Operation and Maintenance Manual


Model TUJR

Tenney Junior

Environmental Test Chambers

Models TJR/TUJR

Order Number: 113119


Model TJR

Revision Date: 01-25-15

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1.0 Introduction

Congratulations on purchasing a chamber from one of the fine divisions of Thermal Product Solutions. Your chamber has been designed to operate with the reliability you expect for the demands you impose on your product and research testing. We truly hope that every aspect of chamber design and quality will measure up to your strictest standards.

Headquartered in New Columbia, Pennsylvania, Thermal Product Solutions includes the following five divisions that manufacture environmental test chambers, industrial ovens, and furnaces. The Blue M, Gruenberg, Tenney, and Lindberg divisions are located in New Columbia, Pennsylvania, which is in the North-Central part of the state. MPH is located in Riverside, Michigan.

Blue M Gruenberg Lindberg/MPH Tenney

1.1 Contact Information

Mailing Address:	Thermal Product Solutions PO Box 150 White Deer, PA 17887	**Physical Address:**	Thermal Product Solutions 2821 Old Route 15 New Columbia, PA 17856
Main Number:	570 - 538 - 7200	**Toll Free Number:**	1 - 800 - 586 - 2473
Fax-Parts Department:	570 - 538 - 7385	**Fax-Service Department:**	570 - 538 - 7391
Fax-Main:	570 - 538 - 7380		
Website:	www.thermalproductsolutions.com		

1.2 Parts and Service Inquires

Your equipment has been designed and manufactured to provide years of reliable service. In the event a component should fail, it is recommended that only OEM approved parts be used as replacements. Please contact the Parts Department for component replacement, or repair.

Parts and service inquiries for equipment within each division should be directed to Thermal Product Solutions by any of the following methods.

Important! Please have the **Model** and **Order Numbers** of your unit available when contacting us.

Model No. ______________________ **Order No.** ______________________

MADE IN THE USA!

1.3 Technical Specifications

This table shows the major mechanical, electrical and environmental specifications for this unit.

Unit Type		
Model Numbers:	Model TJR	Tenney Junior - Benchtop Unit
	Model TU-JR	Tenney Junior - Upright Unit
Mechanical		
Shipping Weight:	260 lbs.	
Internal Capacity:	16" W **x** 11" D **x** 12" H = 1.22 Ft^3 (406.4 W **x** 279.4 D **x** 304.8 H Millimeters)	
Electrical		
Standard Chambers	120 V, 16 A, 60 Hz, 1 PH	
CE Marked Chambers	220 V, 13 A, 50 Hz, 1 PH	
Environmental		
General	• Indoor use only. • Facility temperature range of 5°C to 30°C (max). • Maximum relative humidity 90%.	
Operating Temperature:	- 75 to + 200 °C, ± 0.3 °C	
	Note: This manual may also apply to special chambers with alternate model numbers (listed below). For special **Model XXXX, O/N xxxxx,** the following custom temperature specifications apply: ▪ Temperature Range:- xx° to + xxx° C, +/- xx deg. after stabilization	
THE LISTED CHAMBER SPECIFICATIONS ARE BASED ON OPERATION AT 24° C AMBIENT TEMPERATURE, ALTITUDE AT SEA LEVEL, AND A 60 HZ POWER SUPPLY. CHAMBER OPERATION UTILIZING A 50 HZ POWER SUPPLY MAY DE-RATE THE LISTED PERFORMANCE SPECIFICATIONS.		
Option Specifications		
Compressed Air Supply	80 PSIG min. to 100 PSIG max.	
GN_2 Supply	Up to 100 psig	
LN_2 Supply	Up to 40 psig	
CO2 Supply	Up to 1000 psig	

2.0 Safety

It is important that you read and understand all Warning statements listed throughout the manual!

2.1 Symbols

Various symbols are used throughout the manual to alert the reader to a potentially dangerous situation.

	Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
	Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury
	Indicates that there is a voltage at this point that may be a hazard.
	Indicates that there is a grounding point at this location.
	Provides additional information on a particular topic.
	WARNING OF ELECTRIC HAZARD INSIDE

2.2 Warnings

1. Read this entire Operation Manual, as well as the vendor manuals and cut-sheets provided before operating this equipment! Failure to adhere to any Safety Warning, or failure to follow the proper operating procedures listed throughout any of the information provided, could cause damage to your equipment, personal injury, or death.
2. Obey all "CAUTION", "DANGER", and "WARNING" signs / labels mounted on the equipment. Do not remove any of these signs / labels.
3. Do not use this equipment in any manner not specified in this manual. Improper use may impair the safety features employed and will void your warranty.
4. Operators and service personnel must be familiar with the location and function of all controls and the inherent dangers of the equipment before operating or maintaining it.
5. Only qualified service personnel should ever be permitted to perform any service-related procedure on this equipment!
6. **Warning!** This chamber is **NOT designed for use with volatile or explosive materials** unless specifically stated in your purchase order. The air conditioning section contains open wire heating elements, which can attain temperatures sufficiently high to ignite gas vapors. Do not install test articles that may release explosive or flammable vapors in the chamber. Loading of such materials **may result in explosion or fire**.
7. Chamber Classification is NFPA 86 Class B: NFPA 86 Class B chambers / ovens are heat utilization equipment operating at approximately atmospheric pressure wherein there are no flammable volatiles or combustible material being heated in the oven.
8. Do not place the unit near combustible materials or hazardous fumes or vapors.
9. Do not install unit in a corrosive environment. A corrosive environment may lead to poor performance and deterioration of unit.
10. Make sure the chamber and any remote equipment provided are leveled when installed. The chamber door may swing shut on personnel if unit is tilted.
11. **A main power disconnect switch may not be provided with your unit.** If not provided, we recommend that a **fused disconnect switch on a separate branch circuit** be installed as the power source in accordance with all National and Local Electrical Codes. If your unit is equipped with a power cord and plug, you must utilize a receptacle with the appropriate rating, which is on a branch circuit of its own.
12. Do not position the chamber in a manner that would make it difficult to operate your main power disconnect switch.
13. Your power supply line voltage may be too low or too high to properly and safely operate your equipment. Before making the power supply connection to your equipment, you must follow the specific directions stated under "Power Connection" in the Installation Instructions section. Failing to perform the directions stated may damage your equipment and void your warranty!
14. Control panels, gauge boxes, the conditioning compartment, etc., contain exposed electrical connections. Keep panels in place properly when the unit is in operation. Disconnect and Lock-Out / Tag-Out all electrical power from the unit at its source before servicing or cleaning.

15. Refrigerant under high pressure is used. Only qualified refrigeration mechanic personnel should ever be permitted to perform any service-related procedure on the refrigeration system.
16. Do not adjust any mechanical components such as refrigeration valves or any electrical components except as directed in this manual.
17. Human exposure to temperature extremes can cause injury. Do not open the chamber door until chamber temperature drops below 200   F (93   C), when applicable. Take appropriate precautions before opening oven doors and upon handling any chamber contents.
18. Do not modify any component on this unit. Use only original equipment manufacturer (OEM) parts as replacement parts. Modifications to any component, or the use of a non-OEM replacement part could cause damage to your equipment, personal injury, or death.
19. Do not overload the floor of the chamber workspace or load the unit unevenly.
20. Do not stand on the roof of the chamber. The roof is not designed to withstand additional weight.

3.0 System Overview

Figure 1 Model TUJR Front View

Figure 2 Model TJR Front View

3.1 Application

The Tenney Junior family of environmental test chambers are innovative reach-in types that provide a wide range of temperature conditioning with a set of diverse optional conditioning equipment. This manual applies to the following models in the Tenney Junior family which employ the Watlow F4 profiling type controller.

3.1.1 Environmental Conditioning Functions

- Heating of the chamber is achieved by recirculating chamber air through low-mass, open-air nichrome wire heater elements in the conditioning plenum. The plenum is located in the chamber ceiling and is isolated from the workspace to prevent direct heat radiation.
- For Intrinsically Safe Interior Designs (TJR-INS) only, heating of the chamber is achieved by recirculating chamber air through a sheathed, low-watt density finned heater in the conditioning plenum.
- Cooling of the chamber is achieved by recirculating chamber air through a refrigerated cooling coil in the conditioning plenum. A cascade type refrigeration system is used with Non-CFC refrigerants.
- Air circulation is generated by a propeller type fan, which is driven by an externally mounted motor.

3.2 Heating-All Models

Heating of the chamber is achieved with the use of open air low mass nichrome wire heating elements. These elements have low thermal lag and provide rapid response to the controller's demands. The elements are configured in a serpentine pattern within stainless steel racks and are supported with ceramic insulators. Heater racks are installed in the conditioning plenum. This isolates them from the workspace and prevents direct radiation to the product. Electric power ratings for your chamber's heater bank are listed on the Power Schematic.

3.2.1 Heater Control

The heaters are controlled by a time proportioned output from the main controller. This output energizes a solid state relay, which provides power to the electric heaters.

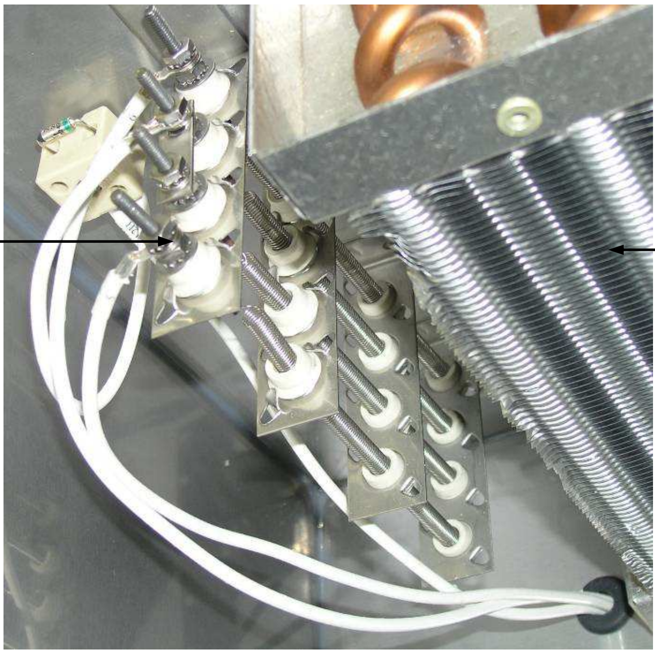


Figure 3 Electrical Heater Rack-Bottom View

3.3 Cooling-All Models

Cooling of the chamber is achieved by re-circulating chamber air through a refrigerated cooling coil in the chamber conditioning plenum. Non-CFC refrigerants are used.

The chamber is equipped with a cascade refrigeration system that uses capillary tube type refrigerant metering to the cooling coils. Two 1.0 HP hermetic compressors are employed in a cascade design, consisting of a low-stage and a high-stage system. A cascade condenser is used in the low stage, where the low stage refrigerant is cooled and condensed by high stage refrigerant. This highly efficient design permits extreme low temperatures to be attained. An air-cooled condenser is used in the high stage. Refrigeration System Description

The main design features of this cascade refrigeration system include capillary tube type refrigerant control and the use of ½ HP hermetic compressors.

This is a multiple refrigeration system consisting of a low stage and a high stage system. These systems are integrated to efficiently provide very low temperature levels. This is achieved by utilizing a cascade condenser in the low stage, where low stage refrigerant is cooled and condensed by high stage refrigerant. The cooled low stage refrigerant now has greater cooling capacity in the chamber evaporator coil. An air-cooled condenser is used in the high stage.

