.5.



Learn to locate your samples quickly to avoid unnecessary warming:

It is important to note that when you lift an inventory control system rack from the refrigerator it is being moved to a warmer environment.

Keep rack inserts (drawers or boxes) and dividers in good condition. Replacement inserts and dividers are available from Worthington Industries and distributors to keep your system as efficient as possible.



Do not let ice or debris collect in the bottom of the chamber:

Schedule periodic cleanings if the racks no longer stand upright; see section 8.





7 OPERATION OF LIQUID NITROGEN LEVEL CONTROL SYSTEM

7.1 CONTROLLER INITIAL START UP

Check that the Sensor Assembly and Thermocouple is in the required position as per section 6.3.



Table 4 Procedure for initial start up of the controller

No	Steps of procedure	Display and notes
1	Plug the M507CE Safety PSU/Connection unit into the mains supply and switch on	After a few seconds the display should show temperature and level (example): <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;">TEMPERATURE -30 C LEVEL EXTRA LOW</div> <p>If the vessel is empty or the LN2 level is low, the refrigerator will begin to fill Alarms may occur</p>
2	Press the <i>Alarm Mute</i> (switch 2) to silence the audible alarm	Ignore any alarm messages for the time being
3	Press the mute switch again to return to the temperature and level display	

When the refrigerator has finished filling the controller should be set-up and calibrated as per section 7.3.

NOTE It is possible that on initial filling the fill timer will time out and switch off the LN2 Fill Solenoid Valve (switch 1). This is indicated by an alarm and the LED blue slow flashing.

If this happens, reset the fill timer and restart filling by pressing the LN2 Fill Solenoid Valve (switch 1) twice!



7.2 CONTROLLER SET UP

There are no internal switches to set on the controller.

All set-up options are accessed via the two main menus TIMERS/CLOCK and CONFIG/CALIBRATE.

Table 5 Timers/Clock Menu's options of the controller

Menu TIMERS/CLOCK
<ul style="list-style-type: none">• Alarm Temperature• Maximum Temperature (for temperature control)• Fill Timer• Sim Fill Delay• Remote timer• Remote Alarm for LN2 Supply failure (On/Off)• Lid timer• Auto Defog timer• Quick Chill timer• Extra High Alarm Delay• Gas Bypass Timer Settings (for use with M507CE-I)• Refrigerator Number• Battery voltage monitor• Clock setting• Day off week setting (For timed fill)• Timed Fill Setting (Time to switch on)• Log Interval Setting

Before proceeding to set-up the data log should be cleared as per section 7.7.

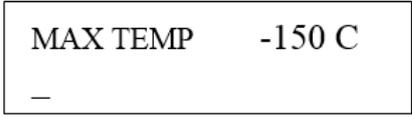
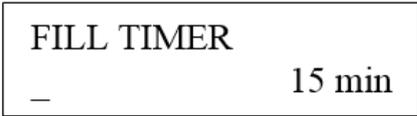




Table 6 Procedure for setting up the controller

No	Steps of procedure	Display and notes
1	Press ↓ key to enter the menu	<p>The Firmware Version number and serial number will be briefly displayed followed by the menu:</p> <div data-bbox="837 539 1249 658" style="border: 1px solid black; padding: 5px; margin: 10px auto; width: fit-content;"> <p align="center">1: VIEW SETTINGS 2: CHANGE SETTINGS</p> </div>
2	Press switch 2 to CHANGE SETTINGS If PASSWORD PROTECTION is disabled go to step 4	<p>If password protection is enabled the following message will appear:</p> <div data-bbox="837 808 1249 927" style="border: 1px solid black; padding: 5px; margin: 10px auto; width: fit-content;"> <p align="center">ENTER CODE _</p> </div>
3	<p>Enter the <u>four digit supervisor's code</u> using the numbered keys and the ↓ and ↑ keys to move the cursor</p> <p>Press ↓ key to finish when the cursor is on the last digit</p> <p>If a code is requested and it is not known, the password will have to be reset as per section 7.3</p>	<p>If the code is accepted (or not requested) the following menu will appear:</p> <div data-bbox="837 1077 1249 1196" style="border: 1px solid black; padding: 5px; margin: 10px auto; width: fit-content;"> <p align="center">1: TIMERS/CLOCK 2: CONFIG/CALIBRATE</p> </div>
<p><i>NOTE On initial installation setup, first configure the required features in the CONFIG/CALIBRATE menu, and then go back to the TIMERS/CLOCK menu!</i></p> <div data-bbox="1362 1357 1445 1435" style="float: right;"></div>		
4	Press switch 1 to set up timers and/or clock	<p>If the TIMERS/CLOCK menu is selected the following message (example) will appear:</p> <div data-bbox="837 1585 1273 1704" style="border: 1px solid black; padding: 5px; margin: 10px auto; width: fit-content;"> <p align="center">ALARM TEMP -130 C _</p> </div>
<p>If the temperature of the thermocouple rises above the displayed value an alarm will be activated.</p> <div data-bbox="1362 1760 1445 1839" style="float: right;"></div>		
5	<p>Use the + and - keys to set the alarm temperature:</p> <p>the ALARM TEMP setting is adjustable between 0 °C and -175 °C in 5-degree</p>	<p>If the Temperature Control Option is enabled (see CONFIG/CALIBRATE menu) the following message (example) will appear:</p>



No	Steps of procedure	Display and notes
	steps Press ↓ key when finished	
<p>If the temperature of the thermocouple rises above the set value the solenoid valve is opened for a short period of time. The disturbance caused by nitrogen gas bubbling through the liquid causes the temperature to drop rapidly. </p> <p>If the required temperature is not achieved a further pulse of gas is admitted after a pre-set time interval. The on time and interval are set up via the CONFIG/CALIBRATION menu.</p>		
6	Use the + and - keys to set the maximum temperature: the MAX TEMP setting is adjustable between 0 °C and –175 °C in 5-degree steps Press ↓ key when finished If the LN2 supply alarm is disabled skip to step 7	If the LN2 supply alarm is enabled (see CONFIG/CALIBRATE menu) the following message (example) will appear: 
<p>If the solenoid valve is operated for longer than the displayed time an alarm will be activated and the solenoid valve will be switched off. Switching off the solenoid valve reduces the risk of overheating if the LN2 supply fails. </p> <p>It is also a safeguard against possible masking of the sensors by a build-up of ice. This situation could cause overfilling of the refrigerator.</p> <p>A time-out during filling is additionally indicated by the Led blue slow flashing.</p> <p>To cancel the alarm the LN2 Fill Solenoid Valve (switch 1) must be pressed.</p>		
7	Use the + and - keys to set the maximum fill time: the maximum FILL TIMER setting is adjustable between 0 min and 175 min in 5-minute steps Press ↓ key when finished	The following message (example) will appear: 
<p>Simultaneous filling is a method of reducing nitrogen consumption. If a number of refrigerators are connected for simultaneous filling, and one refrigerator demands LN2 it sends a signal to the others so that they start to fill also. </p> <p>This reduces the number of times that the common pipework needs to be cooled and hence reduces evaporation losses. For further details on simultaneous filling and interconnection of refrigerators see Appendix F.</p> <p>In some installations the LN2 supply pressure may be insufficient to feed all of the</p>		



No	Steps of procedure	Display and notes
<p>connected refrigerators simultaneously, resulting in LN2 supply alarms.</p> <p>This may be overcome by staggering the fill start times by setting a sim fill delay, which delays the start of filling following the receipt of a sim fill input signal.</p> <p>By selecting suitable delays the filling may be sequenced so that not all refrigerators demand for nitrogen at the same time.</p>		
8	<p>Use the + and - keys to set the sim fill delay:</p> <p>the SIM FILL DELAY setting is adjustable between 0 min and 125 min in 5-minute steps</p> <p>Press ↓ key when finished</p>	<p>The following message (example) will appear:-</p> <div data-bbox="847 674 1259 786" style="border: 1px solid black; padding: 5px; text-align: center;"><p>REMOTE TIMER _ 15 min</p></div>
<p>The remote timer setting displays the time that will elapse between the occurrence of the first alarm and activation of the remote alarm relay. </p> <p>In the case of an extra high level alarm the remote alarm timer defaults to 5 minutes maximum.</p>		
9	<p>Use the + and - keys to set the remote timer:</p> <p>the REMOTE TIMER setting is adjustable between 0 min and 90 min in 5-minute steps</p> <p>Press ↓ key when finished</p>	<p>The following message (example) will appear:</p> <div data-bbox="847 1182 1259 1294" style="border: 1px solid black; padding: 5px; text-align: center;"><p>REMOTE ALARM (LN2 SUPPLY) ON</p></div>
<p>If required the remote alarm may be disabled for failure of the LN2 supply. </p> <p>This may be useful to avoid unnecessary fault call-outs in situations where the refrigerator and its nitrogen supply are regularly monitored.</p> <p>It should be used with caution and is not recommended if the refrigerator is situated in an unattended location.</p>		
10	<p>Use the + key to set the LN2 supply REMOTE ALARM ON</p> <p>Use the - key to set the LN2 supply REMOTE ALARM OFF.</p> <p>Press ↓ key when finished</p>	<p>The following message (example) will appear:</p> <div data-bbox="847 1758 1259 1870" style="border: 1px solid black; padding: 5px; text-align: center;"><p>LID TIMER _ 15 min</p></div>



No	Steps of procedure	Display and notes
<p>The lid timer setting is the maximum length of time that the lid can be left open before an alarm is activated. A closed contact on the lid switch indicates that the lid is open. </p> <p><i>NOTE A lid switch must be fitted to utilise this feature.</i></p>		
11	<p>Use the + and - keys to set the lid timer: the LID TIMER setting is adjustable between 0 min and 30 min in 5-minute steps Press ↓ key when finished</p>	<p>The following message (example) will appear:</p> <div data-bbox="842 600 1251 712" style="border: 1px solid black; padding: 5px; text-align: center;"><p>AUTO DEFOG _ 05 (s)</p></div>
<p>When the lid is opened LN2 is allowed into the refrigerator for the displayed time. This has the effect of dispersing the fog within the vessel. </p> <p><i>NOTE A lid switch must be fitted to utilise this feature.</i></p>		
12	<p>Use the + and - keys to set the auto defog timer: the AUTO DEFOG timer setting is adjustable between 0 sec and 90 sec in 5-second steps Press ↓ key when finished</p>	<p>The following message (example) will appear:</p> <div data-bbox="842 1095 1251 1207" style="border: 1px solid black; padding: 5px; text-align: center;"><p>QUICK CHILL _ 05 (s)</p></div>
<p>When the lid is closed liquid nitrogen is allowed into the refrigerator for the displayed time. This has the effect of rapidly cooling the vessel. </p> <p><i>NOTE A lid switch must be fitted to utilise this feature.</i></p>		
13	<p>Use the + and - keys to set the quick chill timer: the QUICK CHILL timer setting is adjustable between 0 sec and 90 sec in 5-second steps Press ↓ key when finished</p>	<p>The following message (example) will appear:</p> <div data-bbox="842 1588 1251 1700" style="border: 1px solid black; padding: 5px; text-align: center;"><p>Extra High Alarm Delay 60 (s)</p></div>
<p>Occasionally during filling, turbulence caused by nitrogen gas entering the refrigerator can cause liquid to splash onto the 'Extra High' Sensor. This may give intermittent level alarms. </p> <p>To avoid these nuisance alarms a short delay can be programmed. This allows time for the initial turbulence to subside and for the liquid to evaporate off from the Extra High Sensor. If the Extra High Sensor still detects liquid at the end of the delay period a level alarm is given as normal.</p>		



