

# Installation Operation Maintenance Manual

## Z-Series





## INTRODUCTION

This manual has been tailored to match the specific features and options provided on your Temperature Chamber at the time of original manufacture. The last section of the manual is the specific information section. This area was developed in an attempt to better define items on CSZ chambers that are "SPECIFIC" to a customer. Please refer to this section for warranty, controller PID parameters, and calibration/verification test data sheets.

Cincinnati Sub-Zero Temperature Chamber:

MODEL NO. \_\_\_\_\_

SERIAL NO. \_\_\_\_\_

**DO NOT USE THIS MANUAL IN AN ATTEMPT TO OPERATE OR MAINTAIN ANY OTHER MODEL OR SERIAL NUMBER.**

**PLEASE READ THIS ENTIRE MANUAL BEFORE OPERATING THIS UNIT.**

## HOW TO CONTACT CSZ

Cincinnati Sub-Zero Products, Inc.  
12011 Mosteller Road  
Cincinnati, OH 45241

Telephone	1-513-772-8810
Toll Free (North America)	1-800-989-7373
Fax	1-513-772-9119
E-mail	<a href="mailto:csz@cszinc.com">csz@cszinc.com</a>
Internet	<a href="http://www.cszinc.com">http://www.cszinc.com</a>

## HOW TO OBTAIN REPLACEMENT PARTS

1. Contact the Service Department at (513) 719-3300 from 7:30 AM to 5:30 PM (Eastern Time Zone).
2. To order the replacement part, please provide the following information:
  - a. The model number and serial number of the chamber for which the replacement part is needed.
  - b. The complete Cincinnati Sub-Zero Part number.
  - c. The specific complaint regarding the failed part.
  - d. Parts may be ordered using a purchase order or credit card.
3. The Service Department will authorize the return of the failed parts and issue an RMA (Return Material Authorization) number.
4. Warranty parts are shipped at no charge. However, if an RMA is assigned, the failed part must be returned to CSZ within 90 days. If the failed part is not returned within the 90 day period, an invoice will be sent for the part at the current list price.
5. All parts are shipped FOB Cincinnati, Ohio, 45241.
6. Please return failed parts to:

Cincinnati Sub-Zero Products, Inc.  
12011 Mosteller Road  
Cincinnati, OH 45241-1528

# SYMBOLS



General Caution or Warning  
Refer to accompanying documents



Caution or Warning - Risk of Electrical Shock



Caution or Warning - Hot Surface



Controller event output



Conditioning system



Humidity System

**N<sub>2</sub>/CO<sub>2</sub>**

Liquid Nitrogen or  
Carbon Dioxide  
Boost Cooling



Dry Air Purge



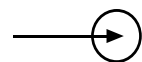
Frozen Coil



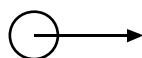
Refrigeration  
Components Location



High heat over-temperature  
condition



Inlet



Outlet



Chamber



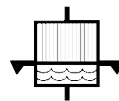
Hi Limit



Product Hi/Low  
Limit Control



Light



Clean humidity nozzle & filter  
every 3 months or 500 hours  
of use.



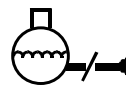
Program/Off/On



Drain



Drain and clean reservoir  
& pump screen every 2 months.



After main power interruptions (4 hours or  
longer), allow unit to warm up 4 hours prior to  
resetting the compressors.



Air



Water



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## INTRODUCTION

### WARNING

Warnings identify any conditions or practices that, if not strictly observed, could result in serious personal injury or possible loss of life.

### CAUTION

Cautions identify any condition or practice that, if not strictly observed, could result in damage to, or destruction of, the system equipment.

## GENERAL SAFETY PRECAUTIONS



### WARNING

Do not replace components or make adjustments inside the equipment with the main power supply turned on. Under certain conditions, dangerous potentials may still exist when the power switch is in the off position due to charges retained by capacitors. To avoid injury, always remove power and ground a circuit before touching it.



### WARNING

Paint thinners, cleaning solutions and other chemicals or solvents should never be stored in the vicinity of the unit. High operating temperatures and live electrical circuits could ignite fumes and cause an explosion.



### WARNING

Do not touch refrigeration piping during chamber operation. The refrigeration piping can become very hot or extremely cold, and cause severe burns.



### WARNING

High voltage remains present when limit switch is open. This unit must be locked out at the main power source prior to servicing. The cover should also remain installed at all times.



### WARNING

The chamber door must remain closed during operation. If the door is required to be open, wear safety goggles to prevent the high velocity airflow from blowing particles or objects into your eyes.



### WARNING

This chamber operates at extreme temperatures. Avoid any personal contact with objects and surfaces that may be hot or cold to prevent severe burns or frostbite.



### WARNING

The refrigeration unit is a pressurized system and hazards exist which could result in personal injury. It is therefore recommended that removal and installation of the hermetic compressor be performed by experienced personnel only. Failure to follow these instructions may result in serious personal injury.



### WARNING

Gaseous nitrogen/C02 vent connection must be ducted to the out doors to prevent displacement of oxygen around the unit.



### WARNING

DO NOT place items in the chamber that could burn or explode at high temperatures. This chamber uses open wire heating elements which generate surface temperatures over 1000°F. This is NOT an explosion-proof chamber.

## GENERAL SAFETY PRECAUTIONS



### CAUTION

**PRODUCT PROTECTION.** Chambers are equipped with high heat limits or safety devices. These safety devices are installed to protect the chamber from exceeding design limits. These safety devices remove power **ONLY** from the chamber heaters and **DO NOT** remove power from your product. Provisions must be made to de-energize the product on test and the chamber in the event of an over-temperature protection.



### CAUTION

On systems 3HP and over only, power must be applied to the unit for four hours or longer before operating the compressor or beginning the pumpdown procedure.



### CAUTION

All OSHA guidelines regarding lockout/tagout procedures must be followed while servicing this unit. This may include a lockable disconnect switch to remove power from the equipment while servicing.



### CAUTION

Do not reach into an enclosure to service or adjust equipment except in the presence of someone who is capable of rendering aid.



### CAUTION

Window frame may become hot during operation.



### CAUTION

**DO NOT** place items in the chamber that could burn or explode at high temperatures. This chamber uses open wire heating elements which generate surface temperatures over 1000°F. This is **NOT** an explosion-proof chamber.



### CAUTION

**DO NOT** place items in the chamber which can omit corrosive vapors or substances.



### CAUTION

There are **NO** provisions for venting fumes.



### CAUTION

To prevent damage to your test samples and the chamber's compressors, **DO NOT** exceed the live load rating of the chamber. (See the General Description Section of this manual for the Live Load rating for your unit.)



### CAUTION

Running Temperature/Humidity points outside of the standard range can cause damage to the refrigeration compressors(s). (See chart on pg. 2-5)



## HANDLING ELECTROSTATIC DISCHARGE SENSITIVE DEVICES

Certain components within the unit can be damaged by electrostatic discharge (ESD). Parts or assemblies are identified as ESD sensitive by the symbol to the left. The following are general precautions that should be observed when handling ESD sensitive devices or assemblies:

1. Handle ESD sensitive devices at approved field force protective work stations.
2. Keep work area free of static generators, such as plastic cups, foam cushions, and rayon or polyester apparel.
3. Avoid static-producing activities, such as wiping feet and removing or putting on smocks while in the work area.
4. Use ESD protective equipment, such as grounded work benches, grounded tools and test equipment, conductive flooring, air ionizers, personnel ground straps with 1 megohm minimum resistance, and protective apparel whenever possible.
5. Store and transport ESD sensitive devices in protective bags, tote boxes, or trays. Use original packaging whenever possible.
6. Remove power before removing or installing ESD sensitive devices or assemblies.
7. Handle ESD sensitive circuit card assemblies by their shunt bars or edges. Do not touch parts, terminals, or circuitry. Do not use canned coolant for fault isolation.

## SAFETY FEATURES

Cincinnati Sub-Zero incorporates many safety features in the design of its equipment. These safety features provide protection for the equipment, as well as for operating and maintenance personnel.

### ELECTRICAL CIRCUIT PROTECTION

1. All power and control circuits have individual short circuit/overload protection provided by either circuit breakers or fuses.
2. Compressors have internal thermal overload protection which will shut down the compressor in the event of a thermal overload.
3. All power to the chamber heaters is provided by a non-cycling power contactor. This contactor is controlled by the chamber over temperature limit and an optional High/Low test limit control. The contactor is de-energized if either a chamber over-temperature or test item over/under-temperature condition exists.

### REFRIGERATION SYSTEM PROTECTION

1. The refrigeration systems utilize refrigerants which are non-flammable and non-explosive.
2. Each refrigeration system is equipped with a high pressure control. This control will shut down the compressor if a high pressure condition is reached. The control will automatically reset once the pressure drops within safe operating limits. 6HP Tundra units have a dual High/Low pressure switch. The high pressure switch is manual reset. The low pressure switch resets automatically. Contact Cincinnati Sub-Zero if this occurs.

### OVER-TEMPERATURE PROTECTION

The high temperature cutoff and fusible link over-temperature protectors are installed to protect the chamber from exceeding design limits. These safety devices remove power only from the chamber heaters when an over-temperature condition exists in the chamber. They DO NOT remove power from the product being tested.

1. High temperature cut-off (TAS)

This device is located on the rear chamber wall and is intended for chamber over-temperature protection only. It is preset to open at the temperature indicated on the electrical schematic (typically 200°C).

On standard Z units, the limit light on the instrument console will illuminate if this device should open and the system will shut down. When the chamber temperature reaches an acceptable lower temperature, the cut-off will close, the

limit light will go out, and the chamber will resume normal operation.

## 2. Fusible link over-temperature protector (SQ)

This device is installed on the heater power supply leads to provide heater over-temperature protection. It is designed to interrupt the heater power in the plenum area if the temperature exceeds the setting indicated on the electrical schematic (typically 240°C). If the device opens, the system controller may indicate that the heater is on; however, the temperature inside the chamber will drop since no heat is being generated. The temperature protector must be replaced if it opens and cause of failure corrected. (See Maintenance Section for replacement instructions.).

## 3. Product High/Low Limit

Every chamber may be equipped with a Product High/Low Limit Alarm that incorporates an independent type "T" thermocouple to monitor part temperature. The high/low limit alarm shuts down the chamber and sounds an audible alarm if the preset temperature limits are exceeded. The alarm can be used by the customer to shut down the product under test (SEE ELECTRICAL SCHEMATIC for proper connection). The limit alarm is both high and low, can be set for latching or non-latching, and has an adjustable hysteresis band.





## SYSTEM DESCRIPTION

The Z(H)-Series Temperature chambers are pre-engineered chambers designed to provide an environment with specific temperature (humidity) conditions. The standard Z-model is composed of three basic sections: 1. Control section, 2. Chamber section, 3. Refrigeration/ Heating section. Optional equipment includes, but is not limited to: 4. Humidity, 5. Pen Recorders, 6. High/Low Limit, 7. IEEE-488 Serial Interface, 8. Boost Cooling System, 9. GN2 Purge System, 10. Frozen Coil, 11. Dry Air Purge.

The chambers have a standard range of -100°F to +375°F (-73°C to +190°C) cascade -50°F to +375°F (-45°C to +190°C) Tundra -30°F to +375°F (-34°C to +190°C) single stage which provide both heating and cooling as required. Note: Single stage is not applicable on the Z-2 unit. Chambers with optional humidity are designed to provide a minimum of 10% and a maximum of 95% relative humidity, as limited by a 40°F (4°C) dewpoint and a 185°F (85°C) maximum dry bulb temperature. The chambers are designed to operate in a commercial environment i.e., temperature of +75°F ±10°F (+23°C ±6°C) and a maximum relative humidity of 95%. Refer to the specifications at the end of this section for additional information.

### 1. CONTROLLER SECTION

The standard controller is composed of a Microprocessor-Based Watlow F4 Controller, a High/ Low limit, normal function switches, indicator lights, and communications electronics. Operating instructions for the F4 controller are found in the Watlow F4 user's manual that accompanied the chamber. Other optional controllers are available including the Chromalox 2104, Chromalox 2030, and the Honeywell UMC 800 controller.

### 2. CHAMBER SECTION

#### A. Chamber Interior

The chamber interior consists of the front workspace and the rear component area, separated by a stainless steel plenum. A probe bracket is attached to the upper left corner of the grill on top of the plenum. The bracket contains the probes for the controller, recorder (if required), and RH sensor (if humidity unit installed). The area behind the plenum contains the refrigeration evaporator, heater, thermal cutoff, evaporator fan(s), humidification and auxiliary cooling nozzles, and the dehumidification coil (if humidity option is installed). Refer to Figures 4 and 5. These items may be accessed by removal of the plenum cover.

#### B. Chamber Exterior

Fiberglass insulation is used with a high temperature binder for temperatures up to 500°F (260°C). The cabinet is constructed with a minimum of mechanical contact between the liner and the exterior to reduce conductive heat losses and minimize condensation on the exterior cabinet.

A multiple-pane window assembly in the door of the chamber allows viewing of the chamber interior during operation. The window is constructed of tempered glass panes with a heater harness to assure frost-free viewing during low temperature chamber operation. Under certain ambient conditions, it may be normal to see some condensation around the outer window frame area during low temperature operation.

### 3. REFRIGERATION/HEATING SECTION

#### A. Refrigeration

Z-Series chambers use one of three types of mechanical refrigeration systems. Single stage, Tundra and cascade. A single stage system is used when the chamber's ultimate low temperature is -30°F (-34°C) or higher. The Tundra system is used when the chambers ultimate low temperature is -50°F (-45°C) or higher. A cascade system is used when the chamber's ultimate low temperature is -100°F (-73°C). The single stage system uses refrigerant R-404A. The cascade system uses refrigerant R-404A in System #1 and R-508B in System #2.

The refrigeration system can either be air cooled or water cooled depending on the model of chamber.

All refrigeration components are selected to ensure safe, reliable, and balanced operation. The components may be purchased from the CSZ Service Department or a local refrigeration wholesaler.

#### B. Heater

Open-coil nichrome heating elements are standard on all systems. The heaters are mounted in porcelain insulators attached to stainless steel frames. The heaters are located behind the rear plenum and do not radiate directly into the test space.

Limited temperature sheath heaters are an option for chambers that may contain flammable vapors. See item 12 of this section for more information.

### 4. HUMIDITY SECTION (OPTIONAL)

The ZH-Series chambers provide the same temperature ranges for heating and cooling as the Z-Series, but add the ability to control humidity within the range of 10% to 95% relative humidity as limited by a 185°F (85°C) dry bulb temperature and a 40°F (4°C) dewpoint. The chambers have the ability to control humidity as low as 5% when the frozen coil option is utilized. ZH-8, 16 & 32 use an atomizing or steam generation humidity system and the ZH-2 uses a steam generator. Refer to Figure 1 for more information on achievable humidity points.

*Note: In some instances and at certain setpoints, the PID parameters in the controller can be changed to achieve better control in humidity mode. Please see Chapter 7 and the controller manual for instructions on how to edit PID's.*

## HUMIDITY PANEL COMPONENTS (Atomizing System and Steam Generator System)

The water supply system for humidity is provided on the humidity panel assembly located on the left side of the unit. The door will need to be opened to access these parts. The following is a description and function of the major components (see Figures 2 and 3).

### 1. Water Valve and Rack Assembly

- a. The valve is used to temporarily turn off the water supply in order to change the demineralizer filter without interrupting chamber operation.
- b. The rack holds the demineralizer filter.

### 2. Water Supplier Solenoid

- a. This is a normally closed solenoid valve and is energized (opened) only when the chamber is in the humidity mode. This valve is primarily used on steam generator systems and may or may not be present on certain atomizer humidity systems.

### 3. Demineralizer Filter

- a. The filter removes most common impurities from tap or soft water.
- b. The outer casing of the filter is transparent and the crystals are visible. A new cartridge is violet or dark blue when water flows through it. A spent cartridge will turn brown, orange, yellow or white. The cartridge should be changed before it completely changes color. A reference mark is provided on the filter to indicate when it should be changed. Spare cartridges are available through the CSZ Service Department. Refer to the Humidity Maintenance Section for instructions on how to change the filter.

### 4. Control Solenoid

- a. This is a normally closed solenoid valve which is energized (opened) to supply water to the atomizer nozzle.
- b. The valve may pulse several times per minute to accurately control the level of humidity within the chamber. The valve has been specifically designed for CSZ and has a cycle life of 20 times that of an ordinary solenoid valve.

### 5. Air Compressor (Atomizing System Only)

- a. The air pump intakes chamber air and pumps it through a specially designed atomizer nozzle in the chamber.

### 6. Steam Generator System (Z-2 Units Only) - See Figure 3

- a. The steam generator provides humidity in the form of steam. The steam generator has a multi-level float switch which controls the water level. The heater boils the water to generate steam. The steam is injected into the chamber.
- b. A high temperature safety thermostat is mounted on the boiler wall to remove heater power if an over-temperature situation is reached.



#### WARNING

Failure to maintain cartridge may result in chloride corrosion of stainless steel interior surfaces.



#### WARNING

Maximum water inlet pressure is 10 PSI. Exceeding this pressure may cause catastrophic failure of the filter housing.

## HUMIDITY CHAMBER COMPONENTS

The chamber area contains the remaining components necessary to generate and maintain humidity levels within the work space. The following is a description of these components (see Figures 4 and 5).

### 1. Solid State Humidity Sensor

- a. **DO NOT RELOCATE.** It has been located at the factory for maximum performance.

This unit utilizes a solid state relative humidity sensor which takes the place of the traditional wet bulb and dry bulb sensors. The solid state sensor is a highly accurate quick responding direct RH measuring device. It feeds an electronic signal to the controller that in turn controls and displays direct relative humidity.

### 2. Atomizing Nozzle

- a. Water flows from the control solenoid at a very slow rate. Air is pumped into this nozzle and picks up the water. The chamber is humidified by the air/water mixture.

### 3. Humidity Wet Coil

- a. This coil is cooled by the R-404A (System 1) system and functions as a dehumidification coil. Dehumidification of the chamber air is accomplished by condensing water from the chamber air onto the refrigerated surface.

### 4. Wet Coil Pan

- a. The wet coil pan is used to collect moisture from the wet coil and disperse it through the chamber drain.

### 5. Recirculating Water

The Recirculating Water Reservoir Option is a fully integrated accessory that requires only minor installation. Just fill the reservoir with water to the fill line, connect a drain line to the plastic ball valve located at the bottom rear of the unit and the system is ready to operate.

#### Typical System Operation:

- A water pump (located under the reservoir) turns on when the humidity function is turned on and pumps water from the reservoir to the boiler
- The water vapor condenses into a liquid and runs down the chamber drain, back to the reservoir
- This cycle is repeated over and over
- The float switch (located on top of the reservoir) turns the pump off when the water level in the reservoir is too low and needs to be replenished, preventing damage to the pump

#### Maintenance:

- Drain and clean the reservoir every 2 months or sooner as required by usage and water conditions

## Achievable Points with Optional Extended Relative Humidity Range

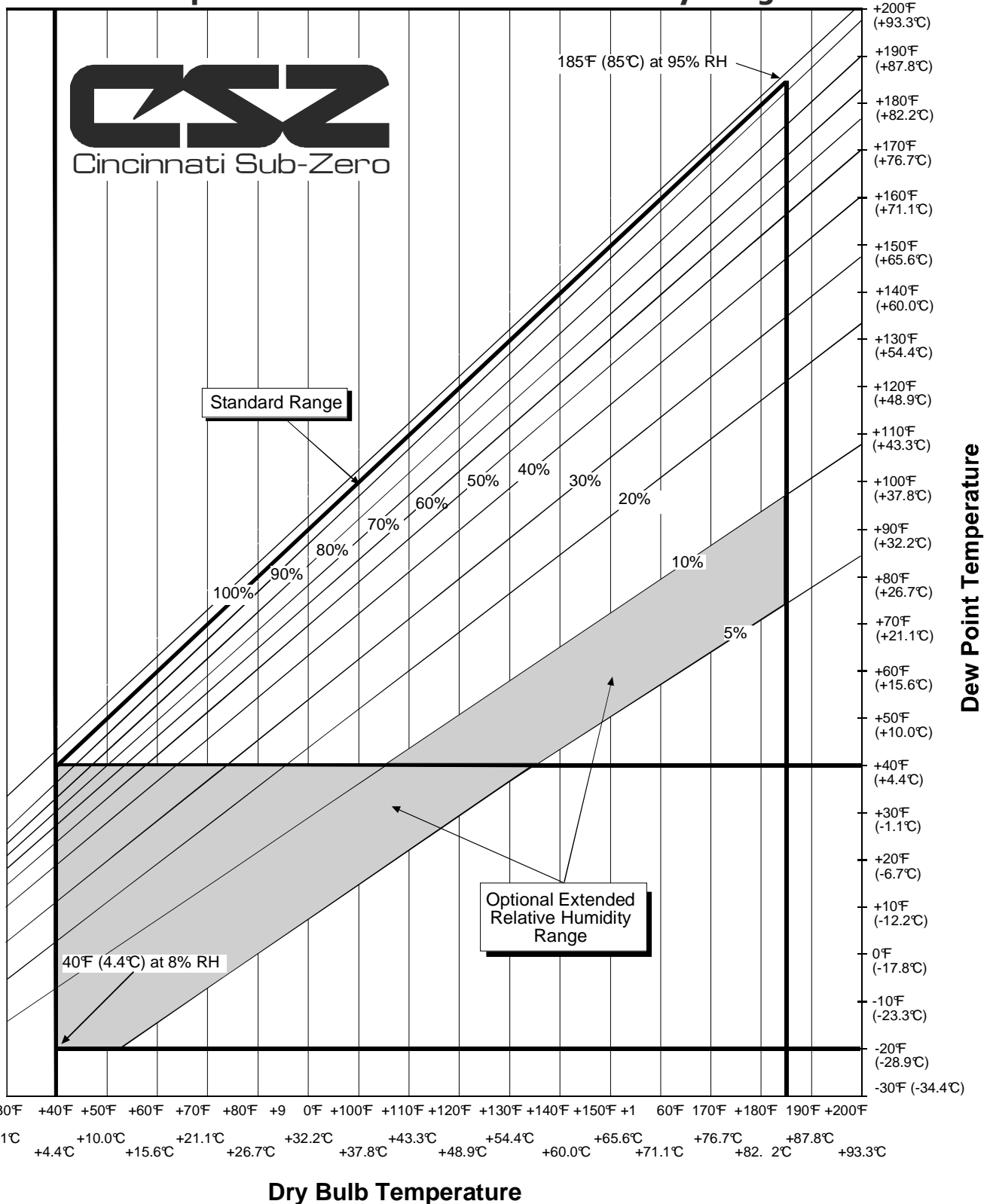


Figure 1. Achievable Points



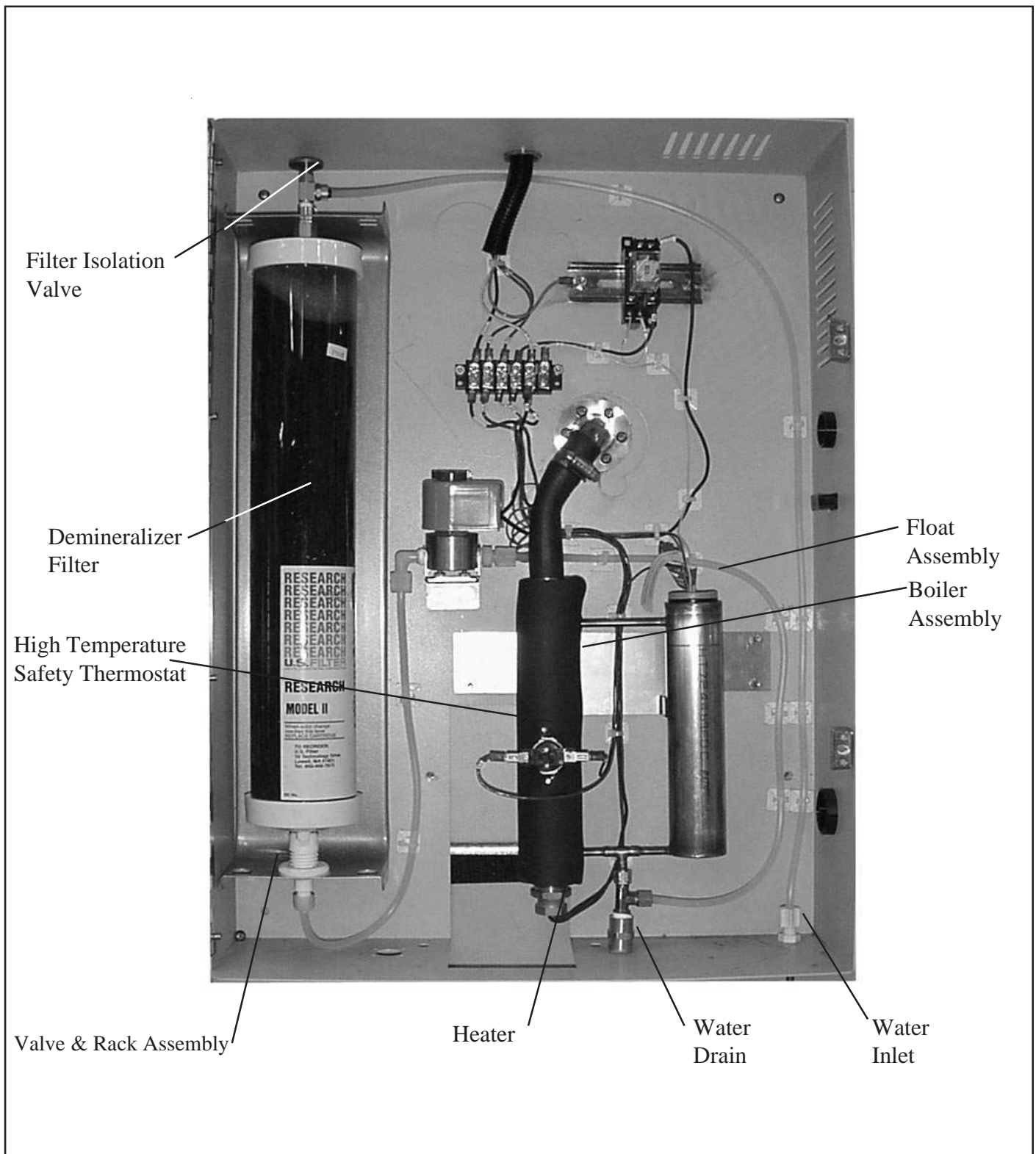


Figure 3. Humidity Panel Assembly (Boiler System)

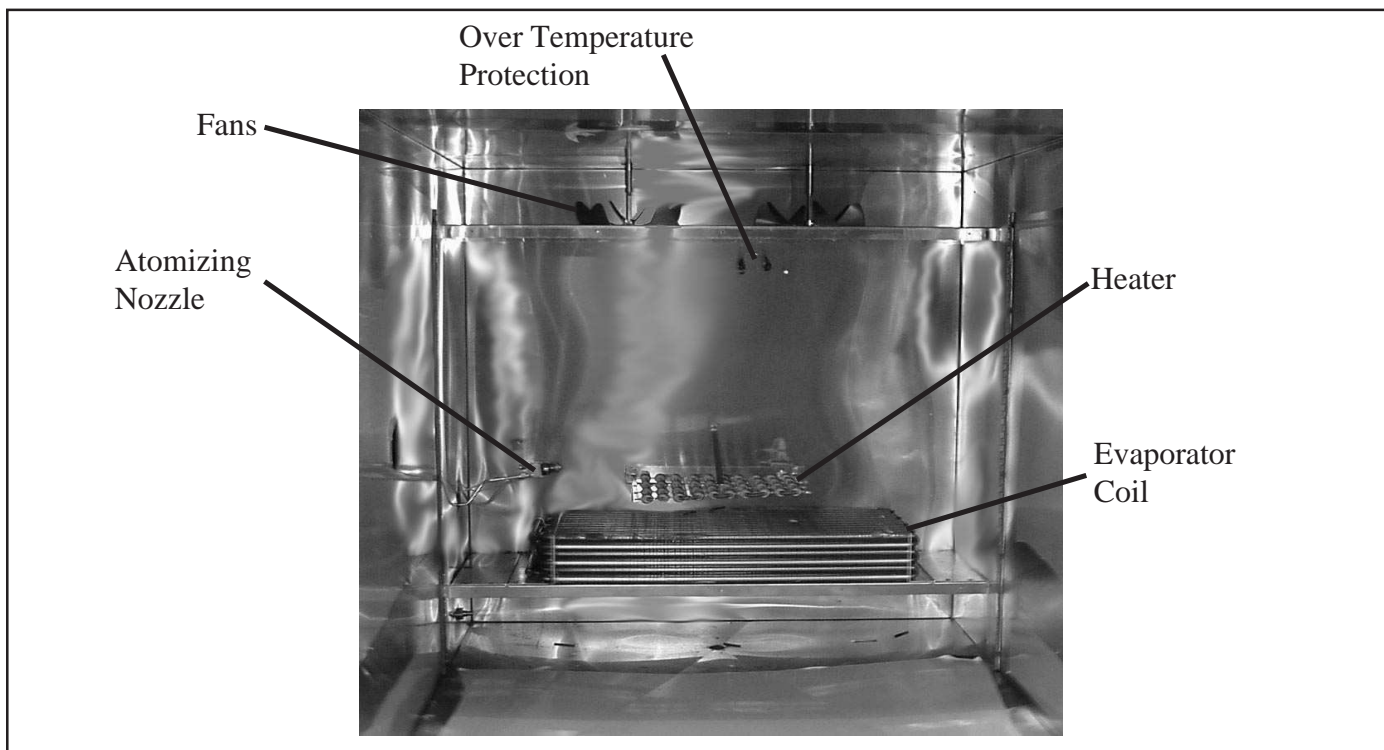


Figure 4. Chamber Interior (Plenum Cover Removed)

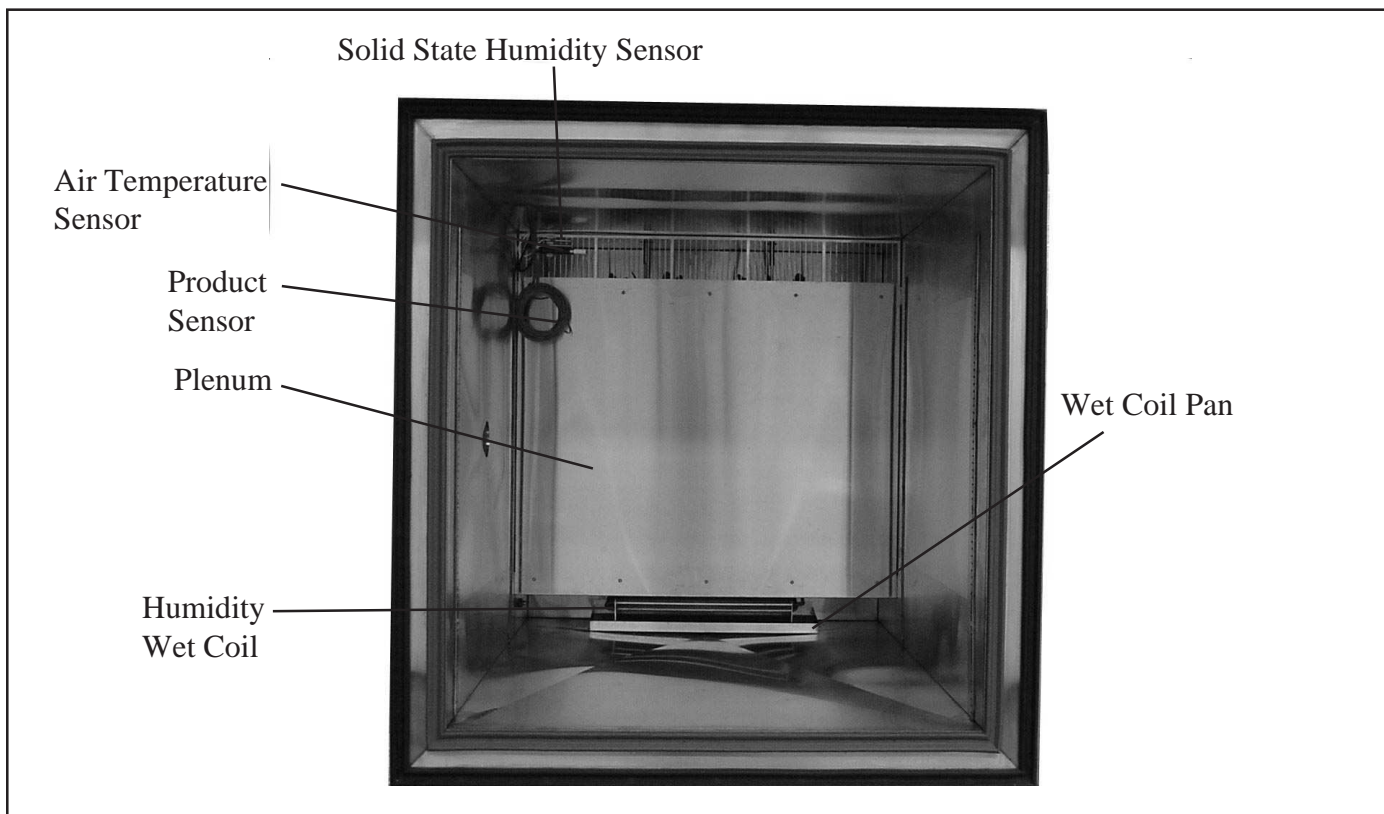


Figure 5. Chamber Interior (With Plenum Cover)



## 5. PEN RECORDERS (OPTIONAL)

The Circular Chart Recorder (not illustrated) features fully programmable inputs ranging and linearization with stepper motor pen and chart drive speed. Refer to the chart recorder manual shipped separately with your unit. This eliminates the need for range cards and chart speed change gears. Configuration is field programmable for flexibility to meet changing test requirements. Replacement chart paper is available from the CSZ Service Department.

