



CRYO FREEZER MANUAL

DO-0001-B

Cryo Freezer Manual

Abeyance Cryo Solutions

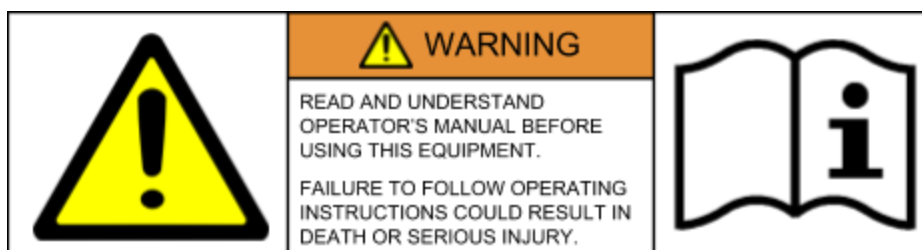
Abeyatech, LLC
2000 N Alliance Ave
Springfield, MO 65803
USA



833-440-2796 | support@abeyancecryo.com | www.abeyancecryo.com

This manual reviews the operation and maintenance of Abeyance Cryo Freezers.

Read before using this equipment. This product is intended for use by trained personnel only. All service and maintenance should be performed by Abeyance or authorized Abeyance representatives.



<i>Revision</i>	<i>Date</i>	<i>Explanation of Changes</i>
A	27 Apr 2018	Initial release
B	30 May 2018	Update part numbers and safety information

Table of Contents

Introduction	5
Safety	6
Liquid Nitrogen (LN2)	6
Frostbite Hazard	6
Asphyxiation Hazard	7
Overpressurization Hazard	7
Pinch and Nip Hazard	7
Product Information	8
Freezer Specifications	8
Control System	9
Plumbing System	10
Facility Requirements	11
Regulatory	11
Environmental	12
Thermal Load	12
Noise Emission	12
Vibrations	12
Decontamination	12
Disposal	12
Installation	13
Uncrating	13
Setup and Initial Fill	14
Settings	15
General Setup Settings	15
Alarm Notification Settings	16
Advanced Settings	16
WiFi Network Settings	17
Default Settings	17
Operation	18
LN2 Vapor Storage	18
Accessing Samples	18
LN2 Level Measurement	19
LN2 Level Control	20

LN2 Usage	21
Temperature Measurement	21
Event Log	22
Cloud Storage	22
Alarm Notifications	22
Battery Backup	23
Preventative Maintenance	24
Troubleshooting	25
Repair Procedures	26
LN2 Transfer Hose Connect / Disconnect	26
Safety Panel Removal	26
Control Cabinet Removal	27
Lid Removal	27
Lid Gasket Replacement	28
Lid Foam Insulation Replacement	28
Pressure Relief Valve Replacement	28
Fill, Purge, and Flush Valve Replacement	29
Isolation Valve Replacement	29
Temperature Probe Replacement	30
Independent Temperature Probe Installation	30
Purge Temperature Probe Replacement	31
Battery Backup Replacement	31
Controller Replacement	31
Power Supply Replacement	32
Fuse Replacement	32
Temperature Probe Calibration Verification	32
Manual LN2 Level Verification	33
LN2 Level Calibration	33
Freezer Decontamination	34
Appendix	35
Spare Parts	35
Altitude - LN2 Temperature Table	36
Temperature - Pt-100 Sensor Resistance Table	36
LN2 Level - Pressure Units Table	37

Introduction

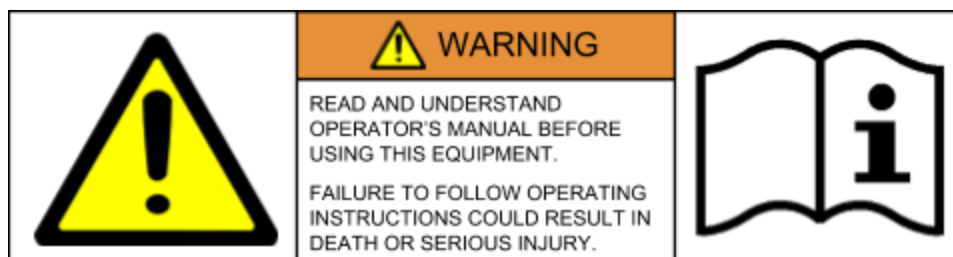
This manual reviews the operation and maintenance of Abeyance Cryo Freezers. Read before using this equipment.

Abeyance Cryo Freezers are designed for safe and efficient storage of biological samples in dry liquid nitrogen (LN2) vapor at -190°C (-310°F). This is a stainless steel, vacuum-insulated, non pressurized Dewar. The control system automatically maintains the LN2 level inside the freezer while monitoring and logging storage conditions. Samples are packaged and placed in racks that are stored inside the freezer within a lazy susan turn tray to allow easy access. The turn tray hangs above a reservoir of LN2 and keeps the samples in a dry storage area. Vaporization of the LN2 reservoir within the insulated freezer provides cryogenic temperatures. LN2 must be regularly replenished in order for the freezer to maintain its cooling function. If LN2 is depleted and not replenished, the freezer will slowly warm and eventually reach ambient temperature.

Certain safety precautions must be followed when working with or handling LN2



Safety



This section reviews the safety guidelines for Abeyance Cryo Freezers. Read before using this equipment. This product is intended for use by trained personnel only. All service and maintenance should be performed by Abeyance or authorized Abeyance representatives.

Liquid Nitrogen (LN2)

Nitrogen is an inert, colorless and odorless gas that forms about 78% of the Earth's atmosphere. LN2 is nitrogen in a liquid state at an extremely low temperature. When properly insulated in cryogenic containers, or Dewars, LN2 can be used as an energy efficient refrigerant for cryopreservation. It is a consumed or depleted refrigerant so additional LN2 must be routinely added to maintain the freezer storage temperature. Certain safety precautions must be followed when handling LN2. UN Number 1977.

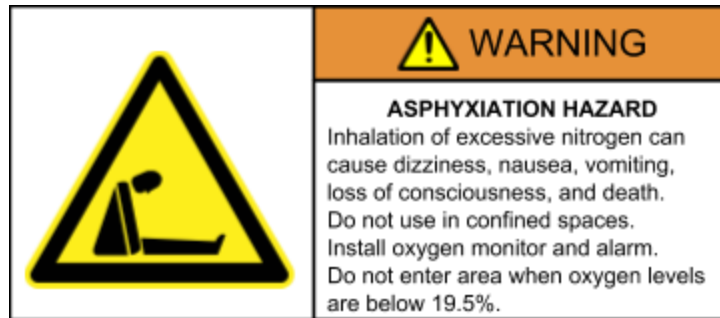
Boiling Point at 1 atm	-195.8°C 77.4 K -320.4°F
Density, Liquid at Boiling Point	1.78 lb/L 50.4 lb/scf 808 g/L 808 kg/m ³
Heat of Vaporization, Liquid	199.1 kJ/kg 85.60 Btu/lb

Frostbite Hazard



LN2 is extremely cold. Contact with LN2, cold nitrogen gas, or cold surfaces can cause frostbite to the eyes and skin. Avoid contact with LN2 and cold surfaces. Always wear proper personal protective equipment as determined by your Health and Human Safety Officer.

Asphyxiation Hazard

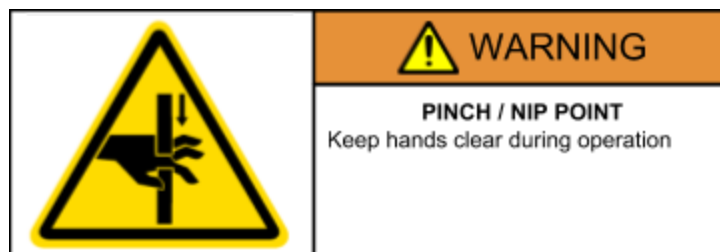


Although nitrogen is nontoxic, it can act as an asphyxiant by displacing oxygen in the air to levels below that required for breathing. Inhalation of excessive nitrogen can cause dizziness, nausea, vomiting, loss of consciousness, and death. Personnel, including rescue workers, should not enter areas where oxygen concentration is below 19.5%, unless equipped with proper breathing apparatus. Oxygen monitors / alarms are recommended for any LN2 setup.