No	Steps of procedure	Display and notes
14	<p>Use the + and - keys to set the extra high alarm delay timer:</p> <p>the EXTRA HIGH ALARM DELAY timer setting is adjustable between 0 sec and 120 sec in 5-second steps</p> <p>Press ↓ key when finished</p> <p>If the gas bypass timer is set off (CONFIG/CALIBRATE menu) skip to step 16</p>	<p>If the gas bypass timer is set on (see CONFIG/CALIBRATE menu) the following message (example) will appear:</p> <div data-bbox="842 488 1251 600" style="border: 1px solid black; padding: 5px; text-align: center;"><p>Gas Bypass Timer 10 min</p></div>
<p><i>NOTE The gas bypass timer is only used in conjunction with the M507CE-I.</i></p> <p>When the refrigerator starts to fill the M507CE-I opens a vent solenoid valve and discharges gas from the pipe-work. A thermocouple in the outlet senses when liquid reaches the outlet and switches off the vent solenoid valve allowing the refrigerator to start filling. If liquid is not detected within a preset time an alarm is sounded and the vent solenoid valve is closed. This preset time is controlled by the gas bypass timer.</p> <p><i>NOTE For further details consult the separate manual (IM1017) or contact Worthington Industries or your distributor.</i></p> 		
15	<p>Use the + and - keys to set the gas bypass timer:</p> <p>the GAS BYPASS TIMER setting is adjustable between 0 min and 30 min in 5-minute steps</p> <p>Press ↓ key when finished</p>	<p>The following message (example) will appear:</p> <div data-bbox="842 1209 1251 1321" style="border: 1px solid black; padding: 5px; text-align: center;"><p>T/couple in Liquid 5 min</p></div>
<p><i>NOTE The thermocouple in liquid timer is only used in conjunction with the M507CE-I.</i></p> <p>When liquid is detected by the thermocouple in the vent outlet the timer is started.</p> <p>If liquid is still present after the preset time it is possible that the valve is stuck open and an alarm is sounded.</p> 		
16	<p>Use the + and - keys to set the thermocouple in liquid timer:</p> <p>the T/COUPLE IN LIQUID timer setting is adjustable between 0 min and 30 min in 5-minute steps</p> <p>Press ↓ key when finished</p>	<p>The following message (example) will appear:</p> <div data-bbox="842 1733 1251 1845" style="border: 1px solid black; padding: 5px; text-align: center;"><p>REFRIGERATOR NO. 01</p></div>



No	Steps of procedure	Display and notes
	<p>This refrigerator number will be printed in the page headings of the data log when it is printed out. A unique number should be chosen for each refrigerator so that printouts from different refrigerators may be identified.</p> <p>If the refrigerator is linked to a PC it will only respond to commands which contain the correct refrigerator number (unless set to 00).</p>	
17	<p>Use the + and - keys to set the refrigerator number:</p> <p>the REFRIGERATOR NO. may be set to any number between 00 and 98</p> <p>Press ↓ key when finished</p>	<p>The following message (example) will appear:</p> <div data-bbox="842 667 1248 779" style="border: 1px solid black; padding: 5px; text-align: center;">Battery = 2.750 V</div>
	<p>The real time clock and RAM require a minimum of 2.2 V to function correctly and retain their settings when mains power is removed.</p> <p>If the battery voltage is too low a warning will be displayed and the clock settings should be checked.</p> <p>A warning will also be given if the battery voltage is too high. This indicates a battery fault (possible open circuit).</p>	
18	<p>Press ↓ key to finish</p>	<p>The following message (example) will appear:</p> <div data-bbox="842 1236 1248 1348" style="border: 1px solid black; padding: 5px; text-align: center;">DATE & TIME 16/05/01 18:51</div> <p>A cursor will appear under the day digits</p>
19	<p>Use the + and - keys to set the correct day of the month</p> <p>Use the ↓ key to move the cursor to the month digits</p> <p>Repeat this step for month, year, hour and minute settings</p> <p>If a mistake is made use the ↑ key to step the cursor backwards</p> <p>When the correct date and time setting has been obtained use the ↓ key to move the cursor to the minutes digits again</p> <p>Press ↓ key once more to finish</p>	<p>The following message (example) will appear:</p> <div data-bbox="842 1536 1248 1648" style="border: 1px solid black; padding: 5px; text-align: center;">TODAY TUES</div>



No	Steps of procedure	Display and notes
<p><i>NOTE</i> The day of week setting is required for some of the timed fill options.</p> 		
20	<p>Use the + and – keys to set the correct day of the week</p> <p>Press ↓ key when finished</p> <p>If the daily fill is set off (see CONFIG/CALIBRATE menu) skip to step 22</p>	<p>If the daily fill is set on (see CONFIG/CALIBRATE menu) the following message (example) will appear:</p> <div style="border: 1px solid black; padding: 5px; margin: 10px auto; width: fit-content;"> <p align="center">Daily Fill 23:59</p> </div> <p>A cursor will appear under the first digit</p>
<p>The daily fill allows the refrigerator to be refilled at a fixed time each day, or on selected days, or at 24, 48 or 72 hour intervals (<i>V3.0 onwards</i>).</p>  <p>This may be useful for any of the following reasons:</p> <ul style="list-style-type: none"> • Safety: filling takes place when no staff are likely to be present; • Security: filling takes place at a time when it can easily be monitored; • Simultaneous filling: several refrigerators may be filled at the same time without the need for interconnection; • Sequential filling: by staggering the start times several refrigerators may be filled in sequence without the need for interconnection. 		
21	<p>Use the + and – keys to set the correct hour</p> <p>Use the ↓ key to move the cursor to the minute digits</p> <p>Use the + and – keys to set the correct minute</p> <p>When the correct hour and minute setting has been obtained use the ↓ key to finish</p>	<p>The following message (example) will appear:</p> <div style="border: 1px solid black; padding: 5px; margin: 10px auto; width: fit-content;"> <p align="center">LOG INTERVAL _ 15 min</p> </div>
22	<p>Use the + and – keys to enter the required logging interval:</p> <p>select LOG INTERVAL from 5, 10, 15, 30, 60 min or 2, 4, 6, 12, 24 hr or</p> <p>No Logging (----- displayed)</p> <p>Press ↓ key when finished</p>	<p>The following message will appear:</p> <div style="border: 1px solid black; padding: 5px; margin: 10px auto; width: fit-content;"> <p align="center">SAVING SETTINGS</p> </div> <p>All settings are saved in non-volatile memory</p> <p>After a few seconds the temperature and level display will reappear</p>



7.3 CONTROLLER CONFIGURATION AND CALIBRATION

Table 7 Configuration/Calibration Menu's options of the controller

Menu CONFIG/CALIBRATE
<ul style="list-style-type: none"> • Language • Thermocouple calibration • Printer/PC connection and mode of operation. • Level Display Mode (High/Low/Normal or cm) • Temperature Control (On/off + timer settings) • Lid Switch Type (NO/NC) • Gas Bypass Setup (on/off) • Valve On/Off (No LN2) • Analogue Output (On/Off + Settings + Calibration check) • Timed Fill On/Off • Timed Fill (Off, 24hr, 48hr, 72hr or select days of week) • Password protection setup

Before proceeding to set-up the data log should be cleared as per section 7.7.



Table 8 Procedure for configuration/calibration the controller

No	Steps of procedure	Display and notes
1	Press ↓ key to enter the menu	<p>The Firmware Version number and serial number will be briefly displayed followed by the menu:</p> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;"> <p align="center">1: VIEW SETTINGS 2: CHANGE SETTINGS</p> </div>
2	Press switch 2 to CHANGE SETTINGS If PASSWORD PROTECTION is disabled go to step 4	<p>If PASSWORD PROTECTION is enabled the following message will appear:</p> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;"> <p align="center">ENTER CODE</p> <p align="center">—</p> </div>



No	Steps of procedure	Display and notes
3	<p>Enter the <u>four digit supervisor's code</u> using the numbered keys and the ↓ and ↑ keys to move the cursor</p> <p>Press ↓ key to finish when the cursor is on the last digit</p> <p>If a code is requested and it is not known, the password will have to be reset as per section 7.3</p>	<p>If the code is accepted (or not requested) the following menu will appear:</p> <div data-bbox="839 450 1249 562" style="border: 1px solid black; padding: 5px; margin: 10px auto; width: fit-content;"><p>1: TIMERS/CLOCK 2: CONFIG/CALIBRATE</p></div>
<p><i>NOTE</i> On initial installation setup, first configure the required features in the CONFIG/CALIBRATE menu, and then go back to the TIMERS/CLOCK menu!</p> <div data-bbox="1366 730 1445 808" style="float: right;"></div>		
4	<p>Press switch 2 to CONFIGURATE/CALIBRATE</p>	<p>If the CONFIG/CALIBRATE menu is selected the following message (example) will appear:</p> <div data-bbox="844 965 1262 1077" style="border: 1px solid black; padding: 5px; margin: 10px auto; width: fit-content;"><p>Language English</p></div>
5	<p>Use the + and – keys to select the LANGUAGE:</p> <ul style="list-style-type: none">• English• German• French <p>Press the ↓ key when finished</p> <p>If the calibration of the first thermocouple is disabled skip to step 10</p>	<p>If the calibration is enabled (see Engineering menu as per section 7.4) the following message will appear:</p> <div data-bbox="844 1279 1270 1391" style="border: 1px solid black; padding: 5px; margin: 10px auto; width: fit-content;"><p>1: CALIBRATE TC1 ↓: NEXT</p></div>
<p><i>NOTE</i> Thermocouples are calibrated using melting ice as a 0 °C reference and liquid nitrogen to set the gain. Ensure both are to hand and within reach of the thermocouple tip before proceeding.</p> <div data-bbox="1366 1563 1445 1641" style="float: right;"></div>		
6	<p>Press switch 1 to select CALIBRATE TC1</p> <p>To skip over calibration press the ↓ key and go to step 10</p>	<p>The following message will appear:</p> <div data-bbox="839 1783 1270 1895" style="border: 1px solid black; padding: 5px; margin: 10px auto; width: fit-content;"><p>Thermocouple in ice? Press ↓ to continue</p></div>
<p><i>NOTE</i> Place the thermocouple in the ice and allow a few seconds for the temperature to stabilise before continuing ice calibration.</p> <div data-bbox="1366 1957 1445 2036" style="float: right;"></div>		



No	Steps of procedure	Display and notes
7	Press the ↓ key to continue calibration	<p>The following message (example) will be displayed for a few seconds:</p> <div data-bbox="844 450 1262 566" style="border: 1px solid black; padding: 5px; margin: 10px 0;"><p>Calibration in progress 188</p></div> <p>The number in the bottom right of the display indicates the measurement being taken by the controller. Typically this will be around 180 - 200 seconds with the thermocouple in ice.</p> <p>If the ice calibration is successful, after a few seconds the following message will appear:</p> <div data-bbox="844 860 1270 976" style="border: 1px solid black; padding: 5px; margin: 10px 0;"><p>Calibration done</p></div> <p>followed by:</p> <div data-bbox="837 1066 1265 1182" style="border: 1px solid black; padding: 5px; margin: 10px 0;"><p>Thermocouple in LN2? Press ↓ to continue</p></div>
<p><i>NOTE</i> Transfer the thermocouple to the liquid nitrogen and allow at least 10 (ten) seconds for the temperature of the thermocouple to stabilise before continuing LN2 calibration.</p> <div data-bbox="1362 1245 1445 1323" style="float: right;"></div>		
8	Press the ↓ key to continue calibration	<p>The following message (example) will be displayed for a few seconds:</p> <div data-bbox="844 1476 1270 1592" style="border: 1px solid black; padding: 5px; margin: 10px 0;"><p>Gain Calibration in progress 695</p></div> <p>The number in the bottom right of the display indicates the measurement being taken by the controller. Typically this will be around 670 - 710 seconds with the thermocouple in liquid nitrogen.</p> <p>If the LN2 calibration is successful, after a few seconds the following message will appear:</p> <div data-bbox="844 1908 1265 2024" style="border: 1px solid black; padding: 5px; margin: 10px 0;"><p>Gain Calibration done</p></div>



No	Steps of procedure	Display and notes
		followed by: <div data-bbox="842 412 1270 528" style="border: 1px solid black; padding: 5px; margin: 10px 0;">1: CALIBRATE TC1 ↓: NEXT</div>
9	The calibration is complete Press switch 1 to repeat the calibration; or Press the ↓ key to proceed to next step; or Press the ↑ key to exit	
<p><i>NOTE</i> It is recommended that the calibration is confirmed by checking the temperature display with the thermocouple in ice and liquid nitrogen.</p> <div data-bbox="1362 831 1449 913" style="float: right;"></div>		
10		<p>If the temperature of the thermocouple is not stable during the ice or LN2 calibration the following message may appear:</p> <div data-bbox="842 1093 1270 1211" style="border: 1px solid black; padding: 5px; margin: 10px 0;">Calibration Failed!</div> <p>If the temperature of the thermocouple is out of an acceptable range (e.g. if it is not correctly inserted into the ice or LN2 during calibration) one of the following message (examples) may appear:</p> <div data-bbox="842 1451 1270 1570" style="border: 1px solid black; padding: 5px; margin: 10px 0;">OUT OF RANGE (ICE) 125</div> <div data-bbox="842 1653 1270 1771" style="border: 1px solid black; padding: 5px; margin: 10px 0;">OUT OF RANGE (LN2) 598</div> <p>Following any of the above messages will return to step 5, i.e.:</p> <div data-bbox="842 1899 1270 2018" style="border: 1px solid black; padding: 5px; margin: 10px 0;">1: CALIBRATE TC1 ↓: NEXT</div>



No	Steps of procedure	Display and notes
11	Press the ↓ key to proceed to next step	If the second thermocouple is enabled the following message will be displayed: <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;"> 1: CALIBRATE TC2 ↓: NEXT </div>
12	Press switch 1 to select CALIBRATE TC2	

NOTE

The steps for the calibration of the second thermocouple are the same as for calibration TC1.



