



# Thermo Scientific TSE Series

## -86C ULT Upright Freezer

Operating and Maintenance Manual 7040933 Rev. 22

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**Important installer and user information:**

A redundant temperature sensing device has been included in this ULT freezer. This device is a type “T” thermocouple. For convenient access, the thermocouple (Figure 1-3) terminates in an interconnect jack (Figure 1-5) behind the base front cover. (May be located differently in chests. See Section 1.) It is strongly recommended that this thermocouple be attached to a redundant 24 hour 7 day monitoring system with alarm capabilities. Connecting the sensor to a monitoring and alarm system separate from the freezer provides the utmost in product safety, should the integral system fail. ▲

**Models Covered**

Number (Model)	Capacity - liters (cu ft)	Voltage /Hz
TSE240V	368 (13)	230/50
TSE240D	368 (13)	208-230/60
TSE240A	368 (13)	120/60
TSE320A	490 (17)	120/60
TSE320D	490 (17)	208-230/60
TSE320V	490 (17)	230/50
TSE400V	652 (23)	230/50
TSE400D	652 (23)	208-230/60
TSE400A	652 (23)	120/60
TSE600D	793 (28)	208-230/60
TSE600V	793 (28)	230/50

**Packing List**

Part No.	Description	Qty
122005	Key Set	1
380520	Neoprene Cap	2
510016	1/4-20 x 5-1/2" Bolt	2
195763	Retaining Clip	1
370563	Remote Alarm Connector	1

**MANUAL NUMBER 7040933**

22	40634	10/31/17	Updated exploded drawings	bpg
21	41728	10/03/17	Added door operation info pg 1-6	bpg
20	31514	8/25/17	Updated drawing 195964-90-1	bpg
19	41370	8/8/17	Updated BUS information	bpg
18	41159/41348	5/12/17	Corrected D-volt rating, operational temp range	bpg
18	41346/41347	5/12/17	Removed SS, AS400 model numbers	bpg
17	40543	12/5/16	Added f-gas regulation to Specifications	ccs
16	31061/FR-2833	9/19/16	Updated door gasket in 902-200-1 on pg 7-1 and 7-2	ccs
15	40688	7/26/16	Removed key ring from packing list	ccs



**Important** Read this instruction manual. Failure to read, understand and follow the instructions in this manual may result in damage to the unit, injury to operating personnel, and poor equipment performance. ▲

**Caution** All internal adjustments and maintenance must be performed by qualified service personnel. ▲

Material in this manual is for information purposes only. The contents and the product it describes are subject to change without notice. Thermo Fisher Scientific makes no representations or warranties with respect to this manual. In no event shall Thermo be held liable for any damages, direct or incidental, arising out of or related to the use of this manual.

The -86C Freezers (see page i for specific list of models) described in this manual are high performance units which can be used for research and in situations that directly support medical applications. When these products are used to support a medical application, it is an accessory to a medical device and is therefore considered as a medical device in its own right by the regulatory body (e.g. FDA).

This product is intended for use:

- As cold storage in research use.
- As a medical device for diagnostic use (storage of samples not intended to be re-introduced to human body).

**Registration:** This medical application is considered a Class I medical device by the FDA. This product is classified as product code – JRM, regulation number 862.2050 and is considered a Class 1 device, 510(K) exempt.

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Important operating and/or maintenance instructions. Read the accompanying text carefully.



Potential electrical hazards. Only qualified persons should perform procedures associated with this symbol.



Extreme temperature hazards, hot or cold. Use special handling equipment or wear special, protective clothing.



WEEE Compliance: Thermo Fisher Scientific has contracted with companies for recycling/disposal in each EU Member State. For further information, send an email to [weee.recycle@thermofisher.com](mailto:weee.recycle@thermofisher.com).



- ✓ Always use the proper protective equipment (clothing, gloves, goggles, etc.)
- ✓ Always dissipate extreme cold or heat and wear protective clothing.
- ✓ Always follow good hygiene practices.
- ✓ Each individual is responsible for his or her own safety.

## Do You Need Information or Assistance on Thermo Scientific Products?

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Our **Sales Support** staff can provide information on pricing and give you quotations. We can take your order and provide delivery information on major equipment items or make arrangements to have your local sales representative contact you. Our products are listed on the Internet and we can be contacted through our Internet home page.

Our **Service Support** staff can supply technical information about proper setup, operation or troubleshooting of your equipment. We can fill your needs for spare or replacement parts or provide you with on-site service. We can also provide you with a quotation on our Extended Warranty for your Thermo Scientific products.

Whatever Thermo Scientific products you need or use, we will be happy to discuss your applications. If you are experiencing technical problems, working together, we will help you locate the problem and, chances are, correct it yourself...over the telephone without a service call.

When more extensive service is necessary, we will assist you with direct factory trained technicians or a qualified service organization for on-the-spot repair. If your service need is covered by the warranty, we will arrange for the unit to be repaired at our expense and to your satisfaction.

Regardless of your needs, our professional telephone technicians are available to assist you Monday through Friday from 8:00 a.m. to 6:00 p.m. Eastern Time. Please contact us by telephone or fax. If you wish to write, our mailing address is:

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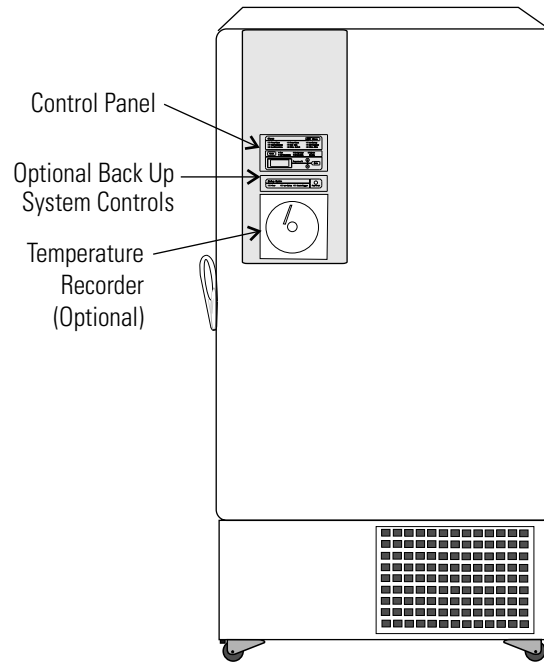
International customers, please contact your local Thermo Scientific distributor.

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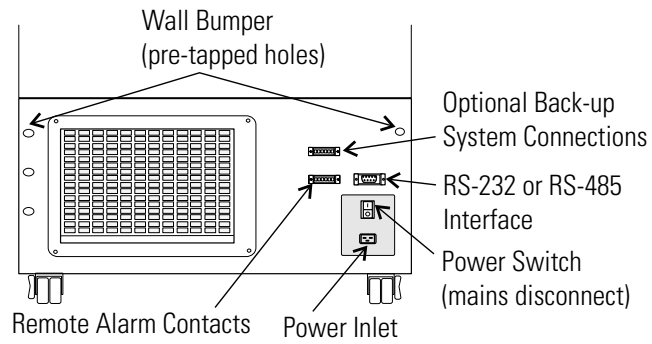
# Section 1 Installation and Start-up



**Figure 1-1.** Freezer Front View Components

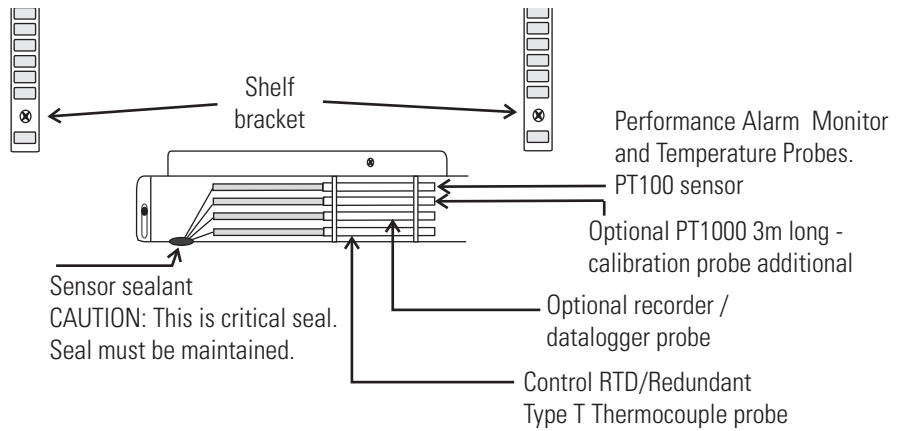
- Control panel - keypad, displays and indicators
- BUS (Optional Back Up System) control panel
- Optional temperature recorder or datalogger



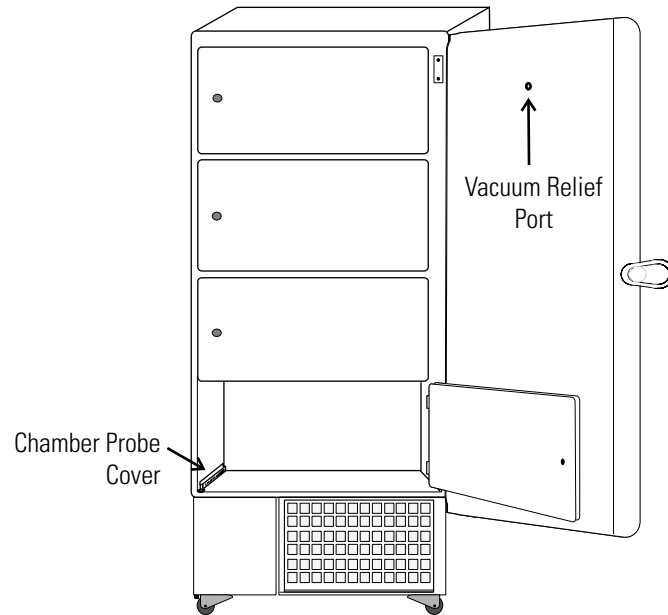


**Figure 1-2.** Freezer Rear View Components

- Remote alarm contacts
- Power inlet for power cord connection.
- Optional BUS connections for probe and solenoid
- RS-232 (default) or RS-485 interface
- Power switch (mains disconnect)

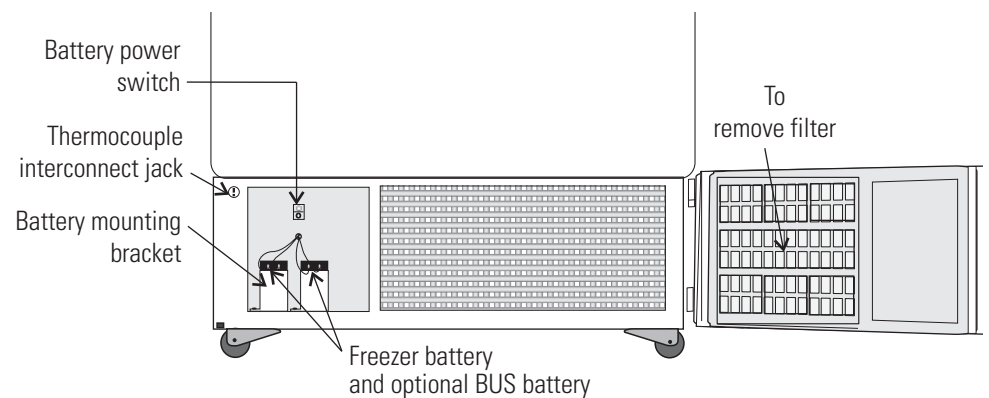


**Figure 1-3.** Chamber Probe(s)



**Figure 1-4.** Vacuum Relief and Probe Cover Location

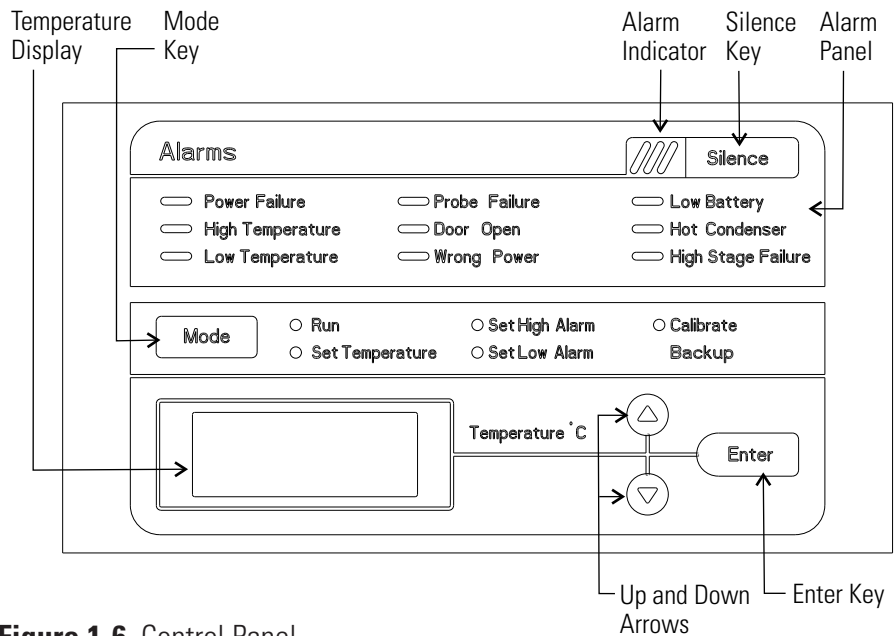
- Vacuum relief port - pressure equalization port
- Probe cover - houses control, optional recorder, datalogger, or optional miscellaneous accessory probes



**Figure 1-5.** Battery(s) location and switch

- Battery mounting bracket(s)
- Battery power switch (freezer and BUS)
- Freezer battery
- Optional BUS battery
- Freezer filter location

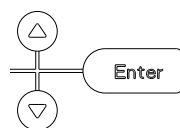
# Control Panel Keys, Displays, Indicators



**Figure 1-6.** Control Panel

- Temperature Display - Displays temperature in degrees Celsius.
- Mode Select Switch - Used to select Run, Set Temperature, Set High Alarm, Set Low Alarm, Calibrate, Backup.
- Alarm Indicator - Light pulses on/off during an alarm condition of the cabinet.
- Silence - Silences the audible alarm. See Section 4 for alarm ringback times.
- Alarm Panel - indicates the current alarm condition.
- Up and Down Arrows - Increases or decreases values, toggles between choices.
- Enter - Stores the value into memory

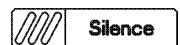
## Operation of the Keypad



The TSE Series freezer has five basic modes which allow freezer setup and operation. Press the Mode key to scroll through the mode selections.

Up Arrow: Increases or toggles the parameter value.

Enter: Must press Enter key to save to memory all changed values.



Down Arrow: Decreases or toggles the parameter value.

Silence Key: Press to silence the audible alarm. See Section 4 for alarm ringback times.

## Install Freezer

**Note** If tipped more than 45°, allow the unit to sit upright for 24 hours before start up. ▲

To remove the freezer from the pallet, use a 7/16" wrench to remove all the bolts securing the shipping bracket to the pallet.

Remove the shipping bracket. Remove the ramp boards from the pallet and place the slotted end over the ramp brackets on the pallet. The support blocks on the ramps will be facing down. Before moving the freezer, make sure the casters are unlocked and moving freely. Align the caster with the ramp boards. Use adequate personnel to roll the freezer off the pallet.

## Choose Location

The freezer can be easily pushed to the desired approved location, described below. If necessary, the doors and lower front panel may be opened to move the unit through tight openings. When the freezer is in position, set the front caster brakes.

**Note** The freezer must not be moved with the product load inside. ▲

**Note** For proper ventilation and airflow, a minimum clearance of 5" at the rear and top and a clearance of 8" on the side of the freezer is required. Allow adequate space in the front of the freezer for door opening. ▲

Locate the freezer on a firm, level surface in an area with an ambient temperature between 18°C and 32°C. Provide ample room to reach the mains disconnect switch (power switch) located on the rear of the freezer.

## Door Operation

Upright freezer models are equipped with an advanced assembly specifically designed for ultra-low temperature freezers.

Features include:

- One-hand operation
- A front-accessible lock
- Hasps for a standard padlock to provide additional security. Length of the shackle must be between ¾ inch (1.9 cm) and 1½ inch (3.8 cm).
- Durable construction for reliable operation and safe product storage.

## Install Wall Bumpers

The parts bag, located inside the cabinet, contains the following parts.

Quantity	Stock #	Description	Purpose
2	510016	1/4-20 x 5-1/2" Bolt	Wall Bumper
2	380520	Neoprene Cap	Cap Protector

**Table 1-1.** Parts bag

Install the bolts into the pre-tapped holes on the back of the compressor section. Install a neoprene cap on each bolt. Refer to Figure 1-2 for the locations of the pre-tapped holes.

## Install Shelves

Install the shelf clips into the shelf pilasters (front and back) at the desired shelf level. Install the shelves in the cabinet onto the clips.

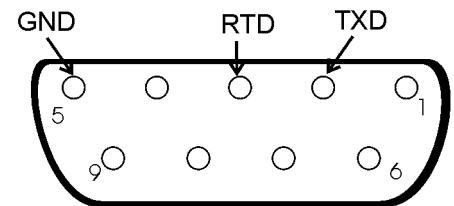
**Note** Maximum shelf load is 100 lbs (45.4 kg) per shelf. ▲

**Note** On units having the optional 5 inner door option, refer to the instructions accompanying the inner door kit. ▲

## RS-232 Communication

The TSE series freezer has a data communications interface. The factory default setting is RS-232.

The wiring identification for the interface is shown in Figure 1-7. One nine pin, sub "D" style connector is located on the back of the freezer. See Figure 1-2 for the location of the connector on the freezer.



**Figure 1-7.** Wiring ID

The freezer transmits temperature information every 60 minutes. A standard DB9 serial extension cable can be used to connect the freezer to a serial device. Some serial devices may require a null modem adapter.

Data format:

Baud . . . . . 1200  
 Data bits . . . . . 8 (7 bit ASCII with leading zero)  
 Start bits . . . . . 1  
 Stop bits . . . . . 2  
 Parity . . . . . none

**RS-232 Communication  
(continued)**

The data transfer sequence is transmitted in the following format. X refers to numerical temperature data.

(NUL) (-) XXX (SP) C (SP) (Error Message) (SP) (LF) (CR) (EOT) (SP)

In the event of a CNTRLFAIL, Er07, or the control probe is out of range error, the numerical temperature data (XXX) in the transmission would be replaced by T\_ERR.

If no alarm condition exists, spaces will be sent. A total of 20 characters will be sent.

- SP - Space                                      LF - Line feed
- CR - Carriage return                      EOT - End of text (4)
- NUL - Null character (00)

If an alarm condition does exist, “Error Message” in the protocol will be replaced by the following:

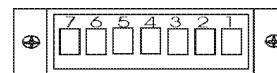
- UNDERTEMP (temperature above the low alarm setpoint)
- OVERTEMP (temperature below the high alarm setpoint)
- PWRFAIL (AC power failure)
- CNTRLFAIL (Control probe failure)
- Er07 (micro failure)
- HSHX FAIL (Heat exchanger failure)
- HOT COND (Hot condenser)

**Remote Alarm Contacts**

**IMPORTANT USER INFORMATION**

CAUTION! Stored product should be protected by a redundant 24 hour/day monitoring system with alarm capability. An interconnect jack and thermocouple are installed for centralized monitoring, should on-board system fail.

See Figure 1-2 for the location of the remote alarm contacts. The remote alarm connector is located in the parts bag provided with the manual. It must be installed if connecting the freezer to an alarm system. After installing the wiring from the alarm system to the connector, install the connector to the freezer microboard and secure with the two screws provided. The remote alarm provides a NO (normally open) output, a NC (normally closed) output and COM (common). The contacts will trip on a power outage and high temperature or low temperature alarms. They will also trip on high stage, control probe or microboard failures.



REMOTE CONTACTS/ANALOG OUTPUT	
PIN# 1	Not Connected
PIN# 2	Not Connected
PIN# 3	Not Connected
PIN# 4	Not Connected
PIN# 5	Normally Closed
PIN# 6	Common.
PIN# 7	Normally Open

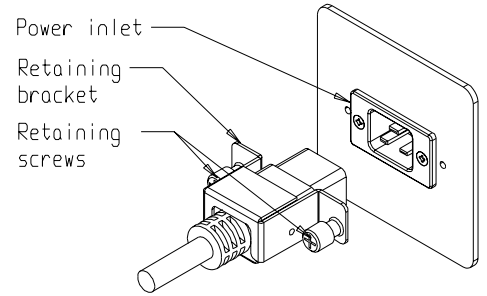
CONTACT RATING: 1A @ 30V  
CONTACTS IN ALARM STATE

Figure 1-8 shows the remote contacts in alarm state.

**Figure 1-8.** Remote Alarm Contacts

## Attach Power Cord

Insert the power cord into the power inlet module. Place the retaining bracket (P/N 195763) over the connector. Secure retaining screws.



**Figure 1-9.** Power Cord Connection

## Connect Unit to Electrical Power



See the serial tag on the side of the unit for electrical specifications or refer to the electrical schematics in this manual.

**Caution** If the factory installed option water-cooled condenser is present, do not turn the freezer on without water connected and flowing. Damage to the refrigeration system could occur within 5 minutes if water is not connected and flowing on unit start-up. Refer to Section 5. ▲

The freezer should be operated on a dedicated grounded service. Check the voltage rating on the serial tag of the unit and compare it with the outlet voltage. Then, with the power switch turned off, plug the line cord into the wall outlet.

First, turn on the freezer power switch. Then open the lower front door by grasping the bottom left corner. Locate the battery switch (Figure 1-5) and turn it to Standby mode (⏻). During initial freezer start-up, the system battery may require charging and the Low Battery indicator may illuminate.

**Note** Ensure the battery switch is turned to Standby mode (⏻). The rechargeable batteries require 36 hours to charge at initial start-up. A “Low Battery” alarm may occur until the batteries are fully charged. Should a power failure occur during the initial start-up period, the electronics will have limited operation. ▲

## Freezer Start-Up

With the freezer properly installed and connected to power, system set points can be entered. The following set points can be entered in Settings mode: Control temperature, high temperature alarm set point, low temperature alarm set point, and (optional) BUS set point. Default settings are shown in the table at right.

**Note** If the set point is changed and the low temperature and high temperature alarms are set 10° from the set point, the alarm set points will be adjusted automatically to maintain a distance of at least 10° from set point. ▲

**Table 1-2.** Default Settings

Default Settings	Temperature
Control Set Point	-80°C
High Temperature Alarm	-70°C
Low Temperature Alarm	-90°C
Optional BUS Set Point	-60°C

## Freezer Start-Up (continued)

**Caution** If the factory installed option water-cooled condenser is present, do not turn the freezer on without water connected and flowing. Damage to the refrigeration system could occur within 5 minutes if water is not connected and flowing on unit start-up. Refer to Section 5. ▲

## Set Operating Temperature

TSE Series freezers have an operating temperature range of -50°C to -86°C, depending on ambient temperature. The freezer is shipped from the factory with a temperature set point of -80°C. To change the operating temperature set point:

1. Press the Mode key until the Set Temperature indicator lights.
2. Press the up/down arrow key until the desired temperature set point is displayed.
3. Press Enter to save the set point.
4. Press the Mode key until the Run indicator lights for Run mode

If no keys are pressed, the freezer will automatically return to RUN mode after 5 minutes.

**Note** If the set point is changed and the low temperature and high temperature alarms are set 10° from the set point, the alarm set points will be adjusted automatically to maintain a distance of at least 10° from set point. ▲

## Set High Temperature Alarm

The high temperature alarm will activate an audible/visual warning when the freezer chamber temperature has reached or exceeded the high temperature alarm set point.