Overpressurization Hazard

Cryo Freezers are non pressurized and vented through the lid into the surrounding environment. The plumbing assembly is equipped with a pressure relief device. All containers, plumbing assemblies, and transfer hoses must be vented to atmosphere or have a pressure relief device present. If an LN2 supply with higher than specified pressure is connected to the freezer, the pressure relief valve will activate, generating flow noise. Long exposure to this noise may cause hearing damage. Nitrogen has a liquid to gas expansion ratio of 1 to 694. Overpressurization can occur if LN2 is trapped in a closed container and can result in death or serious injury.

Pinch and Nip Hazard



Potential pinch and nip point hazards exist on the hinged step, lid, and rotating turn tray if not operated properly. Raise and lower the step and lid with caution. Rotate and stop the turn tray slowly and with caution.

Product Information

Freezer Specifications

	A220	A440	A700	A1000
Outer Diameter - in (mm)	34.0 (864)	45.0 (1143)	55.0 (1397)	65.0 (1651)
Overall Height - in (mm)	58.0 (1473)	59.0 (1499)	60.0 (1524)	65.0 (1651)
Usable Height - in (mm)	30.0 (762)	30.0 (762)	30.0 (762)	30.0 (762)
Step Height - in (mm)	9.5 (241)	10.5 (267)	9.0 (229) x 2	10.0 (254) x 2
Liftover Height - in (mm)	39.5 (1003)	39.5 (1003)	33.0 (838)	33.0 (838)
LN2 Capacity	65 L	150 L	270 L	390 L
LN2 Volume/Level - L/in (L/cm)	12 (30)	22 (56)	33 (84)	45 (114)
Hold Time	> 10 Days	> 15 Days	> 20 Days	> 25 Days
Weight Empty - lbs (kg)	650 (295)	900 (408)	1,250 (567)	1,750 (794)
Weight Working - lbs (kg)	1,150 (522)	1,850 (840)	2,700 (1225)	3,700 (1680)
Weight Max - lbs (kg)	1,400 (635)	2,200 (998)	3,5000 (1588)	5,000 (2268)



Control System

The control system is designed to automatically maintain the freezer LN2 level while monitoring and logging storage conditions. It consists of a custom controller and touchscreen monitor. The main power input and battery backup selector switch are located along the safety panels towards the back of the freezer.

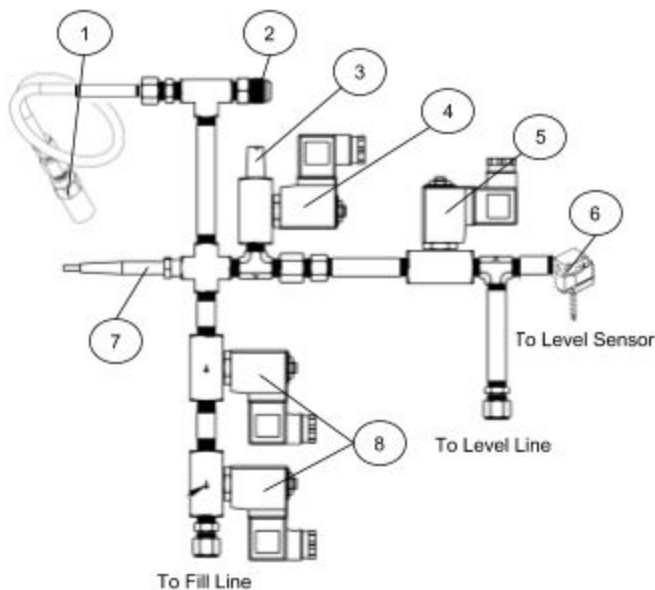


Freezer control system input/output locations

<i>Control System</i>	<i>Specification</i>	<i>Part Number</i>
Controller	30VDC 3A Wireless 2.4 GHz 802.11n USB 2.0 Dry Alarm Contacts NO/NC	XX-0073
Temperature Sensors	2 x Pt-100 RTD -200°C to 70°C $\pm 1.0^{\circ}\text{C}$	EL-0021
Level Sensor	Differential Pressure ± 0.5 in (1.3 cm)	EL-0018
Power Supply	Input: 100-230VAC 50-60Hz Output: 24VDC 3A	EL-0013
Battery Backup	2 x 12VDC 20AH Lead-acid	EL-0011
LED	Cryogenic LED	EL-0020
Lid Switch	Proximity Switch	EL-0001

Plumbing System

The plumbing system safely and efficiently transfers LN2 from the supply system to the freezer and transmits the LN2 differential pressure level signal to the controller. It is installed underneath the top cover, behind the safety panels. The LN2 input and pressure relief valve extend through the safety panels and are accessible along the back of the freezer.



No	Plumbing System	Specification	Part Number
1	Pressure Relief Valve	50 PSI (3.45 Bar)	FT-0009
2	LN2 Input	CGA-295	FT-0007
3	Purge Muffler	Sintered Bronze Muffler	FT-0020
4	Purge Valve	24VDC 52 ohms Normally Closed PTFE Seal	FT-0015
5	Flush Valve	24VDC 52 ohms Normally Closed PTFE Seal	FT-0015
6	Isolation Valve	24VDC 1,650 ohms Normally Open	FT-0022
7	Purge Temp Sensor	Pt-100 RTD -200°C to 70°C ±1.0°C	FT-0004
8	Fill Valves	2 x 24VDC 52 ohms Normally Closed PTFE Seal	FT-0015

Facility Requirements

	A220	A440	A700	A1000
Space Required L x W x H - in (mm)	34.0 x 45.0 x 78.0 (864 x 1143 x 1956)	45.0 x 55.0 x 79.0 (1143x1397x2007)	55.0 x 65.0 x 80.0 (1397x1651x20302)	65.0 x 75.0 x 81.0 (1651x1905x5057)
Max Floor Load lbs/ft ² (kg/m ²)	378 (1846)	352 (1719)	322 (1572)	305 (1490)
Electrical	100-230VAC 50-60Hz 0.7A continuous, 2.9A full load			
LN2 Supply	22-35 PSI (1.5-2.4 Bar) CGA-295			
Ventilation	General laboratory air change rate minimums are typically sufficient for LN2 freezer installations; however, consult your Health and Human Safety Officer or equivalent group			
Oxygen Monitoring	Oxygen monitoring and alarms are recommended for any LN2 setup			
Temperature	Near room temperature, 18°-27°C (65°-80°F)			
Relative Humidity	Less than 50%, non condensing			
Seismic Restraint	Seismic restraints may be required in earthquake prone areas. Please follow local standards and regulations. Contact Abeyance for more information.			

Regulatory

Abeyance Cryo Freezers meet the following safety requirements conforming to:

UL STD 61010-1, CSA STD C22.2 # 61010-1, Low Voltage Directive (2014/35/EU)

Environmental

Thermal Load

Freezer thermal load is negligible with no mechanical refrigeration. Vaporization of LN2 within the insulated freezer provides cryogenic temperatures.

Noise Emission

Freezer noise emission is negligible with no mechanical refrigeration. Flow noise is generated by the pressurized LN2 supply when relief valves release excess pressure or when the freezer is purging or filling. A purge muffler is included to suppress flow noise while the freezer is purging, but the freezer is not the sound source.

Vibrations

Freezer does not generate vibrations or environmental vibration hazards.

Decontamination

Freezers are designed for the safe and efficient storage of biological material at cryogenic temperatures. The freezer must be properly decontaminated prior to freezer shipment or disposal. Please refer to the decontamination repair procedure RP20.