13	Press the ↓ key when finished or to skip calibration	The following message will be displayed: <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;"> Printer/PC mode Printer </div>
14	Use the + and – keys to select the PRINTER/PC MODE as required: Printer — continuous printout of data Printer (NC) — print on demand PC RS232 PC RS485 Press the ↓ key when finished	If PRINTER mode is selected the following message will appear: <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;"> Printer Connection M506 </div>
15	Use the + and – keys to select the PRINTER CONNECTION options: M506 M507	If the M506 option is selected, printer output is routed to the 7 pin plug on the controller. If the M507 option is selected, printer output is routed to the M507CE PSU/Connector box via the 25 pin I/O connector on the M506CE.

NOTE *To use the M507 option an M512CE RS232/RS485 Interface PCB must be installed in the M507CE. Connection to the printer is then made at the M512CE terminals.*



Printers and PCs must comply with current electrical safety standards and be connected as per the instructions in this manual and/or in the separate manual IM1015. Only RS232/RS485 level signals should be applied to the printer/PC connection ports as per the instructions in the separate manual IM1005.

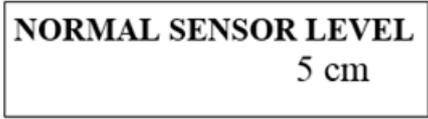
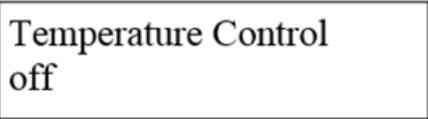
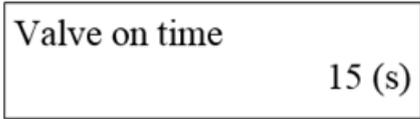
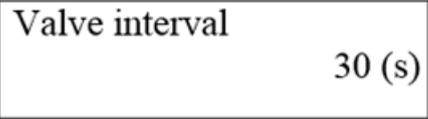
For further details contact Worthington Industries or your distributor.

NOTE *If a PC mode is selected, input/output routing defaults to the 25 pin I/O connector*



No	Steps of procedure	Display and notes
<i>on the M506CE. If a PC is plugged into the 7 pin plug on the controller panel it is automatically detected and the input/output data is re-routed</i>		
16	Press the ↓ key when finished	The following message (example) will be displayed: <div data-bbox="847 568 1270 685" style="border: 1px solid black; padding: 5px; text-align: center;">Level Display High/Low/Normal</div>
<p>The M505CE controller has the facility to display the liquid level in the refrigerator in centimetres. This is done by measuring the time taken for the liquid level to fall due to evaporation of liquid nitrogen from the high to the low sensor. </p> <p>If the high and the low sensor positions are known the level may be calculated from the time elapsed since the last fill.</p> <p>On the initial fill/evaporate cycle a Nominal Evaporation Rate for the refrigerator type is assumed.</p> <p>On subsequent cycles the actual rate is computed.</p> <p>NOTE</p> <p><i>The positions of the high and the normal sensors should be set as per Appendix D.</i></p>		
17	Use the + and – keys to select the LEVEL DISPLAY mode: <ul style="list-style-type: none">• High• Low• Normal Press the ↓ key when finished If the High/Low/Normal mode has been selected go to step 19	If the Centimetre Level Display has been selected the following message (example) will be displayed: <div data-bbox="842 1368 1270 1485" style="border: 1px solid black; padding: 5px; text-align: center;">REFRIGERATOR TYPE 10K</div>
18	Use the + and – keys to select the REFRIGERATOR TYPE Press the ↓ key when finished	The following message (example) will be displayed: <div data-bbox="842 1760 1270 1877" style="border: 1px solid black; padding: 5px; text-align: center;">HIGH SENSOR LEVEL 15cm</div>
19	Use the + and – keys to input the position of the HIGH SENSOR LEVEL (upper liquid level)	The following message (example) will be displayed:



No	Steps of procedure	Display and notes
	Press the ↓ key when finished	
20	Use the + and – keys to input the position of the NORMAL SENSOR LEVEL (lower liquid level) Press the ↓ key when finished	The following message will be displayed: 
<p>If the temperature control option is set to on, the temperature control will attempt to maintain the refrigerator temperature below the maximum temperature (see TIMERS/CLOCK menu) by bubbling nitrogen gas through the liquid pool in the bottom of the vessel. </p> <p>The disturbance caused by nitrogen gas bubbling through the liquid causes the temperature to drop rapidly.</p>		
21	Use the + and – keys to select TEMPERATURE CONTROL: <ul style="list-style-type: none">• on• off If the temperature control option is set to off, go to step 23	If the temperature control option is set to on the following message (example) will be displayed: 
<p>The valve on time is the period for which the solenoid valve is opened during the temperature control cycle. The optimum setting will depend upon the length and layout of the pipe-work and is best found by trial and error. </p>		
22	Use the + and - keys to set the valve on timer: the VALVE ON TIME setting is adjustable between 0 sec and 30 sec in 5-second steps Press ↓ key when finished	The following message (example) will be displayed: 
<p>The valve interval is the period for which the solenoid valve is closed during the temperature control cycle. The optimum setting will depend upon the length and layout of the pipe-work and is best found by trial and error. </p>		
23	Use the + and - keys to set the valve interval timer:	The following message will be displayed:



No	Steps of procedure	Display and notes
	the VALVE INTERVAL time setting is adjustable between 0 sec and 90 sec in 5-second steps Press ↓ key when finished	<div data-bbox="842 353 1264 474" style="border: 1px solid black; padding: 5px; text-align: center;">Lid Switch Type Normally Open</div>
<p>There are two types of lid switch fitted to refrigerators.</p> <p><i>NOTE</i> If the wrong lid switch type is selected the lid open alarm will sound.</p> <div data-bbox="1362 562 1449 640" style="float: right;"></div>		
24	Use the + and - keys to select the correct lid switch type: <ul style="list-style-type: none">• normally open• normally closed Press ↓ key when finished	The following message (example) will be displayed: <div data-bbox="842 792 1264 913" style="border: 1px solid black; padding: 5px; text-align: center;">Gas Bypass M360/Off</div>
<p>If the gas bypass feature is not required or is provided by an M360 system, no action or monitoring is required.</p> <p>If the gas bypass feature is used with the M507CE-I the controller will monitor the gas bypass thermocouple and send a signal to start venting when filling is called for.</p> <div data-bbox="1362 981 1449 1059" style="float: right;"></div>		
25	Use the + and - keys to select the correct gas bypass type: <ul style="list-style-type: none">• M360/Off• M507I Press ↓ key when finished	The following message (example) will be displayed: <div data-bbox="842 1281 1264 1402" style="border: 1px solid black; padding: 5px; text-align: center;">No LN2 Alarm Off</div>
<p>The LN2 supply alarm (fill timer) may be disabled if required, e.g. to avoid false alarms on systems with long filling times. If the 'Alarm Off' option is selected the refrigerator will fill indefinitely without giving an LN2 supply alarm.</p>		
26	Use the + and - keys to select the option: <ul style="list-style-type: none">• Alarm Off• Alarm On Press ↓ key when finished If the Alarm Off option has been selected go to step 28	If the Alarm On option has been selected the following message (example) will be displayed: <div data-bbox="842 1722 1264 1843" style="border: 1px solid black; padding: 5px; text-align: center;">No LN2 Valve Off</div>
<p>If a time-out occurs during filling the solenoid valve may be switched off or left on.</p> <p><i>NOTE</i> It is recommended that 'Off' is selected, especially when connected to a bulk LN2 tank. The pressurised gas in a large empty tank may cause the refrigerator to boil dry if the valve is left open!</p>		



No	Steps of procedure	Display and notes
<p><i>If the solenoid valve is switched off by a time-out it will remain off until manually reset by pressing the LN2 Fill Solenoid Valve (switch 1).</i></p> <p><i>NOTE Filling does not automatically restart at the extra low level. This prevents fill cycling if alarms are left unattended.</i></p>		
27	<p>Use the + and - keys to select the option:</p> <ul style="list-style-type: none">• Valve Off• Valve On <p>Press ↓ key when finished</p>	<p>The following message (example) will be displayed:</p> <div data-bbox="847 658 1262 770" style="border: 1px solid black; padding: 5px; text-align: center;">Analogue Output Off</div>
28	<p>Use the + and - keys to select the correct ANALOGUE OUTPUT option:</p> <ul style="list-style-type: none">• Off• 0 - 2 V• 0 - 10 V & 4 - 20 mA <p>Press ↓ key when finished</p>	<p>The following message will be displayed:</p> <div data-bbox="847 898 1267 1010" style="border: 1px solid black; padding: 5px; text-align: center;">1: Check Analogue o/p ↓: Next</div>
<p>NOTE </p> <p><i>If an Analogue Output PCB (M511CE) is fitted, the output range may be set to any of the above options.</i></p> <p><i>If 'Off' is selected the output is set 0 V & 4 mA.</i></p> <p><i>This feature allows the Analogue Output PCB (M511CE) to be tested and enables connected equipment to be calibrated for Zero and Full Scale Outputs.</i></p> <p><i>NOTE For further details consult the separate manual (IM1019) or contact Worthington Industries or your distributor.</i></p>		
29	<p>Press switch 1 if CHECK ANALOGUE O/P is required</p> <p>Press ↓ key to skip to step 31</p>	<p>If CHECK ANALOGUE O/P is selected the following message will be displayed:</p> <div data-bbox="847 1671 1270 1783" style="border: 1px solid black; padding: 5px; text-align: center;">0%</div>
<p>NOTE </p> <p><i>If the 0 - 2 V range was selected the output will be set to 0 V, 1 V or 2 V depending on the option that has been selected (in step 28).</i></p> <p><i>If the 0 - 10 V & 4 - 20 mA range was selected the output will be set to 0 V / 4 mA, 5 V / 12 mA or 10 V / 20 mA depending on the option that has been selected (in step 28).</i></p>		



No	Steps of procedure	Display and notes
30	<p>Use the + and - keys to select the required Voltage/Current option (in % of full scale output):</p> <ul style="list-style-type: none">• 0 %• 50 %• 100 % <p>Press ↓ key when finished</p>	<p>The following message (example) will be displayed:</p> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;">Daily Fill Off</div>

The Daily Fill allows the refrigerator to be refilled at a fixed time each 24 hours (see TIMERS/CLOCK menu). If any option other than 'Off' is selected the Fill Start time must be set up in the TIMERS/CLOCK Menu.



31	<p>Use the + and - keys to select the required DAILY FILL option:</p> <ul style="list-style-type: none">• Off or On; or• Off, 24h, 48h, 72h; or• Select Days <p>Press ↓ key when finished</p>	<p>If the SELECT DAYS option is selected the following message will appear:</p> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;">Mon off</div>
32	<p>Use the + and - keys to select for:</p> <ul style="list-style-type: none">• MONday off or on <p>Press ↓ key to step to TUESday; and Repeat the steps for each day of the week up to SUNday; then Press ↓ key to finish</p>	<p>The following message (example) will be displayed:</p> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;">Password Protection off</div>

PASSWORD PROTECTION uses a four digit access code to prevent unauthorised alterations to the controller settings, and to monitor access to the refrigerator.



There are two priority levels:

- at supervisor level the Supervisor (Operator 1) may alter settings including access codes; and open the lid of the refrigerator
- at operator level the Operators (2 to 8) may only open the lid of the refrigerator.

The Supervisor and Operator access codes may be used to record which Operator has accessed the refrigerator and when (if the security options are enabled).

NOTE If an invalid code or no code is entered an alarm is sounded and the unauthorised access is recorded in the data log.

NOTE Controller settings may be viewed by anyone by selecting VIEW SETTINGS from TIMERS/CLOCK menu.



No	Steps of procedure	Display and notes
33	<p>Use the + and - keys to select the required level of PASSWORD PROTECTION:</p> <ul style="list-style-type: none">• Settings and Access• Settings only• Off <p>Press ↓ key when finished</p>	<p>If the SETTINGS AND ACCESS or the SETTINGS ONLY option is selected the following message will appear:</p> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;"><p>Code – Operator 01 6666</p></div>
<p>NOTE</p> <p><i>Operator 01 is the Supervisor.</i></p> <p><i>6666 is the default code, to which access codes are reset.</i></p>		
34	<p>Set each code digit using the + and - keys and the ↓ and ↑ keys to move the cursor</p> <p>Press ↓ key to finish when the cursor is on the last digit</p>	<p>The following message will appear:</p> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;"><p>Code – Operator 02 6666</p></div>
35	<p>Set the code for Operators 02 to 08 in the same way as for OPERATOR 01</p> <p>NOTE <i>Unused operator codes should be set to the same value as the Supervisor code.</i></p> <p>Press ↓ key when all Operator codes have been set</p>	<p>The following message will appear:</p> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;"><p>SAVING SETTINGS</p></div> <p>All settings are saved in non-volatile memory. After a few seconds the Temperature and Level display will reappear</p>

If the password codes are lost or corrupted they may be reset to the default code 6666 using a PC and the PC Cable (M519CE) or the USB-PC Cable (M549CE).

