

TECHNICAL MANUAL

RC095 and RC115 CHILLERS



Manual# D70001, Rev H

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INTRODUCTION

Receiving the New Chiller

Inspect the new chiller immediately upon receiving it. If the unit shows shipping damage, contact the transportation company and file a Freight Damage Claim. Retain all cartons and packing material until the unit is operated and found to be in good condition. The chiller has been fully tested at the Boyd Corporation factory with clean water. Although the system has been drained, some residual fluid may remain. This will not hinder the performance of the chiller.

About the Warranty

All units returned for warranty claims must have an RMA (Return Material Authorization) number on the outside of the container. Call Boyd Corporation Customer Service at +1-781-933-7300 for an RMA number. Refer to the end of manual for the chiller warranty. Units should be drained of all fluids and packaged in its original packaging.

Customer Service Support

Boyd Corporation is committed to servicing the customer, both during and after the sale. If you have any questions concerning the operation of your unit, contact our Application Engineering Department at +1-781-933-7300. To facilitate your call, please have the part number and serial number of the unit (located on the rear of the chiller) for the Boyd Corporation Applications Engineer.

Service Hotline

Boyd Corporation has a 24-hour per day, 7 day per week service hotline to help you with questions on the startup and operation of your chiller. **(Boyd Corporation recommends consulting the troubleshooting guide on page 51 before calling the service hotline.)** Boyd Corporation service can be reached by dialing +1-781-933-7300. To facilitate your call please have the part number and serial number (located on rear of the chiller) of the unit for the Boyd Corporation Service Technician.

PRODUCT SPECIFICATIONS

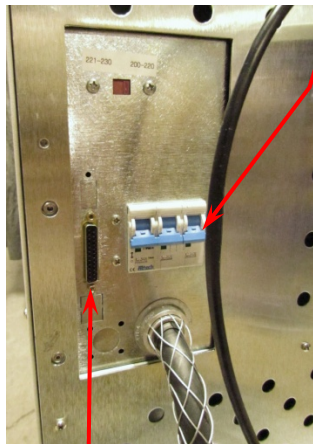
RC095/RC115 System Performance Characteristics Summary

MET Listed to UL1995 / CE Marked	Yes
Dimensions (l, w, h):	43 in, 32 in, 45 in
	109.2 cm, 81.3 cm, 114.3 cm
Noise Levels (at 1 meter)	69.1 dBA
Unit Weight {dry/ shipping}:	517 lb / 593 lb (235 kg / 269 kg) Water cooled 527 lb / 700 lb (240 kg / 317.5 kg)
Ambient Temperature Range:	41° F to 95° F (5° C to 35° C)
Process Temperature Range:	39° F to 95° F (4° C to 35° C) – Standard 14° F to 86° F (-10° C to 35° C)- Optional
Communications Options:	25 Pin D-sub Flow, Temperature and Level 9 pin D-sub, RJ45 Ethernet
Cooling Capacity Configurations RC095:	9,800 Watts at 20C SV in 20C ambient, 60Hz, 8,400 Watts at 20C SV in 30C ambient, 60Hz
Cooling Capacity Configurations RC115:	11,000 Watts at 20C SV in 20C ambient, 60 Hz 9,500 Watts at 20C SV in 30C ambient, 60 Hz
Pump Configurations:	8 gpm Turbine pump 12 gpm Centrifugal pump
Reservoir Size:	1.75 Gal (6.5 L)
Electrical Configuration:	
M01	200-220V/3 ph/50 Hz – 208-230V/3 ph/60 Hz NEMA L15-30 4 conductor plug
T01- R01	380V/3 ph/50 Hz – 460V/3ph/60 Hz NEMA L16-20 4 conductor plug
Power Cord:	10ft, 600volt 10 ga. SO cord with appropriate plug provided
Refrigerant:	R-407C (water cooled versions use R134a)
Facility water requirement (water cooled units only)	5.4 GPM (20.4 LPM) Facility water at 41° F to 77° F (5° C to 25° C)

Notes: Data taken in an unrestricted ambient air for air-cooled chillers
Capacities decrease with increasing ambient temperature.

Product Specifications (continued)

Electrical

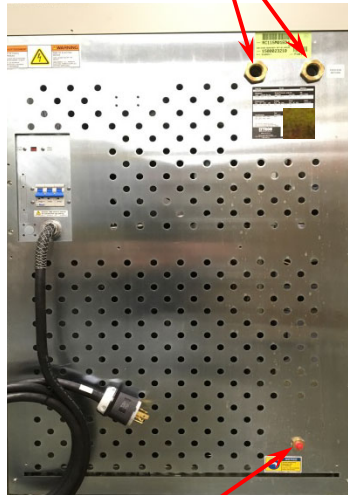


Communications

Circuit
Breaker

Rear Panel

Process
Connections



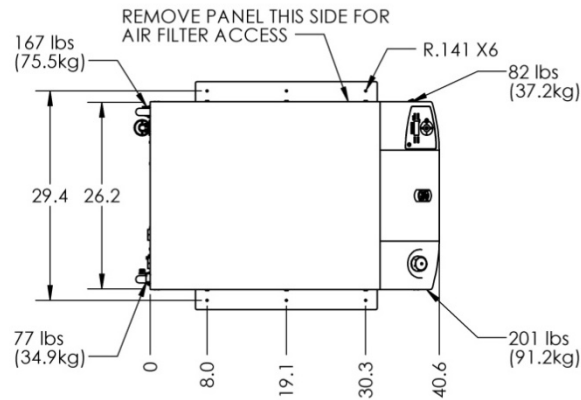
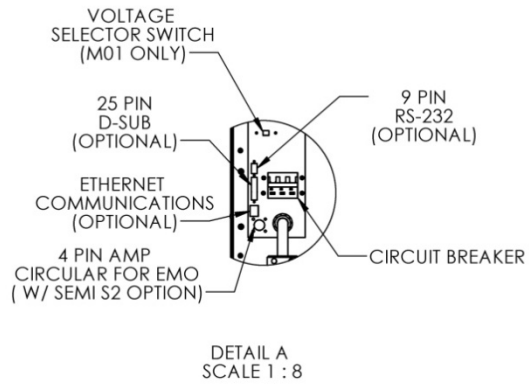
Drain Connection
Location