Disposal

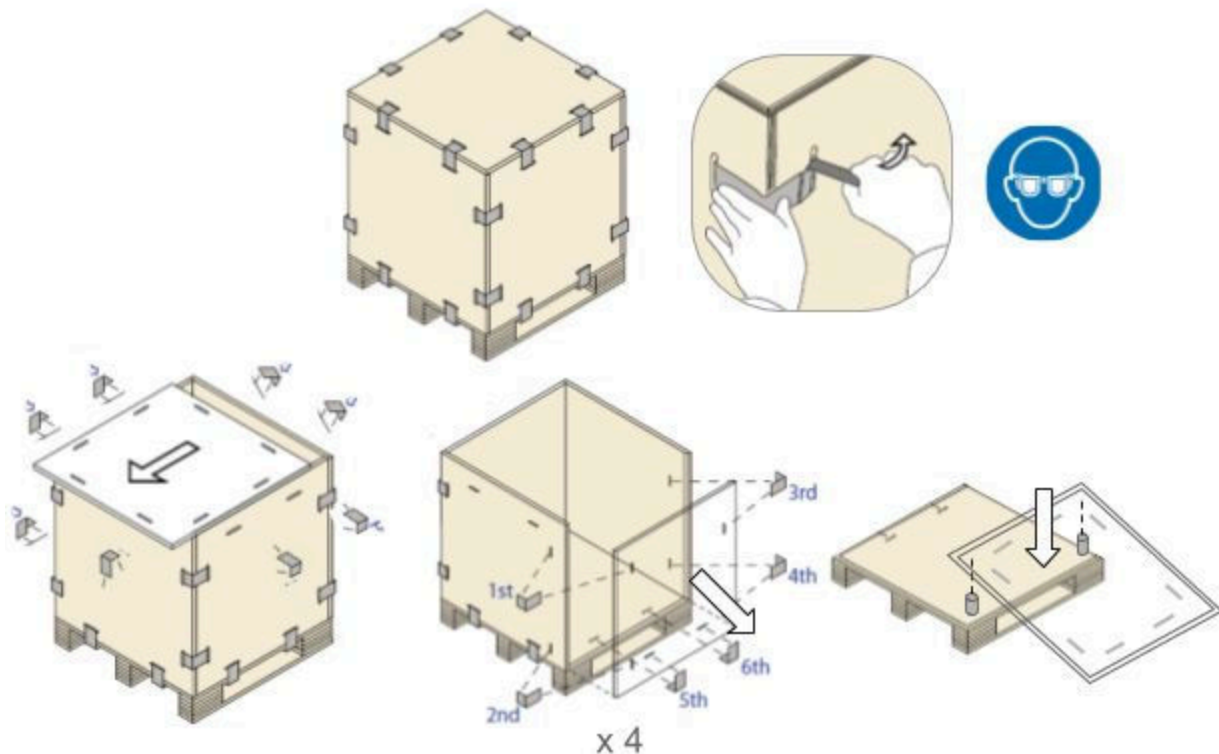
Battery backup consists of two, 12VDC, 20AH, lead-acid batteries. These and other electronic components such as the freezer control system should be properly recycled or disposed of according to local regulatory guidelines. The freezer itself is a stainless steel, vacuum insulated vessel with an aluminum inner turn tray. Once freezer has been decontaminated and any prohibited components removed, the freezer may be disposed of or recycled according to local regulatory guidelines.

Installation

Uncrating

The reusable, snap together quick crate reduces, time, waste, and cleanup. The empty crate can be flat packed and efficiently stored or shipped back to be reused. Always inspect the freezer crate for damage and verify the bill of lading prior to accepting the shipment.

1. Locate the clip remover tool stored underneath one of the clips.
2. To remove, cover the clip with your hand and carefully rotate the tool towards the center of panel to pry loose both the clip and the tool.
3. To remove remaining clips, insert the tool into the clip raised pocket, cover the clip with your hand and carefully rotate the tool towards the center of the panel.
4. Start with the top panel and proceed with the side panels.
5. Place the reinforced side panel ramp so the locating holes align with those on the skid and insert the mounting pins.
6. Unbolt wheel blocks from caster bracket then reattach the caster bracket nuts.
7. Unlock the wheel brakes and carefully roll the freezer down the ramp.
8. Flat pack crate and store or ship back to be reused.



Setup and Initial Fill

Abeyance Cryo Freezers arrive ready for a plug and play setup. The control system is preinstalled with temperature and level sensors factory calibrated. A convenient initial fill routine avoids nuisance alarms as the freezer cools down. The initial fill takes longer and uses more LN2 than a normal fill. The freezer should be installed in an area appropriate for LN2 service with adequate ventilation, oxygen monitoring, and an even floor with sufficient load support. Please see the Safety and Facility Requirements section of the manual for more information.

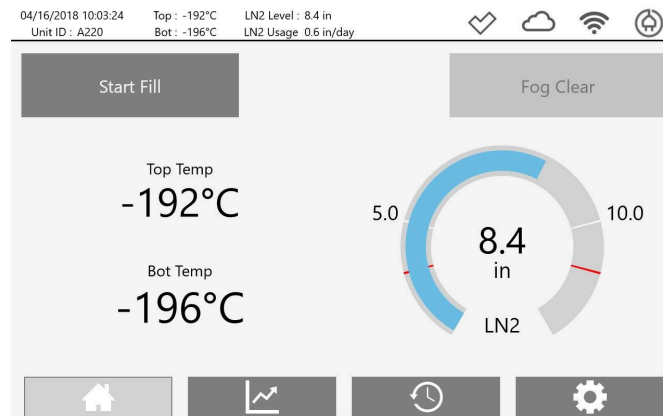


Following the initial fill, normal controller operation will continue to maintain LN2 levels while monitoring and logging storage conditions. Allow the freezer to cool for 48 hours prior to introducing samples. Routinely verify freezer LN2 Level and ensure sufficient LN2 supply volume and pressure.

	A220	A440	A700	A1000
LN2 Needed for Initial Fill and Cool Down	180 L	230 L	410 L	460 L

Settings

The Home page displays the current freezer status and storage conditions. Freezer temperatures and LN2 level are predominantly displayed. The header includes the date, time, freezer ID, temperatures, LN2 level, and usage. Status indicator icons for alarms, cloud, WiFi, and main power turn red signaling an issue. Touching the alarm indicator will open the alarm status window and display any current alarms. Touching the WiFi indicator will provide the freezer IP address. The other main pages are Graphs, Event Log, and Settings.



Home Page

General Setup Settings

General freezer setup parameters can be adjusted by navigating to the Settings page General Setup tab. These include display units, timers, temperature alarm and LN2 level setpoints. The LN2 level alarms are automatically placed 0.5 in (1.3 cm) above the High Level Fill and below the Low Level Fill. The Maximum Fill Time and Maximum Purge Time set points should be tailored to each installation and LN2 supply setup. Password is required to change any settings.

The Settings Page: Setup Tab interface displays the following configuration options:

- Header:** 04/16/2018 10:06:18, Unit ID: A220, Top: -192°C, Bot: -196°C, LN2 Level: 8.4 in, LN2 Usage: 0.6 in/day. Status icons for alarm, cloud, WiFi, and power are shown.
- Tabs:** Setup (selected), Alarms, Advanced, and Network.
- Temperature:** Units set to °C. Top Temp Alarm: -150, Bot Temp Alarm: -150, Purge Temp Setpoint: -50. Current Purge Temp: 18°C.
- LN2 Level:** Units set to inches. High Level Fill Limit: 10, Low Level Fill Limit: 5.
- Time (min):** Max Fill Time (1-120): 120, Max Purge Time (0-10): 5.
- Bottom:** Password field with a mask and a "Save Config" button.
- Bottom Navigation:** Home (house icon), Graphs (line graph icon), Event Log (clock icon), and Settings (gear icon).