To set the high temperature alarm set point:

1. Press the Mode key until the Set High Alarm indicator lights.
2. Press the up or down arrow key until the desired high temperature alarm set point is displayed.
3. Press Enter to save the setting.
4. Press the Mode key until the Run indicator lights for Run mode.



## Set High Temperature Alarm (continued)

If no control keys are pressed, the freezer will automatically return to RUN mode after 5 minutes.

**Note** The high alarm set point must be set at least 5°C from the control set point. ▲

**Note** At initial start-up, the high temperature alarm is disabled until the cabinet reaches set point or 12 hours elapse. ▲

## Set Low Temperature Alarm

The low temperature alarm will activate an audible/visual warning when the freezer chamber temperature has reached or decrease below the low temperature alarm set point.

To set the low temperature alarm set point:

1. Press the Mode key until the Set Low Alarm indicator lights.
2. Press the up or down arrow key until the desired low temperature alarm set point is displayed.
3. Press Enter to save the setting.
4. Press the Mode key until the Run indicator lights for Run mode

If no control keys are pressed, the freezer will automatically return to RUN mode after 5 minutes.

**Note** The low alarm set point must be set at least 5°C from the control set point. ▲

## Run Mode

Run mode is the default mode for the freezer. This mode displays the cabinet temperature on the temperature display under normal operating conditions. In addition, the Run mode allows display of the high stage heat exchange temperature.

This information scrolls by pressing the up or down arrow keys. The display returns to the operating temperature in 10 seconds if no keys are pressed.

## Section 2 Calibrate

Once the freezer has stabilized, the control probe may need to be calibrated. Calibration frequency is dependent on use, ambient conditions and accuracy required. A good laboratory practice would require at least an annual calibration check. On new installations, all parameters should be checked after the stabilization period.



**Caution** Before making any calibration or adjustments to the unit, it is imperative that all reference instruments be properly calibrated. ▲

### Calibrate Control Probe

Plug a type T thermocouple reader into the receptacle located inside the lower door (see Figure 1-5). Compare the control temperature set point to the temperature of the measuring device.

1. Press the Mode key until the Calibrate indicator lights.
2. Press up/down arrow to match the display to calibrated instrument.
3. Press Enter to store calibration.
4. Press the Mode key to return to Run mode.

### Temperature Stabilization Periods

**Startup** - Allow 12 hours for the temperature in the cabinet to stabilize before proceeding.

**Already Operating** - Allow at least 2 hours after the display reaches set point for temperature to stabilize before proceeding.

During calibration, the temperature display will not be available. ▲

If no keys are pressed for approximately five minutes while in calibration mode, the system will reset to Run mode.

## Section 3 Alarms

The TSE Series freezer alarms are displayed on the freezer control panel. When an alarm is active, the indicator next to the alarm description will light and there will be an audible alarm. Press the Silence key to disable the audible alarm for the ringback period. The visual alarm will continue until the freezer returns to a normal condition. The alarms are momentary alarms only. When an alarm condition occurs and then returns to normal, the freezer automatically clears the alarm condition.

**Table 3-1.** Alarm Indicators

Description	Delay	Ringback	Relay
Power Failure	1 min.	15 min.	Yes
High Temperature Alarm	1 min.	15 min.	Yes
Low Temperature Alarm	1 min.	15 min.	Yes
Probe Failure - see Section 3	1 min.	15 min.	No
Door Open	1 min.	15 min.	No
Wrong Power	0 min.	none	Yes
Low Battery*	1 min.	8 hours	No
Low BUS Battery (optional)	1 min.	15 min.	No
Hot Condenser	1 min.	none	No
High Stage Failure	0 min.	15 min.	Yes
Micro Board Failure	0 min.	15 min.	Yes

*All alarm delays and ringback times are  $\pm 30$  seconds.*

*\* The automatic battery test runs immediately on power-up, then every 8 hours thereafter.*

## **High Stage System Failure**

The "high stage system failure" condition is created when the high stage compressor and fans run for 30 minutes and are not capable of cooling the interstage heat exchanger to the proper temperature. Under this condition, the high stage compressor and fans will turn off after 30 minutes and an audible and visual alarm will occur. The audible alarm can be silenced and will ring back every 15 minutes.

## **Probe Failure Alarm**

The microprocessor in TSE Series freezers continually scans all probes including the control probe, heat exchanger probe and condenser probe to ensure that they are operating properly. Should an error be detected, the "Probe Failure" alarm will occur as described above. If an error is detected with the control probe, the high and low stage compressors will run continuously. As a result, the cabinet temperature will decrease until it reaches the lowest temperature that the refrigeration system can maintain. If an error is detected with the heat exchanger probe, the freezer will cycle properly at its temperature set point using a 5 minute step start between the high and low stage compressors. If an error is detected with the condenser probe, there is no impact on the performance of the freezer; however, the hot condenser alarm may also occur. Contact the Technical Services department or your local distributor.

Error	Notes
Er00	<p><b>Name:</b> Improper model selected.</p> <p><b>Description:</b> Indicates that DIP SW3 has not selected a proper model or can't be accessed properly.</p> <p><b>Response:</b> Display shows "Er00" and will not start-up until a proper model is selected. Contact Technical Services.</p>
ErA1	<p>This error condition will prevent peripherals (fans, compressors, etc.) from powering up with the incorrect voltage.</p> <p><b>Name:</b> Voltage/Frequency failure</p>
ErC1	<p><b>Description:</b> Indicates the measured RMS line voltage did not agree with the logic level sensed by the micros provided by the installed high voltage PCB; or the measured RMS voltage is not within a tolerable range (180 &lt; Vac &lt; 270 for 230VAC unit / 85 &lt; Vac &lt; 160 for 115VAC unit); or the frequency measured over 10 cycles was not within a tolerable range (55 Hz &lt; Freq &lt; 70 Hz for 60 Hz units / 40 Hz &lt; Freq &lt; 55 Hz for 50 Hz units)</p>
ErD1	<p><b>Response:</b> This condition is checked at power on reset and if it is active, the unit will NOT power up. The unit will indefinitely display "Er_1" in the display and continue to monitor the frequency and voltage. Furthermore, the audible alarm will sound. Other startup error messages may be displayed prior to this message; however, the system will stop the startup sequence for this condition.</p>
ErE1	
ErF1	<p>ErA1 .. No pulses (zero crossings) detected to determine frequency (50 / 60 Hz)</p> <p>ErC1 .. Frequency detected is below 50 Hz</p> <p>ErD1 .. Frequency detected is above 60 Hz (possible noise spikes on supply voltage)</p>
ErG1	<p>ErE1 .. Unit is 230V and the voltage detected is below the low limit (180VRMS)</p> <p>ErF1 .. Unit is 230V and the voltage detected is above the high limit (260VRMS)</p> <p>ErG1 .. Unit is 115V and the voltage detected is below the low limit (85VRMS)</p>
ErH1	<p>ErH1 .. Unit is 115V and the voltage detected is above the high limit (160VRMS)</p>
Er02	<p><b>Name:</b> Control (Cabinet) Sensor Failure</p> <p><b>Description:</b> This condition indicates that the control sensor has failed to produce a valid reading for <math>\geq 12</math> consecutive reads (~60 seconds).</p> <p><b>Response:</b> The unit will stage both compressors on (if necessary) and the unit will attempt to head to bottom out. If the sensor recovers, the system will begin to operate normally and respond to the temperature feedback. The remote alarm contacts will become active. 'Er02' will be added to the main display queue and the last valid cabinet temperature value will not be displayed.</p>
Er03	<p><b>Name:</b> Heat Exchange Sensor Failure</p> <p><b>Description:</b> This condition indicates that the heat exchange sensor has failed to produce a valid reading for <math>\geq 12</math> consecutive reads (~60 seconds).</p> <p><b>Response:</b> The display will show "Er03" only when the button sequence to read the heat exchange sensor is depressed.</p>

### Section 3

#### Alarms

Error (cont.)	Notes
Er05	<p><b>Name:</b> Display Firmware Integrity Failure</p> <p><b>Description:</b> The display firmware has failed to pass its CRC CCITT checksum integrity test.</p> <p><b>Response:</b> The display performs this check at startup and the display board will fail to startup without any error indication if it does not pass this at power on.</p>
Er06	<p><b>Name:</b> Micro Firmware Integrity Failure</p> <p><b>Description:</b> The micro firmware has failed to pass its CRC CCITT checksum integrity test.</p> <p><b>Response:</b> This is checked at power on reset and the "Er06" will be displayed for ~10 seconds at startup if this condition exists.</p>
Er07	<p><b>Name:</b> Micro Fail - CS5521 SPI Failure / UISR Failure</p> <p><b>Description:</b> This condition indicates a micro board failure due to either the SPI bus is unable to communicate with the ADC device or a UISR event caused the microcontroller to be in an unstable state.</p> <p><b>Response:</b> The unit will try to recover from this fault three times by a hardware reset of the micro board. In the event that the system couldn't rectify the issue, the following sequence of events will occur:</p> <ol style="list-style-type: none"> <li>1. Remote alarm contacts will become active.</li> <li>2. Buzzer will annunciate audibly and will have a ringback of 15 minutes.</li> <li>3. "Seven segment" display will show "Er07".</li> <li>4. The system will have 10 minute staging between the high stage compressor and the low stage compressor activation.</li> <li>5. The system will go to bottom out temperatures.</li> </ol>
Er09	<p><b>Name:</b> Stuck Button</p> <p><b>Description:</b> This condition indicates that the display board has a stuck button.</p> <p><b>Response:</b> The Er09 will show on the display periodically.</p>
Er11	<p><b>Name:</b> Condenser Probe Sensor Failure</p> <p><b>Description:</b> This condition indicates that the condenser probe sensor has failed to produce a valid reading for <math>\geq 12</math> consecutive reads (~60 seconds).</p> <p><b>Response:</b> The display shows "Er11".</p>
dErr	<p><b>This is a general display error in which value being displayed can not be represented within characters provided.</b></p>
(Four dashes) ---- in display	<p><b>Name:</b> Lost Communication</p> <p><b>Description:</b> Communication between the micro board and the display board has been lost. Under this condition, the visual alarm flashes along with dashes in the temperature display (----). Contact Technical Services.</p>

## Section 4 Maintenance

### Clean Cabinet Exterior

Wipe down the freezer exterior using soap and water and a general use laboratory disinfectant. Rinse thoroughly with clean water and dry with a soft cloth.

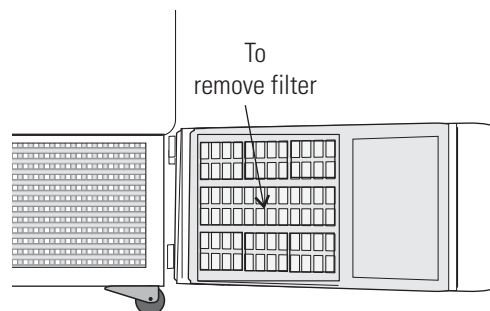


**Caution** Avoid the excessive use of water around the control area due to the risk of electrical shock. Damage to the controls may also result. ▲

### Clean Air Filter

The air filter should be cleaned four times a year, minimum.

1. Open the front lower door by grasping the bottom left corner.
2. Locate the grille on the door. See Figure 4-1. Grasp the middle of the grille material and gently pull out to remove.
3. Wash the filter material using water and a mild detergent.
4. Dry by pressing between two towels.
5. Install the filter back into the grille and attach the grille.



**Figure 4-1.** Grille with Filter Location

### Clean Condenser

The condenser should be cleaned once per year, minimum.

1. Open the front lower door by grasping the bottom left corner.
2. Using a vacuum cleaner, exercising care to not damage the condenser fins, clean the condenser.

Depending upon environmental conditions, the condenser may need to be cleaned more frequently.

## Clean Water-cooled Condenser

The water-cooled condenser can be cleaned-in-place by using the CIP procedure. Cleaning solutions can be used, depending on type of deposits or build-up to be removed.

**Note** Do not use liquids that are corrosive to stainless steel or the brazing material (copper or nickel). ▲

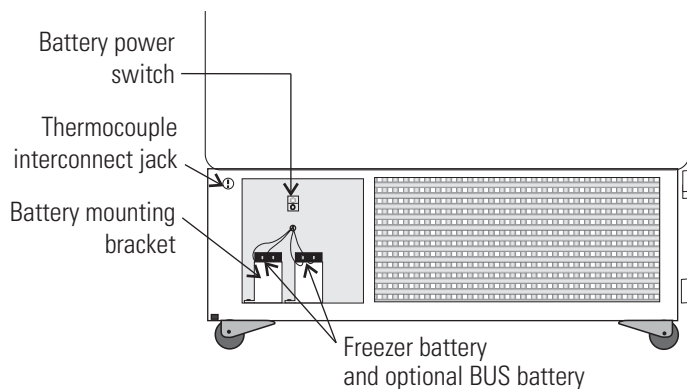
### CIP (Clean-In-Place) Procedure

1. Disconnect the unit from the water supply.
2. Drain the unit.
3. Rinse with fresh water and drain the unit again.
4. Fill with fresh water.
5. Add cleaning agent (solution and concentration dependent on deposits or build-up).
6. Circulate cleaning solution (if feasible).
7. Drain the cleaning solution.
8. Add and circulate a passivating liquid for corrosion inhibition of plate surfaces.
9. Drain this liquid.
10. Rinse with fresh water and drain.
11. Reconnect the water supply and fill the unit.
12. Return to service.

## Prepare Unit for Storage

Defrost the unit as described in 'Defrost Freezer'. This will prepare the unit for storage. Turn off the battery power switch (O). Turn off the freezer power switch. Disconnect power to the battery(s) and to the freezer.

**Note** If the unit has been in service, turn it off and disconnect the power cord connector before proceeding with any maintenance. ▲



**Figure 4-2.** Battery Power Switch



## Long Term Storage with Water-cooled Condenser



**Caution** To prevent permanent damage to the refrigeration system of this freezer, proper draining and preparation is required for long term storage. The water-cooled condenser must be dry and sealed. If stored clean and dry, restoring to service only requires a new in-line strainer filter, proper installation and waterflow balancing per Section 5, Water Cooled Condenser. ▲

**Required:** Cleaning solution, supply of dry air or N2

**Note** Do not use liquids corrosive to stainless steel or the brazing material (copper or nickel). Do not use hydrochloric acid or muriatic acid. ▲

1. Turn the freezer off.
2. Drain and clean the unit following the procedure in this section, Clean Water-cooled Condenser.
3. The condenser must be fully dry prior to storage. Use dry air to purge and dry the condenser circuit as much as possible. Since the freezer is not running, the internal valve will be closed and dry air cannot be circulated through the loop. Allow the condenser to dry, open to the air, until no moisture is seen at the connecting ports.
4. After the condenser water loop is dry, purge both the inlet and outlet with nitrogen or dry air and cap the ports.

**Note** On restarting a freezer that has been stored for some time, it is suggested to run the unit briefly, then check and clean the particulate filter, if fitted, to ensure that no sediment or growth occurred in the condenser during storage.

## Defrost Chamber

1. Remove all product and place it in another freezer.
2. Turn the unit off and disconnect it from the power source.
3. Turn off the battery switch (O). See Figure 4-6.
4. Open all of the doors and place towels on the chamber floor.
5. Allow the frost to melt and become loose.
6. Remove the frost with a soft cloth.
7. After defrosting is complete, clean the interior with a non-chloride detergent. Rinse thoroughly with clean water and dry with a soft cloth.
8. Plug unit in and turn power switch on.
9. Turn the battery power switch to Standby mode (⏻).
10. Allow the freezer to operate empty overnight before adding product.

## Clean Door Gasket

The door gasket should be cleaned monthly, minimum. Using a soft cloth, remove any frost build-up from the gasket and door(s). The door gasket may need to be cleaned more frequently if dirt or excessive frost build-up prevents the door from closing properly.

## Vacuum Relief Port

The exterior door gasket provides an excellent seal to protect product, provide an energy efficient thermal barrier to keep cold air in and room temperature air out, and reduce frost build up on the inner doors.

Because the door gasket seals so well, a vacuum can be created after a door opening. Warm air enters the cabinet, cools and contracts, creating a vacuum that pulls the door in tightly against the seal.

To equalize the pressure inside the cabinet after a door opening requires 1.5-3.0 cu.ft. of ambient air to be drawn into the cabinet. The amount of air required to equalize the pressure varies depending on the cabinet size, cabinet temperature, duration of door opening, inventory volume and the temperature/humidity of the ambient air. The unit is designed with a “vacuum relief port” that allows the pressure to be equalized.

The time required to draw 1.5-3.0 cu.ft. of air into the cabinet depends on two factors:

- a) size and number of paths available for the air to enter cabinet, and
- b) pressure difference between internal cabinet and ambient room.

Cabinets with the vacuum relief port operating normally, (i.e. vacuum relief port is not iced over) will require a minimum of 30 seconds up to a maximum of 120 seconds for the cabinet to equalize. This is also a good indication that the exterior door is well sealed.

The vacuum relief port requires routine maintenance. It will ice over unless preventive measures are taken. If the vacuum relief port becomes iced over, the freezer will take several hours to equalize pressure.



**Warning** Do not leave the freezer unattended while the door is unlatched. The vacuum could release, resulting in a door opening and product loss. ▲

Observe the inner side of port periodically for frost and ice build-up. Remove any frost with a soft dry cloth. If the tube should become clogged with ice, it must be cleaned. **Make sure during cleaning that the vacuum relief tube is completely free of ice to prevent rapid ice formation.**

Factors that can affect the performance of the vacuum relief port include: high ambient temperature, high humidity conditions and frequent door openings. Maintenance should be performed weekly or as needed.



**Warning** Failure to maintain the vacuum relief port may result in excessive ice build up inside the tube, clogging the port, and inability to open the door. The vacuum relief port may need to be cleaned more often with frequent door openings and high humidity environments. ▲

## Check Battery(s)

1. To gain access to the battery, open the lower door by grasping the bottom left corner. The battery is rectangular in shape, located on the front left corner of the compressor compartment and is secured in place by a mounting bracket.
2. Directly above the battery(s) is the battery power switch. Turn the battery power switch to the off position (O).
3. Cut the tie wrap securing the battery to the mounting bracket. Lift the battery out of the bracket.
4. Disconnect the red and black wires from the battery.
5. Use a voltmeter set to DC volts. Matching the wire colors, connect the meter to the battery.
6. If the voltage reads less than 10.8 volts, replace the battery. If above 10.8, re-install as previously.
7. Turn the battery power switch to Standby mode (⏻).
8. Close lower panel door.

## Replace Battery(s)

1. To gain access to the battery, open the lower door by grasping the bottom left corner. The battery is rectangular in shape, located on the front left corner of the compressor compartment and is secured in place by a mounting bracket.
2. Directly above the battery(s) is the battery power switch. Turn the battery power switch to the off position (O).
3. Disconnect the battery connections.
4. Remove the old battery and install the new battery.
6. Reconnect the battery (red to positive and black to negative).
7. Turn the battery power switch to Standby mode (⏻).
8. Close lower panel door.



**Warning** The % of charge can vary depending on the age, usage and condition of the battery. For a consistent and dependable charge, replace the battery every 2 years. Replacement batteries must be rechargeable and are available from Thermo. Refer to the parts list for stock number and description of the replacement batteries. Dispose of the used batteries in a safe manner and in accordance with good environmental practices. ▲

**PREVENTIVE MAINTENANCE**

**Freezers**

Your equipment has been thoroughly tested and calibrated before shipment. Regular preventive maintenance is important to keep your unit functioning properly. The operator should perform routine cleaning and maintenance on a regular basis. For maximum performance and efficiency, it is recommended that the unit be checked and calibrated periodically by a qualified service technician.

The following is a condensed list of preventive maintenance requirements. See the specified section of the instruction manual for further details.

We have qualified service technicians, using NIST traceable instruments, available in many areas. For more information on Preventive Maintenance or Extended Warranties, please contact the Technical Services Department. Cleaning and calibration adjustment intervals are dependent upon use, environmental conditions and accuracy required.

**Tips:**

- Fill an upright by starting at the bottom near the probe and add racks to one shelf at a time. Allow freezer to recover to set point between shelves.
- Fill a chest by starting at the left side near the probe. Filling with room temperature racks will result in a long pull-down time.
- Fill unit with frozen product to help overall performance; frozen water jugs, for example.
- Always make certain the vacuum relief port is free of frost and ice, to allow for timely re-entry into the freezer after a door opening.

Action	Monthly	Yearly	Every 2 Years
Verify ambient temperature, <90°F	✓		
* Adjust door handle for firm latching, as needed	✓		
Check and clean probe cover, gaskets, hinges and lid(s) of ice and snow. See Figure 1-4 for probe location. See “Cleaning the Lid Gasket”.	✓	<i>More frequent cleaning may be required, depending on use and environmental conditions.</i>	
Check air filter. Clean or replace as needed. See “Cleaning the Air Filter”.		✓ 4X	
Check alarm back-up battery. See “Connecting the unit to Electrical Power” in Section 1 and “Replacing the Battery” in Section 4.	✓		**Replace
Check condenser fan motor for unusual motor noise or vibration.		✓	
* Verify and document calibration, at the minimum, annually. See Section 2 Calibration.		✓	
* Clean condenser compartment and wipe off condenser See “Cleaning the condenser” in Section 4.		✓	
Preventive Maintenance *Back-up System - inject test & battery. See Section 5.	✓		

**To minimize ice build-up inside of freezer:**

- Locate the freezer away from drafts or heating/cooling vents
- Keep the number of door openings to a minimum
- Minimize the length of time door is open
- Make sure door latches securely after opening

## Section 5 Factory Installed Options

### Back Up System (BUS) - P/N 1960445, 1960447

**Note** Before installation of BUS components, make sure the power to the freezer is disconnected, the battery switch is turned off (O) and the freezer has warmed to ambient temperature. ▲

The built-in BUS (back up system) maintains the freezer chamber temperature below the critical level in the event of a power or equipment failure. If power to the freezer fails, or temperature increases to the back up alarm set point, the BUS injects liquefied gas into the chamber to keep the chamber temperature within the specified range.

The BUS operates on an internal 12-volt, rechargeable battery which is kept charged during normal operation by the integral battery charger.

### Install Vent Stack, Solenoid and Injection Assembly

1. Install the injection assembly through the 1/2" pre-punched hole, directly behind the 2" vent stack hole in the center of the chamber ceiling.

**Note** Cover the open end of injection assembly with tape to keep insulation from entering the nipple. ▲

2. Slide 3/8" flatwasher over open end of nipple.
3. Insert the covered end of the injection assembly through the exterior hole.
4. Remove the tape covering from the end of the nipple and install the 1/8" NPT brass tee on the open end of the nipple. Place Permagum sealant between the brass tee and the interior top.
5. Remove the two Phillips head screws securing the metal bracket on the vent stack assembly.
6. Install the vent stack through the opening and secure it to the top of the freezer, using screws.