PC software is available by E-mail for this purpose.

Instructions are supplied with the PC software.





7.4 CONTROLLER OTHER SETTINGS (ENGINEER MENU)

The following additional settings are only accessible to authorized service personnel!

NOTE For further details consult the separate manual (IM1026) or contact Worthington Industries or your distributor.



Table 9 **Engineer Menu's options of the controller**

- Service Call Indicator
- Show/Hide User Calibration
- Number of Thermocouple inputs
- Aux Relay Function
- Sim Fill Repeat
- PC Software Type
- Fill Timer, Start immediately or after Venting
- Sim Fill Delay, Start immediately or after Venting
- Analog Output 'Polarity'
- Set Memory Size
- Set Baud rate for serial communications

7.5 CONTROLLER IN NORMAL OPERATION

During normal operation of the K SERIES Cryostorage System the controller display shows the actual temperature of the thermocouple and the liquid level relative to the sensors.



Filling takes place automatically to compensate for evaporative losses.

Filling may also be triggered by an external fill signal (Simultaneous Fill).

Once a simultaneous fill input signal has been accepted the controller will not respond to another simultaneous fill input signal until 30 minutes have elapsed.

This is to avoid the possibility that two or more controllers could interact causing repeated short fill cycles.

The 30 minute timer may be cleared by resetting the controller as described in section 7.7. This may be useful when testing for correct operation of a system connected for simultaneous filling.





The LN2 switch 1 may be used to top up the liquid level or for defogging the storage area.

When the fill solenoid valve is active a blue light above the LN2 switch 1 is illuminated.

Before opening the lid the lid switch 3 should be pressed. If the security feature is enabled the operator will be prompted for a access code.

If no access code or an invalid code is entered and the lid is opened the alarm will be activated. This will be recorded in the data log as an unauthorised access.



The alarm can be muted in the same way as any other alarm but can only be cleared by the supervisor entering the correct access code.

7.6 CONTROLLER ALARMS

The alarm settings of the liquid level controller supplied with the Worthington Industries K SERIES Cryostorage System has been pre-configured and may be adjusted depending on the application and installation requirements of the operating company.



A list of the default alarm settings is given in Appendix I

To prevent unauthorised changes to the controller alarm settings the PASSWORD PROTECTION option must be enabled and the supervisor's code should be changed from its default setting (see section 7.3).



Caution should be exercised in setting the various alarm limits to appropriate values to reduce risk to stored samples while minimising the occurrence of false alarms.



In particular the settings for Temperature Alarms and the maximum Fill time should be carefully considered.

If the K SERIES Crostorage System is installed in an unattended location it is important that use is made of the remote alarm feature: This will give a global Alarm signal to a remote location to indicate that prompt attention is required. This might be an alarm panel which is constantly monitored, or an auto-dialler.



Alarm settings may be restored to their default values via the Engineer menu.

NOTE For further details consult the separate manual (IM1026) or contact Worthington Industries or your distributor.



All alarms have been defined as 'High Priority' and require prompt user/operator attention.





Alarm signal Generation Delay (Local Alarm signals)

Local alarm signals are generated within 5 (five) seconds of the alarm condition occurring.

The exception is the Extra High alarm. This has a delay which may be programmed from 0 to 120 seconds. This may be used to limit false alarms during the initial stages of refilling.

Alarm signal Generation Delay (Remote Alarm signals)

The time from an alarm occurring to a remote alarm being generated is programmable and should be adjusted by Worthington Industries.

If the delay is set to zero the remote relay will de-energise within 5(five) seconds of the alarm condition.

Characteristics of Visual Alarm signals

An Alarm condition is visually indicated by a flashing red LED located in the 'Mute' key (switch 2).

Alarms are acknowledged by pressing this key. When Alarms are 'Acknowledged' the LED changes to a steady state. If further Alarms occur the LED reverts to flashing.

Pressing the Mute key also displays the current alarm state(s) on the character display. If more than one alarm is present these are displayed in sequence. Longer alarm messages are scrolled across the display.

Pressing the Mute key also toggles the character display between its normal status display (temperature and level), and the alarm display.

If the alarm has been muted the sounder may be re-activated by pressing the 'Undo' key (switch 4).

Volume and characteristics of Audible Alarm signals

An alarm condition is audibly indicated by a sounder mounted behind the controller fascia panel.

The alarm tone, burst sequence and volume comply with EN60601-1-8.

Volume was measured as 57.5 dB (M506CE) and 62.7 dB (M506CE-B) when measured in accordance with the standard.

Volume is not adjustable. The alarm may be silenced by pressing the mute switch. (See above)

New alarms will re-activate the sounder.

Latching/Non latching Alarm signals

All alarms are non- latching except the General Alarm. This will latch until the controller is restarted.

Unauthorised Access. This is reset by entry of the operator's code.



Information signals

Filling is indicated by a blue LED in the LN2 Key. If filling times out and an LN2 supply alarm occurs the LED flashes slowly. The alarm is reset in this case by pressing the LN2 key

Alarm logging

The level controller can store up to 8 000 or 20 000 records depending on the memory configuration.

The log contains regular status reports and alarm reports.

All alarms are logged with time and date and a unique alarm code. A list of all alarm codes is given in Appendix H.



NOTE For further details consult the separate manual (IM1026) or contact Worthington Industries or your distributor.

On power failure or power down the log is maintained for 4 weeks minimum by an internal battery.* When the log is full the oldest records are overwritten.

General Alarm

If a certain number of alarms (currently set to 25) occur in a 24 hour period time, a General Alarm is raised. The controller needs to be reset to clear the alarm, or alternatively it will also be cleared at the end of a 24 hour period (Midnight).

The general alarm indicates when multiple intermittent problems are occurring. If the alarms do not persist for long enough to trip the remote alarm they might not be noticed for some time.

The purpose of the general alarm is to draw attention to this situation, and to the inspection of the data log to reveal the cause.



Service Call Indicator

With the Service Call option set, the controller will prompt when a service becomes due. When a service is due a '!' symbol flashes in the left hand corner of the display.

The Service Call option (on/off) and Service due date (month and year) are set in the ENGINEER MENU.



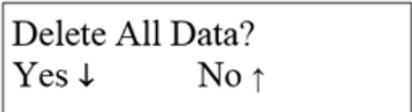
7.7 CONTROLLER RESET

The RESTARTING function can be used to force the controller to go through its start-up sequence. This can be used for resetting the controller and clearing the data log.



NOTE Resetting the controller clears the data log and all data will be lost.

Table 10 Procedure for resetting the controller

No	Steps of procedure	Display and notes
1	Make sure the PC cable (M519CE or M549CE) is not plugged in, if used Press the ↑ key to enter the menu	After a few seconds the following message will appear: 
2	Press and hold the ↓ key until the controller will bleep three times	The following message will appear: 
3	Press the ↓ key to proceed or Press the ↑ key to return to the Temperature/Level display	If PASSWORD PROTECTION is enabled the following message will appear: 
4	Enter the <u>four digit supervisor's code</u> using the numbered keys and the ↓ and ↑ keys to move the cursor Press ↓ key to finish If a code is requested and it is not known, the password will have to be reset (see section 7.3)	If the code is accepted (or not requested) the following message will appear: 
5	Use the ↓ and ↑ keys to select: <ul style="list-style-type: none">• Yes or No If No is selected the data memory is left intact and the controller returns to the Temperature/Level display	If Yes is selected the following message will appear:



Instruction Manual

K SERIES Cryostorage System

IM: CryoCeK
Revision: 02
Approved by: CB
Page 53 of 87

No	Steps of procedure	Display and notes
		<div data-bbox="842 353 1251 470" style="border: 1px solid black; padding: 5px; text-align: center;">Data Log Cleared System Reset</div>
6	Release the ↓ key	After a few seconds the Temperatur/Level display should reappear

NOTE *If the controller is restarted with a PC cable plugged in it will start the Program Loader. If this happens, remove the PC cable and switch off the power to the controller for a few seconds. Alternatively, wait for a few minutes and the main program will restart. Do not press any keys while the Program Loader screen is present.*





8 CARE AND MAINTENANCE OF DEVICE

8.1 GENERAL CONSIDERATIONS

The Worthington Industries K SERIES Cryostorage System should be subject to a maintenance schedule to ensure its functionality and safety of the professional user, operator or any other person.

It is the sole responsibility of the operating company to ensure that the K SERIES Cryostorage System is held in a state compliant with this instruction manual and applicable regulations and standards by appropriate maintenance for the entire duration of use.



A proper maintenance program should be in place, taking into account the operating location and ambient conditions, the mode and frequency of sample transfer, any wear parts, the potential hazard in the event of a failure, the resources for the servicing and maintenance and the availability of replacement parts.

Keep the service history log up-to-date:



Sign off in the service history log each time service and maintenance is finished to your Cryostorage System, stating the serviced and/or replaced parts.

Appropriate measures must be taken to avert hazardous situations, if any may occur in the course of maintenance!



In the case of special events (e.g., crash racks, topple down refrigerator, collision with other equipment, exposure to high temperatures, significant modifications which have not been foreseen by the manufacturer, major repairs), which have adverse effects on the safety of the Cryostorage System, an extraordinary test for proper condition after repair shall be done.

If a defect is identified during a recurring inspection, all users involved must be informed and the defect must be eliminated before re-use of the K SERIES Cryostorage System.

Inspection, maintenance and repair, as well as all associated tests should only be performed by qualified persons:



These persons are qualified due to their special education and their practical experiences, in particular with regard to the relevant legislation and standards, to recognize the potential impact and hazards and to assess the necessary measures.

The operator may only replace the inventory storage system. All other work must be carried out by service personnel instructed and authorized only by Worthington Industries. Details of the inventory storage system you will find in our Sales Sheet.

Worthington Industries and the distributor of the K SERIES Cryostorage System refuse all liability when the device



- is not repaired by service centers expressly authorized by the manufacturer; or
- is not used with genuine replacement parts; or
- fails to comply with the recommended maintenance intervals.



8.2 INSPECTION AND MAINTENANCE SCHEDULE

IMPORTANT

The following safety precautions apply to the Worthington Industries K SERIES Cryostorage System:

If your K SERIES Cryostorage System is to be taken out of service for any reason, the following steps must be performed to safely take the refrigerator out of operation:



- Disconnect electrical power and liquid nitrogen supply.
- Remove all stored samples and the inventory control system, including the bottom platform.
- Remove sensors.
- Use a source of dry nitrogen gas to purge the refrigerator as the temperature rises to ambient.

The purge gas can be installed on the sensor tube or fill tube or directly into the liquid via a tube or hose after the appropriate components have been removed. The purge gas may also simply be delivered to the refrigerator through a bent metal tube under the lid.

A flow rate of 8 to 17 m³/h regulated at 0.3 to 0.5 bar is sufficient to prevent water from collecting inside the refrigerator. This flow of purge gas will also speed the warming of the refrigerator to ambient temperature.

NOTE For further detailed instructions see the subsequent sections.

Worthington Industries strongly recommends to inspect and maintain your K SERIES Cryostorage System as follows:

Table 11 Recommended inspection and maintenance schedule

Inspection and maintenance activities	Frequency
Check any alarm messages on the controller display for necessary actions	Daily or via remote alarm (if used)
Inspect cables, wires and connectors of solenoid valve, lid switch, level sensor assembly, thermocouple assembly, level control system, power supply for any connecting problems, cracks or other damages	Annually (at least)
Clean the strainer as per section 8.3	Annually or whenever the ice buildup exceeds approx. 5mm



Inspection and maintenance activities	Frequency
Defrost the Cryostorage System as per section 8.4	Annually or whenever the ice buildup exceeds approx. 5 mm
Disinfect the Cryostorage System as per section 8.5	Prior to change of the type of stored samples or before the device is taken out of operation
Perform Normal Evaporation Rate test as per section 8.6	Due to sign of abnormally nitrogen consumption
Test for electrical safety	Every two years
Replace the solenoid valve and other replacement parts as necessary	Every three years

In particular, local specific regulations may also apply to your K SERIES Cryostorage System to which extended inspections and tests require shorter periods of time.



8.3 CLEANING THE STRAINER

The Worthington Industries K SERIES Cryostorage System is supplied with a strainer.

The refrigerator will not fill properly if the strainer is clogged with ice or dirt.