## 6. HIGH/LOW LIMIT CONTROL (Optional on Z-2 and ZH-2 Units Only)

The High/Low Limit Control is designed with set-points for high and low temperatures. These can be precisely set at temperatures to permit safe operation. Power to the product being tested and a circuit interrupting power to the chamber must be wired through the output relay of the device. The Limit Control will shut down the chamber operation and product operation if the safe operating temperature limit of the product, either hot or cold, has been exceeded.

## 7. IEEE-488 SYSTEM (OPTIONAL)

The IEEE-488 bus is also known as the "General Purpose Interface Bus" (or GPIB). The purpose of the IEEE-488 bus is to transfer information between two or more devices. A device may either be an instrument or a computer. Devices may 'Talk' (send), 'Listen' (receive), or be idle on the bus. Only one device can be 'addressed' (allowed) to Talk on the bus at a time, while one or more devices may Listen.

One device on the bus must be the System Controller. The Controller determines which device will talk and which devices will listen. The Controller is usually a computer containing a IEEE-488 interface card and application programs. The IEEE-488 specification allows the System Controller to pass its duties to another device, making it the 'Active Controller'.

There are two types of messages sent over the IEEE-488 bus: interface messages and device dependent messages. Interface messages manage the IEEE-488 bus, using commands to clear the interface, address devices to talk or listen, and so forth. Device dependent messages transfer commands specific to the device controller.

## 8. LN2/BOOST COOLING SYSTEM (OPTIONAL)

In addition to the main refrigeration system, the chamber is equipped with an optional connection port for supplying boost cooling from an external source of cryogenic liquefied gas (either carbon dioxide or liquid nitrogen). The boost cooling gas is vented directly into the chamber by a controller under the conditions of sustained cooling demand.

## WARNING

Gaseous Nitrogen/CO<sub>2</sub> vent must be ducted out doors. To prevent displacement of oxygen around the unit. Asphyxia can occur if this is not installed properly.

The System Diagrams Chapter illustrates the schematic diagram for the boost cooling system when using LN<sub>2</sub> as the boost cooling agent.

### Specifics

The LN<sub>2</sub> cylinder should be connected with a well insulated line that is at least 3/8" inside diameter. The line length should be 5FT or less. The LN<sub>2</sub> tank should have a maximum supply pressure of 25 PSIG.

To operate the chamber with LN<sub>2</sub> there are two modes: Mechanical cooling with LN<sub>2</sub> boost and LN<sub>2</sub> cooling only below -85C.

### Mode

**Mechanical cooling with LN<sub>2</sub> boost:** At temperatures above -85C the refrigeration system operates normally. When the LN<sub>2</sub> switch is turn "on" the LN<sub>2</sub> cooling valve will open when there has been a call for cooling from the controller for more than 10 seconds. This will boost the cooling effect and reduce the temperature in the chamber faster.

**LN<sub>2</sub> cooling only below -85C:** If the controller is set for a temperature below -85C, the refrigeration system will turn off (below -85C) and the LN<sub>2</sub> will do all of the cooling.

## 9. GN2 PURGE SYSTEM (OPTIONAL)

The GN<sub>2</sub> Purge system must be vented outdoors. To prevent displacement of oxygen around the unit. DO NOT enter the chamber while the boost/purge is turned on. The door must be left open to ventilate the chamber before entering. A GN<sub>2</sub> Purge system reduces condensation within the test chamber and is used when low humidity is required. The purge system consists of a control solenoid and flow meter. GN<sub>2</sub> has a dewpoint approaching -300°F (-185°C) that when introduced into the chamber workspace, creates a slightly positive pressure within the chamber to minimize the migration of moist ambient air into the chamber. The system requires approximately 5 scfm (142 std liters/minute) of GN<sub>2</sub> at 70 psig (560 kpa).

## 10. FROZEN COIL (OPTIONAL)

The Frozen Coil option for humidity chambers is for the purpose of providing extended low RH conditions not obtained with a standard wet coil dehumidification package. It is almost always used in conjunction with a Dry Air Purge system to achieve the extended range that is depicted in Figure 1.

The Frozen Coil dehumidifies the chamber air to dewpoint temperatures of approximately -12°F (-24.4°C). This is accomplished by bypassing the standard wet coil circuit which controls the evaporator temperature at approximately +32°F (0°C) and allows the coil to operate in a frozen condition. The lower dewpoint conditions are then achieved by freezing the water vapor from the chamber air.

As the water vapor is removed, the relative humidity level is reduced. Operation of the Dry Air Purge system in conjunction with the Frozen Coil provides for extended operation at these conditions. The purge air at dew points even lower than the Frozen Coil (approx. -100°F) sublimates the frost from the coil to prevent excessive accumulation which would render the coil ineffective.

## 11. DRY AIR PURGE (OPTIONAL)

A Dry Air Purge system can be provided to reduce condensation within the test chamber and for use when low humidity is required. The system consists of a heatless air dryer that has twin, desiccant towers, control solenoid, and flow meter. Every 30 seconds during normal operation the tower will switch from drying to regeneration. Compressed air is dried to a dewpoint approaching  $-100^{\circ}\text{F}$  ( $-73^{\circ}\text{C}$ ) then introduced into the chamber workspace, creating a slightly positive pressure within the chamber to minimize the migration of moist ambient air into the chamber. The system requires approximately 5 scfm (142 std liters/minute) of compressed air at 90 psig (720 kpa) free of all oil and entrained water droplets. The system features a dropout filter and oil removal filter at the inlet. See Figure 6 below.

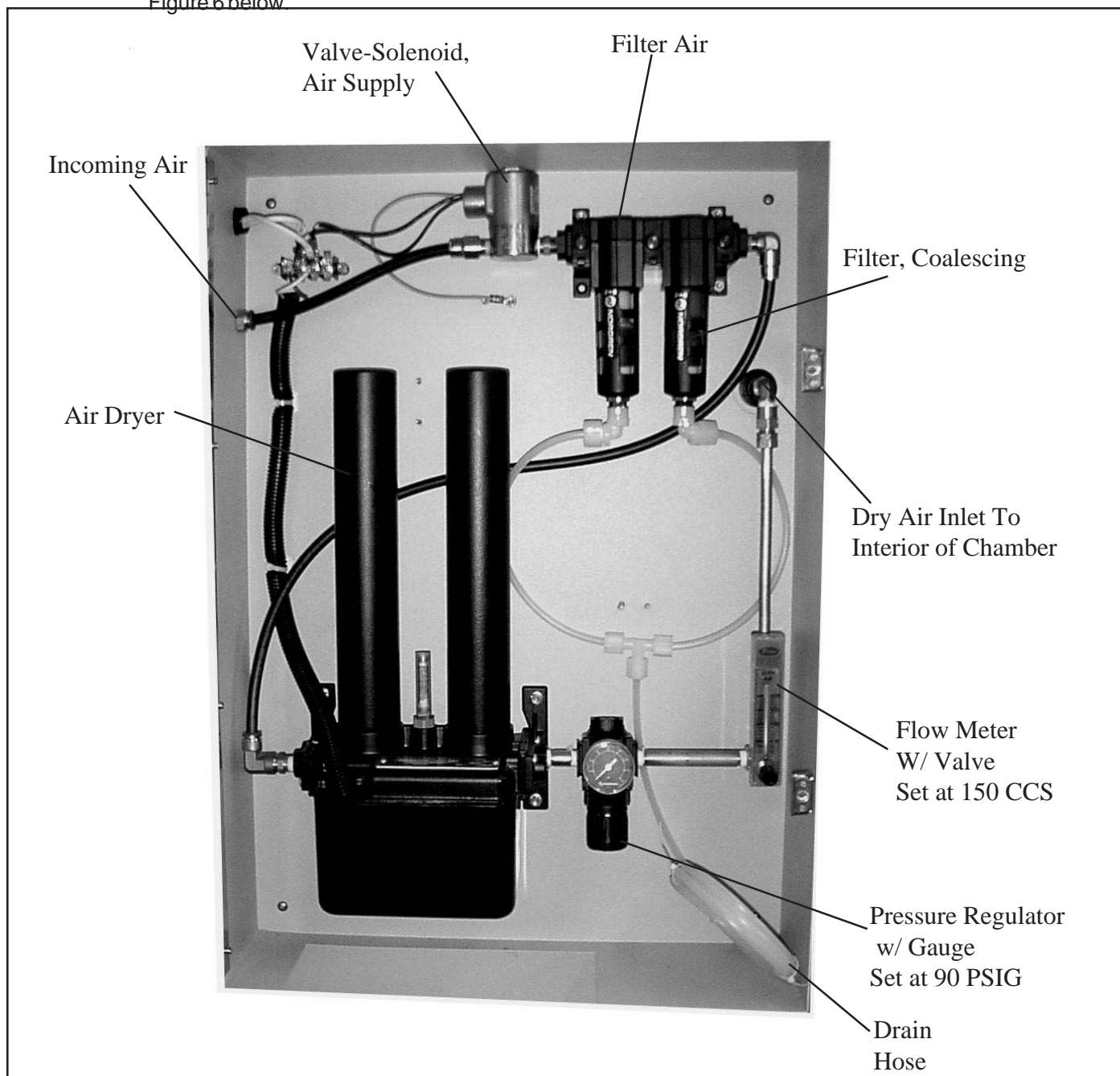


Figure 6. Dry Air Purge System Components Location

## NOTE

The high limit has a blue reset button and the light turns on during an alarm condition. The temperature controller only has a light which illuminates during a normal condition.

## 12. LIMITED TEMPERATURE SHEATH HEATERS (OPTIONAL)

Each heater has its own temperature controller and redundant high limit safety. The temperature controller is set to maintain the heater sheath temperature below 80% of the auto ignition temperature of the fluid or vapor in the chamber. The temperature high limit is set +10°C above the temperature controller as a safety.

Per section 501-10 of the N.E.C.:

"The heater shall not exceed 80 percent of the ignition tempertaure in degrees Celsius of the gas or vapor involved on any surface that is exposed to the gas or vapor when continuously energized at the maximum rated ambient temperature."

## MODEL Z-2/ ZH-2 SPECIFICATIONS

**NOTE:**

*Additions of certain options will effect performance*

Temperature Range:

-67.8°C (-90°F) to 190°C (375°F) Cascade

Temperature Stability:

±1°C (±2°F) at steady state condition after stabilization (usually 1 hour)

±1°C (±2°F); ±4% relative humidity at steady state condition after stabilization (usually 1 hour)

Temperature Performance:

Cascade

Temperature pulldown from 23°C (75°F) to:

-40°C (-40°F) in 25 minutes

-54°C (-65°F) in 35 minutes

-68°C (-90°F) in 60 minutes

Temperature heatup from 23°C (75°F) to:

+93°C (200°F) in 30 minutes

+190°C (375°F) in 60 minutes

Live Load Capacity:

Cascade

200 watts at -40°C (-40°F)

150 watts at -54°C (-65°F)

Interior Dimensions

521mm (20.5in)W x 349mm (13.75in)D x 318mm (12.5in)H

Exterior Dimensions

824mm (28.5in)W x 857mm (33.75in)D x 1160mm (45.84in)H

(Addition of certain accessories may increase dimensions)

Shipping Weight

Z-2 Cascade: 450 lbs.    ZH-2 Cascade: 500 lbs.

Utility Requirements: 115 volt (-0%, +5%), 60 Hz.

Z(H)-2-033-033-H/AC    1 phase, 16 full load amperes

Heat Rejection: Approximately 1,758 watts (6,000 BTU/hr) maximum during cooling operation

Included Accessories:

- Access port, 70 mm (2.875 in.)
- Shelf supports
- Refrigeration service taps
- Humidity water demineralizer (ZH-2 Only)

Included Instruments:

- Chromalox 2104 or Watlow F4 Controller

## MODEL ZH-2 SPECIFICATIONS

Humidity Range:

10% to 95% relative humidity as limited by a 85°C (185°F) maximum dry bulb and 4°C (40°F) minimum dewpoint



## MODEL Z-16/ ZH-16 SPECIFICATIONS

**NOTE:**

Additions of certain options will effect performance

Temperature Range

-73°C (-100°F) to 190°C (375°F) Cascade  
-34°C (-30°F) to 190°C (375°F) Single Stage

Temperature Stability

±1°C (±2°F) at steady state condition after stabilization (usually 1 hour)  
±1°C (±2°F) ±4% relative humidity at steady state condition after stabilization (usually 1 hour)

Temperature Performance

Cascade:

Temperature pulldown from 23°C (75°F) to:  
-40°C (-40°F) in 20 minutes  
-54°C (-65°F) in 25 minutes  
-68°C (-90°F) in 35 minutes

Single Stage:

Temperature pulldown from 23°C (75°F) to:  
-18°C (0°F) in 10 minutes  
-34°C (-30°F) in 20 minutes

Temperature heatup from 23°C (75°F) to:

+93°C (200°F) in 15 minutes                      +190°C (375°F) in 35 minutes

Live Load Capacity

Cascade

1500 watts at -40°C (-40°F)  
1100 watts at -54°C (-65°F)

Single Stage

1700 watts at -18°C (0°F)  
760 watts at -34°C (-30°F)

Interior Dimensions

760mm (30in)W x 760mm (30in)D x 760mm (30in)H

Exterior Dimensions

1040mm (41in)W x 1450mm (58in)D x 1960mm (78in)H  
(Addition of certain accessories may increase dimensions)

Shipping Weight

Cascade: Approx. 1750 lbs.  
Cascade: Approx. 1825 lbs.

Single Stage: Approx. 1650 lbs.  
Single Stage: Approx. 1725 lbs.

Utility Requirements: 208/230 volt (-0%, +5%), 60 Hz.

ZH/ Z-16-2-H/AC	1 phase, 35 full load amperes	3 phase, 31 full load amperes
ZH/ Z-16-2-2-H/AC	1 phase, 51 full load amperes	3 phase, 39 full load amperes

Heat Rejection: Approximately 9,000 watts (30,000 BTU/hr) maximum during cooling operation

Included Accessories:

- Viewing window, 12 3/4 H x 19 3/4 W
- Interior light with switch
- Casters, heavy-duty, 75mm (3in) wheel
- Access port, 70 mm (2.875 in.)
- Shelf supports
- Refrigeration service taps
- Communications port
- Humidity water demineralizer (ZH-16 Only)

Included Instruments:

- Watlow F4 Controller and High/Low Limit

## MODEL ZH-16 SPECIFICATIONS

Humidity Range: 10% to 95% relative humidity as limited by a 85°C (185°F) maximum dry bulb and 4°C (40°F) minimum dewpoint



## MODEL Z-32/ ZH-32 SPECIFICATIONS

**NOTE:**

Additions of certain options will effect performance

Temperature Range

-73°C (-100°F) to 190°C (375°F) Cascade  
-34°C (-30°F) to 190°C (375°F) Single Stage

Temperature Stability

±1°C (±2°F); ±4% relative humidity at steady state condition after stabilization (usually 1 hour)  
±1°C (±2°F); at steady state condition after stabilization (usually 1 hour)

Temperature Performance

Cascade:

Temperature pulldown from 23°C (75°F) to:  
-40°C (-40°F) in 20 minutes.  
-54°C (-65°F) in 30 minutes.  
-68°C (-90°F) in 45 minutes.

Single Stage:

Temperature pulldown from 23°C (75°F) to:  
-18°C (0°F) in 15 minutes.  
-34°C (-30°F) in 30 minutes.

Temperature heatup from 23°C (75°F) to:

+93°C (200°F) in 20 minutes.                      +190°C (375°F) in 55 minutes.

Live Load Capacity

Cascade

1500 watts at -40°C (-40°F)  
1100 watts at -54°C (-65°F)

Single Stage

1700 watts at -18°C (0°F)  
760 watts at -34°C (-30°F)

Interior Dimensions

965mm (38in)W x 965mm (38in)D x 965mm (38in)H.

Exterior Dimensions

1320mm (53in)W x 1630mm (66in)D x 1960mm (78in)H  
(Addition of certain accessories may increase dimensions)

Shipping Weight

Cascade: Approx. 2175 lbs.                      Single Stage: Approx. 2075 lbs.  
Cascade: Approx. 2100 lbs.                      Single Stage: Approx. 2000 lbs.

Utility Requirements: 208/230 volt (-0%, +5%), 60 Hz.

Z/ ZH-32-2-H/AC    1 phase, 35 full load amperes.                      3 phase, 31 full load amperes.  
Z/ ZH-32-2-2-H/AC    1 phase, 51 full load amperes.                      3 phase, 39 full load amperes.

Heat Rejection: Approximately 9,000 watts (30,000 BTU/hr) maximum during cooling operation.

Included Accessories:

- Viewing window, 12 3/4 H x 19 3/4 W
- Interior light with switch
- Casters, heavy-duty, 75mm (3in) wheel
- Access port, 70 mm (2.875 in.)
- Shelf supports
- Refrigeration service taps
- Humidity water demineralizer
- Communications port

Included Instruments:

- Watlow F4 Controller and High/Low Limit

## MODEL ZH-32 SPECIFICATIONS

Humidity Range:

10% to 95% relative humidity as limited by a 85°C (185°F) maximum dry bulb and a 4°C (40°F) minimum dewpoint.



## MODEL Z-8-2-SCT/AC SPECIFICATIONS

**NOTE:**

*Additions of certain options will effect performance*

Temperature Range

-45°C (-50°F) TO +190°C (+375°F)

Temperature Stability

±1°C (±2°F) at steady state condition after stabilization.

Temperature Performance

Temperature pull down from +24°C (+75°F) to:  
-18°C (0°F) in 7 minutes.  
-40°C (-40°F) in 20 minutes.

Temperature heat-up from:  
+24°C (+75°F) to +94°C (+200°F) in 6 minutes  
+24°C (+75°F) to +190°C (+375°F) in 15 minutes  
-34°C (-30°F) to +24°C (+75°F) in 5 minutes

(Based on +24°C/+75°F ambient, 230 volt service, and use of included accessories. Some accessories may affect performance.)

Live Load Capacity

1,800 watts at -18°C (0°F)  
725 watts at -40°C (-40°F)

Interior Dimensions

24" wide x 24" deep x 24" high

Exterior Dimensions

35" wide x 51" deep x 77.5" high  
(Addition of certain accessories may increase dimensions.)

Shipping Weight

Approximately 850 pounds

Utility Requirements: 208 or 230 volt (±5%), 60 Hz

-1 phase, 39 FLA, 50 amp minimum service  
-3 phase, 38 FLA, 50 amp minimum service  
(Customer to provide power cord and plug)

Heat Rejection: Approximately 5,900 watts (20,000 BTU/hr) maximum during cooling operation.

Included Accessories:

- One (1) 19 3/4" wide x 12 3/4" high Multi-pane Fog-Free Wiperless Window in door
- Liquid filled refrigeration gauges
- Interior light with switch
- Heavy Duty Casters, 3" wheel
- 2.875" access port centered in left hand side
- Shelf supports
- Refrigeration service taps

Included Instruments:

- CSZ F4 programmable controller with up to five optional event relays, Product Monitor, and EIA-232/485 Computer Interface
- Digital Display Temperature Limit and Alarm

## MODEL Z-16-305-SCT/AC SPECIFICATIONS

**NOTE:**

Additions of certain options will effect performance

Temperature Range

-45°C (-50°F) TO +190°C (+375°F)

Temperature Stability

±1°C (±2°F) at steady state condition after stabilization.

Temperature Performance

Temperature pull down from +24°C (+75°F) to:  
-18°C (0°F) in 7 minutes.  
-40°C (-40°F) in 18 minutes.

Temperature heat-up from:  
+24°C (+75°F) to +94°C (+200°F) in 8 minutes  
+24°C (+75°F) to +190°C (+375°F) in 20 minutes  
-34°C (-30°F) to +24°C (+75°F) in 6 minutes

(Based on +24°C/+75°F ambient, 230 volt service, and use of included accessories. Some accessories may affect performance.)

Live Load Capacity

3,000 watts at -18°C (0°F)  
1,300 watts at -40°C (-40°F)

Interior Dimensions

30" wide x 30" deep x 30" high

Exterior Dimensions

41" wide x 58" deep x 77.5" high  
(Addition of certain accessories may increase dimensions.)

Shipping Weight

Approximately 1,650 pounds

Utility Requirements: 208 or 230 volt (±5%), 60 Hz

-1 phase, 50 FLA, 60 amp minimum service  
-3 phase, 46 FLA, 60 amp minimum service  
(Customer to provide power cord and plug)

Heat Rejection: Approximately 9,700 watts (33,000 BTU/hr) maximum during cooling operation.

Included Accessories:

- One (1) 19 3/4" wide x 12 3/4" high Multi-pane Fog-Free Wiperless Window in door
- Liquid filled refrigeration gauges
- Interior light with switch
- Heavy Duty Casters, 3" wheel
- 2.875" access port centered in left hand side
- Shelf supports
- Refrigeration service taps

Included Instruments:

- CSZ F4 programmable controller with up to five optional event relays, Product Monitor, and EIA-232/485 Computer Interface
- Digital Display Temperature Limit and Alarm

## MODEL Z-32-305-SCT/AC SPECIFICATIONS

**NOTE:**

*Additions of certain options will effect performance*

Temperature Range

-45°C (-50°F) TO +190°C (+375°F)

Temperature Stability

±1°C (±2°F) at steady state condition after stabilization.

Temperature Performance

Temperature pull down from +24°C (+75°F) to:  
-18°C (0°F) in 10 minutes.  
-40°C (-40°F) in 25 minutes.

Temperature heat-up from:  
+24°C (+75°F) to +94°C (+200°F) in 12 minutes  
+24°C (+75°F) to +190°C (+375°F) in 30 minutes  
-34°C (-30°F) to +24°C (+75°F) in 8 minutes

(Based on +24°C/+75°F ambient, 230 volt service, and use of included accessories. Some accessories may affect performance.)

Live Load Capacity

3,000 watts at -18°C (0°F)  
1,300 watts at -40°C (-40°F)

Interior Dimensions

38" wide x 38" deep x 38" high

Exterior Dimensions

49" wide x 64" deep x 77" high  
(Addition of certain accessories may increase dimensions.)

Shipping Weight

Approximately 2,000 pounds

Utility Requirements: 208 or 230 volt (±5%), 60 Hz

-1 phase, 50 FLA, 60 amp minimum service  
-3 phase, 46 FLA, 60 amp minimum service  
(Customer to provide power cord and plug)

Heat Rejection: Approximately 9,700 watts (33,000 BTU/hr) maximum during cooling operation.

Included Accessories:

- One (1) 19 3/4" wide x 12 3/4" high Multi-pane Fog-Free Wiperless Window in door
- Liquid filled refrigeration gauges
- Interior light with switch
- Heavy Duty Casters, 3" wheel
- 2.875" access port centered in left hand side
- Shelf supports
- Refrigeration service taps

Included Instruments:

- CSZ F4 programmable controller with up to five optional event relays, Product Monitor, and EIA-232/485 Computer Interface
- Digital Display Temperature Limit and Alarm

## MODEL Z-32-6-SCT/AC SPECIFICATIONS

### Temperature Range

-40°C (-40°F) TO +190°C (+375°F)

### Temperature Stability

±1°C (±2°F) at steady state condition after stabilization.

### Temperature Performance

#### (Non-humidity operation)

Chamber will be able to go from +45°C (+113°F) to -25°C (-25°F) with 100 pounds of aluminum, 50 pounds of plastic and 600 watts live load in 20 minutes (3.5°C average air change rate).

#### Temperature heat-up from:

+24°C (+75°F) to +94°C (+200°F) in approximately 15 minutes  
+24°C (+75°F) to +190°C (+375°F) in approximately 35 minutes  
-34°C (-30°F) to +24°C (+75°F) in approximately 7 minutes  
-68°C (-90°F) to +24°C (+75°F) in approximately 14 minutes

(Based on +24°C/+75°F ambient, 230 volt service, and use of included accessories. Some accessories may affect performance.)

### Live Load Capacity

1,800 watts at -40°C (-40°F)

3,600 watts at -18°C (0°F)

Note: Humidity control will be affected by the addition of live load.

### Interior Dimensions

38" wide x 38" deep x 38" high

### Exterior Dimensions

53" wide x 66" deep x 77.5" high

(Addition of certain accessories may increase dimensions.)

### Shipping Weight

Approximately 2,500 pounds

### Utility Requirements: 575 volt, 3 phase, 60 Hz

26.2 FLA, 35 amp minimum service

(Customer to provide power cord and plug)

### Water Requirements: +29°C (+85°F) Water = 15.2 GPM Maximum

+24°C (+75°F) Water = 7.5 GPM Maximum

+18°C (+65°F) Water = 5.2 GPM Maximum

Heat Rejection: Approximately 1,300 watts (4,430 BTU/hr) maximum during cooling operation.

### Included Accessories:

- One (1) 19 3/4" wide x 12 3/4" high Multi-pane Fog-Free Wiperless Window in door
- Liquid filled refrigeration gauges
- Interior light with switch
- Heavy Duty Casters, 3" wheel
- 2.875" access port centered in left hand side
- Shelf supports
- Refrigeration service taps

### Included Instruments:

- CSZ F4 programmable controller with up to five optional event relays, Product Monitor, and EIA-232/485 Computer Interface
- Digital Display Temperature Limit and Alarm

## SEQUENCE OF OPERATION

### CASCADE UNIT - SYSTEM 1 (R-404A) DESCRIPTION

Refer to Refrigeration Diagram in Drawing Section

NOTE: Pressure settings are approximate.

The compressor (item 1) will pump compressed R-404A vapor through the discharge line where the high pressure gauge displays the pressure of the refrigerant. The high pressure switch (item 95) senses the discharge refrigerant pressure and will open a contact in the event that discharge pressure exceeds 350 psig. This contact opening will serve to shut down the unit and will automatically reset when the pressure drops to 250 psig. The discharge refrigerant vapor enters the air cooled condenser.

The air cooled condenser (item 5) cools the high pressure R-404A vapor and condenses it into a high pressure liquid. The condenser fan motor will be energized anytime System 1 is running.

High pressure liquid refrigerant exits the condenser and passes a service port. The liquid flows through a receiver, filter-drier, sight glass, and into the T.E.V. (item 11) where it changes to a low pressure two-phase refrigerant. The two phase refrigerant is cold due to the flashing of refrigerant. It enters the cascade condenser (item 13) where the heat from system 2 boils the rest of the R-404A into a vapor. The cascade condenser serves as the evaporator for system 1. If humidity is called for, some of the R-404A refrigerant is diverted to the humidity loop prior to entering the T.E.V. See humidity loop section below for description.

Superheated R-404A vapor exits the cascade condenser and moves through the system 1 suction line. A service valve is located near the compressor.

*Humidity Loop* - When humidity control is called for, some of the liquid R-404A is diverted to the humidity loop. The refrigerant passes through a solenoid valve (item H27) and a Wet Coil T.E.V. (item H23). Two phase refrigerant exits the T.E.V. and enters the wet coil (item H25). The wet coil is cold enough to attract water from the chamber air, but not cold enough to freeze the water on the coil. The temperature of the coil is regulated by a pressure regulating E.P.R. valve (item H26) and is intended to be a flooded coil by design. The E.P.R. valve is set at 68 psig which corresponds to a 29°F wet coil temperature. The warm chamber air keeps the moisture from freezing on the coil. After the E.P.R. valve, there is a check valve (item H28) which keeps refrigerant from migrating to the wet coil when humidity mode is inactive. After the refrigerant passes through the check valve, it enters the suction line and returns to the compressor.