## Install Vent Stack, Solenoid and Injection (continued)

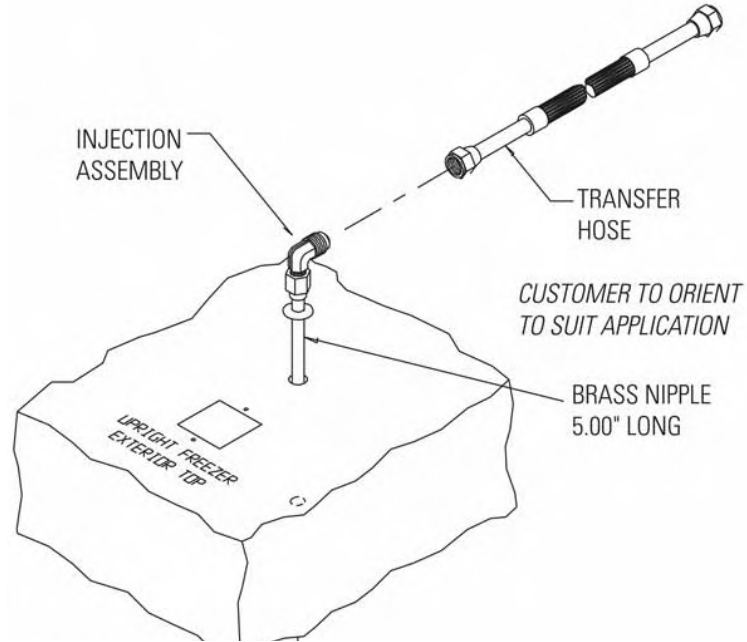


Figure 5-1. Injection Assembly

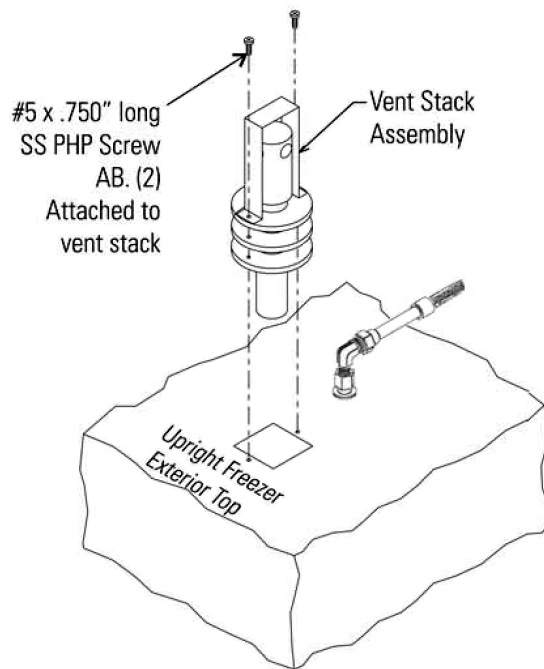


Figure 5-2. Vent Stack Assembly

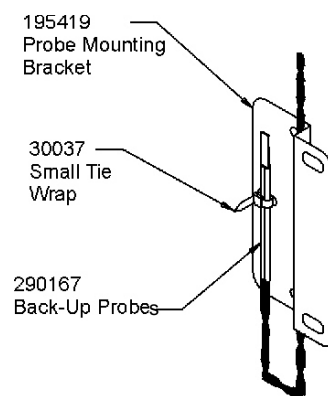
## Install Vent Stack, Solenoid and Injection (continued)

7. Inside the chamber, seal around the end of the vent stack with Permagum.
8. Install the transfer hose connecting one end to the injection assembly, the other to the solenoid valve. Connect the solenoid valve to the supply source. The solenoid mounting bracket may be discarded.

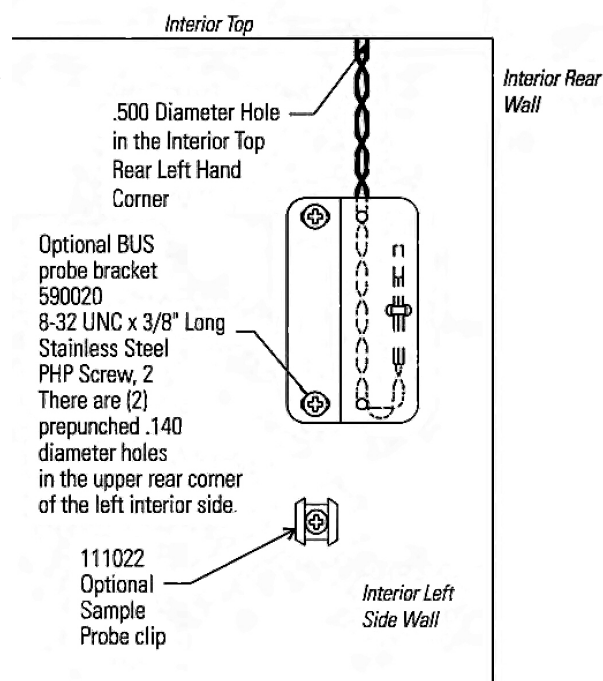
**Note** When selecting a CO<sub>2</sub> supply cylinder, it must be equipped with a siphon tube. ▲

## Install Temperature Probe

1. Locate the 0.500" pre-punched hole in the upper left hand back corner of the chamber ceiling. Remove the tie wrap securing the coiled probe/solenoid harness. Uncoil the probe lead and run the probe tip (approximately 12") down through 0.500" porthole (Figure 5-4).
2. As shown in Figure 5-3, thread the small tie wrap through the openings in the front of the bracket. Secure the probe on the back of the bracket with the tie wrap.
3. Tap #8-32 the two pre-punched holes located on the interior left wall of the freezer. Mount the bracket. Figure 5-4 shows the Back-Up probe mounted on the interior left side wall of the freezer.



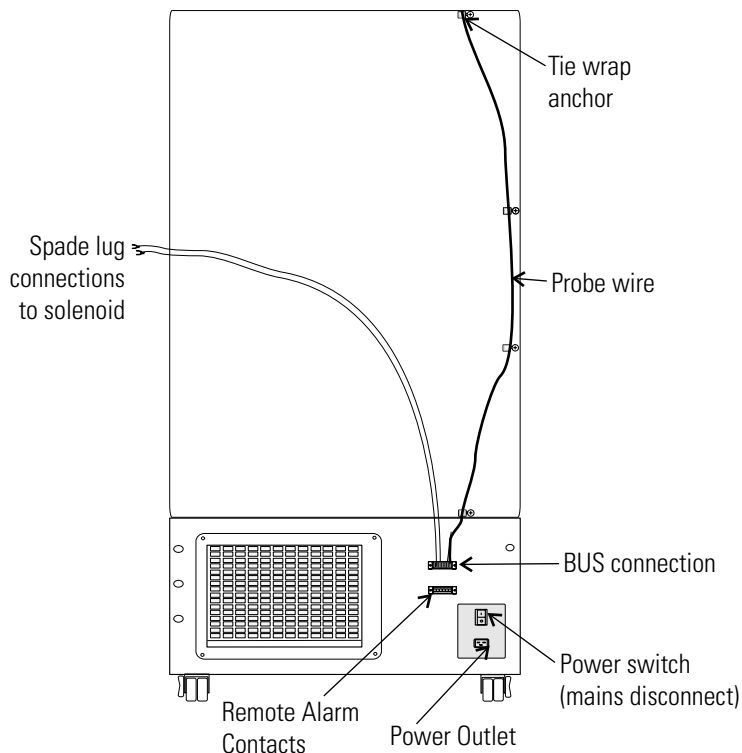
**Figure 5-3.** Secure probe



**Figure 5-4.** Mounted probe clip

## Section 5

### Factory Installed Options



**Figure 5-5.** Probe wire and solenoid connections

## Connect Probe/Solenoid Harness

1. Remove the four screws on the freezer back panel and use them to mount the tie wrap anchors as shown in Figure 5-5. Secure the probe wire with tie wraps.
2. Plug the solenoid/probe connector into the BUS connection and secure with a screw on the right and left side. The connector is keyed.
3. Loosen the terminal screws on the solenoid. Slide the spade lug connectors under the screws and tighten to secure.
4. Connect power to the freezer. Turn the freezer On, with battery switch Off (O).

### a. Arming on Power On

The arming function occurs only one time at initial power-on. It may occur in 3 ways; BUS timeout arming, both sensors fail and BUS temperature sensor arming.

At power-on, the BUS will perform a Hold-off period check. The BUS will not inject the refrigerant for a Hold-off period, calculated as follows:



Hold-off period:

- 12 hour is between 0 and +70C
- 12 hour is between 0 and (BUS Setpoint - Hysteresis)
- 0 hours is below (BUS Setpoint - Hysteresis)
- 0 hours is temperature Out Of Range or both probes fail.

b. The Low Battery indicator may also illuminate.

5. Turn the battery switch to Standby mode (⏻) to charge both batteries.

## BUS Control Panel

The following section describes the configuration and operation of the BUS.



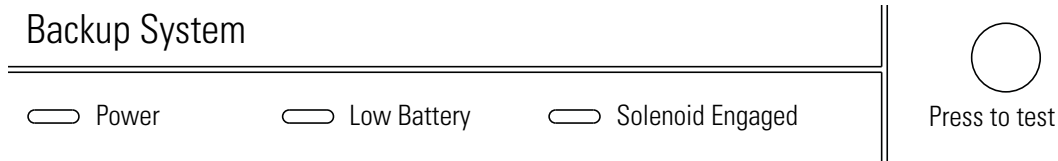
**Warning** When activated, this unit injects liquid nitrogen or carbon dioxide. Liquid nitrogen can cause serious freezing (frostbite) if it comes in contact with unprotected skin or eyes. Nitrogen suppresses oxygen levels and may cause suffocation if area is not well ventilated. Refer to Appendix A for the proper handling of liquid LN<sub>2</sub>. ▲



**Caution** Make sure the pressure relief valve on any LN<sub>2</sub> tank is adjusted to 30 PSI maximum blow-off. ▲



**Warning** Carbon dioxide gas suppresses oxygen levels and may cause suffocation if area is not well ventilated. Refer to “Handling Liquid CO<sub>2</sub> in Appendix B of this manual. ▲



**Figure 5-6.** BUS Control Panel

**Power** - indicates the unit has AC power.

1. Normal Operation

- Low Battery: Illuminates only after a battery test which occurs every 8 hours. The battery test is a loaded test and during the test, the battery voltage is monitored. When the battery voltage is less than a certain threshold, this light will illuminate and stay illuminated until the next battery test.
- Solenoid Engaged: Illuminates any time the controller is activating the solenoid. Illumination will only occur when the controller senses the solenoid is active and calling for injection.

## BUS Control Panel (cont.)

### 2. Fault Code

This same user interface will also permit fault codes to be easily viewed when the user presses and releases the Press to Test button in less than 2 seconds. When this occurs, both the Low Battery LED and Solenoid Engaged LED will blink twice ON/OFF quickly indicating that fault code display mode is active. For the next ~10 seconds, the fault codes will be displayed as shown in the table below. The display shows only

Low Battery LED	Solenoid Engaged LED	Fault Code Number	Fault Code Definition
OFF	OFF	0	Normal Operation
OFF	Blinks 1 time	1	Primary Probe Failure
OFF	Blinks 2 times	2	Secondary Probe Failure
OFF	Blinks 3 times	3	Solenoid Driver Failure
OFF	Blinks 4 times	4	Low Tank

**Table 5-1.** BUS fault codes

Each blink will take one second, with half of the second interval being ON (illuminated) and the other half of the second interval being OFF. After the sequence concludes, both the Low Battery LED and the Solenoid Engaged LED will flash four times ON/OFF quickly to indicate a return to normal display.

### 3. BUS Injection Test

The user must press and hold the Press-to-Test button for  $\geq 2$  seconds before injection occurs. After the Press-to-Test button is pressed for  $>30$  seconds, the solenoid will turn off. This will avoid a button or button signal becoming stuck in an active condition.

During a Press-to-Test injection, if either RTD #1 or RTD #2 reads a temperature less than  $20^{\circ}\text{C}$  below BUS set point and it is determined to be a valid input, then injection will terminate immediately.

### 4. BUS Set point “Validation” Feedback

Whenever the BUS set point or working fluid changes, the BUS acknowledges the set point acceptance by causing the Low Battery LED and Solenoid Engaged LED to blink three times ON/OFF quickly. This does not imply that the BUS error-checked the values, other than that the value received was within the range of the BUS working correctly with prior programming.)

**Note** Solenoid will not engage if door is open. ▲

## BUS Control Panel (cont.)



**Caution** The back-up system is designed to inject refrigerant (CO<sub>2</sub> or LN<sub>2</sub>). In the unlikely event of both probes failing, the back-up system will operate in PWM or Non-PWM mode based on jumper settings as per Note below. ▲

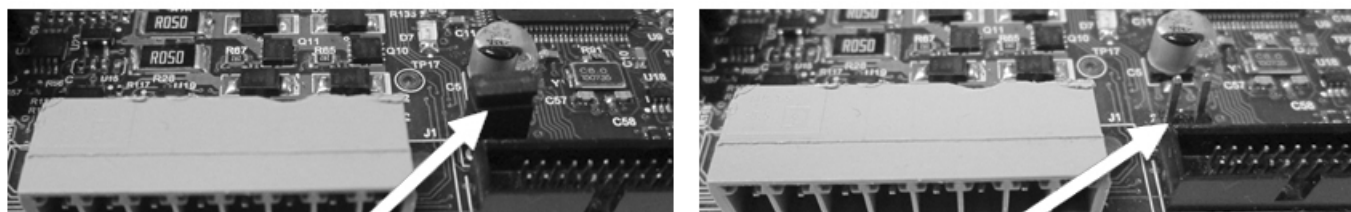
For Hysteresis & Dual probe fault mode settings (Figure 5-7), locate Jumper J17 near to solenoid/sensor connector (J1), refer to the following table for operation details:

Jumper PIN	Status	Hysteresis	Dual Probe Fault Mode
J17 PIN 1 & PIN 2	Short Together/ Jumper Cap Installed	5°C	Non-PWM Mode
J17 PIN 1 & PIN 2	Open/No-Jumper Installed	9°C	PWM Mode

**Table 5-2.** Probe fault modes

PWM mode: If both probes fail, the solenoid will activate periodically, allowing the flow of refrigerant (CO<sub>2</sub> or LN<sub>2</sub>).

Non-PWM mode: If both probes fail, the solenoid remains OFF and no refrigerant will flow.



**Figure 5-7.** Jumper Cap for Hysteresis & Dual Probe Fault Mode Selection

## Configure Optional BUS (Back-Up System)

The optional BUS can be configured for LN<sub>2</sub> or CO<sub>2</sub> supply. To select the supply type:

1. Press the Mode key until the Backup indicator lights.
2. Press the up or down arrow key. The display will show “cO<sub>2</sub>” or “Ln<sub>2</sub>” for selection.
3. Press Enter to save the setting.
4. Press the Mode key until the Run indicator lights for Run mode

If no control keys are pressed, the freezer will automatically return to to RUN mode after 5 minutes.

## Set Optional BUS Set Point

The optional back up system is designed to inject CO<sub>2</sub> or LN<sub>2</sub> into the freezer compartment if the temperature rises above back up system set point. To set the BUS set point:

1. Press the Mode key until the Set Temperature and Backup indicators light.
2. Press the up or down arrow key until the desired BUS set point is displayed.
3. Press Enter to save the setting.
4. Press the Mode key until the Run indicator lights for Run mode

If no control keys are pressed, the freezer will automatically return to to RUN mode after 5 minutes.



**Warning** Changing the operating temperature set point can affect the BUS set point. The BUS set point will self-adjust to maintain a temperature of at least 10°C above the operating temperature set point. ▲

**Note** The BUS set point can not be set any colder than the high temperature alarm set point. (See Section 1 - “Setting the High Temperature Alarm). If the back-up system is installed with CO<sub>2</sub>, then -65°C is the coldest BUS set point that can be used (if the cabinet set point is -75°C or colder). ▲

## Test BUS Operation

After the freezer has stabilized and both batteries are fully charged, the BUS can be tested to verify proper operation.

1. Disconnect the AC power to the freezer by turning power switch off.
2. As the freezer warms up, verify the BUS injects at the desired temperature. Displayed temperature may vary by a few degrees from inject temperature due to the differences in probe locations.
3. **Preventive Maintenance** - Monthly maintenance action to check CO<sub>2</sub> or LN<sub>2</sub> back-up system operation, and battery voltage.

- Check for fault codes on the BUS probe per Table 5.1 (page 5-6).  
Also verify solenoid operation by performing a Press-To-Test.

## Clean Vent Stack

Routinely check the vent stack for frost or ice build-up. The type of frost that forms in the vent stack is generally very soft and may be easily removed with a bristle brush or soft cloth. If ice build-up has occurred, a complete defrost may occasionally be required. See Section 4 for freezer defrost instructions.

## Disconnect Fitting Asm. and Transfer Hose

To disconnect the freezer back-up from the gas supply:

1. Close the supply valve.
2. Depress the test button on the BUS control box to remove the gas from the line.
3. Slowly disconnect the fitting assembly from the supply (in the event that any gas remains in the line).

## Chart Recorder

The following section describes the set up and operation of the optional chart recorder.

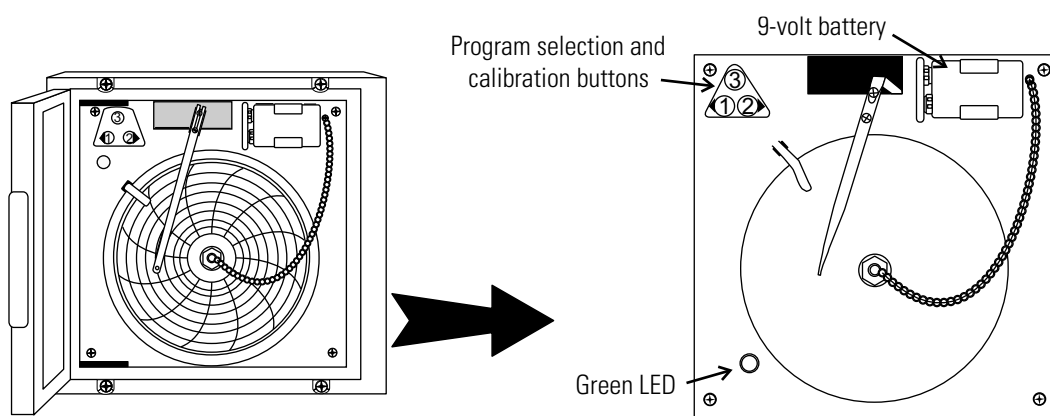


Figure 5-8. Recorder Details

## Installing the Chart Paper

1. Open the plastic door of the recorder and press button #3 until the pen begins to move outward.
2. Unscrew the knob at the center of the chart and remove the paper.
3. Install the new chart paper, position the paper to the correct time line and replace the knob.
4. Remove the cap from the felt pen and press button #3.

## Change Recorder Temperature Range

The chart recorder contains eight factory programmed temperature ranges. To change the recorder range:

1. Press and hold button #3 for one second, then let the pen move off the chart paper.
2. Press and hold for five seconds either button #1 or button #2.

## Change Recorder Temperature Range (cont.)

3. Release button and the green LED begins to flash. Count the number of flashes to determine the present program setting.
4. To change the program setting, press the left or right arrows to increase or decrease the count.
5. When the desired program number is flashing, press button #3 to bring the pen arm back onto the chart. Recording will begin in the new program.

Program	From	To
1	-40	30°C
2	0	60°C
3	-100	38°C
4	-5	50°C
5	0	100°C
6	-100	200°C
7	-115	50°C
8	-10	70°C

## Recorder Calibration

**Note** The recorder must be in service for 24 hours before performing the following calibration procedure. ▲

1. Place an accurate thermometer in the chamber next to the recorder probe. Temperature probes for the recorder are located in the left front corner of the freezer chamber (Figure 1-4).
2. After about three minutes, compare the thermometer reading with the chart recorder reading.
3. If an adjustment is necessary, press the #1 button to move the pen to the left or the #2 to move the pen to the right. The button must be held about five seconds before the pen begins to move. Release the button when the pen position matches the thermometer.

**Note** The felt-tip pen on the recorder requires periodic replacement. The ink will appear to fade before replacement becomes necessary. Additional pen tips may be purchased from Thermo. ▲

## Datalogger

Dataloggers and ELPRO evaluation software provide monitoring and documentation of temperature and alarm conditions. The dataloggers have a memory capacity of 64,000 measured values or data points. Temperature is measured, stored and displayed. Alarm conditions are recorded. Evaluation software permits data to be downloaded to a PC. A variety of statistical information is provided through calculations, analysis, graphs and printed reports. Refer to ELPRO documentation for operation.

## Water-cooled Condenser

The water-cooled condenser is a factory installed option (195964 [13 cu ft], 195965 [17, 23, 28 cu ft], 195967 [12, 17, 20 cu ft chest]) and requires a qualified technician at freezer installation. Installation should include proper adjustment of the regulating valve, which controls the discharge pressure. Refer to Table 5-3 for the specifications for this option.

## Water-cooled Condenser (cont.)

Water Pressure	Not to exceed 90 psig (620.5 kpa)
Water Temperature Range	Not to exceed 29.4C (85F)
Inlet Connection	½" NPT
Outlet Connection	½" NPT
Flow Rate Required (minimum)	1.0 gallons (3.8 liters) per minute

**Table 5-3.** Water-Cooled Condenser Specifications

**Water Quality:** Free of particulates that could cause a blockage, or impair function of the regulating valve or heat exchanger. A stainless steel inline strainer is factory installed in the inlet pipe to minimize particulates in the water supply.

**Water Drainage:** If water return line labeled WATER OUTLET is not connected to a closed loop chiller system, connect the return line water to a reservoir tank or drain. This will hold/dispose of the water from the freezer to avoid flooding.

To verify operating requirements, you will need:

- a flowmeter capable of measuring up to at least 5.3 gallons (20 liters) per minute to measure flow rates at the water return line labeled WATER OUTLET.
- a pressure gauge ranging from 0 to 300 psig to measure pressure at the water inlet labeled WATER INLET.
- a thermocouple or other temperature monitor to measure the water temperature near the water inlet fitting labeled WATER INLET.

**Clearance:** Before installing water connections, position freezer with an extra 2 inches (5cm) clearance in back for a hose. This is in addition to the 6 inches (15cm) clearance in back previously recommended in this manual.



**Caution** When using multiple freezers in a water loop, proper water flow and inlet temperature must be maintained for EACH freezer in the loop. It is recommended that a valve be installed in the supply line of each freezer to facilitate a balanced flow rate.