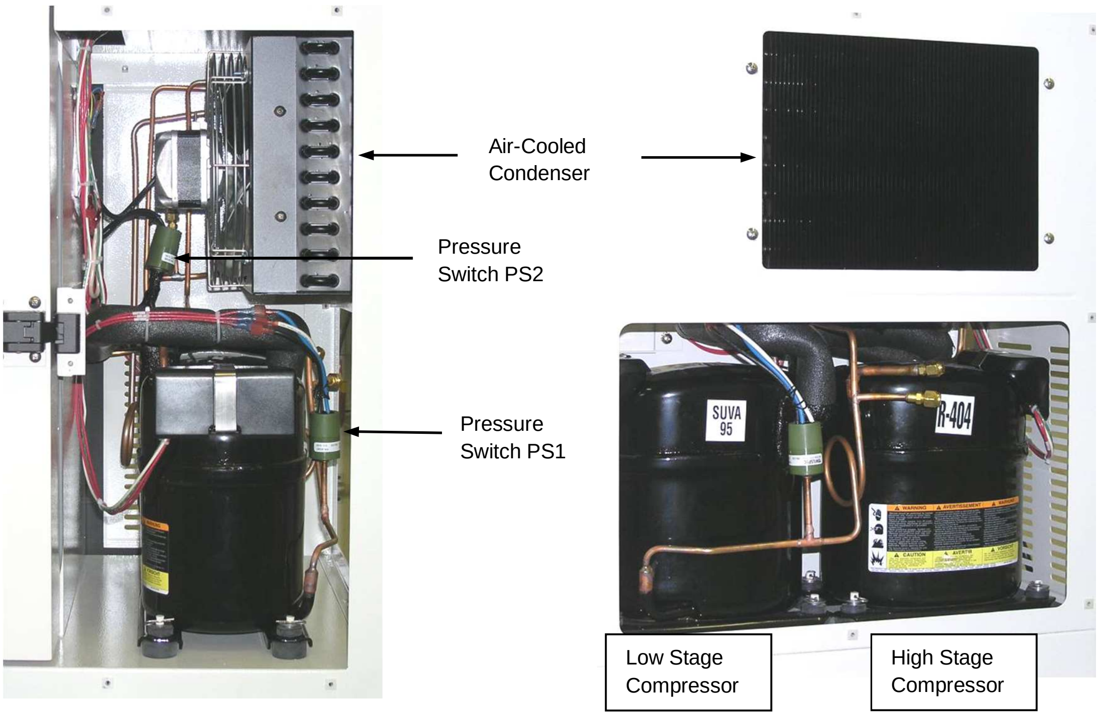


Figure 4 TJR Refrigerant System

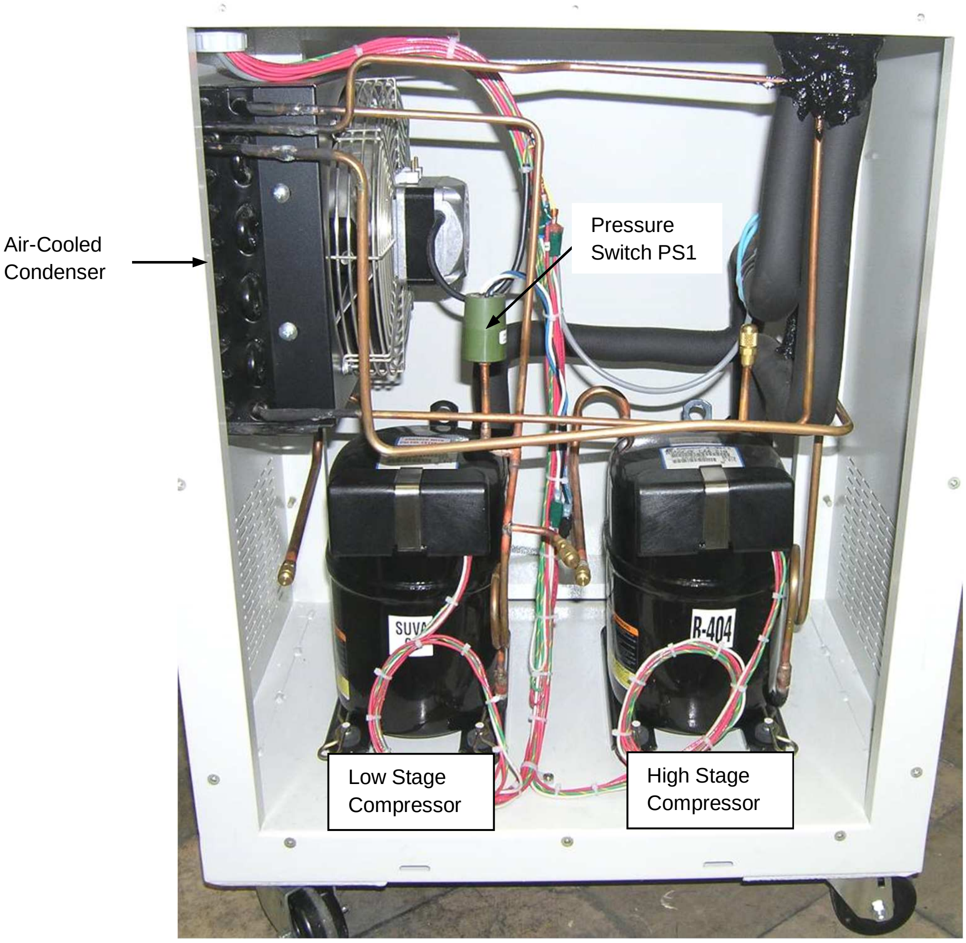


Figure 5 TJR Refrigerant System-Rear View

3.3.1 Capillary Tube Control Description

This system employs capillary tube type refrigerant control. A long length of seamless copper tubing with a small internal diameter is used to feed the evaporator coil. The tube acts as an automatic throttle in controlling refrigerant pressure and flow to the evaporator. With the compressor running, a high pressure is maintained on the inlet to the capillary tube, and a low pressure is maintained in the evaporator. The pressures will balance when the compressor is turned off. This places a low starting load on the compressor motor when turned back on. A fine filter or filter-drier is provided at each capillary tube inlet to remove moisture and dirt from the refrigerant.

3.3.2 Low Stage Description

The low stage system includes the compressor, the cascade condenser, an expansion tank, and the evaporator coil located in the chamber conditioning section.

Refrigerant flow in the low stage is from the compressor as a hot compressed gas and then through a desuperheater where most of the heat of compression is removed. The desuperheater is part of the high stage air cooled condenser. As a cooled gas, it then flows to the cascade condenser where it condenses to liquid form by heat exchange with circulating high stage refrigerant. The liquid refrigerant flows through a drier assembly, and is metered through a capillary tube to the evaporator cooling coil in the chamber conditioning section. Warm chamber air circulates through the cooling coil, and heat exchange occurs as the liquid refrigerant boils, vaporizes, and absorbs heat. The vaporized refrigerant returns to the compressor through the suction line. The cycle is repeated.

3.3.3 High Stage Description

The high stage system includes the compressor, an air cooled condenser, and a suction line accumulator to guard against liquid refrigerant return to the compressor.

3.3.4 Refrigerant Flow

Refrigerant flow in the high stage is from the compressor as a hot compressed gas, to the air cooled condenser where the gas cools and condenses to liquid form. It then flows to the cascade condenser, being metered by a capillary tube. In the cascade condenser, high stage refrigerant absorbs heat from the circulating low stage refrigerant. As it absorbs heat, the high stage refrigerant boils and vaporizes. It then returns to the compressor through the suction line accumulator SLA. The cycle is repeated.

3.4 Safety Devices

3.4.1 Low Pressure Cut-In Switch PS2 and Timer 1TDR

In order to prevent both compressors from hitting the power line at the same time, Low Pressure Cut-In Switch PS2 and Digital Timer 1TDR are provided to delay the start-up of the low stage compressor. The high stage compressor will start first when cooling is demanded by the main controller. PS2 monitors the suction pressure in the high stage compressor suction line. PS2 will close when the suction pressure reaches 20 PSIG, which involves a short delay. In order to insure that PS2 is closed before the low stage compressor is permitted to start, a 30 second On-delay is programmed into 1TDR. 1TDR contacts will close after the delay to start the low stage compressor. 1TDR is mounted inside the control panel.

3.4.2 High Pressure Cut-In Switch PS1

An Artificial Loading solenoid valve SV will be energized by the High Pressure Cut-in Switch PS1 when low stage compressor head pressures reaches 280 PSI. This action dumps refrigerant into the expansion tank for storage until the pressure drops to 220 PSI.

3.4.3 Compressor Motor Overloads

A motor overload protective device is installed in the windings of each compressor, which will open if the motor windings exceed a preset temperature. Probable causes are insufficient refrigerant flow across the motor due to a refrigerant loss, or a failure of the liquid injection valve provided for suction gas cooling. The motor overload will automatically reset and restart the compressor after the motor has cooled.

NOTE: Please reference the section entitled "Servicing Cascade Refrigeration Systems" for a more detailed description.

3.5 Air Circulation

Tenney Junior Test Chambers are provided with an efficient vertical-down airflow system that maintains maximum temperature uniformity.

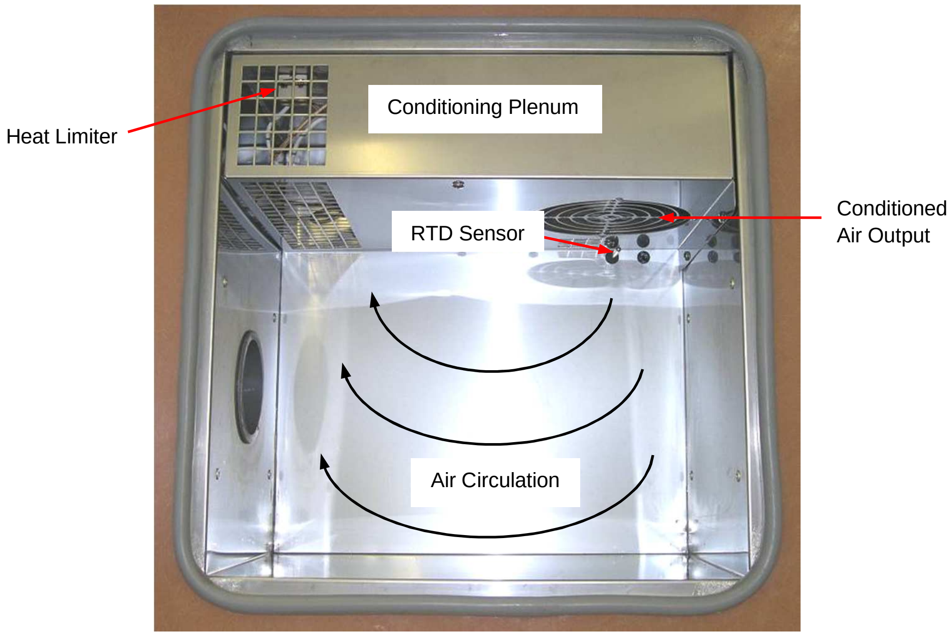


Figure 6 Air Circulation

Chamber air is conditioned in the ceiling plenum where the circulation fan, heater elements, and refrigeration coil are located. A propeller type fan driven by an externally mounted motor generates airflow. The plenum cover prevents direct heat radiation to the workspace.

Process air is drawn up into the left side of the plenum. It flows through the heater elements and the refrigeration coil, and is discharged by the fan down into the workspace to condition the product. The cycle repeats. A 100 ohm Platinum RTD sensor mounted below the fan measures the conditioned air temperature.

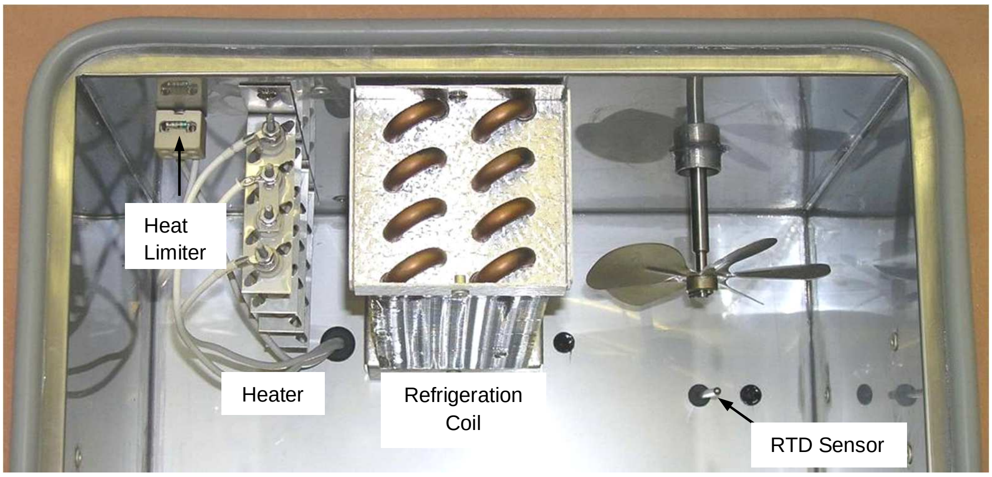


Figure 7 Conditioning Plenum

3.6 Over Temperature Protection

Chamber over temperature protection is provided with a thermal cutoff.

This is an axial leaded one-shot protection device that is mounted in a small white ceramic terminal block. For chambers with a top temperature limit of 200 degrees C, the Heat Limiter is designed to open when the surrounding temperature reaches 240 degrees C. For chambers with a lower temperature limit, either an alternate thermal cutoff will be used, or the Watlow LV Limit Controller will be used.

Figure 8 Thermal Cutoff

3.7 Watlow F4 Temperature Controller

3.7.1 Features

Temperature conditions may be controlled with the standard Watlow F4 Controller. The WF4 is a powerful ¼ DIN profiling type controller with the following features.

- Single Channel
- Profiling: Forty Profiles, 256 Steps
- Automatic & Manual Control
- 1 Input: Universal Type (RTD is Std.)
- 4 Digital Inputs
- 2 Auxiliary Analog Inputs - Optional
- 2 Control Outputs: Time Proportioned, On/Off, or 4-20 ma
- 2 Alarm Outputs
- 8 Digital Event Outputs
- 2 Retransmit Outputs - Optional
- Communications: EIA-232 and EIA-485 with Modbus RTU protocol

Figure 9 Watlow F4 Temperature Controller

3.7.2 Displays

- PV Display: (Upper Display) Process Value. Error information when applicable.
- LCD Display: (Lower Display) 4 line display shows information about setup, operation, and programming. A cursor (>) indicates the selected parameter or present value in memory. Cursor moves via the 4 navigation keys.
- Scroll Bar: (Within LCD Display) Appears when the Up or Down Keys can reveal more information in the LCD Display.

3.7.3 Indicator Lights

1A, 1B, 2A, 2B: Lights when the corresponding controller channel output is active.

Alarm 1 & 2: (Bell #1 and Bell #2 graphics) Lights during an alarm state.

Communications: (Phone graphic) Lights (pulsates) when the controller sends or receives valid data.

Profile Indicator: (Chart-line graphic) Run / Hold Status. Lights when a ramping profile runs. When blinking, the profile is on hold. When not lit, operates as a static set point controller.