### CASCADE UNIT - SYSTEM 2 (R-508B) DESCRIPTION

The compressor (item 41) will pump compressed R-508B vapor through the discharge line where the high pressure gauge senses the pressure of the refrigerant. The high pressure switch (item 95) senses the discharge refrigerant pressure and will open a contact in the event that discharge pressure exceeds 350 psig. This contact opening will serve to shut down the unit and will automatically reset when the pressure drops to 250 psig. The discharge refrigerant vapor passes through the discharge desuperheating loops of the condenser (item 44). This cools the vapor before entering the oil separator. The oil separator (item 45) removes the oil in the refrigerant vapor. It collects the oil and drains it back to the compressor crankcase. This prevents oil logging in the evaporator. The discharge refrigerant vapor then enters the cascade condenser.

The cascade condenser (item 13) cools the high pressure R-508B vapor and condenses it into a high pressure liquid. A relief valve is mounted near the condenser and will relieve at 400 psig.

High pressure liquid refrigerant exits the cascade condenser. The liquid flows through a filter-drier and enters a tee. The tee will divert some of the liquid refrigerant to be used in the bypass circuit (see last paragraph of this section). The rest of the refrigerant passes through the liquid line solenoid valve (item 49) and into the T.E.V. (item 50) where it changes to a low pressure two-phase refrigerant. The two phase refrigerant is cold due to the flashing of refrigerant. It enters the distributor where the refrigerant is evenly distributed to the evaporator circuits. The evaporator (item 52) serves to boil the rest of the R-508B into a vapor. This boiling action cools the chamber. In humidity mode, the liquid refrigerant would flow through a smaller liquid line solenoid valve (item H49) and a smaller T.E.V. (item H50) instead of items 49 and 50. This allows for tighter dry bulb temperature control in humidity mode.

Superheated R-508B vapor exits the evaporator and moves through the system 2 suction line. A service valve is located near the compressor.

The bypass circuit is composed of two lines in parallel. The Hot Gas Bypass Line, and the Liquid Injection Line. The hot gas bypass line consists of a solenoid valve (item 62) and Hot Gas Bypass Regulator (item 63). The liquid injection line consists of a Liquid Injection T.E.V. (item 61). The hot gas bypass solenoid (item 62) will open and close opposite of the liquid line solenoid (item 49). It will allow hot discharge refrigerant vapor to flow directly to the suction line. This is done as a means to control cooling capacity or to "unload" the system. The liquid injection T.E.V. will sense the temperature of the suction line. It will open automatically to feed liquid refrigerant into the suction line. This will provide cooling for the hot gas that is being fed into the suction line. The cooling effect keeps the compressor from overheating.

## **CASCADE CONTROL SYSTEM**

Refer to Refrigeration Diagram in Drawing Section

### **Mode: Normal cooling**

When there is call for cooling the R-508B liquid line solenoid (2-Sol) energizes, and the R-404A compressor turns on. Thirty seconds later the R-508B compressor turns on. High pressure switches (1 & 4 PS) will turn off the compressors if a high discharge pressure is reached on either system. Contact Cincinnati Sub-Zero's service department if this occurs. The high pressure switches automatically reset.

When there is a call for cooling 2-Sol is energized. When the chamber is near the set point the controller begins to cycle 2-Sol on and off. At the same time the R-508B hot gas by-pass solenoid (5-Sol) is cycling on and off opposite of 2-Sol. If the controller does not call for cooling for ninety seconds the refrigeration system will turn off.

### **Mode: Humidity (Optional Equipment)**

In humidity mode, the system starts in the same manner as above with the following differences.... When Dehumidification is called for, Solenoid H-11 Sol is energized. This allows refrigerant to flow in the humidity loop.

When humidity is called for, Solenoid H-11 Sol is de-energized.

For Dry Bulb Temperature cooling in humidity mode, system 2 solenoid H-1 Sol is energized. Solenoid 2-Sol is not energized. This allows refrigerant to flow through the R-508B humidity dry bulb T.E.V. which has tighter temperature control.

For Dry Bulb Temperature heating, solenoid H-1 Sol is de-energized and the heaters are activated.

## TUNDRA DESCRIPTION

Refer to Refrigeration Diagram in Drawing Section

The compressor (item 1) will pump compressed refrigerant vapor through the discharge line where the high pressure gauge displays the pressure of the refrigerant. The high pressure switch (item 95) senses the discharge refrigerant pressure and will open a contact in the event that discharge pressure exceeds 425 psig. This contact opening will serve to shut down the unit and will automatically reset when the pressure drops to 325 psig. The discharge refrigerant vapor passes a tee which diverts some of the refrigerant to the bypass loop (see bypass description), and enters the air cooled condenser.

The air cooled condenser (item 5) cools the high pressure refrigerant vapor and condenses it into a high pressure liquid. The condenser fan motor (item 96) will be energized anytime the system is running.

High pressure liquid refrigerant exits the condenser and passes a service port. The liquid flows through a filter-drier, sight glass, liquid line solenoid (item 49) and into the T.E.V. (item 50) where it changes to a low pressure two-phase refrigerant. The two phase refrigerant is cold due to the flashing of refrigerant. It enters the distributor where the refrigerant is evenly distributed to the evaporator circuits. The evaporator (item 52) serves to boil the rest of the refrigerant into a vapor. This boiling action cools the chamber. If humidity is called for, some of the R-404A refrigerant is diverted to the humidity loop prior to entering the T.E.V.. See humidity section for description.

Superheated refrigerant vapor exits the evaporator and moves through the system 1 suction line. A service valve is located near the compressor.

*Humidity Loop* - When humidity control is called for, some of the liquid refrigerant is diverted to the humidity loop. The refrigerant passes through a solenoid valve (item H27) and a Wet Coil T.E.V. (item H23). Two phase refrigerant exits the T.E.V. and enters the wet coil (item H25). The wet coil is cold enough to attract water from the chamber air, but not cold enough to freeze the water on the coil. The temperature of the coil is regulated by a pressure regulating E.P.R. valve (item H26) and is intended to be a flooded coil by design.

*Bypass Loop* - The bypass circuit is composed of two lines in parallel. The Hot Gas Bypass Line, and the Liquid Injection Line. The hot gas bypass line consists of a solenoid valve (item 17) and Hot Gas Bypass Regulator (item 18). The liquid injection line consists of a Liquid Injection Solenoid (item 21) and Liquid Injection T.E.V. (item 23). The hot gas bypass solenoid (item 17) will open and close opposite of the liquid line solenoid (item 49). It will allow hot discharge refrigerant vapor to flow directly to the suction line. This is done as a means to control cooling capacity or to "unload" the system. The liquid injection T.E.V. will sense the temperature of the suction line. It will open automatically to feed liquid refrigerant into the suction line. This will provide cooling for the hot gas that is being fed into the suction line. The cooling effect keeps the compressor from overheating.

## TUNDRA CONTROL SYSTEM

Refer to Refrigeration Diagram in Drawing Section

### **Mode: Normal cooling**

When there is call for cooling the liquid line solenoid (2-Sol), and the Liquid Injection Solenoid (8-sol) energize, the compressor turns on. High pressure switch (1 PS) will turn off the compressor if a high discharge pressure is reached. Contact Cincinnati Sub-Zero's service department if this occurs. The high pressure switch automatically resets. (Except on 6HP, it is manual reset)

When there is a call for cooling 2-Sol is energized. When the chamber is near the set point the controller begins to cycle 2-Sol on and off. At the same time the hot gas by-pass solenoid (9-Sol) is cycling on and off opposite of 2-Sol. If the controller does not call for cooling for ninety seconds the refrigeration system will turn off.

### **Mode: Humidity**

In humidity mode, the system starts in the same manner as above with the following differences:

When Dehumidification is called for, Solenoid H-11 Sol is energized. This allows refrigerant to flow in the humidity loop.

When humidity is called for, Solenoid H-11 Sol is de-energized.

For Dry Bulb Temperature cooling in humidity mode, solenoid 2- Sol is energized. This allows refrigerant to flow through the main cooling T.E.V. to reduce the temperature of the chamber.

For Dry Bulb Temperature heating, solenoid 2- Sol is de-energized and the heaters are activated.



## SINGLE STAGE - SYSTEM 1 (R-404A) DESCRIPTION

Refer to Refrigeration Diagram in Drawing Section

The compressor (item 1) will pump compressed R-404A vapor through the discharge line where the high pressure gauge displays the pressure of the refrigerant. The high pressure switch (item 95) senses the discharge refrigerant pressure and will open a contact in the event that discharge pressure exceeds 350 psig. This contact opening will serve to shut down the unit and will automatically reset when the pressure drops to 250 psig. The discharge refrigerant vapor passes a tee which diverts some of the refrigerant to the bypass loop (see bypass description), and enters the air cooled condenser.

The air cooled condenser (item 5) cools the high pressure R-404A vapor and condenses it into a high pressure liquid. The condenser fan motor (item 96) will be energized anytime System 1 is running.

High pressure liquid refrigerant exits the condenser and passes a service port. The liquid flows through a filter-drier, sight glass, liquid line solenoid (item 49) and into the T.E.V. (item 50) where it changes to a low pressure two-phase refrigerant. The two phase refrigerant is cold due to the flashing of refrigerant. It enters the distributor where the refrigerant is evenly distributed to the evaporator circuits. The evaporator (item 52) serves to boil the rest of the R-404A into a vapor. This boiling action cools the chamber. In humidity mode, the liquid refrigerant would flow through a smaller liquid line solenoid valve (item H49) and a smaller T.E.V. (item H50) instead of items 49 and 50. This allows for tighter dry bulb temperature control in humidity mode. If humidity is called for, some of the R-404A refrigerant is diverted to the humidity loop prior to entering the T.E.V.. See humidity section for description.

Superheated R-404A vapor exits the evaporator and moves through the system 1 suction line. A service valve is located near the compressor.

*Humidity Loop* - When humidity control is called for, some of the liquid R-404A is diverted to the humidity loop. The refrigerant passes through a solenoid valve (item H27) and a Wet Coil T.E.V. (item H23). Two phase refrigerant exits the T.E.V. and enters the wet coil (item H25). The wet coil is cold enough to attract water from the chamber air, but not cold enough to freeze the water on the coil. The temperature of the coil is regulated by a pressure regulating E.P.R. valve (item H26) and is intended to be a flooded coil by design. The E.P.R. valve is set at 68 psig which corresponds to a 29°F wet coil temperature. The warm chamber air keeps the moisture from freezing on the coil. After the E.P.R. valve, there is a check valve (item H28) which keeps refrigerant from migrating to the wet coil when humidity mode is inactive. After the refrigerant passes through the check valve, it enters the suction line and returns to the compressor.

*Bypass Loop* - The bypass circuit is composed of two lines in parallel. The Hot Gas Bypass Line, and the Liquid Injection Line. The hot gas bypass line consists of a solenoid valve (item 17) and Hot Gas Bypass Regulator (item 18). The liquid injection line consists of a Liquid Injection Solenoid (item 21) and Liquid Injection T.E.V. (item 23). The hot gas bypass solenoid (item 17) will open and close opposite of the liquid line solenoid (item 49). It will allow hot discharge refrigerant vapor to flow directly to the suction line. This is done as a means to control cooling capacity or to "unload" the system. The liquid injection T.E.V. will sense the temperature of the suction line. It will open automatically to feed liquid refrigerant into the suction line. This will provide cooling for the hot gas that is being fed into the suction line. The cooling effect keeps the compressor from overheating.

## **SINGLE STAGE CONTROL SYSTEM**

Refer to Refrigeration Diagram in Drawing Section

### **Mode: Normal cooling**

When there is call for cooling the R-404A liquid line solenoid (2-Sol), and the Liquid Injection Solenoid (8-sol) energize, the R-404A compressor turns on. High pressure switch (1 PS) will turn off the compressor if a high discharge pressure is reached. Contact Cincinnati Sub-Zero's service department if this occurs. The high pressure switch automatically resets.

When there is a call for cooling 2-Sol is energized. When the chamber is near the set point the controller begins to cycle 2-Sol on and off. At the same time the R-404A hot gas by-pass solenoid (9-Sol) is cycling on and off opposite of 2-Sol. If the controller does not call for cooling for ninety seconds the refrigeration system will turn off.

### **Mode: Humidity**

In humidity mode, the system starts in the same manner as above with the following differences:

When Dehumidification is called for, Solenoid H-11 Sol is energized. This allows refrigerant to flow in the humidity loop.

When humidity is called for, Solenoid H-11 Sol is de-energized.

For Dry Bulb Temperature cooling in humidity mode, solenoid H-1 Sol is energized. Solenoid 2-Sol is not energized. This allows refrigerant to flow through the R-404A humidity dry bulb T.E.V. which has tighter temperature control.

For Dry Bulb Temperature heating, solenoid H-1 Sol is de-energized and the heaters are activated.

## PREPARATION FOR USE



### WARNING

Do not locate system in a area near flammable or toxic material. Failure to follow these instructions may result in serious personal injury.

### NOTE

In moving or relocating the chamber, never tip the unit more than 45 degrees without instructions from Cincinnati Sub-Zero.

1. Inspect all equipment for damage that may have occurred during shipment. **Contact Cincinnati Sub-Zero immediately if any shipping damage is noticed.**
2. Ensure that all packing materials have been removed from all parts.
3. Read this manual in its entirety.
4. Select a suitable location for chamber.
  - a. A minimum clearance of 10" must be maintained for proper ventilation around chamber. Water and electrical connections should be at least 3 ft long so the unit can be serviced easily.
  - b. The chamber must be installed in an environment of 75°F ±10°F (+23°C ±6°C) with a maximum relative humidity of 95% for proper operation.
  - c. The chamber and its compressors must be level to ensure proper lubrication.
  - d. Units give off between 6,000 and 50,000 BTU/HR of heat to the room, depending on the unit. There must be a means of removing this heat to keep the chamber environment within spec.
  - e. Select a suitable location for Chamber location must be smooth and level with a maximum slop in any direction of 1/8" x 10'.
5. To Level Unit:
  - a. Leveling feet have been provided at the front of the unit. A 1/2" open end wrench can be used to extend the leveling feet. The unit must be level or slightly tilted to the rear for proper water drainage in the chamber.
  - b. If the door is binding, the hinge side leveling foot must be extended approximately 1/4" higher than the latch side leveling foot.

Note: Results may not be immediate, please wait several hours before continuing adjustments.

## MAIN POWER CONNECTION

1. Connect to the power source per electrical schematic.

The main power wiring must be connected per the NEC, CEC and any applicable local codes or regulations. For installation the chamber is a category III piece of equipment. The unit can be cord connected or hard wired.

A main power disconnect must be provided with a time delay fused switch or circuit breaker with ampere rating of that specified in (Table 1 below) for the particular unit being connected. The switch or circuit breaker must remove power from all ungrounded conductors.



MODEL NUMBER	POWER REQUIREMENTS
Z(H)-2-033-033	115V (-0%, +5%), 1phase, 60Hz, 20 amps
Z-8-1	208-230V (-0%, +5%), 1 phase, 60 Hz, 30 amps 208-230V (-0%, +5%), 3 phase, 60 Hz, 30 amps
Z-8-1-1	208-230V (-0%, +5%), 1 phase, 60 Hz, 45 amps 208-230V (-0%, +5%), 3 phase, 60 Hz, 30 amps
ZH-8-1	208-230V (-0%, +5%), 1 phase, 60 Hz, 35 amps 208-230V (-0%, +5%), 3 phase, 60 Hz, 30 amps
ZH-8-1-1	208-230V (-0%, +5%), 1 phase, 60 Hz, 45 amps 208-230V (-0%, +5%), 3 phase, 60 Hz, 35 amps
Z/ZH-16/32-2	208-230V (-0%, +5%), 1 phase, 60 Hz, 45 amps 208-230V (-0%, +5%), 3 phase, 60 Hz, 40 amps
Z/ZH-16/32-2-2	208-230V (-0%, +5%), 1 phase, 60 Hz, 70 amps 208-230V (-0%, +5%), 3 phase, 60 Hz, 50 amps

Table 1. Power Requirements

MODEL NUMBER	TUNDRA POWER REQUIREMENTS
Z-8-2-SCT	208-230V ( $\pm 5\%$ ), 1 phase, 60 Hz, 50 amps 208-230V ( $\pm 5\%$ ), 3 phase, 60 Hz, 50 amps
ZH-8-2-SCT	208-230V ( $\pm 5\%$ ), 1 phase, 60 Hz, 55 amps 208-230V ( $\pm 5\%$ ), 3 phase, 60 Hz, 50 amps
Z-16-305-SCT	208-230V ( $\pm 5\%$ ), 1 phase, 60 Hz, 50 amps 208-230V ( $\pm 5\%$ ), 3 phase, 60 Hz, 60 amps
ZH-16-305-SCT	208-230V ( $\pm 5\%$ ), 1 phase, 60 Hz, 60 amps 208-230V ( $\pm 5\%$ ), 3 phase, 60 Hz, 60 amps
Z-16-6-SCT	208-230V ( $\pm 5\%$ ), 3 phase, 60 Hz, 60 amps
Z-32-305-SCT	208-230V ( $\pm 5\%$ ), 1 phase, 60 Hz, 60 amps 208-230V ( $\pm 5\%$ ), 3 phase, 60 Hz, 60 amps
ZH-32-305-SCT	208-230V ( $\pm 5\%$ ), 1 phase, 60 Hz, 60 amps 208-230V ( $\pm 5\%$ ), 3 phase, 60 Hz, 60 amps
Z-32-6-SCT	575V, 3 phase, 60 Hz, 35 amps

Table 2. Power Requirements Cont'd.

## 1. Cord Connected

### Z(H)-8-16-32 Units

Use SO type cord with a minimum of 8 AWG copper stranded conductors for all units except the single phase Z(H)-32 unit. This unit requires a 6 AWG minimum conductor. The strain relief should be provided with a 90° cord grip with an integral strain relief. It is recommended that the power plug be a twist-lock device to insure a solid electrical connection.

## 2. Hard Wired

### Z(H)-8-16-32 Units

Use a liquid tight metallic or nonmetallic flexible conduit. Power wires should be a minimum of 8 AWG THHN type or equivalent for all units except single phase Z(H)-32 unit. This unit requires a 6 AWG minimum conductor. Conduit should be a minimum 3/4" diameter.

## 3. Grounding

Protective earth conductor must be equivalent in size to main power leads and connected to the protective earth terminal on TB-1 of the electrical panel.

## VOLTAGE CHANGE ON Z CHAMBERS

Your chamber was configured prior to shipment for the particular voltage that was specified at the time of order. These instructions should be used to change the input voltage from one configuration to another.

All Z-Series chambers (except the Z-2) can be set to run off 208V or 230V, 60 Hz., and 1 phase or 3 phase power. The change between one to three phase supply requires jumper changes on TB-1 (main power terminal block) on the electrical sub-panel. The voltage change requires a jumper to be changed on TB-1 for the control transformer's primary voltage tap. The chambers come pre-configured for the voltage and phase specified upon order.

**To switch from single phase to three phase power.** Remove the jumpers between terminals two and three (1L1, 1L3) and four and five (1L2, 1L4) on TB-1. Place one jumper between terminals 3 and 4 (1L3, 1L2). See Main Power Wiring, Figures 1, 2, 3, 4 & 5.

**To switch from three phase to single phase power.** Remove the jumper between terminals 3 and 4 (1L3, 1L2) on TB-1. Place one jumper between terminals 2 and 3 (1L1, 1L3) and 4 and 5 (1L2, 1L4). Connect main power leads as shown in Figures 1, 2, 3, 4 & 5 for single or three phase connection.

To change between 208V and 230V, locate the jumper between TB-1 terminals nine and ten and place between terminals ten and eleven (Depending on the date of the unit, the terminal designations will be H2, 2L4, and 2L4, H3 or H3, 2L4, and 2L4, H5 respectively). For more information refer to note 1 on the electrical schematic located in the "Drawings" section of this manual.