If the number of freezers in a loop is more than 5, it is recommended that one freezer be started at a time and tested to verify water flow, before starting all and allowing to run. Water flow of at least 1 gpm, at or below the maximum allowed inlet temperature, is required. Values higher than minimum are acceptable. **Do not allow the freezer to continue to run with no observed water flow within several seconds of compressor starting.** ▲

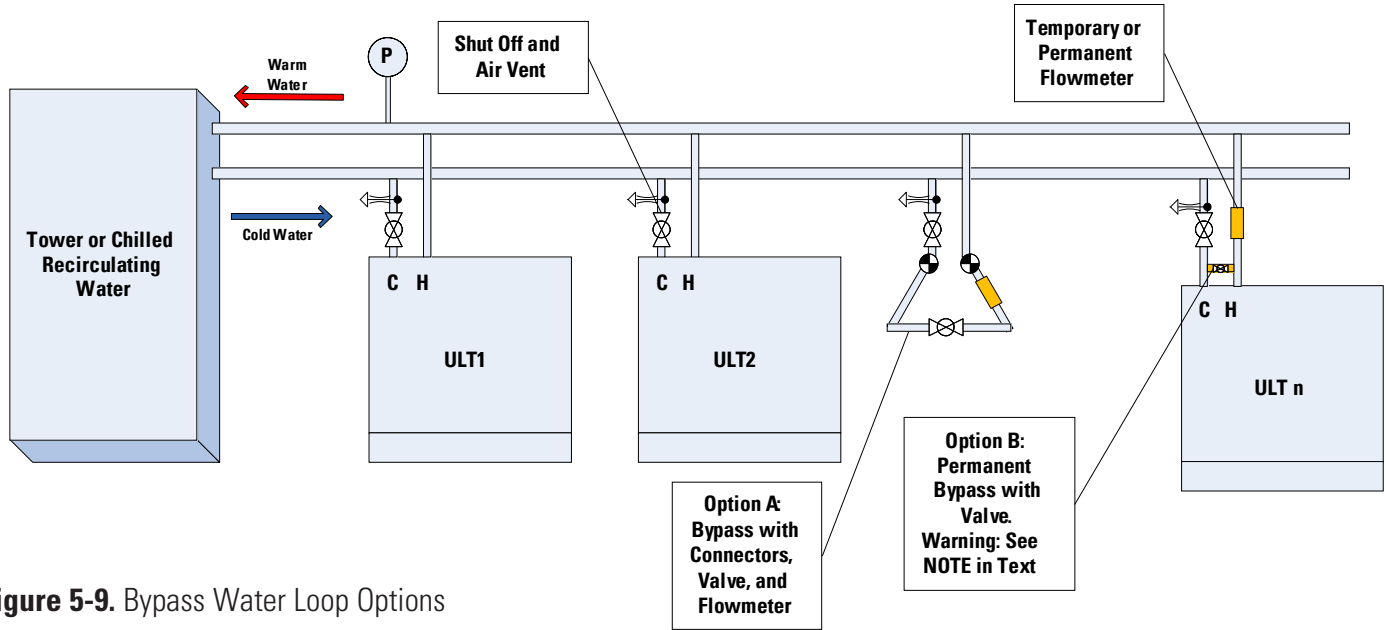


Figure 5-9. Bypass Water Loop Options

**Recommended Bypass Water Loop Assembly:** The bypass loop contains fittings, a valve, and a flowmeter to simulate the presence of a freezer and allows for balancing of the entire water supply system to ensure that 1 gpm is available for each freezer in the loop before the freezers are started. Values higher than minimum are acceptable. **Do not adjust the valve inside the deck of the freezer. It is pre-set at the factory.**

Option A: Install the bypass instead of a freezer (Figure 5-9).

Option B: Install the bypass permanently (Figure 5-9) so that all freezers can be left connected but water flow can be simulated using the bypass without turning on all freezers.



**Caution** If Option B is used, the bypass valve **MUST** be closed prior to freezer operation to ensure all water passes through the freezer rather than the bypass. Failure to do this will result in damage to the freezer. ▲

## Water Connections

To install the water connections:

1. It is recommended to install automatic air purge vents near the water inlet (or in each branch circuit in larger systems) to ensure air is purged from the lines as the system operates.
2. Remove the caps from the WATER INLET/WATER OUTLET fittings on lower back of the freezer.

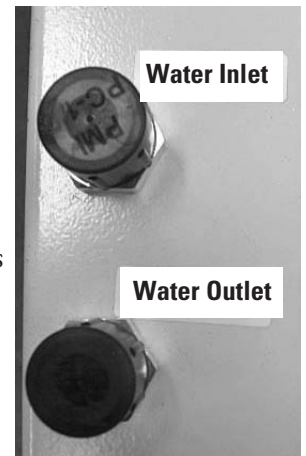


Figure 5-10. Fittings





**Caution** Thread sealant or Teflon® tape is highly recommended for use on threaded fittings. ▲

3. Make sure the water line is clear of blockage or debris.
4. Connect the incoming water supply line to the WATER INLET fitting.
5. Connect the water return/drain line to the WATER OUTLET fitting.
6. Adjust to specified operating standards (pressures, temperature).
7. Turn on water flow to the unit. Check for leakage. Close bypass, if installed.
8. Refer to the Installation and Start-Up section of this manual before starting the freezer.
9. Adjust the water flow rate. Note that the water will not flow through the outlet until the first stage compressor is running. Do not confuse the fan running with the compressor start-up.



**Caution** Only authorized service personnel should turn the freezer on without water connected and flowing. ▲



**Caution** See Bypass Water Loop Assembly information, if required. ▲

## Five Inner Door Option

The five inner door option (P/N 189405 [13 cu ft], 189406 [17 cu ft], 189407 [23 cu ft], 195652 [28 cu ft]) is factory installed. The freezer is converted to accommodate four adjustable specimen shelves with the fifth “shelf” as the bottom of the freezer chamber.

## Section 6 Specifications

Number	TSE240V	TSE240D	TSE240A
<b>Temperature Range</b>	-50°C (-58°F) to -86°C (-123°F) in an 18C to 32C * (64.4F to 89.6F) ambient		
<b>Exterior Dimensions</b>	33.3"W x 77.9" H x 32.9" F-B (84.6cm x 197.9cm x 83.6cm)		
<b>Interior Dimensions</b>	23.0"W x 51.5"H x 19.3" F-B (58.4cm x 130.8cm x 49.0cm)		
<b>Capacity</b>	13.0 cu. ft. (368.1 liters)		
<b>Refrigeration</b>	Two 1 HP (2545 BTUH each)		
<b>Insulation</b>	Non CFC, foamed-in-place urethane: 5.0" (12.7cm) cabinet; 4.5" (11.4 cm) door		
<b>Electrical</b>	230VAC, 50 Hz, 12.0 FLA Operating Range: 208VAC-240VAC	208-230VAC, 60 Hz, 12.0 FLA Operating Range: 208VAC-240VAC	120VAC, 60 Hz, 16.0 FLA Operating Range: 108VAC-130VAC
<b>Breaker Requirements</b>	15 Amp, Dedicated Circuit, 15 Amp Time Delay Breaker	15 Amp, Dedicated Circuit, 15 Amp Time Delay Breaker	20 Amp, Dedicated Circuit, 20 Amp Time Delay Breaker
<b>Shipping Weight</b>	696 lbs. ( 316 kg)		

Number	TSE320A	TSE320V	TSE320D
<b>Temperature Range</b>	-50°C(-58°F) to -86°C(-123°F) in an 18C to 32C * (64.4F to 89.6F) ambient		
<b>Exterior Dimensions</b>	33.3"W x 77.9" H x 38.9" F-B (84.6cm x 197.9cm x 94.0cm)		
<b>Interior Dimensions</b>	23.0"W x 51.5"H x 25.3" F-B (58.4cm x 130.8cm x 64.3cm)		
<b>Capacity</b>	17.3 cu. ft. (489.9 liters)		
<b>Refrigeration</b>	Two 1 HP (2545 BTUH each)		
<b>Insulation</b>	Non CFC, foamed-in-place urethane: 5.0" (12.7cm) cabinet; 4.5" (11.4 cm) door		
<b>Electrical</b>	120VAC, 60 Hz, 16.0 FLA Operating Range: 108VAC-130VAC	230VAC, 50 Hz, 12.0 FLA Operating Range: 208VAC-240VAC	208-230VAC, 60 Hz, 12.0 FLA Operating Range: 208VAC-240VAC
<b>Breaker Requirements</b>	20 Amp, Dedicated Circuit, 20 Amp Time Delay Breaker	15 Amp, Dedicated Circuit, 15 Amp Time Delay Breaker	15 Amp, Dedicated Circuit, 15 Amp Time Delay Breaker
<b>Shipping Weight</b>	763 lbs. (346 kg)		

**Section 6**  
Specifications

Number	TSE400V	TSE400D	TSE400A
<b>Temperature Range</b>	-50°C(-58°F) to -86°C(-123°F) in an 18C to 32C * (64.4F to 89.6F) ambient		
<b>Exterior Dimensions</b>	40.8"W x 77.9" H x 38.9" F-B (103.6cm x 197.9cm x 94.0cm)		
<b>Interior Dimensions</b>	30.6"W x 51.5"H x 25.3" F-B (77.7cm x 130.8cm x 64.3cm)		
<b>Capacity</b>	23.0 cu. ft. (651.3 liters)		
<b>Refrigeration</b>	Two 1 HP (2545 BTUH each)		
<b>Insulation</b>	Non CFC, foamed-in-place urethane: 5.0" (12.7cm) cabinet; 4.5" (11.4 cm) door		
<b>Electrical</b>	230VAC, 50 Hz, 12.0 FLA Operating Range: 208VAC-240VAC	208-230VAC, 60 Hz, 12.0 FLA Operating Range: 208VAC-240VAC	120VAC, 60 Hz, 16.0 FLA Operating Range: 108VAC-130VAC
<b>Breaker Requirements</b>	15 Amp, Dedicated Circuit, 15 Amp Time Delay Breaker	15 Amp, Dedicated Circuit, 15 Amp Time Delay Breaker	20 Amp, Dedicated Circuit, 20 Amp Time Delay Breaker
<b>Shipping Weight</b>	900 lbs. (408 kg)		

Number	TSE600V	TSE600D
<b>Temperature Range</b>	-50°C(-58°F) to -86°C(-123°F) in an 18C to 32C * (64.4F to 89.6F) ambient	
<b>Exterior Dimensions</b>	46.8"W x 77.9" H x 38.9" F-B (118.9cm x 197.9cm x 94.0cm)	
<b>Interior Dimensions</b>	36.6"W x 51.5"H x 27.0" F-B (93.0cm x 130.8cm x 68.6cm)	
<b>Capacity</b>	28.0 cu. ft. (792,8 liters)	
<b>Refrigeration</b>	Two 1 HP (2545 BTUH each)	
<b>Insulation</b>	Non CFC, foamed-in-place urethane: 5.0" (12.7cm) cabinet; 4.5" (11.4 cm) door	
<b>Electrical</b>	230VAC, 50 Hz, 12.0 FLA Operating Range: 208VAC-240VAC	208-230VAC, 60 Hz, 12.0 FLA Operating Range: 208VAC-240VAC
<b>Breaker Requirements</b>	15 Amp, Dedicated Circuit, 15 Amp Time Delay Breaker	15 Amp, Dedicated Circuit, 15 Amp Time Delay Breaker
<b>Shipping Weight</b>	1070 lbs. (485 kg)	

**Certifications**

Declaration of Conformity is available upon request.

**Safety Specifications**

Indoor Use Only

Altitude - up to 2,000 meters

Temperature - 5°C to 43°C

Humidity - Maximum RH 80% for temperatures up to 31°C, decreasing linearly to 50% RH at 40°C

Mains Supply Fluctuations - Mains supply voltage fluctuations not to exceed ±10% of the nominal voltage

Installation Category II <sup>1</sup>

Pollution Degree 2 <sup>2</sup>

Class of Equipment I

**Intended Use**

This product is intended for use as a General Purpose Laboratory Freezer for storing samples or inventory between -50 and -86C.

This unit is not intended for use in an explosive environment, nor to be used for the storage of flammable inventory. This unit is not intended for use in a Class II medical application as defined by Title 21 of the Federal Code of Regulations.

**Fluorinated Greenhouse Gases**

Compliant with Regulation(EU) No 517/2014 of the European Parliament and of the council on fluorinated greenhouse gases.

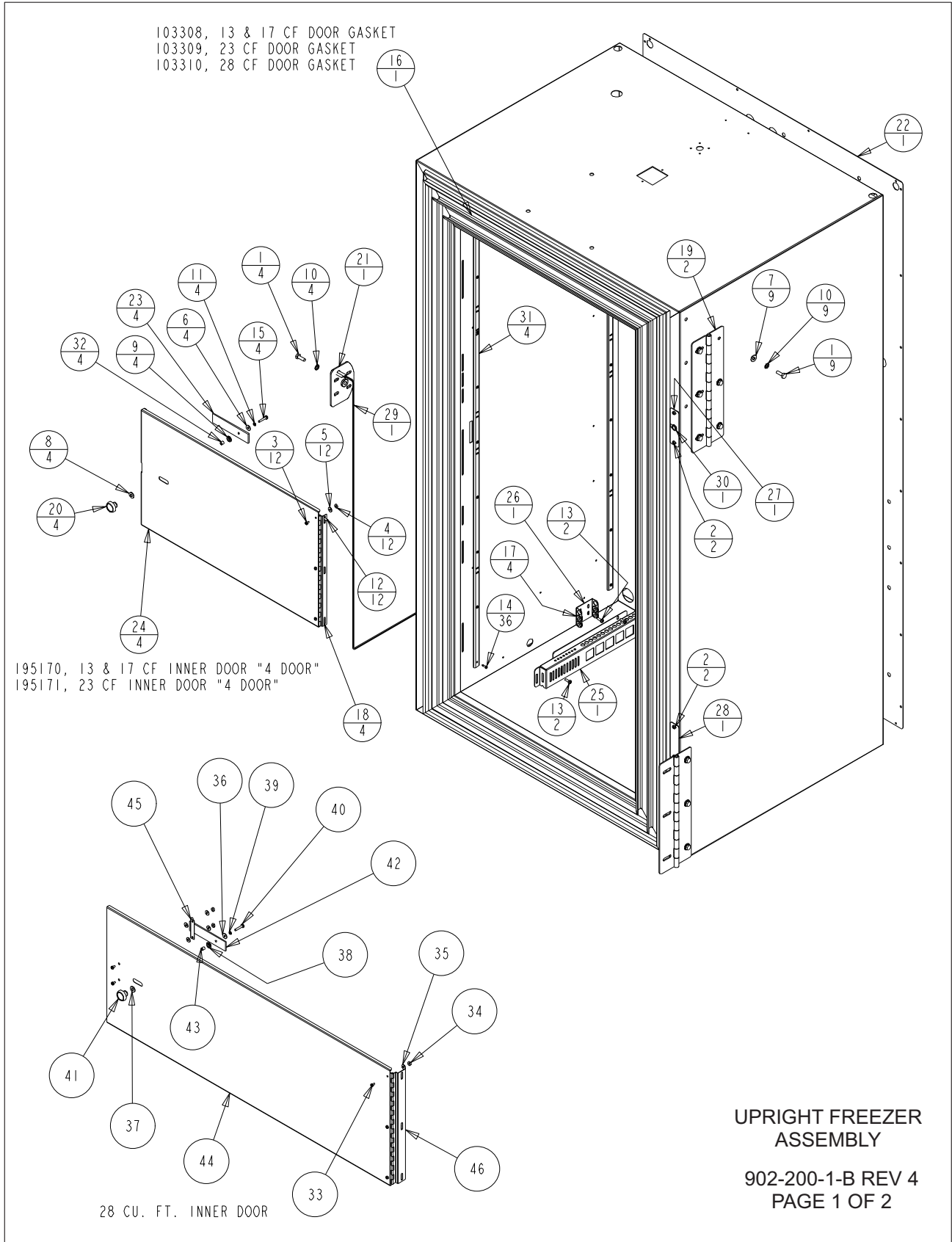
This product contains fluorinated greenhouse gases in a hermetically sealed system. This product contains foam blown with fluorinated greenhouse gas, R-245fa. If a leak in the sealed system is detected, the operator shall repair without undue delay.

For ULT models rated 230V/50Hz, intended for import into the EU, the following sizes are designed for use with the following amounts of fluorinated greenhouse gases:

Size (ft <sup>3</sup> )	1st Stage			2nd Stage		
	Refrigerant	Amount (kg)	GWP	Refrigerant	Amount (kg)	GWP
<b>13</b>	R-404a	0.723	3 922	R-508b	0.306	13 396
<b>17</b>	R-404a	0.751	3 922	R-508b	0.388	13 396
<b>23</b>	R-404a	0.751	3 922	R-508b	0.425	13 396
<b>28</b>	R-404a	0.652	3 922	R-508b	0.397	13 396

<sup>1</sup> Installation category (overvoltage category) defines the level of transient overvoltage which the instrument is designed to withstand safely. It depends on the nature of the electricity supply and its overvoltage protection means. For example, in CAT II which is the category used for instruments in installations supplied from a supply comparable to public mains such as hospital and research laboratories and most industrial laboratories, the expected transient overvoltage is 2500V for a 230V supply and 1500V for a 120V supply.

<sup>2</sup> Pollution degree describes the amount of conductive pollution present in the operating environment. Pollution degree 2 assumes that normally only non-conductive pollution such as dust occurs with the exception of occasional conductivity caused by condensation.



**Section 7**

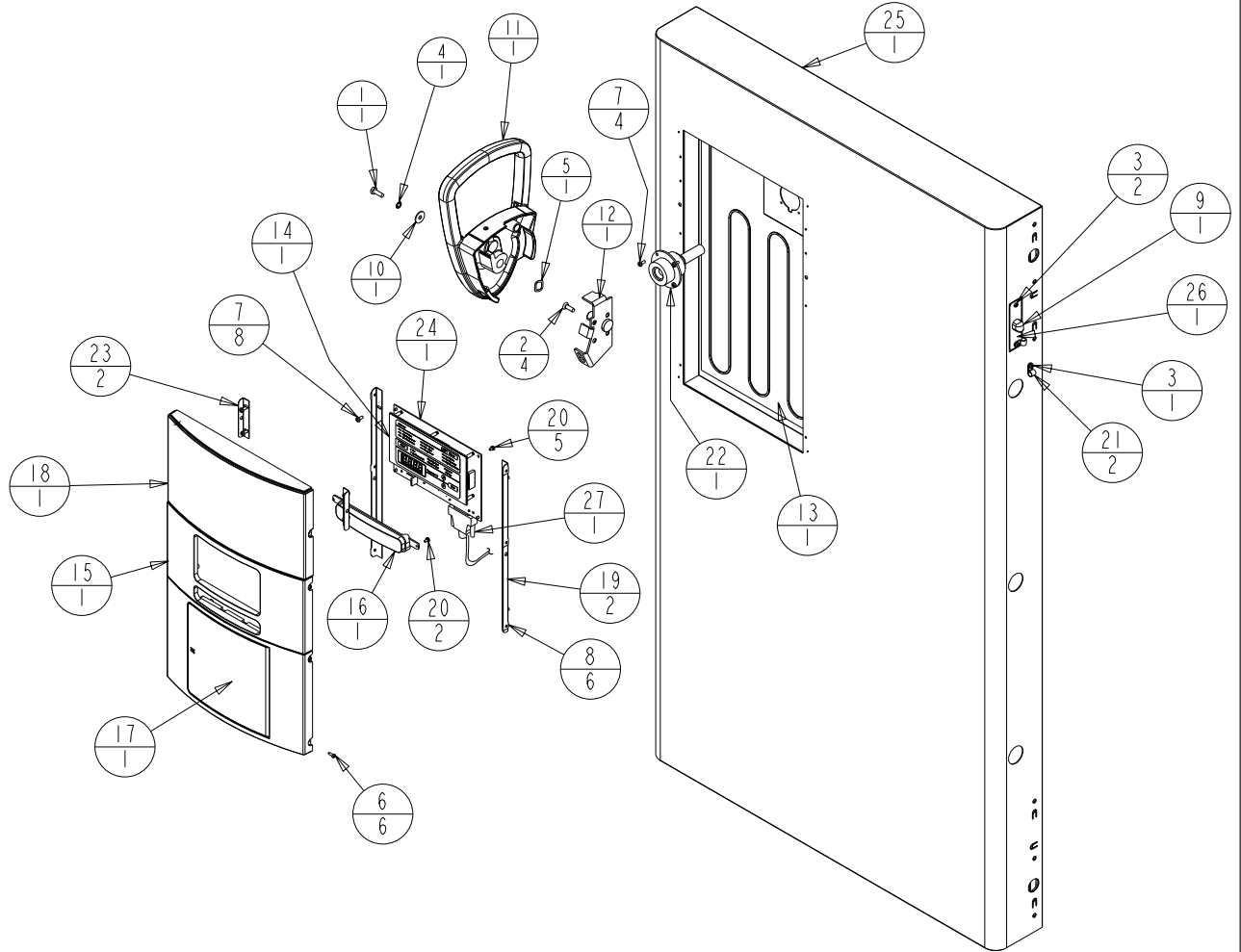
Parts

BILL OF MATERIALS		
ITEM NO.	PART NO.	PART DESCRIPTION
1	20003	1/4-20 X 3/4 SS HH CAP SCREW
2	22053	#8-32 X 1/2 SS PHP SCREW
3	22115	#6-32 X 1/4 SS PHP SCREW
4	23009	#6-32 SS HEX NUT
5	23020	#6 SS FLAT WASHER
6	23021	#8 SS FLAT WASHER
7	23023	1/4 SS FLAT WASHER
8	23043	NYLON FLAT WASHER
9	23044	1/4" NYLON SHOULDER WASHER
10	23062	1/4 SS EXT TOOTH LOCKWASHER
11	23080	#8 SS SPRING LOCKWASHER
12	24032	#8-32 X 3/8 SS PHP SCREW F POINT
13	24042	#8-32 X 1/2 SS PHP SCREW F POINT
14	25018	1/8 X 1/4 SS POP RIVET
15	59008	#8-32 X 7/8 SS PHP SCREW
16	103308	13/17 CU.FT. SINGLE DOOR FRAME GASKET
17	114020	5/8" X 1/2" ID GROMMET
18	116077	FRONT PANEL HINGE
19	116092	EXTERIOR FREEZER DOOR HINGE
20	120400	BLACK PLASTIC KNOB
21	121099	FRZ CAM LATCH STRIKE
22	189921	EXTERIOR BACK 13 & 17
23	195169	LATCH TAB
24	195170	13/17 CU.FT. INNER DOOR
25	195866	PROBE GUARD
26	195867	PROBE MOUNT
27	195830	UR DOOR WIREWAY COVER PLATE
28	195900	MAGNETIC SWITCH
29	30033	RT. ANGLE STRAIN RELIEF
30	500177	PILASTER STRIPS
31	515083	1/4 DIA. X 1/4L SS SPACER
32	22115	#6-32 X 1/4 SS PHP SCREW
33	23009	#6-32 SS HEX NUT
34	23020	#6 SS FLAT WASHER
35	23021	#8 SS FLAT WASHER
36	23043	NYLON FLAT WASHER
37	23044	1/4" NYLON SHOULDER WASHER
38	23080	#8 SS SPRING LOCKWASHER
39	59008	#8-32 X 7/8 SS PHP SCREW
40	120400	BLACK PLASTIC KNOB
41	195169	LATCH TAB
42	515083	1/4 DIA. X 1/4L SS SPACER
43	1950217	28 CU. FT. INNER DOOR
44	1950218	28 CU.FT. INNER DOOR LATCH GUIDE
45	116090	FRONT PANEL HINGE
46	24030	8 X 1/2 ZP PHP SCREW TEKS

UPRIGHT FREEZER  
ASSEMBLY

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195774, 23 CU. FT. UPRIGHT FREEZER DOOR  
195775, 28 CU. FT. UPRIGHT FREEZER DOOR