3.7.4 Keys

- Profile: (Chart-line graphic) Profile Run / Hold. Summons a menu that allows you to start, hold, resume or terminate a profile.
- Information: ("i" in a circle) Provides information in the LCD Display about the cursor-selected parameter. Another press toggles the display back to the parameter.
- Up & Down Arrows: Move the cursor (>) position in the LCD Display through the software in the direction of the key arrow. Increase or decrease a value, or change a letter in a user-nameable field, such as alarms, events, and profile names.
- Left & Right Arrows: Move right to select the choice to the right of the cursor and proceed to the next screen. Move left to exit.

To Clear an Alarm or Error: In an alarm condition, an alarm message will appear on the Main page in the LCD Display (if this option has been selected on the Setup Page). To silence it, move the cursor to the alarm message and press the Right Key >. A pop-up message will confirm the silencing of the alarm, and the indicator light will go off. When the condition causing the error or alarm is corrected, return to the error or alarm message on the Main Page, and press the Right Key again. Pop-up message will confirm.

3.7.5 Data Communications

Standard data communications with the VT V is Type RS232. A VTV Communication Command Set manual, along with various other related communication manuals are provided in the Supplemental Instructions Section. As a reference, different data communication types are briefly described below.

RS232C / RS423A: Both interfaces are compatible and use 3 wires: a single transmit wire; a single receive wire; and a common line. The maximum wire length is 50 feet. Only a single chamber may be connected to your computer. Data signals are measured as plus and minus 12 Volts to common with RS232C, and plus and minus 5 Volts to common with RS423A.

RS422A: This interface uses 5 wires: a transmit pair; a receive pair; and a common line. Up to ten chambers may be connected to your computer on a multi-drop network up to 4,000 feet long. Data signals in each pair are measured as a plus or minus 5 Volt differential.

EIA-485: This interface uses only 2 wires. Both wires are used for transmitting and receiving data, and therefore, only one device may talk at a time. Up to 10 chambers may be connected to your computer on a multi-drop network up to 4,000 feet long. Data signals are measured as a plus or minus 5 Volt differential. An EIA-485 card must be installed for signal conversion.

IEEE-488: This is a parallel multi-drop interface with several control and data lines. Each device connected must be set to a unique address. Data from other test devices may also be collected. An IEEE-488 to serial converter card must be installed. Maximum cable length is approx. 33 ft.

3.7.6 Controller Configuration

The pre-programmed controller configuration for your chamber is documented in the Test Report, which is located in the Supplemental Instructions Section. Refer to the controller manual for programming details.

Important! The configuration set-up is mainly provided for your reference. Not all of the parameters shown apply to your chamber. Changes to some of the set-up parameters may drastically affect your chamber performance and void your warranty. Contact the TPS Service Dept. before attempting any changes.

4.0 Options

There are several options that are available for this series that can be ordered as required.

4.1 Boost Heat

As an option, your chamber may be equipped with the boost heat feature, which includes extra heaters to provide rapid increases in temperature. As the main controller's heat output energizes the main heater bank, it will also energize an internal On-Delay timer. If the timer times out before the controller's heat output turns off, the timer output will energize the Boost Heat Solid State Relay BHSSR to provide power to the boost heaters. Contacts of the Boost Heat Arm Contactor BHCON must also close.

Check to see if any features or optional equipment must be turned on with an Event Output from the main controller. If an Event Output were supplied, a **Controller Event Output Label** with the Event Output listing would be installed on the side of the chamber. Event Outputs are described either in one of the various "Option" sections, or in the "Temperature Control - Conditioning Control Functions" section for unique applications.

Event No. 3: Boost Heat

4.2 Dry Air Purge System

A Dry Air Purge System may be provided to purge the chamber of moisture or undesirable process vapors.

4.2.1 Operation

The Dry Air Purge System is activated by an Event output from the main controller, which must be turned ON. Reference the Event Label on the side of the chamber or your Test Report for the Event Number assigned to this feature. When activated, the event output will directly energize the dryer and the Dry Air Purge solenoid valve ASOL.

4.2.2 Dry Air Equipment Description

The dryer is a twin tower heatless desiccant type that is self-regenerating. Each desiccant tower (chamber) contains a compression packed molecular sieve. As the compressed air passes through the sieve, moisture is picked up by the desiccant. The dried air is released through an outlet port and injected into the test chamber's conditioning airflow through solenoid valve ASOL. A small portion of the dried air is passed through a sized orifice to the other tower to purge the desiccant of moisture collected during the previous cycle. There are four distinct phases of the heatless dryer where the compressed air is alternately cycled and dried in each of the two desiccant towers. Integral timers and solenoid valves within the dryer control this operation.

Figure 10 Heatless Dryer

Your chamber will require a compressed air supply for the Dry Air Purge System option. The system employs a twin tower heatless desiccant dryer that is mounted on the back side of the chamber. The compressed air supply should be clean and dry, and range from 80 PSIG min. to 100 PSIG max. The connection type is ¼" FPT. Make sure the connection is secure. Reference the corresponding "Option" section in this manual for a detailed operation description.

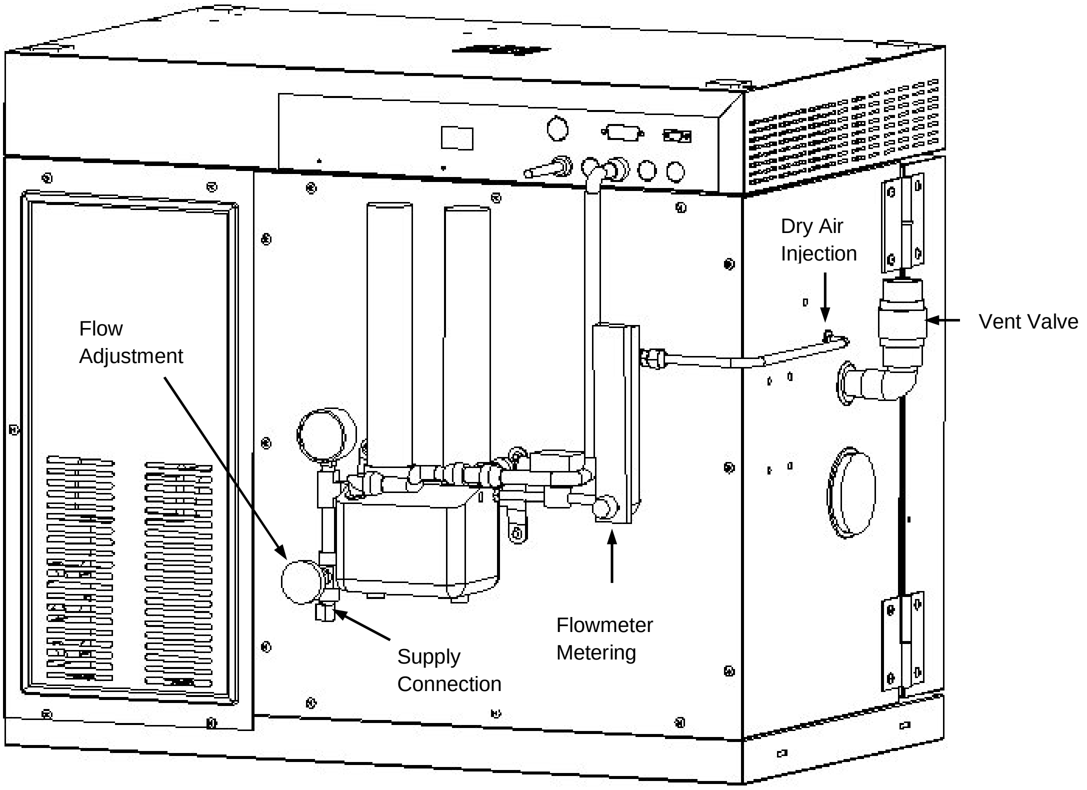


Figure 11 Dry Air Purge System

4.3 GN_2 Purge System

Your chamber will require a supply of gaseous nitrogen for the GN2 Purge System option. The supply may range up to 100 PSIG maximum. The connection is type 1/8" NPT. Make sure the connection is secure. Reference the corresponding "Option" section in this manual and your chamber specifications for more details.

Note: A **check valve** is added to insure that the chamber does not become pressurized.

WARNING	Gaseous nitrogen displaces oxygen. Make sure the area surrounding the chamber is well ventilated to dilute the gas vented from the Strato-flo check valve.
WARNING	Burn Hazard. Avoid contact with cryogenic materials. Serious burns from immediate frostbite will result. Insulated gloves, eye goggles, and protective clothing MUST be worn when working with or around these materials. Gloves should be loose fitting so they can be quickly discarded in case liquefied gas spills or sprays into them.

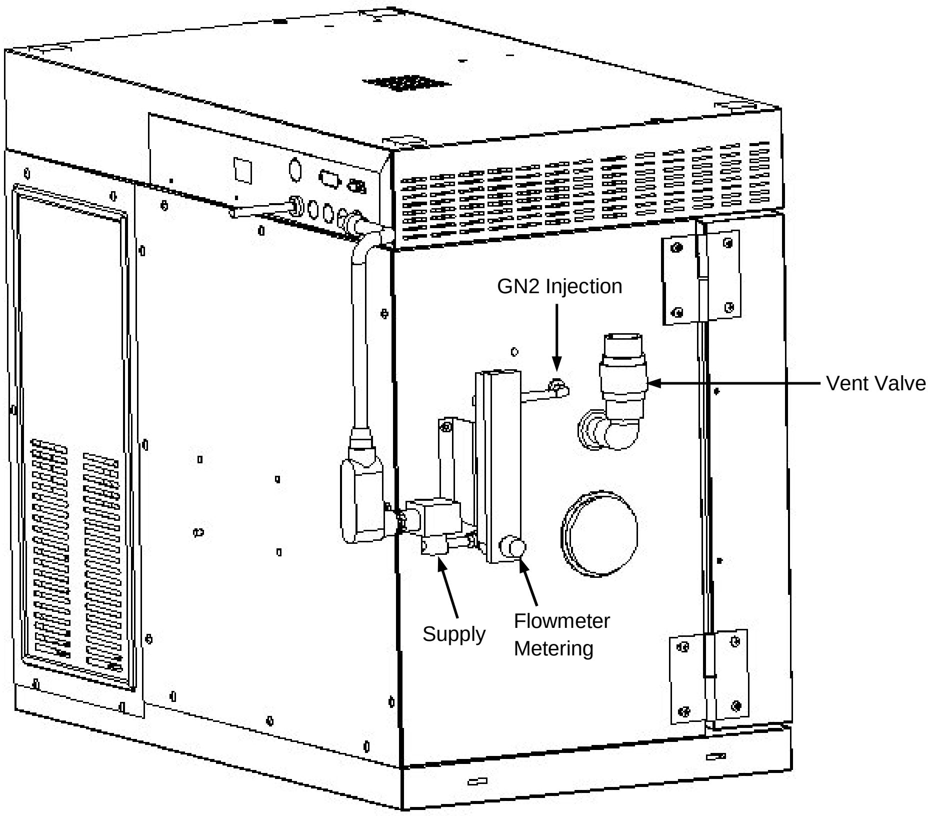


Figure 12 GN_2 Purge System

4.4 LN_2 Boost Cooling System

The LN_2 Boost Cooling System is provided to increase the rate or limit of cooling beyond the means of the refrigeration system. Boost cooling is achieved by injecting liquid nitrogen into the chamber through a header pipe in the conditioning section. LN_2 has a boiling point of -196 degrees Celsius (-320 deg. F). As the liquid sprays out of the header pipe, it vaporizes and absorbs chamber heat while it mixes with process air.

LN_2 systems are provided with a manually set flow adjustment valve, which permits the adjustment of nitrogen flow to avoid incomplete evaporation at varying LN_2 supply pressures. As the chamber cools to the extreme cold temperature limit, complete evaporation of liquid nitrogen may not occur if the supply pressure is allowed to drop.

Note: A **Strato-Flo check valve** is added (See **Error! Reference source not found.**) to insure that the chamber does not become pressurized.

CAUTION	Incomplete evaporation will cause droplets of liquid to fall to the floor and accumulate. If enough liquid accumulates, it may seep towards the chamber door gasket. Do not allow LN2 to contact the door gasket. Exposure to LN2 will damage the gasket and violate the seal.

	Refer to the Installation Instructions Section for supply and connection type specifications.

WARNING	Gaseous nitrogen resulting from vaporized LN_2 displaces oxygen. Make sure the area surrounding the chamber is well ventilated to dilute the gas vented from the chamber vent port check valve!

4.4.1 Operation

The system is activated by an event output from the main controller (or by a manual switch). To use the system, the Event must be turned ON. Reference the Event Label on the side of the chamber or your Test Report for the Event Number assigned to this feature.

Once the system is enabled with the event output, the controller's time proportioned Full Cooling output will energize a solid state On-delay timer. If the Full Cooling output remains on longer than ten seconds, the timer will time out and energize the LN_2 Injection solenoid valve SOL. This valve will open to permit the flow of LN_2 into the chamber to boost the cooling rate. As soon as the Full Cooling output turns off, the timer output will open to de-energize SOL and shut off the flow of LN_2.