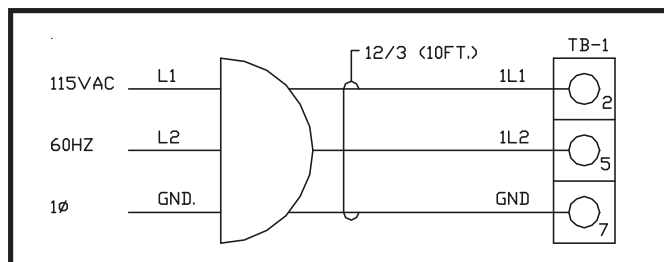


Figure 1. Main Power Wiring, Z-2

# INSTALLATION

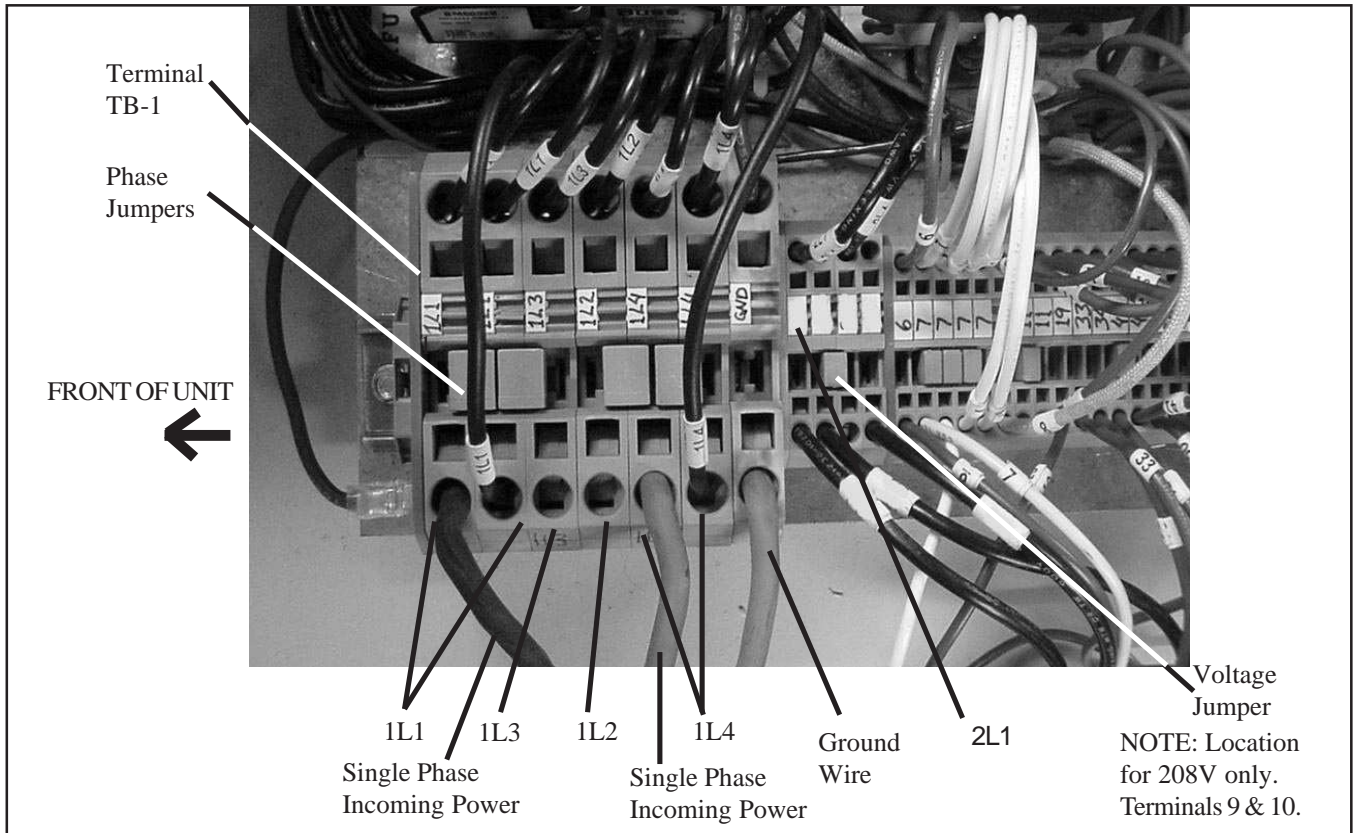


Figure 2. Main Power Wiring Z-8, 16, 32 Single Phase 208V

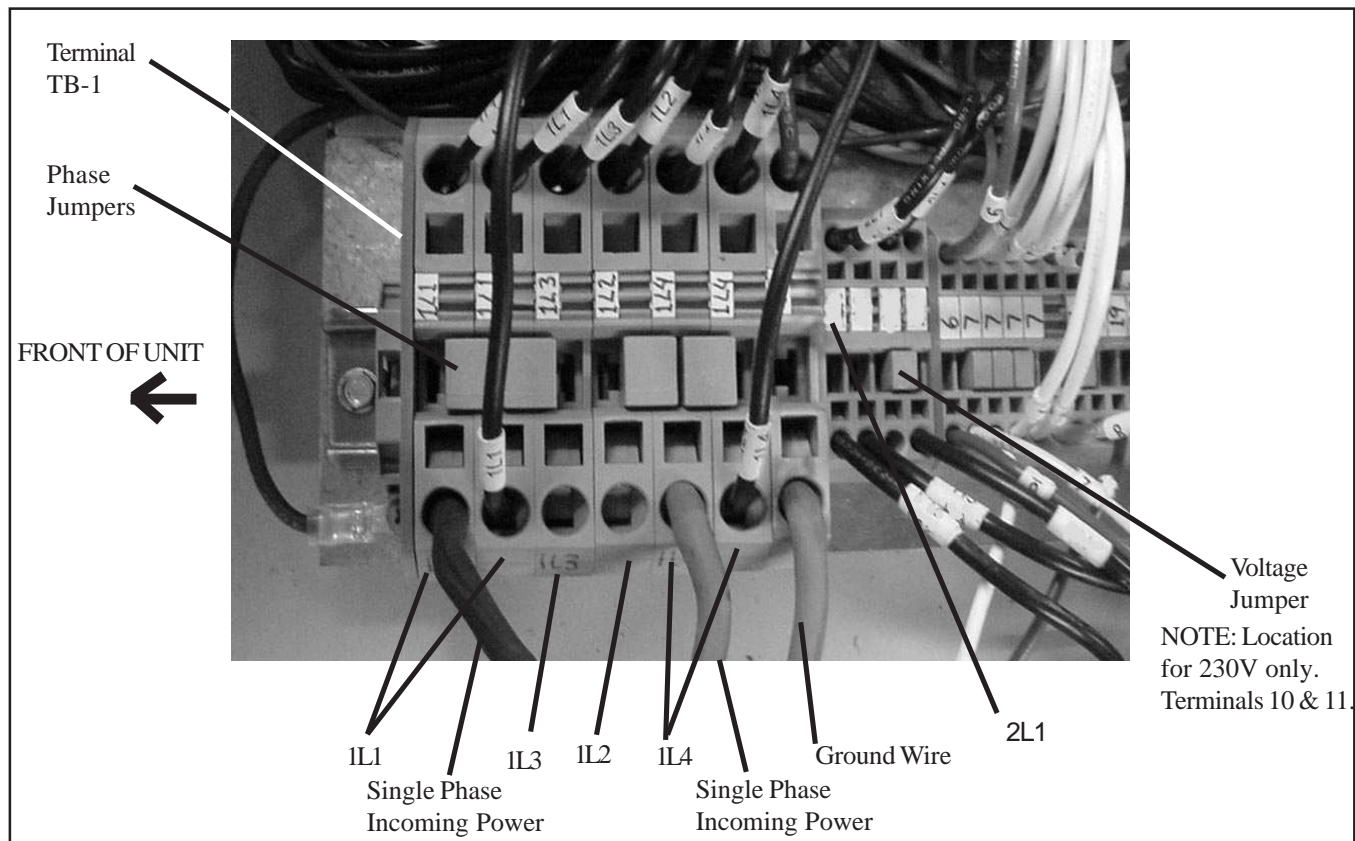


Figure 3. Main Power Wiring Z-8, 16, 32 Single Phase 230V

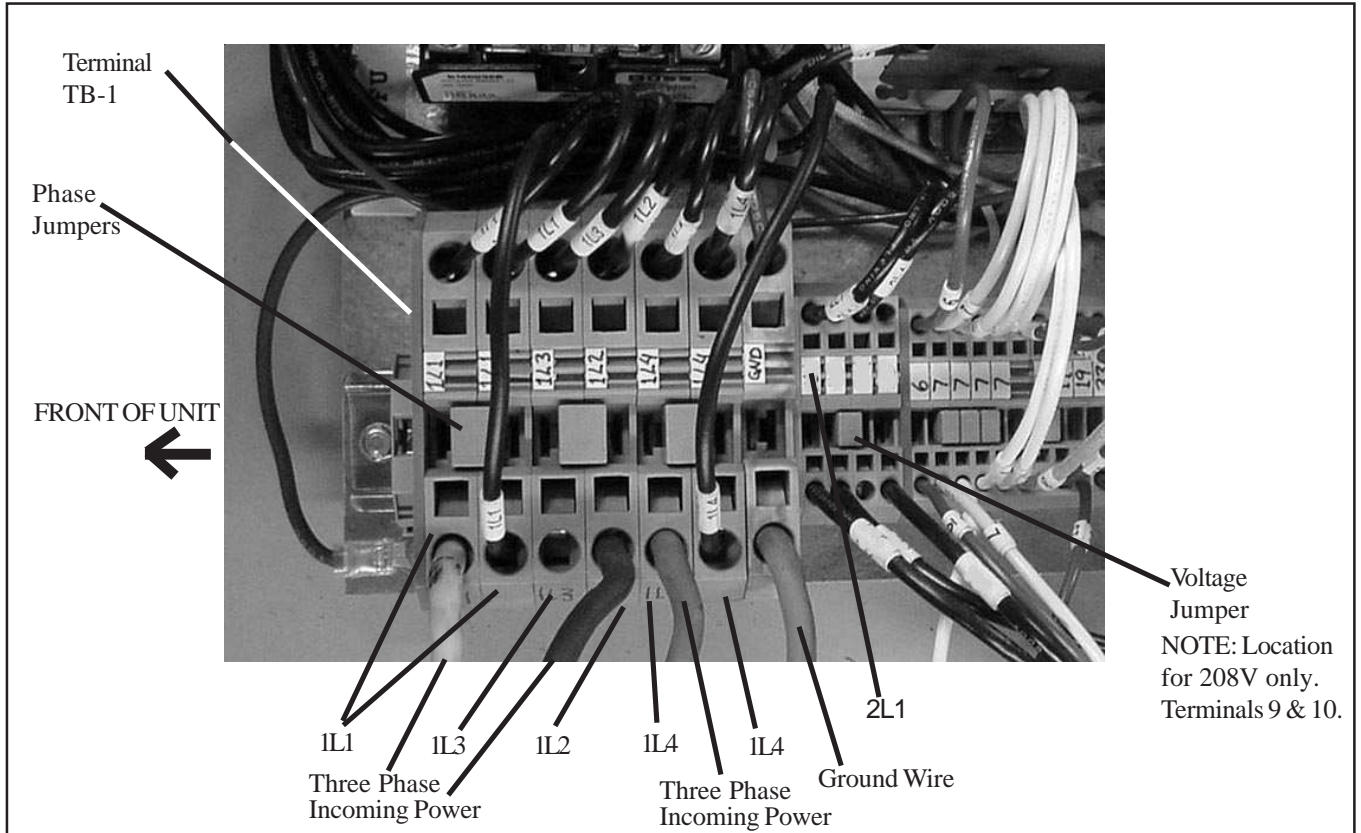


Figure 4. Main Power Wiring Z-8, 16, 32 Three Phase 208V

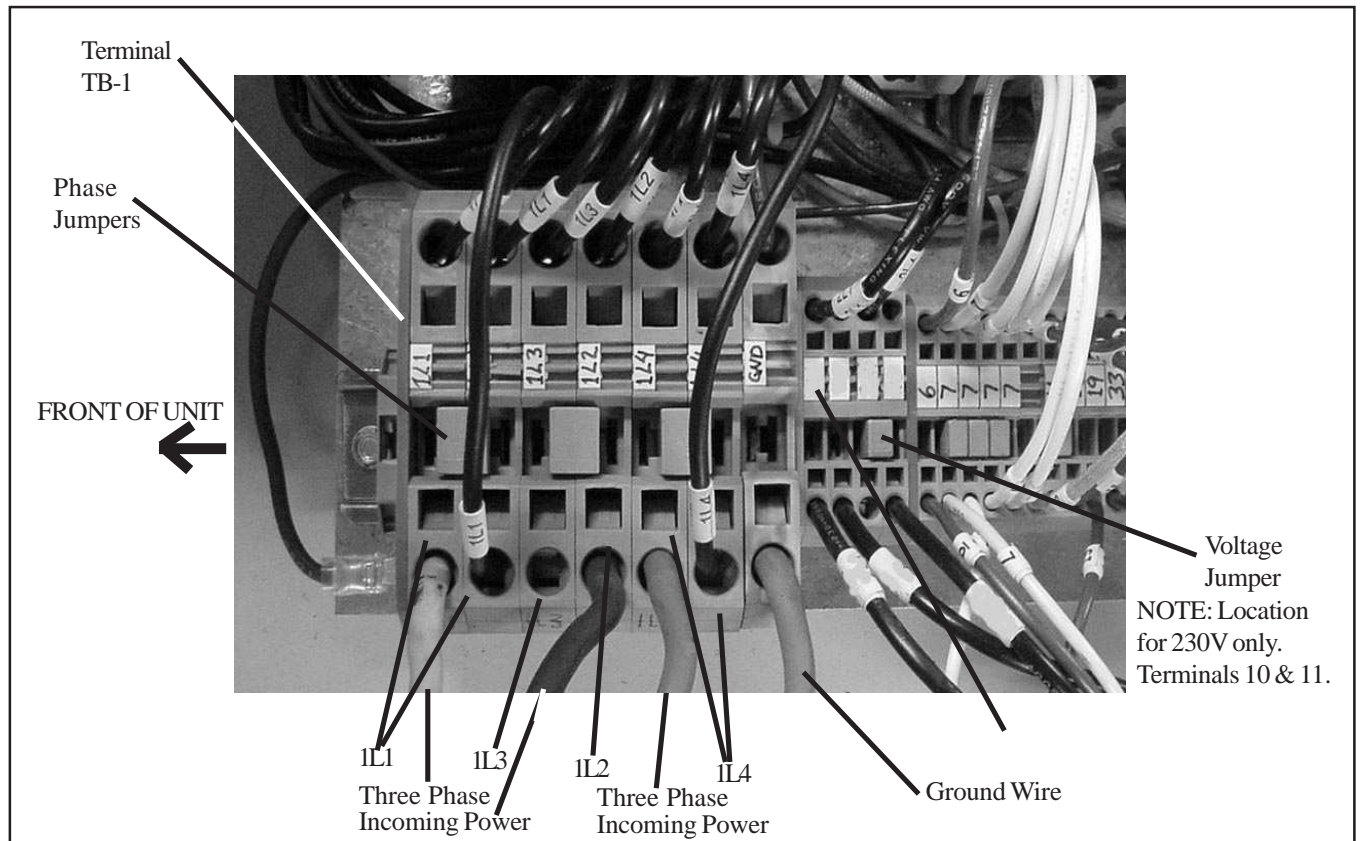


Figure 5. Main Power Wiring Z-8, 16, 32 Three Phase 230V

## REFRIGERATION SYSTEM PRESSURES

Check the system pressures using the refrigeration system pressure gauges.

1. If the R-508B/R-23 (System 2) static pressure is more than 30 PSI lower than that specified on the data plate, contact the CSZ Service Department. **DO NOT START.** If the R-404A (System 1 or Tundra) pressure is less than 100 PSI, contact the CSZ Service Department. **DO NOT START.**



### CAUTION

Do not make final connection to water inlet fitting on the chamber until any newly installed line has been flushed thoroughly to remove any pipe compound, metal chips, or foreign matter.

## WATER COOLED UNITS (OPTIONAL)

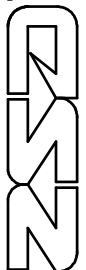
If water cooled, provide and connect water supply and return lines to the inlet and outlet for the condenser. The line size should be equal to or larger than the inlet fitting provided on the chamber (See Water Usage Table Below).

Note: Water cooled systems require a minimum of 40 PSI differential pressure (supply pressure minus return pressure) on the water system. Where water discharges to an open drain or non-pressurized return, supply must be 40 PSIG minimum. On systems using a closed loop cooling water system with a pressurized return, supply pressure must be at least 40 PSI greater than return pressure.



LOW TEMP HERMETIC & SEMI-HERMETIC COMPRESSORS																			
		WATER TEMPERATURE																	
		85F		80F		75F		70F		65F		60F		55F		50F		45F	
		29C		27C		24C		21C		18C		16C		13C		10C		7C	
HP	PIPE SIZE	GPM	PSID	GPM	PSID	GPM	PSID	GPM	PSID	GPM	PSID	GPM	PSID	GPM	PSID	GPM	PSID	GPM	PSID
1	3/8"	3.3	11.2	2.6	6.1	2.0	4.1	1.6	3.4	1.4	3.2	1.3	3.1	1.1	2.9	1.0	2.8	0.9	2.5
1.5	1/2"	4.8	15.6	3.8	9.5	2.8	5.9	2.4	4.9	2.0	4.1	1.9	4.0	1.6	3.5	1.5	3.4	1.3	3.3
2	1/2"	8.9	22.3	7.0	15.3	5.2	11.8	4.4	9.7	3.8	8.1	3.5	7.4	3.0	6.5	2.7	5.8	2.4	5.1
3	3/4"	11.0	26.1	8.7	20.2	6.5	15.5	5.4	12.5	4.7	10.8	4.3	9.6	3.8	9.1	3.3	7.5	3.0	6.6
6	3/4"	20.0	28.3	15.8	18.6	11.8	14.0	9.8	12.1	8.5	11.2	7.8	10.5	6.8	9.9	6.1	9.5	5.5	8.4
7.5	1"	23.8	31.3	18.7	23.1	14.1	18.1	11.7	14.9	10.1	13.5	9.3	13.0	8.1	12.2	7.2	11.4	6.5	10.0
10	1"	34.2	34.6	26.9	24.5	20.2	20.3	16.8	19.4	14.5	18.6	13.3	17.9	11.6	17.3	10.4	16.1	9.3	15.2
15	1 1/4"	44.4	36.7	34.9	30.2	26.2	25.3	21.8	22.7	18.8	21.3	17.3	20.2	15.1	18.7	13.4	17.5	12.1	16.4
22	1 1/2"	53.7	36.8	42.3	29.3	31.7	24.3	26.4	19.7	22.8	18.6	20.9	17.5	18.3	16.7	16.3	16.0	14.7	15.7
27	1 1/2"	67.7	46.1	53.4	36.2	40.0	28.3	33.2	24.8	28.7	20.2	16.4	19.7	23.1	18.9	20.5	17.3	18.5	16.7
30	2"	78.6	50.1	61.9	38.6	46.5	31.5	39.6	28.1	33.4	25.1	30.6	21.5	26.8	20.0	23.8	19.1	21.4	18.1
LOW TEMP SCROLL COMPRESSORS																			
		WATER TEMPERATURE																	
		85F		80F		75F		70F		65F		60F		55F		50F		45F	
		29C		27C		24C		21C		18C		16C		13C		10C		7C	
HP	PIPE SIZE	GPM	PSID	GPM	PSID	GPM	PSID	GPM	PSID	GPM	PSID	GPM	PSID	GPM	PSID	GPM	PSID	GPM	PSID
2	1/2"	4.8	15.6	3.7	9.5	2.8	5.9	2.3	4.9	2.0	4.1	1.9	4.0	1.6	3.5	1.4	3.4	1.3	3.3
3	1/2"	6.4	18.9	5.1	14.5	3.8	9.7	3.2	7.1	2.7	5.7	2.5	5.2	2.2	4.6	2.0	4.1	1.8	4.0
3.5	1/2"	7.9	22.1	6.2	18.7	4.7	14.8	3.9	10.1	3.4	8.6	3.1	7.1	2.7	5.9	2.4	5.1	2.2	4.7
5	3/4"	11.0	26.1	8.7	20.2	6.5	15.5	5.4	12.5	4.7	10.8	4.3	10.1	3.8	9.7	3.3	8.8	3.0	8.1
6	3/4"	13.2	28.5	10.4	22.5	7.8	18.3	6.5	15.8	5.6	12.8	5.1	11.8	4.5	10.5	4.0	9.8	3.6	9.2
7.5	3/4"	16.1	33.1	12.7	27.9	9.5	22.6	7.9	18.4	6.8	16.1	6.3	15.5	5.5	12.5	4.9	11.5	4.4	10.4
10	1"	22.9	25.3	18.1	20.1	13.6	17.7	11.3	16.7	9.7	15.6	8.9	13.3	7.8	13.1	7.0	12.2	6.3	11.7
13	1"	28.2	31.2	22.2	24.5	16.6	19.8	13.8	17.9	11.9	17.2	11.0	16.5	9.6	15.5	8.5	13.2	7.7	12.8
15	1 1/2"	33.3	35.2	26.2	28.2	19.7	23.1	16.4	19.2	14.1	18.1	13.0	17.5	11.4	16.9	10.1	15.8	9.1	14.5

Table 3. Water Usage





## CAUTION

This unit is phase sensitive. The scroll compressors will not operate properly if the phase is incorrect.

## SCROLL COMPRESSORS ONLY

Three phase scroll compressors will run backwards if the power leads are incorrect. Check for proper rotation on scroll compressors by monitoring the refrigeration system gauges and noting if the discharge pressure increases and the suction pressure decreases when the compressor is running. If the leads are reversed, the discharge pressure will fall and the suction pressure will rise. Reverse any two leads on the incoming three-phase power to correct the compressor rotation and re-check.

## NOTE

If using a city water line, a water regulating valve may have to be installed to lower the water pressure to 10 PSIG . High water pressure may cause the top or bottom cap (white) on the water filter to crack. This may result in water leakage that can damage the unit and/ or customer property.

## HUMIDITY SYSTEM (OPTIONAL)

Prior to operating the humidity system check the following:

1. Unit is connected to proper voltage.
2. Water supply and drain lines have been connected to the Water Inlet and the Water Outlet connections on the humidity panel. Humidity water pressure should not exceed 10 P.S.I.G.
3. The chamber drain hose located in the compressor area should be drained to an external drain.
4. Water line compression fittings on humidity panel should be secure.

## NOTE

Do not connect boiler or cooling tower water to this system. These types of water have additives and will deplete the demineralizer in a short period. Use the purest water available.

## NOTE

Humidity performance will be affected if live loads are placed in the chamber when trying to achieve certain humidity levels.

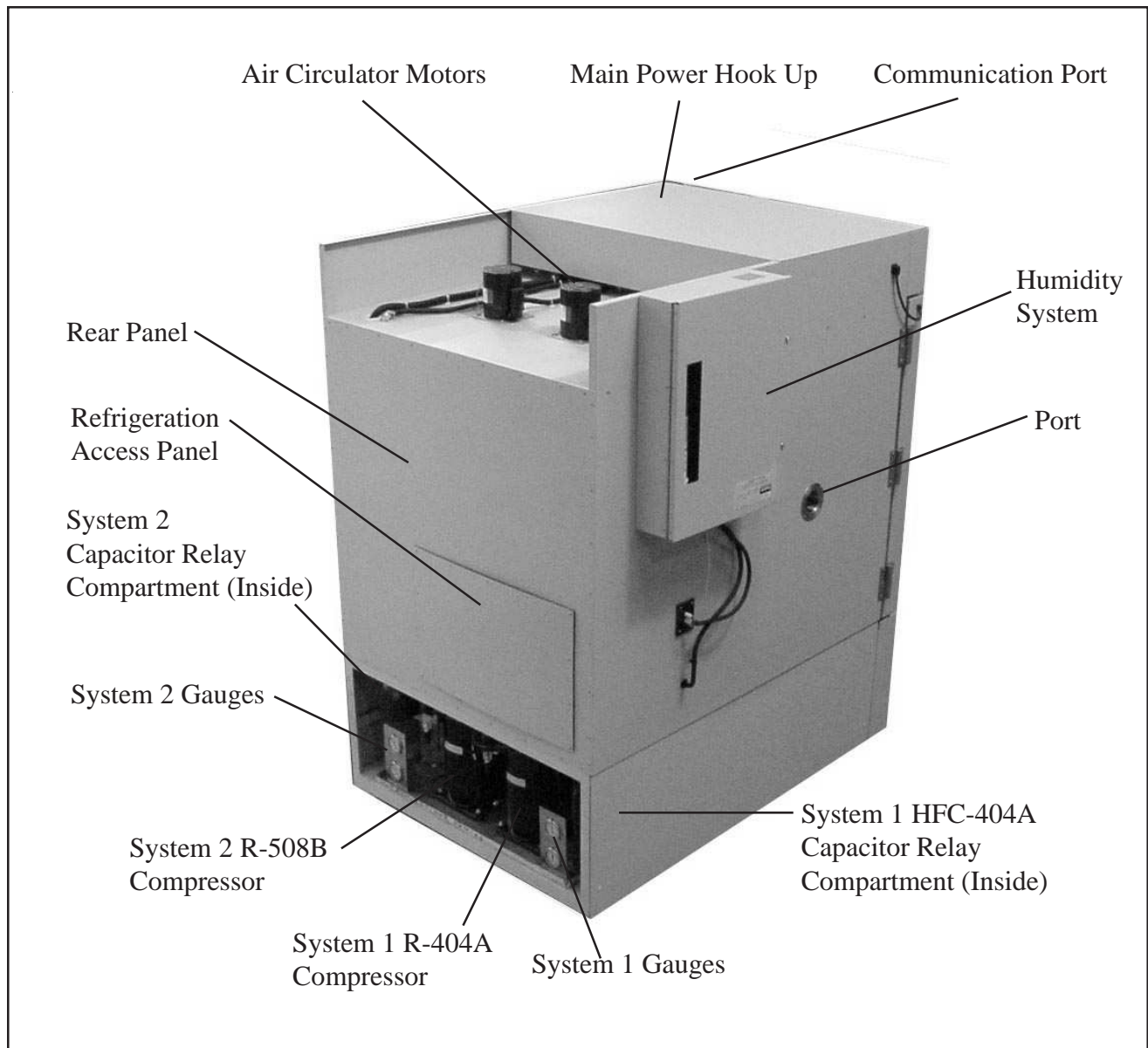
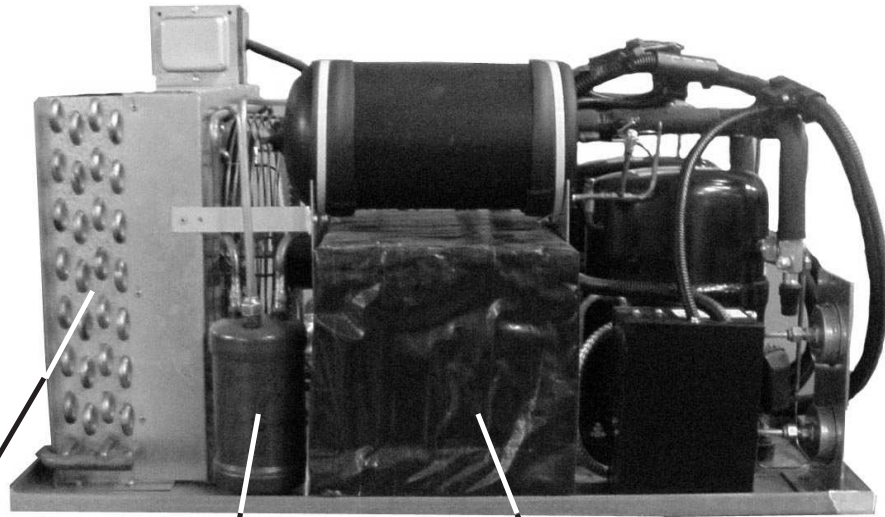


Figure 6. Installation Locations

Note: Cincinnati Sub-Zero is constantly upgrading the components used in its equipment. Consequently, physical appearance of certain components may vary from that shown.

## Z-8-1-1-H/AC POWER PACK (1 HP CASCADE SYSTEM)

NOTE: Cincinnati Sub-Zero is constantly upgrading the equipment. Therefore, physical appearance may vary from that shown. A typical Cascade unit is shown, your unit may vary in appearance depending on the unit size and HP.



REAR OF  
UNIT

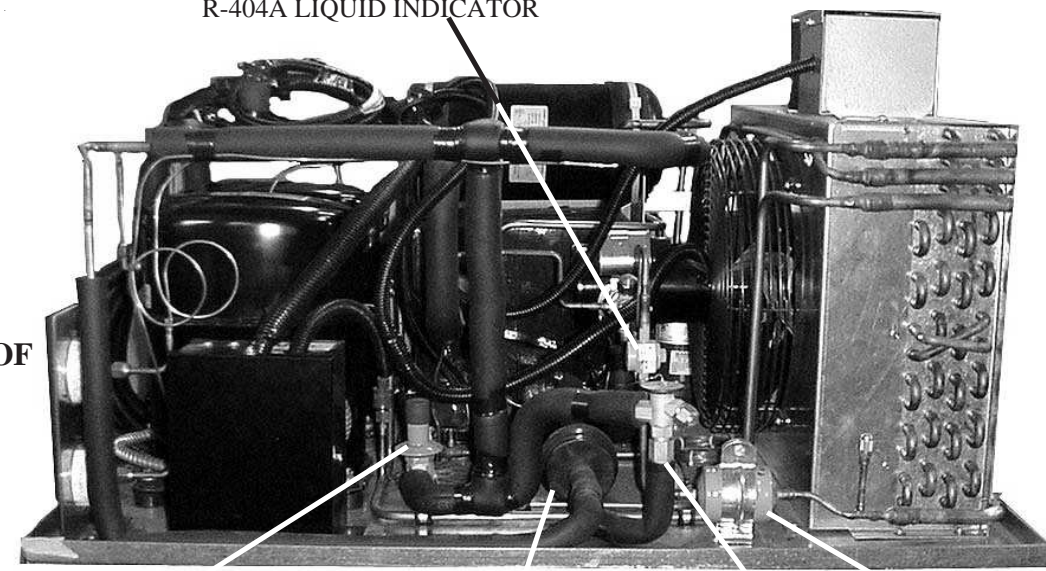
ITEM 5  
R-404A CONDENSER

ITEM 45  
R-508B OIL SEPARATOR

ITEM 13  
CASCADE CONDENSER

ITEM 9  
R-404A LIQUID INDICATOR

REAR OF  
UNIT



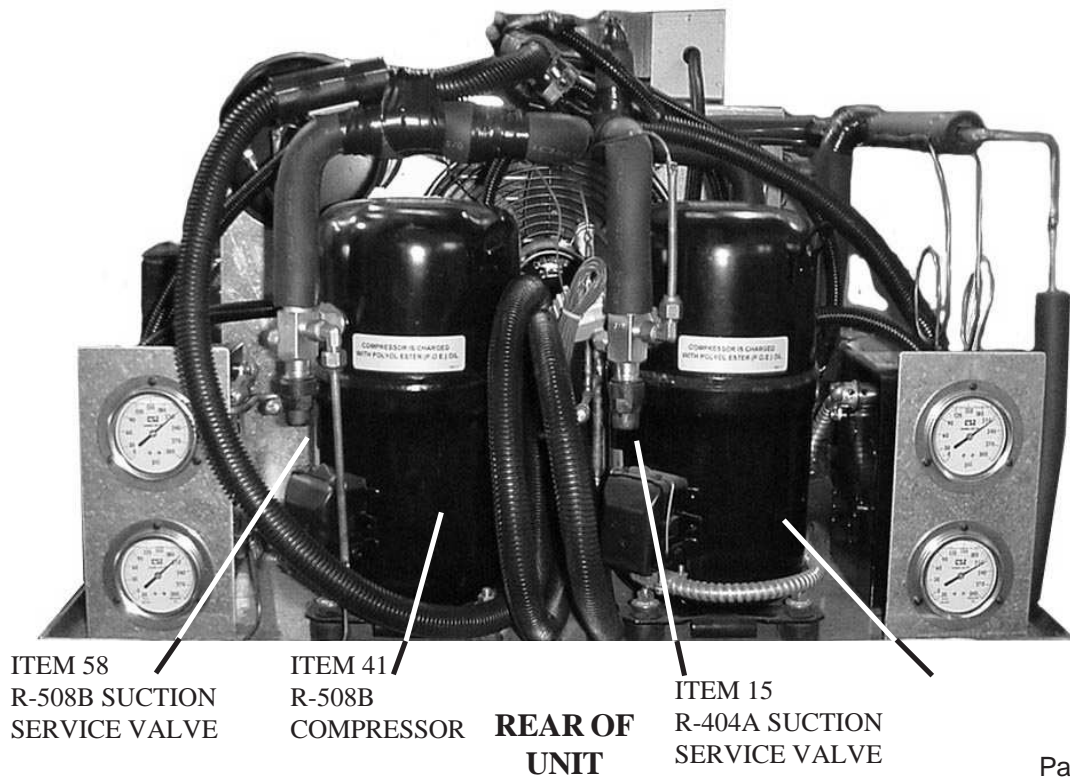
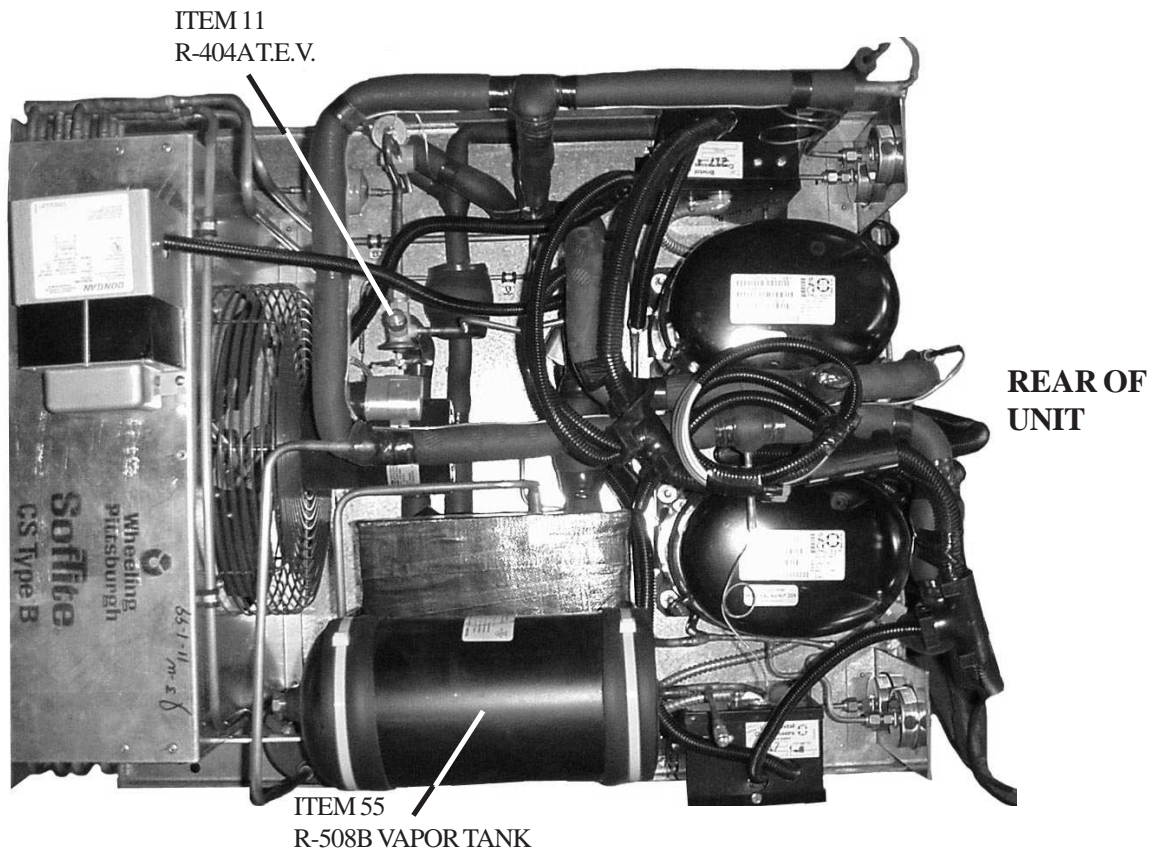
ITEM 63  
R-508B HOT GAS BY-PASS  
REGULATOR

ITEM 48  
R-508B FILTER DRIER

ITEM 61  
R-508B LIQUID  
INJECTION T.E.V.

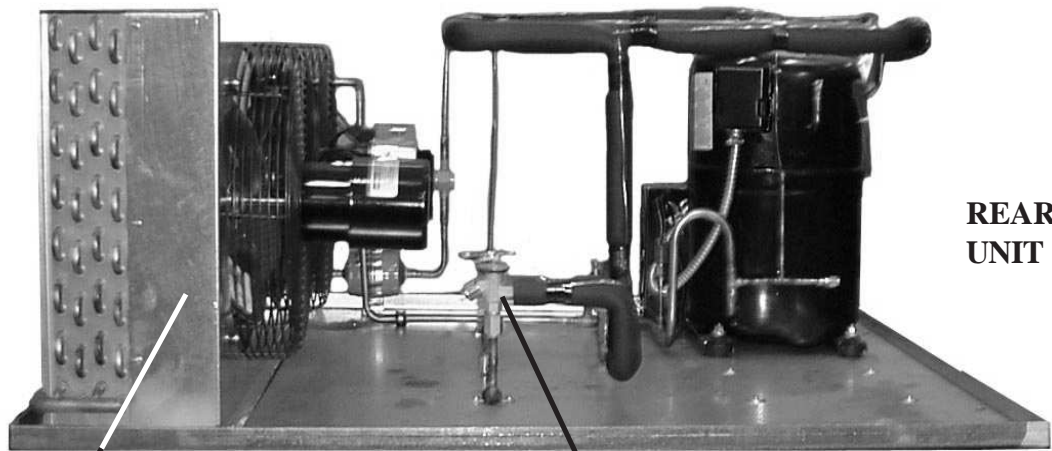
ITEM 8  
R-404A FILTER DRIER

## Z-8-1-1-H/AC POWER PACK (1 HP CASCADE SYSTEM)



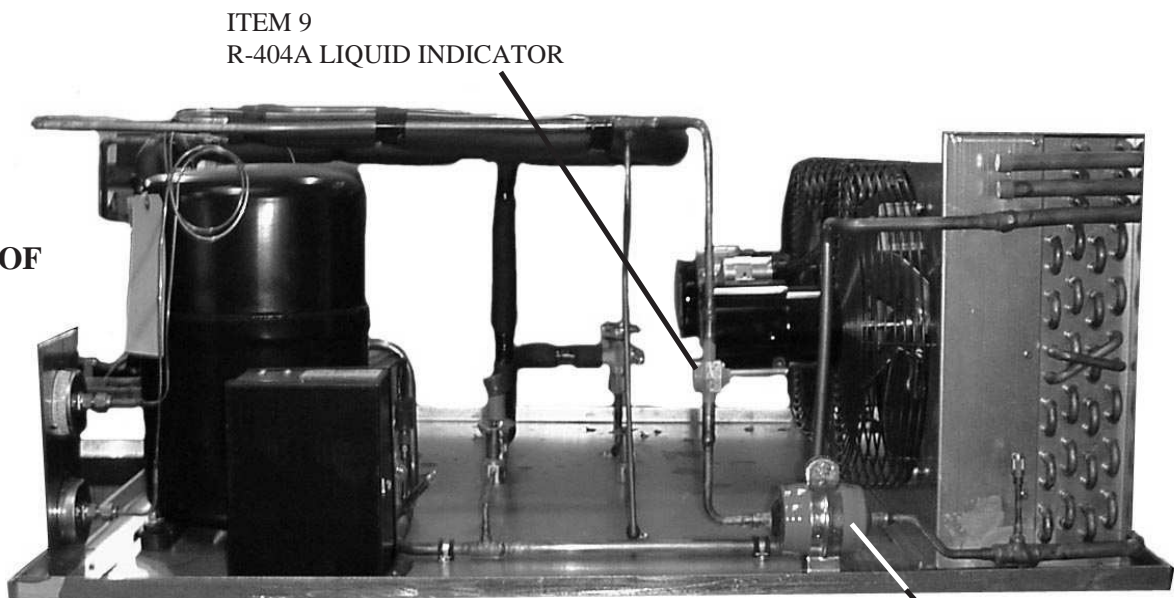
## Z-16-2-H/AC POWER PACK (2 HP SINGLE STAGE)

NOTE: Cincinnati Sub-Zero is constantly upgrading the equipment. Therefore, physical appearance may vary from that shown. A typical Cascade unit is shown, your unit may vary in appearance depending on the unit size and HP.



ITEM 5  
R-404A CONDENSER

ITEM 23  
R-404A LIQUID  
INJECTION T.E.V.