Settings Page: Setup Tab

Alarm Notification Settings

Setup remote text and email notifications by navigating to Settings Alarm Notifications tab. Choose the specific alarms and enter the phone numbers and/or email addresses to receive notifications. Controller must be connected to WiFi for remote alarm notifications to be sent.

04/16/2018 10:07:00 Top : -192°C LN2 Level : 8.4 in
Unit ID : A220 Bot : -196°C LN2 Usage 0.6 in/day

Setup Alarms Advanced Network

Remote Alarm Notifications

Usage Alarm ☒

Max Fill Time ☒

High Level ☒

Low Level ☒

High Temp ☒

Lid Switch ☒

Battery In Use ☒

Stuck Valve ☒

Alarm Notifications example: 12223334444

Cell Phone1 (Text)

Cell Phone2 (Text)

Cell Phone3 (Text)

Email1

Email2

Email3

UnitName A220

Password X

Needs Saved!

Settings Page: Alarm Notifications Tab

Advanced Settings

On the Advanced Settings tab you can set passwords, restart the app and monitor, send a test alarm notification, manually flush the level line, and retrieve the freezer serial number and controller versions.

A four digit numerical password is required to change any settings. Three unique passwords can be setup and assigned to different users. These can be added or changed by navigating to the Settings Advanced Settings tab.

04/16/2018 10:07:10 Top : -193°C LN2 Level : 8.3 in
Unit ID : A220 Bot : -196°C LN2 Usage 0.6 in/day

Setup Alarms Advanced Network

Restart HMI App

Restart HMI

Shutdown HMI

Send a Test Text Message

Level Sensor Line Flush

Admin Password

User1 Password

User2 Password

HMI Version 1.1.188.0

PLC Version 0.0

Serial Number

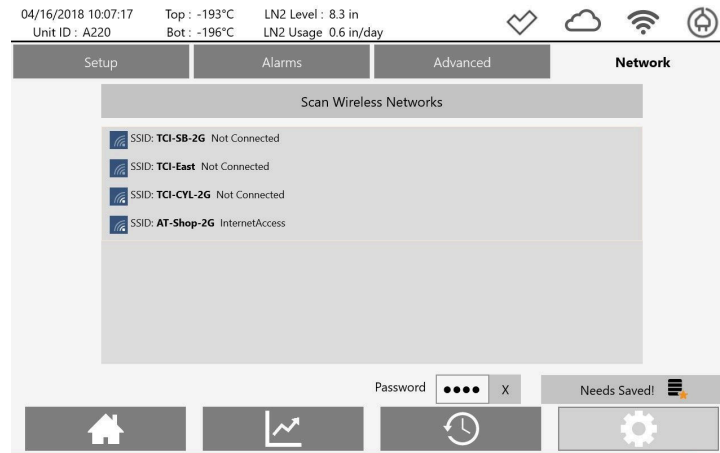
Password X

Needs Saved!

Settings Page: Advanced Settings Tab

WiFi Network Settings

Connect to a WiFi network by navigating to the Settings Network tab. Scan for wireless networks, select a network and enter the security key if required.



Settings Page: WiFi Network Tab

Default Settings

Each freezer comes preloaded with default settings tailored to vapor storage. Temperature sensors are placed at the top and bottom of the storage space to capture the full range of sample temperatures. Verify and adjust these settings as needed.

Default Setting	A220	A440	A700	A1000
Low Level Fill - in (cm)	5.0 (12.7)	7.0 (17.8)	9.0 (22.9)	11.0 (27.9)
High Level Fill - in (cm)	7.0 (17.8)	9.0 (22.9)	11.0 (27.9)	13.0 (33.0)
High Level Alarm - in (cm)	High Level Fill +0.5 in (1.3 cm)			
Low Level Alarm - in (cm)	Low Level Fill -0.5 in (1.3 cm)			
High Temperature Alarms	-150°C			
Fill Time Alarm	60 min			
Purge Time	5 min			
Purge Temp	0°C			
Temp Level Units	°C in			
Password	8888			

Operation

LN2 Vapor Storage

Cryopreservation is the storage of material below -135°C (-211°F) in order to provide longevity to biospecimens. Around -135°C is referred to as the glass transition point (T_g) of polyol's water solution. It is generally accepted that below T_g , biological activity essentially ceases. At these temperatures, enzymatic activity slows to a stop while frozen water molecules inside cells can no longer move freely and participate in chemical reactions. Current best practices recommend dry storage below -150°C in LN2 vapor for a significant safety margin and to reduce the risk of cross contamination between samples. Properly preserved samples can be retrieved after decades of storage, successfully reanimated, and be virtually the same physiologically as the day they were frozen.

When properly insulated in cryogenic containers, or Dewars, LN2 can be used as an energy efficient refrigerant for cryopreservation. It is a consumed or depleted refrigerant so additional LN2 must be routinely added to maintain the freezer storage temperature. If LN2 is depleted and not replenished, the freezer will slowly warm and eventually reach ambient temperature.

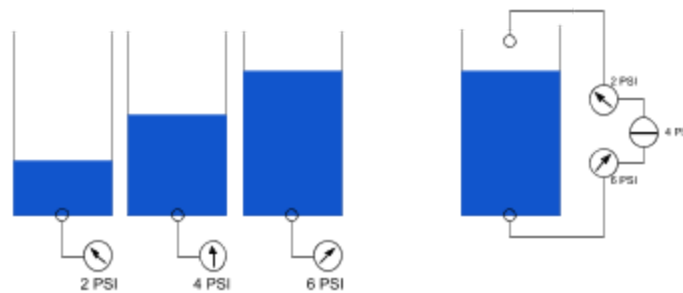
LN2 is piped into the freezer from a pressurized supply system so that it fills the freezer from the bottom up. The control system automatically maintains the LN2 level inside the freezer while monitoring and logging storage conditions. A freezer typically requests additional LN2 once or twice a week to top itself off in order to keep enough LN2 in the reservoir to hold temperature for up to several weeks. The sample turn tray hangs above this reservoir of LN2 and keeps the samples in a dry vapor storage area. Vaporization of the LN2 inside the insulated freezer provides cryogenic temperatures with a very small temperature gradient of only $\pm 3^{\circ}\text{C}$.

Accessing Samples

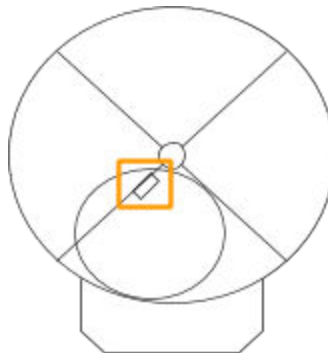
Samples are packaged in containers and racks and then placed in the freezer turn tray storage area through the offset lid opening. The turn tray should be rotated and stopped slowly to avoid any nip or pinch hazards. The folding step, handle, offset opening, and hinged lid make accessing samples easy. Carefully lower and raise the folding step to avoid any pinch hazard. Carefully open and close the lid to avoid any pinch hazard. Sufficient work space is available for transfer units to pick and place or identify samples, etc., while properly maintaining the cold chain. When the lid is opened, fog clear is initiated and a cryogenic LED illuminates the freezer interior for visibility. Even with the lid left open, the freezer temperature will maintain well below -150°C . LN2 usage will increase because of the additional heat input, so a five minute lid open alarm is included to help avoid energy waste. The turn tray is easily rotated in either direction by hand to bring the target storage location to you so the sample can be pulled or placed directly up or down. Each freezer lid includes a locking tab so that access to the freezer contents can be restricted with a clasp type lock.

LN2 Level Measurement

A differential pressure system is used to measure the LN2 level inside the freezer. This system is based on the principle that the pressure generated by a fluid column is proportional to the depth of that fluid column. The difference between the pressure measured at the inside bottom of the freezer and atmospheric pressure will determine the pressure generated by the LN2. This is then displayed as inches or centimeters of LN2. Once every 24 hours, a level sensing line flush occurs using LN2 supply pressurized gas to ensure the differential pressure signal is unobstructed. This differential pressure system allows for an accurate and reliable method of monitoring the LN2 level.