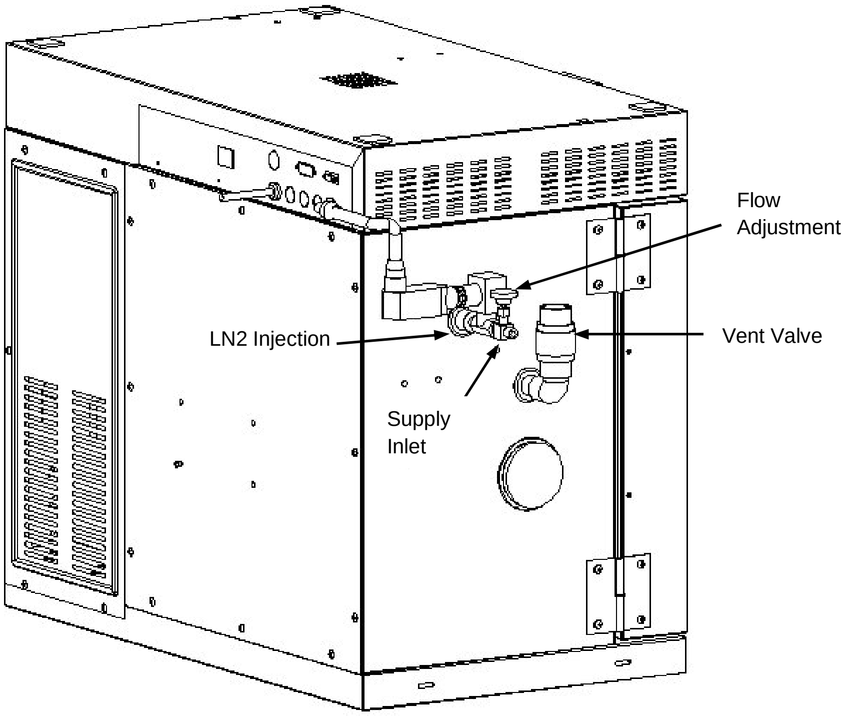


Figure 13 LN_2 Supply System

4.5 CO_2 Boost Cooling System

The CO_2 Boost Cooling System option may be provided to increase the rate of cooling beyond the means of the refrigeration system. Boost cooling is achieved by injecting liquid carbon dioxide into the chamber through an orifice within an injection port. CO_2 has a boiling point of -78.5 degrees Celsius (-109.3 deg. F). As the liquid sprays out of the orifice, it immediately vaporizes and absorbs chamber heat while it mixes with process air.

Note: A **Strato-Flo check valve** is added (See **Error! Reference source not found.**) to insure that the chamber does not become pressurized.

4.5.1 Operation

The system is activated by an event output from the main controller (or by a manual switch). To use the system, the Event must be turned ON. Reference the Event Label on the side of the chamber or your Test Report for the Event Number assigned to this feature.

Once the system is enabled with the event output, the controller's time proportioned Full Cooling output will energize a solid state On-delay timer. If the Full Cooling output remains on longer than ten seconds, the timer will time out and energize the CO_2 Injection solenoid valve SOL. This valve will open to permit the flow of CO_2 into the chamber to boost the cooling rate. As soon as the Full Cooling output turns off, the timer output will open to de-energize SOL and shut off the flow of CO_2.

Refer to the Installation Instructions Section for supply and connection type specifications.

WARNING

Oxygen is displaced by carbon dioxide gas. Make sure the area surrounding the chamber is well ventilated to dilute the gas vented from the chamber vent port check valve!

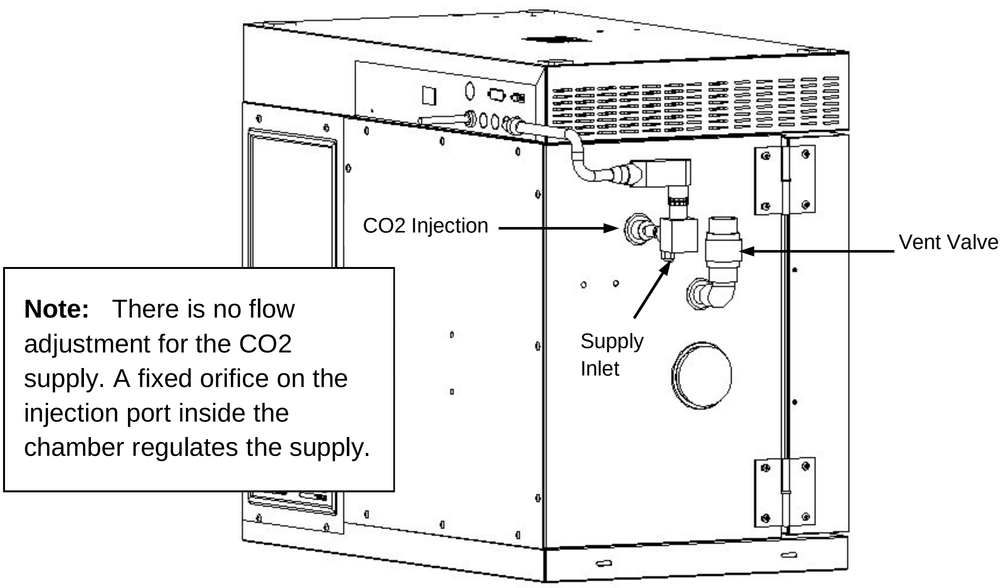


Figure 14 CO_2 Boost Supply System

4.6 TEMPGARD IV IV Alarm and Shutdown Circuit

A comprehensive alarm and shutdown circuit may be provided for protection against product over/under temperature. This optional feature utilizes a Watlow EZ Zone Controller configured as a Tempgard IV IV temperature protector. The EZ Zone is a microprocessor based controller that incorporates programmable high and low temperature limits. A 100 ohm Platinum RTD is used for temperature measurement. It is placed near the plenum in the downstream airflow, which is the most responsive area of the chamber.

Figure 15 Control Panel with Tempgard IV IV Option

Figure 16 Tempgard IV Controller

1	Audible Buzzer	Activates when the alarm setpoint is exceeded.
2	Watlow EZ Zone	Used to program high or low limit temperature setpoints.
3	RESET	This button is pressed to reset an alarm activation. See 6.4.1 for a detailed description.
4	SILENCE	This two position rocker switch is used to reset and clear alarms. See 6.4.1 for a detailed description.
5	OVERTEMP	Light turns on indicating an over temperature condition.
6	ALARM	This light is on whenever there is an active alarm.
7	NORMAL	This light is on when there are no alarms and will turn off on alarm activation.
8	SILENCE	Turns on when there is an alarm activation.

4.7 Intrinsically Safe Interior Design

4.7.1 Overview

Intrinsically safe equipment has been incorporated into the chamber interior design to help protect the chamber from an explosive condition that could arise when processing with flammable volatiles or combustibles. Explosion relief equipment is included with this design. Please note that using the equipment below does not automatically classify your chamber as a Class A type chamber under NFPA 86.

4.7.2 Intrinsic Design Features

To prevent the source of ignition, the following equipment and design features may be employed.

4.7.3 Sheathed electrical heaters

These heaters are low-watt density types that have the heater element encased in either a stainless steel or Incoloy type sheath material. Stainless steel heat transfer fins are attached the full length of the heater. <u>One heater only</u> is typically used in the T2C / T2RC and <u>Tenney Junior</u> series. Two heaters are typically used in the BTC / BTRC chambers.

Figure 17 Conditioning Plenum Model TJR-INS

Your equipment configuration may be slightly different from what is shown.

Older style heaters are larger in diameter.

4.7.4 Heater Surface Temperature Control

Surface temperature of each sheathed heater is monitored by two separate Watlow LV Limit Controllers to prevent auto ignition of combustible vapors / materials processed in the chamber. Each controller uses a dedicated Type T thermocouple which is encased in a separate tube that runs along the length of the heater surface. Two separate points along the heater are monitored. Note: Some units may have both thermocouples encased in the same T/C tube.

One of the LV Limit Controllers is used to cycle power to the heater OFF when the surface temperature reaches a predetermined high limit setpoint. These controllers are normally designated **2TS, 4TS, 6TS**, etc. 2TS / 6TS will automatically reset and restore power to the heater as soon as the temperature drops below the limit setpoint. **For O/N 6xxxx, the 2TS high limit setpoint is factory preset at xxx° C (xxx° F).**

The second LV Limit Controller can be set up in two different configurations that require a manual reset of the system.

Configuration #1: The second LV Limit Controller is used to disable the Heat Control Output of the main controller when a different, slightly higher limit setpoint is reached. These controllers are normally designated **1TS, 3TS, 5TS**, etc. A high limit alarm from 1TS / 5TS would normally indicate a loss of air circulation resulting from a failure within the air circulation system. This limit controller will not automatically reset. To reset the Limit Controller you must cycle power to the unit by disconnecting the chamber power supply plug from its receptacle and then by plugging it back in. **For O/N xxxxx, the 1TS high limit setpoint is factory preset at xxx° C (xxx° F).**

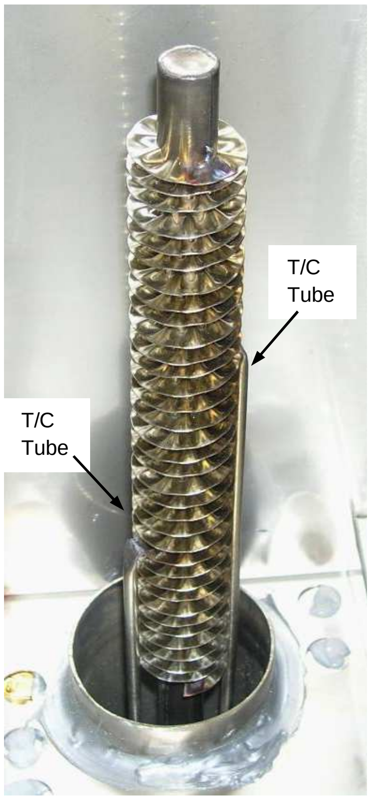


Figure 18 Thermocouple Tubes

Configuration #2: The second LV Limit Controller is used to remove power from Master Contactor 1CON and the conditioning control circuitry when a different – slightly higher limit setpoint is reached. These controllers are normally designated **1TS, 3TS, 5TS**, etc. A high limit alarm from 1TS, 3TS, or 5TS would normally indicate a loss of air circulation resulting from a failure within the air circulation system. 1TS, 3TS, and 5TS are incorporated into the optional Alarm and Shutdown Circuit. When employed, they will function as the standard Watlow LV Limit Controller described in that section. **For O/N xxxxx, the 1TS high limit setpoint is factory preset at xxx° C (xxx° F).**

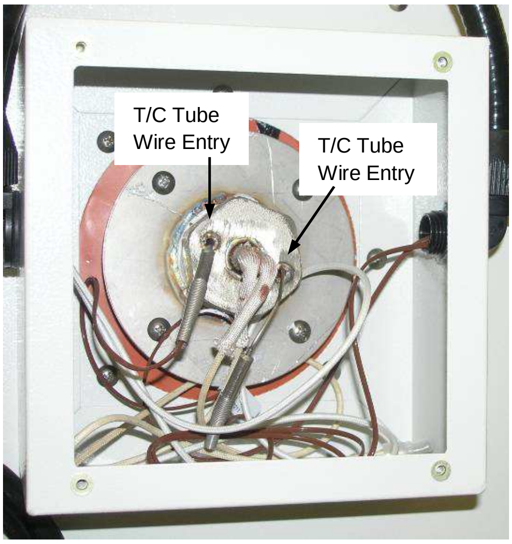


Figure 19 Heater Junction Box

4.7.5 Watlow LV Limit Controller

The Watlow LV is a 1/8 DIN type controller with a four character setpoint LED display, and setpoint increment and decrement keys. A new setpoint is entered 3 seconds after the last key is pressed. A red LED on the Watlow LV will illuminate in an alarm condition. This controller uses a Type T thermocouple to measure temperature.

WARNING	You must set the Watlow LV Limit Controller to a temperature setpoint that is well below the auto ignition temperature of the vapor present in the chamber! This setpoint is only determined by the customer.

Figure 20 Watlow LV Limit Controller

4.7.6 Loss of Airflow

With a loss of airflow through the heaters, the temperature of the surface will quickly climb. Loss of airflow generation may be the result of a loose circulation fan or blower wheel, a faulty conditioner motor, or a loss of a motor start command from either the main controller or VFD. The Watlow LV Limit Controllers 1TS, 3TS, and 5TS described above are used for this purpose.

4.7.7 Non-Sparking Conditioner Fan Design

The conditioner fan is made of aluminum and the inlet ring is made of stainless steel. If the fan or fan shaft develops an alignment problem causing the fan blades to strike the inlet ring, no sparks can be generated between the two dissimilar metals.

4.7.8 Intrinsic Safety Barriers

Signal wires from RTDs, thermocouples, or transducers are connected to intrinsic safety barriers in the control compartment. Intrinsically safe equipment is defined as “equipment and wiring which is incapable of releasing sufficient electrical or thermal energy under normal or abnormal conditions to cause ignition of a specific hazardous atmospheric mixture in its most easily ignited concentration.” (ISA-RP12.6) This is achieved by limiting the amount of power available to the electrical equipment in the hazardous area to a level below that which will ignite the gases. Basic intrinsic safety barrier design uses zener diodes to limit voltage, resistors to limit current, and a fuse.

4.7.9 Explosion Proof internal Light Fixtures

The following features would be fully described in a custom manual when employed:

- GN2 Purge System with initial high flow purge and low flow purge to maintain an inert atmosphere
- Oxygen Monitoring System to detect oxygen levels above the lower LEL level for the process involved
- Exhaust Blower Purge Air System

4.7.10 Explosion Relief

There are two methods of employing unobstructed explosion relief for freely relieving internal explosion pressures according to NFPA 86A. These methods include the use of explosion relief vents and explosion venting door latches. Each are described is separate sections. Explosion relief is designed as a ratio of relief area to oven volume. The minimum design shall be at least 1 ft^2 (0.093 m^2) of relief area for each 15 ft^3 (0.424 m^3) of oven volume.

