Cryo Freezer Operator Manual

AZENTA
LIFE SCIENCES

383055 Revision A

Azenta US, Inc.

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Original manual printed in English.

These are the original instructions for the Cryo Freezer.

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Revision History

Part Number: 383055

Cryo Freezer Operator Manual

Revision	Date
Revision A	13 JUN 2022

Table of Contents

1. Safety

This section reviews the safety guidelines for 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 Azenta or authorized Azenta representatives.

Liquid Nitrogen

Nitrogen is an inert, colorless, and odorless gas that forms about 78% of the Earth's atmosphere. Liquid Nitrogen (LN_2) is nitrogen in a liquid state at an extremely low temperature. When properly insulated in cryogenic containers, or dewars, LN_2 can be used as an energy efficient refrigerant for cryopreservation. It is a consumed or depleted refrigerant so additional LN_2 must be routinely added to maintain the freezer storage temperature. Certain safety precautions must be followed when handling LN_2. Please follow the appropriate handling instructions for UN number 1977.

CAUTION

Liquid Nitrogen Hazard

Moving a cold refrigerant line may cause gas line to crimp and insulation to crack which may cause minor or moderate injury along with hazardous refrigerant discharge.

- Do not attempt to move or position the refrigerant lines.

Frostbite

CAUTION

Extreme Temperature

LN_2 is extremely cold. Contact with LN_2, cold nitrogen gas, or cold surfaces can cause frostbite to the eyes and skin.

- Avoid contact with LN_2 and cold surfaces.
- Always wear proper personal protective equipment as determined by your Health and Human Safety Officer.

Asphyxiation

DANGER

Asphyxiation Hazard

Because the Cryo Freezer uses liquid nitrogen, off-gassing occurs. Due to the closed and insulated nature of the system, the off-gassing of nitrogen displaces oxygen and other naturally occurring atmospheric gases. This can pose a major health risk to anyone who opens the Cryo Freezer lid without first accurately measuring the oxygen level and/or properly dissipating the concentration of nitrogen gas. Although oxygen levels can vary based on the level of LN_2 in the system and/or time between refilling the LN_2 cavity, worst case scenario must be assumed.

- Vent the exhaust from the pressure relief valves according to facility or local environmental regulations.
- Install an alarm to alert personnel of dangerously low levels of oxygen.
- Perform service on the refrigeration unit in a well ventilated area.

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 LN_2 setup.

It is important that operators and technicians understand how reduced oxygen concentration in air can affect the body. Should any of the symptoms in the following table be noticed, the person should immediately move away from the store and ensure that the nitrogen is immediately shut off at source and the laboratory ventilated.

Oxygen Content (% by Volume)	Effects and Symptoms
20.9%	Oxygen concentration in normal air.
19.5%	Minimum permissible oxygen level.
15% to 19%	Decreased ability to work strenuously. May impair co-ordination and may cause early symptoms for persons with coronary, pulmonary, or circulatory problems.
10% to 12%	Respiration further increases in rate and depth. May display poor judgment, blue lips.
8% to 10%	Mental failure, fainting, unconsciousness, ashen face, nausea, vomiting.
6% to 8%	Recovery still possible after four to five minutes, 50% fatal after six minutes. Fatal after eight minutes.
4% to 6%	Coma in 40 seconds, convulsions, respiration ceases, death.

Over-Pressurization

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 LN_2 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. Over-pressurization can occur if LN_2 is trapped in a closed container and can result in death or serious injury.

Pinch and Nip

CAUTION

Pinch Point

Moving parts of the product may cause squeezing or compression of fingers or hands resulting in personal injury.

- Do not operate the product without the protective covers in place.
- Keep hands clear during operation.

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.

2. Introduction

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

Cryo Freezers are designed for safe and efficient storage of biological samples in dry liquid nitrogen (LN_2) vapor at -190°C (-310°F). This is a stainless steel, vacuum-insulated, non-pressurized dewar. The control system automatically maintains the LN_2 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 LN_2 and keeps the samples in a dry storage area. Vaporization of the LN_2 reservoir within the insulated freezer provides cryogenic temperatures. LN_2 must be regularly replenished in order for the freezer to maintain its cooling function. If LN_2 is depleted and not replenished, the freezer slowly warms and eventually reaches ambient temperature.

Certain safety precautions must be followed when working with or handling LN_2. Please see the chapter "Safety" on page 7 for more details.

3. Product Information

Freezer Specifications

Specification	A220	A440	A700	A1000
Outer Diameter - in (mm)	34.0 (824)	45.0 (1143)	55.0 (1397)	65.0 (1651)
Overall Height - in (mm)	58.0 (1473)	59.0 (1143)	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) * 2	10.0 (254) * 2
Liftover Height - in (mm)	39.5 (1003)	39.5 (1003)	33.0 (838)	33.0 (838)
LN_2 Capacity	65 L	150 L	270 L	390 L
LN_2 Volume/Level - L/in (L/cm)	12 (4.7)	22 (8.7)	33 (13.0)	45 (17.7)
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)	3,500 (1588)	5,000 (2268)

Control System

The control system is designed to automatically maintain the freezer LN_2 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.