ITEM 9  
R-404A LIQUID INDICATOR

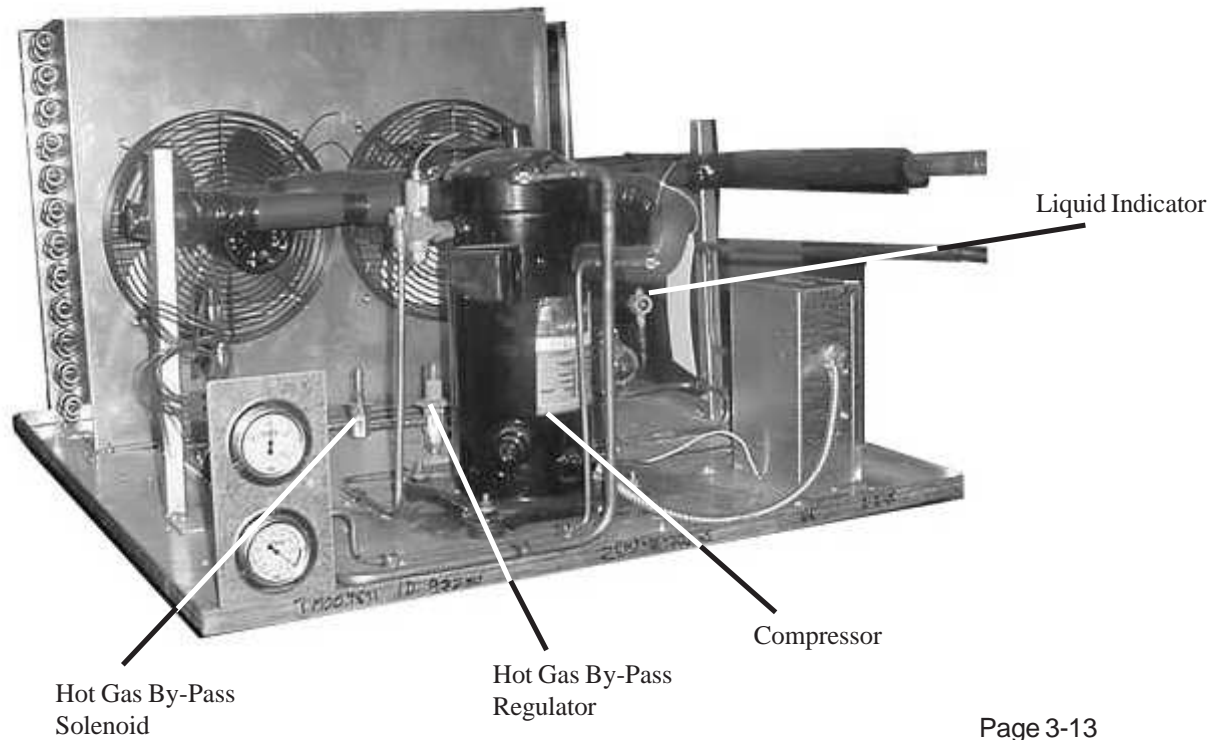
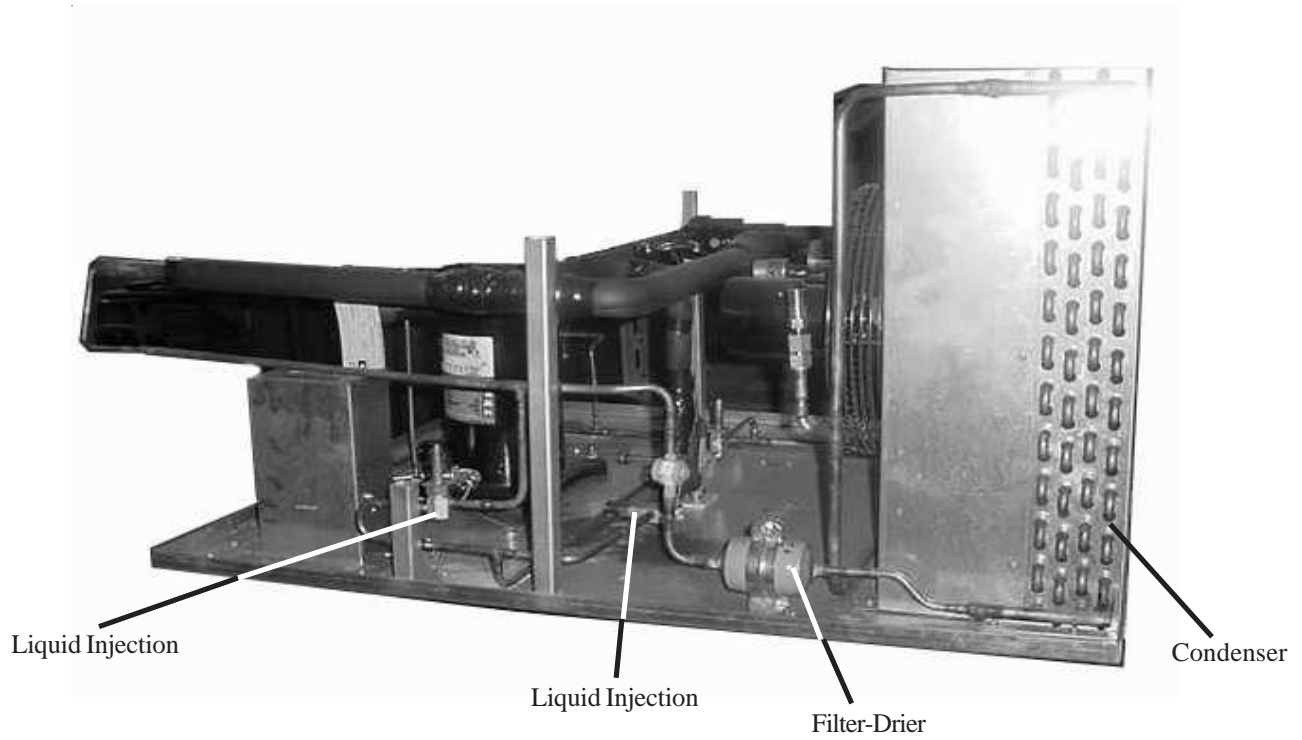
REAR OF  
UNIT

ITEM 8  
R-404A FILTER DRIER

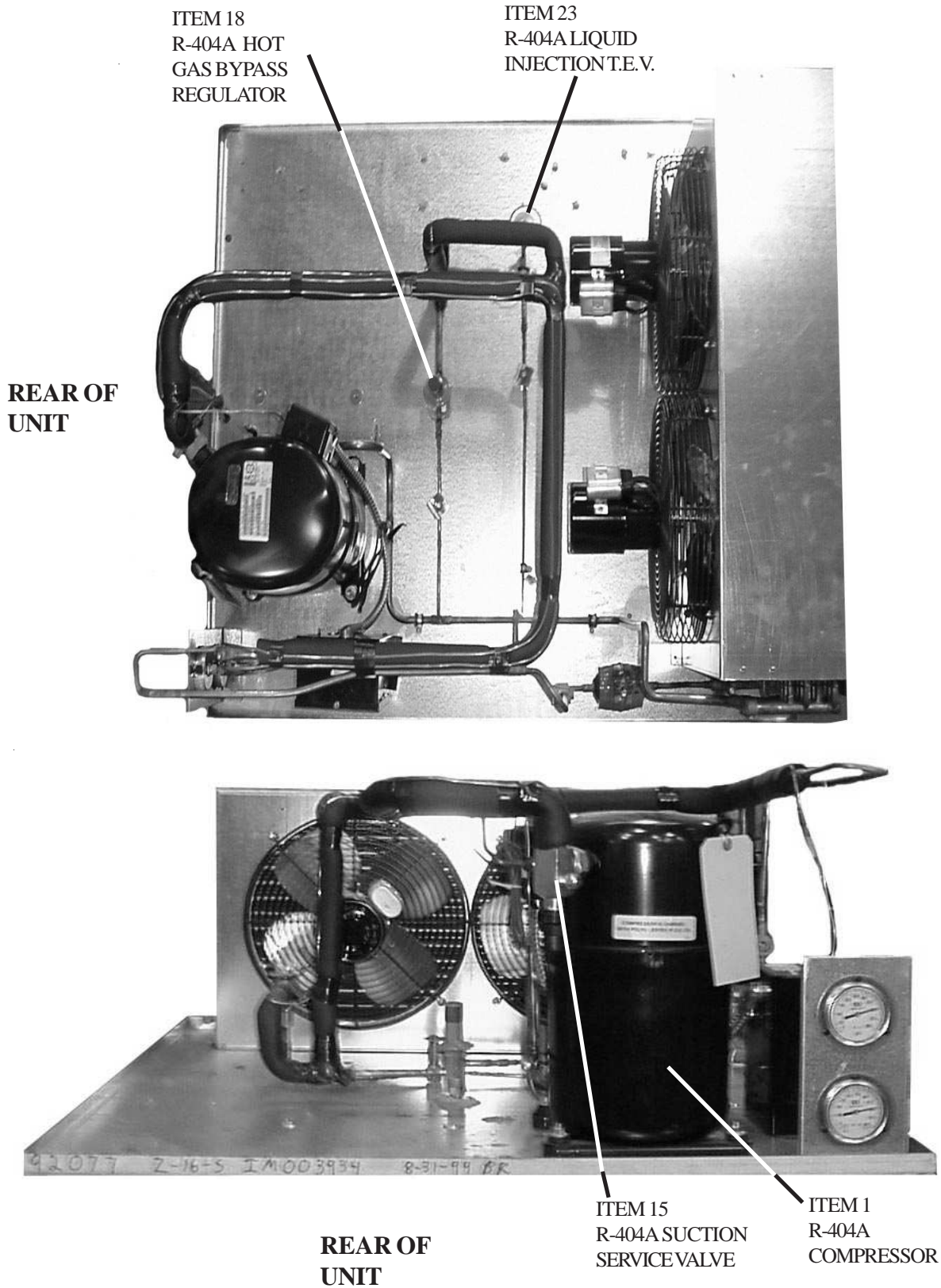
# INSTALLATION



## Z-16-305-SCT/AC POWER PACK (3.5 HP TUNDRA)



## Z-16-2-H/AC POWER PACK (2 HP SINGLE STAGE)





The following start-up instructions are written for the F4 controller. For optional controller, please refer to Specific Instructions in controller manual.

## NOTE

Switch must be on manual mode for single set-point operation.

## START-UP INSTRUCTION SUMMARY

1. Turn the power switch **ON**.
2. Load your test sample into the chamber.
3. Enter the Single Set-Point Operation Temperature.
4. Enter the Single Set-Point Operation Humidity if applicable.
5. Turn **ON** the conditioning system



Figure 1. Standard Watlow F4 Control Section

## SUMMARY FOR STEP-BY-STEP SET-POINT OPERATION - F4 CONTROLLER

These instructions will enable the operator to use the Watlow F4 Programmer/Controller in a single set-point operation. The User's Manual for the Watlow F4 Programmer/Controller should be reviewed for more detailed operation.

### Single Set-Point Operation - Temperature

1. When Turning the Main Power Switch **ON**
  - a. This will supply power to the Watlow F4 Controller, Product Hi/Low Limit and chamber light. The Watlow F4 controller will perform a 5-10 second start-up self-test. The upper display will be blank and the lower display will show Watlow F4 and current software revision. Wait for the completion of the self-test.
2. When operating the chamber, the PGM/OFF/ON switch determines if event No. 1 must be on to run the chamber.
  - a. **ON**  
The PGM/OFF/ON switch should be set in this position when running single set-points or when operating in a program mode without using events to turn on-off option features.
  - b. **PGM**  
The PGM/OFF/ON switch must be set in this position when running a program profile where events are used to turn features on and off.



## Single Set-Point Operation - Temperature

3. Use the arrow keys to navigate through the lower display and place the arrow cursor on setpoint 1.
  - a. Use the ▶ right arrow key to enter the setpoint field.
  - b. Use the ▲ ▼ up and down arrow keys to change the setpoint.
  - c. Use the ◀ ▶ right or left arrow keys to exit the setpoint field.

### NOTE

Humidity performance will be affected if live loads are placed in the chamber when trying to achieve certain humidity levels.

## Single Set-Point Operation - Humidity (Optional)

1. Turn the humidity system **ON**.
2. Use the arrow keys to navigate through the lower display and place the arrow cursor on setpoint 2.
  - a. Use the ▶ right arrow key to enter the setpoint field.
  - b. Use the ▲ ▼ up and down arrow keys to change the setpoint.
  - c. Use the ◀ ▶ right or left arrow keys to exit the setpoint field.
3. When returning to temperature only operation, turn the humidity system off. Failure to do this will result in the unit not reaching low temperatures.
4. Verify that the demineralizer cartridge is fresh. The color of the cartridge should be dark.

### NOTE

When running at high humidity levels for an extended period of time, the tip of the humidity sensor can become saturated, resulting in erroneous readings. To correct this condition, it is recommended that the tip be dried out by turning the humidity system off and raising the temperature to 250°F for 10 minutes. The sensor accuracy will be restored by evaporating the water out of the porous cover over the sensing element.

### NOTE

#### Dry Air Purge Units Only

During humidity operation, the dry air purge system must be turned off.

### NOTE

Any changes to the CSZ configurations programmed in the temperature controller or safety limit without prior authorization by CSZ could void warranty. Related issues and costs associated from the changing of these configuration settings could be deemed customers responsibility. Call factory prior to changing these configurations.



## WATLOW F4 CONTROLLER OUTPUTS

### Control Outputs

Output IA: Heating output. Cycles chamber heaters to when heating is called for.

Output IB: Cooling output. Cycles refrigeration valves when cooling is called for.

The compressors will run as long as cooling is called for before the timeout period has expired. If cooling is not called for within the preset timeout period, the compressors shut off. They will turn back when cooling is called for.

Output 2A: Humidify output. Cycles boiler heater or atomizing nozzle of humidity system when humidity is called for.

Output 2B: De-humidify output. Cycles refrigeration valves when de-humidification is called for.

The compressors will run as long as de-humidification is called for before the timeout period is expired. If de-humidification is not called for within the preset timeout period, the compressors will shut off. The compressors will turn back on when de-humidification is called for.

### Event Outputs

Event # 1: Conditioning system. Turns on refrigeration system components.

Event # 2: Humidity system. Turns on humidity system components.

Event # 3: Auxiliary cooling system. Turns on LN2 or CO2 boost cooling components.

Event # 4: Dry air purge system. Turns on GN2 and or air dryer components.

Event #5: Turns on Frozen Coil for low RH mode.

Event # 6-8: User defined event. Can be used to turn on test equipment, initiate a test cycle, etc.



## NOTE

If other devices are used to measure humidity or temperature within the chamber, such as a chart recorder (optional). The temperature readings between the chamber controller and the chart recorder will vary slightly due to the tolerances between the two devices and their individual sensing elements.

## CHROMALOX 2104 CONTROLLER

(Standard on Z-2)

The optional controller, is composed of a Micro-processor Based 2104 Controller, a High Low Limit, normal function switches, indicator lights, and communication electronics. Specifications for the controller may be found in the Chromalox 2104 user's manual supplied with your unit.

## CHAMBER PERFORMANCE

The performance of your chamber is significantly effected by the characteristics of your test sample. Factors including size, material, shape, weight and power dissipation if energized. The test sample should be placed in the chamber in a manner that allows proper ventilation. Air flow is taken in from the bottom of the plenum and exits from the top. Test samples should be placed on the shelves, not placed directly on the chamber floor. Multiple test samples should be distributed throughout the chamber to ensure proper airflow and minimize temperature gradients.



## CAUTION

Do not expose the bowl or sight glass to materials such as carbon tetrachloride, trichlorethylene, acetone, paint thinner, or other similar materials as they can also cause a chemical reaction with the plastic and can cause it to rupture.

## DRY AIR PURGE (OPTIONAL)

In normal operation the dryer towers will switch every 30 seconds. Each tower purges with an audible exhaust. Do not plug or restrict the purge air exhausts. If operating conditions change, different purge orifices may be required. If orifices are replaced, they should be replaced in matched pairs.

The heat of absorption and the solenoid valves will cause the unit to become warm. This is normal and does not indicate a malfunction. The temperature rise is more pronounced in a dryer operating at a low flow rate.

During operation, there may be a faint fume from the solenoid valves. This is caused by the AC voltage on the coil. It does not indicate a malfunction.

## NOTE

**CLEAN AND OIL-FREE AIR SHOULD BE USED TO SUPPLY THE DRY AIR PURGE SYSTEM.**

The hose inside the dry air purge package must be ran to a drain. Both oil and water will be drained through this line.

The highest ambient temperature at which a heatless dryer can be operated is 125°F (52°C). The maximum air temperature at the inlet which the instrument should handle is 125°F (52°C).



## NOTE

Since the F4 transmits and receives binary data, it is not possible for the converter to sense the end of the F4's message since a EOM character could be part of the message. Therefore, it is necessary to set the number of bytes to be read from the converter when it is addressed to talk. Since the packet structure is fixed, the number of bytes will remain a set value.

## IEEE 488 - F4 CONTROLLER (OPTIONAL)

The ICS GPIB to Serial Converter is used to convert the information on the GPIB bus into serial data to communicate with the F4. The F4 is set to use its RS-232 interface with the ICS converter. The F4 and converter are set up at the factory. The F4 settings are the default values for the serial interface. The ICS converter settings have been modified from their default values as listed below to interface with the F4.

F4 Settings:		ICS Converter Settings:	
Address	1	SYST:MODE	G
Baud Rate	9600	STAT:QUES:ENAB	0
		SYST:COMM:SER:EOI	0
		STAT:OPER:ENAB	512
		*SRE	128

The converter address is set to four (4). For a more detailed explanation on the ICS converter settings and how to change the address, see Section 3 of the ICS manual (Operating from the GPIB Bus).

### Sending/Receiving Data

The F4 uses Modbus protocol for its communications. This requires all data being sent to, and all data being received from, the F4 will be hexadecimal characters formatted into packets. It is recommended that the user become familiar with this format before any attempt is made to communicate with the F4. Watlow provides a very useful and well-documented manual on how to perform Modbus communications with the F4. This manual is available on Watlow's web site and is called the Data Communications Reference Electronic User's Manual. The manual explains how to format the data strings, what commands are available, and how to create subroutines to generate checksums.

The commands and format used to communicate over the GPIB bus will be identical to that explained in the manual. The only difference will be that a line feed (LF) terminator will have to be appended to the data string when it is sent so the GPIB converter can sense the end of the message. The data will be sent to the F4 which will then send a response back to the converter. When addressed to talk, the converter will send the data string from the F4 with a line feed (LF) terminator appended to it.

*Example:*

*Read Register 0 (model number) of controller at address 0:*

*Send: 01030000001840A*

*Received: 01030203DCB92D*

*NOTE: All data is in HEX format. The bus controller must address device number four (4), the GPIB converter, when sending and receiving the data. Line feed terminators are used to signal end of transmission; however, it is necessary for the bus controller to transmit the number of bytes to be read when addressing the converter to talk. In the above example, the byte count would be seven (7).*



## HIGH/ LOW LIMIT CONTROL (Standard on all units except Z-2)

If the chamber is operated with a live load (heat dissipating product), protection should be provided. Provisions must be made to remove power from the product being tested and from the chamber in the event the chamber temperature exceeds safe limits for the product being tested. When testing a dead load (non-heat dissipating product), protection need only remove power from the chamber.

**NOTE:** A two amp alarm relay contact is provided for customer's use. **It is the customer's responsibility** to interlock this control to the test product power source to de-energize the product during an alarm condition. The High/Low Limit Control will also provide protection from a malfunctioning temperature control unit and associated device.

The High/Low Limit Control shuts down the chamber and product under test operation if the preset temperature limits are exceeded. Should the temperature go beyond these limits, an audible alarm sounds and the chamber shuts down. The Limit Control is a high and low limit control. It accepts an input from a single Type "T" thermocouple to sense process temperature. An LED display provides process temperature or limit set point information. Discrete LEDs tell the operator the status of the unit. High and low limit set points are user selectable at the front of the panel. The output device is a six amp mechanical relay.

The High/Low Limit Control incorporates auto power reset. In a non-limit condition, auto power reset will automatically energize the output relay and silence the audible alarm when power is applied. If a limit condition exists, the output relay will latch in a de-energized state and the audible alarm will sound.

The output relay can be re-energized and the audible alarm silenced by the front panel "Reset" switch being depressed one time only when the limit condition no longer exists. The "Reset" should be depressed a second time to reset the alarm.

The limit has three alarms that must be set up the same to energize all alarm contacts at the same conditions. Alarm 1 shuts down the chamber. Alarm 2 sounds the audible alarm. Alarm 3 is used to de-energize the test product.



## INSPECTION SCHEDULE

### NOTE

If any of the following scheduled inspections require maintenance, contact a qualified service technician or Cincinnati Sub Zero's Service department.

In the day-to-day operation of this equipment, you will become aware of certain levels of noise, vibration, temperature and pressure. If you encounter any significant changes in these levels, investigate them immediately.

A inspection program should be developed for this equipment. To assist in your development of this program, Cincinnati Sub-Zero has prepared a list of routine inspections. While this list is not all inclusive, it will serve as a good base on which to build your own custom program. The establishment of such a program will add significantly to the life of the equipment and will reduce unscheduled down time on the equipment.

## PREVENTIVE MAINTENANCE SCHEDULE

INSPECT	DAILY	WEEKLY	MONTHLY	ANNUALLY
1. Interior & Exterior Cleaning	X			
2. R-404A Charge or Tundra		X		
3. R-508B Standby		X		
4. Humidity Demineralizer Filter		X		
5. Electrical Panel			X	
6. Air Cooled Condenser			X	
7. Tubing Abrasion			X	
8. Water Cooled Condenser				X
9. Chamber Controller Calibration/ Verification				X

### DAILY

#### 1. Interior and Exterior Cleaning

- a. Wipe or vacuum out all debris.
- b. Clean interior surfaces with a damp cloth, mild detergent, or stainless-steel cleaner. Avoid cleaners that are abrasive or leave a residue. DO NOT use steel wool.
- c. Clean the chamber exterior and door gaskets with a damp cloth or a mild detergent. If a detergent is used, test a small area to make sure it does not damage the finish.

### WEEKLY

#### 2. R-404A and Tundra Charge

Check the sightglass for bubbles every 7 to 14 days. If bubbles are present on a continuous basis, the unit may be low on refrigerant. Call a qualified service technician to check the system.

#### 3. System 2 (R-508B) Stand-By Pressure

Check the pressure in the controller prior to starting the conditioning system. A discharge pressure reading lower than the standby pressure on the data plate could indicate a leak in the system. DO NOT START. To check the stand-by pressure, power off the unit. Let the unit stand for 24 hours (this will allow for full equalization). Check pressure reading on the gauges. Note: For Z(H)-2 units, the service gauges must be used to obtain this reading.



## WEEKLY (CONT'D)

### 4. Humidity Demineralizer Filter

The demineralizer filter should be replaced when the color change reaches 3" from the bottom of the filter. Damage will occur if the filter is not replaced when the color changes from dark blue to orange brown.

## MONTHLY

### 5. Electrical Panel

Check for components and wires which may vibrate loose during operation. Check for signs of contactor or relay arcing. Check to see that power and ground connections remain secure.

### 6. Air-Cooled Condenser

Should be cleaned monthly with a vacuum. This period may be extended if operating conditions warrant. A dirty, clogged condenser can lead to excessive head pressure in the R-404A system or Tundra units and can result in a loss of system efficiency and premature failure.

### 7. Tubing Abrasion

Check for evidence of friction wear on all refrigeration lines. Particular care should be taken in inspecting capillary tubes to pressure gauges/transducers. Check lines any time the system is shut down.

## ANNUALLY

### 8. Water-Cooled Condenser (Optional Equipment)

Annually check the condenser for buildup of scale on the condensing surface. This interval may need to be shortened if the buildup is of a substantial amount.

### 9. Chamber Controller Calibration/Verification

Calibrate/Verify the chamber controller settings if all instruments in your facility are periodically calibrated to one device (metrology), or if a measurement system component fails. The calibration/verification procedure is located in the Controller Manual which accompanied your unit.

CSZ provides on-site calibration. Contact the CSZ service department at 513-719-3300 for details.





## GENERAL VISUAL INSPECTION

### 1. Chassis

Deformation, dents, punctures, badly worn surfaces, damaged connectors, damaged fastener devices, or damaged handles. Inspect for corrosion and damage to finish.

### 2. Circuit Cards

Dirty contacts, pins and loose connections. Inspect components for signs of overheating, loose connections, cracked, broken, or charred terminal insulation; case damage; body damage; Components loose, broken, or corroded terminal studs, lugs, or leads; lose, broken, or poorly soldered connections. Inspect for physical damage to forms and adjustment screws.

### 3. Connectors

Broken or deformed shells or clamps, and other irregularities. Inspect for cracked or broken insulation and for contacts that are broken, deformed, or out of alignment. Inspect for corroded or damaged plating on contacts and for loose, poorly soldered, or corroded terminal connections.

### 4. Indicators

Cracked or missing lenses

### 5. Jacks

Corrosion, rust, loose or broken parts, cracked insulation, bad contacts, and other irregularities.

### 6. Metal Parts

Physical damage to mounting plates, chassis, brackets, nuts, bolts, screws, washers, handles, fasteners, and hardware.

### 7. Plastic Parts

Signs of cracked or charred insulation, and loose or missing mounting hardware on plastic parts such as terminal boards, mounting blocks, and insulating members. Inspect for other abnormalities that might indicate future breakdown.

### 8. Wiring

Physical damage and charring on open and laced wiring of chassis, terminal boards, and parts of equipment, by checking insulation. Inspect wires for breakage and for improper dress.



**NOTE**

Only qualified maintenance personnel should be permitted to perform any maintenance procedures.

## TEST EQUIPMENT REQUIRED FOR MAINTENANCE

Table 1 is a list of the test equipment required to test and maintain the chamber. Equivalent equipment may be used.

Nomenclature	Use
Precision millivolt source	Millivolt source for use in calibrating High/Low Limit temperature settings
Type "T" reference table	Reference table used for calibrating controls
Digital voltmeter	Measures voltage
Digital Clamp-on Ammeter	Reads current draw of electrical components. (Heaters, compressors, etc.)

Table 1. Required Test Equipment



## GENERAL TROUBLESHOOTING

PROBLEM	PROBABLE CAUSE	CORRECTIVE ACTION
Compressor will not run	Conditioning system OFF No electrical power Wrong voltage to applied to unit Compressor internal overload tripped High/Low Limit tripped Control alarm energized Motor failure Motor shorted Fuse may need to be replaced	Turn ON conditioning system Check fuses Check voltage and correct Will automatically reset when cooled Correct cause of limit condition, repair and reset Check winding resistance and lead to ground resistance Replace compressor Refer to section on Replacing Fuse
Unit short cycles continuously	Restricted or improperly adjusted thermal expansion valve Time-out timer set too low Gain setting too high Proportional band setting to low Compressor low on refrigerant	Replace or adjust valve Increase "Time-out" time Decrease gain setting Increase proportional band setting Check refrigerant and charge if necessary
Compressor difficult to start	Wrong voltage applied to unit Defective run/start capacitor(s) Defective start relay Refrigeration overcharge	Connect correct voltage Replace capacitor(s) Replace start relay Recover and recharge
High load amps	Low voltage Electrical malfunctions Defective start relay	Check supply circuit Check for proper wiring and correct compressor capacitor. Check for grounds and measure winding resistance Check and replace
Low Amps	Low refrigerant	Check for leaks; charge system

Table 2. General Troubleshooting



## GENERAL TROUBLESHOOTING

PROBLEM	PROBABLE CAUSE	CORRECTIVE ACTION
Insufficient cooling effect	Refrigerant shortage Frosted coil Low air circulation Exceeding rated live load capacity (See data sheets) Cooling coils obstructed TXV defective Solenoid coil burned out Solenoid valve bad Dirty condenser R-404A compressor frosting	Repair leak and recharge Defrost and dry coil Check fan blade and shaft. Blade may have come off Reduce live load Remove obstruction or defrost Replace valve Replace coil Replace valve Clean condenser Possible leak in R-508B. Check ambient pressures
R-508B Head Pressure too high	Refrigerant overcharge Humidity unit switch "on" Exceeding rated live load capacity (See data sheets) Air in system R-404A system short of gas	Recover excess refrigerant Turn switch "off" during low temperature operation or turn Humidity event "off" in program Reduce live load Recover, evacuate and recharge. Repair leak and recharge
R-508B Head Pressure too low R-404A Head Pressure too high Water Cooled Units	Refrigerant shortage Condensing air too warm Restricted air cooled condenser Air in system Condenser water too warm Differential pressure too low	Repair leak and recharge Maximum condenser inlet air = 85°F Clean condenser Recover, evacuate and recharge Supply cooler water Minimum water differential = 40 PSI
R-404A Head Pressure too low	Condensing air too cold Condenser water too cold Low refrigerant charge	Location may need to be changed Raise supply temperature Repair leak & recharge

Table 2. General Troubleshooting



## GENERAL TROUBLESHOOTING

PROBLEM	PROBABLE CAUSE	CORRECTIVE ACTION
Noisy unit	Insufficient compressor oil Fan Tubing rattle Compressor mounting	Consult Cincinnati Sub Zero Check blades and bearing Bend tubes away from contact Tighten

Table 2. General Troubleshooting

## HUMIDITY TROUBLESHOOTING (Optional)

PROBLEM	PROBABLE CAUSE	CORRECTIVE ACTION
Humidity not reaching desired level	Atomizing Nozzle Clogged	Remove & Clean Replace Demineralizer Filter if required
	Water is not connected to unit	Connect water
	Air pump is not functioning	Check air pump
	Water control solenoid not energized	Check coil - replace if burned Check solenoid circuit - repair circuit
	Chamber fan not functioning	Check fan circuit Check fan blade for tightness on shaft
	Filter/Strainer clogged	Remove & Clean
	Humidity switch not on	Turn switch ON
	Solid state sensor defective	Replace
	Water metering valve not adjusted properly	Adjust to 20.25 CCS
Demineralizer cartridge clogged internally	Replace cartridge	

Table 3. Humidity System Troubleshooting Chart



## DRY AIR PURGE TROUBLESHOOTING (Optional)

PROBLEM	PROBABLE CAUSE	CORRECTION ACTION
<p>Unit delivers wet air.</p> <p>Moisture indicator is pink.</p>	<p>Improper operating conditions</p> <p>Solenoid core spring broken</p> <p>Purge orifice plugged</p> <p>Solenoid coil burned out</p> <p>Improper operation of cycle timer</p> <p>Desiccant attrition or contamination</p> <p>Water in Customer air supply lines</p>	<p>Change temperature and RH setpoint to be within recommended operating range for Dry Air Purge</p> <p>Remove solenoid valve Spring should be seated on core and not broken. Replace if necessary.</p> <p>Remove, inspect, and clean orifice. Use air gun to clean. Do not force wires through critically drilled holes.</p> <p>Remove cover, place iron or steel material (screw driver or nail) on exposed end of solenoid base to feel the magnetic effect indicating proper operation. Each coil should be energized for 30 seconds. Depress switch lever by hand and listen for clicking contact. Switch should click when depressed and when released. Replace if necessary.</p> <p>Check the power supply . If the correct voltage is not present between L1 and both of the L2 terminals, check the wiring and protective device supply ing power to the dryer.</p> <p>Dryers with DC solenoid valves should alternately have DC voltage between L2 and DC1 and between L2 and DC2. Replace the timer if voltage is present at either DC terminal continuously or not at all.</p> <p>Timer Input 120VAC/Timer Output 53 VDC Timer Input 240 VAC/Timer Output 106 VDC</p> <p>Timers P-06521-F1 and F2 are the standard timers used on the HF200, HF300A and HF300B air driers. The timers permit simultaneous switching of the solenoid valves every 30 seconds.</p> <p>Inspect outlet air line for indication of excessive oil. Check operation of dropout filter.</p> <p>Remove chamber from manifold and depress perforated disc at open end of chamber. If it can be depressed more than 1/4" from the retaining ring.</p> <p>Find and correct problem</p>

Table 4. Dry Air Purge Troubleshooting Chart



## DRY AIR PURGE TROUBLESHOOTING CONT'D (Optional)

PROBLEM	PROBABLE CAUSE	CORRECTION ACTION
Excessive drop in outlet pressure	Improper operating conditions	Correct operating conditions
	Solenoid coil burned out	Remove cover, place iron or steel material (screwdriver or nail) on exposed end of solenoid base to feel the magnetic effect indicating proper operation. Each coil should be energized for 30 seconds. Depress switch level by hand and listen for clicking contact. Switch should click when depressed and when released. Replace if necessary.
	Improper operation of cycle timer	<p>Check the power supply. If the correct voltage is not present between L1 and both of the L2 terminals, check the wiring and protective devices supplying power to the dryer.</p> <p>Dryers with DC solenoid valves should alternately have DC voltage between L2 and DC1 and between L2 and DC2. Replace the timer if voltage is present at either DC terminal continuously or not at all.</p> <p>Timer Input 120VAC/Timer Output 53 VDC Timer Input 240 VAC/Timer Output 106 VDC</p> <p>Timers P-06521-F1 and F2 are the standard timers used on the HF20, HF300A and HF300B air driers. The timers permit simultaneous switching of the solenoid valves every 30 seconds.</p>
	Check valve balls seating	Remove check balls and springs and inspect for excessive wear or damage. Replace if necessary.
	Plugged air passages	Check inlet and outlet air passages and piping for blockage. Correct if necessary.
	Desiccant attrition or contamination	Inspect outlet air line for indication of excessive oil. Check operation of dropout filter.
		Remove chamber from manifold and depress perforated disc at open end of chamber. If it can be depressed more than 1/4 from retaining ring, replace chamber.
Solenoid valve chatter	Solenoid valve defective	Replace solenoid valve core assembly and solenoid base.

