Model 115A
Temperature Chamber

Operation and Service Manual

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Chapter 1 – Safety Instructions

Introduction

Follow all CAUTION notices to prevent damage to the chamber or your test sample. Failure to follow all CAUTION notices may void your warranty. CAUTION may also indicate a potentially hazardous situation which, if not avoided, may result in minor or moderate personal injury.

WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

The safety alert symbol ⚠ precedes a general CAUTION or WARNING statement.

The electrical hazard symbol ⚠ precedes an electric shock hazard CAUTION or WARNING statement.

Installation Safety Notices

⚠ **WARNING:** The power cord is equipped with a NEMA 5-20P grounded/polarized plug. To prevent a shock hazard, DO NOT defeat the ground or polarization feature. This device MUST be plugged DIRECTLY into a properly grounded and polarized NEMA 5-20R receptacle. Due to high current demand on start-up, use of an extension cord is NOT recommended.

⚠ **CAUTION:** The minimum clearance you should allow for proper ventilation around the chamber must be at least 6" from both the left and right side, and 12" from the rear.

⚠ **CAUTION:** This chamber is designed for operation in a conditioned laboratory environment. Operation above 30°C (85°F) or below 16°C (60°F) ambient room temperature is NOT recommended.

Operation Safety Notices

⚠ **CAUTION:** The Temperature Controller's "Alarm" functions are NOT used in the chamber's safety system and are NOT connected. TestEquity does NOT recommend using the Temperature Controller's alarm function as the main protection device. The independent EZ-Zone Limit Controller functions as the main protection device.

⚠ **CAUTION:** Always verify that the Limit Controller's high and low limits are set to temperatures that are appropriate for your test sample.

⚠ **WARNING:** Do NOT put items in the chamber that could burn or explode at high temperatures. This chamber uses open wire heating elements which generate surface temperatures over 1000ºF. This is NOT an explosion-proof chamber.

⚠ **WARNING:** Do NOT put items in the chamber that can emit corrosive vapors or substances.

⚠ **WARNING:** This chamber is NOT a curing oven. There are NO provisions for venting fumes.

⚠ **WARNING:** The chamber door must remain closed while the chamber is operating. If you need to open the door while the chamber is operating, 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 contact with air, objects, and surfaces that are hot or cold to prevent severe burns or frostbite. Protective gloves are recommended.

⚠ **CAUTION:** If your test sample is energized, it may be capable of raising the workspace temperature beyond safe limits. This could occur if your test sample exceeds the live load rating of the chamber or if the chamber's refrigeration system fails. You are responsible for providing thermal protection devices to your test sample.

⚠ **CAUTION:** To prevent damage to your test sample and the chamber's compressor, do not exceed the live load rating of the chamber.

Chapter 2 – Installation

Uncrating

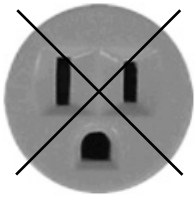
Inspect the shipping container for any signs of visible damage. Notify the carrier and TestEquity immediately if there are signs of shipping damage.

1. Cut the bands that hold the packaging together.
2. Remove the top cover and top foam inserts.
3. Remove the outer box.
4. Remove the front and one side 2x4 retainer from the base of the pallet.
5. Remove the foam inserts from the base of the pallet.
6. Carefully roll (for model 115A-F) and/or lift the chamber off the pallet. This should be done with at least four people.

Preparation For Use

⚠ **WARNING:** The power cord is equipped with a NEMA 5-20P grounded/polarized plug. To prevent a shock hazard, DO NOT defeat the ground or polarization feature. This device MUST be plugged DIRECTLY into a properly grounded and polarized NEMA 5-20R receptacle. Due to high current demand on start-up, use of an extension cord is NOT recommended.

YES
NEMA 5-20R
20 Amp Receptacle



NO!
NEMA 5-15R
15 Amp Receptacle

1. Inspect the chamber for signs of shipping damage.
2. Read this entire manual.
3. Select a suitable location to install the chamber.
4. Connect to a 120 VAC, 60 Hz power source with a minimum 20 Amp breaker.
5. Perform the procedure “How to verify the chamber performance” in the Maintenance chapter of this manual to make sure that no damage has occurred in shipment.

Installation Location

The chamber will produce a moderate amount of heat during normal operation. Locate the chamber in an area with adequate ventilation to prevent excessive heat build-up. The chamber must be on a solid and level surface that is rated to hold at least 350 pounds.

⚠ **CAUTION:** The minimum clearance you should allow for proper ventilation around the chamber must be at least 6" from both the left and right side, and 12" from the rear.

⚠ **CAUTION:** This chamber is designed for operation in a conditioned laboratory environment. Operation above 30°C (85°F) or below 16°C (60°F) ambient room temperature is NOT recommended.

Condensate Drain

The condensate drain connection is located on the rear of the chamber. This provides a way to remove condensate that may accumulate on the evaporator (cooling coil) during temperature cycling or when the refrigeration system runs to maintain moderate temperatures.

Any time the ambient air is subjected to temperatures below the dew point, 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 or the cooling system turns off, the ice or frost will turn into water.

The drain fitting accommodates a 1/4-inch male pipe thread. The chamber drain water is not under pressure and is fed by gravity. Therefore, it must empty into a container or open floor drain. Alternatively, the chamber drain can empty into a condensate pump. You can purchase a condensate pump from suppliers such as Grainger (www.grainger.com).

Under most circumstances, you will not see any water coming out of the drain.

Reversible Chamber Door

The chamber door can be mounted to open from the left or right side. The chamber cabinet has mounting holes on both sides for the hinges and door latch. If you reverse the door, see “How to inspect the door seal” in the Maintenance chapter of this manual to make sure the hinges and door latch are adjusted correctly.

Chapter 3 – Operation

Introduction

The Front Panel Switches control power to the temperature controller and all chamber functions.

The Limit Controller is a protection device. It turns the chamber OFF and sounds an alarm if the workspace temperature exceeds either a high temperature or low temperature limit set point.

The Temperature Controller controls the temperature of the chamber. The Temperature Controller automatically turns the refrigeration system on or off as required based on the deviation from temperature set point.

Refer to the separate F4 or F4T Temperature Controller manual for details on how to use the Temperature Controller.