One or more Brixon Explosion Venting Latches are installed on the chamber door to provide venting in the event of an internal explosion or deflagration. The latches are non-sparking types, which are made of either aluminum or brass and are designed to release at a predetermined pressure. Latches may be chrome plated.

When chamber air pressure rises (due to a deflagration) to the release point of the door latches, the latches will disengage and allow the door to blow out away from the chamber. A stainless steel safety chain with a snap action clasp is attached to the oven door to limit the outward travel of the door should an explosion occur.

WARNING

You must set the Watlow LV Limit Controller to a temperature setpoint that is well below the auto ignition temperature of the vapor present in the chamber! This setpoint is only determined by the customer.

Your equipment configuration may be slightly different from what is shown.

.

Figure 21 Explosion Relief Features

4.8 Data and Communications Ports

Three types of communication to external devices are offered as options.

4.8.1 RS-485 Interface

RS-485 is a multipoint communications standard set by the Electronics Industry Alliance (EIA) and Telecommunications Industry Association (TIA). RS-485 supports several connection types, including DB-9 and DB-37. Because of lower impedance receivers and drivers, RS-485 supports more nodes per line than RS-422.

Refer to electrical drawings for pin outs.

4.8.2 Ethernet Communications Port

This type of port can be used to connect oven to another computer, a local network, or an external DSL or cable modem.

4.8.3 IEEE Communications Port

The **IEEE 1394 interface** is a serial bus interface standard for high-speed communications and isochronous real-time data transfer.

4.9 LinkTenn32 Software

LinkTenn32 is a Microsoft Visual Basic Software application designed for the Microsoft Windows™ family of PC Operating Systems. LinkTenn32 utilizes a Multi-Document Interface (MDI) familiar to Windows™ software applications so more than one Environmental Chamber Window can be used at a time. LinkTenn32 provides centralized remote monitoring and control of multiple process controllers simultaneously. LinkTenn32 supports the following controllers: **TPS - VersaTenn III, IV, and V, Blue M Pro550 / 750, Watlow 942 & F4, and Partlow MIC 1462 Controllers**. The major features provided include:

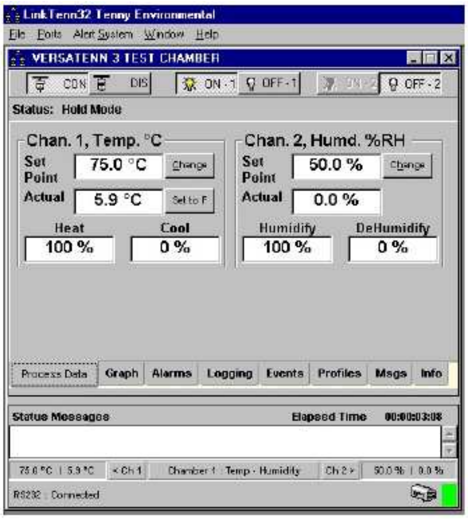
- Interactive remote control and monitoring.
- Alarm reporting and notification via Email or Fax.
- User-friendly profile program editor.
- Logging, printing and graphing of process data.
- Exporting of logging history data via an ASCII comma separated values (CSV) file for easy import into Microsoft Excel or any analysis package that accepts comma separated values (CSV) file format.

Go to website: www.tidaleng.com for more information on LinkTenn32 Software.

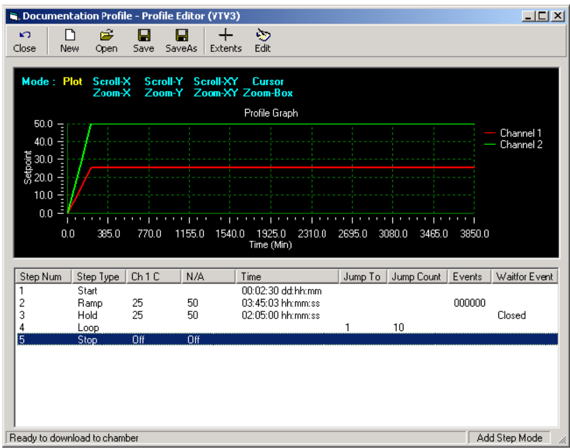
The minimum hardware requirements for LinkTenn32 are as follows:

- One of these Microsoft Windows™ PC Operating Systems: Windows 95, 98, 98 Special Edition, NT 4.0 Service Pack 6a, 2000 Service Pack 2
- A Pentium Processor 233 MHz or better
- 128 MB Ram plus 32 MB for each simultaneous chamber session
- 40 MB hard disk space
- One serial port
- One National Instruments GPIB IEEE Interface (Optional)
- One 10/100 Ethernet card using TCP/IP (Optional)
- Printer (Optional)
- Fax Modem (Optional)

Example Screens



LinkTenn32 - 2 Channel VersaTenn III Screen



LinkTenn32 Sample Graph Screen - 2 Channel

4.10 Chart Recorder

As an option, your chamber may be provided with either a circular or strip type chart recorder to record temperature versus time. This recorder is typically a one-pen type, which also digitally displays the process value. A 100 ohm platinum RTD is used for temperature measurement. It is placed in the discharge air of the chamber plenum.

The recorder configuration is documented in the Test Report, which is located in the Supplemental Instructions Section. Reference the recorder's user manual for a detailed operation of the unit. The recorder mounting locations for both the Model TJR and TUJR are shown in the drawings below.

CHART RECORDER with MODEL TJR

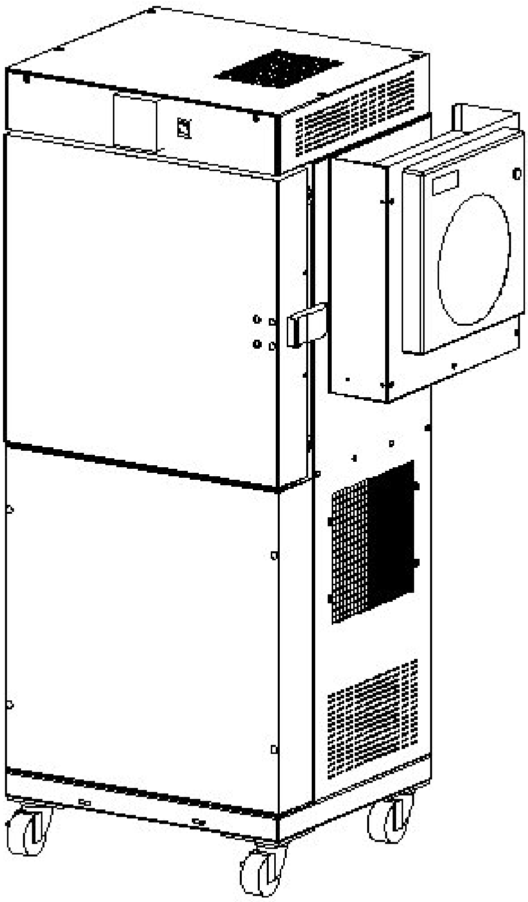


CHART RECORDER LOCATION - MODEL TU-JR

Figure 22 Chart Recorder Locations

5.0 Installation

Follow the steps in this section to ensure a safe and accurate installation of your unit.

5.1 Delivery and Uncrating of Unit

Inspect equipment and shipping crate immediately upon receipt. If any damage is apparent, you should discuss it with the trucking delivery person and contact the transportation company immediately. Make notes of any damage on the Bill Of Lading. Retain all shipping materials for inspection. Any claims for damage must start at the receiving point. When submitting a claim for shipping damage, request that the carrier inspect the shipping container and equipment. Check packing slip carefully and make sure all materials have been received as indicated on the packing ticket. Unless otherwise noted, YOUR ORDER HAS BEEN SHIPPED COMPLETE. Check packing slip carefully and make sure all materials have been received as indicated on the packing ticket.

CAUTION	Chambers and any remote machinery skids or control cabinets should be handled and transported in an upright position. They <u>must never</u> be carried on their back, front, or any side.
CAUTION	Do to the vibration incurred during shipping and handling, it is possible that mechanical connections could become loose. Check all connections to make sure they are secure.
CAUTION	Inspect the circulation fan inside the chamber. The fan is driven by an external motor that is mounted on isolation bushings. Sometimes during shipping, the motor is pushed out of vertical alignment. If this has occurred, the fan blade may strike the plenum cover. Eliminate the interference by pushing the motor back into alignment on its rubber mounts. However, be sure that the shipping abuse was not so great that the extension shaft on the fan has been bent.

5.2 Location and Installation of Unit

Your equipment has been fully operated, tested, and balanced in our plant prior to shipment, <u>unless notified otherwise</u>. Follow the installation requirements below.

- Chamber Weight: Approximately 260 lbs.
- Environmental Specifications - For CE Marked Chambers Only
- <u>Pollution Degree 2</u>, <u>Installation Category III</u>
- Do not place the unit near combustible materials or hazardous fumes or vapors.
- Ventilation: The chamber should be installed in an area where there is good air ventilation, especially if an air-cooled condenser is used. Allow a minimum of 18 inches between any wall and chamber side, or to any equipment mounted to the chamber side.
- Do not locate unit in areas of wide ambient temperature variation such as near vents or outdoor entrances.
- Do not install unit in a corrosive environment. A corrosive environment may lead to poor performance and deterioration of unit.

- **Do not position the chamber in a manner that would make it difficult to operate your main power disconnect switch.** See "Power Connection" below.
- Make sure the chamber is leveled when set up.

Very Important! Upon completion of the initial installation of the chamber and upon completion of any maintenance procedure, make sure that all access panels that have been removed are reinstalled securely before operating the unit.

5.3 Air Supply Connection

Your chamber will require a compressed air supply for the Dry Air Purge / Dry Air Dehumidification System option. The supply should be clean and dry, and range from 80 PSIG min. to 100 PSIG max. The connection type is 1/4" FPT. Make sure the connection is secure. Reference the corresponding "Options" section in this manual and your chamber specifications for more details.

A **Strato-flo check valve** is mounted on the side of the chamber to insure that the chamber does not become pressurized.

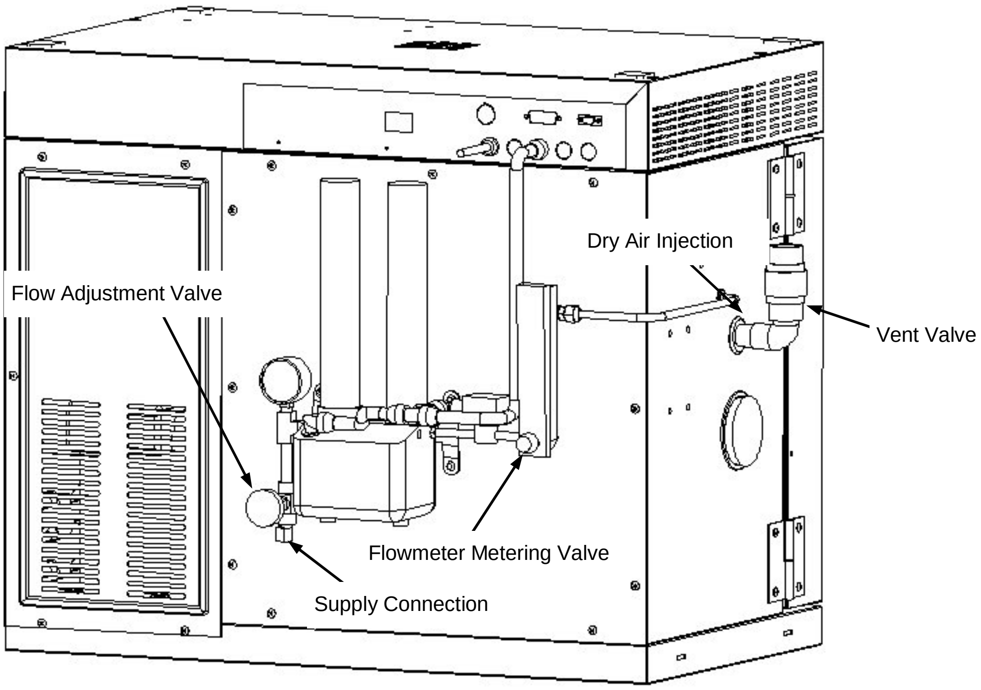


Figure 23 Dry Air Purge System Connections

5.3.1 Flow Adjustments

Adjust the **flow adjustment valve** at the supply connection to maintain 100 PSIG max. Adjust the flowmeter **metering valve** to approximately 300 cubic feet per hour.

5.4 GN_2 Connection

Your chamber will require a supply of gaseous nitrogen for the GN_2 Purge System option. The GN_2 supply may range up to 100 PSIG maximum. The connection is type 1/8" FPT. Make sure the connection is secure. Reference the corresponding "Option" section in this manual for a detailed operation description.

WARNING	Gaseous nitrogen displaces oxygen. Make sure the area surrounding the chamber is well ventilated to dilute the gas vented from the chamber vent valve.
WARNING	Burn Hazard. Avoid contact with cryogenic materials. Serious burns from immediate frostbite will result. Insulated gloves, eye goggles, and protective clothing MUST be worn when working with or around these materials. Gloves should be loose fitting so they can be quickly discarded in case liquefied gas spills or sprays into them.