Table 4. Dry Air Purge Troubleshooting Chart (Cont'd)



## GN2 SYSTEM TROUBLESHOOTING (Optional)

PROBLEM	PROBABLE CAUSE	CORRECTION ACTION
Unit doesn't reach low humidity setpoint	<p>Solenoid core spring broken</p> <p>Solenoid coil burned out</p>	<p>Remove solenoid valve and inspect core assembly. Spring should be seated on core and not broken. Replace if necessary.</p> <p>Remove cover, place iron or steel material (screw driver or nail) on exposed end of the solenoid base to feel the magnetic effect that indicates proper operation. Each coil should be energized for 30 seconds. Depress switch lever by hand and listen for clicking contact. The switch should click when depressed and when released. Replace if necessary.</p>
Excessive drop in outlet pressure	Solenoid coil burned out.	<p>Remove cover, place iron or steel material (screw driver or nail) on exposed end of the solenoid base to feel the magnetic effect that indicates proper operation. Each coil should be energized for 30 seconds. Depress switch lever by hand and listen for clicking contact. The switch should click when depressed and when released. Replace if necessary.</p>
Solenoid valve chatter	Solenoid valve defective	Replace solenoid valve core assembly and solenoid base.

Table 5. GN2 System Troubleshooting Chart





## LN2 SYSTEM TROUBLESHOOTING (Optional)

PROBLEM	PROBABLE CAUSE	CORRECTION ACTION
No LN2 Flow	Check LN2 Supply  Check Solenoid Valves	Is LN2 Supply tank empty?  Are the solenoid valves opening?  Do the solenoid coils have power? They should have 120 VAC applied to the coil.

Table 6. LN2 System Troubleshooting Chart

## FROZEN COIL TROUBLESHOOTING (Optional)

PROBLEM	PROBABLE CAUSE	CORRECTION ACTION
Coil not Freezing  Water	Frozen Coil Mode Not Engaged  Solenoid Valve Not Working  Frozen Coil T.E.V. out of Adjustment	Dewpoint not low enough, let wet coil remove moisture before unit enters frozen coil mode  Check liquid line solenoid (Frozen Coil)  Check EPR bypass solenoid. Do they have power?  Adjust T.E.V. to increase superheat  Verify Frozen Coil is turned on by the event and/or switch on control panel

Table 7. Frozen Coil Troubleshooting Chart



## SATURATED TEMPERATURE/PRESSURE CHART

Temp. °F	GAUGE PRESSURE (P.S.I.G.)						
	R -502	R-404A	R-410A	R-13	R-23	R-503	R-508B
-130	27.8*	28.0*	-	11.5*	11.4*	2.1*	3.8*
-125	27.3*	27.5*	-	8.2*	7.9*	1.2	0.4
-120	26.7*	27.0*	-	4.5*	3.9*	3.7	2.9
-115	26.1*	26.1*	-	0.4*	0.3	6.6	5.9
-110	25.3*	25.5*	-	2.1	2.9	9.8	9.2
-105	24.3*	24.6*	-	4.7	5.7	13.3	12.8
-100	23.3*	23.5*	-	7.6	9.0	17.6	16.8
-95	22.0*	22.3*	-	10.8	12.7	21.6	21.4
-90	20.6*	20.9*	-	14.3	16.7	26.4	26.3
-85	19.0*	19.2*	-	18.2	21.3	31.7	31.8
-80	17.2*	17.5*	12.0*	22.5	26.3	37.5	37.8
-75	15.1*	15.2*	10.2*	27.1	32.0	43.9	44.3
-70	12.7*	12.8*	7.0*	32.3	38.0	50.8	51.5
-65	10.1*	10.1*	3.4*	37.8	44.7	58.4	59.3
-60	7.2*	7.0*	0.3	43.9	52.0	66.6	67.7
-55	3.9*	3.6*	2.5	50.4	60.0	75.5	76.9
-50	0.2*	0.2	5.0	57.5	68.7	85.1	86.8
-45	2.0	2.2	7.8	64.1	78.1	95.5	97.5
-40	4.1	4.5	10.8	73.3	88.3	106.7	109.0
-35	6.5	7.0	14.2	82.2	99.4	118.7	121.3
-30	9.2	9.8	17.8	91.6	111.3	131.6	134.6
-25	12.1	12.9	21.9	101.7	124.0	145.5	148.8
-20	15.3	16.2	26.3	112.5	137.8	160.3	164.0
-15	18.8	19.9	31.2	124.0	152.5	176.1	180.2
-10	22.6	23.8	36.4	136.1	168.2	193.0	197.5
-5	26.7	28.1	42.2	149.1	185.1	211.0	215.8
0	31.1	32.8	48.2	162.9	202.9	230.0	235.3
5	35.9	37.8	55.1	177.4	221.1	250.3	256.0
10	41.0	43.3	62.1	192.8	242.4	271.8	277.9
15	46.5	49.1	70.1	209.1	264.0	294.5	301.2
20	52.4	55.4	78.2	226.3	286.9	318.5	325.7
25	58.8	62.2	87.5	244.4	311.3	343.9	351.6
30	65.6	69.4	96.8	263.3	337.1	370.6	378.9
35	72.8	77.2	107.5	283.6	364.5	398.7	407.7
40	80.5	85.5	118.0	304.8	393.6	428.2	438.0
45	88.7	94.3	130.2	327.1	424.4	459.2	469.9
50	97.4	113.7	142.0	350.5	457.1	491.7	503.5
55	106.6	115.7	156.0	375.1	491.7	525.6	538.7
60	116.4	124.3	170.0	401.0	528.5	561.0	C.P.
65	126.7	135.6	185.2	428.2	567.5	597.7	
70	137.6	147.5	200.0	456.9	608.9	C.P.	
75	149.1	160.1	218.0	487.2	652.9		
80	161.2	173.5	235.0	519.4	C.P.		
85	174.0	187.6	254.0	C.P.			
90	187.4	202.4	274.0				
95	201.4	218.1	295.0				
100	216.2	234.6	317.0				
105	231.7	252.0	340.0				
110	247.9	270.3	364.0				
115	264.9	289.5	390.0				
120	282.7	309.6	417.0				
125	301.4	330.8	445.0				
130	320.8	352.9	475.0				
135	341.2	376.1	506.0				
140	362.6	400.5	538.0				

\*Inches of mercury below one atmosphere



## **PFC REFRIGERANTS**

**(Only applicable to chambers using refrigerant R-508B)**

This equipment contains the refrigerant SUVA<sup>®</sup> 95 (R-508B) in the low side system. SUVA<sup>®</sup> 95 is chlorine-free and meets all EPA regulations for ozone-safe refrigerants. It has also been established that SUVA<sup>®</sup> 95, a PFC, has a long atmospheric lifetime and therefore, emissions of this refrigerant should be minimized. Cincinnati Sub-Zero Products, Inc. recommends that SUVA<sup>®</sup> 95 should never be discharged to the atmosphere, and that servicing of your equipment should be performed by those persons certified to work on this type of refrigerant system.

Specifically, we recommend the following maintenance instructions:

1. Implement practices to recover, reclaim, recycle, or destroy the PFC refrigerants during equipment servicing and upon the retirement of the equipment.
2. Reduce or contain to a minimum the emission of PFC refrigerant during normal operation, maintenance, manufacture or installation of systems; and ensure that the annual leakage from systems containing PFC refrigerants will not exceed 25% of the system charge in the previous year. On July 1, 1997, the maximum allowable annual leakage will be reduced to 20%.

If you have any questions about refrigerants, please call Cincinnati Sub Zero and speak with our Manager of Application Engineering.



## REPLACING A FUSE

1. If the unit fails to operate properly, fan or compressors do not operate, a fuse may have opened due to an overload condition. To replace the fuse, disconnect main power from the unit and access the electrical sub-panel by removing the cover from the top of the unit. The fuses are labeled as shown on the electrical schematic as well as Figures 1 and 2 below. Check and replace blown fuses as necessary. The fuses must be replaced with fuses of an identical type and rating type as noted in the tables below. All fuses are FNQ-R.

<b>CINCINNATI SUB-ZERO PRODUCTS</b> <b>Z(H)-8, 16, 32 ELECTRICAL DATA LABEL</b>								
ALL MODELS: 208/230V - 1/3 PHASE - 50/60HZ**								
MODEL NO.*	FULL LOAD AMPS		LARGEST MOTOR	FUSE REPLACEMENT SIZES				
	1 PHASE	3 PHASE		1,2FU	4,5FU	7,8FU	10,11FU	16,17FU***
Z-8-1	24A	22A	1HP	5A	15A	N/A	20A	N/A
Z-8-1-1	33A	23A				15A		
ZH-8-1	27A	22A		N/A				
ZH-8-1-1	35A	26A		15A				
Z/ZH-16/32-2	35A	31A	2HP	10A	25A	N/A	20A	7A
Z/ZH-16/32-2-2	51A	39A				25A		

\*SEE EQUIPMENT DATA PLATE FOR MODEL NUMBER DESIGNATION  
 \*\*FOR 230V/50HZ OPERATION, BUCKING TRANSFORMERS ARE REQUIRED  
 \*\*\*USED ON HUMIDITY BOILER SYSTEMS ONLY

Figure 1. Z(H)-8/16/32 Fuse Replacement Table

<b>CINCINNATI SUB-ZERO PRODUCTS</b> <b>Z/ZH-2 ELECTRICAL DATA LABEL</b>			
MODEL NO.*	FULL LOAD AMPS		LARGEST MOTOR
	1 PHASE	3 PHASE	
Z-2-.33-.33	16A	N/A	.33HP
ZH-2-.33-.33	16A		


  

FUSE REPLACEMENT SIZES			MINIMUM SERVICE
1,2FU	3FU	4FU	20A
15A	10A	1A	

\*SEE EQUIPMENT DATA PLATE FOR MODEL NUMBER DESIGNATION

Figure 2. Z(H)-2 Fuse Replacement Table




 <b>CINCINNATI SUB-ZERO PRODUCTS</b> <b>Z(H)-8, 16, 32 ELECTRICAL DATA LABEL</b>									
SINGLE STAGE/TUNDRA: 208/230V - 1/3 PHASE - 50/60HZ									
MODEL NO.*	FULL LOAD AMPS		LARGEST MOTOR	FUSE REPLACEMENT SIZES				MAIN CB SIZE	
	1 PHASE	3 PHASE		1,2FU	4,5FU	10,11FU	16,17FU**	1PH	3PH
Z-8-1-H	24A	22A	1HP	5A	15A	20A	N/A	30A	30A
Z-8-2-SCT	40A	38A	2HP		20A	30A		50A	50A
ZH-8-1-H	27A	22A	1HP	10A	15A	20A	7A	35A	30A
ZH-8-2-SCT	42A	38A	2HP		20A	30A		50A	50A
Z/ZH-16/32-2-H	35A	31A	2HP		25A	20A		45A	40A
Z/ZH-16/32-3.5-SCT	49A	45A	3.5HP		30A	30A	60A	60A	

\*SEE EQUIPMENT DATA PLATE FOR MODEL NUMBER DESIGNATION  
 \*\*USED ON HUMIDITY BOILER SYSTEMS ONLY  
 NOTE: USE A MINIMUM OF 60°C RATED COPPER CONDUCTORS ONLY FOR INCOMING POWER.

56380-A

Figure 3. Z(H)-8/16/32-SCT Fuse Replacement Table

 <b>CINCINNATI SUB-ZERO PRODUCTS</b> <b>Z(H)-8, 16, 32 ELECTRICAL DATA LABEL</b>								
TUNDRA 6HP MODEL: 208/230V - 3 PHASE - 50/60HZ								
MODEL NO.*	FULL LOAD AMPS	LARGEST MOTOR	FUSE REPLACEMENT SIZES					MAIN CB SIZE
	3 PHASE		1-3FU	4-6FU	10-12FU	13-14FU	16,17FU**	3PH
Z/ZH-8/16/32-6	46A	6HP	5A	35A	20A	5A	7A	60A

\*SEE EQUIPMENT DATA PLATE FOR MODEL NUMBER DESIGNATION  
 \*\*USED ON HUMIDITY BOILER SYSTEMS ONLY  
 NOTE: USE A MINIMUM OF 60°C RATED COPPER CONDUCTORS ONLY FOR INCOMING POWER.

56381-A

Figure 4. Z(H)-8/16/32-6-SCT Fuse Replacement Table



## HUMIDITY SYSTEM MAINTENANCE

**CAUTION**

The demineralizer filter should be replaced when the color change reaches 3" from the bottom of the cartridge. Damage will occur if the cartridge is not replaced when the color changes from dark blue to orange-brown.

**CAUTION**

Make sure that the rubber gaskets at each end are properly oriented before tightening the locking ring.

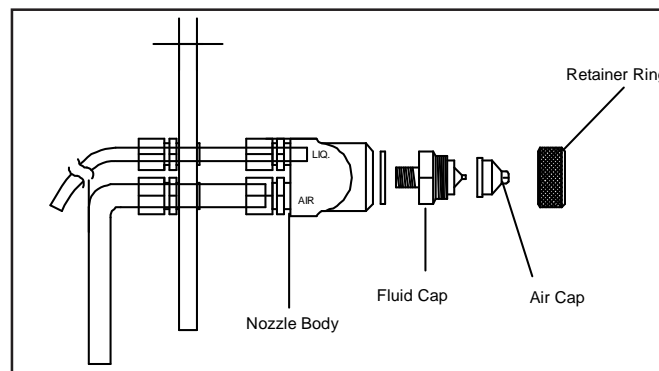
1. The outer casing of the demineralizer filter is transparent and the crystals are visible. A new cartridge is violet or dark blue when water flows through it. A spent cartridge will turn brown, orange, yellow or white. The cartridge should be changed before it completely changes color. Spare cartridges are available through the Cincinnati Sub-Zero Products' Service Department.

## CHANGING THE CARTRIDGE

1. To change the demineralizer filter cartridge, close the valve, and loosen the large, white-locking ring on the bottom of the cartridge and rack. This will reduce the pressure on the cartridge. Push the cartridge straight up and pull the lower part of the cartridge out. Reverse the operation when replacing the cartridge. SEE CAUTION.
2. Check the compression fittings on the humidity panel periodically for tightness.

## REMOVING THE ATOMIZING NOZZLE (FLUID CAP)

1. Turn off the unit power.
2. Disconnect the recirculating water.
3. Open the humidity side pack cover.
4. Locate square plate with two compression fittings.
5. Remove the plate with the nozzle assembly attached.
6. Remove the retainer ring at the end of the nozzle assembly.
7. Gently pull the air cap from the fluid cap.
8. Remove the fluid cap from the body of the nozzle.





## NOTE

On humidity units, a water atomizing nozzle is used to create humidity. With clean water, the nozzle and filter should be cleaned every three months or 500 hours of use, whichever comes first. If clean water is not available, please install a pre-filter (40 micron) at the inlet. Please refer to the cleaning procedure described above.

## NOTE

On units with a recirculating water option, drain and clean reservoir and pump screen every two months or sooner as required by usage and water conditions.

## HUMIDITY SYSTEM MAINTENANCE (CONT'D)

### CLEANING THE ATOMIZING NOZZLE (FLUID CAP)

1. To clean you will need a 12" piece of stranded electrical wire.
2. Strip back 4" of the wire at one end and 1" of the wire at the opposite end.
3. Use the 4" section of the wire and separate one strand to clean the end of the fluid cap.
4. Use the 1" section of the wire to clean the other end of the fluid cap.
5. Blow out the fluid cap with compressed air and reassemble.

### CLEANING THE HUMIDITY SENSOR

It is recommended to perform this routine maintenance monthly to avoid inaccurate readings. If you are having trouble achieving levels or if you can see dirt, please make sure to clean the sensor.

1. Routine maintenance is to clean the sintered tip of the sensor with alcohol.
2. It is then recommended that the tip be dried out by turning the humidity system off and raising the temperature to 250°F for 10 minutes.

*Be aware that there is an allowable tolerance for humidity readings:*

1. < 90% + or - 2% and > 90% + or - 3% for the sensors within the chambers.
2. Handheld accuracy is typically + or - 2% for quality instruments.

It is also important to calibrate the sensor *at least* once per year.

## WATER QUALITY

Purified water is recommended for use with our humidity systems. Water should be provided within 0.05 to 2M (.25 to 10ppm) DI, Distilled water or Reverse Osmosis (RO) water outside of these limits may cause *either corrosion or scaling*. Tap water may be used with our optional \*Demineralizer Filtration System. A \*Recirculation Humidity Water Supply System is also available. Inlet water pressure should not exceed 10psi for use with an atomizer or 25 psi for use with a boiler. A \*Water Pressure Regulator must be used.



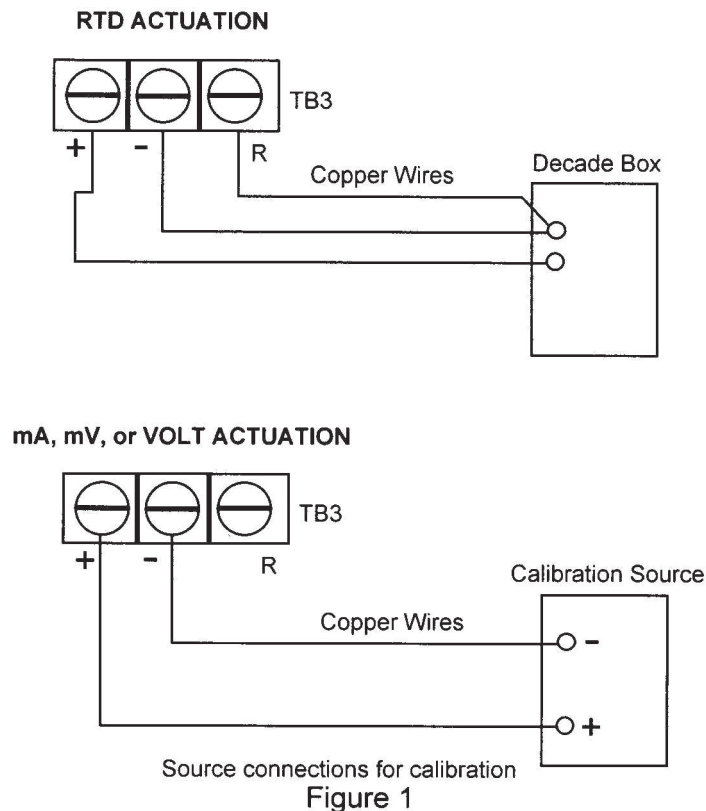
Please refer to your instrument manual for calibration instructions that are not listed here.

## DR4300EV RECORDER CALIBRATION PROCEDURE

Equipment Needed: Thermocouple Calibration or RTD simulator (Decade Box), Milliamp source (current calibration source).

### I. CALIBRATION CHECK

1. Turn the unit OFF.
2. Open recorder door and access panel.
3. Disconnect chamber RTD or thermocouple leads from terminals for pen 1.
4. Connect calibration source as appropriate for given sensor simulation from Figure 1.
5. Set calibration source to equivalent zero value in Table 1.
6. Turn the unit ON and let recorder sit for 1/2-hours ambient conditions.







## DR4300EV RECORDER CALIBRATION PROCEDURE CONTINUED

Voltage and Resistance Equivalents for 0% and 100% Range Values				
	PV Input Range		Range Value	
	°F	°C	0%	100%
Thermocouples T	-300 to 700	-184 to 371	-5.341 mV	19.095 mV
RTD				
-100 ohms	-300 to 900	-184 to 484	25.18 Ohms	274.96 Ohms
-100 ohms (low)	-130 to 392	-90 to 200	64.30 Ohms	175.84 Ohms
-100 ohms (T)	-238 to 482	-150 to 250	38.79 Ohms	195.57 Ohms
Linear Milliampere (dc)	4 to 20 mA		4mA	20 mA

Table 1

7. Input temperature values as follows:
  - a. Upper limit of chamber.
  - b. Lower limit of chamber.
  - c. Midpoint of chamber range.

NOTE: For RTD input refer to the attached Minco resistancetables for 138.50 curve probe.

8. Record initial readings on Calibration/Verification Test Data Sheet (IF0003).
9. Calibration Limits
  - Thermocouple Input  $\pm 1.6^{\circ}\text{F}$  ( $\pm 0.9^{\circ}\text{C}$ )
  - RTD Input  $\pm 0.8^{\circ}\text{F}$  ( $\pm 0.5^{\circ}\text{C}$ )
  - 4-20 mA Humidity Input  $\pm 0.4\%$  RH

### II. CALIBRATION PROCEDURE FOR OUT OF TOLERANCE CONDITION.

1. Recorders with 2 pens, be sure correct input is on display - INP1 or INP2 indicator lit. Press FUNC key to change as required.
2. Press SET UP key until CAL appears in the upper display with INPUT in lower one.

NOTE: If CAL doesn't appear or prompt access is denied, check the "LOCK" software configuration.

3. Press FUNC key. Display shows: DIS  
CALIN
4. Press RAISE or LOWER key to change upper display to BEGN.
5. Press FUNC key. Display shows: APLY  
INZERO



## DR4300EV RECORDER CALIBRATION PROCEDURE CONTINUED

6. Be sure the calibration source is set to correct 0% range value as noted in Table 1 for given input type.
7. Wait 30 seconds.
8. Press FUNC key. Display shows: APLY  
INSPAN
9. Set calibration source output equal to 100% range value as noted in Table 1 for given input type.
10. Wait 30 seconds.
11. If you are calibrating a thermocouple-input type, press FUNC key. Display shows: 25.9  
CJTEMP

The value in upper display represents ambient temperature at input terminals as recognized by recorder. If the temperature is wrong, use RAISE and LOWER keys to correct it.

Press FUNC key to store field calibration constants in memory and exit calibration mode.

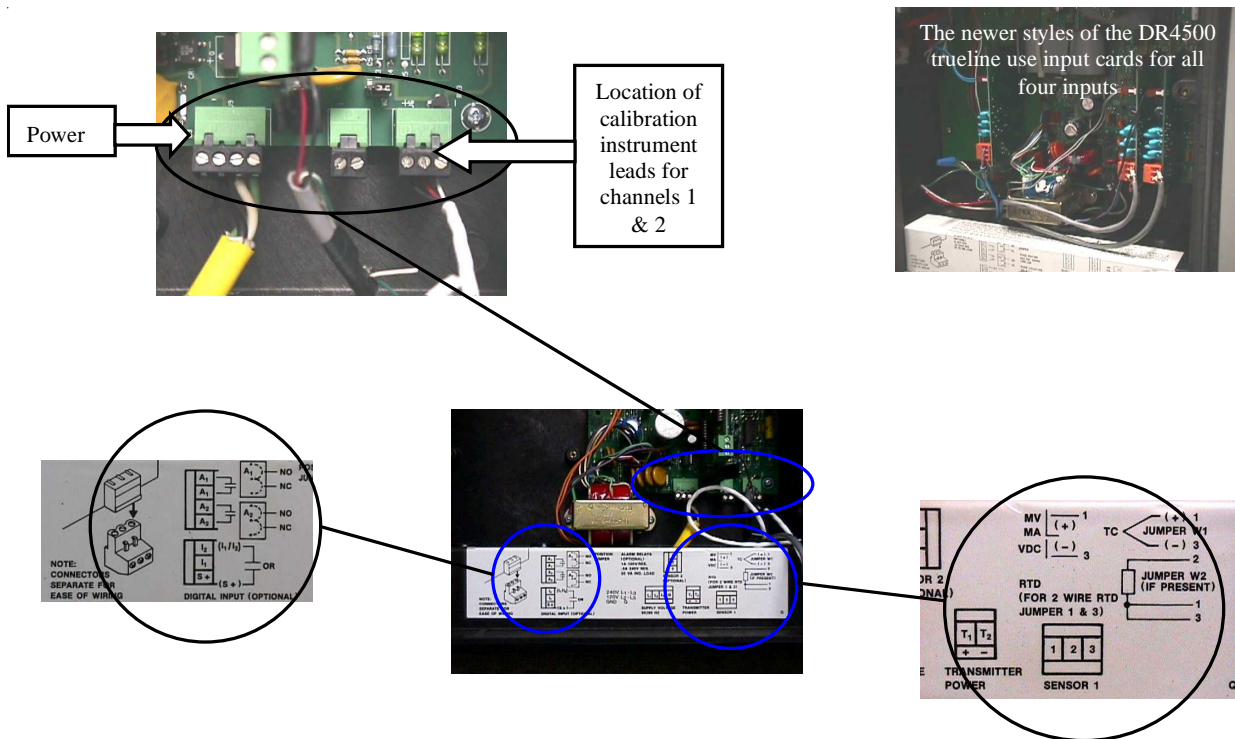
12. Repeat entire procedure for other pen, if applicable.
13. Remove power from unit. Disconnect calibration source and connect input leads.
14. Close chart plate and door. Apply power and resume normal operation.



## DR4500 RECORDER CALIBRATION PROCEDURE

Equipment Needed: Thermocouple Calibration or RTD simulator (Decade Box), Milliamp source (current calibration source).

1. Turn off power to the recorder.



2. Open the cover and the face to expose the circuit board on the inside of the housing.
3. Look at the information chart on the inside of the unit to find the proper location to connect the calibration instrument.
4. Connect the correct input simulator to the terminals using the information listed on the information chart. This is dependent upon the parameters the recorder is going to record (mV, mA, RTD, T/C).
5. Close the face and power up the recorder. Allow approximately 30 seconds for the self tests to perform. When the tests are finished the display will show the current value of the input.



Key Pad





## DR4500 RECORDER CALIBRATION PROCEDURE (CONT'D)

6. Press the Setup key until the display reads the setup input (#) (where # is the number of the input being calibrated).



Shown here is the display for calibrating an RTD probe.

7. Press the function key until the display reads the correct input type.
8. Press the Function key record the Hi Side values. Press the function key and record the Low Side values.
9. Press the Lower Display key until you see the current input on the display.
10. Look up the Hi Side & Lo Side values recorded earlier in the Resistance temperature table (138.50 European Curve) and input the values using the calibration input device (i.e. Decade box).

### If the recorder is out of calibration:

1. Press the Setup key until you see "Lockout" on the display. Press the Function key until "Lockout" displays on the lower portion of the display and use the up & down arrow keys until the upper portion of the display reads "None".
2. Press Setup key until Calib Input (#) is displayed. Input the previously noted Lo Side value using the input device.
3. Press the Function key until the display reads "Disable".
4. Press the up & down arrow keys until the display reads "Begin CLB IN 1 (or other correct input number)".
5. Press the Function until the display reads "Apply IN 1 Zero"
6. Allow the recorder a minute or so for calibration to set. Press the Function key until display reads "Apply IN 1 Span" and input the Hi Side value recorded earlier.
7. Press Function key to take out of calibration mode.



## DR4500 RECORDER CALIBRATION PROCEDURE (CONT'D)

8. Press the Lower Display key to bring up the current value from the calibration instrument.
9. Test the calibration by inputting the Lo Side & Hi Side values with the input device again.
10. If the values are still off then press the Setup key until the display reads "INPTCOMP" (input compensation). Use the up & down arrows to adjust the compensation accordingly.
  - ❖ The above actions should be performed for each input device that will be used.
11. Disconnect the calibration equipment and connect the proper input device. Close cover and lock lid.