Summary of Chamber Operation

1. Turn the POWER Switch ON.
2. Enter the desired temperature safety limits on the Limit Controller.
3. Enter the desired temperature set point on the Temperature Controller.
4. Load your test sample in the chamber.
5. Turn the CONDITIONING Switch ON. Alternatively, turn the CONDITIONING Switch to the EVENT 1 position and turn EVENT 1 on the F4 controller or the Power button on the F4T controller ON.

Front Panel Switches and Lights

POWER Switch
The POWER Switch controls power to the entire chamber. The POWER Switch illuminates when it is ON.

CONDITIONING Switch – ON Mode
The CONDITIONING Switch enables all chamber functions. When the CONDITIONING Switch is OFF and the POWER Switch is ON, only the Temperature Controller and Limit Controller is operational. When both the CONDITIONING and POWER Switches are ON, the chamber's temperature conditioning system will function to maintain the temperature set point. The CONDITIONING Switch does NOT illuminate in any position.

CONDITIONING Switch – EVENT 1 Mode
When the CONDITIONING Switch is in the EVENT 1 position, you can enable and disable all chamber functions through Event 1 (Digital Output 1) of the F4 Temperature Controller or the Power button on the F4T Temperature Controller.

LIGHT Switch
The LIGHT Switch controls the workspace light. The LIGHT Switch illuminates when it is ON.

HEAT Light
The HEAT Light will illuminate when the Temperature Controller turns on the heater to maintain the workspace temperature. The HEAT Light will cycle on/off as the workspace temperature approaches and reaches the temperature set point.

COOL Light
The COOL Light will illuminate when the Temperature Controller turns on the cooling valve to maintain the workspace temperature. The COOL Light will cycle on/off as the workspace temperature approaches and reaches the temperature set point.

Loading the Chamber

⚠ **WARNING:** Do NOT put items in the chamber that could burn or explode at high temperatures. This chamber uses open wire heating elements that generate surface temperatures over 1000ºF. This is NOT an explosion-proof chamber.

⚠ **WARNING:** Do NOT put items in the chamber that can emit corrosive vapors or substances.

⚠ **WARNING:** This chamber is NOT a curing oven. There are NO provisions for venting fumes.

⚠ **WARNING:** The chamber door must remain closed while the chamber is operating. If you need to open the door while the chamber is operating, 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 contact with air, objects, and surfaces that are hot or cold to prevent severe burns or frostbite. Protective gloves are recommended.

⚠ **CAUTION:** If your test sample is energized, it may be capable of raising the workspace temperature beyond safe limits. This could occur if your test sample exceeds the live load rating of the chamber or if the chamber's refrigeration system fails.

⚠ **CAUTION:** To prevent damage to your test sample and the chamber's compressor, do not exceed the live load rating of the chamber.

Live Load Capacity for Model 115

Temp	**+23°C**	**0°C**	**–40°C**	**–55°C**	**–65°C**
Watts	300 W	255 W	160 W	110 W	80 W

Port Plugs

Foam port plugs are provided with a gray silicone surface on one side. The port plug must be inserted with the gray silicone surface facing the inside of the chamber. Port plugs should be considered expendable and be replaced when they no longer provide a good seal.

Performance Considerations

The performance of all chambers is significantly affected 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. The air plenum is located on the back wall of the chamber, where air is sucked in from the bottom and exits from the top. 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. Verify that the temperature gradients are within acceptable limits, by measuring the chamber temperature at strategic points using a multipoint thermocouple meter or data logger.

You may find that the temperature throughout the chamber is even, but always different from what the temperature controller indicates. The correct way to adjust what the temperature controller "displays" compared to what is measured at some point other than the controller's sensor is with the "Calibration Offset" parameter, NOT by recalibrating the controller.

Avoiding Moisture

Any time the ambient air is subjected to temperatures below the dew point, moisture will condense out of the air. The effect is ice or frost during low temperature operation, or water when maintaining over 0°C and cooling is required.

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.

Internal Test Fixtures

Some applications require internal fixtures to support test samples and provide a convenient method of connecting wires and sensors. Fixtures must be designed to minimize their impact on chamber functionality and performance.

Fixtures should be designed for easy removal to permit maintenance and cleaning of the chamber. The chamber liner should never be drilled or screwed into. This will compromise the integrity of the liner and permit moisture migration due to condensation into the insulation, which will eventually impact performance and lead to premature rusting of the outer cabinet.

Fixtures should be constructed of stainless steel. This also applies to all screws and fasteners. All welds should be passivated. To prevent rust and corrosion, never use iron or mild steel even if it is painted or plated. Aluminum may be used. However, since the specific heat of aluminum is double that of steel, it represents a greater load and will have more impact on the chamber performance.

Make sure that all connectors, wiring, pc boards, and auxiliary components can withstand the temperature extremes that they will be subjected to. In some cases, these components may not be able to last after repeated tests and should be considered expendable.

Chapter 4 - Limit Controller

Introduction

The EZ-Zone Limit Controller is a protection device. It turns the chamber OFF if the workspace temperature exceeds either a high temperature or low temperature limit. You can set these limits to correspond to the maximum and minimum temperature that your test sample can safely withstand. This provides protection against someone setting the Temperature Controller to a temperature that is unsafe for the test sample. It also provides protection in the unlikely event of a chamber system component failure. The Limit Controller has its own temperature sensor (thermocouple) and functions completely independent of the Temperature Controller.

This section provides a brief overview on how to operate the Limit Controller. For more detailed instructions, see the "EZ-Zone User's Manual".

⚠ **CAUTION:** The "EZ-Zone User's Manual" is a general manual and is written by the manufacturer, Watlow, for a wide variety of applications and configurations. Not all features or functions are applicable. Only the capabilities of a model PM6L1AJ-AAAABAA are applicable.

⚠ **CAUTION:** The EZ-Zone Limit Controller has been properly configured by TestEquity to match the chamber's system requirements. Improper modifications to these setup values can result in unreliable and unsafe operation. Do not attempt to modify the setup values, unless you thoroughly understand what you are doing. The correct values are documented in the "EZ-Zone Limit Controller Setup Parameters" section of this manual.

⚠ **CAUTION:** Always verify that the Limit Controller's high and low limits are set to temperatures that are appropriate for your test sample.

⚠ **CAUTION:** If your test sample is energized, it may be capable of raising the workspace temperature beyond safe limits. This could occur if your test sample exceeds the live load rating of the chamber or if the chamber's refrigeration system fails. This chamber has a set of contacts that can be used to remove power to your test sample if the Limit Controller's temperature limits are exceeded.