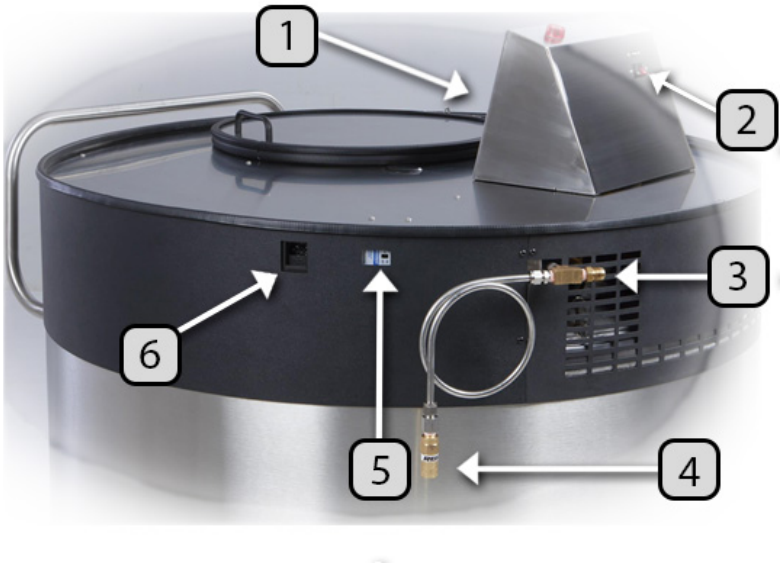


Figure 3-1: Freezer control system input/output locations

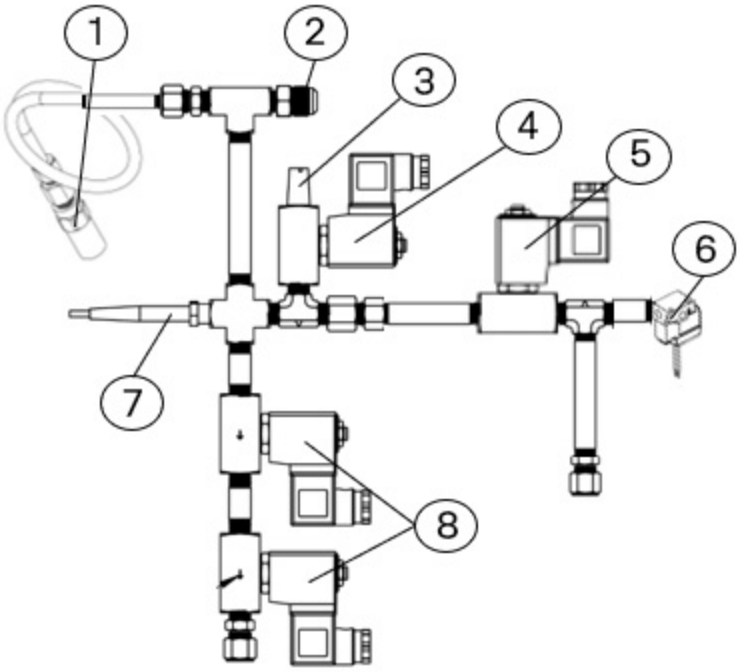
Part No.	Part Name
1	Touchscreen Monitor
2	USB & Alarm Contacts
3	LN_2 Input (22-35 PSI)
4	Relief Valve (50 PSI)
5	Battery Backup Switch
6	Main Power Input (110-220VAC)

Control System Specification

Control System	Specification	Part Number
Controller	30VDC | 3A Wireless 2.4 GHz 802.11n USB 2.0 Dry Alarm Contacts NO/NC	XX-0073
Temperature Sensor	2 x Pt-100 RTD | -200°C to 70°C | ±1.0°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 * 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 LN_2 from the supply system to the freezer and transmits the LN_2 differential pressure level signal to the controller. It is installed underneath the top cover, behind the safety panels. The LN_2 input and pressure relief valve extend through the safety panels and are accessible along the back of the freezer.



No.	Plumbing System	Specifications	Part Number
1	Pressure Relief Valve	50 PSI (3.45 Bar)	FT-0009
2	LN_2 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 Opened	FT-0022
7	Purge Temp Sensor	Pt-100 RTD | -200°C to 70°C | ±1.0°C	FT-0004
8	Fill Valves	2 * 24VDC | 52 ohms | Normally Closed | PTFE Seal	FT-0015

Facility Requirement

	A220	A440	A700	A1000
Space Required - Steps Up: L x W x H - in (mm)	34.0 x 36.0 x 78.0 (864 x 914 x 1956)	45.0 x 47.0 x 79.0 (1143 x 1194 x 2007)	55.0 x 62.5 x 80.0 (1397 x 1588 x 2032)	65.0 x 72.2 x 81.0 (1651 x 1834 x 2057)
Space Required - Steps Down: L x W x H - in (mm)	34.0 x 44.5 x 78.0 (864 x 1130 x 1956)	45.0 x 55.0 x 79.0 (1143 x 1397 x 2007)	55.0 x 74.0 x 80.0 (1397 x 1880 x 2032)	65.0 x 83.7 x 81.0 (1651 x 2126 x 2057)
Max Floor Load lbs/ft^2 (kg/m^2)	378 (1846)	352 (1719)	322 (1572)	305 (1490)

	E264	E528	E840	E1200
Space Required - Step Up: L x W x H- in (mm)	34.0 x 40.0 x 82.0 (864 x 1016 x 2083)	45.0 x 52.0 x 83.0 (1143 x 1321 x 2108)	55.0 x 62.5 x 84.0 (1397 x 1588 x 2134)	65.0 x 72.2 x 85.0 (1651 x 1834 x 2159)
Space Required - Steps Down: L x W x H - in (mm)	34.0 x 50.0 x 82.0 (864 x 1270 x 2083)	45.0 x 62.5 x 83.0 (1143 x 1588 x 2108)	55.0 x 74.0 x 84.0 (1397 x 1880 x 2134)	65.0 x 83.7 x 85.0 (1651 x 2126 x 2159)
Max Floor Load lbs/ft^2 (kg/m^2)	454 (2217)	422 (2060)	386 (1885)	366 (1787)

Electrical	100-230VAC | 50-60Hz | 0.7A continuous, 2.9A full load
LN_2 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 LN_2 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 Azenta for more information.

Regulatory

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 LN_2 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 LN_2 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 "Freezer Decontamination"on page 59.

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.

4. 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.

To uncrate the freezer, follow the Cryo Freezer Uncrating Procedure (PN: 382451).

Setup and Initial Fill

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 LN_2 than a normal fill. The freezer should be installed in an area appropriate for LN_2 service with adequate ventilation, oxygen monitoring, and an even floor with sufficient load support. Please see the "Safety" on page 7 and "Facility Requirement"on page 15 section of the manual for more information.

Step	Action
1.	Open the lid and remove desiccant packs.
2.	Connect the outlet power (110-220VAC). Switch the battery backup on. 
3.	Connect LN_2 supply (22-35 PSI) with the provided transfer hose. Open the LN_2 supply valve. Do a leak check.
4.	Touch **Start Fill** to begin the initial fill routine. Close the lid when complete.