To clean the strainer follow the procedure:

- Close the liquid nitrogen supply valve to the refrigerator
- Vent the fill line of all pressure
- Remove and warm the strainer to ambient temperature
- Purge the strainer from both directions with dry nitrogen gas or dry oil-free air
- Rinse the strainer with alcohol
- 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 strainer or filter in the correct orientation.



Contact Worthington Industries or your distributor for further information.

8.4 DEFROSTING THE CRYOSTORAGE SYSTEM

The Worthington Industries K SERIES Cryostorage System is as all liquid nitrogen storage systems subject to ice and frost buildup over time.

Ice and frost buildup in the sensor tube may restrict the movement of sensor probes in the tube, and 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.



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.

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 very low levels, and may cause the low alarm sensor and the low LN2 supply alarm to be activated.



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 area, near the top. Warm with a hair dryer or other safe low heat source with the solenoid valve in the open position. If this is not successful in 2 (two) 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.

Ice and frost buildup on the lid may occur 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.

NOTE Care must be taken to insulate the inventory control system from high temperatures, which may affect the viability of the stored samples.

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



8.5 CLEANING AND DISINFECTING THE CRYOSTORAGE SYSTEM

The Worthington Industries K SERIES Cryostorage System may need to be cleaned and disinfected if the type of stored samples is changed or the device is taken out of operation.

Assure interim re-storage of vital samples or dispose of discarded samples	
Always clean and disinfect the Cryostorage System, regardless of the type of stored samples, prior to return to Worthington Industries for repair or maintenance.	
Never use chlorine-based disinfectants or abrasive detergents, steam pressure or water jets to clean your K SERIES Cryostorage System. <i>NOTE A suitable disinfectant for use herein is a non-glutaraldehyde cold sterilant manufactured by Alcide Corporation and known commercially as EXSPOR™</i>	

To clean and disinfect the K SERIES Cryostorage System follow the procedure:

- Close the liquid nitrogen supply valve to the refrigerator,
- Vent the fill line of all pressure,
- Turn the controller off,
- Disconnect the power source and the liquid nitrogen source,
- Remove all stored samples 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,
- 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/water solution,
- Allow surface contact to be maintained for a minimum of fifteen minutes,
- Rinse the inner vessel surface with water,
- Remove all water, and towel dry.



8.6 NORMAL EVAPORATION RATE (NER) TEST

Nitrogen consumption is an accumulation of all cryogenic storage system components and user introduced evaporation.

Although the Worthington Industries K SERIES Cryostorage System consists of a storage area in a double walled, vacuum insulated vessel, it contributes to the daily consumption of liquid nitrogen.

Other contributing factors that may affect the overall nitrogen consumption are:

- the liquid nitrogen supply and transfer hose
- choosing to control the vapor temperature, combined with the liquid level and temperature specified
- opening the lid to retrieve and/or adding samples.

However, if the nitrogen consumption of the K SERIES Cryostorage System seems excessive, it may be appropriate to perform an estimated Normal Evaporation Rate (NER) test.



Never use hollow rods or tubes as dip-sticks to perform the NER test.

When a warm tube is inserted into liquid nitrogen, liquid will spout from the top of the tube and may cause personal injury



To perform an NER test follow the procedure:

- Fill the Cryostorage System to the “High Level” sensor.
- Measure the liquid nitrogen level with a plastic or wooden measuring rod.
- Close and lock the lid of the Cryostorage System for forty-eight (48) hours.
- Open the Cryostorage System and measure the liquid nitrogen level.

Typically, the liquid nitrogen level will drop approx. 25 mm / 1 inch per day.

If your measurement indicates a drop in excess of 50 mm / 2 inch per day, contact Worthington Industries or your distributor for further information.





8.7 TRANSPORT OF DEVICE

When moving your K SERIES Cryostorage System to or from its current location to a transport vehicle or new location for any reason, make sure to use a suitable forklift or pallet truck.

Always move your K SERIES Cryostorage System in an upright position and in empty and defrosted condition, and without inserted inventory control system.



Use straps to secure the refrigerator onto a palette.

Take particular care to lock all casters and use wheel chocks.

Fix flexible parts with low tack tapes or preferably bungee cords.

Protect the refrigerator with a blanket.

8.8 RETURN OF DEVICE

If it is necessary to return any part of the K SERIES Cryostorage System for repair, maintenance or replacement, a Cryo Product Return Information Form (see Appendix C) must be filled in before returning the device to Worthington Industries.



Any K SERIES Cryostorage System received without this Cryo Product Return Information will be returned to the sender.



It is your responsibility to assure that the goods are adequately packaged for return.

If necessary, consult Worthington Industries for shipping and packing instructions.

All refrigerators returned to Worthington Industries must be clean and disinfected before return, as per section 8.5.

8.9 DISPOSAL OF DEVICE

The Worthington Industries K SERIES Cryostorage System has been designed and manufactured with high quality materials and components, which can be recycled and reused.

Do not dispose of waste liquid nitrogen in-door



Dispose of waste liquid nitrogen out-of-doors where its cold temperature cannot damage floors or driveways and where it will evaporate rapidly.

An outdoor pit filled with clean sand or gravel will evaporate liquid nitrogen safely and quickly.



Do not dispose of this Cryostorage System along with normal waste material:



All materials from stainless steel, aluminium and aluminium foil can be reused as recyclable materials. All plastics, epoxy tube, glass paper and the molecular sieve must be disposed of as industrial waste or incinerated. Electronic components (controller / control unit) must be supplied to the hazardous waste.

Dispose of this device and discarded samples in line with local regulations.

Your local authority will give all disposal information on the available local waste collection system or recycle facilities for electrical and electronic products or contact your local distributor for returning the Cryostorage System to Worthington Industries.



9 WARRANTY TERMS

Worthington Industries provides the following manufacturer’s warranty against breakdown during normal use.

Table 12 K SERIES Cryostorage System warranty terms

MODEL	Vacuum warranty	Material warranty	Workmanship warranty
K SERIES	5 (five) years	2 (two) years from shipment	2 (two) years from shipment
Controller/Display	N/A	2 (two) years from shipment	2 (two) years from shipment

Claims are only accepted under the following terms:



Notify Worthington Industries and/or your distributor without delay of the functional fault giving cause for the guarantee claim.

Follow the instructions issued by Worthington Industries concerning the returning of the device, as per section 8.8.

Give a legible copy of the invoice with date of purchase for the device in question.

Describe the defect or malfunction discovered.

The warranty shall be rendered null and void if it is discovered that:



The inspection and maintenance instructions have not been followed as per section 8.2.

The device was damaged by force or an user error, or that it was used in any way contrary to that set out in this instruction manual.

Accessories, spare parts or materials have been used which are not genuine Worthington Industries accessories or replacement parts.

Measures for repair or servicing are undertaken by service personnel not authorized by Worthington Industries.

If Worthington Industries is required to meet a warranty claim in accordance with these terms, the operating company shall bear the cost and risk of transporting the Cryostorage System from and to the location of use.

Worthington Industries and your distributor will not be liable for slight negligence in any circumstances. The compensation of lost earnings and profit is likewise excluded.



10 MANUFACTURER'S DECLARATION

This Worthington Industries K SERIES Cryostorage System is manufactured by:

Worthington Cylinders GmbH

Beim Flaschenwerk 1
A-3291 Kienberg bei Gaming / Austria

Tel +43 7485 606 0
Fax +43 7485 606 100
E-Mail wca@wthg.at

As the manufacturer we declare under our sole responsibility that the

Worthington Industries K SERIES Cryostorage System

is a class IIa medical device

and complies with the EU Directive **93/42/EEC (Medical Device Directive)**.

This conformity is indicated by the CE mark followed by the registration number 0044 of the notified body TÜV Nord Cert GmbH, Langemarckstraße 20, 45141 Essen, Germany.

This Worthington Industries K SERIES Cryostorage System complies with the following EU Directives

WEEE - Directive 2012/19/EU (Waste of Electrical and Electronic Equipment)

RoHS 2 - Directive 2011/65/EU (Restriction of Hazardous Substances in Electrical and Electronic Equipment)

NOTE *A copy of the Declaration of Conformity is supplied with the K SERIES Cryostorage System and is also available upon request.*



11 ADDITIONAL TECHNICAL DATA

Table 13 *Technical data of the K SERIES Cryostorage System*

Device group:	K SERIES CRYOSTORAGE SYSTEM
Device type:	MEDICAL ELECTRICAL EQUIPMENT (ME EQUIPMENT)
Protection rating (EN 60601-1):	Class I
Supply voltage:	230 V +/- 10% ~ 50 Hz
Current consumption:	1.0 A max
Outputs:	24 V ~ 3.3 A max 10 V ~ 0.5 A max 12 V = = = 1.0 A max
Protection code (EN 60529):	IP20
Fuses (EN 60127):	1x T 1AH, 250 V (M507CE, next to power inlet) 1x T 1AH, 250 V (M507CE, transformer cover) 1x T 1AH, 250 V (M507CE, PSU, PCB) 1x T 3.15AH, 250 V (M507CE, PSU, PCB)
Operating mode:	Continuous operation
Supply connection:	Appliance coupler (Mains cord), built-in safety isolating transformer No patient applied parts, Only operator contact
Firmware:	Microcontroller-Software Version V4.0 (from SN xxx onwards)

NOTE for UK equipment only: Fused Mains Plugs are fitted with a 3 Amp fuse (1" x ¼)

Disconnect the K SERIES Cryostorage System completely from the mains supply before replacing internal fuses.





Electromagnetic Compatibility (EMC) Test Results

Table 14 *Radiated Immunity*

Frequency Range	Test Level	EUT Face	Antenna Polarity
80 – 2500Hz 2500 – 2700MHz	3V/m 1V/m	Front	Horizontal
80 – 2500Hz 2500 – 2700MHz	3V/m 1V/m	Front	Vertical
80 – 2500Hz 2500 – 2700MHz	3V/m 1V/m	LHS	Horizontal
80 – 2500Hz 2500 – 2700MHz	3V/m 1V/m	LHS	Vertical
80 – 2500Hz 2500 – 2700MHz	3V/m 1V/m	Rear	Horizontal
80 – 2500Hz 2500 – 2700MHz	3V/m 1V/m	Rear	Vertical
80 – 2500Hz 2500 – 2700MHz	3V/m 1V/m	RHS	Horizontal
80 – 2500Hz 2500 – 2700MHz	3V/m 1V/m	RHS	Vertical

NOTE The temperature fluctuated by +/-1 °C and the current fluctuated by 0.1 mA.

All fluctuations were within the tolerances.

Table 15 *Conducted Immunity*

Cable	Frequency Range	Coupling Unit	Test Level
Mains supply	150kHz - 80MHz	CDN	3V rms
4-20mA output	150kHz - 80MHz	CDN	3V rms
Fill cable	150kHz - 80MHz	CDN	3V rms

NOTE The temperature fluctuated by +/-1 °C and the current fluctuated by 0.07 mA.

All fluctuations were within the tolerances.

Immunity to Burst

No malfunctions or influences were detected. The device fulfills the required criterion.



LIST OF APPENDIXES

Appendix A1	INITIAL INSTALLATION LOG
Appendix A2	INITIAL INSTRUCTION LOG
Appendix B	SERVICE HISTORY LOG
Appendix C	CRYO-PRODUCT RETURN INFORMATION FORM
Appendix D	SENSOR AND THERMOCOUPLE POSITIONING
Appendix E	REMOTE ALARM CONNECTIONS
Appendix F	SIMULTANEOUS AND SEQUENTIAL FILLING
Appendix G	CONNECTIONS FOR GAS VENTING
Appendix H	ALARMS AND EVENTS
Appendix I	ALARMS OVERVIEW
Appendix J	OPTIONAL ACCESSORIES



Appendix A1 - INITIAL INSTALLATION LOG

IMPORTANT: Fill in this form after the initial installation of your Worthington Industries Cryostorage System has been done.

Customer Information

Operating Company Name: _____

Service Company Name: _____

Cryostorage System Information

Cryostorage Model: _____ Serial No: _____

Controller Model: _____ Serial No: _____ Version No: _____

Operation Conditions – Actual

Liquid Level via Dipstick: _____

Level Sensor Type: FG 8T 4T

Lid Open: _____ Lid Closed: _____

Filling: Yes No

Temperature: _____

LN2 Supply: ltr bar/kPa

Ice Build-up: a little a lot

Gasket Condition: seals leaks

Display Lights: On Off

Operation Conditions – Controller Reading

Liquid Level per Controller: _____

Liquid Level Setting: HIGH LOW

Lid Open: _____ Lid Closed: _____

Filling: Yes No

Temperature: _____

Supply Alarm: On Off

Remote Alarm: On Off

Audible Alarm: On Off

Temperature Control Setpoint at: _____ °C

Initial Installation Checks

Controller Alarms Test:	Yes	No	Remarks:
LN2 Shut-off Valve:	Yes	No	Remarks:
LN2 Relief Valve:	Yes	No	Remarks:
LN2 Pressure Regulator:	Yes	No	Remarks:
Location Ventilation:	Yes	No	Remarks:
Electrical Power Supply:	Yes	No	Remarks:
Electromagn. Sources:	Yes	No	Remarks:
ICS Rack Arrangements:	Yes	No	Remarks:

Initial Installation completed

Service Company

Operating Company

Print Name: _____

Date/Signature: _____

In-service Date: _____ LOG NO _____

NOTE: Please send a copy of this form to Worthington Cylinders GmbH, Customer Service via Fax: +43 7485 606 100 or Email: customerservice@wthg.at.