Limit Controller Keys and Displays

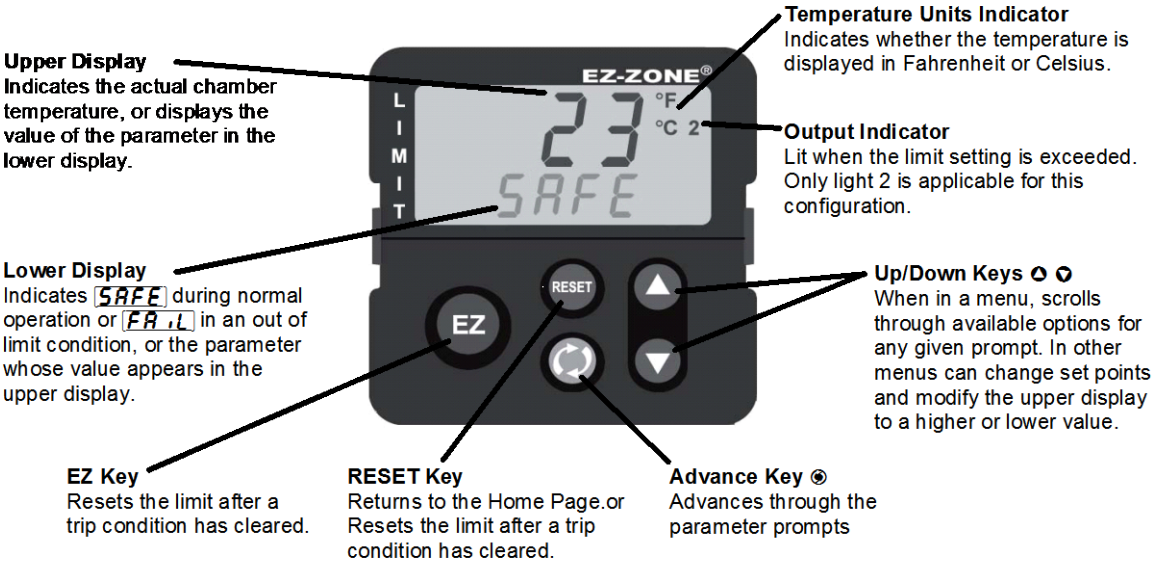


Figure 4-1 – Limit Controller Keys and Displays

How to Set the High and Low Temperature Safety Limits

1. Press the ◉ key once to get the LLS prompt in the lower display. This is the Low Limit Set Point prompt.
2. Press the ▲or ▼ key to enter the desired Low Limit Set Point in the upper display. Make sure it is lower than your actual chamber temperature set point, and at least below room temperature to prevent nuisance tripping.
3. Press the ◉ key once again to get the LHS prompt in the lower display. This is the High Limit Set Point prompt.
4. Press the ▲or ▼ key to enter the desired High Limit Set Point in the upper display. Make sure it is higher than your actual chamber temperature set point to prevent nuisance tripping.
5. Press the RESET Key to return to the Home Page.
6. The upper display will show the actual chamber temperature while the lower display will show SAFE as long as the limits are not exceeded.

Resetting an Out of Limit Condition

If the limit is exceeded, the Limit Controller will flash L iH 1 (high limit) or L iL 1 (low limit) in the upper display and AtEn in the lower display, alternating with the actual chamber temperature in the upper display and FA iL in the lower display. It will also shut down all chamber functions. The Limit Controller cannot be reset until the temperature returns to within the limit set points. Then, you must press the RESET or EZ Key to resume normal operation.

Silencing the Audible Alarm

Turning off the TEMP switch on the chamber front panel lets you temporarily turn off the Audible Alarm, even though the High or Low Limit condition may still exist.

Chapter 5 – Purge

Introduction

Optional GN_2 (gaseous nitrogen) Purge or optional Dry Air Purge can be used to reduce to possibility of condensation in the chamber at low temperatures.

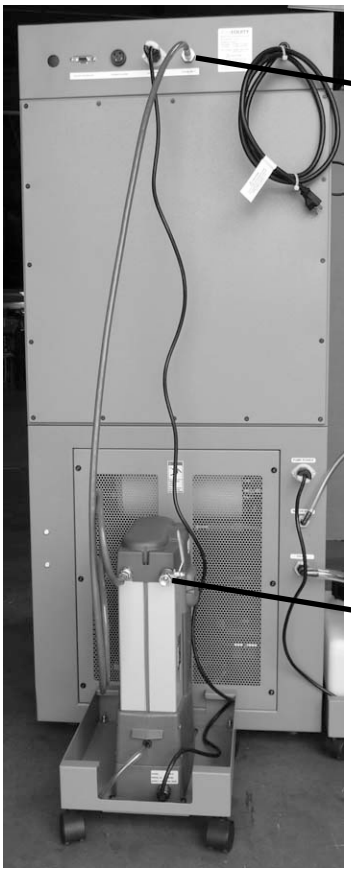
⚠ **CAUTION:** Nitrogen cannot be detected by human senses. Nitrogen is non-toxic. However, if adequate ventilation is not provided, nitrogen will displace air. This can cause dizziness, unconsciousness or death without warning. The chamber must be located in a well-ventilated area. Do not open the chamber door with the GN_2 flowing.

GN2 (Gaseous Nitrogen) Installation (Option TE-1009)

Connect a supply of GN_2 with a maximum pressure of 100 psig to the 1/4-inch FPT fitting which is designated PURGE on the rear panel.

Dry Air Installation (Option TE-0017)

Connect the hose from the Dry Air system to the fitting which is designated PURGE on the rear panel. Connect a supply of compressed air to the 3/8-inch FPT shutoff valve of Dry Air system. This system requires a 5 cfm supply air flow rate at 100 psig (175 psig max).



Purge Inlet from Dry Air System
Connect to PURGE fitting on chamber.

Compressed Air Inlet to Dry Air System.
Shutoff valve on the Dry Air System is shown in the off position. Valve must be in the on position to operate.

Figure 5-1 – Dry Air Purge System Installation (typical)

Purge Operation

The Purge mode is enabled through Event 2 (Digital Output 2) in the F4 Controller or the Purge button on the F4T controller.

Adjusting the Purge Flow

A flowmeter is located on the front panel to adjust the flow of purge gas into the chamber. The flowmeter has a scale, calibrated in SCFM. The flow of purge gas should be adjusted to the minimum amount required to obtain the desired drying in the chamber for your particular conditions. A suggested starting setting is 2 SCFM.