Following the initial fill, normal controller operation continues to maintain LN_2 levels while monitoring and logging storage conditions. Allow the freezer to cool for 48 hours prior to introducing samples. Routinely verify freezer LN_2 Level and ensure sufficient LN_2 supply volume and pressure.

	A220/E254	A440/E258	A700/E840	A1000/E1200
LN_2 Needed for Initial Fill and Cool Down	180 L	230 L	410 L	460 L

5. Settings

This chapter covers the settings of the touchscreen monitor of the Cryo Freezer. Each tab contains the same header that includes the date, time, Unit ID, Top and Bot temperatures, LN_2 level, and LN_2 Usage and status indicator icons for Alarms, cloud, WiFi, and main power turn red signaling an issue. The chapter also covers the different settings withing each Settings tab and how to adjust them.

Home Page

The **Home** page displays the current freezer status and storage conditions. Freezer temperatures and LN_2 level are predominantly displayed. The header includes the date, time, *Unit ID*, *Top* and *Bot* temperatures, *LN_2 level*, and *LN_2 Usage*. Status indicator icons for Alarms, cloud, WiFi, and main power turn red signaling an issue. Touching the **Alarm** icon opens the alarm status window and display any current alarms. Touching the **WiFi** icon provides the freezer IP address. The other main pages are **Graphs**, **Event Log**, and **Settings**.

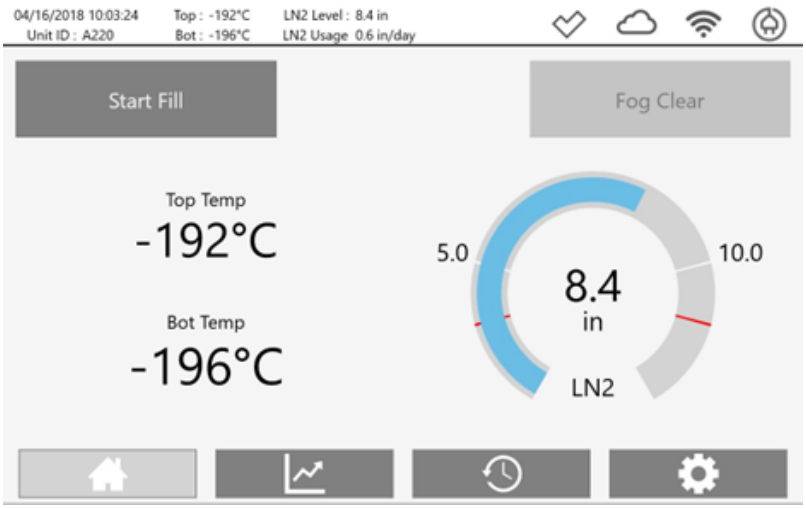


Figure 5-1: Home Page

Setup Settings

General freezer setup parameters can be adjusted by navigating to the **Settings > Setup** tab. These include display units, timers, temperature alarm, and LN_2 level setpoints. The LN_2 level alarms are automatically placed 0.5 in (1.3 cm) above the *High Level Fill* and below the *Low Level Fill*. The *Max Fill Time* and *Max Purge Time* set points should be tailored to each installation and LN_2 supply setup. Password is required to change any settings.

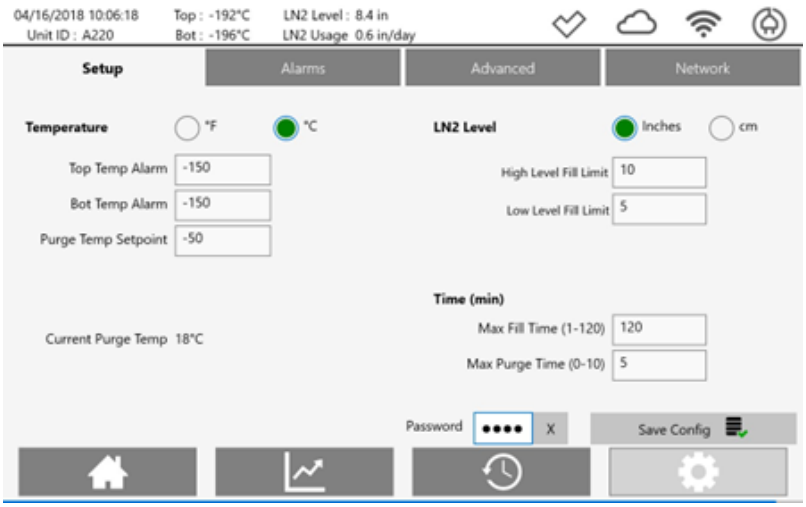


Figure 5-2: Settings Page > Setup Tab

Alarms Setting

Setup remote text and email notifications by navigating to **Settings > Alarms** 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.

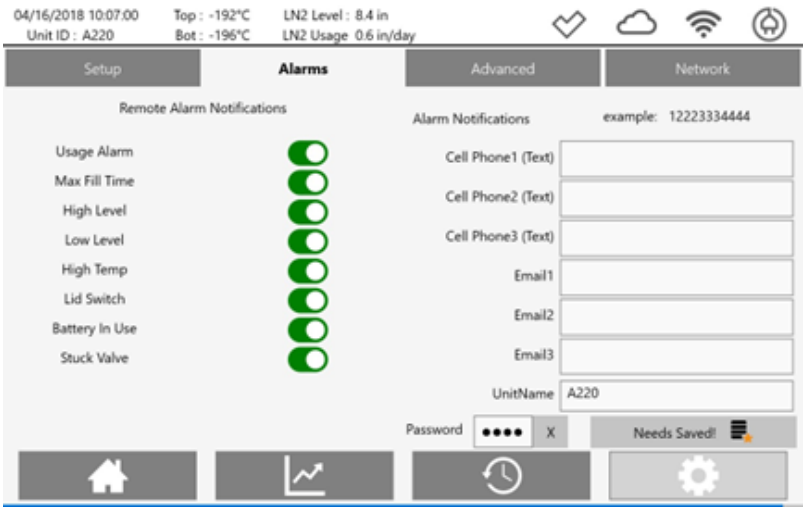


Figure 5-3: Settings Page > Alarms Tab

Advanced Settings

On the **Advanced** 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** tab.