Appendix A2 – INITIAL INSTRUCTION LOG

IMPORTANT: Fill in this form after the initial instruction of your Worthington Industries Cryostorage System has been done.

Customer Information

Operating Company Name: _____

Service Company Name: _____

Cryostorage System Information

Cryostorage Model: _____ Serial No: _____

Controller Model: _____ Serial No: _____ Version No: _____

Following users have been instructed using this instruction manual:

Print Name: _____	Personal No: _____	Signature: _____
Print Name: _____	Personal No: _____	Signature: _____
Print Name: _____	Personal No: _____	Signature: _____
Print Name: _____	Personal No: _____	Signature: _____
Print Name: _____	Personal No: _____	Signature: _____
Print Name: _____	Personal No: _____	Signature: _____
Print Name: _____	Personal No: _____	Signature: _____
Print Name: _____	Personal No: _____	Signature: _____

With your signature you confirm that you has been committed to the proper handling of the respective medical device with reference to this instruction manual including all relevant aspects for the proper operation and necessary safety precautions, and any inspections to be performed prior to each application, and maintenance to be carried out in certain intervals.

Initial Instruction completed

Service Company

Operating Company

Print Name: _____	Print Name: _____
Date/Signature: _____	Date/Signature: _____
Instruction Date: _____	LOG NO _____

NOTE: Please send a copy of this form to Worthington Cylinders GmbH, Customer Service via Fax: +43 7485 606 100 or Email: customerservice@wthg.at.



Appendix C - CRYO-PRODUCT RETURN INFORMATION FORM

IMPORTANT: Fill in this form before returning any part of your Worthington Industries Cryostorage System for repair, maintenance or replacement to Worthington Cylinders GmbH.

Product Information

Material Return Authorization No: _____

Model No: _____

Serial No: _____

Product Stored: _____

Customer Information

Name: _____

Email: _____

Address: _____

Phone No: _____

Reason for return

Decontamination Information

Contaminated refrigerators can not be accepted!

Federal law prohibits the transfer of any equipment or products that are contaminated with a radiological, biological, or chemical waste residue.

Therefore Worthington Cylinders GmbH requests customers to authenticate the following (check one):

- A. The equipment was never used.
- B. The equipment was not used in conjunction with any radiological, biological, or chemical matter.
- C. The equipment was exposed to radiological, biological, or chemical matter, was decontaminated, and is rendered safe for handling, use, or disposal.

Authorization

By accepting authorization to return this product, the customer assumes all responsibility and liability for biological, radiological, and chemical decontamination and cleaning. Worthington Cylinders GmbH reserves the right to refuse delivery of products which in our judgment do not appear to have been properly decontaminated. We reserve the right to bill the customer for any and all cost associated with the decontamination or disposal of products which do not appear to have been properly decontaminated. If the product contained radioactive material, the signature of your radioactive safety officer is required.

Print name: _____

Signature _____ Date _____

NOTE: Please make a copy of this form for your own records and email original to: CryoScience@WTHG.AT.
Please forward all returns to following address (unless otherwise specified): Worthington Cylinders GmbH,
Attn: Ivana Lapcakova, Beim Flaschenwerk 1, A-3291 Kienberg bei Gaming, AUSTRIA.



Appendix D - SENSOR AND THERMOCOUPLE POSITIONING

Installation as well as all associated inspections should only be performed by qualified persons:



These persons are qualified due to their special education and their practical experiences, in particular with regard to the relevant legislation and standards, to recognize the potential impact and hazards and to assess the necessary measures.

Sensor Positioning

The position of the sensors in the sensor tube determines the level of liquid nitrogen to be maintained.

Sensor position is determined by measuring the distance from the top of the sensor tube to the bottom of the refrigerator, then subtracting the desired liquid level.

The result is used to position a split rubber bung on the sensor leads. When correctly installed, the bung will position the sensors at the correct level when the sensor assembly is inserted into its tube.

The bung caps the tube and functions as a sensor retainer.

The lead with the single pod is the low level sensor assembly, consisting of the Extra Low and Normal sensors.

The lead with two pods is the high level sensor assembly, consisting of the High and Extra High sensors.

The Normal and High sensors must be separately positioned to set the liquid levels at which the controller will start and terminate each fill cycle.

Determination of the liquid level to be maintained depends upon the application and the product being stored, and is beyond the scope of this manual.

Position the sensors as shown in *Figure 8*.

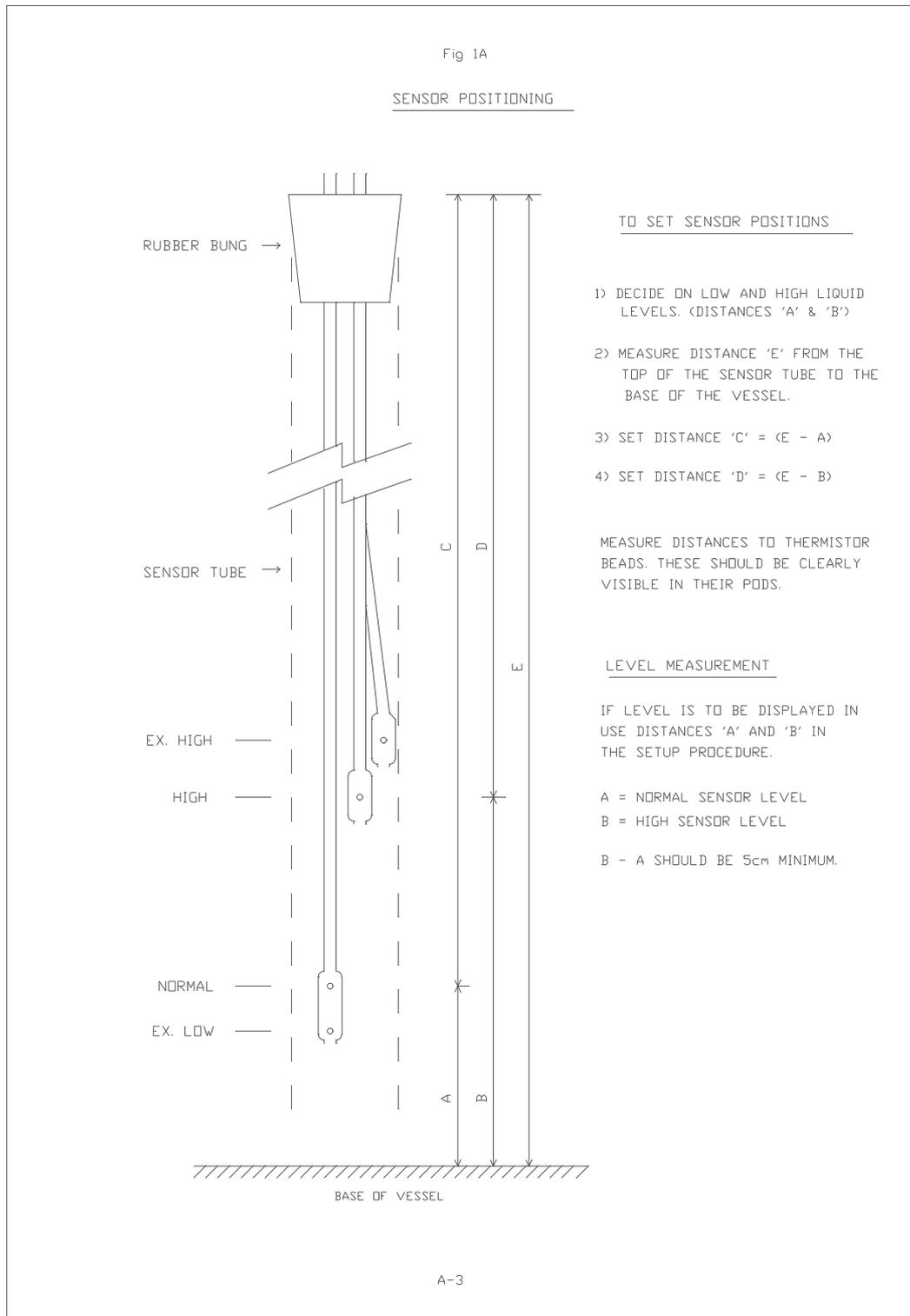


Figure 8 Sensor positioning



Thermocouple Position

The thermocouple(s) may be positioned anywhere in the refrigerator within the limits of their length.

For models with two thermocouples, thermocouple TC1 is used for collection of temperature data and this should be given priority when selecting the desired monitoring point.

Typically the product will be stored in vapour phase with about 15 to 20 cm of liquid in the vessel.

The 'worst case' temperature for vapour phase storage is just below the lid of the refrigerator and it is suggested that the optimum position for the thermocouple is within the sensor tube and level with either the bottom of the lid or the top of the inventory control system.

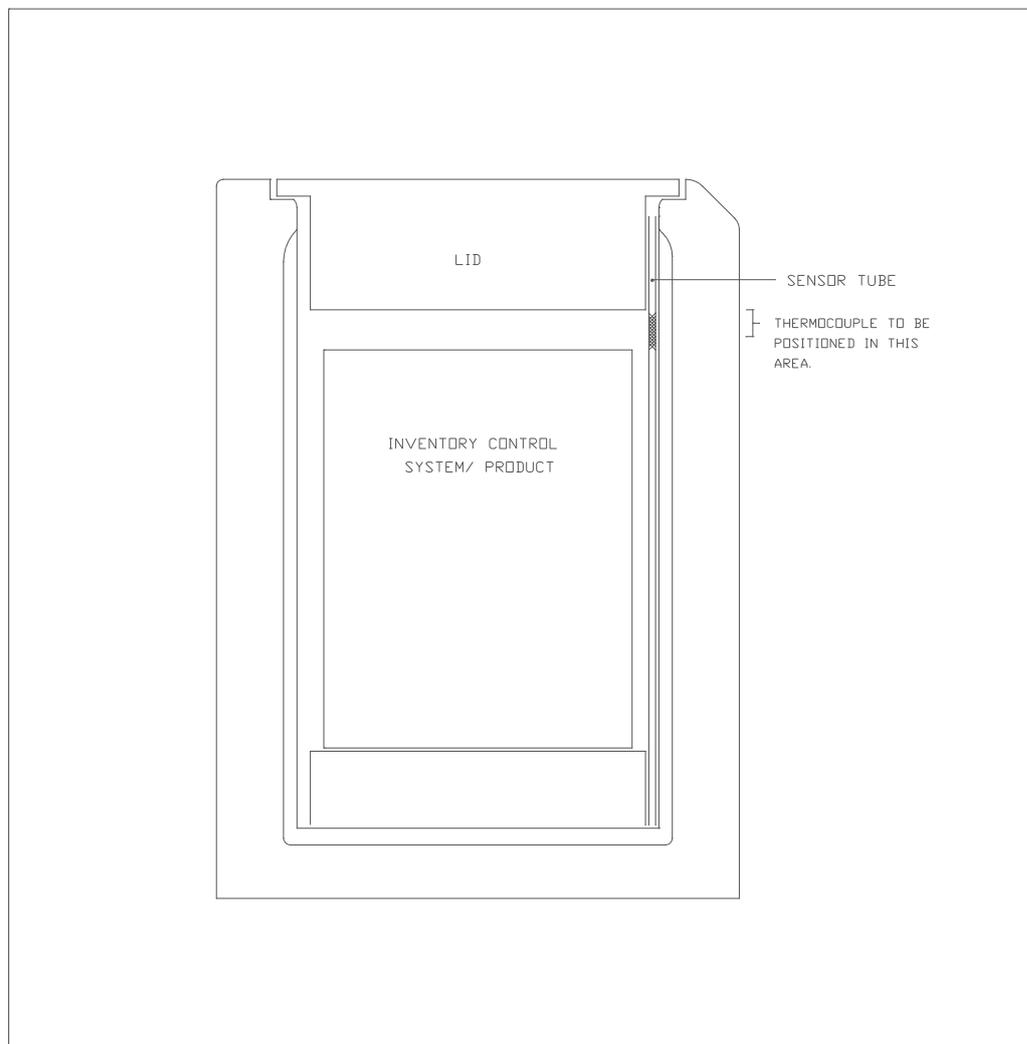


Figure 9 Thermocouple positioning



Thermocouple Accuracy and Sources of Error

The thermocouple should be accurate to within 3 °C.