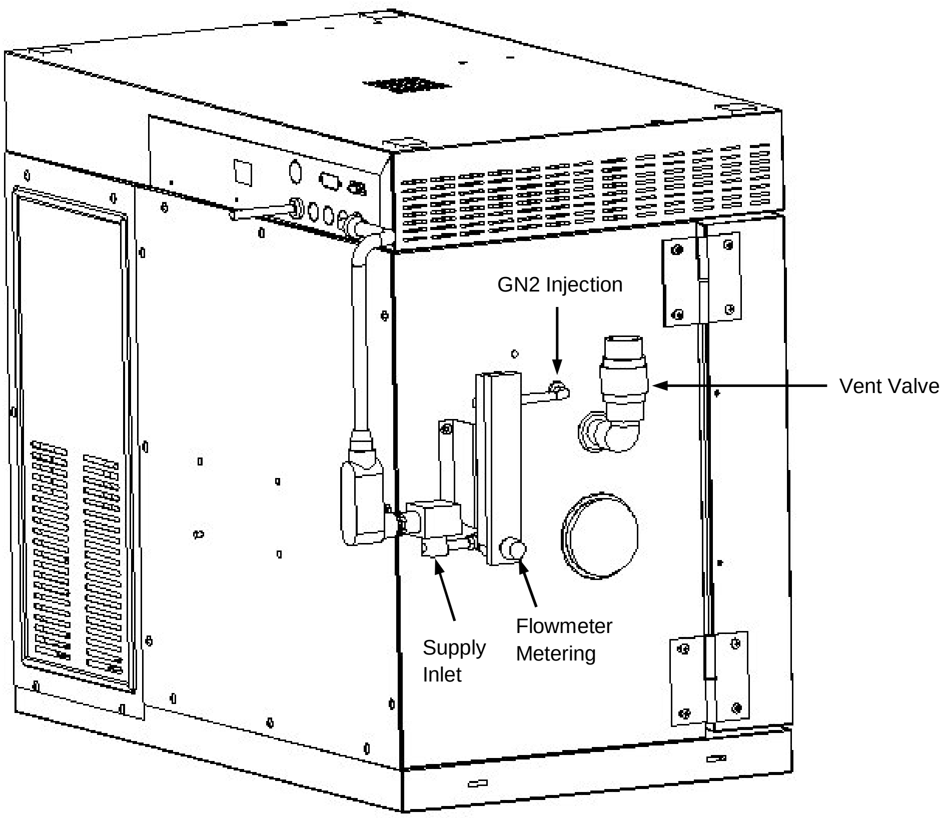


Figure 24 GN_2 Supply System Connections

5.4.1 Flow Adjustment

Adjust the flowmeter Metering Valve to maintain approximately 300 cubic feet per hour.

5.5 LN_2 Connection

Your chamber will require a supply of liquid nitrogen for the LN2 Boost Cooling option. The supply may range up to 40 PSIG maximum. The connection is type 1/8" NPT. Make sure the connection is secure. Reference the corresponding "Option" section in this manual and your chamber specifications for more details.

	A **Strato-flo check valve** is mounted on the side of the chamber to insure that the chamber does not become pressurized.
WARNING	Gaseous nitrogen resulting from vaporized LN2 displaces oxygen. Make sure the area surrounding the chamber is well ventilated to dilute the gas vented from the Strato-flo check valve!
WARNING	Burn Hazard. Avoid contact with cryogenic materials. Serious burns from immediate frostbite will result. Insulated gloves, eye goggles, and protective clothing MUST be worn when working with or around these materials. Gloves should be loose fitting so they can be quickly discarded in case liquefied gas spills or sprays into them.
WARNING	Do not allow liquid nitrogen to contact the door gasket. Exposure to LN2 will damage the gasket and violate the seal.

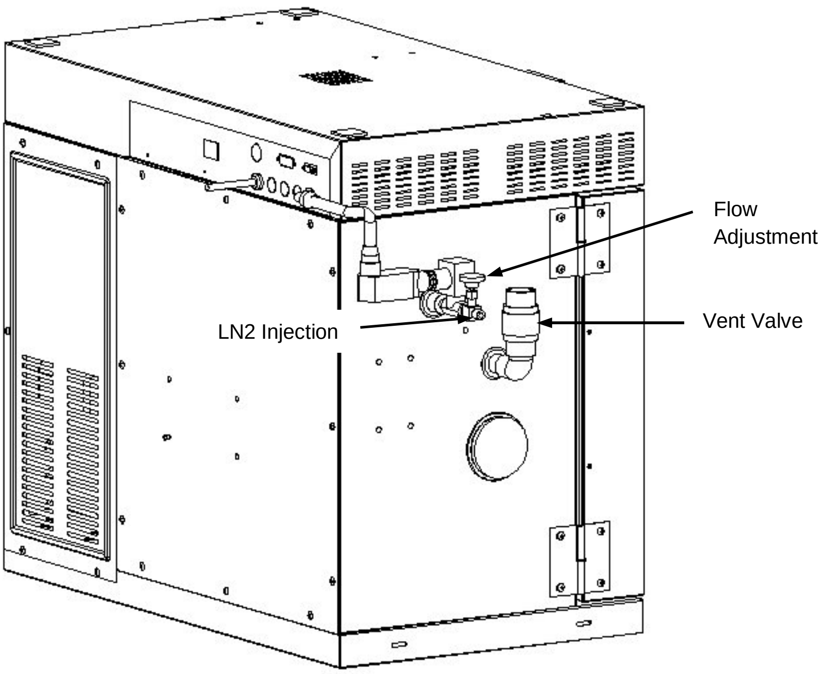


Figure 25 LN2 Cooling System Connections

5.5.1 LN_2 Flow Adjustment

LN2 systems are provided with a manually set flow adjusting valve, which permits the adjustment of nitrogen flow to avoid incomplete evaporation at varying LN2 supply pressures. As the chamber cools to the extreme cold temperature limit, complete evaporation of liquid nitrogen may not occur if the supply pressure is allowed to drop. Incomplete evaporation will cause droplets of liquid to fall to the chamber floor and cause liquid to accumulate.

A setting of 4 turns open of the valve generally provides good performance at a supply pressure of 20 to 25 PSIG. This valve may be readjusted as necessary to accommodate the supply pressure at the end use point.

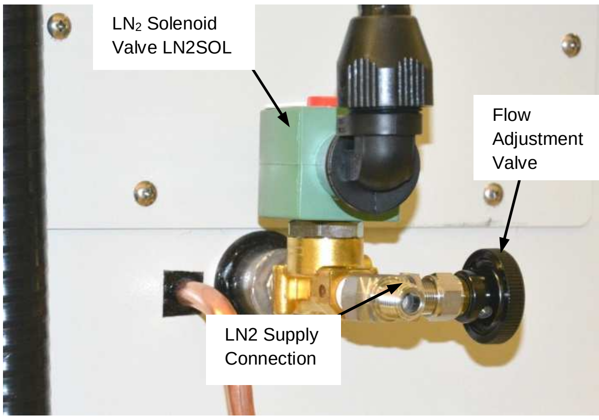


Figure 26 LN_2 Supply Connection and Flow Adjustment

5.6 CO_2 Connection

Your chamber will require a supply of liquid carbon dioxide for the CO_2 Boost Cooling option. The supply may range up to 1000 PSIG. The connection is type 1/4" 90° Flare. Make sure the connection is secure. Reference the corresponding "Option" section in this manual for a detailed operation description.

WARNING

Carbon Dioxide gas displaces oxygen. Make sure the area surrounding the chamber is well ventilated to dilute the gas vented from the chamber vent port check valve!

WARNING

Burn Hazard. Avoid contact with cryogenic materials. Serious burns from immediate frostbite will result. Insulated gloves, eye goggles, and protective clothing MUST be worn when working with or around these materials. Gloves should be loose fitting so they can be quickly discarded in case liquefied gas spills or sprays into them.

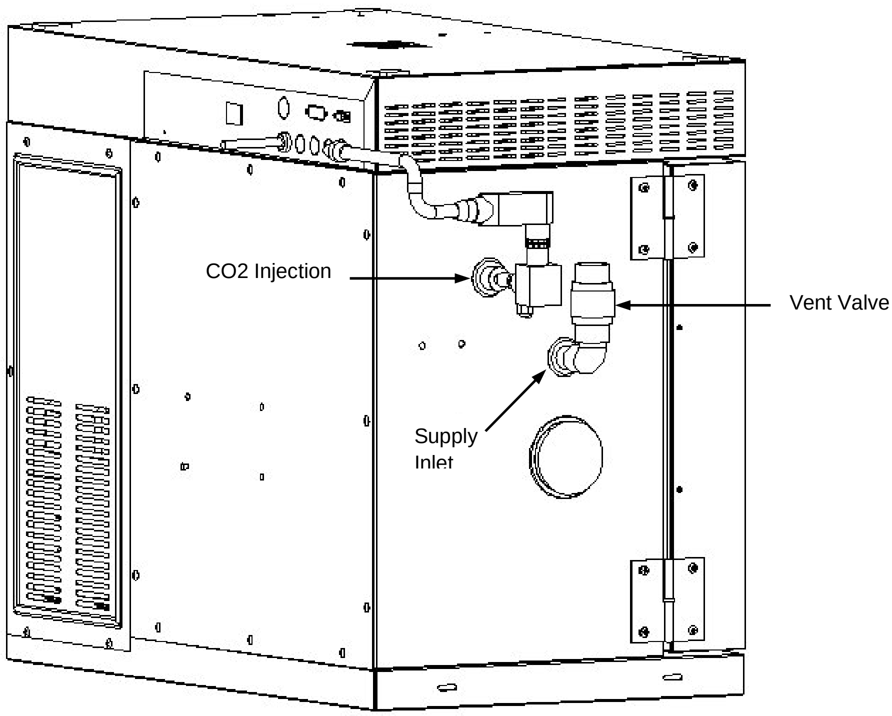


Figure 27 CO_2 Supply Connections

There is no flow adjustment for the CO_2 supply. A fixed orifice on the injection port inside the chamber regulates the supply.

5.7 Power Supply Specifications and Connection

Specifications for Model TJR-INS can be listed as either Standard or CE Marked. See sales quote.

Standard Chambers: 120 V, 16 A, 60 Hz, 1 PH (Standard units do not employ the CE Mark)

Your main power fused disconnect switch should be fused at 20 Amps.

CE Marked Chambers Only: 220 V, 13 A, 50 Hz, 1 PH

Your main power fused disconnect switch should be fused at 16 Amps

5.8 Power Connection

WARNING

Before making the power supply connection to your unit, you must perform the following procedure:

1. Verify the power supply voltage rating established for your chamber (listed above). The voltage rating is also found on the serial tag on the side of the oven. Note the rated value here: _____________
2. Measure and record the intended voltage source. Note the measured value here:_____________
3. Reference the "Line Voltage Min/Max Tables" below. Verify that the power supply voltage source you measured and recorded is within the minimum and maximum allowable operating voltages for your chamber voltage rating. If it is not within this operating range, do not make the power connection! Otherwise, erratic operation and damage may occur to your equipment, which may void your warranty. If you have any questions, please call the TPS Service Department.

One of the most common causes of equipment malfunction is low line voltage as the power source to the unit. Ordinarily in this condition, the heat output would be reduced and the system's motors would operate erratically, eventually overheat, and shut down. You must be certain that your equipment is connected to a circuit with an adequate voltage and current source. An oversupply voltage would also cause erratic operation and eventual shutdown, or damage to your equipment.

- 60 HERTZ SUPPLIES - LINE VOLTAGE MIN. / MAX. TABLE		
Chamber Voltage Rating	**Minimum Voltage**	**Maximum Voltage**
120	108	132
208	188	228
230	207	253
60 Hz Supply	**Operation outside these limits can result in damage to chamber equipment.**	

- 50 HERTZ SUPPLIES - LINE VOLTAGE MIN. / MAX. TABLE		
Chamber Voltage Rating	**Minimum Voltage**	**Maximum Voltage**
200	180	220
220	198	242
50 Hz Supply	**Operation outside these limits can result in damage to chamber equipment.**	

5.8.1 Making the Power Supply Connection to the Chamber

A main power disconnect is not provided with your chamber. We recommend that a fused disconnect switch on a separate branch circuit be installed as the power source to your chamber, in accordance with all National and local electrical codes. Reference your Electrical or Power Schematic for all electrical requirements.

The power connection is made via a 6 foot long cord and plug for standard units. Connect the plug to a receptacle that has the appropriate power supply on a branch circuit of its own.

WARNING	High Accessible Current – An Earth connection is essential before connecting the power supply. Make sure equipment is properly grounded in accordance with all codes.
WARNING	Make sure that all electrical wiring is properly installed in accordance with all National and Local Electric Codes. Make sure all connections are secure.

Figure 28 TJR Power Cable and Plug

5.8.2 Application of Power

- Before energizing any equipment, make a visual inspection for loose components, electrical connections, fittings, etc. Shut all operating switches to the “OFF” position before energizing.
- Have trained personnel start and check out the equipment before its first cycle.

6.0 Operation

6.1 Standard Control Panel

The Control panel is used to control all operator functions of the chamber.

- Power ON/OFF Switch-Controls power to the chamber. The integral green light is on when power is on to the chamber.
- Chamber ON/OFF Light Switch (optional) - Turns the light on or off in the chamber.
- Watlow Temperature Controller- Temperature is controlled with the Watlow F4S Controller. The F4S is a profiling type single channel ¼ DIN controller.