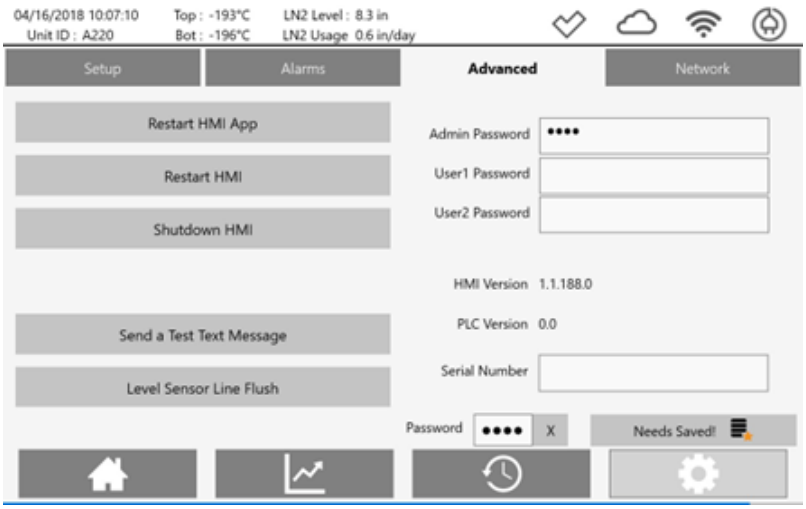


Figure 5-4: Settings Page > Advanced Tab

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.

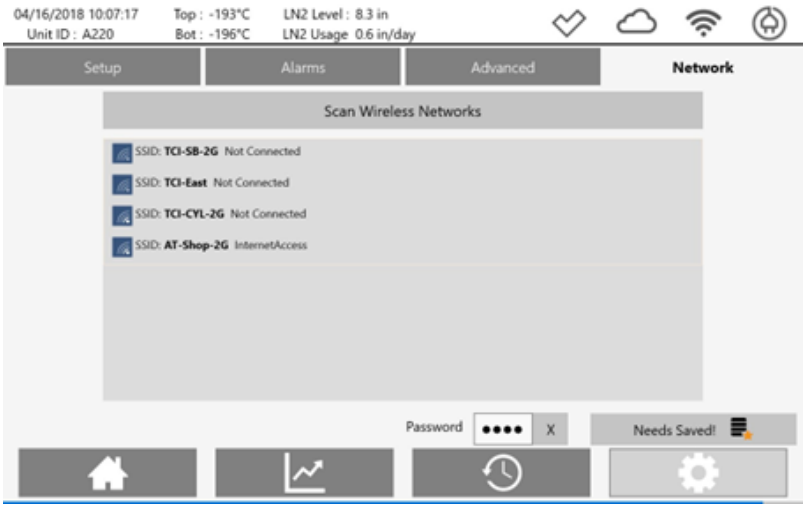


Figure 5-5: Settings Page > Network Tab

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/E264	A440/E528	A700/E840	A1000/E1200
Low Level Fill - in (cm)	5.0 (12.7)	7.0 (17.8)	7.0 (17.8)	8.0 (20.3)
High Level Fill - in (cm)	7.0 (17.8)	9.0 (22.9)	9.0 (22.9)	10.0 (25.4)
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			

6. Operation

LN_2 Vapor Storage

Cryopreservation is the storage of material below -135 °C (-211 °F) in order to provide longevity to bio-specimens. Around -135 °C is referred to as the glass transition point (Tg) of polyol's water solution. It is generally accepted that below Tg, biological activity 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 LN_2 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, LN_2 can be used as an energy efficient refrigerant for cryopreservation. It is a consumed or depleted refrigerant so additional LN_2 must be routinely added to maintain the freezer storage temperature. If LN_2 is depleted and not replenished, the freezer will slowly warm and eventually reach ambient temperature.

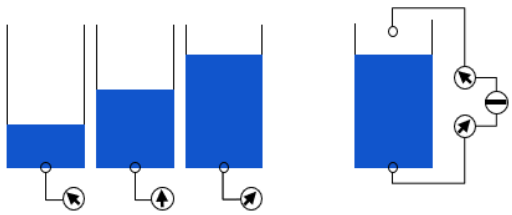
LN_2 is piped into the freezer from a pressurized supply system so that it fills the freezer from the bottom up. The control system automatically maintains the LN_2 level inside the freezer while monitoring and logging storage conditions. A freezer typically requests additional LN_2 once or twice a week to top itself off in order to keep enough LN_2 in the reservoir to hold temperature for up to several weeks. The sample turn tray hangs above this reservoir of LN_2 and keeps the samples in a dry vapor storage area. Vaporization of the LN_2 inside the insulated freezer provides cryogenic temperatures with a very small temperature gradient of only ± 3 °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 maintains below -150 °C. LN_2 usage increases 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.

LN_2 Level Measurement

A differential pressure system is used to measure the LN_2 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 LN_2. This is then displayed as inches or centimeters of LN_2. Once every 24 hours, a level sensing line flush occurs using LN_2 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 LN_2 level.



Manual confirmation of the LN_2 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 LN_2 frost line. Subtract 0.5 in (1.3 cm) to account for rapid boiling of the LN_2 to obtain your LN_2 level.