Manual confirmation of the LN2 level is performed with the provided measuring stick. A measuring channel is included along the turn tray divider that allows you to insert the measuring stick all the way down to the bottom of the freezer. Fully insert the measuring stick and wait approximately 10 seconds. Carefully remove the measuring stick and observe the LN2 frost line. Subtract 0.5 in (1.3 cm) to account for rapid boiling of the LN2 to obtain your LN2 level.



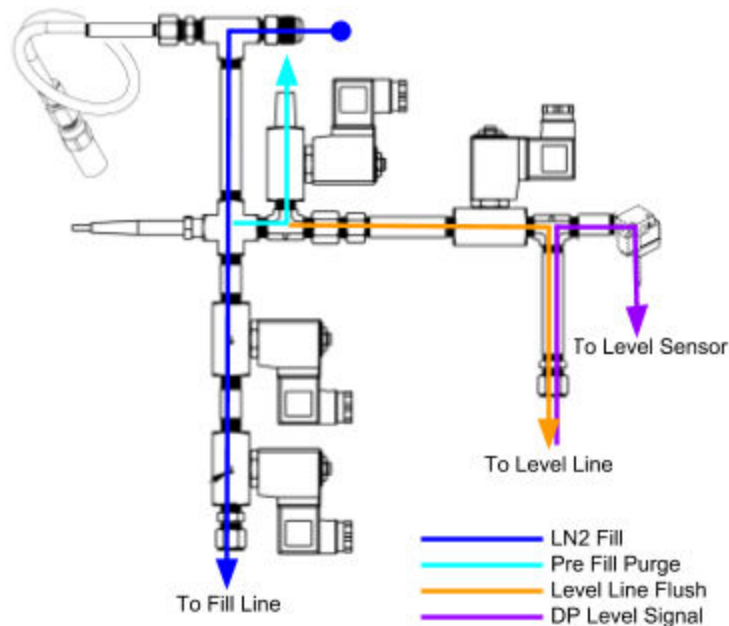
Measuring channel for manual LN2 level confirmation located along freezer divider

Abeyance Cryo Freezers feature a second, redundant LN2 level line. This can be used for independent, third party level monitoring, troubleshooting or in the event of a main line blockage. This second annular line is offset from the main lines, located higher up in the freezer.

LN2 Level Control

The LN2 level is automatically maintained by the control system. The user defined High Fill and Low Fill set points determine when the freezer requests LN2. Each freezer is shipped with default level settings tailored to vapor storage for each model. These setpoints are easily adjusted from the controller interface. Alarm thresholds are automatically placed at 0.5" (1.3 cm) above the High Fill and 0.5" (1.3 cm) below the Low Fill set point. These alarms are to notify the user to take corrective action if the LN2 level ever gets outside of the set range.

Following the initial fill, the LN2 level will slowly decrease as LN2 boils off until the Low Fill setting is reached. Prior to starting the fill, a prefill purge is initiated to exhaust warm gas from the freezer plumbing and supply lines. This system helps reduce the fill time and long term LN2 consumption. The freezer purge valve opens allowing pressurized air and nitrogen gas to exit the purge muffler at the back of the freezer. It can take several minutes of purging, depending on the supply setup, before the plumbing and supply lines are cold enough to support LN2 flow. The exhaust temperature is monitored and when it cools down to its setpoint, the LN2 supply lines are primed and ready to deliver LN2. The purge valve then closes and the fill valves open allowing LN2 to flow into the freezer. LN2 is piped into the freezer so that it fills from the bottom until the High Fill setting is reached and the freezer fill valves close. This process is repeated to maintain the appropriate operating LN2 level range.



Plumbing system flow diagram showing fill, pre fill purge, level line flush, and level signal

During a fill, the LN2 vapor is vented through the lid gasket, directed underneath the top cover and out the safety panel towards the back of the freezer. Some condensation around the lid, LN2 input, and safety panel vents while filling is normal. Persistent, excessive, or patterned condensation and frost along the body of the freezer could be indicative of an insulation issue and should be addressed.

Fill functionality is intentionally disabled or paused under certain circumstances for user safety and convenience:

- When the LN2 level is displayed as 0.0" (0.0 cm), automatic fill is disabled:
 - to avoid unexpected filling during initial startup
 - to avoid a potential overfill if level sensing fails
 - "Start Fill" must be touched to initiate automatic or initial fill
- When the LN2 level is at or above High Fill, fill is disabled:
 - to avoid a potential overfill
 - Fog Clear will continue to function, but the freezer will not fill
- "Stop Fill" is touched while the LN2 level is at or below the Low Fill, automatic fill is temporarily paused and will resume in 15 minutes:
 - to allow time to change or address LN2 supply and avoid unintentional filling
 - Touching "Start Fill" will override this pause and resume automatic fill
- When running on battery backup, automatic fill is disabled:
 - to save power and maximize battery backup monitoring life
 - Touching "Start Fill" or "Fog Clear" will still initiate a fill or fog clear

LN2 Usage

The insulated freezer is designed to minimize heat transfer in order to efficiently maintain cryogenic temperatures for an extended period of time. The LN2 usage provides a running average of the rate of LN2 boil off. An LN2 usage alarm is triggered if there is a significant increase in the LN2 consumption, which could possibly be indicative of a freezer insulation issue. Several things can impact the short term LN2 usage such as introducing warm racks, leaving the lid off for an extended period, etc., but corrective action may be required if the LN2 usage steadily increases and does not return to its baseline value. The LN2 Usage is displayed and the alarm is initiated when the usage doubles within a 24-hour period.

Temperature Measurement

The freezer temperature is measured and controlled through the presence and vaporization of LN2 inside the insulated freezer. RTD temperature sensors are placed at the top and bottom of the sample storage area. The resistance output of these sensors is directly correlated to their temperature. This output is displayed as °C or °F on the controller and recorded in the event log.

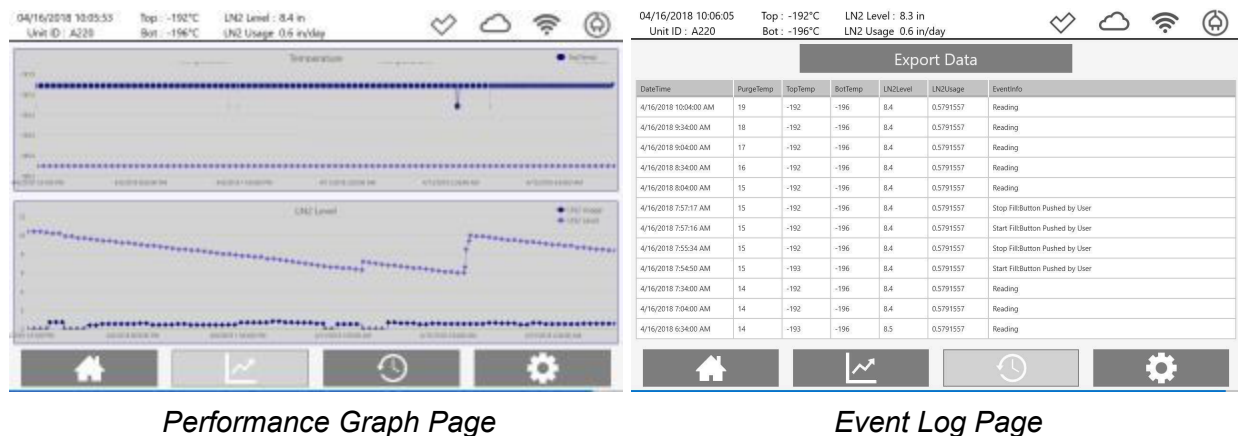
The freezer is setup to accommodate an independent, third party temperature sensor for redundancy and further sample security. The temperature sensor can be installed by removing

the center plug in the top cover, loosening the retaining cap, inserting sensor, retightening retaining cap and reinserting the plug according to RP11.