900 Single Door BOM Assembly  
(F - TS -86)

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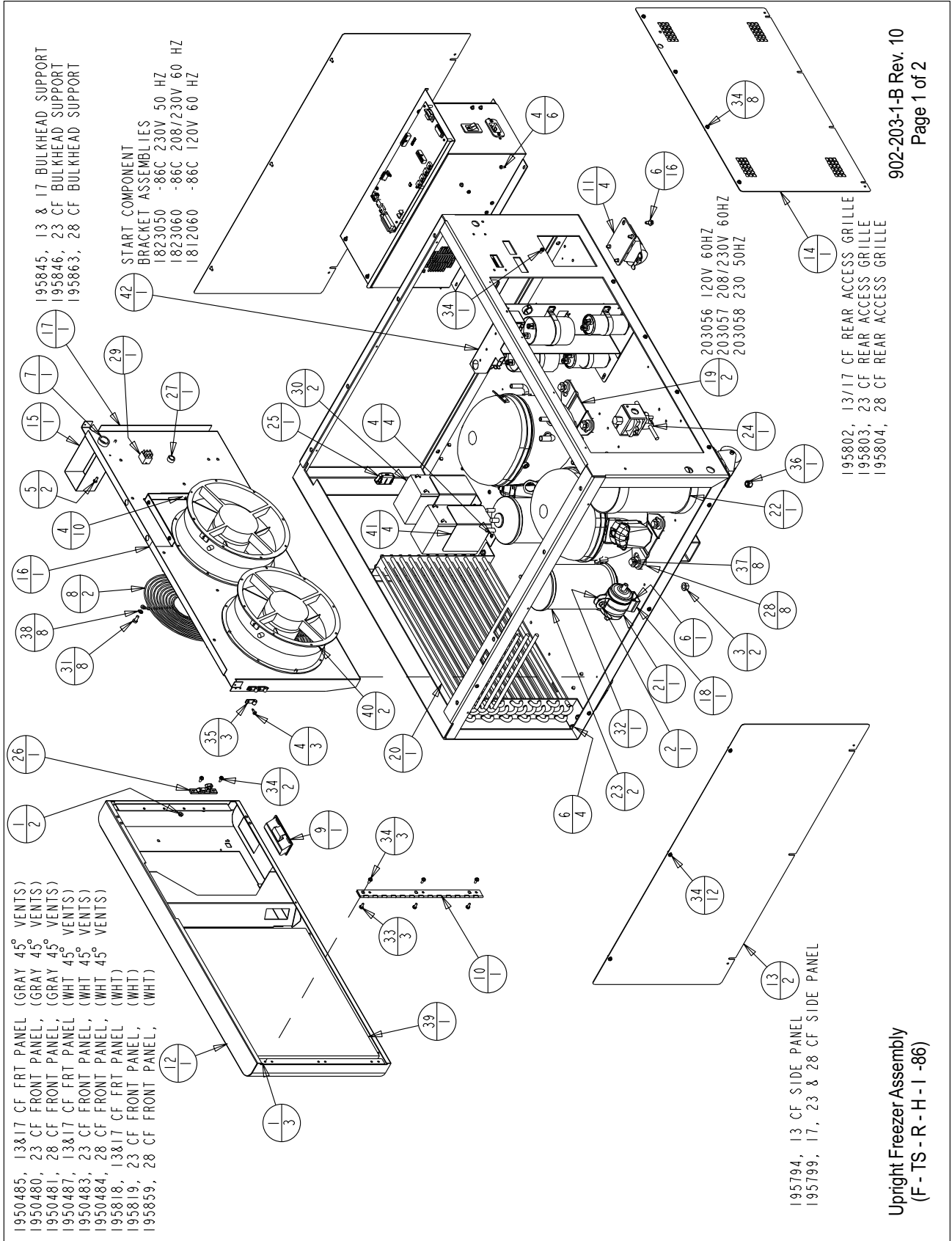
**Section 7**  
Parts

BILL OF MATERIALS		
ITEM NO.	PART NO.	PART DESCRIPTION
1	20003	1/4-20 X 3/4 SS HH CAP SCREW
2	20058	#1/4-20 X 3/4 SS FHP UC SCREW
3	22053	#8-32 X 1/2 SS PHP SCREW
4	23033	1/4 SS INTERNAL TOOTH LOCK WASHER
5	23057	5/8 WAVE WASHER
6	24016	#6 X 1/2" SS PHP SCREW AB POINT
7	24032	#8-32 X 3/8 SS PHP SCREW F POINT
8	25040	#6 U SPEED NUT STL. STL.
9	30033	RIGHT ANGLE STRAIN RELIEF
10	121092	.856" OD FLAT WASHER
11	121098	FINISHED HANDLE/LATCH ASSEMBLY "WHT"
12	121102	CAM LATCH MOUNT
13	132114	HEATER, 3W, 14VDC
14	140444	CONTROL PANEL ASSEMBLY
15	180305	CONTROL CENTER DISPLAY BEZEL "SID BLU"
16	180306	THERMO BACK-UP SYSTEM BLANK PANEL "SID BLUE"
17	180308	CONTROL CENTER RECORDER BLANK "SID BLU"
18	180360	CONTROL BLANK PANEL "SID BLUE"
19	195837	MOUNTING ANGLE FOR 180305
20	590027	#6-32 X 1/4 SS PHP EXT SEMS SCREW
21	600085	5/16 NYLON CABLE CLAMP
22	1950069	HEATED VACUUM RELIEF PORT
23	1950492	MOUNTING ANGLE
24	191956	FREEZER DISPLAY BOARD
25	195773	13 & 17 CU. FT. UPRIGHT FREEZER DOOR
26	195830	UPRIGHT DOOR WIREWAY COVER PLATE
27	430336	15 FT, RS-232 CABLE 25 POS.

900 Single Door BOM Assembly  
(F - TS -86)

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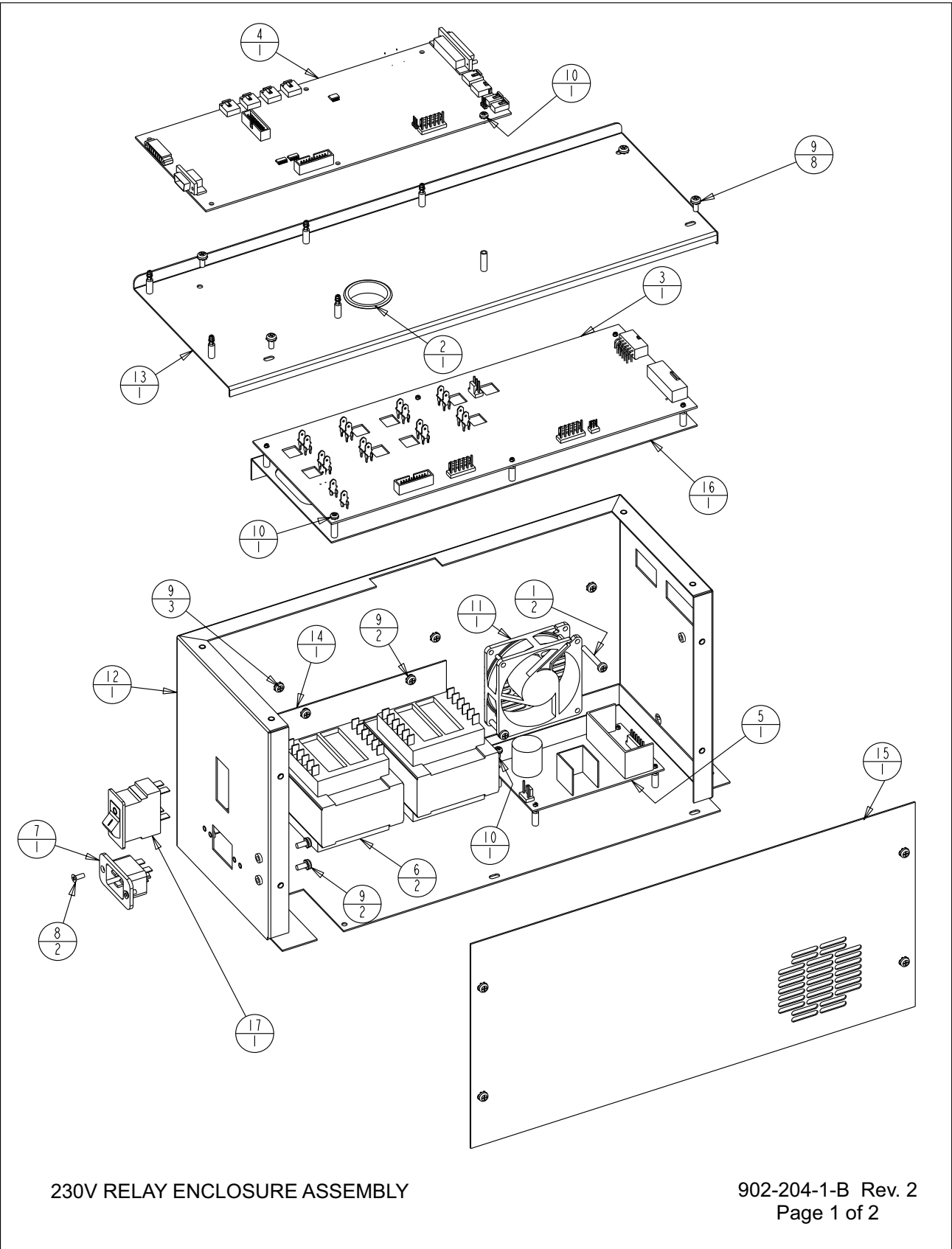


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Upright Freezer Assembly  
(F - TS - R - H - I - 86)

BILL OF MATERIALS		
ITEM NO.	PART NO.	PART DESCRIPTION
1	23002	#8-32 ZP LKWASH HEX NUT
2	23011	1/4-20 ZP LKWASH HEX NUT
3	23013	3/8-16 ZP LKWASH HEX NUT
4	24030	#8 X 1/2" TEKS SCREW
5	24032	#8-32 X 3/8 SS PHP SCREW F POINT
6	24038	1/4-20 X 1/2 SELF TAPPING SCREW
7	30016	1" SNAP BUSHING
8	108020	10" WIRE FAN GUARD
9	115032	BLACK ABS PLASTIC PULL
10	116115	FRONT PANEL HINGE
11	120011	DUAL WHEEL CASTER
12	195746	13817 CU. FT. UR FRZ BASE FRONT PNL
13	195799	SIDE PANEL 17, 23 AND 28 CU. FT. UPRIGHT
14	195802	13/17 REAR ACCESS GRILLE
15	195829	MULLION/DOOR SWITCH WIRE COVER
16	195844	UR FRZ FAN BULKHEAD
17	195845	13817 CU. FT. FAN BULKHEAD SUPPORT
18	200126	2" RIGID HANGER
19	203057	UPRIGHT COMPRESSOR 208/230V 60HZ
20	204009	REFRIGERATION CONDENSER

BILL OF MATERIALS (CONTINUED)		
ITEM NO.	PART NO.	PART DESCRIPTION
21	209020	LIQUID LINE FILTER DRYER WITH ACCESS PORT
22	214018	10.000" H X 5.000" DIA. EXPANSION TANK
23	214023	OIL SEPARATOR
24	220626	120V - 50/60 HZ SOLENOID VALVE
25	319388	LATCH CATCH, PART OF 319388 ASSEMBLY
26	319388	LATCH KEEPER, PART OF 319388 ASSEMBLY
27	330002	5/8" SNAP BUSHING
28	350096	RUBBER MOUNT FOOT EMBRACO
29	360248	MINI SNAP-IN POWER SWITCH
30	400159	SEALED LEAD ACID BATTERY - 12 VOLT - 7.2 Ah
31	510035	#12-24 X 1/2 SS HH CAP SCREW
32	550043	1/4-20 X 1" L ZP CARRIAGE BOLT
33	590020	#8-32 X 3/8 SS PHP EXT SEMS SCREW
34	590029	#8-32 X 3/8 SS PHP EXT SEMS SCREW W/PATCH
35	600080	1/4 ALUM CLAMP W/LINER
36	610053	3/8-16 NYLON INSERT LOCK NUT
37	680030	5/16-18 X 1.75 SS HH SHOULDER BOLT
38	730087	#12 SS EXT TOOTH LOCKWASHER
39	760203	AIR FILTER
40	900113	10" TUBEAXIAL FAN, 115V
41	1950074	BATTERY MOUNTING BRACKET
42	120230-01-2	UPRIGHT FREEZER START COMPONENT BRACKET ASSY.



230V RELAY ENCLOSURE ASSEMBLY

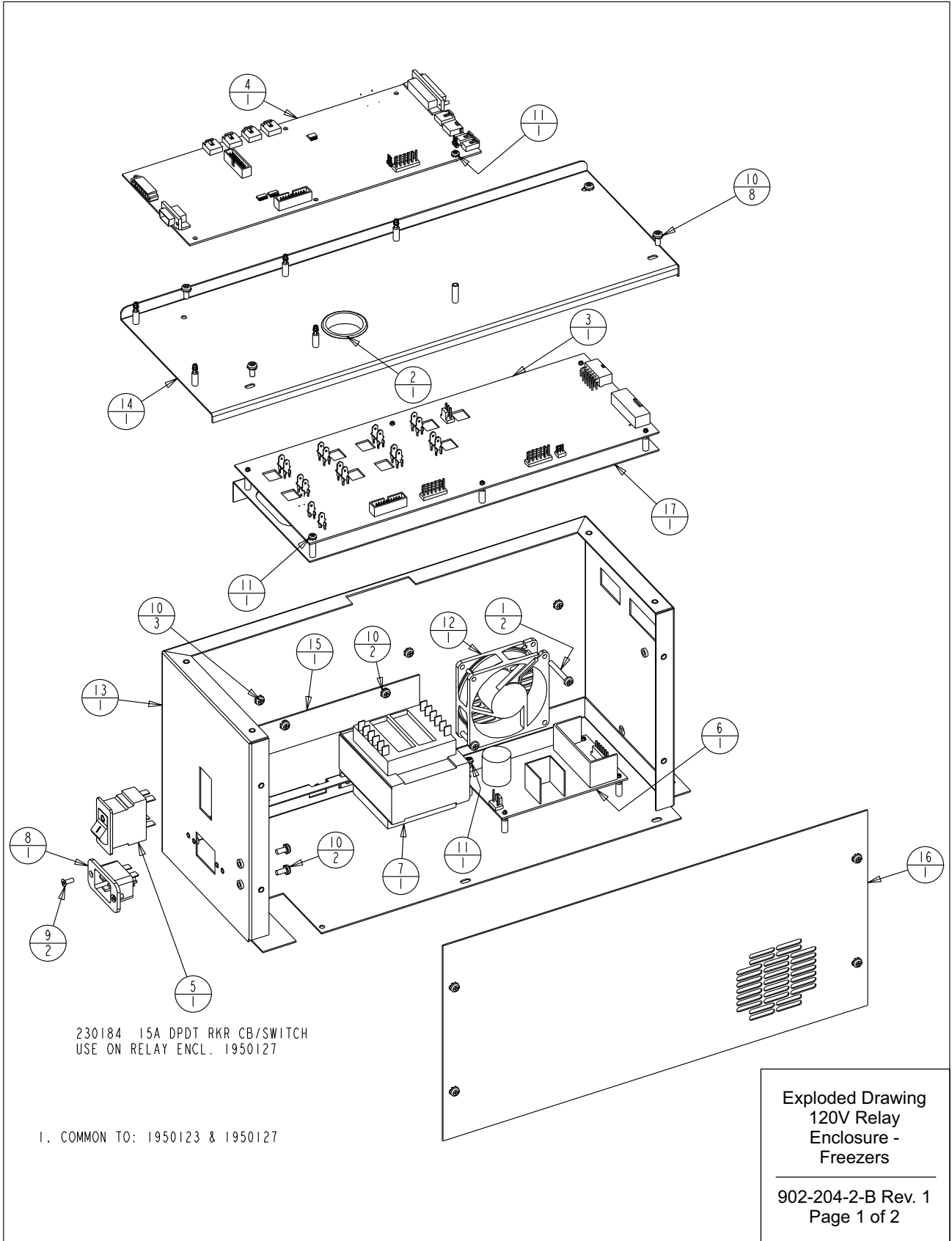
**Section 7**  
Parts

BILL OF MATERIALS		
ITEM NO.	PART NO.	PART DESCRIPTION
1	22143	#8-32 x 1-1/4 SS PHP SCREW
2	30077	1-1/2" SNAP BUSHING
3	191923	HIGH VOLTAGE BOARD 230V
4	191989	MICRO BOARD ( HIGH END)
5	400165	SWITCHER BOARD
6	420090	175V TRANSFORMER
7	460169	POWER INLET, 16/20A
8	490009	#6-32 X 3/8 SS FHP UC SCREW
9	590020	#8-32 X 3/8 SS PHP EXT SEMS SCREW
10	590027	#6-32 X 1/4 SS PHP EXT SEMS SCREW
11	900134	TUBEAXIAL FAN, 30 CFM, 12V
12	195631-16-1	RELAY ENCLOSURE SPOTWELD SUB-ASSEMBLY
13	195631-16-4	RELAY ENCLOSURE COVER/191656 SUPPORT
14	195631-31-3	TRANSFORMER HOLD DOWN
15	195631-31-5	RELAY ENCLOSURE COVER (MAIN)
16	195730-16-1	191658 SUPPORT BRACKET SUB-ASSEMBLY
17	230184	15A DPDT SWITCH/CIRCUIT BKR

I. COMMON TO: 1950124 & 1950128

230V RELAY ENCLOSURE ASSEMBLY

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**Section 7**  
Parts

REV	ECN NO.	DATE	BY	CAD	APPD	DESCRIPTION OF REVISION
0	FR-2202	06-23-11	KDG	KDG	DRP	RELEASED FOR PRODUCTION / REL. 6
1	FR-2409	10-10-12	AJC	KDG	CCS	REMOVED 1950121 & 1950125 LOW END BOXES

BILL OF MATERIALS		
ITEM NO.	PART NO.	PART DESCRIPTION
1	22143	#8-32 x 1-1/4 SS PHP SCREW
2	30077	1-1/2" SNAP BUSHING
3	191932	HIGH VOLTAGE BOARD 120V
4	191989	MICRO BOARD ( HIGH END)
5	230183	20A DPDT SWITCH/CIRCUIT BKR
6	400165	SWITCHER BOARD
7	420065	175V TRANSFORMER
8	460169	POWER INLET, 16/20A
9	490009	#6-32 X 3/8 SS FHP UC SCREW
10	590020	#8-32 X 3/8 SS PHP EXT SEMS SCREW
11	590027	#6-32 X 1/4 SS PHP EXT SEMS SCREW
12	900134	TUBEAXIAL FAN, 30 CFM, 12V
13	195631-16-1	RELAY ENCLOSURE SPOTWELD SUB-ASSEMBLY
14	195631-16-4	RELAY ENCLOSURE COVER/191656 SUPPORT
15	195631-31-3	TRANSFORMER HOLD DOWN
16	195631-31-5	RELAY ENCLOSURE COVER (MAIN)
17	195730-16-1	191658 SUPPORT BRACKET SUB-ASSEMBLY

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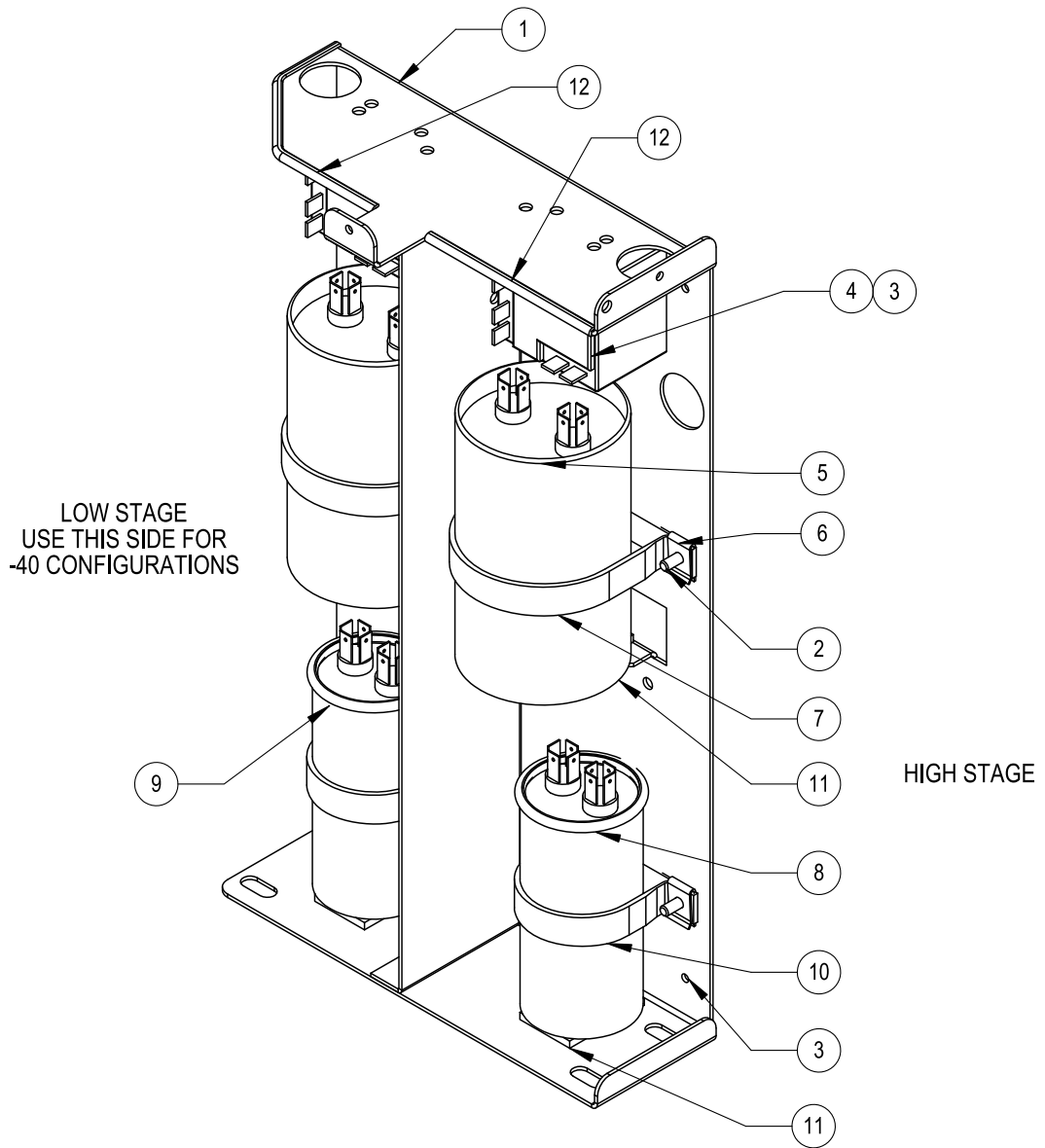
**ThermoFisher**  
**SCIENTIFIC**

BOX 649, MARIETTA, OHIO 45750

MODEL/PART NAME: RELAY ENCLOSURE ASSEMBLY					
DWG TITLE: 120 VOLT RELAY ENCLOSURE ASSY					
DWN: KDG	CAD: KDG	APPD: DRP	DATE: 06-23-11	SCALE: 0.250	
MATERIAL: -					
PAINT: N/A					
TOLERANCE UNLESS OTHERWISE SPECIFIED			DRAWING NUMBER	SIZE	
ANGLES:                   DECIMAL: .XX=± .xxx=±			902-204-2	B	

**Exploded Drawing**  
**120V Relay**  
**Enclosure -**  
**Freezers**

902-204-2-B Rev. 1  
Page 2 of 2



Upright Freezer Start Component  
Enclosure Assembly

**Section 7**

Parts

UPRIGHT FREEZER START COMPONENT BRACKET ASSEMBLIES							
ITEM NO.	DESCRIPTION	1823050 -86C 230V 50 Hz	1823060 -86C 208/230V 60Hz	1812060 -86C 120V 60 Hz	1445230 -40C 230V 50 Hz	146230 -40C 208/230V 60Hz	146120 -40C 120V 60 Hz
1	COMPONENT BRACKET	120230	120230	120230	120230	120230	120230
2	#8 X 1/2 PHP TYPE AB	24021 (4)	24021 (4)	24021 (4)	24021 (2)	24021(2)	24021 (2)
3	8-32 X 3/8 SCREW	590020 (4)	590020 (4)	590020 (4)	590020 (2)	590020 (2)	590020 (2)
4	START RELAY	312286 (2)	312186 (2)	312086 (2)	300445 (1)	300432 (1)	300431 (1)
5	START CAPACITOR	623050 (2)	623060 (2)	612060 (2)	170236 (1)	170154 (1)	170154 (1)
6	#8 SPEED NUT, S.S.	327675 (4)	327675 (4)	327675 (4)	327675 (2)	327675 (2)	327675 (2)
7A	2.5" VINYL COATED STRAP	N/A	N/A	600106 (4)	N/A	N/A	600106 (2)
7B	2" VINYL COATED STRAP	600108 (2)	600108 (2)	N/A	600108 (1)	600108 (1)	N/A
8	RUN CAPACITOR	223050	223060	212060	N/A	N/A	N/A
9	RUN CAPACITOR	223050	223050	212060	170097 (1)	170226 (1)	170224 (1)
10	1.75" VINYL COATED STRAP	600107 (2)	600107 (2)	SEE 7A	600107 (1)	600107 (1)	SEE 7A
11	NEOPRENE TAPE 1/8" X 1" X 2"	28003 (4)	28003 (4)	28003 (4)	28003 (2)	28003 (2)	28003 (2)
12	EDGE GUARD (CUT TO LENGTH)	114012	114012	114012	114012	114012	114012
NOT SHOWN *	13 ULT MAIN HARNESS (REFERENCE ONLY)	350092	350092	350092	350093	350093	350093
NOT SHOWN	14 ENCLOSURE LOW STAGE HARNESS	350108	350108	350108	350108	350108	350108
NOT SHOWN	15 ENCLOSURE HIGH STAGE HARNESS	350107	350107	350107	N/A	N/A	N/A
NOT SHOWN	16 NOMEX COVER	250138	250138	250138	250138	250138	250138
NOT SHOWN	17 ESD WARNING LABEL	220555 (2)	220555 (2)	220555 (2)	220555 (2)	220555 (2)	220555 (2)
NOT SHOWN, SEE NOTE 3	18 IDENTIFICATION LABEL	823050 (2)	823060 (2)	812060 (2)	423050 (2)	423060 (2)	412060 (2)

\* THE ULT MAIN HARNESS IS LISTED FOR INFORMATION ONLY. IT IS NOT PART OF THIS ASSEMBLY.