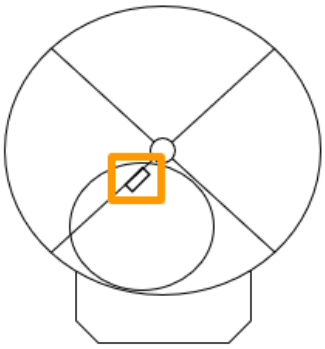


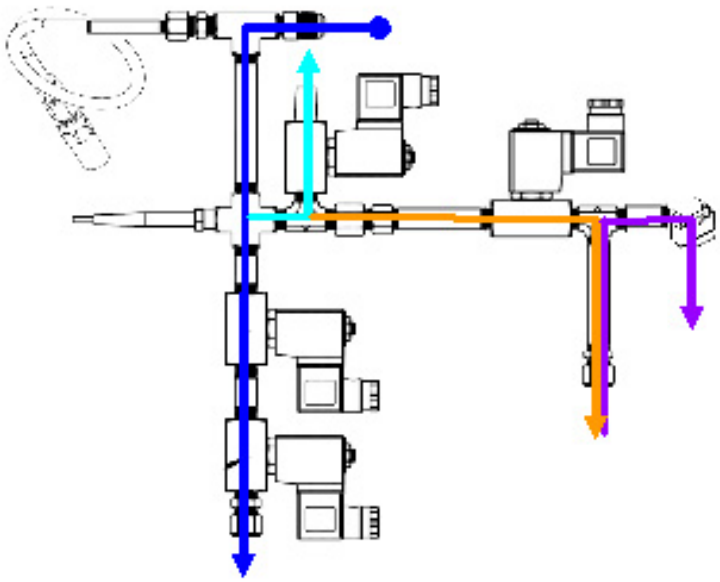
Figure 6-1: Measuring channel for manual LN_2 level confirmation located along freezer divider.

Cryo Freezers feature a second, redundant LN_2 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.

LN_2 Level Control

The LN_2 level is automatically maintained by the control system. The user-defined High Fill and Low Fill set points determine when the freezer requests LN_2. 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 in (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 LN_2 level ever gets outside of the set range.

Following the initial fill, the LN_2 level will slowly decrease as LN_2 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 LN_2 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 LN_2 flow. The exhaust temperature is monitored and when it cools down to its setpoint, the LN_2 supply lines are primed and ready to deliver LN_2. The purge valve then closes and the fill valves open allowing LN_2 to flow into the freezer. LN_2 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 LN_2 level range.



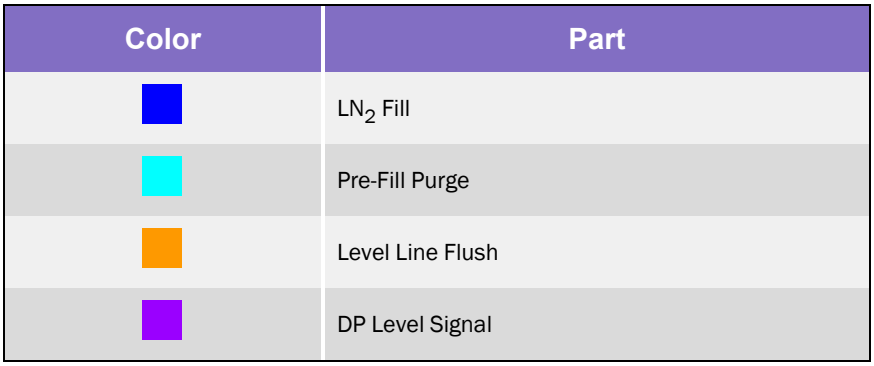


Figure 6-2: Plumbing system flow diagram showing fill, pre-fill purge, level line flush, and level signal.

During a fill, the LN_2 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, LN_2 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 LN_2 level is displayed as 0.0 in (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 LN_2 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 LN_2 level is at or below the *Low Fill*, automatic fill is temporarily paused and resumes in 15 minutes:
  - to allow time to change or address LN_2 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

LN_2 Usage

The insulated freezer is designed to minimize heat transfer in order to efficiently maintain cryogenic temperatures for an extended period of time. The LN_2 usage provides a running average of the rate of LN_2 boil off. An LN_2 usage alarm is triggered if there is a significant increase in the LN_2 consumption, which could possibly be indicative of a freezer insulation issue. Several things can impact the short term LN_2 usage such as introducing warm racks, leaving the lid off for an extended period, etc., but corrective action may be required if the LN_2 usage steadily increases and does not return to its baseline value. The LN_2 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 LN_2 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 set up 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, re-tightening retaining cap and reinserting the plug according to "Independent Temperature Probe Installation"on page 50.

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 Azenta 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

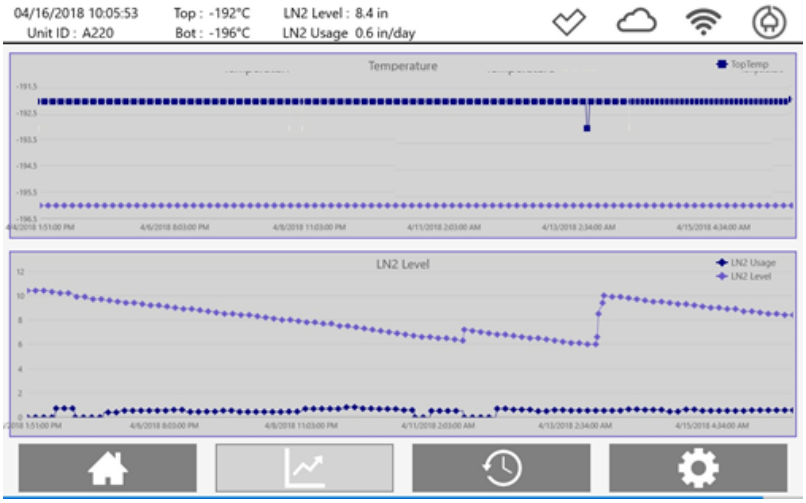


Figure 6-3: Performance Graph Page

Figure 6-4: Event Log Page

Cloud Storage

When connected to a WiFi network, the controller automatically pushes 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 in initiated or resumes after being silenced. Touching the **Alarms** icon displays the alarm status window. This status window lists any current alarm and the time started.

Figure 6-5: 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	LN_2 level below Low Level Alarm setting.
High Level Alarm	LN 2 level below High Level Alarm setting.
Sensor Error	No temperature or level signal; sensor not functioning properly.
Valve Stuck Open	Freezer plumber assembly has not warmed significant 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.

Alarm	Condition
On Battery Power	Main power is lost and freezer operating on battery backup.
Maximum Fill Time	Fill time exceeds maximum fill time.
LN_2 Usage	LN_2 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 lasts approximately 36 hours in monitoring mode. A fully depleted battery takes approximately 8 hours to fully recharge under normal operation. If main power is lost, the freezer automatically switches to battery power and a *Running on Battery Backup* alarm is initiated. While running on battery backup, full monitoring, logging, and alarm functionality remain active; however, auto-fill 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.