Event Log

The freezer storage conditions are logged and displayed in the controller event log. This time stamped event log provides an unalterable electronic history of freezer performance for traceability, record keeping, and troubleshooting.

The most recent two week event log can be viewed on the Event Log page and is graphically displayed on the Graphs page. The entire event log can be easily exported as a .csv file from the Event Log page and saved to a USB flash drive, emailed to a designated address, or sent directly to Abeyance tech service. The USB port is located on the back of the monitor housing. The freezer must be connected to WiFi for the event log to be emailed or pushed to the cloud.



Cloud Storage

When connected to a WiFi network, the controller will automatically push data to the Microsoft Azure Cloud. This additional level of security and data storage allows for remote access, analysis, and custom reporting options to help simplify managing the regulatory environment.

Alarm Notifications

All alarm conditions are accompanied by an audible buzzer and visual alerts on the monitor and alarm beacon. The audio/visual alerts can be silenced for five minute intervals, but will resume unless the alarm condition is corrected. Remote notifications can be sent via text and/or email when connected to WiFi. Normally open and normally closed dry alarm contacts are also provided on the back of the controller cabinet. The alarm status window opens anytime an alarm is initiated or resumes after being silenced. Touching the alarm indicator icon will display the alarm status window. This status window lists any current alarm and the time started.



Alarm Notifications: local audio/visual, remote text and email, dry alarm contacts

Alarm	Condition
Top Temp Alarm	Top Temp warmer than Top Temp Alarm setting
Bottom Temp Alarm	Bottom Temp warmer than Bottom Temp Alarm setting
Low Level Alarm	LN2 level below Low Level Alarm setting
High Level Alarm	LN2 level above High Level Alarm setting
Sensor Error	No temperature or level signal; sensor not functioning properly
Valve Stuck Open	Freezer plumbing assembly has not warmed significantly 30 minutes after a fill cycle has ended. Indication of a possible valve stuck open.
Lid Open	Lid left open for more than 5 minutes
On Battery Power	Main power is lost and freezer operating on battery backup
Maximum Fill Time	Fill time exceeds maximum fill time
LN2 Usage	LN2 Usage doubles in a 24 hour period. If usage does not return to baseline value, possible indication of a freezer insulation issue. Take corrective action.

Battery Backup

An onboard battery backup is included with each freezer. When the controller is connected to main power, the battery backup receives a trickle charge. A fully charged battery backup will last approximately 36 hours in monitoring mode. A fully depleted battery will take approximately 8 hours to fully recharge under normal operation. If main power is lost, the freezer will automatically switch to battery power and a “Running on Battery Backup” alarm will be initiated. While running on battery backup, full monitoring, logging, and alarm functionality remain active; however, autofill and auto fog clear are disabled to save power. Manual fill and fog clear are still available, but require touching “Start Fill” or “Fog Clear” on the controller Home page. Filling or fog clearing while on battery power will reduce how long the battery backup will last.

Preventative Maintenance

This is the recommended preventative maintenance schedule for Abeyance Cryo Freezers. Preventative maintenance is performed while the equipment is operating properly to reduce the likelihood of potential failure.

	<i>Weekly</i>	<i>Monthly</i>	<i>Yearly</i>	<i>5 Years</i>	<i>As Needed</i>
Verify Temperature, LN2 Level and Usage	X				
Verify LN2 Supply Volume and Pressure	X				
Inspect for Excessive Frost/Condensation		X			
Check LN2 Connections		X			
Perform Function Test			X		
Verify Temperature Sensor Calibration			X		
Solenoid Valve Replacement				X	
Relief Valve Replacement				X	
Temperature Sensor Replacement				X	
Battery Replacement				X	
Lid Gasket Replacement					X
Thaw, Decontaminate, and Dry Freezer					X

Troubleshooting

Symptom	Causes
Freezer Not Filling Slow Fill Max Fill Time Alarm	<ul style="list-style-type: none"> • Insufficient LN2 supply volume and/or pressure • LN2 supply incorrectly connected • Freezer fill valve(s) connection / faulty • Plumbing assembly leak • Auto fill temporarily disabled (see LN2 Level Control)
Short Cycle Fill	<ul style="list-style-type: none"> • Insufficient lid venting • Leak in isolation valve • Level line obstructed
LN2 Exiting Muffler	<ul style="list-style-type: none"> • Purge temp set too cold • Purge valve stuck open • Purge temp sensor connection / faulty
Short / Skipped Purge Cycle	<ul style="list-style-type: none"> • Purge temp set too warm • Purge temp sensor connection / faulty
Incorrect Temp / Sensor Error	<ul style="list-style-type: none"> • Temp probe connection / faulty
Incorrect LN2 Level / Sensor Error	<ul style="list-style-type: none"> • No level signal • Insufficient lid venting • Level line leak • Level sensor connection / faulty
Excessive Frost / Condensation High LN2 Usage / Usage Alarms	<ul style="list-style-type: none"> • Possible vacuum insulation issue • Plumbing assembly leak
Low Level Alarm	<ul style="list-style-type: none"> • Freezer Not Filling • Incorrect LN2 Level / Sensor Error
High Level Alarm	<ul style="list-style-type: none"> • Freezer fill valves stuck open • Incorrect LN2 Level / Sensor Error
High Temp Alarm	<ul style="list-style-type: none"> • Insufficient LN2 in freezer • Freezer Not Filling • Incorrect Temp / Sensor Error
Valve Stuck Alarm	<ul style="list-style-type: none"> • Freezer fill valves stuck open • Purge valve stuck open • Purge temp sensor connection / faulty • Plumbing assembly connection / leak
Battery Backup Alarm	<ul style="list-style-type: none"> • Main power lost and running on battery backup • Power supply, battery backup connection / faulty
Lid Switch Alarm	<ul style="list-style-type: none"> • Lid open for more than 5 minutes • Lid switch connection / faulty

Repair Procedures

Repair procedures should never be performed when LN2 is flowing, freezer is filling, purging, or connected to an open LN2 supply. Always close the LN2 supply valve, release any pressure, disconnect LN2 transfer hose and ensure freezer plumbing assembly is room temperature prior to beginning repair procedures. Battery backup selector should be in the OFF position and main power disconnected prior to beginning repair procedures on any electrical components. Failure to observe these precautions can result in severe injury. All service and maintenance should be performed by Abeyance or trained Abeyance representatives. Refer to the Safety section of this manual for more information.

RP1: LN2 Transfer Hose Connect / Disconnect	
Tools required: 3/4" wrench	Time Required: 0.1 hr
The LN2 transfer hose should never be removed while the freezer is filling, purging, LN2 is flowing, the hose is cold, pressurized, or connected to an open LN2 supply valve. Failure to observe these precautions can result in severe injury.	
Installation: <ol style="list-style-type: none"> 1. Connect and tighten LN2 transfer hose to LN2 supply (22-35 PSI) liquid use valve 2. Connect and tighten other end of LN2 transfer hose to freezer LN2 input 3. Carefully open liquid valve on LN2 supply and check for leaks 	
Removal: <ol style="list-style-type: none"> 1. Close the LN2 supply valve 2. Touch "Start Fill" to initiate a fill/purge cycle 3. Allow LN2 flow or pressure to cease and LN2 transfer hose to warm to room temperature 4. Touch "Stop Fill" to close freezer valves 5. Carefully disconnect hose from freezer LN2 input 6. Carefully disconnect hose from LN2 supply 	

RP2: Safety Panel Removal	
Tools required: 1/8" hex bit driver Dead blow hammer	Time Required: 0.1 hr
The safety panels are sections of kydex that cover the control and plumbing systems. Their purpose is to prevent accidental user contact with cold surfaces that may result in frostbite or burns. The panels should only be removed when performing maintenance or repair and should be replaced after repairs are complete. Safety panels should not be removed when LN2 is flowing or while the plumbing assembly is cold.	