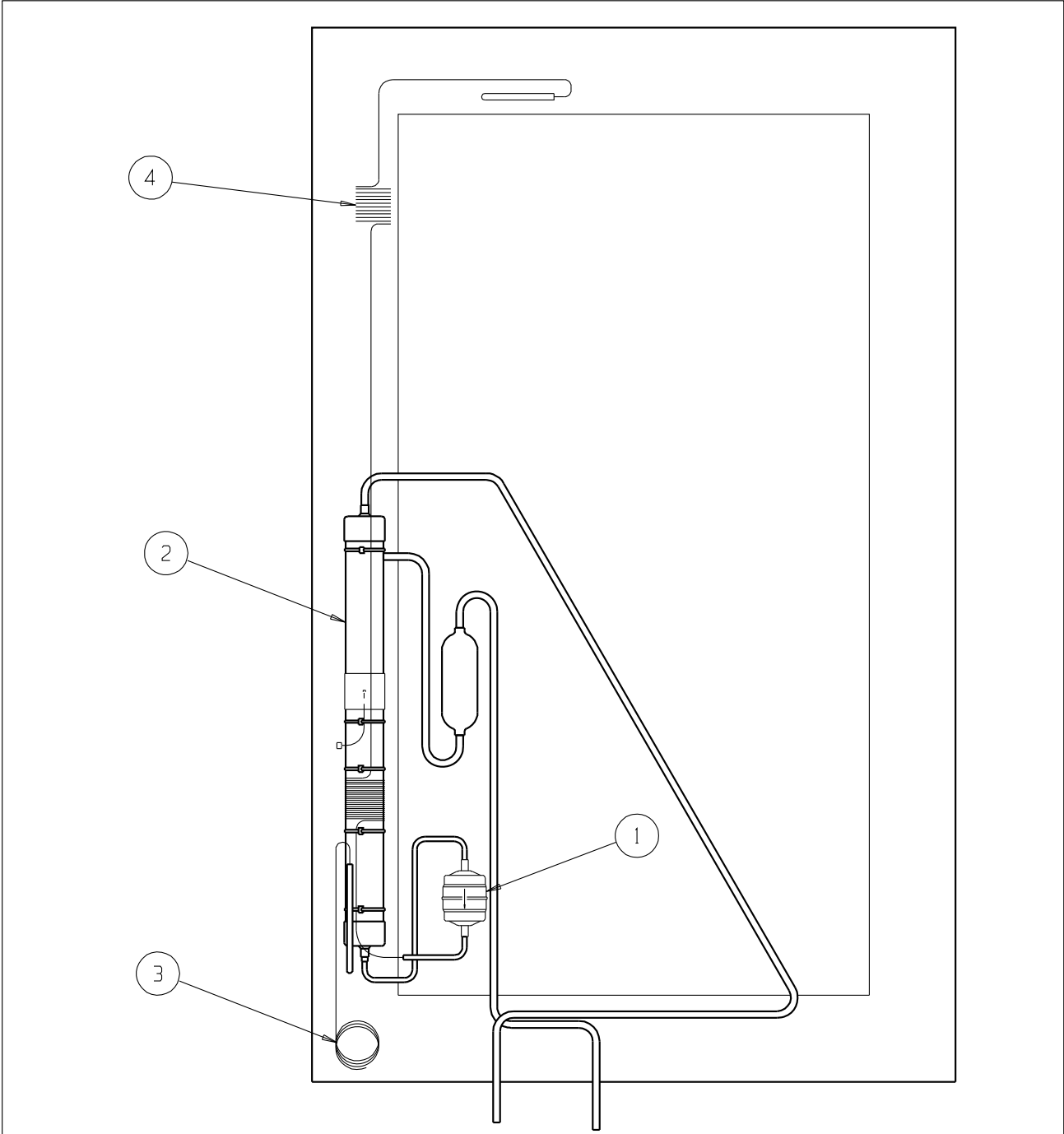
NOTES:

1. SEE PSS 8602-724-012 FOR ASSEMBLY WIRING AND OTHER DETAILS.
2. AFTER ATTACHING NOMEX COVER (250138) WITH SCREWS (590029), STICK ESD LABEL (220555) TO OUTSIDE OF COVER.
3. IDENTIFY EACH ASSEMBLY WITH LABELS ON THE BOTTOM AND BACK THAT INCLUDE THE FOLLOWING:  
 FIRST LINE - ASSEMBLY NUMBER AND REVISION  
 SECOND LINE - BAR CODE OF ASSEMBLY AND REVISION  
 THIRD LINE - UNIQUE SERIAL NUMBER INCLUDING DATE OF MANUFACTURE IN THE FOLLOWING FORMAT AND ORDER:  
 THREE LETTER MANUFACTURING SITE, TWO DIGIT YEAR MANUFACTURED, TWO DIGIT WEEK MANUFACTURED FOLLOWED  
 BY A UNIQUE FOUR DIGIT NUMBER.  
 FOURTH LINE - BAR CODE OF UNIQUE SERIAL NUMBER.  
 FIFTH LINE - ASSEMBLY DESCRIPTION IN THE FOLLOWING FORMAT: UPRIGHT, TEMPERATURE, VOLTAGE AND FREQUENCY.

Upright Freezer Start Component  
Enclosure Assembly

120230-01-2-D Rev 9  
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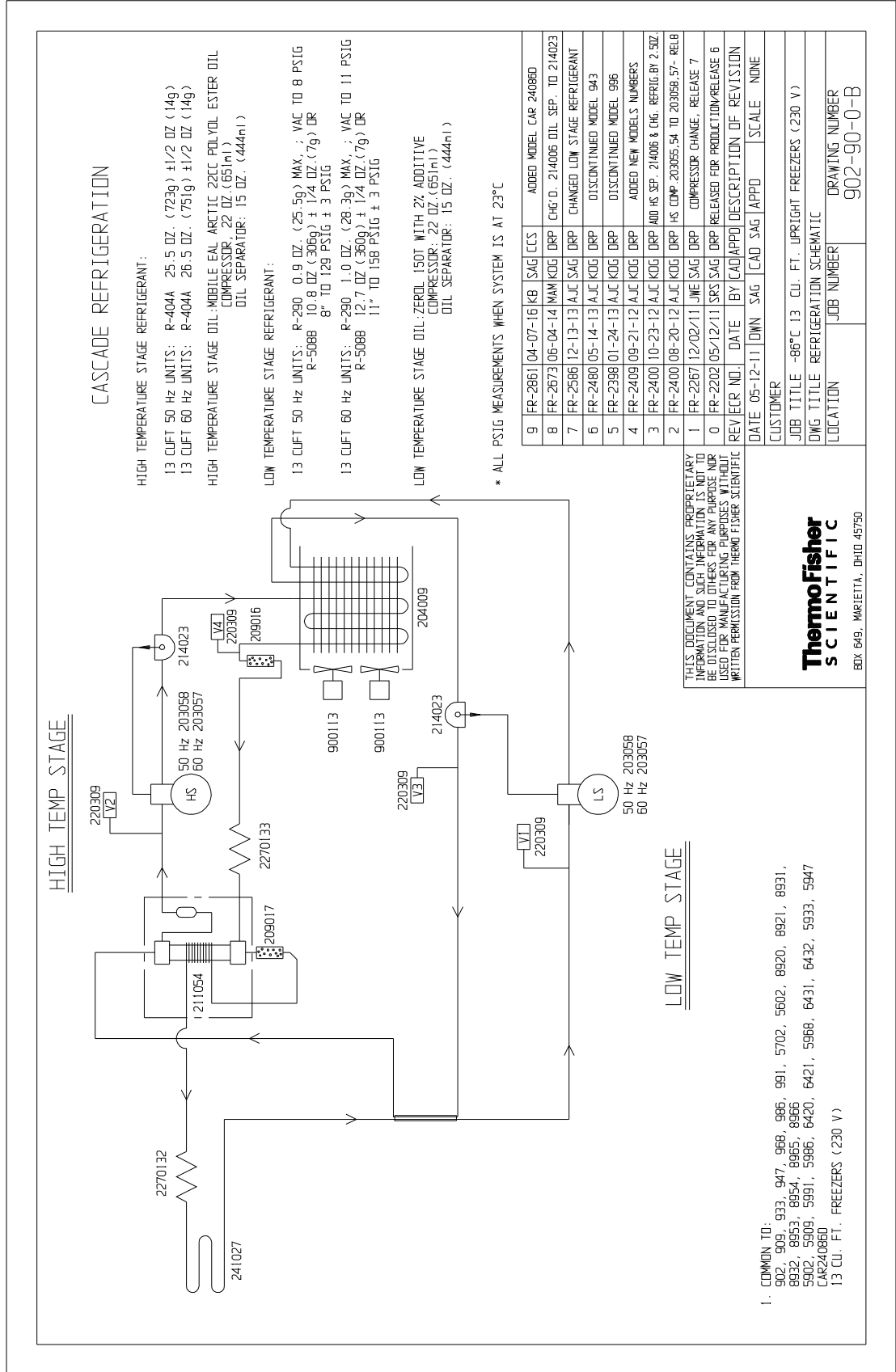


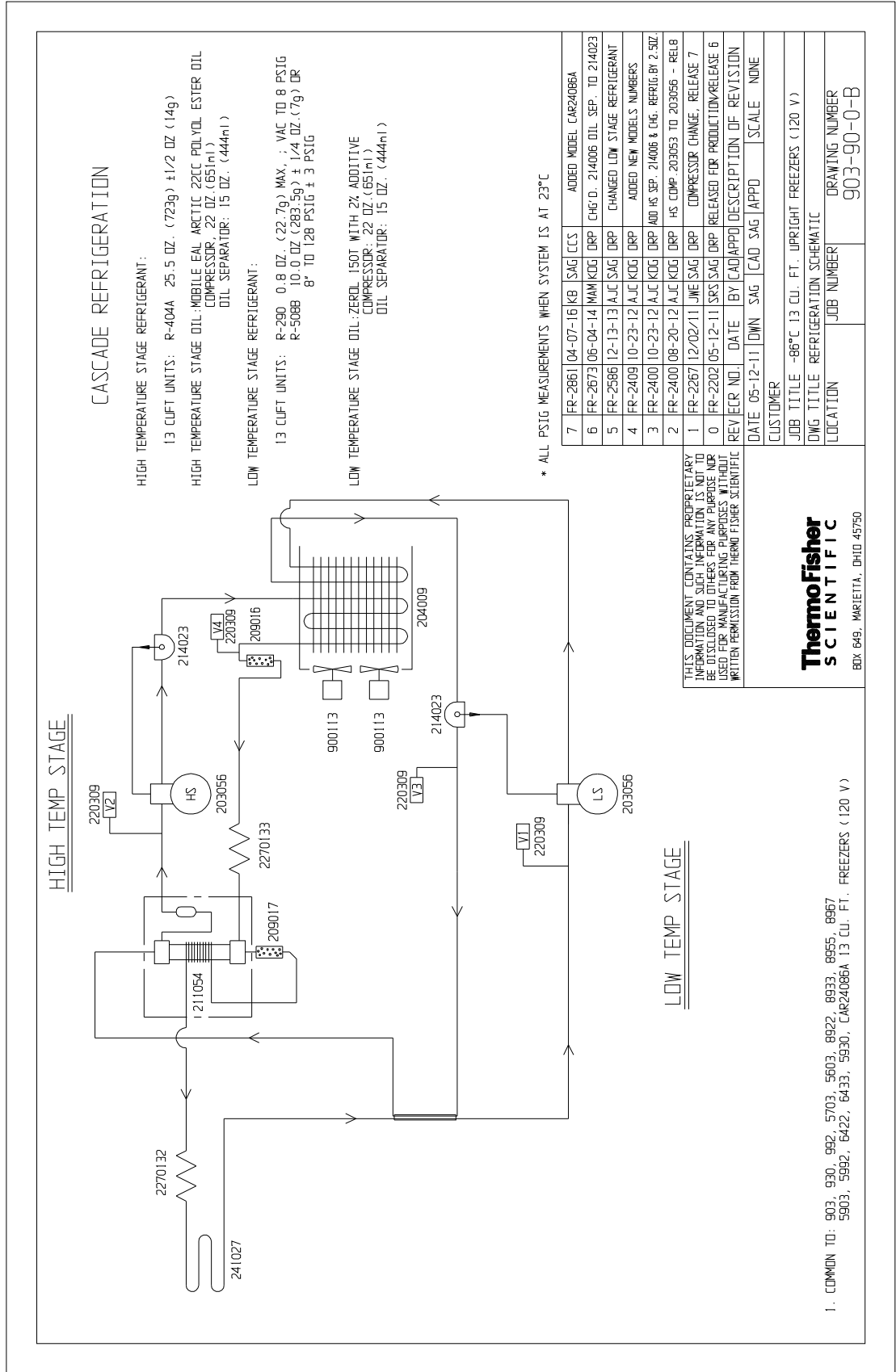
BILL OF MATERIALS		
ITEM NO.	PART NO.	PART DESCRIPTION
1	209017	DRYER
2	211050	HEAT EXCHANGER
3	227927	HIGH STAGE CAP. TUBE
4	227928	LOW STAGE CAP. TUBE

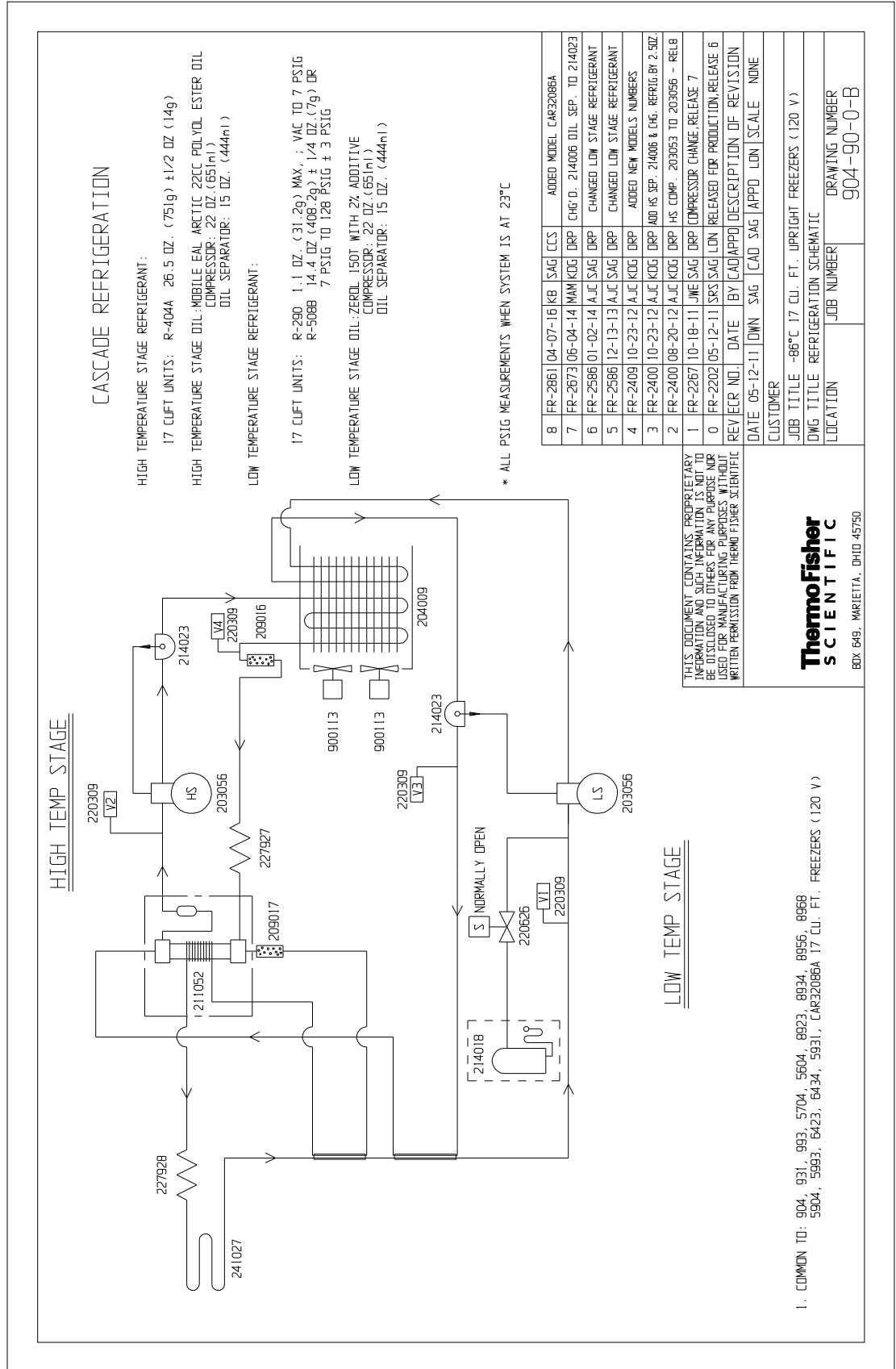
Exploded Drawing  
Heat Exchanger  
Upright Freezer

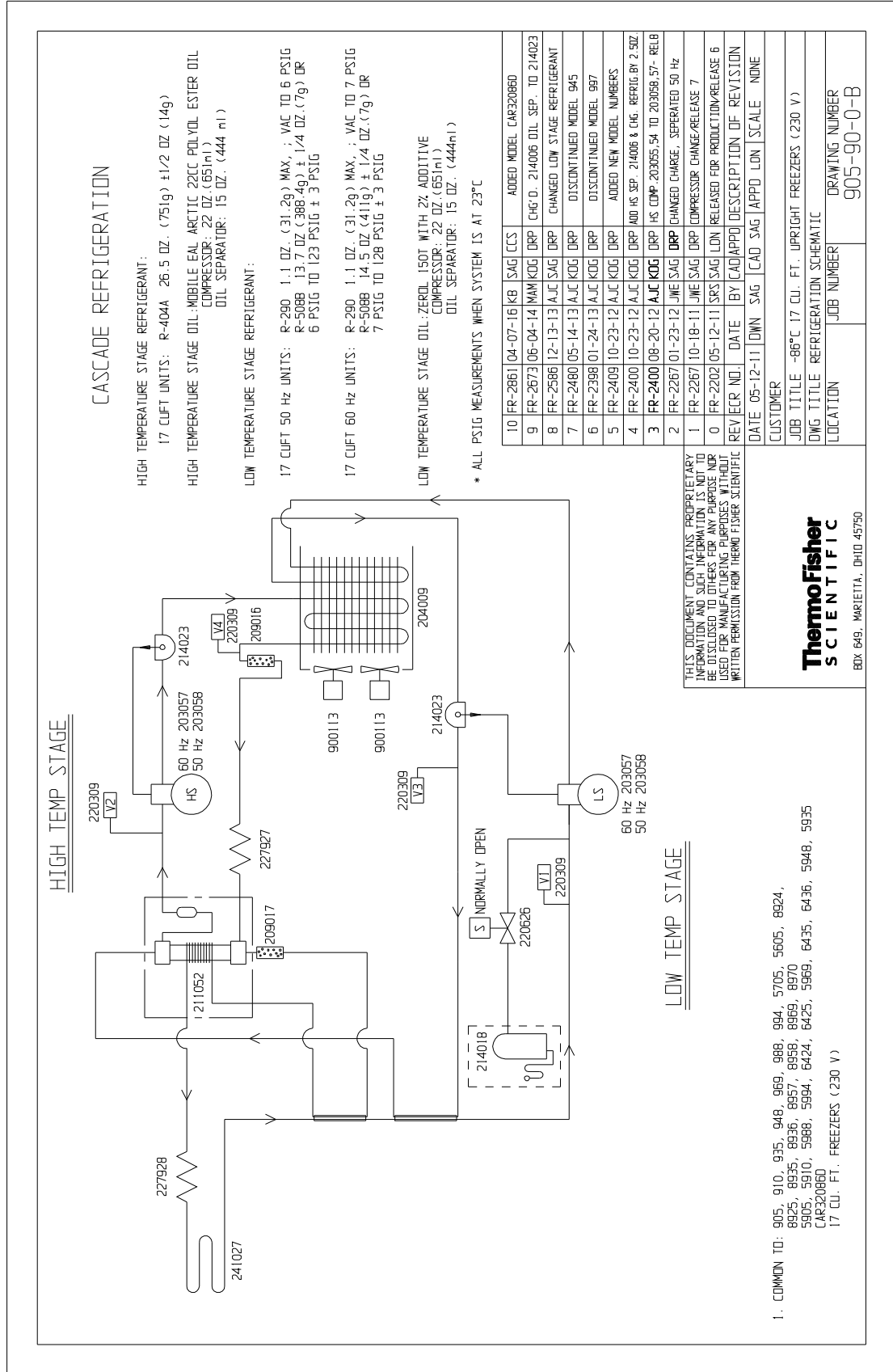
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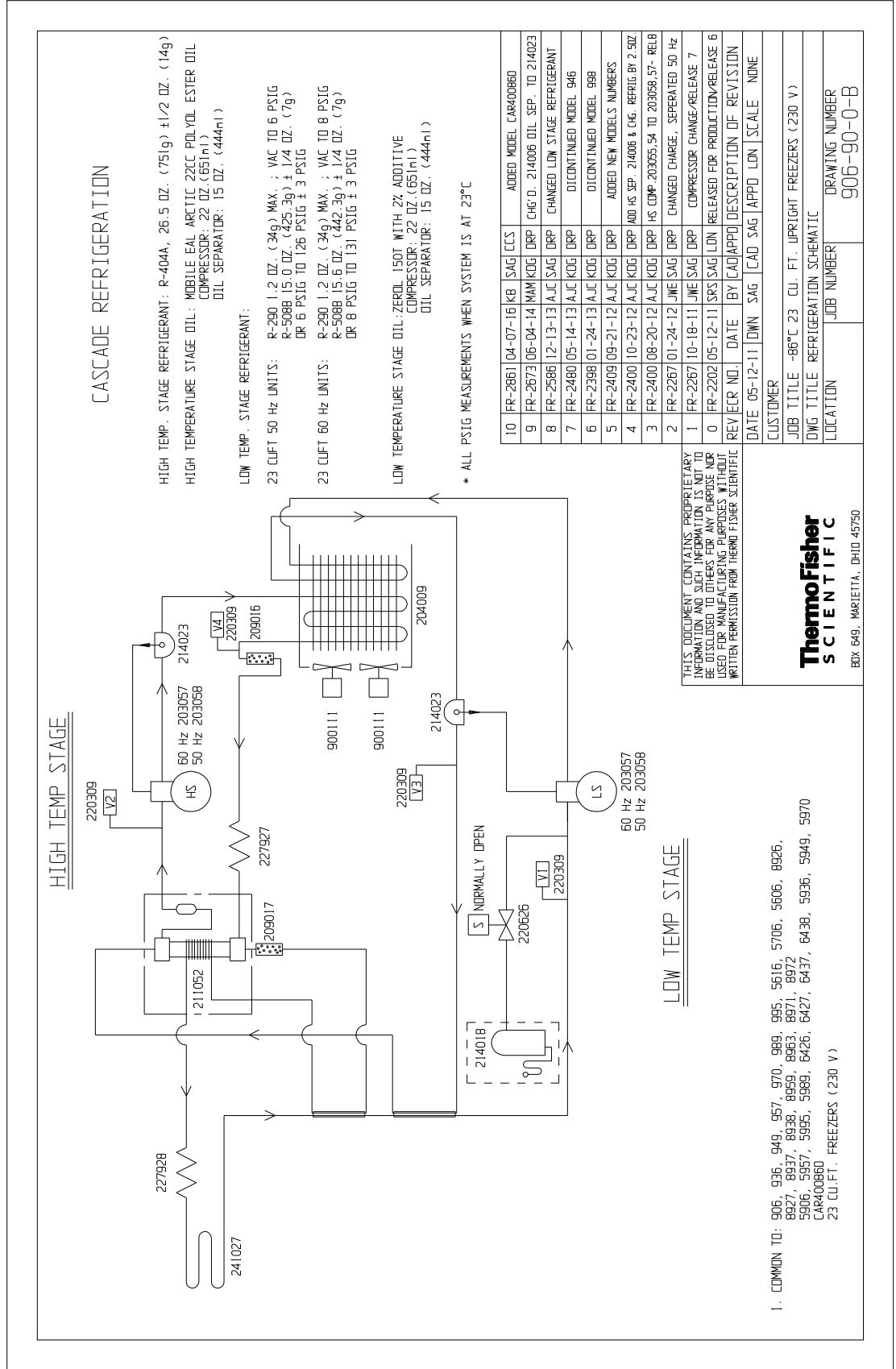
902-205-1-B Rev. 0  
Page 1 of 1