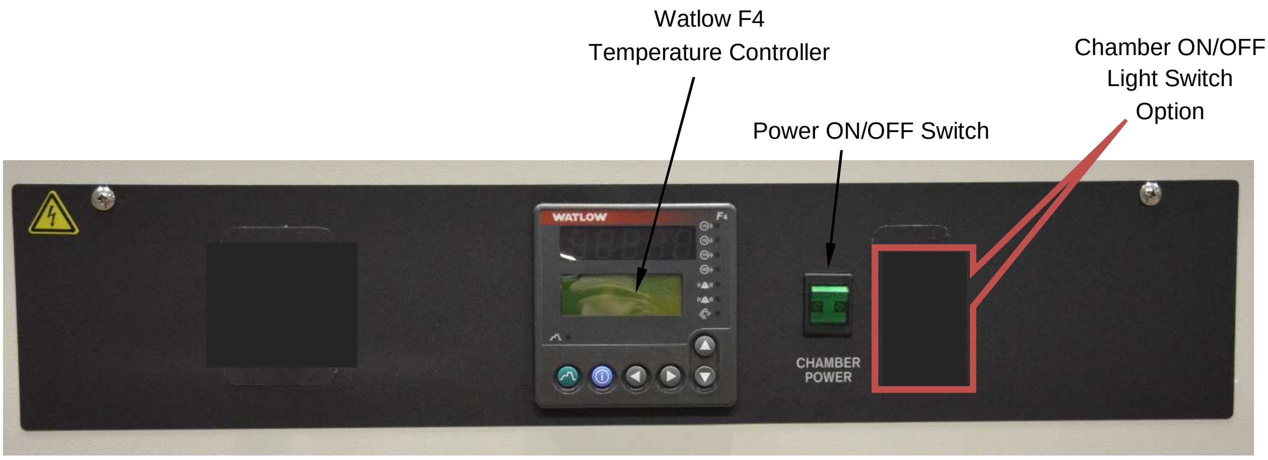


Figure 29 Standard Control Panel

6.2 Standard Operation Procedure

WARNING	Do not open chamber doors until chamber temperature drops below 200° F (93° C) when applicable. Human exposure to temperature extremes can cause injury. Take appropriate precautions when handling product.
WARNING	Do not open chamber door after operating at extreme low temperatures. Human exposure to temperature extremes can cause injury. Take appropriate precautions when handling product.
CAUTION	Always cool the chamber down below 167° F (75° C) before shutting it down. Otherwise, damage to the circulation motor shaft bearings will result.
	For **complete** programming and/or operating instructions on any of the controllers, electrical / mechanical components, or optional equipment, you must refer to their operating manuals included with your Tenney manual.
WARNING	This equipment is not designed for use with volatile or explosive materials unless it is equipped with a solvent venting package or intrinsically safe interior design, and specifically stated in your chamber specifications. Loading of such materials may result in explosion or fire.
CAUTION	Make sure you have read (and understand) this entire manual before beginning operation.
CAUTION	**Make sure the Installation Instructions have been properly followed before operating the chamber.** All switches should be in the OFF position before starting the sequence below.

1. Plug the chamber power supply cord into your power supply receptacle. The display of the main controller should be illuminated.

2. Load the product and make sure the door is securely closed.

3. Enter the desired temperature program, or manual setpoints into the main controller.

   Important: Check to see if any optional equipment must be turned on with an Event Output from the main controller. If an Event Output were supplied, a **Controller Event Output Label** with the Event Output listing would be installed on the side of the chamber. Reference the corresponding ‘Option’ section for a description of any optional feature.

5. Close the Power switch on the main controller panel. The conditioner fan will start, and chamber conditioning will begin.

6.3 Operation with Tempgard IV IV Installed

Figure 30 Tempgard IV Controller

1	Audible Buzzer	Activates when the alarm setpoint is exceeded.
2	Watlow EZ Zone	Used to program high or low limit temperature setpoints.
3	RESET	This button is pressed to reset an alarm activation. See 6.4.1 for a detailed description.
4	SILENCE	This two position rocker switch is used to reset and clear alarms. See 6.4.1 for a detailed description.
5	OVERTEMP	Light turns on indicating an over temperature condition.
6	ALARM	This light is on whenever there is an active alarm.
7	NORMAL	This light is on when there are no alarms and will turn off on alarm activation.
8	SILENCE	Turns on when there is an alarm activation.

6.4 Operation Procedure

1. Plug the chamber power cord into an outlet capable of supplying the operating power.
2. Turn on the power switch on the control panel. The green Main Power Switch light should illuminate.
3. The display of the controller should be illuminated. When power is first turned ON to the chamber, with the SILENCE Switch in the NORMAL (Right) position, the alarm buzzer will sound for several seconds and then turn off. The SILENCE Light does not illuminate. If the SILENCE Switch is in the SILENCE (Left) position with NO alarm, the buzzer and SILENCE Light will turn ON.
4. Press the SILENCE Switch to the NORMAL (Right) position.
5. Load product and close the door securely.
6. Enter the desired temperature program or manual setpoints into the main controller.

Important: Check to see if any features or optional equipment must be turned on with an Event Output from the main controller. If an Event Output were supplied, a **Controller Event Output Label** with the Event Output listing would be installed on the side of the chamber. Event Outputs are described either in one of the various "Option" sections, or in the "Temperature Control - Conditioning Control Functions" section for unique applications.

	If you wish to use the Tempgard IV IV feature for product over / under temperature protection, set the Watlow EZ Zone's high/low temperature limits at this time. Refer to the "Temperature Alarm and Shutdown Circuit", and the "Watlow EZ Zone - Tempgard IV IV Alarm Setpoint Entry" sections for further details.
	If you wish to use the Tempgard IV IV feature for chamber over / under temperature protection, do not change the factory preset values. These have been set to ± 4° C for the high/low ratings of your chamber.

6.4.1 Alarms

1. With the SILENCE Switch is in the NORMAL (Right) position and an alarm occurs, the alarm buzzer and SILENCE Light will turn ON.
2. Press the SILENCE Switch to the SILENCE (Left) position to turn the alarm buzzer OFF. The SILENCE light will remain ON.

6.4.1.1 Clearing Alarms

1. When the alarm clears, the buzzer will turn back ON and the SILENCE Light will remain ON. The chamber circuitry needs to be reset.
2. If you press the red RESET pushbutton first, the buzzer and SILENCE Light will remain ON. (The red RESET pushbutton light will turn OFF.) You must then press the SILENCE Switch to the NORMAL (Right) position to turn the buzzer and the SILENCE Light OFF.
3. If you press the SILENCE switch first, the SILENCE Light will go out and the buzzer will remain ON. Press the red RESET pushbutton. The buzzer will turn OFF.

6.5 Tempgard IV IV Alarm Setpoint Entry–WATLOW EZ

The purpose of this section is to explain how to set your low & high temperature alarm setpoints with the optional **Watlow EZ Zone Tempgard IV IV**. This feature is normally used for <u>product</u> over / under temperature protection and can be changed for each process cycle desired. However, it can also be used for <u>chamber</u> temperature protection, which is the factory preset default. It is part of the Alarm and Shutdown Circuit described earlier.

Normal Conditions: When conditions are within the alarm setpoints, the upper display of the EZ Zone will indicate the process temperature (normally in degrees Celsius), and the lower display will be blank. Temperature measurements are made with a 100 ohm platinum RTD sensor, which is placed in the discharge air of the conditioning plenum.

Figure 31 Watlow EZ Zone Limit

6.5.1 Alarm Setpoint Entry Procedure

This controller incorporates preconfigured software that is designed for this particular type of test chamber. Operations and Setup type parameters have been set at the factory and cannot be changed. Only the high and low limit setpoints can be changed with the procedure below.

1. Press the Advance key one time. The High Limit Setpoint "Lh.S1" parameter will appear in the green lower display, while the current setpoint for that parameter will be displayed in the upper display.
2. Press the Up or Down arrow key to adjust the High Limit Setpoint. Please note that the preprogrammed software <u>already has the maximum High Limit Setpoint permitted for this particular chamber</u>. As a result, as factory received, you can only adjust the High Limit downward.
3. Press the Advance key one time. This will register the new High Limit Setpoint value.
4. The Low Limit Setpoint "LL.S1" parameter will appear in the green lower display, while the current setpoint for that parameter will be displayed in the upper display.
5. Press the Up or Down arrow key to adjust the Low Limit Setpoint. Please note that the preprogrammed software <u>already has the maximum Low Limit Setpoint permitted for this particular chamber</u>. As a result, as factory received, you can only adjust the Low Limit upward.
6. Press the Advance key one time. This will register the new Low Limit Setpoint value. The upper display will now show the current process temperature.

6.5.2 Alarm Conditions

When an out of limit condition occurs the green lower display will flash "Attn", while the red upper display will flash "L ı H1" for a high limit alarm and "L ı L1" for a low limit alarm. This will alternate with the actual process temperature in the upper display. The alarm buzzer will sound.

Important: When the alarm condition has cleared, you must first press the Reset key on the EZ Zone faceplate to reset the EZ Zone TGIV alarm contacts.

You must then press the red lighted RESET pushbutton on the TGIV panel. This will reset the chamber main control circuitry.

6.5.3 Saving and Restoring User Settings (<u>Copied</u> from the Watlow Limit Controller Manual)

Recording setup and operations parameter settings for future reference is very important. If you unintentionally change these, you will need to program the correct settings back into the controller to return the equipment to operational condition.

After you program the controller and verify proper operation, use User Save Set - "**USr.S**" (Setup Page, Global Menu) to save the settings into either of two files in a special section of memory. If the settings in the controller are altered and you want to return the controller to the saved values, use the User Restore Set - "**USr.r**" (Setup Page, Global Menu) to recall one of the saved settings.

A digital input or the Function Key can also be configured to restore user settings.

Note: Only perform the above procedure when you are sure that all the correct settings are programmed into the controller. Saving the settings overwrites any previously saved collection of settings. Be sure to document all the controller settings.

7.0 Preventive Maintenance

WARNING Only qualified maintenance and electrical personnel should be allowed to perform any maintenance or repair work.

WARNING Turn the main power disconnect switch on the front of the oven to the OFF position and proceed with your company's Lock-Out / Tag-Out procedure before servicing or cleaning. The oven's main power disconnect switch is a lockable type.

Frequency of preventative maintenance operations depends upon your particular process application and frequency of use. Because of this, a hard and fast schedule of maintenance operations is difficult to present. A set of guidelines suitable for an "average use" oven might not be sufficient for an oven with a high frequency use. Therefore, the preventative maintenance measures given here are offered as a guide, allowing you to arrange your own program.

A Preventative Maintenance Schedule/Log chart is provided at the end of this section. The suggested inspection/service dates given are for average use.

7.1 Maintenance Checks/Procedures

Periodic Maintenance Tasks		
Period	**Assembly**	**Task**
Daily or Start of Operation	Oven Interior	Inspect interior for debris etc.
Monthly	Door Seal	Check that the door seal evenly around its perimeter to negate heat loss. Adjust door latch if necessary.
Monthly	Air-Cooled Condenser Coil / Fan	Inspect the condenser coil for dust or dirt accumulation that would impede the flow of air. A dirty condenser will decrease system efficiency and

Periodic Maintenance Tasks		
Period	**Assembly**	**Task**
		drive up compressor head pressure, causing it to trip out. If necessary, clean with a brush or vacuum cleaner. Frequency of cleaning depends upon the air quality at the chamber. The condenser fan should also be checked for cleanliness. Make sure the fan spins freely.
Bi-Annually	**Conditioner Fan**	Inspect and clean the conditioner fan in the conditioning plenum. Make sure the fan spins freely and that it is tight on its shaft.
Bi-Annually	**Evaporator Cooling Coil**	Clean the evaporator cooling coil in the conditioning plenum
Bi-Annually	**General Electrical Connections**	Inspect inside the control panel and the machinery compartment for loose electrical connections, frayed wires, loose components, or other potential problems.
Bi-Annually	**Electric Heaters**	Inspect the electric heaters inside the chamber conditioning plenum and look for sagging elements, broken insulators, or other defects.
Bi-Annually	**Electrical Supply Voltage**	Measure the power supply voltage to your oven and verify that it is within the ±10% tolerance established for the nameplate rating of your oven
Annually	**Main Controller Calibration**	The main temperature controller should be checked for temperature indicating accuracy, and for the proper activation of limit or alarm outputs (when provided). Please reference the controller user manual for more information.

All interlocks and safety features should be tested periodically for proper operation.

7.2 Preventative Maintenance Schedule / Log

For each of the items to be inspected, refer to item description sections for details on maintenance and service.

PREVENTATIVE MAINTENANCE SCHEDULE / LOG					
ITEM TO BE INSPECTED	**Inspection Period**	**Actual Date Inspected / Serviced**	**Actual Date Inspected / Serviced**	**Actual Date Inspected / Serviced**	**Actual Date Inspected / Serviced**
Door Gaskets	30 Days				
Door Sealing Quality	30 Days				
Condenser Coil / Fan	30 Days				
Conditioner Fan	6 Months				
Evaporator Cooling Coil	6 Months				
General Electrical Connections	6 Months				
Electric Heaters	6 Months				
Electrical Supply Voltage	6 Months				
Main Temperature Controller Calibration	1 Year				

8.0 Troubleshooting

This section does not propose to be a complete and comprehensive troubleshooting guide for the serviceman. However, it attempts to help you locate the causes of possible troubles so that you can make simple repairs or adjustments yourself. The information here should also help you in localizing trouble so that you can better describe the malfunction when contacting the TPS Service Department. Refer to the appropriate electrical and refrigeration drawings when using these troubleshooting suggestions.