Relief Vent

Excess pressure in the chamber workspace is vented through a pressure-relief check-valve, which is located within the electrical compartment. There is no need to vent this externally.

Chapter 6 – Frequently Asked Questions

I need to send the chamber outside North America. Will it work with their power?
Outside North America, most countries have 50 Hz. Nominal voltages in are typically 220 V to 240 V. You CANNOT simply step the voltage down to 120 V because the compressors have a 50 Hz rating of 100 V nominal (95 V min. to 110 V max.).

We do make a special export version for this purpose, model 115A-EX. It has 230 V, 50 Hz compressors and an internal step-down transformer for the heater and control circuitry.

Why does my chamber heat or cool slower than the published specifications?
Performance is significantly affected 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. You can determine if the chamber is operating properly by following the procedure in "How to verify the chamber performance".

How can I modify the chamber to cool faster?
Unfortunately, there is little you can do to improve upon the designed-in performance. TestEquity does NOT recommend using CO_2 or LN_2 in this chamber to achieve faster cooling due to reliability and safety considerations, so it is NOT an available option. Modifying the chamber to add CO_2 or LN_2 will void the warranty.

Why is there water/ice/snow in the chamber?
Any time the ambient air is subjected to temperatures below the dew point, 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.

My test specification requires convection heat only. Can I turn the circulator motor off?
NO! This will damage the heating and refrigeration systems and void the warranty. You need a "gravity convection oven" for that kind of test.

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 Temperature Controller uses a thermocouple control sensor, which 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 ±0.5°C, or a total of 1°C. For example, the temperature set point may be –25.0°C. The actual temperature varies between –25.4°C and –24.5°C. This corresponds to –0.4°C and +0.5°C or a total of 0.9°C of RELATIVE variations. These specifications are for an empty chamber. The addition of a test sample may affect 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 for this chamber is ±1.0°C or a total of 2°C, when measured at least 3" away from the chamber interior walls. These specifications are for an empty chamber. The addition of a test sample may affect the temperature uniformity. For example, an energized test sample will produce a higher temperature near the sample.

Controller Accuracy – This is the ability of the temperature controller to accurately display a temperature measurement when compared to a standard. The controller display accuracy is ±1.66°C. However, the total measurement accuracy in the chamber includes the thermocouple sensor wire accuracy. Thermocouple wire accuracy is ±1°C or 0.75% of reading, whichever is greater. Therefore, total system accuracy over the chamber's operating range can be as much as ±2.66°C, although the typical accuracy is often better than ±1.0°C.

Can I tilt the chamber to move it?
You should be able to tilt the chamber 45 degrees to move it. After tilting it and moving it into place, perform the steps as outlined in "How to inspect the refrigeration machinery compartment" and "How to check the refrigerant charge" before placing the chamber back into service to make sure that no damage has occurred.

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 TestEquity 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, TestEquity does not recommend this. Just follow the maintenance procedures and clean the condenser fins periodically.

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. TestEquity 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.

Chapter 7 – Specifications

Model 115A Chamber Specifications

Temperature Range	–73°C to +175°C
Control Tolerance	±0.2°C (Measured at the control sensor after stabilization)
Uniformity	±1.0°C (Variations throughout the chamber after stabilization)

Live Load Capacity @	**+23°C**	**0°C**	**–40°C**	**–55°C**	**–65°C**
	300 W	255 W	160 W	110 W	80 W

Cool Down Transition Time*

	End Temp					
Start Temp to →	**+23°C**	**0°C**	**–40°C**	**–55°C**	**–65°C**	**–73°C**
+23°C	----	5 min	20 min	30 min	40 min	ultimate
+85°C	16 min	25 min	45 min	57 min	69 min	ultimate

Heat Up Transition Time* 5°C per minute typical

***Note:** Transition times are measured after a 1 hour soak at the respective start temperature with an empty chamber, as indicated on the temperature controller, 23°C ambient. Measured with set point beyond the start and end temperatures. Does not include the effect of proportional band when approaching set point. Measured at nominal line voltage of 120V, 60 Hz.

Refrigeration and Heating System

High Stage Refrigerant	R-404A (Dupont HP-62)
Low Stage Refrigerant	R-508B (Dupont SUVA-95)
Compressors	1/2 HP x 1/3 HP hermetic compressors in a cascade configuration.
Condenser	Air Cooled
Heater Power	600 Watts
Input Power	120 V nominal (110 to 126 VAC), 60 Hz, 1 PH Max Current Draw 15 A, Recommended Minimum Service 20 A
Workspace Dimensions	16" W x 12" H x 14" D (1.55 cubic feet)
Outside Dimensions	Bench Version 24" W x 44" H x 26" D (nominal) Floor Version 24" W x 61" H x 26" D (nominal)
Min. Installed Clearance	6" from the left and right side, 12" from the rear
Access Ports	3" Port on left and right side (two total), Supplied with foam plugs
Weight	115A-B: Bench Version, 260 pounds. 115A-F: Floor Version, 300 pounds.
Sound Level	52 dBA in cooling mode (A-weighted, measured 36" from the front surface, 63" from the floor, in a free-standing environment)

NOTE: Performance is typical and based on operation at 23°C (73°F) ambient and nominal input voltage. This product is designed for use in a normal conditioned laboratory. Operation at higher ambient temperatures will result in decreased cooling performance. Additional ports and shelves will also affect performance. Operation above 30°C (85°F) or below 16°C (60°F) ambient is not recommended.

Chapter 8 – Maintenance

⚠ **WARNING:** Maintenance must be performed by properly trained personnel only.

Preventive Maintenance Intervals

Daily or As Needed
- Clean chamber interior and exterior.
- Listen for abnormal noise or vibration.

Every 6 Months
- Inspect the door seal.
- Clean the condenser.
- Inspect the electrical and refrigeration machinery compartments.
- Verify the chamber performance.

Every 12 Months
- Verify the calibration.

Maintenance Procedures

How to clean the chamber interior and exterior

- Wipe or vacuum out all debris.
- Clean 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.
- If you clean the interior with something other than water, you may want to operate the chamber at high temperature (approximately +125°C) after cleaning. This helps to "bake out" any residue. Remove the port plugs to permit the residual vapors to escape.
- Clean the silicone door gaskets with a damp cloth or mild detergent.
- Clean the exterior painted surfaces with a damp cloth or mild detergent. If you are using a detergent, test a small inconspicuous area to make sure it does not damage the finish.