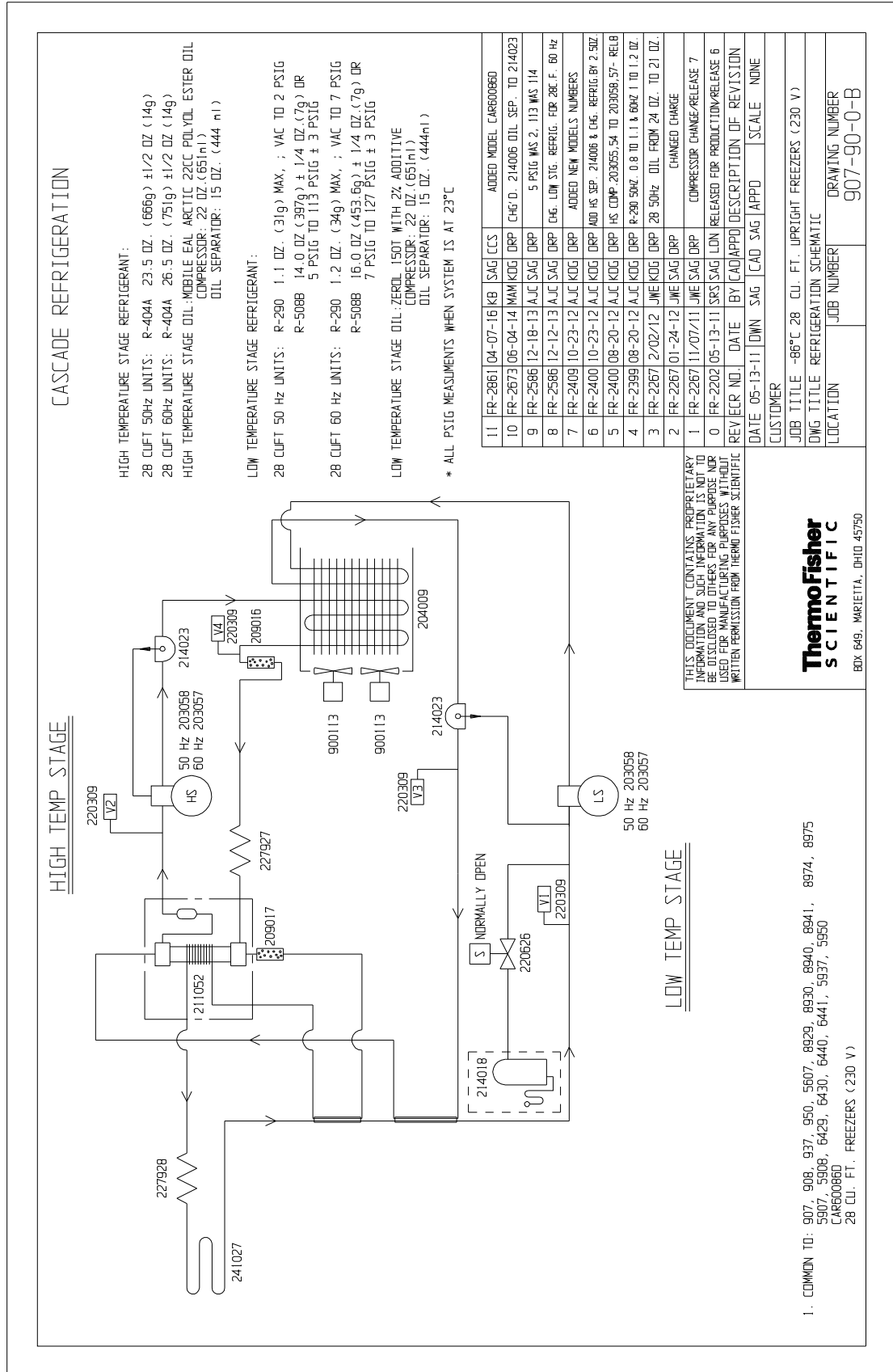


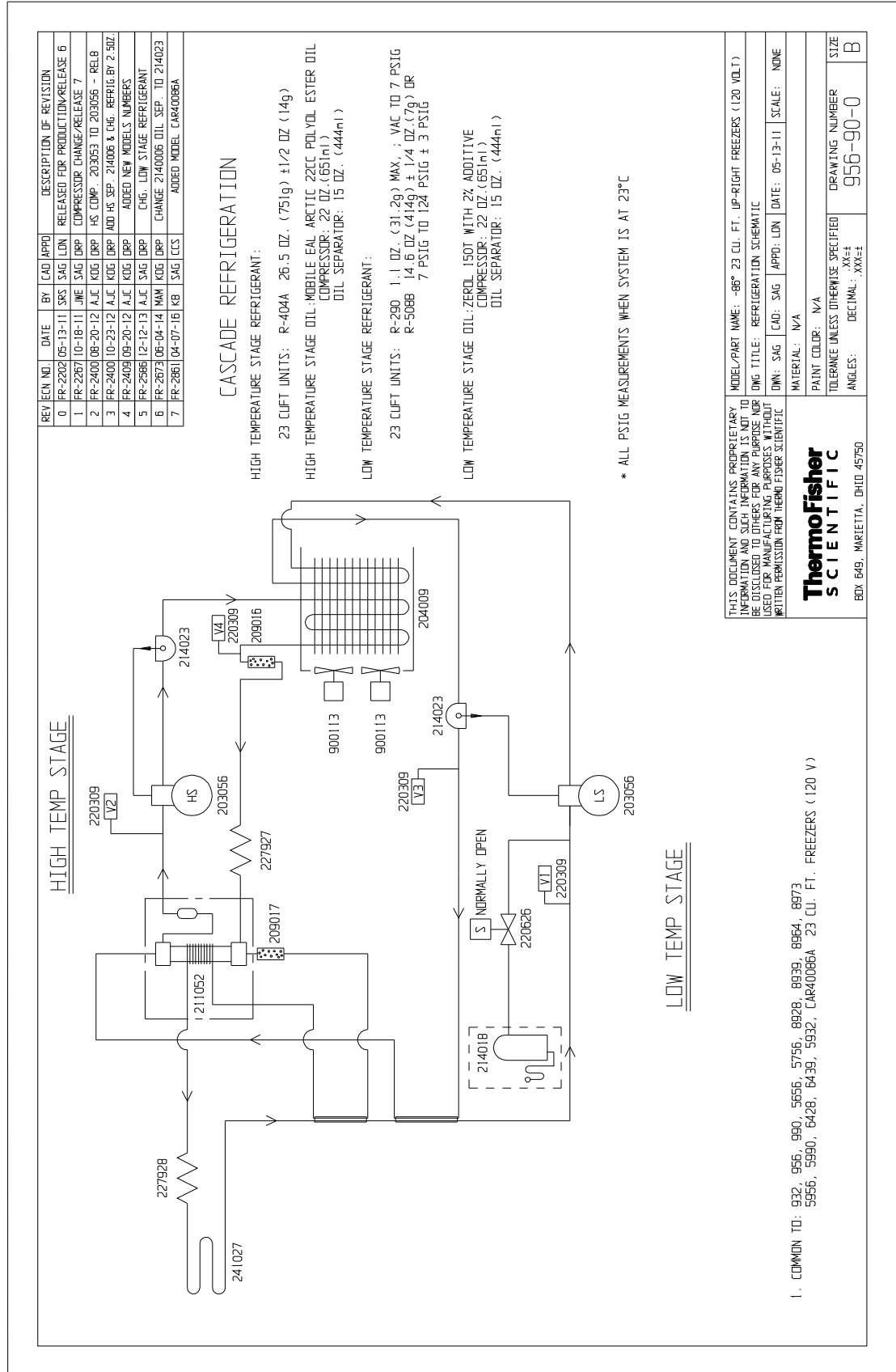












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MODEL/PART NAME: -86° 23 CU. FT. UP-RIGHT FREEZERS (120 VOL.T)	ENG TITLE: REFRIGERATION SCHEMATIC
DMN: SAG	CAO: SAG
APPO: LDN	DATE: 05-13-11
SCALE: NONE	
MATERIAL: N/A	
PAINT COLOR: N/A	
TOLERANCE UNLESS OTHERWISE SPECIFIED	DRAWING NUMBER
ANGLES: .XX±	956-90-0
SIZE	B

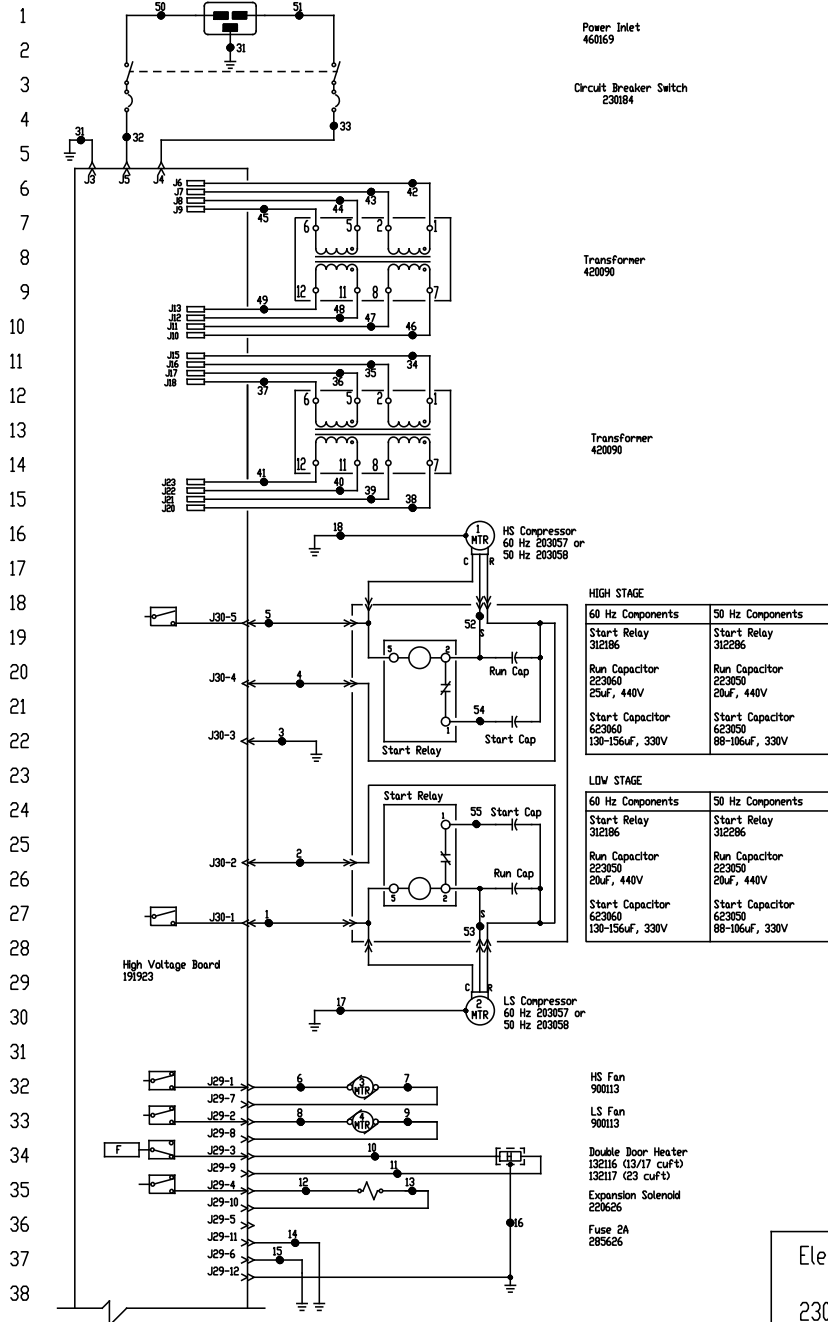
1. COMMON TO: 932, 956, 960, 5656, 5756, 8928, 8939, 8964, 8973, 5956, 5990, 6428, 6439, 5932, CAR40066A 23 CU. FT. FREEZERS (120 V)

**ThermoFisher**  
**SCIENTIFIC**  
BOX 649, MARLETTA, OHIO 45750





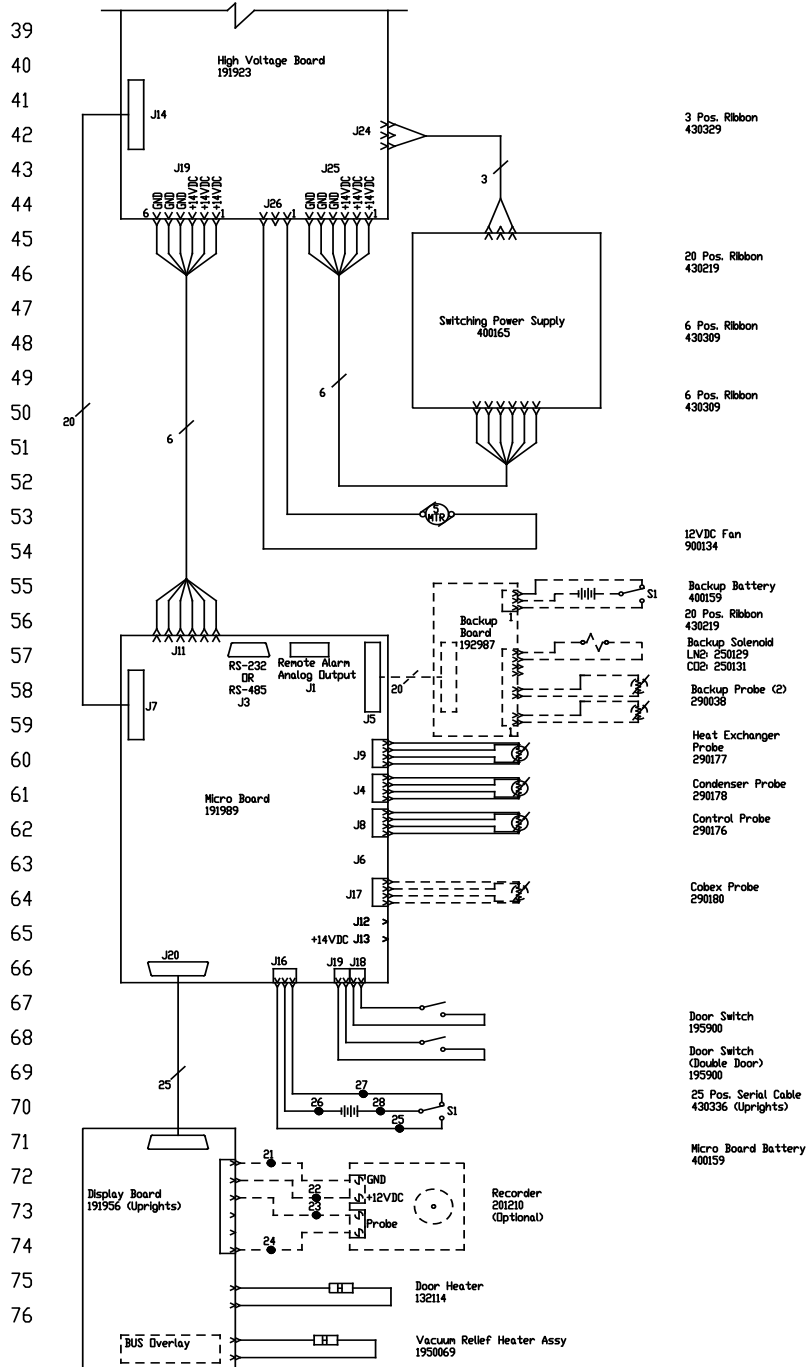
POWER CONNECTION  
230V/50HZ & 208/230V/60HZ, 1Ø, 2V, 120 FLA  
(OPERATING RANGE 207-253V)



Electrical Schematic  
Model:  
230V, 50 & 60Hz, -86°C  
ULT Upright Freezers

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**Section 9**  
Electrical Schematics



Electrical Schematic  
Model:  
230V, 50 & 60Hz, -86°C  
ULT Upright Freezers

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WIRE #	COLOR	GAUGE	WIRE #	COLOR	GAUGE
1	BLK	14	29	-	-
2	RED	14	30	-	-
3	GRN/YEL	14	31	GRN/YEL	14
4	RED	14	32	BLU	14
5	BLK	14	33	BLU	14
6	BLK	18	34	BLK	14
7	BLK	18	35	BLU	14
8	BLK	18	36	BLK	14
9	BLK	18	37	BLU	14
10	BLK	18	38	BLK	14
11	BLK	18	39	BLU	14
12	BLK	18	40	BLK	14
13	BLK	18	41	BLU	14
14	GRN/YEL	18	42	BLK	14
15	GRN/YEL	18	43	BLU	14
16	GRN/YEL	18	44	BLK	14
17	GRN/YEL	14	45	BLU	14
18	GRN/YEL	14	46	BLK	14
19	-	-	47	BLU	14
20	-	-	48	BLK	14
21	BLK	18	49	BLU	14
22	RED	18	50	BLK	14
23	BLK	18	51	BLU	14
24	RED	18	52	YEL/WHT	14
25	WHT	18	53	YEL	14
26	BLK	18	54	BLU/WHT	14
27	BLK	18	55	BLU	14
28	RED	18			

UPRIGHT MODELS:  
13 CU.FT. (230V) - 902, 909, 986, 991, CAR24086D, EXF21686D, EXF24086D, EXF24086V, HFU2408D  
HFU2408V, TSE240D, TSE240V, 909GP, EXF24086GPD, TSE240GPD, 986GP  
17 CU.FT. (230V) - 905, 910, 988, 994, CAR32086D, EXF28886D, EXF32086D, EXF32086V, HFU3208D, HFU3208V  
TSE320D, TSE320V, 910GP, EXF32086GPD, TSE320GPD, 988GP  
23 CU.FT. (230V) - 906, 957, 989, 995, CAR40086D, EXF36086D, EXF40086D, EXF40086V, HFU4008D, HFU4008V  
TSE400D, TSE400V, 957GP, EXF40086GPD, TSE400GPD, 989GP  
28 CU.FT. (230V) - 907, 908, CAR60086D, EXF60086D, EXF60086V, HFU6008D, HFU6008V, TSE600D, TSE600V, 908GP  
EXF60086GPD, TSE600GPD

RS-232 SPECIFICATION

BAUD = 1200  
PARITY = N  
BITS = 8  
STOP BITS = 2

REMOTE CONTACTS/ANALOG OUTPUT

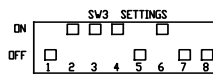
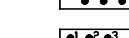
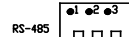
PIN# 1	Analog Output +
PIN# 2	Analog Output -
PIN# 3	Not Connected
PIN# 4	Not Connected
PIN# 5	Normally Closed
PIN# 6	Common
PIN# 7	Normally Open

RS-232 PORT

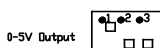
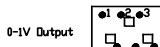
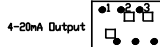
PIN# 2	TXD
PIN# 3	RXD
PIN# 5	GND

CONTACT RATING 1A @ 30V  
CONTACTS IN ALARM STATE

SV2 Settings for Communication Output



SV1 Settings for Analog Output



- Schematic represents single & double door upright models. Expansion solenoid on 17, 23 & 28 cuft uprights only.
- Door switches shown in open position.
- Battery switch shown in the OFF position.
- Circuit breaker switch shown in OFF position.
- Options and accessories shown in dashed lines.