TENNEY JUNIOR TROUBLESHOOTING GUIDE		
PROBLEM	**POSSIBLE CAUSE**	**CORRECTIVE ACTION**
1. Conditioner fan dead	Motor shaft frozen	Verify - rotate by hand carefully!
	Defective motor	Verify - feel for heat & measure current
2. Insufficient Heat	Chamber door is ajar	Close securely
	One heater element is burned out	Verify - measure current
	Controller failure	Carefully check programming
3. No Heat	Heat Limiter opened	Replace
	Heater elements burned out, or open	Replace
	Heat output failing to close	Verify - Contact TPS Service
	Solid State Relay 1SSR failed open	Replace
	Open temperature sensor	Replace
4. Excessive Heat	1SSR failed in conducting state (usual failure mode)	Replace
	Heat output failing to open	Verify - Contact TPS Service
	Short circuited temperature sensor	Replace
5. Refrigeration System Dead	Cooling output failing to close	Verify - Contact TPS Service
	Solid State Relay 2SSR failing to conduct	Replace
	Compressor motor overload protector has tripped	Wait for 5 minutes. If overload does not close - replace it

TENNEY JUNIOR TROUBLESHOOTING GUIDE		
PROBLEM	**POSSIBLE CAUSE**	**CORRECTIVE ACTION**
6. Compressor hums but will not start	Low line voltage	Get proper electrical service
	Starting capacitor is defective	Replace
	Internal compressor problem	Measure winding resistance, test for grounds, contact TPS Service
7. Repeated shorting or blowing of start capacitors	Excessive start time, voltage too low	Correct low line voltage problem
8. Compressor starts, hums, runs slowly, staying on start winding	Low line voltage	Get proper electrical service
	Shorted winding	Test resistances, test for grounds, contact TPS Service
9. Low stage compressor will not run	Pressure switch PS2 not closing	Contact TPS Service
10. Low stage runs, but little or no cooling	Low stage is low on refrigerant	Have system leak tested
	Artificial loading valve SV stuck open full time	Replace
	Main cooling coil badly frosted	Raise temperature to defrost
11. Compressor runs but cools inefficiently	Restricted ventilation, dirty condenser fins	Move unit away from wall, clean condenser fins
12. Refrigeration works long or continuously	Excessive heat load	Reduce load if possible
	Ice on evaporator coil	Defrost
	Low refrigerant charge	Have charge checked by refrigeration mechanic - charges are on ID label

TENNEY JUNIOR TROUBLESHOOTING GUIDE		
PROBLEM	**POSSIBLE CAUSE**	**CORRECTIVE ACTION**
13. Compressor repeatedly trips out overload protector	Pressure switch failure	Have refrigeration mechanic check switches. Contact TPS Service.
Noisy compressors	Compressor loose on mounts	Tighten hold down nuts.
15. Noisy compressors, even with secure hold-downs	Broken springs within compressor housing	Replace compressor - Call TPS for assistance

9.0 Maintenance and Servicing

9.1 Refrigeration System

The refrigeration system is permanently sealed and a periodic oil change is NOT required.

If a loss of cooling performance is noted, immediately check the condenser for restricted air flow.

All motors are permanently lubricated; therefore, greasing or oiling is not required.

9.1.1 Introduction

Only qualified service personnel should ever be permitted to perform any service related procedure on this chamber!

This information is written to help the refrigeration serviceman trouble-shoot and repair low temperature cascade systems. It is assumed that the reader is familiar with standard refrigeration practice and is interested in the special techniques applicable to cascade systems

Please remember that the following description may differ in some respects to the refrigeration system equipped with your particular chamber.

9.1.2 History

Prior to the development of low boiling point refrigerants such as R13 (-114 deg. F) and R503 (-127 deg. F), reaching ultra-low temperatures with mechanical refrigeration was difficult. R22 was used down to -80 deg. F, but its system had serious drawbacks. Large and cumbersome, the machinery was subject to the many troubles that afflict a compound system operating at suctions as low as 23 inches of vacuum. The modern cascade system can reach as low as -120 deg. F with suction pressures of 0 PSIG or higher. Compact, serviceable, and reliable, today's cascade system is found on thousands of environmental test chambers.

9.1.3 How It Works

Two types of popular cascade systems are expansion valve and capillary tube. The system described in this manual is the capillary tube type.

Refrigerants with low boiling points have correspondingly high condensing pressures at normal ambient temperatures. They cannot be liquefied by conventional air or water-cooled condensing units. Therefore, low temperature refrigerants are condensed by a separate refrigeration system called “the high stage”. The main job of the high stage in most cascade systems is to condense low stage refrigerant.

9.1.3.1 High Stage

The high stage is a conventional single-stage system having a compressor, air or water cooled condenser, expansion valve, and evaporator. The evaporator is the cascade condenser, serving the low stage. Modern systems use R404a in the high stage, making -50 deg. F refrigerant temperature possible at 0 PSIG suction pressure.

9.1.3.2 Low Stage

The low stage is charged with refrigerant in vapor phase only to a specified gauge pressure. When the low-stage is idle with all components stabilized at 70 deg. F, it will contain no liquid refrigerant. When the system is activated, the low stage compressor will pump hot gas through the discharge line to the de-superheater (on 1HP units only). The de-superheater (air or water-cooled) removes some heat from the refrigerant gas, lightening the heat load on the cascade condenser. Leaving the de-superheater, the gas passes through an oil separator and flows to the cascade condenser. Here it is liquefied by heat exchange with high stage refrigerant and flows to the expansion valve.

Frosted Lines Are Typical

A low-stage characteristic is frosted liquid and suction lines. In a normal cascade system, the liquid line is always below +32 deg. F. The suction line, returning from a -100 deg. F evaporator, assuming 15 degree superheat, will also be far below freezing.

9.1.3.3 Cascade Condenser

The cascade condenser is the high stage system's evaporator and low stage system's condenser. It can be either tube-in-tube with the low-stage refrigerant in the outside tube, or tube-in-shell with the low-stage refrigerant in the shell.

9.1.3.4 De-Superheater (only on 1HP units)

The de-superheater consists of coils as part of the high stage condenser with low stage discharge gas running through them. Its purpose is to remove some heat from the low stage discharge gas and thereby lighten the load on the high-stage system.

9.1.3.5 Evaporator Coil

The evaporator coil is part of the low stage system in which the liquid refrigerant boils or evaporates, absorbing heat as it changes into a vapor. Refrigerant flow to the evaporator is metered by a capillary tube type valve.

9.1.3.6 Capillary Tube

A capillary tube is a length of tubing of small diameter with the internal diameter held to extremely close tolerances. It is used as a fixed orifice to meter the proper feed of liquid refrigerant.

9.1.3.7 Thermostat

A thermostat TS is mounted on the suction return line near the low stage compressor to monitor the temperature of the return gas flow. When a predetermined high temperature is reached, the thermostat will energize the Artificial Loading solenoid 14SOL. The setting is normally 70 degrees Fahrenheit.

9.1.3.8 Load Limit Switch

A high pressure cut-in sensor monitors the pressure inside the low stage compressor and will activate the Load Limit Switch 4PS when the low stage discharge pressure reaches 280 PSIG. This will energize the Artificial Loading solenoid 14SOL. 4PS will be deactivated when the pressure falls to 240 PSIG.

9.1.3.9 Artificial Loading

In response to the Thermostat switch TS or the Load Limit switch 4PS, the Artificial Loading solenoid will inject liquid refrigerant into the suction side of the low stage. It will first enter the expansion tank where the added volume permits the charging of additional refrigerant without increasing the standby or charging pressure beyond workable limits. Refrigerant gas is then sucked out of the expansion tank and metered through a capillary tube to the suction side of the low stage compressor. This action will maintain a positive cool refrigerant flow to the compressor, preventing overheating of the compressor and the discharge gas.

9.1.3.10 Expansion Tank

An expansion tank is provided to add volume to the low stage. Added volume permits the charging of additional refrigerant without increasing the standby or charging pressure beyond workable limits. Refrigerant gas is sucked out of the expansion tank during system operation. It is metered through a capillary tube, regulating the rate of gas entry into the system.

9.1.4 Leak Testing

Loss of refrigerant is the most common cause of refrigeration failure. Because of temperature extremes experienced by its metal parts, the cascade system is particularly susceptible to leaks.

Check the entire system with an electronic leak detector. If the system is empty or at low pressure, boost pressure to 200 PSIG with inert gas (not oxygen) diluted with a percentage of R22 refrigerant. Test again.

A leak check while the system is at low temperature, -80°F or colder, is a necessity. Expansion valve flanges, superheat adjustment caps, and other mechanical joints should be tightened and checked for leaks while at low temperature.

You may use a Halide torch to locate large leaks, but make your final test with the more sensitive electronic leak detector. This is especially important on the low stage. The low stage is gas charged with a relatively small quantity of refrigerant. Because of this, small leaks can quickly incapacitate the system.

9.1.5 Testing by Static Charge

One advantage of a gas charged system is that its tightness can be checked by periodic observation of static or standby pressure. You must read the pressure with all parts of the system at ambient temperature. This is important. The unit must be shut down at least 24 hours before a static pressure reading is taken. To eliminate the possibility of cooling the cascade condenser with the high-stage, pump-down cycle, all power to the unit must be off during the shutdown period.

When reading static pressure, consider ambient temperature. Most static charge data are for a 10 deg. F decrease in temperature. Due to a large system’s considerable thermal mass, several days may be required for all components to completely stabilize at a particular ambient.

9.1.6 Evacuation

Refrigerants R23 and R404a are expensive and there are times when charges must be recovered. A contaminated system must be cleaned and evacuated regardless of refrigerant expense.

If there is a possibility that moisture, non-condensable materials, or the wrong refrigerant contaminated a system, recover the charge and evacuate.

Select a two-stage pump capable of pumping the system down below 200 microns, and connect an appropriate gauge to ready system pressure. The ordinary compound refrigeration gauge is inadequate, however a thermocouple gauge is ideal. Evacuating a leaky system is an exercise in futility. Therefore, make sure the system is absolutely tight before beginning evacuation.

9.1.7 Charging a Low Stage

- Do not charge liquid into the low stage.
- Do not charge the system when it is below room temperature.
- Do not use charging hoses on very high pressure refrigerants or low stage refrigerants. Cylinder pressure exceeds 500 PSIG.
- Never charge the unit when it is running.

As you will note from the above, low stage charging procedure differs from the conventional method. Correct charging pressure will be noted on the equipment nameplate or in the instructions. Remember that it is important that you charge by pressure, not by volume of refrigerant.

Use 1/4 inch copper tube between refrigerant cylinder and system. Open the cylinder valve very slowly. Charge into the suction side while closely watching the discharge gauge. When correct pressure is reached, shut off the refrigerant cylinder valve, allowing the system to equalize from 10 to 15 minutes. If the pressure drops, crack open the cylinder valve, and slowly raise the pressure. Always take enough time. Systems with expansion tanks connected by a capillary tube or restrictor valve may need several minutes for gas pressure to equalize.

Keep the refrigerant cylinder upright when charging. Above all, be careful. Do not over-pressurize. Disconnect the cylinder immediately when charging is complete. A leaky cylinder valve could continue to bleed high pressure refrigerant into the system, possibly causing it to rupture. Do not take chances. The saturation pressures of low temperature refrigerants are extremely high.

9.2 Spare Parts

Spare parts are available for the small water supply level reservoir from the TPS Service Department. However, there are no internal spare parts available for the main generator housing. The entire generator housing would need to be replaced if it is found to be defective.

When you order any spare parts for the small water supply level reservoir or if the generator housing needs replaced, please specify the model and order number of the equipment served by your Vapor-Flo IV Humidity Generator.

9.3 Thermal Cutoff Replacement

WARNING

Before replacing the Thermal Cutoff, make sure all power is completely disconnected from the chamber. Pull the power supply plug from the power supply receptacle and perform your company Lock Out / Tag Out procedure

1. Remove plenum cover.
2. Loosen the 2 appropriate screws on the bottom side of the white ceramic mounting block using a flat blade screwdriver. Pull out the Thermal Cutoff with needle nose pliers.
3. Bend the leads of a new Thermal Cutoff as indicated below. Insert it into the ceramic block, and tighten the 2 screws.

Figure 32 Thermal Cutoff

CAUTION

You must place needle nose pliers as shown before bending each lead. Otherwise, you may damage the device.

10.0 Drawings and OEM Manuals

Drawing Name	Drawing #
Electrical Schematic – Special Chambers, e.g., Model TJR-INS	D800
Electrical Schematic w/ WF4 (Standard Chambers)	E - 3362 - 4
Electrical Schematic w/ WF4 (CE Marked Chambers Only)	E - 3417 - 4
Refrigeration Schematic (Standard Chambers)	R - 1851 - 4
Refrigeration Schematic (CE Marked Chambers Only)	R - 1852 - 4
General Layout - Model TJR	896499
General Layout - Model TUJR	896500

10.1.1 OEM Manuals

10.1.1.1 Standard Units

- Watlow F4 Temperature Controller
- Test Report

10.1.1.2 Manuals Supplied with Options

- IEEE Communications Manual
- Chart Recorder Manual
- Heatless Dryer Manual (with Dry Air Purge Option
- Watlow EZ Zone Limit Controller
- LinkTenn32 Software