How to listen for abnormal noise or vibration

You should become familiar with normal operating noises. Being able to recognize changes from normal operating noises can be a valuable way to identify problems and prevent further damage. Examples of noises to be aware of include:

- Circulator motor and fan noises (with compressors off).
- Compressor start-up and running noises, sequential starting of compressors.
- Condenser fan noises.
- Valve cycling noises.

How to inspect the door seal

The chamber has two silicone gaskets to minimize thermal losses and moisture migration.

- Inspect the gaskets for dirt and tears.
- Repair minor tears with a high quality RTV silicone such as GE RTV167.
- Check the integrity of the door seal by closing the door on a sheet of paper. With the door closed, slowly pull the paper. You should feel the resistance. Repeat this all around the door at several places.
- If the seal is not tight on the latch side, adjust the latch bracket. The latch bracket is mounted to the chamber, and has slotted holes to permit adjustment.
- If the seal is not tight on the hinge side, adjust the door hinge. The hinges have a slotted hole on the door side to permit adjustment.

How to clean the condenser

1. Unplug the chamber from the power source.
2. Remove the condenser cover (lower panel) from the front of the chamber.
3. Clean the condenser fins with a vacuum cleaner.

NOTE: You may need to clean the condenser more frequently if the chamber is in a dusty environment. You may be able to clean the condenser less frequently if the chamber is in a very clean environment.

How to inspect the electrical & refrigeration machinery compartments

⚠ **WARNING:** Wear safety goggles when inspecting the refrigeration machinery compartment to protect against a refrigerant line which could break.

1. Unplug the chamber from the power source.
2. Remove the top, side and rear panels.
3. Inspect for signs of refrigeration tubing abrasion.
4. Inspect for oil around refrigeration valves, fittings and joints. This may be a sign of leaks.
5. Inspect for loose hardware and tighten as required.
6. Inspect for loose wires and burned insulation near terminals.
7. Inspect for signs of insect or rodent infestation. Yes, it does happen!

How to verify the calibration.

⚠ **CAUTION:** TestEquity does not recommend performing the controller calibration procedures unless you have verified that the controller is actually out of calibration.

TestEquity recommends verifying the calibration before attempting to actually perform a calibration. The state-of-the-art instrumentation used in TestEquity chambers is of the highest quality and seldom goes out of calibration. If you try to calibrate the instrumentation before determining that calibration is necessary, you may make it worse if done incorrectly.

Variations in temperature throughout the chamber interior are NOT a measurement of controller accuracy. These variations, called “gradients”, are a function of the physical design of the chamber and its airflow, the characteristics of the test sample, and how it is oriented in the chamber. You cannot “calibrate” to improve gradients. The common practice of measuring multiple points in the chamber and adjusting the temperature controller’s calibration to correct for these errors is incorrect! The correct way to adjust what the temperature controller “displays” compared to what is measured at some point other than the controller’s sensor, is with the “Calibration Offset” parameter. The F4 or F4T Temperature Controller User’s Manual for details. Calibration verification should be performed with the Calibration Offset set to 0.0 (zero).

Total system accuracy in the chamber includes the controller plus the thermocouple wire accuracy. Total system accuracy over the chamber’s operating range is typically ±1.55°C, ±1 LSD or a theoretical total of ±2.55°C. The easiest way to verify the instrumentation accuracy is with an independent calibrated temperature sensor and display. Place the sensor inside the chamber, near the chamber’s conditioner fan grille. If the readings agree within the specified limits, then no calibration adjustments are necessary.

For the F4 Controller: If calibration of the temperature controller is necessary, refer to the “F4 Temperature Controller User’s Manual”.

For the F4T Controller: If calibration of the temperature controller is necessary, refer to the “F4T Touch Screen Controller User’s Guide”.

How to verify the chamber performance.

These tests verify the performance of the heating, refrigeration, electrical controls, temperature controller, and air circulation systems. The chamber should meet all published performance specifications if all of these tests are successfully passed. If the chamber fails any of these tests, it should be removed from service to prevent further damage until the cause of the problem is determined and resolved.

These tests assume that the Temperature Controller's setup and tuning values have not been changed from the values as shipped from TestEquity. Also, the Limit Controller high limit must be set to over +85°C (+88°C would be fine), and the low limit set to –74°C. The ambient temperature **must** be approximately 23°C for the cool down times to be valid.

All temperature readings below are as indicated on the temperature controller.

1. The chamber interior should be empty and at ambient temperature, approximately +23°C.
2. Turn ONLY the MASTER Switch ON. Set the Temperature Controller Set Point to +85°C. Then, turn the TEMP Switch ON.
3. The Heat Light should be ON continuously.
4. The chamber should heat up to about +80°C and begin controlling (HEAT Light cycles ON/OFF) within approximately 12 minutes.
5. The chamber temperature should slowly increase and stabilize to +85°C. It should NOT overshoot beyond +85.5°C, and the compressors should NOT need to turn ON in order to maintain +85°C.
6. After stabilization, the chamber temperature should vary no more than ±0.2°C, or a total of 0.4°C.
7. Let the chamber remain at +85°C for 30 minutes.
8. After 30 minutes at +85°C, set the Temperature Controller Set Point to –65°C.
9. The high-stage compressor should turn ON within a few seconds. Then, the low-stage compressor should turn ON within approximately 30 seconds, and the HEAT Light should be OFF.
10. The chamber should cool down to about –60°C and begin controlling (Cool Light cycles ON/OFF) within 1 hour and 7 minutes (67 minutes).
11. The chamber temperature should slowly decrease and stabilize to –65°C. It should NOT undershoot beyond –65.5°C, and the compressors should NOT need to turn OFF in order to maintain –65°C.
12. After stabilization, the chamber temperature should vary no more than ±0.2°C, or a total of 0.4°C.
13. Set the Temperature Controller Set Point to +23°C. The chamber should begin to heat up. The compressors should turn off within approximately 1 minute.
14. This concludes the chamber performance verification tests.
15. Let the chamber heat up to +23°C before turning the chamber OFF.

Theory of Operation

Overview

The chamber is heated by an open element nichrome heater. Cooling is accomplished by a cascade refrigeration system, which consists of two compressors. The air is circulated by a propeller fan. The heater, evaporator (cooling coil), and fan are located within an air plenum which is on the top of the chamber interior.

Refer to the electrical and refrigeration drawings to identify the referenced items described below.