7. Preventative Maintenance

This chapter covers the preventative maintenance for the Cryo Freezer. Preventative maintenance must be completed weekly, monthly, yearly, every five years, and as needed. Please see the "Preventative Maintenance Table"on the next page for the preventative maintenance schedule. Preventative maintenance should be maintained while the system is operating properly.

Preventative Maintenance Table

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

	Weekly	Monthly	Yearly	5 Years	As Needed
Verify Temperature, LN_2 Level and Usage	X				
Verify LN_2 Supply Volume and Pressure	X				
Inspect for Excessive Frost/Condensation		X			
Check LN_2 Connections		X			
Perform Function Test			X		
Verify Function Test			X		
Replace Real Time Clock Battery			X		
Solenoid Valve Replacement				X	
Relief Valve Replacement				X	
Battery Replacement				X	
Temperature Sensor Replacement					X
Lid Gasket Replacement					X
Thaw, Decontaminate, and Dry					X
Freezer					

8. Troubleshooting

Symptoms	Causes
Freezer Not Filling Slow Fill Max Fill Time Alarm	• Insufficient LN_2 supply volume and/or pressure • LN_2 supply incorrectly connected • Freezer fill valve(s) connection / faulty • Plumbing assembly leak • Auto fill temporarily disabled (see"LN2 Level Control"on page 29)
Short Cycle Fill	• Insufficient lid venting • Leak in isolation valve • Level line obstructed
LN_2 Exiting Muffler	• Purge temp set too cold • Purge valve stuck open • Purge temp sensor connection / faulty
Short / Skipped Purge Cycle	• Purge temp set too warm • Purge temp sensor connection / faulty
Incorrect Temp / Sensor Error	• Temp probe connection / faulty
Incorrect LN_2 Level / Sensor Error	• No level signal • Insufficient lid venting • Level line leak • Level sensor connection / faulty
Excessive Frost / Condensation High LN_2 Usage / Usage Alarms	• Possible vacuum insulation issue • Plumbing assembly leak
Low Level Alarm	• Freezer Not Filling • Incorrect LN_2 Level / Sensor Error
High Level Alarm	• Freezer fill valves stuck open • Incorrect LN_2 Level / Sensor Error

Symptoms	Causes
Valve Stuck Alarm	• Freezer fill valves stuck open • Purge valve stuck open • Purge temp sensor connection / faulty • Plumbing assembly connection / leak
Battery Backup Alarm	• Main power lost and running on battery backup • Power supply, battery backup connection / faulty
Lid Switch Alarm	• Lid open for more than 5 minutes • Lid switch connection / faulty

9. Repair Procedures

Repair procedures should never be performed when LN_2 is flowing, freezer is filling, purging, or connected to an open LN_2 supply. Always close the LN_2 supply valve, release any pressure, disconnect LN_2 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 Azenta or trained Azenta representatives. Refer to the "Safety" on page 7 of this manual for more information.

LN_2 Transfer Hose Connect / Disconnect

Tools Required

- 3/4 in wrench

Time Required

- 0.1 hr

The LN_2 transfer hose should never be removed while the freezer is filling or purging, or while LN_2 is flowing, the hose is cold, pressurized, or connected to an open LN_2 supply valve. Failure to observe these precautions can result in severe injury.

Installation

Step	Action
1.	Connect and tighten the LN_2 transfer hose to the LN_2 supply (22-35 PSI) liquid. Use the valve.
2.	Connect and tighten the other end of the LN_2 transfer hose to the freezer LN_2 input.
3.	Carefully open the liquid valve on the LN_2 supply and check for leaks.

Removal

Step	Action
1.	Close the LN_2 supply valve.
2.	Touch **Start Fill** to initiate a fill/purge cycle.
3.	Allow the LN_2 flow or pressure to cease and the LN_2 transfer hose to warm to room temperature.
4.	Touch **Stop Fill** to close freezer valves.
5.	Carefully disconnect the hose from freezer the LN_2 input.
6.	Carefully disconnect the hose from the LN_2 supply.

Safety Panel Removal

Tools Required

- Plastic fastener removal tool
- 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 LN_2 is flowing or while the plumbing assembly is cold.

Step	Action
1.	Switch the battery backup selector to the **OFF** position.
2.	Disconnect the main power.
3.	Remove pinchweld from the section of safety panel, starting at the nearest seam.
4.	Remove the push rivets that mount the safety panel to the freezer brackets.
5.	Reinstall the safety panel in reverse order.
6.	Gently tap the pinchweld back into place using the dead blow hammer, if needed.
7.	Reconnect the main power.
8.	Switch the battery backup selector to the **ON** position.

Control Cabinet Removal

Tools Required

- N/A

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.

Step	Action
1.	Switch the battery backup selector to the **OFF** position.
2.	Disconnect the main power.
3.	Remove the rear safety panel ("Safety Panel Removal" on page 41).
4.	Remove the wingnuts on the underneath side of the top cover.
5.	Lift to remove the control cabinet, careful not to over extend the wires.
6.	Reinstall the control cabinet in reverse order.
7.	Reconnect the main power.
8.	Switch the battery backup selector to the **ON** position.

Lid Removal

Tools Required

- T25 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.

Step	Action
1.	Close the LN_2 supply valve.
2.	Remove the four screws that attach the lid to lid hinge on the freezer top cover and remove the lid.
3.	Reinstall the lid in reverse order.
4.	Open the LN_2 supply valve.

Lid Gasket Replacement

Tools Required

- T25 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.

Step	Action
1.	Remove the lid according to "Lid Removal"on the previous page.
2.	Remove the pinchweld gasket from the lid, starting at the seam.
3.	Slide the new gasket, starting by inserting the hinge popout through the slit in the gasket.
4.	Tap the gasket into place using the dead blow hammer, starting at the seam.
5.	Trim the gasket, if needed.
6.	Reinstall the lid according to "Lid Removal"on the previous page.