1. Switch battery backup selector to OFF position
2. Disconnect main power
3. Remove pinchweld from section of safety panel starting at the nearest seam
4. Loosen and remove hex screws that mount safety panel to freezer brackets
5. Detach velcro and remove safety panel
6. Reinstall safety panel in reverse order
7. Gently tap pinchweld back into place using dead blow hammer if needed
8. Reconnect main power
9. Switch battery backup selector to ON position

RP3: Control Cabinet Removal

Tools required: 1/8" hex bit driver

Time Required: 0.1 hr

The control cabinet must be removed anytime maintenance or repair is to be performed on any of the control system components. Do not remove control cabinet while freezer is filling or plumbing assembly is cold.

1. Switch battery backup selector to OFF position
2. Disconnect main power
3. Loosen and remove hex screws that secure control cabinet to top cover
4. Lift to remove control cabinet, careful not to over extend wires
5. Reinstall control cabinet in reverse order
6. Reconnect main power
7. Switch battery backup selector to ON position

RP4: Lid Removal

Tools required: 1/8" hex bit driver

Time Required: 0.1 hr

Lid removal may take place while the freezer is in operation. The freezer can maintain a temperature of at least -150°C with the lid completely removed. If the lid has to be removed for an extended period, it is recommended to cover the freezer opening to prevent excess moisture from entering the freezer. Do not remove the lid while the freezer is filling or plumbing assembly is cold.

1. Close the LN2 supply valve
2. Open lid
3. Remove screws that attach lid to lid bracket on freezer top cover and remove lid
4. Reinstall lid in reverse order
5. Open the LN2 supply valve

RP5: Lid Gasket Replacement	
Tools required: 1/8" hex bit driver Utility knife Dead blow hammer	Time Required: 0.5 hr
The lid gasket is a wear item that will need to be replaced as necessary. The gasket should be replaced if damaged or deformed so that it is no longer adequately sealing the lid to the freezer.	
<ol style="list-style-type: none"> 1. Remove lid according to RP5 2. Remove pinchweld gasket from lid starting at the seam 3. Cut the new gasket to length using the old gasket as a template 4. Cut a small slit in the gasket for the hinge bracket using the old gasket as a template 5. Slide the new gasket over the hinge bracket 6. Tap the gasket into place using dead blow hammer starting at the hinge bracket and working around the edge of the lid 7. Trim gasket if needed 8. Reinstall lid according to RP5 	

RP6: Lid Foam Insulation Replacement	
Tools required: 1/8" hex bit driver 7/16" socket or wrench	Time Required: 0.25 hr
Lid insulation may be replaced with the lid on but it is recommended to remove the lid first.	
<ol style="list-style-type: none"> 1. Remove lid according to RP5 2. Loosen and remove fasteners from foam insulation 3. Remove retaining washers 4. Remove foam insulation 5. Install new foam insulation over retaining bolts 6. Reinstall retaining washers and fasteners finger tight 7. Do not overtighten - turn fasteners 1 turn past finger tight 8. Reinstall lid according to RP5 	

RP7: Pressure Relief Valve Replacement	
Tools required: 3/4" wrench 5/8" wrench Thread tape/sealant	Time Required: 0.1 hr

Relief valve should be replaced when leaking, relieving at +/-10% of rating, or as required by the preventative maintenance schedule. Do not remove pressure relief valve while LN2 is flowing, freezer is connected to an open LN2 supply or plumbing assembly is cold.

1. Disconnect LN2 transfer hose according to RP1
2. While holding the compression fitting with one wrench, loosen and remove the relief valve with the other wrench
3. Apply thread tape/sealant on the first few threads of the relief valve
4. Thread the relief valve into the fitting
5. Tighten with one wrench while holding the compression fitting stationary with the other wrench
6. Reconnect LN2 transfer hose according to RP1 and check for leaks

RP8: Fill, Purge, and Flush Valve Replacement

Tools required: 3/4" wrench
1/8" hex bit driver
14 mm socket or wrench
22 mm deep well socket
Wire cutters/strippers
Wire crimpers
Ohm meter / DMM

Time Required: 0.5 hr

Replace valves if operating improperly or as required by the preventative maintenance schedule. In most instances, the valve body does not need to be replaced. Replacing the valve stem and/or coil are adequate for preventative maintenance and most repairs.

1. Disconnect LN2 transfer hose according to RP1
2. Remove safety panels according to RP2
3. Remove valve housing by removing retaining nut
4. Measure and verify coil resistance. Remove coil if out of specification
5. Remove valve stem, plunger, and spring as required
6. Install new valve stem, plunger, and spring if required
7. Install new valve coil if required
8. Reinstall valve housing and tighten retaining nut
9. Reconnect LN2 transfer hose according to RP1 and check for leaks
10. Reinstall safety panels according to RP2 and verify operation

RP9: Isolation Valve Replacement

Tools required: 3/4" wrench
1/8" hex bit driver
#0 Phillips screwdriver
Wire cutters/strippers
Wire crimpers
Ohm meter / DMM

Time Required: 0.5 hr

Replace valve if operating improperly or as required by the preventative maintenance schedule. In most instances, the valve body does not need to be replaced. Replacing the valve stem and/or coil are adequate for preventative maintenance and most repairs.

1. Disconnect LN2 transfer hose according to RP1
2. Remove safety panels according to RP2
3. Remove valve housing by loosening and removing Phillips head screws
4. Measure and verify coil resistance. Remove assembly if out of specification
5. Install new coil and stem assembly if required
6. Reinstall valve housing and tighten Phillips head screws
7. Reconnect LN2 transfer hose according to RP1 and check for leaks
8. Reinstall safety panels according to RP2 and verify operation

RP10: Temperature Probe Replacement

Tools required: N/A

Time Required: 0.25 hr

Replace temperature probes if operating improperly or as required by the preventative maintenance schedule.

1. Remove center plug from top cover.
2. Disconnect temp probe wires
3. Verify temp probe resistance. Refer to Appendix table
4. If out of specification, replace temp probe
5. Mark the depth of the temp probe as a guide for the replacement
6. Loosen temp probe retainer cap
7. Gently remove old temp probe from center tube
8. Gently insert the new temp probe into the center tube through the cap so that it passes down between the orange silicone piece and black o-ring
9. Connect temp probe wiring
10. Retighten temp probe retainer cap
11. Reinstall center plug in top cover

RP11: Independent Temperature Probe Installation

Tools required: N/A

Time Required: 0.1 hr

The freezer is setup to accommodate an independent, third party temperature probe.

1. Remove center plug from top cover.
2. Loosen temp probe retainer cap
3. Gently insert the temp probe into the center tube through the cap so that it passes down between the orange silicone piece and black o-ring
4. Place probe at the desired depth. Top box depth near the top of the turn tray is recommended.

5. Retighten temp probe retainer cap
6. Tread temperature through center plug cable grommet
7. Reinstall center plug in top cover

RP12: Purge Temperature Probe Replacement

Tools required: 3/4" wrench
1/8" hex bit driver
X/X" wrench
Thread tape/sealant

Time Required: 0.25 hr

Replace temperature probe if operating improperly or as required by the preventative maintenance schedule.

1. Remove LN2 transfer hose according to RP1
2. Remove safety panels according to RP2
3. Disconnect purge temperature probe wiring
4. Measure and verify probe resistance. Replace probe if out of specification
5. Unscrew and remove purge temperature sensor from plumbing assembly
6. Apply thread tape/sealant on the first few threads of the new probe
7. Install and tighten probe
8. Connect probe wiring
9. Reconnect LN2 transfer hose according to RP1 and check for leaks
10. Reinstall safety panels according to RP2 and verify operation

RP13: Battery Backup Replacement

Tools required: 1/8" hex bit driver

Time Required: 0.5 hr

Batteries should be replaced if operating improperly, corroded, leaking or as required by the preventative maintenance schedule.