Heating System

The chamber is heated by an open-element nichrome heater (HT1). The heater is located in the air plenum. The temperature controller (TCR1) provides a time-proportioned output to a solid state relay (SSR1). This turns the heater on/off as required to maintain the temperature set point. The heat pilot light (PL1) provides an indication on the front panel when the heater is on.

A fusible heat limiter (HL) provides failsafe protection against a catastrophic failure by opening the heater circuit at +240°C. The master heat contactor (C1) provides a power interlock for the heaters, circulator fan motor, and the control system. C1 is controlled by both the power switch (SW1), temp switch (SW2), and temperature limit controller (TCR2).

Refrigeration System

Cooling is accomplished by a cascade refrigeration system. A cascade refrigeration system consists of two interdependent refrigeration systems. The low-stage provides cooling to the chamber interior through a finned evaporator coil, which is located in the air plenum. The high-stage provides cooling to the cascade condenser. The cascade condenser is a heat exchanger that has one circuit which is the evaporator of the high-stage, and another circuit which is the condenser of the low-stage.

The high-stage uses refrigerant R-404A. High pressure liquid refrigerant is fed from the condenser through the liquid line filter-drier, to a capillary tube with feeds the evaporator circuit of the cascade condenser. The capillary tube reduces the pressure of the refrigerant to the evaporating or low side pressure. The reduction of pressure on the liquid refrigerant causes it to boil or vaporize, absorbing heat which provides a cooling effect. The refrigerant vapor travels through the suction line to the compressor suction inlet. The compressor takes the low pressure vapor and compresses it, increasing both the pressure and the temperature. The hot, high pressure vapor is forced out of the compressor discharge valve and into the condenser. As the high pressure vapor passes through the condenser, it is cooled by a fan, which blows ambient air across the finned condenser surface. The vapor condenses into a liquid and the cycle is repeated.

The low-stage uses refrigerant R-508B. High pressure liquid refrigerant is fed from the condenser circuit of the cascade condenser, through the filter-drier and capillary tube. The capillary tube feeds the finned evaporator coil, which is located in the air plenum where heat is absorbed to provide a cooling effect within the chamber. The refrigerant vapor travels through the suction line to the compressor suction inlet. The compressor takes the low pressure vapor and compresses it, increasing both the pressure and the temperature. The hot, high pressure vapor is forced out the compressor discharge valve and into the desuperheater. The finned coil

desuperheater removes some of the heat of compression. Next, the vapor goes through the oil separator, which returns any entrained oil back to the compressor's crankcase. The vapor flows through the condenser circuit of the cascade condenser, where it is condensed back into a liquid.

The temperature controller cycles the low-stage liquid-line solenoid valve SV2 on/off to control the chamber temperature. When SV2 is on, liquid refrigerant flows through the capillary tube and evaporator to cool the chamber. When SV2 is off, the flow stops. The hot gas regulator (19) is adjusted to keep the suction pressure at 5 PSIG when SV2 is off. This is also called "bypass mode". Pilot Light PL2 provides an indication on the front panel when the F4 Controller is turning SV2 is on.

The low-stage discharge pressure is kept within safe limits with the discharge pressure switch (PS1). If the discharge pressure exceeds 280 PSIG, the PS1 will energize solenoid valve SV1 to "dump" refrigerant into the expansion tank. The expansion tank also provides sufficient volume in the system to keep the "standby pressure" (also known as static or balance pressure), when the system is off, within safe limits.

During a high temperature pull down, it is possible for excessive hot gas to return to the compressor. The suction line cooling thermostatic expansion valve senses the suction line temperature and injects liquid refrigerant to cool the hot gas within safe limits.

The high-stage has a high pressure switch (PS2) which turns off both compressors if the high-stage discharge pressure exceeds safe limits (approximately 350 psig).

The temperature controller has internal logic to turn the compressors on if cooling is required to maintain the temperature set point. The low-stage compressor turns on 30 seconds after the high-stage turns on through Timing Module (TM1). This reduces the system's starting current, while allowing the cascade condenser to get cool before the low-stage turns on.

Troubleshooting

SYMPTOM	CONDITION	CAUSES
Does not heat up at all.	1. If F4 controller light 1A is ON (F4T left PWR bar is 100%), circulator fan is ON, circulator fan is ON, the Heat light is OFF. 2. If the Heat light is ON.	1. Solid State Relay SSR1 is defective (open). 2. Heat Limiter HL is open.
Heat is on all the time.	1. If F4 controller light 1A is OFF (F4T left PWR bar is 0%).	1. Solid State Relay SSR1 is defective (shorted).
Compressors do not run.	1. If F4 controller light 1B and DigitalOut 8 are ON (F4T Cool & Compressor outputs are ON).	1. Pressure switch PS2 is tripped.
R-404A pressure switch PS2 trips.	1. Trips after operating for a while.	1. Ambient temperature may be too high (over 90°F). Dirty condenser, inadequate clearance from back of chamber to the wall.
Cools down too slow.	1. Does not meet published specifications with empty chamber and ambient temperature is not over 80°F.	1. Low charge (leak). Solenoid valve SV1 is defective (doesn't close completely).
Does not cool down at all.	1. Both compressors are running.	1. Low charge (leak). Plugged capillary tube.
Temperature varies more than ±0.5°C or 1°C total.	1. If PID parameters in temperature controller were changed. 2. If PID parameters in temperature controller are correct and only occurs in cool mode.	1. Re-enter values as shipped from TestEquity. 2. Solenoid valve SV2 may be defective (does not completely seal when cycled off).
Compressors turn on and off too frequently.	1. If compressor control parameters in temperature controller were changed. 2. If compressor control parameters in temperature controller are correct.	1. Re-enter values as shipped from TestEquity. 2. Solenoid valve SV2 may be defective (does not completely seal when cycled off).

Figure 8-1 – PS2 Pressure Switch Reset Button (lower rear panel removed)

Refrigeration System Charging Instructions

⚠ **WARNING:** Repair of the refrigeration system must be performed only by a properly trained mechanic who is experienced in repairing cascade refrigeration systems. Do NOT substitute any component. Do NOT substitute refrigerants. Improper repairs will void the warranty.

These instructions are intended as guidelines for repairing TestEquity chambers. Details such as how to attach a gauge manifold are not covered. These are NOT do-it-yourself instructions!