Lid Foam Insulation Replacement

Tools Required

- 7/16 in 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.

Step	Action
1.	Open the lid.
2.	Remove the nuts and retaining washers from the foam insulation, leaving the all thread.
3.	Remove the foam insulation.
4.	Install the new foam insulation over the all thread.
5.	Reinstall the retaining washers and fasteners, finger tight.
6.	Do not over-tighten - turn fasteners 1 turn past finger tight.

Pressure Relief Valve Replacement

Tools Required

- 3/4 in wrench
- 5/8 in 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 LN_2 is flowing, freezer is connected to an open LN_2 supply or plumbing assembly is cold.

Step	Action
1.	Disconnect the LN_2 transfer hose according to "LN2 Transfer Hose Connect / Disconnect" on page 40.
2.	While holding the compression fitting with one wrench, loosen and remove the relief valve with the other wrench.
3.	Apply the 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 the LN_2 transfer hose according to "LN2 Transfer Hose Connect / Disconnect"on page 40 and check for leaks.

Fill and Purge Valve (Main Line Assembly)

Tools Required

- 7/8 in wrench
- 11/16 in wrench
- 9/16 in wrench
- 3/8 in wrench

Time Required

- 0.5 hr

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

Step	Action
1.	Disconnect the LN_2 transfer hose ("LN2 Transfer Hose Connect / Disconnect"on page 40).
2.	Disconnect the power.
3.	Remove the safety rear panel ("Safety Panel Removal"on page 41).
4.	Disconnect the connection for solenoid valves.
5.	Disconnect the ¼ in copper line by loosening the brass compression fitting.
6.	Disconnect the plumbing bracket by removing the (2) ⅜ in nuts on back of the bracket.
7.	Disconnect the stainless fill line by loosening the stainless compression fitting closest to plumbing.
8.	Reconnect the new assembly in reverse order (7 thru 1).
9.	Reconnect the LN_2 transfer hose according to "LN2 Transfer Hose Connect / Disconnect"on page 40 and check for leaks.
10.	Reinstall the safety panels according to "Safety Panel Removal"on page 41 and verify the operation.

Isolation Valve Replacement

Tools Required

- 3/4 in wrench
- 1/8 in hex bit driver
- #0 Phillips screwdriver
- Wire cutters/strippers
- Wire crimpers
- Ohmmeter / 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.

Step	Action
1.	Disconnect the LN_2 transfer hose according to "LN2 Transfer Hose Connect / Disconnect"on page 40.
2.	Remove the safety panels according to "Safety Panel Removal"on page 41.
3.	Remove the valve housing by loosening and removing the Phillips head screws.
4.	Measure and verify the coil resistance. Remove the assembly if out of specification.
5.	Install the new coil and stem assembly if required.
6.	Reinstall the valve housing and tighten the Phillips head screws.
7.	Reconnect the LN_2 transfer hose according to "LN2 Transfer Hose Connect / Disconnect"on page 40 and check for leaks.
8.	Reinstall the safety panels according to "Safety Panel Removal"on page 41 and verify the operation.

Temperature Probe Replacement

Tools Required

- Terminal screwdriver

Time Required

- 0.25 hr

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

Step	Action
1.	Remove the center cap from top cover.
2.	Remove the rear safety panel ("Safety Panel Removal"on page 41).
3.	Remove the controller cabinet ("Control Cabinet Removal"on page 42).
4.	Disconnect the temp probe wires located in the terminal strip on the RTD module inside the controller cabinet.
5.	Verify the temp probe resistance. Refer to "Appendices" on page 60.
6.	If out of specification, replace the temp probe.
7.	Mark the depth of the temp probe as a guide for the replacement.
8.	Remove the center plug by loosening the knob a half turn and pulling straight up.
9.	Gently remove the old temp probe from center tube.
10.	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.
11.	Connect the temp probe wiring.
12.	Re-tighten the temp probe retainer cap.
13.	Reinstall the center plug in top cover.

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.

Step	Action
1.	Remove the center plug from the top cover.
2.	Loosen the 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 the probe at the desired depth. Top box depth near the top of the turn tray is recommended.
5.	Re-tighten the temp probe retainer cap.
6.	Tread the temperature through the center plug cable grommet.
7.	Reinstall the center plug in top cover.

Purge Temperature Probe Replacement

Tools Required

- 3/4 in wrench
- 1/8 in hex bit driver
- X/X in wrench
- Thread tape/sealant

Time Required

- 0.25 hr

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

Step	Action
1.	Remove the LN_2 transfer hose according to "LN2 Transfer Hose Connect / Disconnect"on page 40.
2.	Remove the safety panels according to "Safety Panel Removal"on page 41.
3.	Disconnect the purge temperature probe wiring.
4.	Measure and verify the probe resistance. Replace the probe if out of specification.
5.	Unscrew and remove the purge temperature sensor from the plumbing assembly.
6.	Apply the thread tape/sealant on the first few threads of the new probe.
7.	Install and tighten the probe.
8.	Connect the probe wiring.
9.	Reconnect the LN_2 transfer hose according to "LN2 Transfer Hose Connect / Disconnect"on page 40 and check for leaks.
10.	Reinstall the safety panels according to "Safety Panel Removal"on page 41 and verify the operation.

Battery Backup Replacement

Tools Required

- T25 bit driver

Time Required

- 0.5 hr

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

Step	Action
1.	Remove the safety panels according to "Safety Panel Removal"on page 41.
2.	Disconnect the wiring from the batteries, careful not to short the battery terminals.
3.	Loosen the velcro strap and remove the battery.
4.	Install the new battery and secure it with velcro strap.
5.	Install the wiring according to the diagram, careful not to short the battery terminals.
6.	Reinstall the safety panels according to "Safety Panel Removal"on page 41 and verify the operation.

Controller Replacement

Tools Required

- N/A

Time Required

- 0.5 hr

Replace controller if operating improperly or as directed by Azenta.