1. Remove safety panels according to RP2
2. Disconnect wiring from batteries careful not to short battery terminals
3. Loosen velcro strap and remove battery
4. Install new battery and secure with velcro strap
5. Install wiring according to diagram careful not to short battery terminals
6. Reinstall safety panels according to RP2 and verify operation

RP14: Controller Replacement

Tools required: 1/8" hex bit driver

Time Required: 0.5 hr

#0 Phillips screwdriver Small flathead screwdriver	
Replace controller if operating improperly or as directed by Abeyance.	
<ol style="list-style-type: none"> 1. Remove control cabinet according to RP3 2. Disconnect wiring from controller 3. Remove controller from control cabinet 4. Install new controller into control cabinet 5. Connect controller wiring 6. Reinstall control cabinet according to RP3 and verify operation 	

RP15: Power Supply Replacement	
Tools required: 1/8" hex bit driver #0 Phillips screwdriver Small flathead screwdriver	Time Required: 0.5 hr
Replace power supply if operating improperly or as directed by Abeyance.	
<ol style="list-style-type: none"> 1. Remove safety panels according to RP2 2. Disconnect wiring from power supply 3. Loosen power supply fasteners and remove from mounting bracket 4. Install new power supply 5. Install wiring according to diagram 6. Reinstall safety panels according to RP2 and verify operation 	

RP16: Fuse Replacement	
Tools required: 1/8" hex bit driver #0 Phillips screwdriver Ohm meter / DDM	Time Required: 0.25 hr
<ol style="list-style-type: none"> 1. Remove control cabinet according to RP3 2. Using ohm meter, check across terminals to determine which fuse needs replacing 3. Lift tab on fuse holder to remove 4. Install new fuse and ensure snap fit 5. Reinstall control cabinet according to RP3 and verify operation 	

RP17: Temperature Probe Calibration Verification	
Tools required: LN2 in small Dewar	Time Required: 0.25 hr

Temperature probes are calibrated at the factory. Temp probe calibration verification should be performed whenever probes are replaced, suspected of improper operation, or as required by the preventative maintenance schedule.

1. Remove center plug from top cover. A small flathead screwdriver may be required
2. Remove temperature probe retainer cap from center tube
3. Mark the depth of the temperature probe as a guide for reinstalling
4. Gently remove temperature probe from center tube
5. Submerge temperature probe in LN2
6. Allow the displayed temperature to stabilize
7. Verify temperature is within specification according to the altitude table in Appendix
8. If within specification, reinstall temp probe in reverse order
9. If out of specification, replace probe according to RP10

RP18: Manual LN2 Level Verification

Tools required: LN2 measuring stick

Time Required: 0.1 hr

LN2 level is calibrated at the factory. Manual LN2 level verification should be performed whenever the controller, flush or isolation valves have been replaced, suspected of improper operation, or as required by the preventative maintenance schedule. Verifying LN2 level on a weekly basis will help prevent or minimize any failures.

1. Open lid
2. Fully insert LN2 measuring stick down the channel located along the turn divider
3. Wait approximately 10 seconds
4. Carefully remove the measuring stick and observe the LN2 frost line
5. Close lid
6. Subtract 0.5 in (1.3 cm) to obtain your LN2 level
7. Verify measured LN2 level is within +/-0.5 in (1.3) cm of the displayed LN2 level

RP19: LN2 Level Calibration

Tools required: LN2 measuring stick

Time Required: 0.1 hr

If the measured and displayed LN2 levels are different, adjust the offset to calibrate the LN2 level.

1. Measure LN2 level according to RP18
2. If LN2 level is incorrect, adjust the offset by navigating to the Advanced Settings page
3. Increase or decrease the current offset so that the displayed LN2 level matches the measured LN2 level
4. Confirm LN2 level is accurate

RP20: Freezer Decontamination		
Tools required:	Bleach solution (10%) Water Wet/dry vacuum Pressurized nitrogen gas	Time Required: 72 hr
<p>Freezers are stainless steel vacuum vessels with an inner aluminum turn tray. They can be decontaminated with a generally accepted 10% bleach solution. Alcohol based disinfectants, detergents, hydrogen peroxide decontamination, ethylene oxide sterilization, and other methods safe to use on stainless steel and aluminum can also be used. Contact Abeyance for more information.</p>		
<ol style="list-style-type: none">1. Ensure freezer is empty and at room temperature2. Cover all inner surfaces, top cover, and handles with bleach solution3. Let stand for 30 minutes4. Thoroughly rinse with water and remove5. Allow freezer to completely6. Prior to returning freezer to service, flush annular lines with nitrogen gas to ensure all moisture has been removed		

Appendix

Spare Parts

<i>Part Number</i>	<i>Description</i>	<i>Notes</i>
RTD	Temperature Probes	Pt-100 RTD
FT-0009	Pressure Relief Valve	50 PSI (3.4 bar)
FT-0015	Fill, Purge, and Flush Valves	24VDC Normally Closed
FT-0022	Isolation Valve	24VDC Normally Open
FT-0004	Purge Temperature Probe	Pt-100 Pipe Plug RTD
FT-0020	Purge Muffler	Sintered Bronze Muffler
Power Supply	Power Supply	100-230VAC 50-60Hz : 24VDC 3A
Power Cord	Power Outlet Cord	NEMA 5-15
Fuse-1A	Fuse - GMA-1A	Pack of 10
Fuse -250mA	Fuse - GMA-250mA	Pack of 10
Lid Gasket	Lid Gasket	Per foot
Pinchweld	Pinchweld - Top Cover	Per foot
PLC	Control System	-
DP Sensor	Level Sensor	Differential Pressure Sensor
EL-0011	Battery	12VDC 20AH Lead-acid
LED	LED	Cryogenic LED
EL-0001	Lid Switch	Proximity Switch
LidFoam220	Lid Foam Insulation - A220	-
LidFoam440	Lid Foam Insulation - A440	-
LidFoam700	Lid Foam Insulation - A700	-
LidFoam1000	Lid Foam Insulation - A1000	-
LN2 Stick	LN2 Measuring Stick	48 in (122 cm)
LN2 Hose	LN2 Transfer Hose	CGA-295 6 ft Vacuum Jacketed

Altitude - LN2 Temperature Table

<i>Altitude</i>		<i>Temperature of LN2</i>
<i>Feet</i>	<i>Meters</i>	<i>°C / °F</i>
0 - 2,000	0 - 610	-196.2 / -321
2,001 - 4,000	611 - 1220	-196.8 / -322
4,001 - 6,000	1221 - 1830	-197.4 / -323
6,001 - 8,000	1831 - 2440	-198.0 / -324
8,001 - 10,000	2441 - 3050	-198.5 / -325

Temperature - Pt-100 Sensor Resistance Table

<i>°C</i>	<i>Ohms</i>	<i>°C</i>	<i>Ohms</i>
-200	18.5	-80	68.3
-190	22.8	-70	72.3
-180	27.1	-60	76.3
-170	31.3	-50	80.3
-160	35.5	-40	84.3
-150	39.7	-30	88.2
-140	43.9	-20	92.2
-130	48.0	-10	96.1
-120	52.1	0	100.0
-110	56.2	10	103.9
-100	60.3	20	107.8
-90	64.3	30	111.7

LN2 Level - Pressure Units Table

<i>in LN2</i>	<i>in H2O</i>	<i>PSI</i>	<i>in LN2</i>	<i>in H2O</i>	<i>PSI</i>
0.5	0.4	0.02	5.5	4.5	0.16
1.0	0.8	0.03	6.0	4.9	0.18
1.5	1.2	0.04	6.5	5.3	0.19
2.0	1.6	0.06	7.0	5.7	0.21
2.5	2.0	0.07	7.5	6.1	0.22
3.0	2.4	0.09	8.0	6.5	0.23
3.5	2.8	0.10	8.5	6.9	0.24
4.0	3.2	0.12	9.0	7.3	0.26
4.5	3.6	0.13	9.5	7.7	0.28
5.0	4.1	0.15	10.0	8.1	0.29