R-404A High-Stage Charge

1. Repair any leaks before recharging.
2. Attach a vacuum pump and manifold gauge to the suction and discharge ports.
3. Evacuate the system to at least 100 microns. DO NOT GUESS! You must use a micron gauge.
4. Use a charging scale to weigh in 7 ounces of R-404A.
5. Verify the cooling performance as outlined in "How to verify the chamber performance".

R-508B Low-Stage Charge

1. Repair any leaks before recharging.
2. Attach a vacuum pump and manifold gauge to the suction and discharge ports.
3. Evacuate the system to at least 100 microns. Do NOT guess! You must use a micron gauge.
4. Do NOT put any additives in the system. Pentane or propane is NOT necessary or desirable.
5. Charge the system until the standby pressure is 120 PSIG at an ambient temperature of 73°F/23°C. Allow time for the charge to equalize as read on the suction and discharge gauges. This is 15 PSIG higher than the target amount of 105 PSIG. This corresponds to approximately 6 ounces. See NOTE below.
6. Verify the cooling performance as outlined in "How to verify the chamber performance".

NOTE: If the low-stage has been evacuated and recharged, the standby pressure should be rechecked after 24 hours to make sure it is 105 PSIG at an ambient temperature of 73°F/23°C. This is because the refrigerant mixes with the POE oil in the compressor, causing a lower standby pressure than was initially observed. Do not mistake this initial loss of pressure with a leak. After verifying that there is no leak, you may need to top-off the charge if the pressure is too low. Or, if the pressure is too high, you will need to bleed out some refrigerant to achieve a standby pressure of 105 psig.

Recommended Spare Parts

Replacement parts are available from TestEquity. Parts are generally in-stock and ready for immediate shipment. Next-day delivery is always available. If you cannot risk being out of service for even one day, then you should purchase critical spare parts in advance. Although most parts are standard and available from a variety of local distributors, some parts are either harder to find or custom.

The following is a list of the kinds of parts that you may want to purchase in advance.

Electrical Parts
Contactors
Relays
Heat Limiter
Circulator Motor and Fan
Switches

Refrigeration Parts
Solenoid Valve
Compressors

Major Electrical Parts

Description	Mfr	Mfr Part No.	Ref #	Part #	Qty	UOM
Line Cord, 12/3, NEMA 5-20P	Intl. Config.	80560	--	200205	1	ea
Audible Alarm	Floyd Bell	MC-09-201-Q	AL1	200005	1	ea
Arc Suppressor	ITW Paktron	104MACQRL150	AS1	200296	1	ea
Relay, DPDT, 30A, 120VAC	Magnecraft	92S11A22D-120	C1	200258	1	ea
Contactor, 1P, 30A	Hartland Controls	HCC-1XT02AA	C2-3	200237	2	ea
Interference Suppression Capacitor	STK Electronics	MPX100K250SP	CP1	280206	1	ea
Fuse, 3/10A	Bussman	MDL-3/10	F1	200130	1	ea
Circulator Motor Kit (w/fan blade)	CUSTOM	100578	FM1	100578	1	ea
Heat Limiter Assembly	CUSTOM	222253	HL	222253	1	ea
Heater, Air	CUSTOM	200199	HT1	200199	1	ea
Lamp, 15W, E14 Base	Philips	T22, 125-130V, 15W, E14	LT1	200203	1	ea
Indicator, Panel, 125V Neon	SoLiCo	1550-4-20-12120	PL1, 2	200025	2	ea
Resistor, 1kΩ, 25W	Vishay	RH0251K000FE02	R1	200295	1	ea
Solid State Relay, 10A, 24VDC In	Omron	G3NE-210T-US DC24	SSR1	200177	1	ea
Solid State Relay, 5A, 5-24VDC In	Omron	G3NA-205B-DC5-24	SSR2, 3	200032	2	ea
Switch, SPST, Rocker	Carlingswitch	LRA211-RA-B/125N	SW1, 3	200023	2	ea
Switch, ON-OFF-ON	Carlingswitch	RC911-RA-B-0-N-XLR1	SW2	200275	1	ea
F4T Temperature Controller	Watlow	F4T1L2EAA2E1017	TCR1	222510	1	ea
F4 Temperature Controller (alternate)	Watlow	F4SH-CKA0-01AE	TCR1	200001	1	ea
High/Low Limit Controller	Watlow	PM6L1AJ-AAAABBS	TCR2	200301	1	ea
Timing Module	Airotronics	THCU30SC	TM1	200287	1	ea

Major Refrigeration Parts

Description	Mfr	Mfr Part No.	Ref #	Part #	Qty	UOM
Accumulator	CUSTOM	100345	4	100345	1	ea
Cap. Tube, 0.050	J/B or equiv.	TC-50 or equiv.	11	100019	120	in
Cap. Tube, 0.050	J/B or equiv.	TC-42 or equiv.	12	100019	15	in
Cap. Tube, 0.042	J/B or equiv.	TC-42 or equiv.	13	100340	60	in
Cascade Condenser	CUSTOM	180572	16	180572	1	ea
Compressor (LS)	Tecumseh	AFE13C3E-IAA-201	1	383233	1	ea
Condensing Unit (HS)	Tecumseh	AE2415Z-AA1A	2	383232	1	ea
Desuperheater Coil	CUSTOM	100325	3	100325	1	ea
Evaporator Coil	CUSTOM	180220	17	180220	1	ea
Expansion Tank	CUSTOM	100346	5	100346	1	ea
Expansion Valve	Danfoss	068U2284	15	180395	1	ea
Filter Drier	Danfoss	023Z5048	14A, B	100524	2	ea
Oil Separator	Temprite	900	18	100536	1	ea
Orifice for 180395	Danfoss	068U1031	22	180396	1	ea
Pressure Control, HS HPCO	Johnson Controls	P20DB-1D	8 (PS2)	100341	1	ea
Pressure Control, LS HP Limit	Johnson Controls	P20EA-1D	7 (PS1)	100342	1	ea
Solenoid Valve	Sporlan	E3S130, 3/8 X 3/8 ODF	6 (SV1)	100010	1	ea
Solenoid Valve	Sporlan	E3S120, 1/4 X 1/4 ODF	20 (SV2)	100310	1	ea
Solenoid Valve Coil	Sporlan	MKC-1-120/50-60	21 (SV1, 2)	100011	2	ea

General Parts

Description	Mfr	Mfr Part No.	Ref #	Part #	Qty	UOM
Caster, Fixed (for 115A-F)	Trio Pines	2521-02P	-	300610	2	ea
Caster, Swivel (for 115A-F)	Trio Pines	2520-02P-SB	-	300609	2	ea
Door Gasket, Inner	CUSTOM	300593	-	300593	1	ea
Door Gasket, Outer	CUSTOM	300594	-	300594	1	ea
Door Latch, Chamber Workspace	Southco	A7-10-301-20	-	300216	1	ea
Port Plug, Silicone Foam, 3"	CUSTOM	300373	-	300373	2	ea
Shelf	CUSTOM	TE-1151	-	TE-1151	1	ea
Viewing Window	CUSTOM	300691	-	300691	1	ea

EZ-Zone Limit Controller Setup Parameters

⚠ **CAUTION:** The EZ-Zone Limit Controller has been properly configured by TestEquity to match the chamber's system requirements. Improper modifications to these setup values can result in erratic performance and unreliable operation. Do not attempt to modify the setup values, unless you thoroughly understand what you are doing. If there is any doubt, please call TestEquity before proceeding.