### Additional steps for the DR4500 Classic:

1. The pens are adjusted using the Pen Adjust screen.
2. Press the Setup key until Pen Adjust is displayed.
3. Press the Function key until the correct pen number appears in the display.
4. Allow approximately 45 seconds for the pen to stabilize.
5. Press the up & down arrow keys until the pen is adjusted correctly.
6. Press the Function key until "Span" is displayed. Allow another 45 seconds for the pen to stabilize. Press the up & down arrow keys until the pen is adjusted correctly.
7. Calibration Limits
  - Thermocouple Input  $\pm 0.6^{\circ}\text{F}$  ( $\pm 0.35^{\circ}\text{C}$ )
  - RTD Input  $\pm 0.4^{\circ}\text{F}$  ( $\pm 0.22^{\circ}\text{C}$ )
  - 4-20 mA Humidity Input  $\pm 0.4\%$  RH



## HUMIDITY SENSOR CALIBRATION PROCEDURE

As long as the probe is operated in an environment free of chemical contaminants and within the operating limits, the long term stability of the humidity sensor is typically better than 1 %RH per year, For maximum accuracy, calibration of the unit may be verified every 6 to 12 months.

Applications where the unit is exposed to significant levels of chemical contaminants may require more frequent verifications. The calibration procedure is described in detail in this manual.

### CALIBRATION BASICS

When calibrating a relative humidity instrument, temperature stability is the single most important requirement. Calibration should be done at room temperature (60 to 80°F or 15 to 26°C) and temperature should be stable to  $\pm 0.25^\circ\text{C}$  or better during the period of time required for each calibration point. Do not calibrate close to an air vent or a heater, 'in direct exposure to sun rays, etc.

### Calibration Device

The ER15 calibration device is a small airtight container that slips over the probe of the H290 and seals around the humidity sensor. During calibration, a known reference humidity is produced inside the calibration device by means of a humidity standard (usually an aqueous salt solution).

During calibration, placing the tip of the probe and calibration device inside an insulating box filled with sand may increase temperature stability.

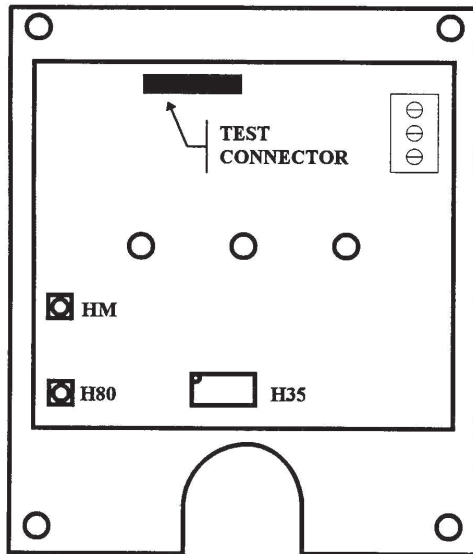
### Humidity Standards

The Rotronic certified humidity standards permit calibration by non-skilled personnel. These standards are available in boxes of 5 glass ampoules of the same value, which can be stored indefinitely. Standards in the range of 5 to 95 %RH are non-saturated aqueous salt solutions that are precisely titrated at our factory for the right concentration. The 0 %RH humidity standard is made of small granules of a highly porous ceramic that have been dried at a high temperature. A Material Safety Data Sheet is available for each standard. Since humidity standards other than the 0 %RH standard are a salt solution, parts that have come in contact with the liquid should be cleaned after each use.



## HUMIDITY SENSOR CALIBRATION PROCEDURE (CONT'D)

### Calibration Potentiometers and Test Connector



Test Connector: used for a 1-Point Calibration (Requires PFC- 150 Calibrator)

H35: Offset Adjustment Potentiometer

H80: Slope Adjustment Potentiometer

HM: Potentiometer used for calibration at 5 or 10 %RH.

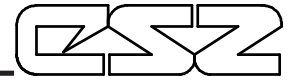
## CALIBRATION PROCEDURES

### One-Point Calibration

When the application is over a narrow range of humidity conditions, a one-point calibration may be used to facilitate maintenance and to save time. This consists in adjusting the output of the H290 against the display of a reference instrument (PFC-150 calibrator). The output of the H290 can be read without interrupting the output signal by connecting the test cable of the PFC-150 to the test connector of the H290 (see "calibration potentiometers and test connector" as well as the manual provided with the PFC150). During the procedure, it is important to satisfy the following requirements:

- The humidity and temperature conditions that are prevalent during calibration must be reasonably stable. Over a period of 15 mi., temperature should not vary by more than 1°F (0.5°C).
- The probe of both instruments should be ventilated or placed in the same stream of *moving air*. Air velocity must be at least 200 ft/min (1m/s).

Usually, it is temperature equilibrium that takes the longest time. Depending on the initial conditions, equilibration can take from a few minutes to as long as 15-20 minutes. If the initial temperature difference between the two probes is more than a few degrees, be sure to wait at least 15 minutes. before calibrating.





## **The input voltage label says 230 VAC (or 208 VAC). I thought I had 220 VAC. Is that ok?**

208V and 230V are NOT the same. 220V is a misnomer—there is no such standard as nominal 220V in the United States. You must verify the exact type of electrical service you have. If there is any doubt, you must consult with a qualified electrician who is familiar with industrial plant wiring. In addition, the input line voltage should be measured while the chamber is operating in the COOL mode to ensure that the expected nominal voltage of either 208V  $\pm$ 5% or 230V  $\pm$ 5% is present.

## **Why doesn't the chamber come with a power cord and plug?**

Most local electrical codes require permanent wiring for this type of equipment. If used as a portable device, a flexible wire with a plug may be acceptable, but local codes may limit the length to 6 feet. Cincinnati Sub-Zero recommends that the appropriate method for your installation be determined by a qualified electrician who is familiar with industrial plant wiring.

## **Why does my chamber heat or cool slower than the published specifications?**

Performance is significantly effected by the characteristics of your test sample. Factors include size, weight, material, shape, and power dissipation if energized. The test sample should be placed in the chamber in a manner that allows for air circulation. You should not place the test sample directly on the chamber floor. It should be placed on the shelf. Multiple test samples should be distributed throughout the chamber to ensure even airflow and minimize temperature gradients. If necessary, additional shelves should be used to evenly distribute the load.

## **How can I modify the chamber to cool faster?**

Unfortunately, there is little you can do to improve upon the designed-in performance. Cincinnati Sub-Zero does offer an LN2 boost package that can be installed in the field to increase cooling performance.

## **Why is there water/ice/snow in the chamber?**

Any time the ambient air is subjected to temperatures below the dewpoint, moisture will condense out of the air. The effect is ice or frost during low temperature operation. When the chamber is heated above 0°C, the ice or frost will turn into water. To avoid moisture condensation, make sure the port plugs are inserted at all times. Also, avoid opening the chamber door while the chamber is operating at temperatures below room ambient. When a low temperature test is completed, warm the chamber to at least room ambient before opening the chamber door and before removing your test sample.

## **How accurate is the chamber?**

That's a loaded question! There is no "chamber accuracy" specification as such. The answer requires an understanding of several performance parameters.

Control Tolerance – The control sensor is located in the discharge airflow. Control tolerance is a measure of how much the temperature varies after stabilization at the control sensor. It is a measure of the relative variations, NOT the absolute accuracy of the readout. The control tolerance specification for this chamber is  $\pm 1^{\circ}\text{C}$ , or a total of  $2^{\circ}\text{C}$ . For example, the temperature set point may be  $-65.0^{\circ}\text{C}$ . The actual temperature varies between  $-64^{\circ}\text{C}$  and  $-66^{\circ}\text{C}$ . These specifications are for an empty chamber. The addition of a test sample may effect the control variations. In some instances, the test sample will reduce these variations.

Uniformity – Also known as Gradients. This is a measure of variations in temperature at different locations throughout the chamber interior, at the same time, after stabilization. The uniformity specification can vary for each chamber. These specifications are for an empty chamber. The addition of a test sample may effect the temperature uniformity. For example, an energized test sample will produce a higher temperature near the sample. For more specific uniformity information please contact CSZ.

## **I'm not going to use the chamber for a while. Is there anything I should do to prepare it for storage?**

Perform ALL the steps in the Preventive Maintenance Schedule before placing the chamber into storage. This will ensure that the chamber will be ready to operate when it is taken out of storage. If the chamber has a problem and is still under warranty, these problems should be resolved before being placed into storage, since the warranty period starts from the date of shipment. The chamber should be stored in a conditioned environment. Do not store it outside or where it will be subjected to dirt or excessive moisture.

## **I haven't used the chamber for a while. Is there anything I should do to prepare it for operation?**

Perform ALL the steps in the Preventive Maintenance Schedule before placing the chamber back into service. This will ensure that nothing has been damaged and that a leak has not developed.

## **Can the person who services our air conditioning also service the chamber?**

Probably not. Most air conditioning mechanics are not familiar with low-temperature cascade refrigeration systems. While this chamber is relatively easy to maintain and repair, most air conditioning mechanics do not have the necessary refrigerants and may not be familiar with the microprocessor-based controls. This chamber should only be serviced by a qualified mechanic that is familiar with low-temperature cascade refrigeration systems. Call Cincinnati Sub-Zero to recommend one in your area, or to check if the one you would like to use is qualified.

## **Can/Should I put a filter in front of the condenser air inlet?**

No, Cincinnati Sub-Zero does not recommend this. Just follow the maintenance procedures and clean the condenser fins periodically.

## **I need to send the chamber to Europe/Asia. Will it work with their power?**

Europe and Asia generally have 50 Hz power. Standard voltages in Europe are typically 220V to 240V, while parts of Asia may be 200V. Operation at 220V to 240V/ 50 Hz requires bucking transformers to lower the voltage to the compressors to 200V. These transformers are available from Cincinnati Sub-Zero for a reasonable cost and are easy to install in the field. Note that the cooling performance will be slightly reduced at 50 Hz. Please call Cincinnati Sub-Zero for details on re-configuring for 50 Hz. operation.

## **How often should I charge the refrigeration system?**

This chamber uses a closed-loop refrigeration system. Just like your refrigerator at home, it does not need periodic charging. If the charge is low, this means that there is a leak. Leaks should be repaired before recharging.

## **What kind of Freon does the chamber use?**

The word Freon® is a DuPont registered trade name for their CFC-based refrigerants and is incorrectly used as a generic term for refrigerants. Cincinnati Sub-Zero chambers do not use CFC-based refrigerants. The high-stage system uses R-404A, which is also known as DuPont Suva® HP62. The low-stage system uses R-508B, which is also known as DuPont Suva® 95. Tundra units use R-410A, also known as Puron and Suva® 9100.

## **My static pressure is lower than the data plate specification. Is this an indication of a leak in my refrigeration system?**

This does not always mean that there is a leak. Ozone friendly refrigerants use POE oil which has the ability to absorb refrigerant to the point of actually causing a lower pressure reading. A decrease in the chambers performance along with lower pressure readings is a possible indicator of a leak. (Please contact Cincinnati Sub-Zero if this occurs).

## **What is the hissing and clicking sound when my unit is at or approaching set point?**

This is normal. The sounds are caused by the solenoid valves alternating between cooling and bypass.

## **What is the average air flow rating inside the chamber?**

The average air flow is 70-100 feet per minute in an empty chamber. The airflow velocity over your test specimen depends on several factors, including test specimen size, geometry location within the chamber.

## **Sometimes I see bubbles in the 404 sight glass. Does this mean my chamber has a leak in it or is undercharged?**

This does not necessarily mean that the unit is undercharged or has a leak. Under certain conditions it is possible to see bubbles in the sight glass. Contact Cincinnati Sub-Zero if you have any questions.

## **Why do I smell something when I operate the chamber for the first time at high temperatures?**

Cincinnati Sub-Zero chambers are cleaned and polished before leaving the factory. Stainless steel polish can give off an odor while at elevated temperatures. This is a temporary condition and is non toxic.



## HUMIDITY BILL OF MATERIALS

UNIT: ZH-ALL

DATE: 08/02/94

PREPARED BY: EDB

SCHEMATIC: RC-6062-A

PAGE: 1 OF 1

B.O.M.#: ZHUMID

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ITEM NO.	I.D. NO.	QTY.	DESCRIPTION	MFG.	MFG. PART NO.
1	00503	1	COMPRESSOR, AIR	THOMAS	107CA
4	00041	1	VALVE AND RACK ASSEMBLY	I.W.T.	27006
5	02037	1	DE-MINERALIZER FILTER	I.W.T.	23004
15	51021	1	GASKET, FLUID	SPRAYING SYS.	CP3612-TEF
15	09051	1	FLUID CAP	SPRAYING SYS.	PF1250
15	14501	1	RETAINER RING	SPRAYING SYS.	1158
15	09052	1	AIR CAP	SPRAYING SYS.	PA73420
15	13250	1	NOZZLE, SPRAY	SPRAYING SYS.	CP4540-NP
23	05013	1	CONTROL SOLENOID	ASCO	8262C226Q
25	05803	1	VALVE-SOLENOID	ASCO	826G226
39	55470	1	FILTER	FAUVER	RVM44PE80X700P
	92825	1	RECIRCULATING WATER SUPPLY (OPTIONAL) (Includes items below)		
42	N/A		SWITCH-FLOAT LEVEL (See Elect. B.O.M.)		
43	53004	1	RESERVOIR-WATER SUPPLY	U.S. PLASTICS	11091
	52228	1	LID	U.S. PLASTICS	11101
	19117	1	RESERVOIR MOUNTING BRACKET		DWG. 19117
44	N/A		PUMP-SUBMERSIBLE (See Elect. B.O.M.)		

# BILL OF MATERIALS



## LN2 (OPTIONAL) BILL OF MATERIALS

UNIT: ZH-ALL

DATE: 11/06/97

PREPARED BY: EDB

PAGE: 1 OF 1

B.O.M.#: LN2BOOST

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ITEM NO.	I.D. NO.	QTY.	DESCRIPTION	MFG.	MFG. PART NO.
1	04800	2	VALVE-PRESSURE RELIEF	REGO	B9432N150
2	05130	1	VALVE-SOLENOID, SUPPLY	ASCO	8263205LT
3	05124	1	VALVE-SOLENOID, LOW COOLING	ASCO	8263A24OLT

# BILL OF MATERIALS



## C02 BOOST (OPTIONAL) BILL OF MATERIALS

UNIT: ZH-ALL

DATE: 08/04/98

PREPARED BY: EDB

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ITEM NO.	I.D. NO.	QTY.	DESCRIPTION	MFG.	MFG. PART NO.
1	05008	1	<u>SUPPLY PRESSURE 300 PSIG</u> VALVE-SOLENOID, CO2 SUPPLY	ASCO	8264D10
1	05015	1	<u>SUPPLY PRESSURE 900-1000 PSIG</u> VALVE-SOLENOID, CO2 SUPPLY	ASCO	8264D9

# BILL OF MATERIALS



## DRY AIR PURGE (OPTIONAL) BILL OF MATERIALS

UNIT: ZH-ALL

DATE: 12/98

PREPARED BY: EDB

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ITEM NO.	I.D. NO.	QTY.	DESCRIPTION	MFG.	MFG. PART NO.
	02038	1	AIR FILTER/VALVE ASSEMBLY *(Includes Parts Below)	SCOTT IND.	02038
1*	05018	1	AIR SUPPLY SOLENOID VALVE	VERSA	ESM-2301-80-A120
2*	02048	1	AIR FILTER	NORGREN	F72G-2AN-AW3
3*	02047	1	COALESCING FILTER	NORGREN	F72C-2AN-AW0
4	02100	1	REGENERATIVE AIR DRYER	WILKERSON	DE2-AC-HMO
5-6	03122	1	PRESSURE REGULATOR W/GAUGE	NORGREN	R72G-2AK-RMG
7	52907	1	FLOW METER, WITH VALVE, RANGE 20-200SCFH	DWYER	RMB-BV-10
8	05803	1	CONTROL VALVE-SOLENOID (Frozen Coil Units)	AS	8262G226



## ELECTRICAL SCHEMATIC SYMBOLS

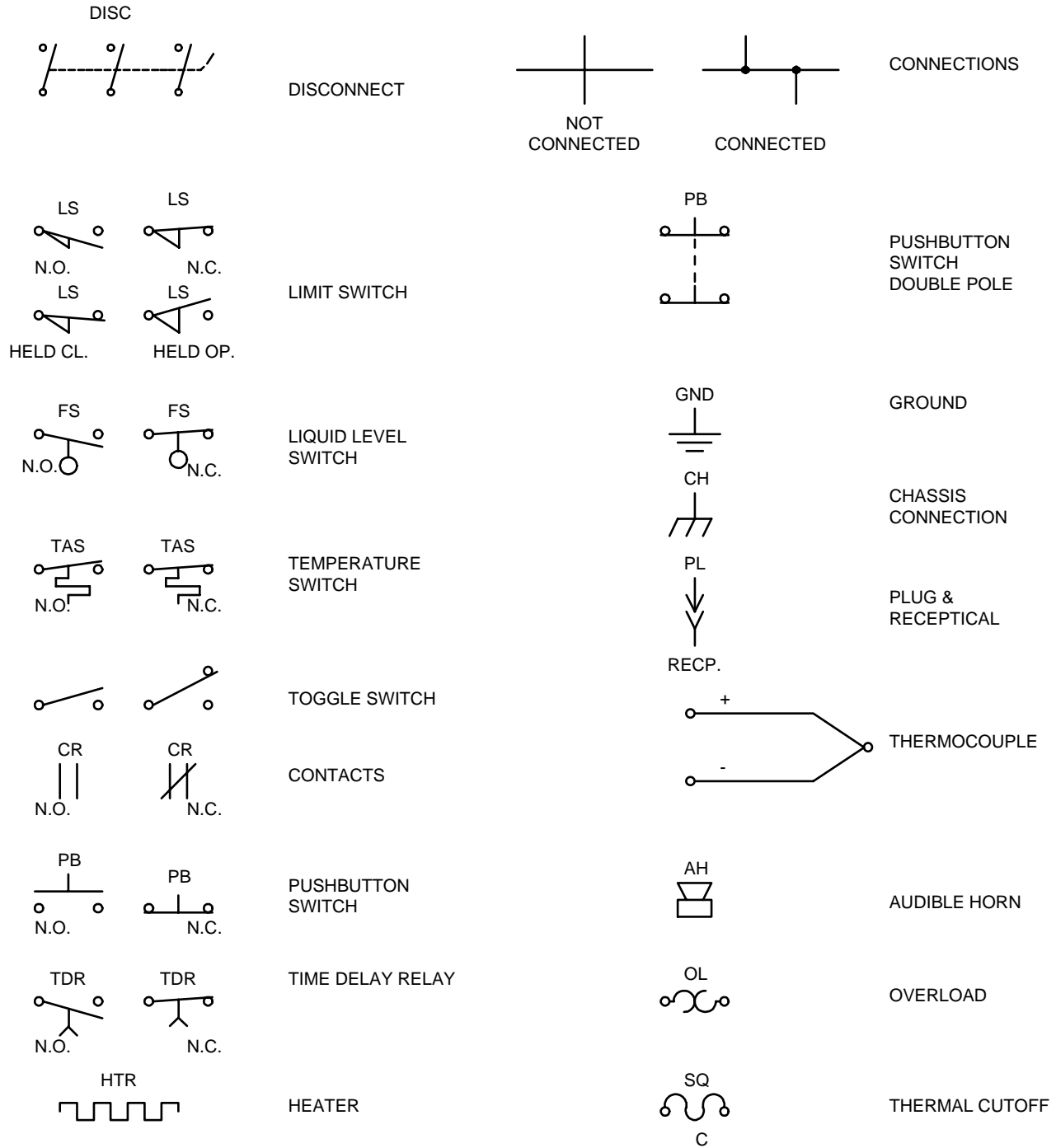


Figure 1. Electrical Symbols Used on Electrical Diagrams

## ELECTRICAL SCHEMATIC SYMBOLS

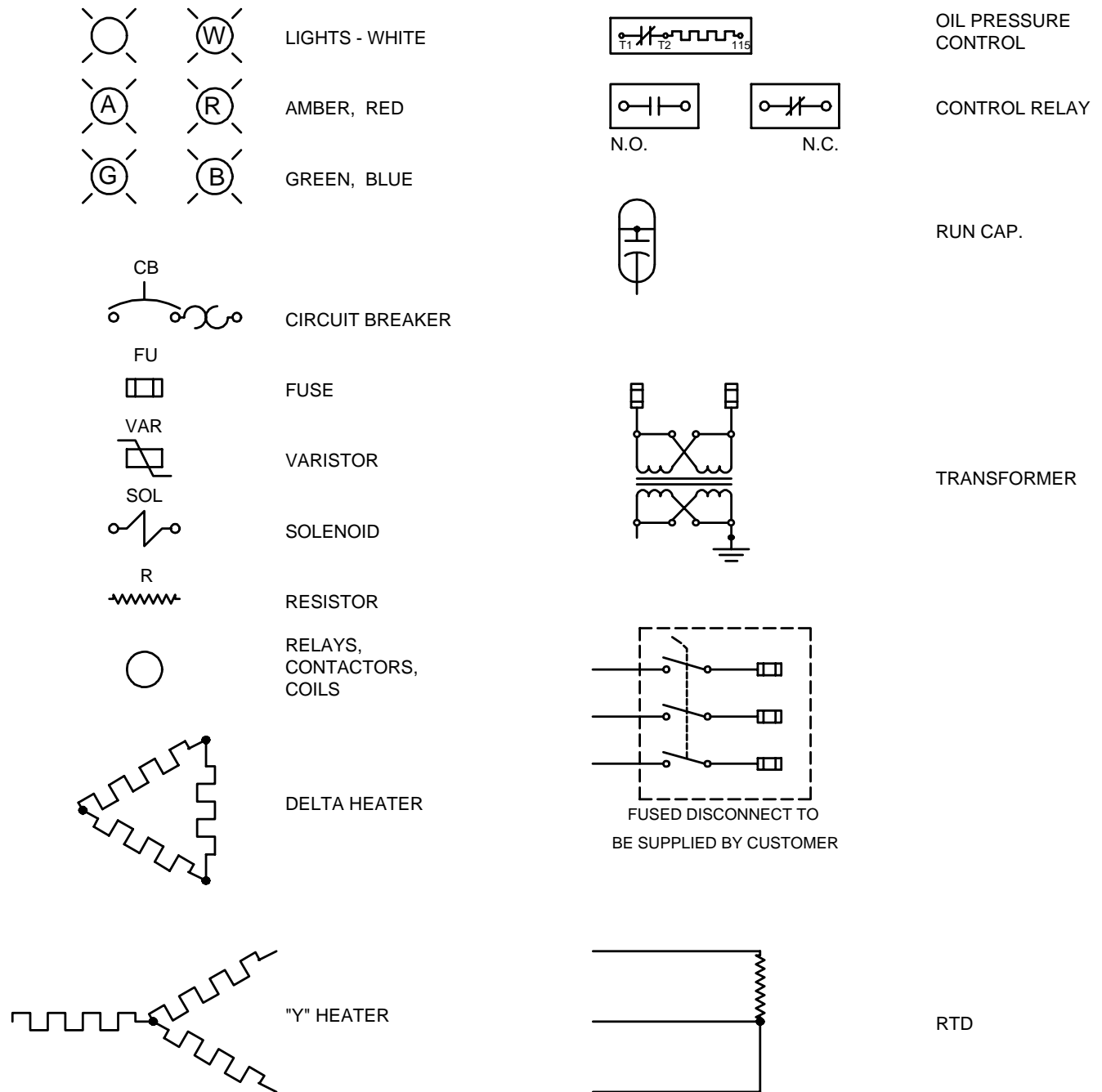


Figure 2. Electrical Symbols Used on Electrical Diagrams (Cont'd)

## REFRIGERATION SCHEMATIC SYMBOLS

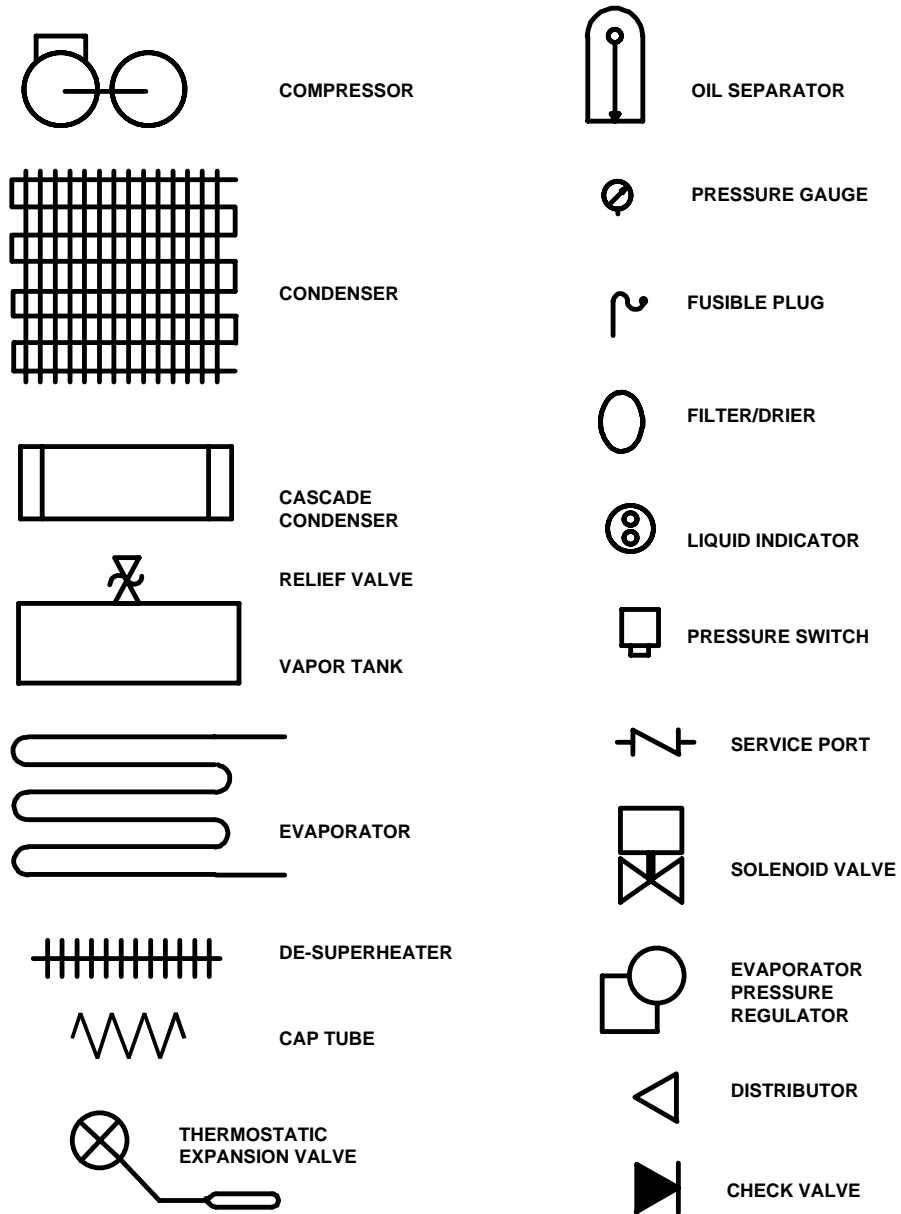
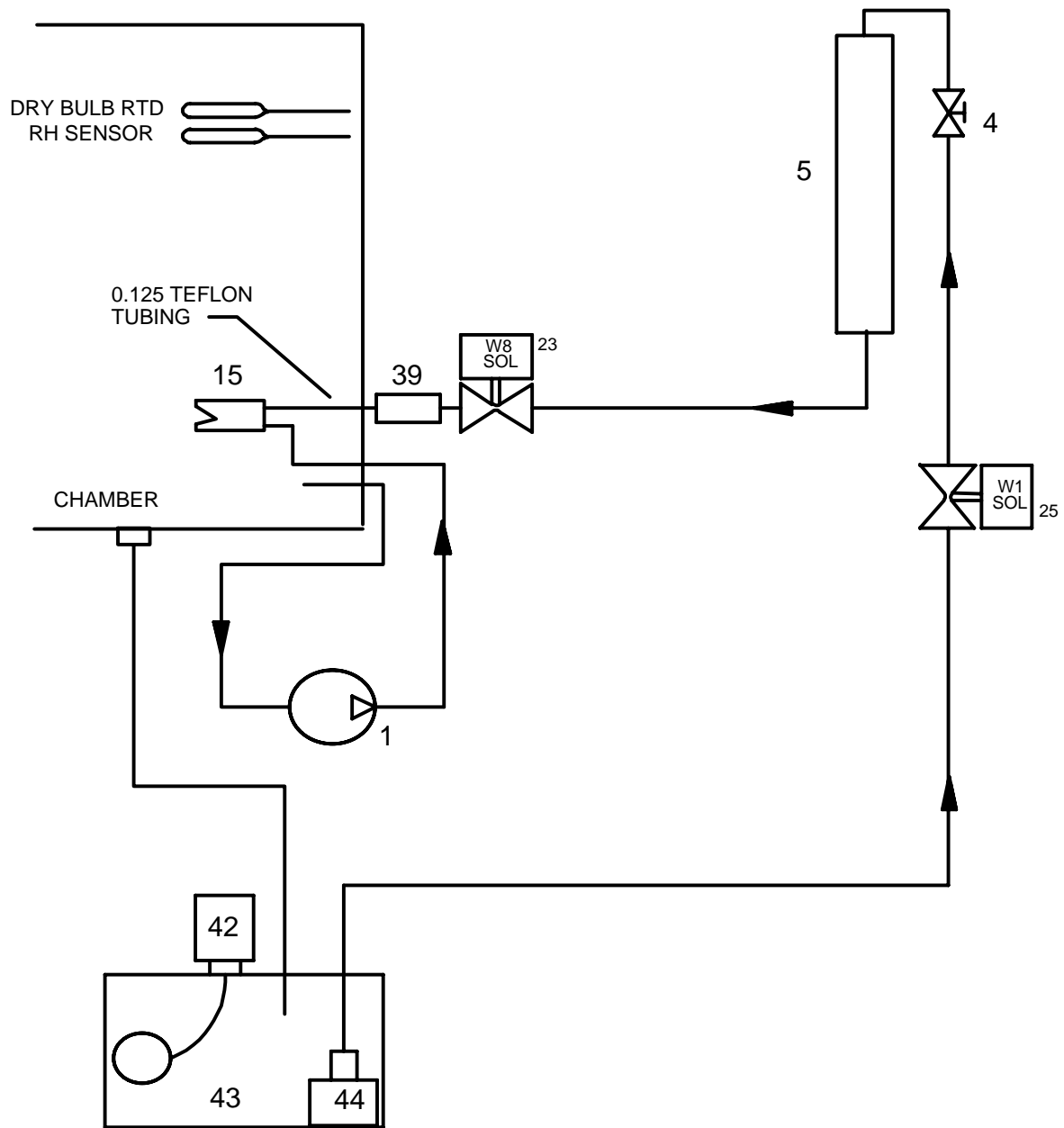
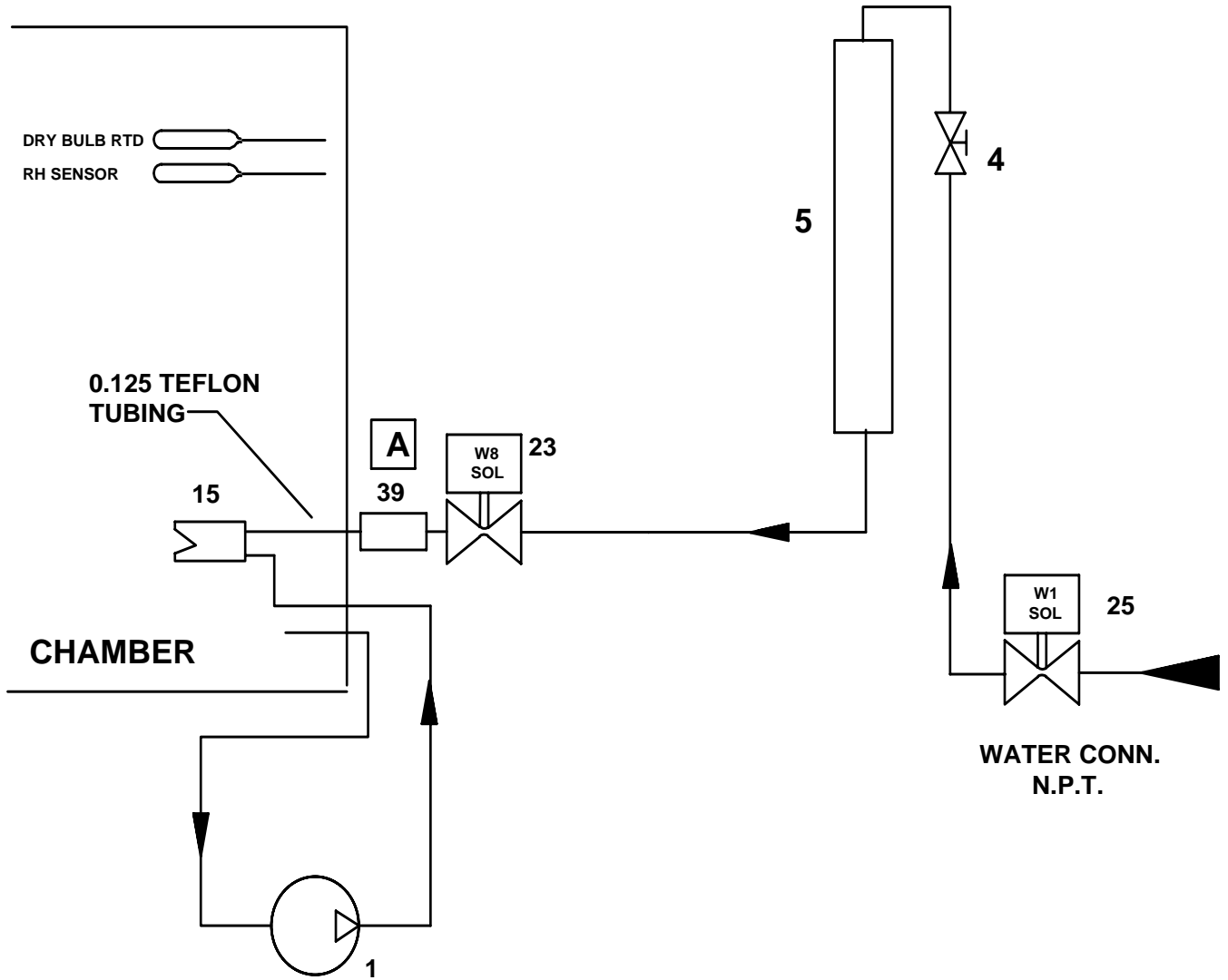