REV	ECN NO.	DATE	BY	CAD	APP'D	DESCRIPTION OF REVISION
12	41795	12-13-17	KWB	TFT		UPDATED "UPRIGHT MODELS" DETAILS
11	FR-2886	08-14-17	KB	KWB		191987 BACKUP BOARD TO 192987
10	FR-2861	04-07-16	KWB	SAG	DRP	ADDED CABLES, MODELS
9	FR-2853	03-07-16	KB	SAG	DRP	REWORK WAS 3226A, 3226B WAS 3226D
8	FR-2781	04-02-15	KB	KDG	DRP	REMOVED REF. TO 195096 (1M SERVED VWP ASSY.
7	FR-2398	01-24-13	AJC	KDG	DRP	DISCONTINUED MODEL 996, 997 & 998
6	FR-2499	09-24-12	AJC	KDG	DRP	REL. LFN 191988 MODEL BUILT HIGH END 191989
5	FR-2386	08-29-12	AJC	KDG	DRP	REVISED OPERATING RANGE FROM 208-240V
4	FR-2480	08-29-12	AJC	KDG	DRP	HS COMP. 2826A/55 TO 28267-50 /REL. L
3	FR-2361	05-09-12	MMH	KDG	DRP	CHG. LFN STAGE RUN CAP. 25µF TO 30µF
2	FR-2267	10/20/11	JVE	SAG	DRP	COMPRESSOR CHANGE / RELEASE 7
1	FR-2202	05/02/11	SRS	SAG	LRN	LIBERTY CAP / RELEASE 6
0	N/A	10-10-10	HCE	KDG	LRN	RELEASED FOR PRODUCTION / RELEASE 5

Electrical Schematic  
Model:  
230V, 50 & 60Hz, -86°C  
ULT Upright Freezers



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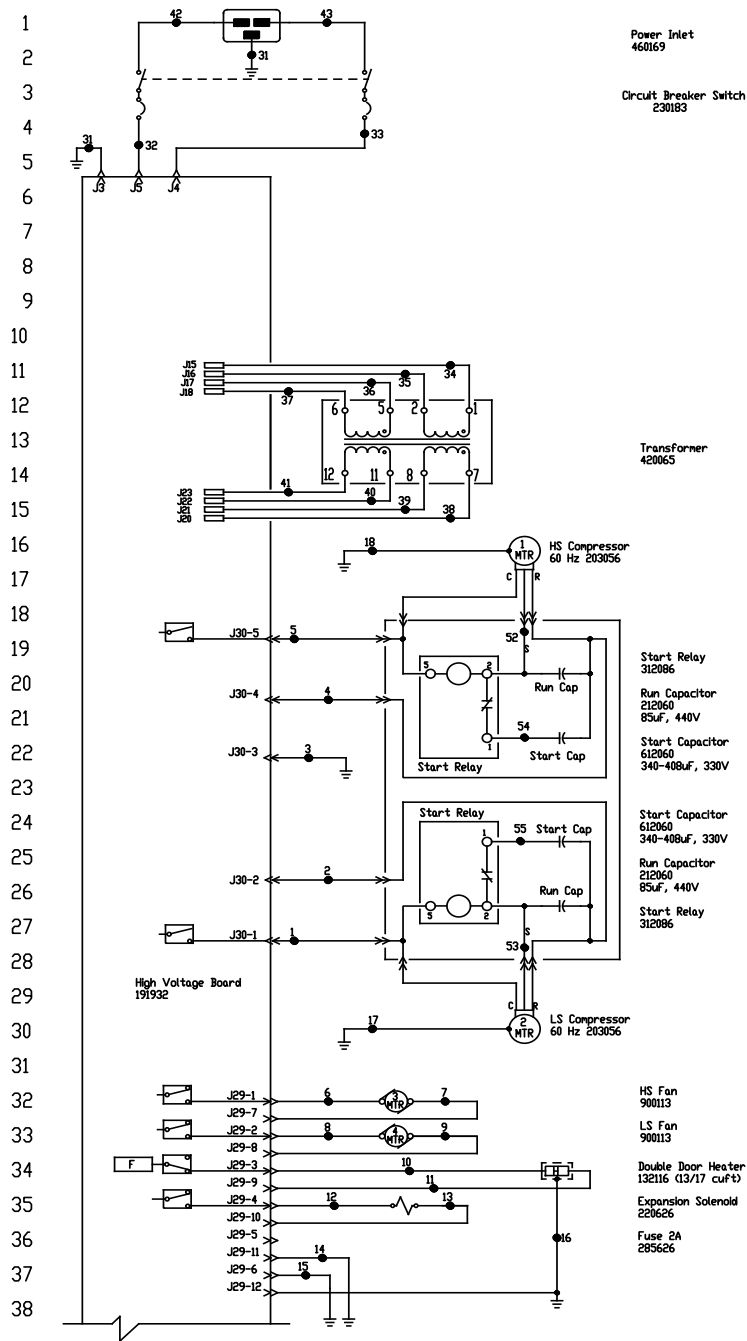
**ThermoFisher SCIENTIFIC**  
BOX 649, MARIETTA, OHIO 45750

MODEL/PART NAME: LFN-END, ULT -86C UPRIGHT FREEZERS, 230V, 50 & 60 Hz  
DWG TITLE: UNIT SCHEMATIC  
DWG HCE CAD KDG APP'D LRN DATE: 10-10-10 SCALE: NONE  
MATERIAL:  
PAINT COLOR:  
TOLERANCE UNLESS OTHERWISE SPECIFIED: DECIMAL .004  
DRAWING NUMBER: 902-70-2  
SIZE: D

902-70-2-0 REV 12  
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**Section 9**  
Electrical Schematics

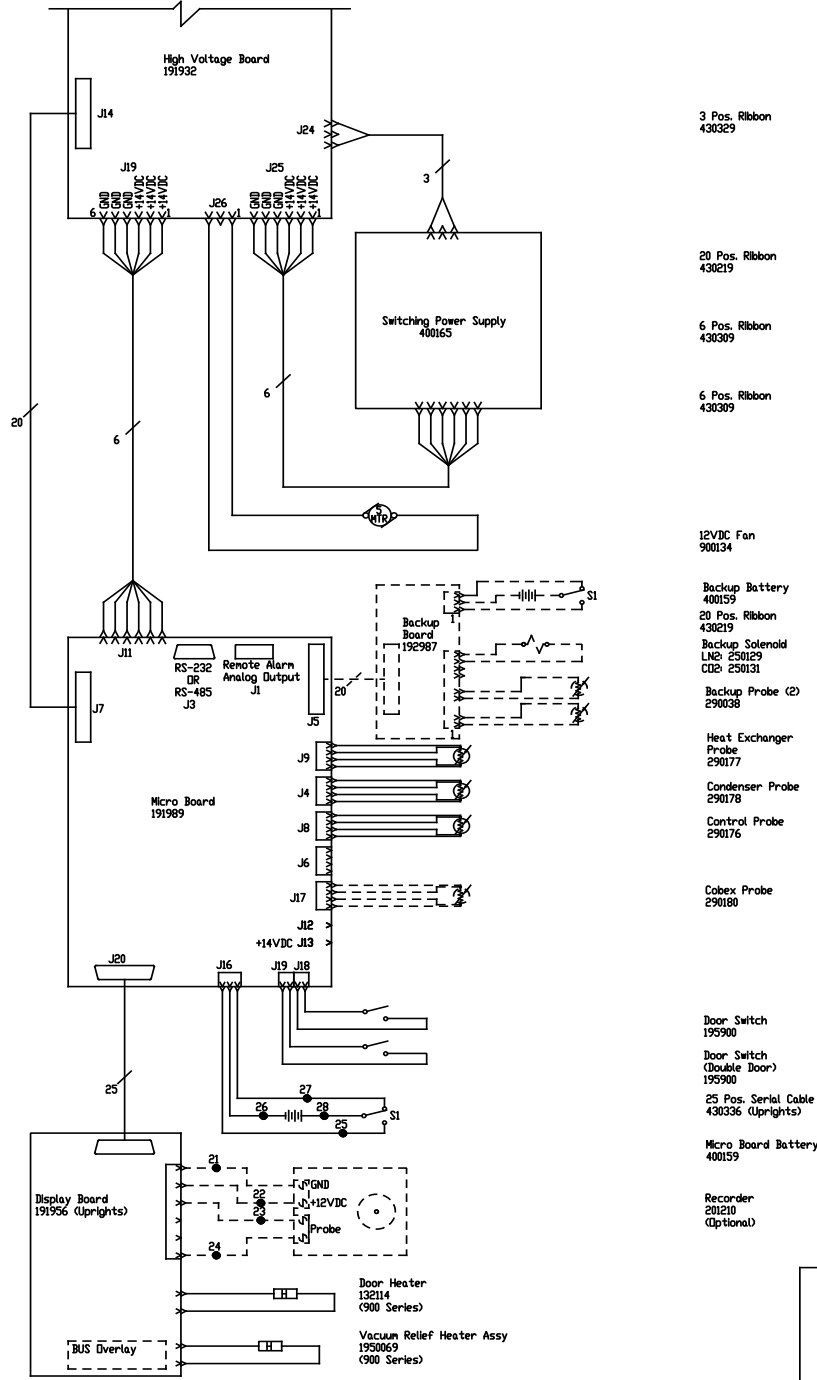
POWER CONNECTION  
120V, 1Ø, 2W, 60HZ, 16.0 FLA  
OPERATING RANGE 108-132V



Electrical Schematic  
Model:  
120V, 60Hz, -86°C  
ULT Upright Freezers

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Electrical Schematic  
Model:  
120V, 60Hz, -86°C  
ULT Upright Freezers

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Page 2 of 3

**Section 9**  
Electrical Schematics

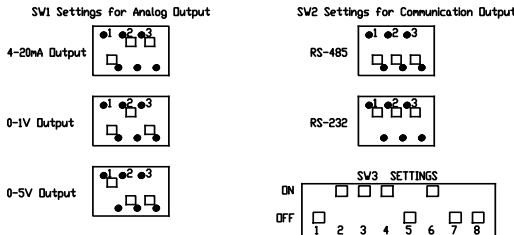
WIRE #	COLOR	GAUGE	WIRE #	COLOR	GAUGE
77	1	14	29	-	-
	2	14	30	-	-
78	3	14	31	GRN/YEL	14
	4	14	32	BLK	14
	5	14	33	BLU	14
79	6	18	34	BLK	14
	7	18	35	BLU	14
80	8	18	36	BLK	14
	9	18	37	BLU	14
81	10	18	38	BLK	14
	11	18	39	BLU	14
	12	18	40	BLK	14
82	13	18	41	BLU	14
	14	18	42	BLK	14
83	15	18	43	BLU	14
	16	18	44	-	-
84	17	14	45	-	-
	18	14	46	-	-
	19	-	47	-	-
85	20	-	48	-	-
	21	18	49	-	-
86	22	18	50	-	-
	23	18	51	-	-
	24	18	52	YEL/WHT	14
87	25	18	53	YEL	14
	26	18	54	BLU/WHT	14
88	27	18	55	BLU	14
	28	18			

UPRIGHT MODELS  
13 CUFT. (120V) - 903, 992, CAR24086A, EXF24086A, HFU2408A, TSE240A  
17 CUFT. (120V) - 904, 993, CAR32086A, EXF32086A, HFU3208A, TSE320A  
23 CUFT. (120V) - 956, 990, CAR40086A, EXF40086A, HFU4008A, TSE400A

**REMOTE CONTACTS/ANALOG OUTPUT**  
PIN# 1 Analog Output +  
PIN# 2 Analog Output -  
PIN# 3 Not Connected  
PIN# 4 Not Connected  
PIN# 5 Normally Closed  
PIN# 6 Common  
PIN# 7 Normally Open  
CONTACT RATING 1A @ 30V  
CONTACTS IN ALARM STATE

**RS-232 SPECIFICATION**  
BAUD = 1200  
PARITY = N  
BITS = 8  
STOP BITS = 2

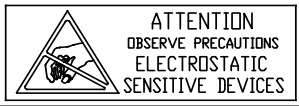
**RS-232 PORT**  
PIN# 2 TXD  
PIN# 3 RXD  
PIN# 5 GND



- Schematic represents single & double door upright models and chest models. All heaters are for uprights only. Expansion solenoid on 17 & 23 cuft uprights only.
- Door switches shown in open position.
- Battery switch shown in the OFF position.
- Circuit breaker switch shown in OFF position.
- Options and accessories shown in dashed lines.

REV	ENCL	DATE	BY	CAD	APPD	DESCRIPTION OF REVISION
11	41795	12-13-17	KWB	TFI		UPDATED "UPRIGHT MODELS" DETAILS
10	FR-3006	08-14-17	KB	KDG	KWB	191987 BACKUP BOARD TO 192987
9	FR-2861	04-07-16	KWB	SAG	DRP	ADDED CARBONAL MODELS
8	FR-2795	05-06-15	SJM	SAG	DRP	32286 WAS 30MSI
7	FR-2781	04-02-15	KB	KDG	DRP	REMOVED REF. TO 190896 CWI SERIES VMP ASSY.
6	FR-2575	11-13-12	SJM	SAG	DRP	30MSI WAS 30MSM
5	FR-2409	09-24-12	AJC	KDG	DRP	RELA. LOW MISC. BLDG. HIGH DB 19089
4	FR-2386	08-29-12	AJC	KDG	DRP	REVISED OPERATING RANGE FROM 100-130V
3	FR-2440	08-29-12	AJC	KDG	DRP	HS COMP. EX3053 TO EX3056 / RELEASE 8
2	FR-2267	10/20/11	JWE	SAG	DRP	COMPRESSOR CHANGE / RELEASE 7
1	FR-2202	05/02/11	SRS	SAG	LIN	LIBERTY CAP / RELEASE 6
0	N/A	10-10-10	HCE	KDG	LIN	RELEASED FOR PRODUCTION / RELEASE 5

Electrical Schematic  
Model:  
120V, 60Hz, -86°C  
ULT Upright Freezers



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**ThermoFisher SCIENTIFIC**  
BOX 649, MARIETTA, OHIO 45750

MODEL/PART NAME: LOW-END, ULT -86C UPRIGHT FREEZERS, 120V, 60Hz  
DWG TITLE: UNIT SCHEMATIC  
DWG HCE CAD: KDG APPD: LIN DATE: 10-10-10 SCALE: NONE  
MATERIAL:  
PAINT COLOR:  
TOLERANCE UNLESS OTHERWISE SPECIFIED: .XX±  
ANGLES: DECIMAL, .XXX±

DRAWING NUMBER: 903-70-2  
SIZE: D

903-70-2-0 REV 11  
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## **THERMO FISHER SCIENTIFIC FREEZER WARRANTY**

The Warranty Period starts two weeks from the date your equipment is shipped from our facility. This allows for shipping time so the warranty will go into effect at approximately the same time your equipment is delivered. The warranty protection extends to any subsequent owner during the warranty period.

During the first two years of the warranty period, component parts proven to be non-conforming in materials or workmanship will be repaired or replaced at Thermo's expense, labor included. The ULT Freezers include an additional two year warranty on the compressors, parts only, F.O.B. factory. Installation and calibration is not covered by this warranty agreement. The Technical Services Department must be contacted for warranty determination and direction prior to any work being performed. Expendable items, i.e., glass, filters, pilot lights, light bulbs and door gaskets are excluded from this warranty.

Replacement or repair of component parts or equipment under this warranty shall not extend the warranty to either the equipment or to the component part beyond the original two year warranty period. The Technical Services Department must give prior approval for the return of any components or equipment.

**THIS WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES, WHETHER WRITTEN, ORAL, OR IMPLIED. NO WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE SHALL APPLY.** Thermo shall not be liable for any indirect or consequential damages including, without limitation, damages relating to lost profits or loss of products.

Your local Thermo Sales Office is ready to help with comprehensive site preparation information before your equipment arrives. Printed instruction manuals carefully detail equipment installation with operation, preventive maintenance and maintenance information on an included CD.

If equipment service is required, please call your Technical Services Department at 1-800-438-4851 (USA and Canada) or 1-740-373-4763. We're ready to answer your questions on equipment warranty, operation, maintenance, service, and special applications. Outside the USA, contact your local Thermo Scientific office or distributor for warranty information.



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## **THERMO FISHER SCIENTIFIC FREEZER INTERNATIONAL DEALER WARRANTY**

The Warranty Period starts two months from the date your equipment is shipped from our facility. This allows for shipping time so the warranty will go into effect at approximately the same time your equipment is delivered. The warranty protection extends to any subsequent owner during the warranty period. Dealers who stock our equipment are allowed an additional four months for delivery and installation, providing the warranty is registered online.

During the first two years of the warranty period, component parts proven to be non-conforming in materials or workmanship will be repaired or replaced at Thermo's expense, labor excluded. The ULT Freezers include an additional two year warranty on the compressors, parts only, F.O.B. factory. Installation and calibration is not covered by this warranty agreement. The Technical Services Department must be contacted for warranty determination and direction prior to any work being performed. Expendable items, i.e., glass, filters, pilot lights, light bulbs and door gaskets are excluded from this warranty.

Replacement or repair of component parts or equipment under this warranty shall not extend the warranty to either the equipment or to the component part beyond the original two year warranty period. The Technical Services Department must give prior approval for the return of any components or equipment.

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# Appendix A Handling Liquid Nitrogen



**Warning** Contact of liquid nitrogen or cold gas with the skin or eyes may cause serious freezing (frostbite) injury. ▲

## **Handle liquid nitrogen carefully.**

The extremely low temperature can freeze human flesh very rapidly. When spilled on a surface the liquid tends to cover it completely and intimately, cooling a large area. The gas issuing from the liquid is also extremely cold. Delicate tissue, such as that of the eyes, can be damaged by an exposure to the cold gas which would be too brief to affect the skin of the hands or face.

## **Never allow any unprotected part of your body to touch objects cooled by liquid nitrogen.**

Such objects may stick fast to the skin and tear the flesh when you attempt to free yourself. Use tongs to withdraw objects immersed in the liquid, and handle the object carefully.

## **Wear protective clothing.**

Protect your eyes with a face shield or safety goggles (safety glasses without side shields do not give adequate protection). Always wear gloves when handling anything that is, or may have been, in immediate contact with liquid nitrogen. Insulated gloves are recommended, but heavy leather gloves may also be used. The gloves should fit loosely, so that they can be thrown off quickly if liquid should splash into them. When handling liquid in open containers, it is advisable to wear high-top shoes. Trousers (which should be cuffless if possible) should be worn outside the shoes.

## Introduction

The safe handling and use of liquid nitrogen in cryogenic refrigerators and dewar flasks is largely a matter of knowing the potential hazards and using common-sense procedures based on that knowledge. There are two important properties of liquid nitrogen that present potential hazards:

1. It is extremely cold. At atmospheric pressure, liquid nitrogen boils at -320°F (-196°C).
2. Very small amounts of liquid vaporize into large amounts of gas. One liter of liquid nitrogen becomes 24.6 cu. ft. (700l) of gas.

The safety precautions in this booklet must be followed to avoid potential injury or damage which could result from these two characteristics. Do not attempt to handle liquid nitrogen until you read and fully understand the potential hazards, their consequences, and the related safety precautions. Keep this booklet handy for ready reference and review.

**Note** Because argon is an inert gas whose physical properties are very similar to those of nitrogen, the precautions and safe practices for the handling and use of liquid argon are the same as those for liquid nitrogen. ▲

### **Use only containers designed for low temperature liquids.**

Cryogenic containers are specifically designed and made of materials that can withstand the rapid changes and extreme temperature differences encountered in working with liquid nitrogen. Even these special containers should be filled SLOWLY to minimize the internal stresses that occur when any material is cooled. Excessive internal stresses can damage the container.

**Do not cover or plug the entrance opening of any liquid nitrogen refrigerator or dewar. Do not use any stopper or other device that would interfere with venting of gas.**

These cryogenic liquid containers are generally designed to operate with little or no internal pressure. Inadequate venting can result in excessive gas pressure which could damage or burst the container. Use only the loose-fitting necktube core supplied or one of the approved accessories for closing the necktube. Check the unit periodically to be sure that venting is not restricted by accumulated ice or frost.

### Use proper transfer equipment.

Use a phase separator or special filling funnel to prevent splashing and spilling when transferring liquid nitrogen into or from a dewar or refrigerator. The top of the funnel should be partly covered to reduce splashing. Use only small, easily-handled dewars for pouring liquid. For the larger, heavier containers, use a cryogenic liquid withdrawal device to transfer liquid from one container to another. Be sure to follow instructions supplied with the withdrawal device. When liquid cylinders or other large storage containers are used for filling, follow the instructions supplied with those units and their accessories.

### Do not overfill containers.

Filling above the bottom of the necktube (or specified maximum level) can result in overflow and spillage of liquid when the necktube core or cover is placed in the opening.

### Never use hollow rods or tubes as dipsticks.

When a warm tube is inserted into liquid nitrogen, liquid will spout from the top of the tube due to gasification and rapid expansion of liquid inside the tube.



### **Warning** Nitrogen Gas Can Cause Suffocation Without Warning! ▲

#### Store and use liquid nitrogen only in a well-ventilated place.

As the liquid evaporates, the resulting gas tends to displace the normal air from the area. In closed areas, excessive amounts of nitrogen gas reduce the concentration of oxygen and can result in asphyxiation. Because nitrogen gas is colorless, odorless and tasteless, it cannot be detected by the human senses and will be breathed as if it were air. Breathing an atmosphere that contains less than 18% oxygen can cause dizziness and quickly result in unconsciousness and death.

**Note** The cloudy vapor that appears when liquid nitrogen is exposed to the air is condensed moisture; not the gas itself. The issuing gas is invisible.

#### Never dispose of liquid nitrogen in confined areas or places where others may enter.

Disposal of liquid nitrogen should be done outdoors in a safe place. Pour the liquid slowly on gravel or bare earth where it can evaporate without causing damage. Do not pour the liquid on pavement.

## Appendix B Handling Liquid CO<sub>2</sub>



**Warning** High concentrations of CO<sub>2</sub> gas can cause asphyxiation! OSHA Standards specify that employee exposure to carbon dioxide in any eight-hour shift of a 40-hour work week shall not exceed the eight-hour time weighted average of 5000 PPM (0.5% CO<sub>2</sub>). The short term exposure limit for 15 minutes or less is 30,000 PPM (3% CO<sub>2</sub>). Carbon dioxide monitors are recommended for confined areas where concentrations of carbon dioxide gas can accumulate. ▲

**Store and use liquid CO<sub>2</sub> only in a well-ventilated place.**

As the liquid evaporates, the resulting gas tends to displace the normal air from the area. In closed areas, excessive amounts of CO<sub>2</sub> gas reduce the concentration of oxygen and can result in asphyxiation. Because CO<sub>2</sub> gas is colorless, odorless and tasteless, it cannot be detected by the human senses and will be breathed as if it were air. Breathing an atmosphere that contains less than 18% oxygen can cause dizziness and quickly result in unconsciousness and death.

**Note** The cloudy vapor that appears when liquid CO<sub>2</sub> is exposed to the air is condensed moisture; not the gas itself. The issuing gas is invisible.

**Never dispose of liquid CO<sub>2</sub> in confined areas or places where others may enter.**

Disposal of liquid CO<sub>2</sub> should be done outdoors in a safe place. Pour the liquid slowly on gravel or bare earth where it can evaporate without causing damage. Do not pour the liquid on pavement.

## Appendix C First Aid

If a person seems to become dizzy or loses consciousness while working with liquid nitrogen or carbon dioxide, move to a well-ventilated area immediately. If breathing has stopped, apply artificial respiration. If breathing is difficult, give oxygen. Call a physician. Keep warm and at rest.

If exposed to liquid or cold gas, restore tissue to normal body temperature (98.6° F) as rapidly as possible, followed by protection of the injured tissue from further damage and infection. Remove or loosen clothing that may constrict blood circulation to the frozen area. Call a physician. Rapid warming of the affected part is best achieved by using water at 108° F. Under no circumstance should the water be over 112° F, nor should the frozen part be rubbed either before or after rewarming. The patient should neither smoke nor drink alcohol.

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