Setup Menu

Prompt	Function	Setting	Alternate Setting
LoC	Lockout Menu	2	See NOTE 1 below
SEn	Sensor Type	tC	Do Not Change
L in	Linearization	t	Do Not Change
dEC	Decimal	0	Alt. "0.0"
C_F	°C or °F	C	Alt. "F"
r.Lo	Range Low	-75	Do not make any lower
r.h i	Range High	180	Do not make any higher
Fn2	Output 2 Function	L inT	Do Not Change
L.Sd	Limit Sides	both	Alt. "high" (High only) or "LoW" (Low only)
L.hY	Limit Hysteresis	2	Change not recommended
A.tY	Alarm Type	oFF	Do Not Change
PAr 1	Upper Display	ACPu	Alt. "none"
PAr2	Lower Display	LSt	Alt. "Lh.s" (High Set Point) or "LL.S" (Low Set Point)
Ad.S	Zone Address	1	Not functional for this application

NOTE 1: The Lockout Menu LoC sets the security clearance level as follows:

- 1 Operations Menu, read only
- 2 Operations Menu, set point read/write
- 3 Operations Menu, set point read or write (same as level 2)
- 4 Operations Menu, full access read/write (required to access Calibration Offset below)
- 5 Operations Menu and Setup Menu full access (required to access Setup Menu and Calibration Offset below)

Operations Menu

Prompt	Function	Setting	Alternate Setting
LLS	Low Set Point	-75	Appropriate Low Limit Set Point
LhS	High Set Point	180	Appropriate High Limit Set Point
iCA	Calibration Offset	0	Calibration Offset as required (see NOTE 2 below)

NOTE 2: LoC parameter in Setup Menu must be set for 4 or 5 to access the Calibration Offset parameter.

Chapter 9 - Warranty

TestEquity LLC Limited Warranty

TestEquity LLC (TestEquity) warrants Environmental Chambers (Equipment) manufactured by TestEquity and supplied under this contract to be free from defects in materials and workmanship under normal use and proper maintenance.

TestEquity will repair or replace any defective part for a period of THREE YEARS from the date of invoice. TestEquity reserves the right to require any defective part be returned, freight prepaid, to TestEquity's factory or to inspect any defective part at the Purchaser's site. TestEquity shall have sole discretion to determine whether any part is defective and whether any defective part will be repaired or replaced. This limited warranty shall extend to any standard chamber accessory and component part which is normally sold by TestEquity. Non-standard accessories and component parts specified by the Purchaser shall be warranted only to the extent of the original manufacturer's warranty, if any exists.

If the repair or replacement is performed in the FIRST YEAR from the date of invoice, TestEquity will also pay for the labor associated with the repair at the Purchaser's site, subject to TestEquity's prior approval. During the SECOND and THIRD YEAR of the warranty period, Purchaser will be responsible for the installation and cost of installation of replacement or repaired parts.

Purchaser shall notify TestEquity in writing of any alleged defect within 10 days after its discovery within the warranty period. TestEquity reserves the right to satisfy the labor portion of this limited warranty either through its own service personnel or an authorized agent. In order to provide expeditious service, TestEquity reserves the right to satisfy its limited warranty obligation by sending replacement parts to be installed by the Purchaser if they can be installed easily without special tools or training. TestEquity reserves the right to satisfy this limited warranty by requiring the Purchaser to return the Equipment to TestEquity when such return is feasible.

TestEquity must initiate field service for in-warranty claims. Purchaser will not be reimbursed for labor if they initiate service on their own without prior approval from TestEquity. Replacement parts must be supplied by TestEquity for in-warranty claims. Purchaser will not be reimbursed for parts they buy on their own without prior approval from TestEquity.

The following parts are excluded from this limited warranty and are sold as-is or are considered expendable: interior light bulb, viewing window, paint and cosmetic surface finishes and treatments, port plugs, and refrigerant.

This limited warranty shall extend in full to Equipment installed within continental United States and Canada. For all other locations, Purchaser is responsible for all labor costs for repairs or parts installation, and for all shipping costs associated with providing replacement parts.

This limited warranty does not cover: (1) Defects or damages arising as the result of shipment by common carriers or private transportation, unless TestEquity undertakes shipment and transportation of the Equipment to Purchaser's site or contractually assumes the risk of damage to the Equipment in shipment; (2) Defects or damages arising out of, or as the result, of mishandling, modification, or improper start up, installation or maintenance of the Equipment (including start up, installation or maintenance not in accordance with TestEquity's written procedures); (3) Defects or damages resulting from, or arising out of, abuse, misuse, neglect, intentional damage, accident, fire, flood, earthquake, or any other act of God.

This warranty as to Equipment is LIMITED to repair or replacement of parts or Equipment in the determination of TestEquity LLC THE FORGOING LIMITED WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES INCLUDING THE IMPLIED WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE AND MERCHANTABILITY. TestEquity LLC DISCLAIMS ANY LIABILITY FOR ANY DAMAGES RESULTING FROM DELAY OR LOSS OF USE IN SERVICE OR REPAIR, OR FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF OR IN CONNECTION WITH THE USE OR PERFORMANCE OF THE EQUIPMENT, EXCEPT AS STATED IN THIS PARAGRAPH.

This limited warranty cannot be modified in any way except in writing by both TestEquity and Purchaser. Invalidation of any one or more of the provisions of this limited warranty shall in no way affect any of the other provisions hereof, which remain in full force and effect.

This limited warranty shall be extended only to the first Purchaser of this Equipment and is not transferable.

Chapter 10 – Drawings