Step	Action
1.	Switch the battery backup selector to the **OFF** position.
2.	Disconnect the main power.
3.	Remove the rear safety panel ("Safety Panel Removal"on page 41).
4.	Remove the wingnuts on the underneath side of the top cover.
5.	Lift to remove the control cabinet, careful not to over extend wires.
6.	Disconnect the molex connections, RTD terminal strip, and the vinyl DP tube.
7.	Reinstall the control cabinet in reverse order.
8.	Reconnect the main power.
9.	Switch the battery backup selector to the **ON** position.

Power Supply Replacement

Tools Required

- T25 bit driver
- #0 Phillips screwdriver
- Small flathead screwdriver

Time Required

- 0.5 hr

Replace power supply if operating improperly or as directed by Azenta.

Step	Action
1.	Remove the safety panels according to "Safety Panel Removal"on page 41.
2.	Disconnect the wiring.
3.	Disconnect the wiring from the power supply.
4.	Loosen the power supply fasteners and remove from the mounting bracket.
5.	Install the new power supply.
6.	Install the wiring according to the diagram.
7.	Reinstall the safety panels according to "Safety Panel Removal"on page 41 and verify the operation.

Fuse Replacement

Tools Required

- 1/8 in hex bit driver
- #0 Phillips screwdriver
- Ohm meter / DDM

Time Required

- 0.25 hr

Step	Action
1.	Remove the control cabinet according to "Control Cabinet Removal"on page 42.
2.	Using the ohmmeter, check across the terminals to determine which fuse needs replacing.
3.	Lift the tab on the fuse holder to remove.
4.	Install the new fuse and ensure a snap fit.
5.	Reinstall the control cabinet according to "Control Cabinet Removal"on page 42 and verify the operation.

Temperature Probe Calibration Verification

Tools Required

- LN_2 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.

Step	Action
1.	Remove the center plug from the top cover. A small flathead screwdriver may be required.
2.	Remove the temperature probe retainer cap from the center tube.
3.	Mark the depth of the temperature probe as a guide for reinstalling.
4.	Gently remove the temperature probe from the center tube.
5.	Submerge the temperature probe in LN_2.
6.	Allow the displayed temperature to stabilize.
7.	Verify that the temperature is within specification according to the Appendix B: "Altitude - LN2 Temperature Table"on page 62.
8.	If it is within specification, reinstall the temp probe in reverse order.
9.	If it is out of specification, replace the probe according to "Temperature Probe Replacement"on page 49.

Manual LN_2 Level Verification

Tools Required

- LN_2 measuring stick

Time Required

- 0.1 hr

LN_2 level is calibrated at the factory. Manual LN_2 level verification should be performed whenever the controller or flush or isolation valves have been replaced, suspected of improper operation, or as required by the preventative maintenance schedule. Verifying LN_2 level on a weekly basis helps prevent or minimize any failures.

Step	Action
1.	Open the lid.
2.	Fully insert the LN_2 measuring stick down the channel located along the turn divider.
3.	Wait approximately 10 seconds.
4.	Carefully remove the measuring stick and observe the LN_2 frost line.
5.	Close the lid.
6.	Subtract 0.5 in (1.3 cm) to obtain your LN_2 level.
7.	Verify the measured LN_2 level is within +/-0.5 in (1.3) cm of the displayed LN_2 level.

LN_2 Level Calibration

Tools Required

- LN_2 measuring stick

Time Required

- 0.1 hr

If the measured and displayed LN_2 levels are different, adjust the offset to calibrate the LN_2 level.

Step	Action
1.	Measure the LN_2 level according to "Manual LN2 Level Verification"on the previous page.
2.	If the LN_2 level is incorrect, adjust the offset by navigating to the "Advanced Settings"on page 23.
3.	Increase or decrease the current offset so that the displayed LN_2 level matches the measured LN2 level.
4.	Confirm that the LN_2 level is accurate.

Freezer Decontamination

Tools Required

- Bleach solution (10%)
- Water
- Wet/dry vacuum
- Pressurized nitrogen gas

Time Required

- 72 hr

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 Azenta for more information.

Step	Action
1.	Ensure that the freezer is empty and at room temperature.
2.	Cover all the inner surfaces, top cover, and handles with bleach solution.
3.	Let it stand for 30 minutes.
4.	Thoroughly rinse it with water and remove.
5.	Allow freezer to completely thaw.
6.	Prior to returning the freezer to service, flush the annular lines with nitrogen gas to ensure that all the moisture has been removed.

10. Appendices

The following chapter contains the appendices for the manual.

Appendix A: Spare Parts

Part Number	Description	Notes
RTD	Temperature Probes	Pt-100 RTD
FT-0009	Pressure Relieve Valve	50 PSI (3.4 bar)
FT-0015	Fill, Purge, and Flush Valves	24VDC | Normally Closed
FT-0022	Isolation Valve	24 VDC | 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 - 240VDC | 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	-
LN_2 Stick	LN2 Measuring Stick	48 in (122 cm)
LN_2 Hose	LN2 Transfer Hose	CGA-295 | 6 ft | Vacuum Jacketed

Appendix B: Altitude - LN_2 Temperature Table

Altitude		Temperature of LN_2
Feet	Meters	°C/ °F
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

Appendix C: Temperature - Pt-100 Sensor Resistance Table

°C	Ohms	°C	Ohms
- 200	18.5	- 80	68.3
- 190	22.8	- 70	72.3
- 180	27.1	- 60	76.3
- 170	31.1	- 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

Appendix D: LN_2 Level - Pressure Units Table

in LN_2	in $H2_0$	PSI	in LN_2	in $H2_0$	PSI
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

Appendix E: WEEE Statement (European Union)

The symbol above indicates that Waste Electrical and Electronic Equipment (WEEE) is not to be disposed of as unsorted municipal waste. Equipment marked with this symbol is to be collected separately.

The objectives of this program are to preserve, protect and improve the quality of the environment, protect human health and utilize natural resources prudently and rationally. Specific treatment of WEEE is indispensable in order to avoid the dispersion of pollutants into the recycled material or waste stream. Such treatment is the most effective means of protecting the customer's environment.

The waste collection, reuse, recycling, and recovery programs available to Azenta Life Sciences-customers, vary by customer location. Please contact the responsible body (e.g., your laboratory manager) for information about local requirements.