Figure 3. Refrigeration Symbols used on Refrigeration Diagrams

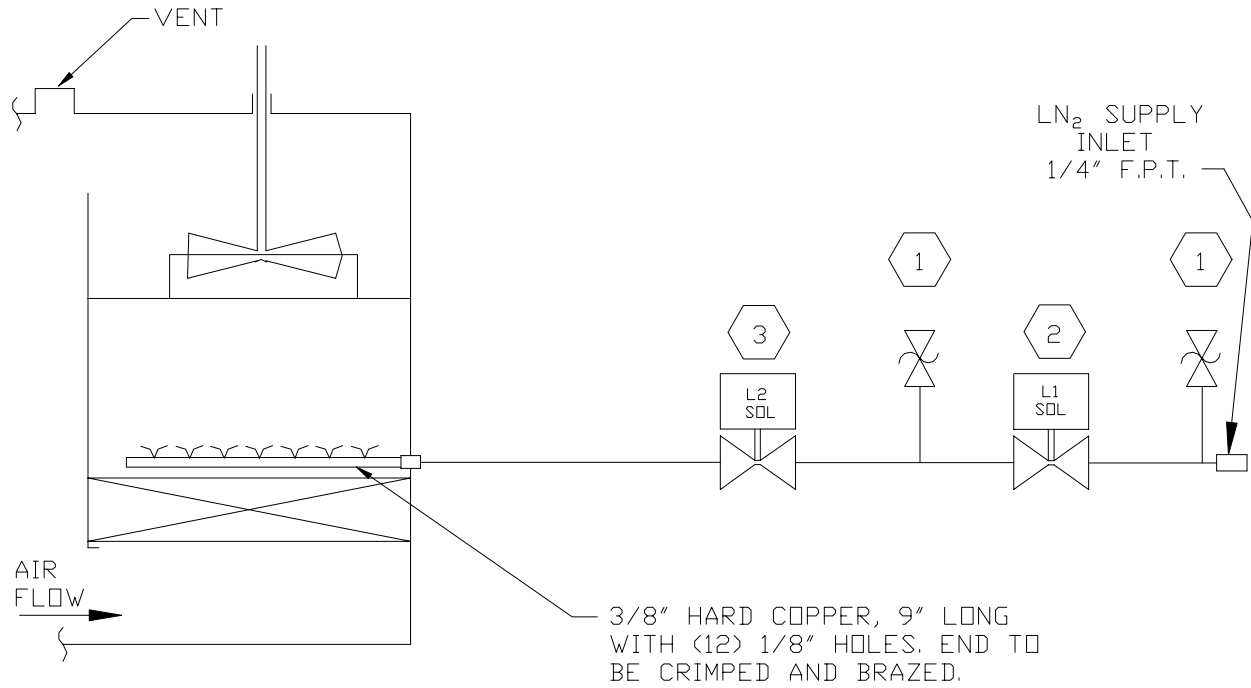
## HUMIDITY FLOW DIAGRAM (WITH RESERVOIR)



## HUMIDITY FLOW DIAGRAM (WITHOUT RESERVOIR)



**LN<sub>2</sub> BOOST (OPTIONAL) FLOW DIAGRAM**

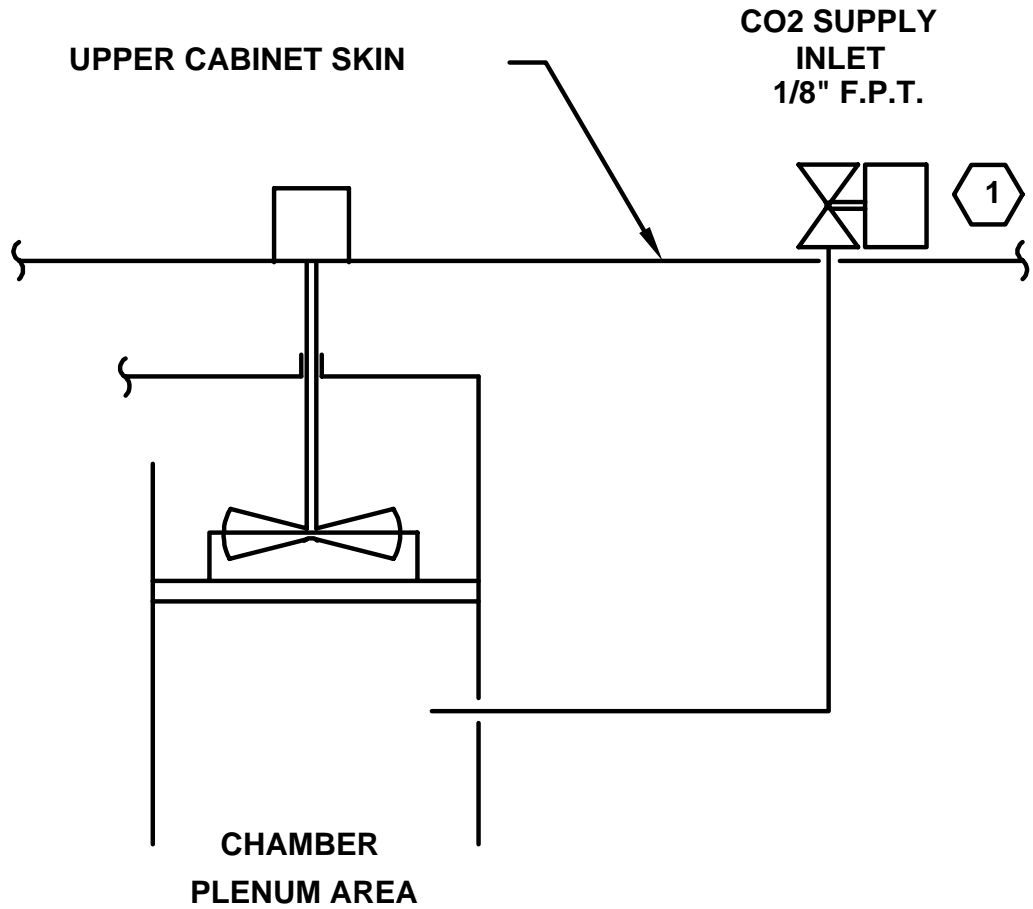


NOTE: FOR THE ASSEMBLY OF THE VALVES AND PIPING REFER TO DWG. 92167.

SUPPLY PRESSURE 25 P.S.I.G.

Figure 3. Humidity Flow Diagram Option (With Reservoir)

**CO2 BOOST (OPTIONAL) FLOW DIAGRAM**

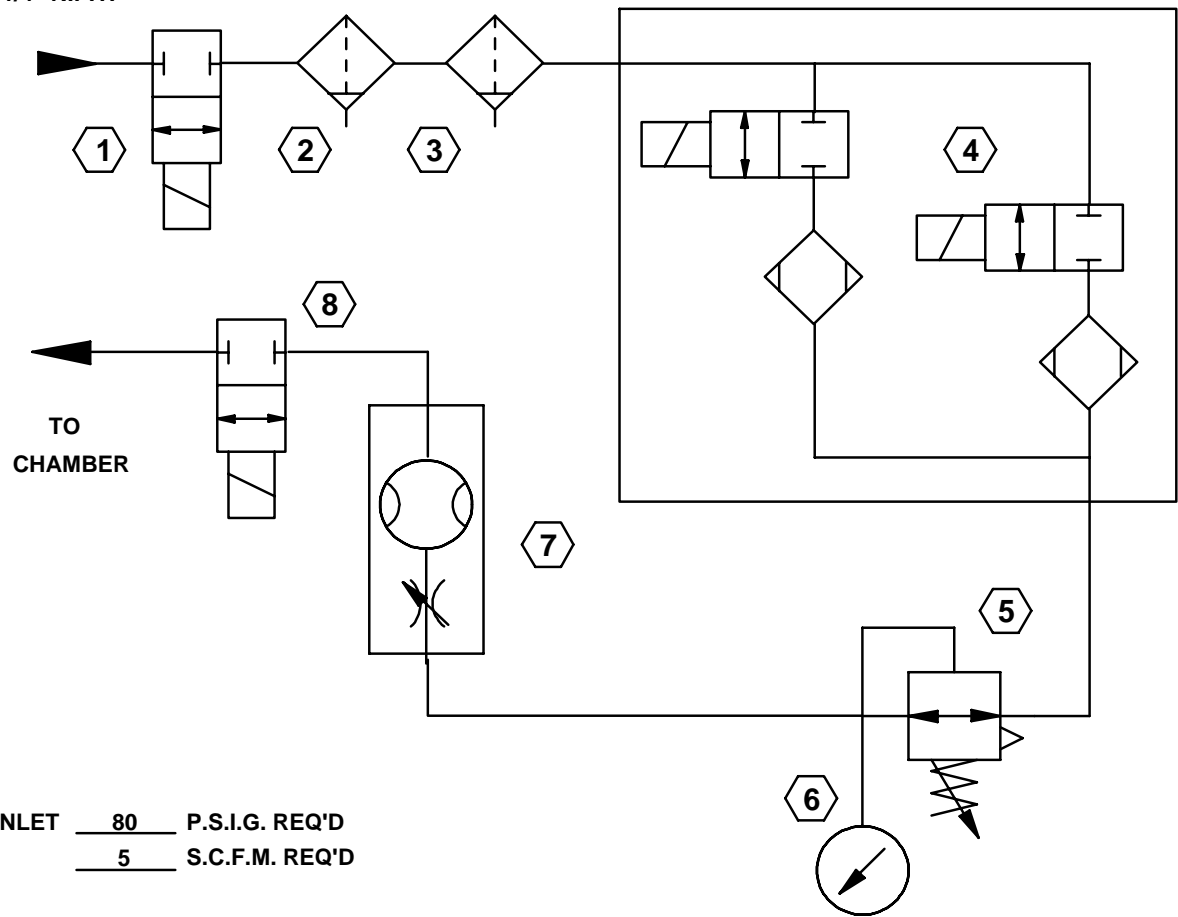


SUPPLY PRESSURE	<u>300</u>	P.S.I.G.	(CENTRAL SYSTEM)
SUPPLY PRESSURE	<u>1000</u>	P.S.I.G.	(SINGLE CO2 TANK)

Figure 2. CO2 Boost Cooling System

## DRY AIR PURGE (OPTIONAL) FLOW DIAGRAM

SUPPLY CONN.  
1/4" N.P.T.



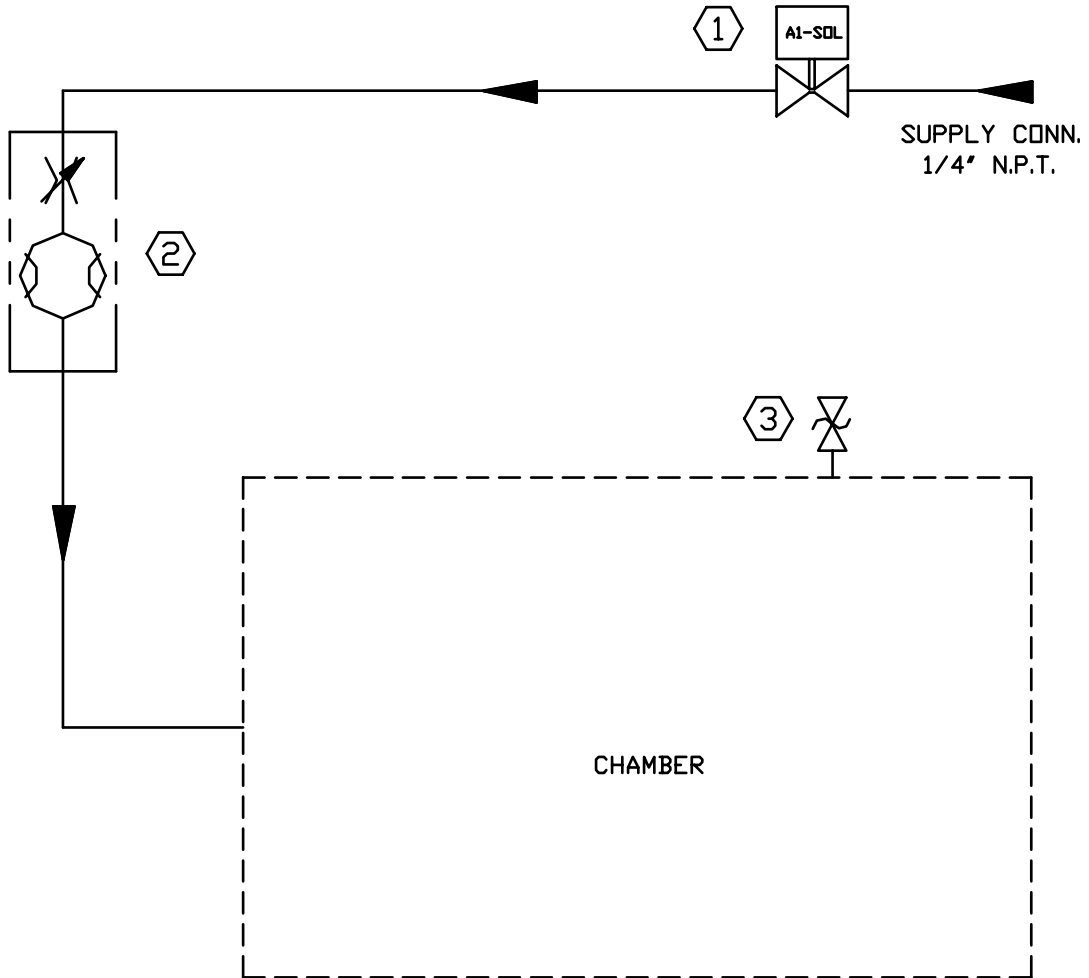
INLET 80 P.S.I.G. REQ'D  
5 S.C.F.M. REQ'D

ITEM SET 5 P.S.I.G. 90

ITEM SET 7 S.C.F.H. 180



## GN2 PURGE (OPTIONAL) FLOW DIAGRAM



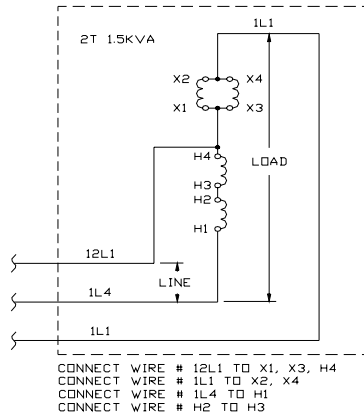
**NOTE:**

CUSTOMER SUPPLY PRESSURE TO BE 70 P.S.I.G. A

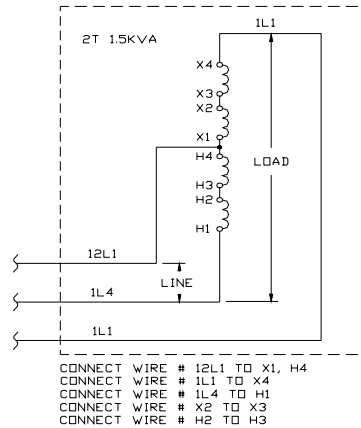
ITEM 2 SET \_\_\_\_\_ S.C.F.H.

## BOOSTING TRANSFORMER TAP CONNECTIONS

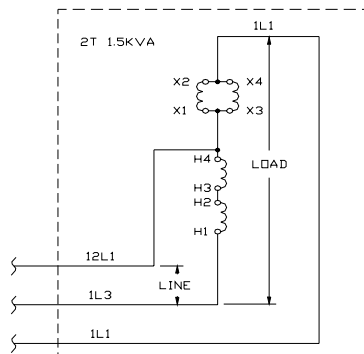
1Ø CONNECTION  
12V BOOSTING



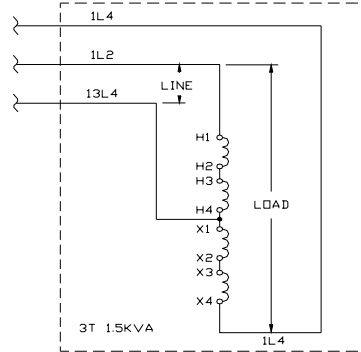
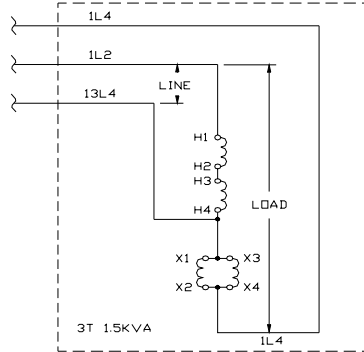
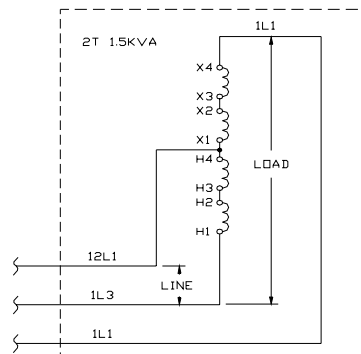
1Ø CONNECTION  
24V BOOSTING



3Ø CONNECTION  
12V BOOSTING



3Ø CONNECTION  
24V BOOSTING



2T  
 CONNECT WIRE # 12L1 TO X1, X3, H4  
 CONNECT WIRE # 1L1 TO X2, X4  
 CONNECT WIRE # 1L3 TO H1  
 CONNECT WIRE # H2 TO H3

2T  
 CONNECT WIRE # 12L1 TO X1, H4  
 CONNECT WIRE # 1L1 TO X4  
 CONNECT WIRE # 1L3 TO H1  
 CONNECT WIRE # X2 TO X3  
 CONNECT WIRE # H2 TO H3

3T  
 CONNECT WIRE # 13L4 TO X1, X3, H4  
 CONNECT WIRE # 1L4 TO X2, X4  
 CONNECT WIRE # 1L2 TO H1  
 CONNECT WIRE # H2 TO H3

3T  
 CONNECT WIRE # 13L4 TO X1, H4  
 CONNECT WIRE # 1L4 TO X4  
 CONNECT WIRE # 1L2 TO H1  
 CONNECT WIRE # X2 TO X3  
 CONNECT WIRE # H2 TO H3

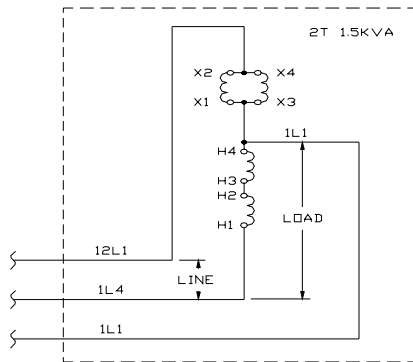
### TYPICAL USES

NOMINAL 200V MAIN INCOMING POWER  
 WITH SAGS BELOW 190V

PRACTICAL USAGE UNLIKELY  
 FOR SEVERELY LOW INCOMING MAIN ONLY

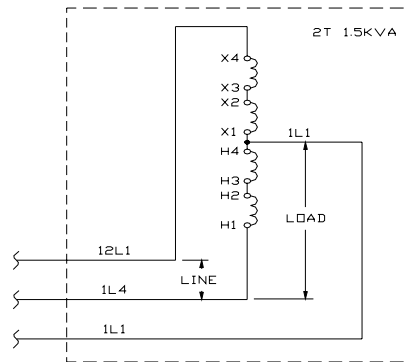
## BUCKING TRANSFORMER TAP CONNECTIONS (FACTORY DEFAULT SETTING - 24V BUCKING)

1Ø CONNECTION  
12V BUCKING



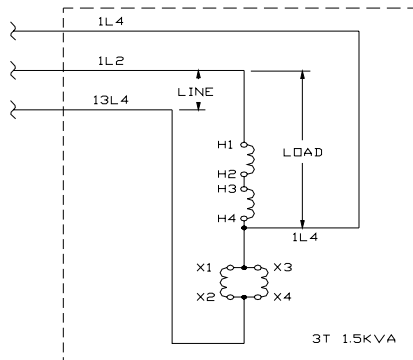
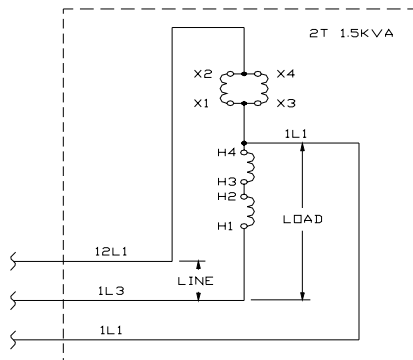
CONNECT WIRE # 12L1 TO X2, X4  
CONNECT WIRE # 1L1 TO X1, X3, H4  
CONNECT WIRE # 1L4 TO H1  
CONNECT WIRE # H2 TO H3

1Ø CONNECTION  
24V BUCKING



CONNECT WIRE # 12L1 TO X4  
CONNECT WIRE # 1L1 TO X1, H4  
CONNECT WIRE # 1L4 TO H1  
CONNECT WIRE # X2 TO X3  
CONNECT WIRE # H2 TO H3

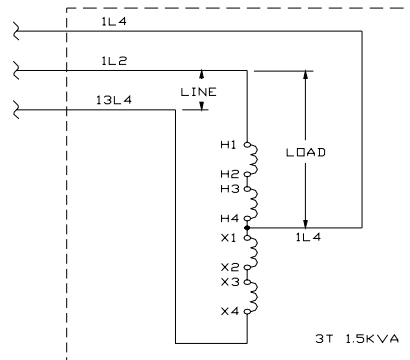
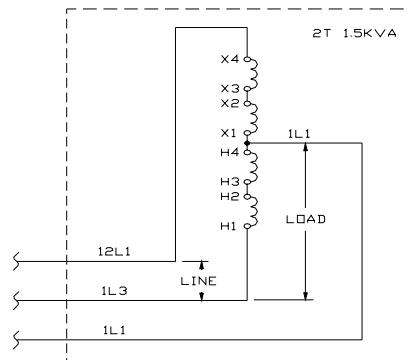
3Ø CONNECTION  
12V BUCKING



2T  
CONNECT WIRE # 12L1 TO X2, X4  
CONNECT WIRE # 1L1 TO X1, X3, H4  
CONNECT WIRE # 1L3 TO H1  
CONNECT WIRE # H2 TO H3

3T  
CONNECT WIRE # 13L4 TO X2, X4  
CONNECT WIRE # 1L4 TO X1, X3, H4  
CONNECT WIRE # 1L2 TO H1  
CONNECT WIRE # H2 TO H3

3Ø CONNECTION  
24V BUCKING



2T  
CONNECT WIRE # 12L1 TO X4  
CONNECT WIRE # 1L1 TO X1, H4  
CONNECT WIRE # 1L3 TO H1  
CONNECT WIRE # X2 TO X3  
CONNECT WIRE # H2 TO H3

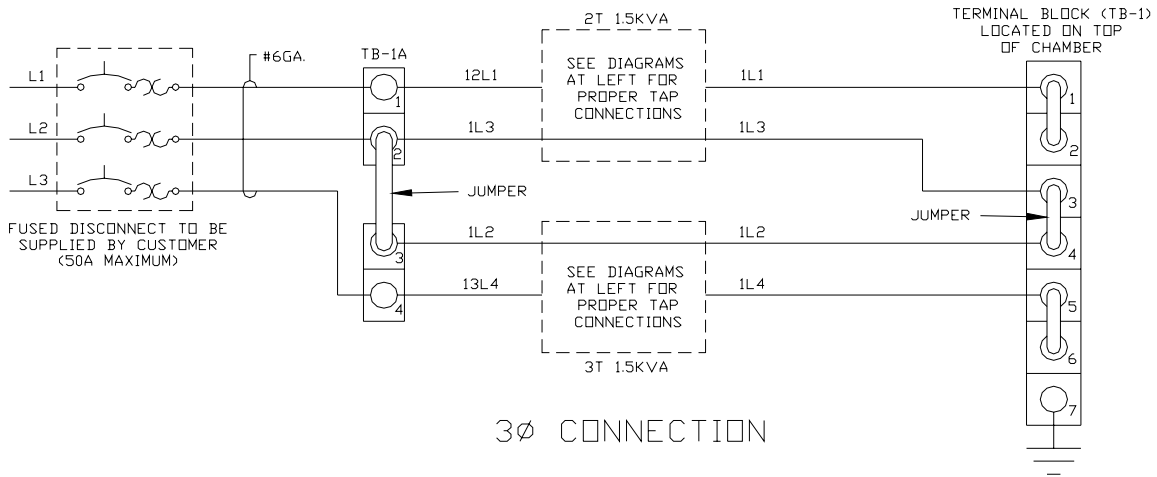
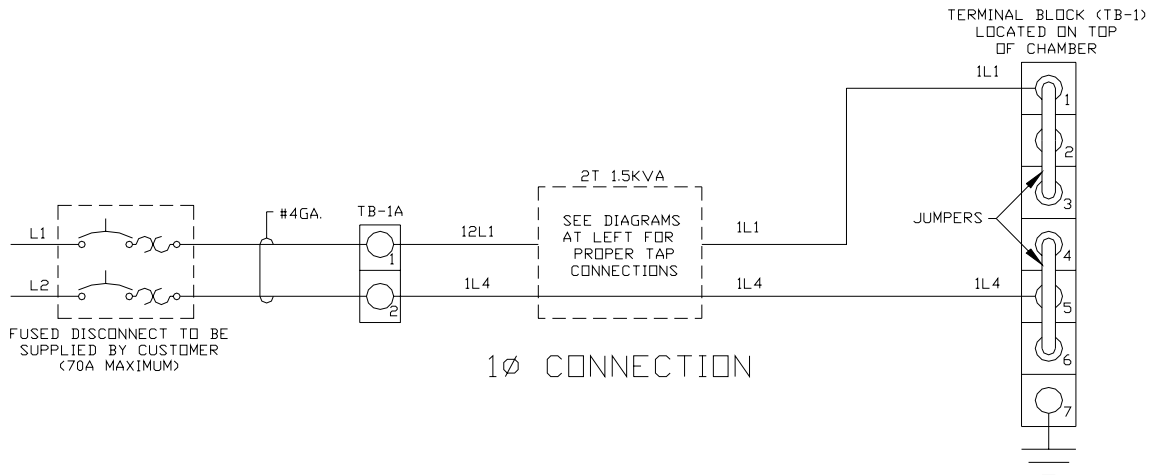
3T  
CONNECT WIRE # 13L4 TO X4  
CONNECT WIRE # 1L4 TO X1, H4  
CONNECT WIRE # 1L2 TO H1  
CONNECT WIRE # X2 TO X3  
CONNECT WIRE # H2 TO H3

### TYPICAL USES

NOMINAL 220V INCOMING MAIN POWER

NOMINAL 230/240V MAIN INCOMING POWER

## MAIN POWER CONNECTIONS



\*ATTENTION: THE COMPRESSORS HAVE AN OPERATIONAL VOLTAGE RANGE OF 190-220V 50Hz AND 197-253V 60HZ. IT IS THE END USER'S RESPONSIBILITY TO INSURE THAT THE VOLTAGE APPLIED TO THE SYSTEM, EITHER BY MAIN INCOMING POWER OR THROUGH THE USE OF THE BUCK-BOOST TRANSFORMERS (WHEN REQUIRED), DOES NOT EXCEED THE MINIMUM OR MAXIMUM VALUES OR DAMAGE TO THE COMPRESSORS WILL RESULT.