The main source of error has been found to be heat leakage from outside the vessel.

The thermocouple is a type T in which the junction is formed between copper and constantin (copper nickel alloy) conductors.

This combination gives good performance at cryogenic temperatures but has high heat conductivity.

If the junction is positioned high in the sensor tube there may be < 20 cm of wire between it and the outside of the vessel and may cause measurement errors.

To overcome this problem it is suggested that the thermocouple is formed into a loop as shown in *Figure 10* before insertion into the sensor tube.

The loop down into the cold gas acts as a buffer between the measuring junction and ambient temperature.

NOTE *The tip of the thermocouple is insulated with a plastic sleeve. If this sleeve becomes detached it is possible for the thermocouple to short to the sensor tube.*

If the temperature readout is incorrect or erratic check that the insulating sleeve is still in place.

Additional Thermocouples (M505CE-2T)

The second thermocouple TC2 may be used as an additional temperature alarm and monitoring point. It does not store data in the log apart from alarm reports.

The second thermocouple is normally disabled and should be activated via the ENGINEER MENU if required.

Positioning of the second thermocouple is dependent on individual customer requirements.

Contact Worthington Industries or your distributor for queries and advice.

Other Thermocouple Types

NOTE *The M505CE Controller is optimised for use with type T thermocouples and other types should not be substituted.*

It may be possible to obtain a calibration in ice and liquid nitrogen but the temperature compensation and linearisation of the controller will not match, resulting in errors.

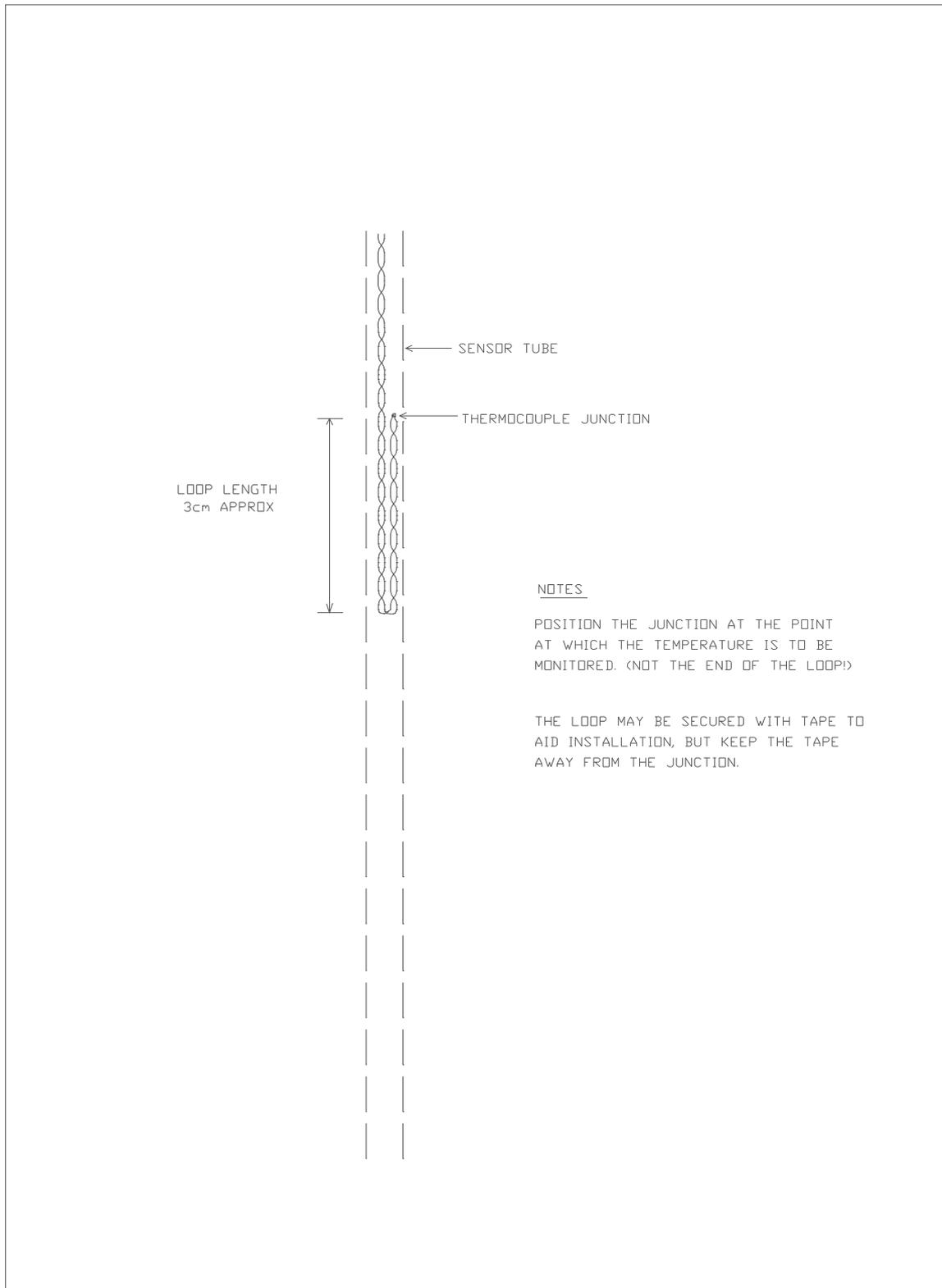


Figure 10 Suggested Form of Thermocouple for Vapour Phase Storage



Appendix E - REMOTE ALARM CONNECTIONS

Installation as well as all associated inspections should only be performed by qualified persons:



These persons are qualified due to their special education and their practical experiences, in particular with regard to the relevant legislation and standards, to recognize the potential impact and hazards and to assess the necessary measures.

A changeover relay contact is provided (Terminals 12, 13 and 14 of the M507CE) to facilitate reporting of an alarm condition at a point remote from the refrigerator.

In the 'good' condition the relay is energised, i.e. the Normally Open (NO) contact is closed and the Normally Closed (NC) contact is open.

If the remote alarm is activated or there is a power failure the relay is released and the contact changes over.

Connections to alarm or monitoring systems must not exceed 2 Amps at 50V AC/DC (resistive load) for safety reasons.



Appendix F - SIMULTANEOUS AND SEQUENTIAL FILLING

Installation as well as all associated inspections should only be performed by qualified persons:



These persons are qualified due to their special education and their practical experiences, in particular with regard to the relevant legislation and standards, to recognize the potential impact and hazards and to assess the necessary measures.

Simultaneous Filling

Where two or more K SERIES Cryostorage Systems are connected to the same liquid nitrogen supply, economies in the use of nitrogen may be realised by synchronising the filling of the refrigerators.

This reduces the number of fill cycles required and hence the losses due to nitrogen being trapped in the common supply pipework and vented at the end of a fill cycle.

To use this feature connect the FILL terminals of the M507CEs using 2 core cable, ensuring that + is connected to + and - to - , as shown in *Figure 11*.

Whenever a refrigerator in the connected group starts to fill a signal is sent to all the others.

This causes them to start a fill cycle if they are not already full.

Up to 20 refrigerators may be connected together in this way.

Make sure however that the supply pressure is adequate to complete filling in a reasonable time.

If not, a supply alarm may be generated by one or more of the controllers.

For large installations it may be better to connect the refrigerators in two or more groups.

The best groupings will depend upon pipework layout.

Alternatively, 'Delayed Sim Fill' may be used to cause the refrigerators to fill in sequence.

Sequential Filling

If the liquid nitrogen supply pressure is insufficient to fill several refrigerators at once it may not be possible to perform Simultaneous Filling.

Sequential Filling may be used to overcome this problem.

This feature minimises the number of times the pipework is filled with LN2 by filling the refrigerators one after another in sequence.

This should give savings in the use of LN2 similar to those achievable with simultaneous filling.

Wiring details for Sequential Fill are shown in *Figure 12*.



The normally open contact of the auxiliary relay on each refrigerator is connected to the External Fill terminals of the next refrigerator in the system. The auxiliary relay contact of the last refrigerator in the system is connected to the External Fill terminals of the first to form a loop.

When a refrigerator requires filling it opens its solenoid valve and fills to the High level sensor. When the liquid reaches the High sensor, filling is terminated and the auxiliary relay is energised for approx. 10 seconds. This starts the fill cycle for the next refrigerator.

The fill signal is passed on from one refrigerator to the next until it reaches the originating refrigerator.

To prevent the fill signal from being passed around the loop forever a timer in each controller terminates the sequence if it receives an external fill signal within 10 hours of the previous one.

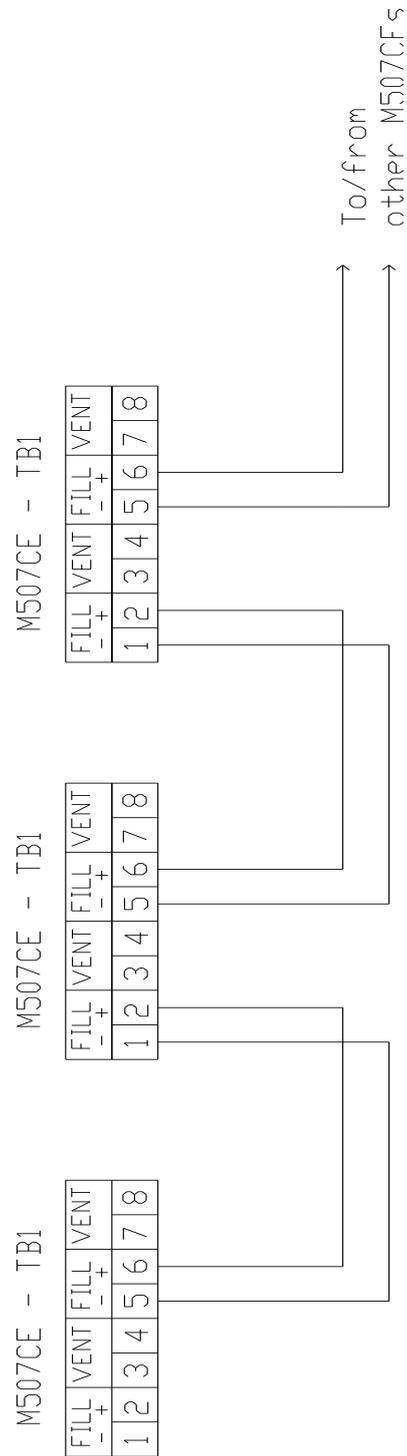


Figure 11 Connection for Simultaneous Filling

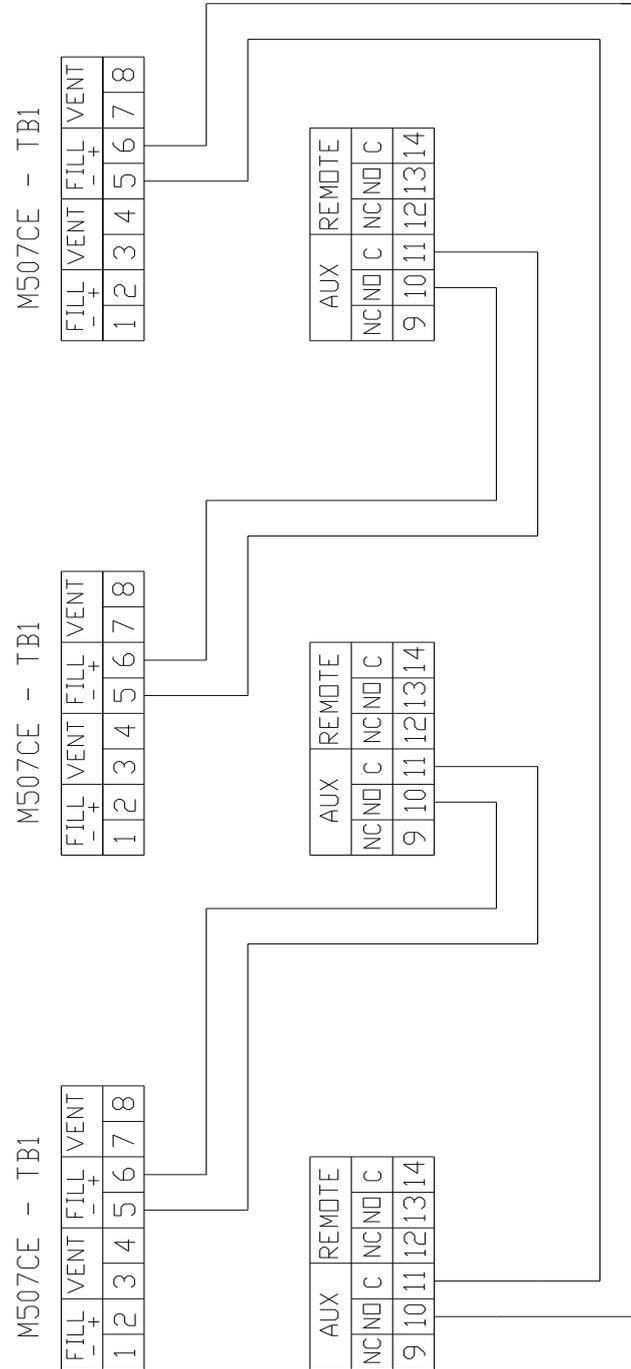


Figure 12 Connection for Sequential Filling



Appendix G - CONNECTIONS FOR GAS VENTING

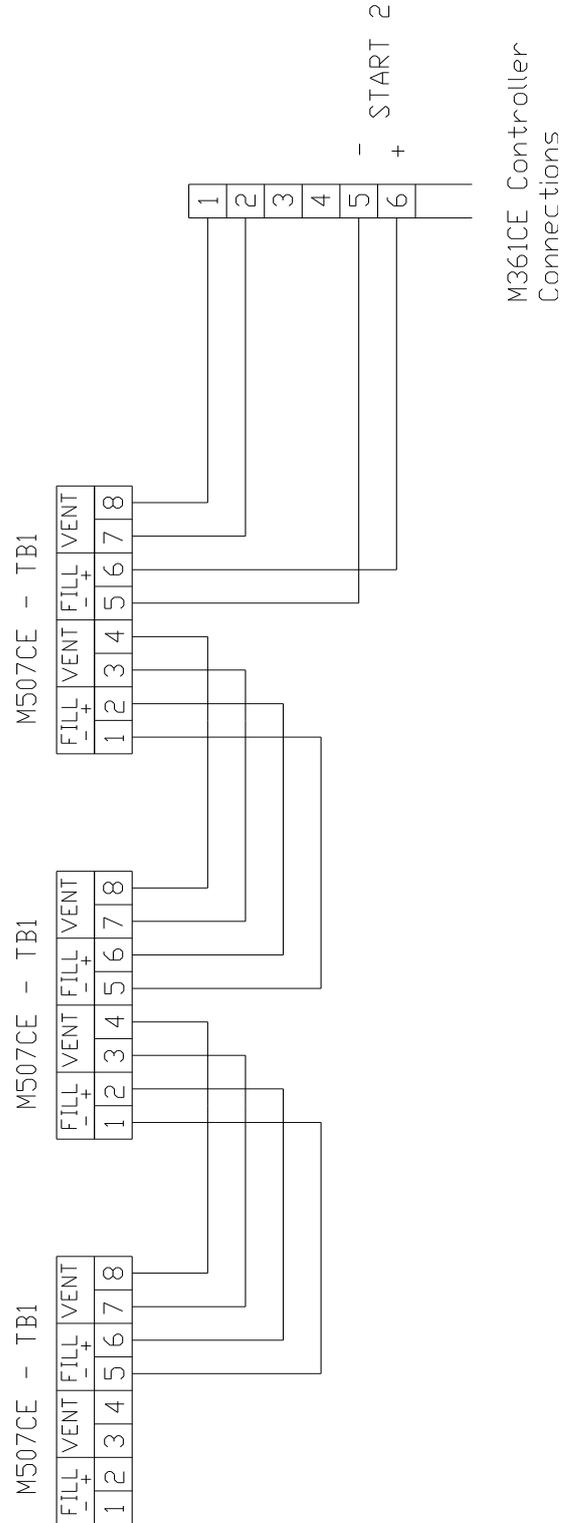


Figure 13 Connection for Gas Venting



Appendix H - ALARMS AND EVENTS

This is a summary of the possible alarms and events that can be reported by the liquid nitrogen level control system. The Alarm/Event code is a number which is inserted into the data log to identify the nature of the alarm condition or the event.

Printed/Displayed Text	Alarm/Event Code (hex)
*** HIGH TEMPERATURE ***	01
*** LID OPEN ***	02
*** LEVEL EXTRA LOW ***	03
*** LEVEL EXTRA HIGH ***	04
*** SENSOR SHORT (EXTRA LOW) ***	05
*** SENSOR SHORT (NORMAL) ***	06
*** SENSOR SHORT (HIGH) ***	07
*** SENSOR SHORT (EXTRA HIGH) ***	08
*** SENSOR OPEN (EXTRA LOW) ***	09
*** SENSOR OPEN (NORMAL) ***	0A
*** SENSOR OPEN (HIGH) ***	0B
*** SENSOR OPEN (EXTRA HIGH) ***	0C
*** NO LN2 SUPPLY (FILL TIMER) ***	0D
*** WARNING - CHECK PRINTER ***	0E
*** THERMOCOUPLE OPEN ***"	0F
*** EXTERNAL FILL INPUT S/CCT ***	10
*** UNAUTHORISED ACCESS ***	11
*** GAS BYPASS THERMOCOUPLE FAULT ***	12
*** NO LN2 (GAS BYPASS TIMER) ***	13
*** GAS BYPASS FAULT - VALVE OPEN? ***	14
*** REMOTE ALARM ***	18
* LID OPENED *	19
* LID CLOSED *	1A
* FILL START *	1B
* FILL STOP *	1C
* POWER OFF *"	1D
* POWER ON *	1E
* SYSTEM RESET *	1F
* ALARMS CLEARED *	20
* POINTER ERROR *DATA LOG CLEARED *	21
** LID OPENED BY SUPERVISOR **	29

NOTE 1



* LID OPENED - OPERATOR No. 2 *	2A	
* LID OPENED - OPERATOR No. 3 *	2B	
* LID OPENED - OPERATOR No. 4 *	2C	
* LID OPENED - OPERATOR No. 5 *	2D	
* LID OPENED - OPERATOR No. 6 *	2E	
* LID OPENED - OPERATOR No. 7 *	2F	
* LID OPENED - OPERATOR No. 8 *	30	
* FILL START (Manual) *	32	
* FILL START (Auto)	33	
* FILL START (External)	34	
* FILL START (Defog/Chill)	35	
* FILL START (Temp Control)	36	
* FILL START (PC)	37	
* FILL START – (Timed Auto Fill)*	38	
* FILL STOP (Manual)	39	
* FILL STOP (Auto)	3A	
* FILL STOP (Defog/Chill)	3B	
* FILL STOP (Temp Control)	3C	
* FILL STOP (PC)	3D	
* FILL STOP Time out (no LN2)	3E	
* TIMER/SETTING CHANGED		NOTE 2
Battery Backup	24	
Settings Restored from Flash	25	
Data recovery	26	

NOTE 1: This alarm is displayed but not recorded in the data log

NOTE 2: If PASSWORD PROTECTION is enabled, a record is inserted into the data log whenever a setting is changed. In the report this will appear as (example):

dd/mm/yy hh:mm *Timer/Setting Changed* Fill timer (01) was 15 minutes, now 20 minutes



Appendix I - ALARMS OVERVIEW

Alarm Name	Alarm Description	Behaviour in Alarm Condition	Attention required	Priority	Range	Default	Notes
High Temperature (TC1)	Thermocouple TC1 higher than pre-set temperature	No change	Immediate	High	-80 to -175°C	-130°C	
Lid Open	Lid open for longer than pre-set time	No change	Immediate	High	0-30min	15 mins	
Level Extra Low	LN2 Level below Ex Low Sensor	No Change	Prompt	High	N/A	N/A	
Level Extra High	LN2 Level at or above Ex High Sensor (Overfill)	H/w interlock forces fill valve off	Immediate	High	N/A	N/A	Can be caused by mechanical failure of valve.
Sensor Short (Extra Low)	Sensor is short cct or low resistance (<10Ω)	Switches fill on	Prompt	High	N/A	N/A	Depending on level condition a false level may be reported. Sensors are low resistance at ambient but not a known failure mode.
Sensor Short (Normal)		Switches fill on	Prompt	High	N/A	N/A	
Sensor Short (High)		Fill stays on once triggered.	Prompt	High	N/A	N/A	
Sensor Short (Extra High)		Ex high not reported	Prompt	High	N/A	N/A	
Sensor Open (Extra Low)	Sensor is open cct or high resistance (>60KΩ)	No change	Prompt	High	N/A	N/A	Depending on level condition a false level may be reported.
Sensor Open (Normal)		Vessel will not fill until Ex Low	Prompt	High	N/A	N/A	
Sensor Open (High)		Vessel will not fill	Prompt	High	N/A	N/A	
Sensor Open (Extra High)		False extra high alarm	Prompt	High	N/A	N/A	
No LN2 Supply (Fill Timer)	Failed to fill to high level within pre-set time limit	Fill switches off or remains on depending on menu settings	Prompt	High	0 – 90min	60 mins	
Thermocouple	Thermocouple is	Bad temperature	Prompt	High	N/A	N/A	



Instruction Manual

K SERIES Cryostorage System

IM: CryoCeK
Revision: 02
Approved by: CB
Page 85 of 87

Alarm Name	Alarm Description	Behaviour in Alarm Condition	Attention required	Priority	Range	Default	Notes
Open (TC1)	open circuit or disconnected	reading (4 dashes on display)					
External Fill Input S/cct	Short cct or polarity reversal on Ext Fill line.	Sim Fill and Gas Bypass disabled	Prompt	High	N/A	15mins	Fixed No adjustment.
Unauthorised Access	Lid opened without PIN code entry	No change	Prompt	High	N/A	N/A	Alarm must be re-set by supervisor
Gas Bypass Thermocouple Fault	Thermocouple is open circuit or disconnected	Local gas bypass will not function	Prompt	High	N/A	N/A	M507CE-I only
No LN2 (Gas Bypass Timer)	Liquid not detected at vent valve within pre-set time limit.	No Fill until liquid detected. Continue venting	Prompt	High	0-60min	30 mins	M507CE-I only
Gas Bypass fault -Valve Open?	Liquid still detected at vent valve after pre-set time.	Vent valve stuck open?	Immediate	High	0-15min	5 mins	M507CE-I only
General Alarm	>20 Intermittent alarms in 24hr period	No Change	Prompt	High	N/A	N/A	Alarms which persist for < Remote timer setting could go undetected without this.
High Temperature (TC2)	TC2 Higher than pre-set temperature	No change	Prompt	High	-80 to -175°C	-130°C	
Thermocouple Open(TC2)	Thermocouple 2 is open circuit or disconnected	Bad temperature reading (4 dashes on display)	Prompt	High	N/A	N/A	
Remote Alarm	Relay released within pre-set time of first alarm	No change	Prompt	High	0-60min	30 mins	Defaults to 5 mins max in case of Ex High Alarm.



Appendix J - OPTIONAL ACCESSORIES

The following accessories are available as optional extras:

- M510CE** Analogue termination kit (for use with M511CE)
- M511CE** Analogue Output PCB (fitted to the main PCB in the Level Controller)
- M512CE** Isolated RS485/RS232 Interface PCB
- M515CE** Printer cable for connection to the M512CE
- M516CE** PC cable for connection to the M512CE
- M517CE** Relay Output PCB. Six relays for individual alarm conditions plus Analogue terminals (for use with M511CE)
- M519CE** PC Cable for connecting a PC to the socket on the Level Controller panel
- M529CE** Ethernet/Internet Interface PCB
- M531CE** Battery pack for maintaining temperature logging during power failures
- M549CE** USB – PC Cable. (USB version of M519CE).
- M507CE-I** Enhanced M507CE with Individual Gas Bypass feature plus RS485 Interface.

NOTE For valid combinations of some accessories see below:

	M510CE	M511CE	M512CE	M517CE	M529CE	Added Function(s)
Standard Controller Type M505CE or M505CE-B	+	+	-	-	-	Analogue Temperature O/P
	-	+	+	-	-	Analogue Temperature O/P + RS485 + RS232
	-	+	-	+	-	Analogue Temperature O/P + Relay Outputs
	-	-	+	-	-	RS485 + RS232
	-	-	-	+	-	Relay Outputs
	-	-	-	-	+	Ethernet Interface
	-	-	-	-	-	Ethernet Interface
M505CE or M505CE-B with M507CE-I	-	+	-	-	-	Analogue Temperature O/P
			RS485 is standard			

NOTE

For a complete list of available accessories and replacement parts for the K SERIES Cryostorage System contact Worthington Industries or your distributor.



Contact Details for the Responsible Organisation

Technical Services / Customer Care:

tel +43 7485 606 286

techservices@worthingtonindustries.com

customerservice@worthingtonindustries.com

lifesciences@wthg.at

www.WorthingtonIndustries.com/LifeSciences