Front Panel

User
Interface



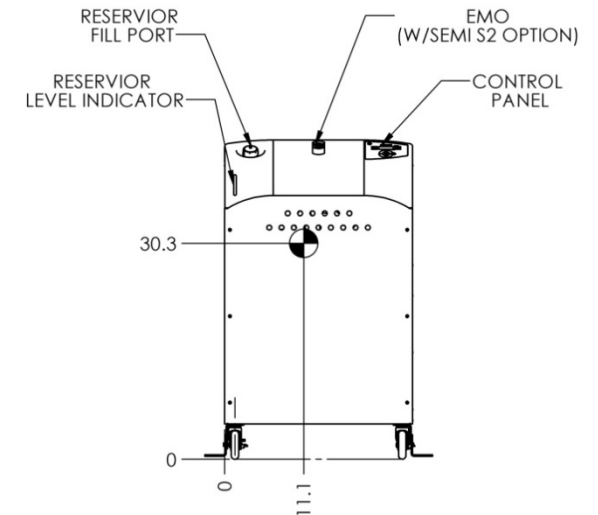
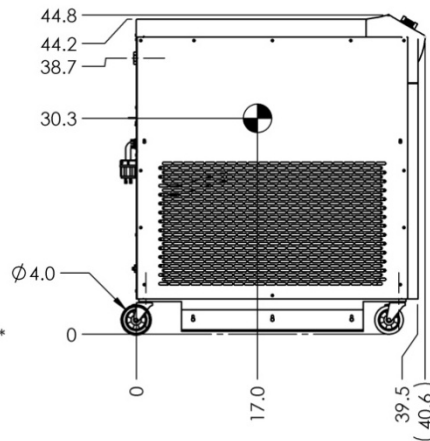
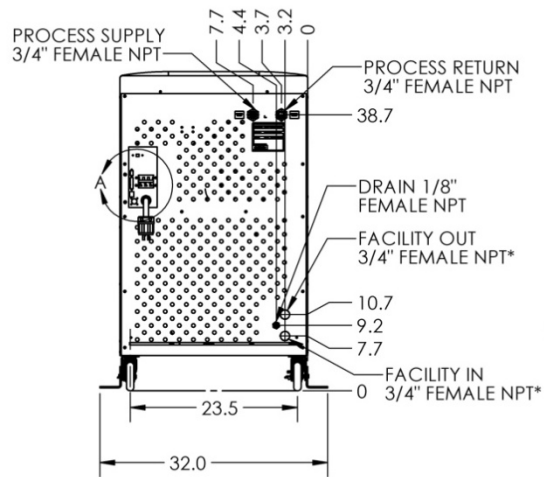
Overall Dimension Drawing



NOTES: TOTAL WEIGHT (FILLED) : 527 lb (239 kg)

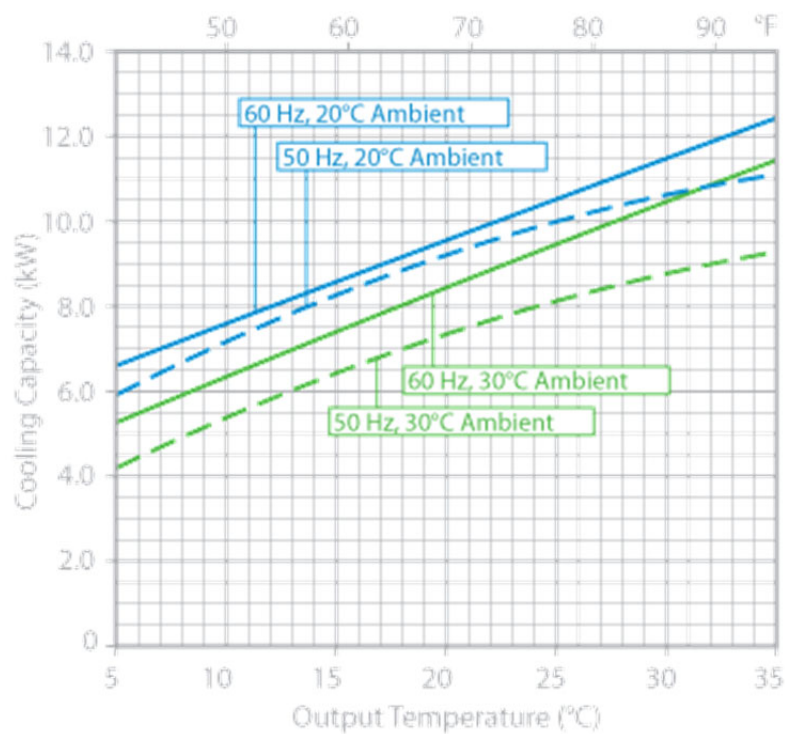
 CENTER OF MASS

* APPLIES TO OPTIONAL WATER COOLED UNITS ONLY

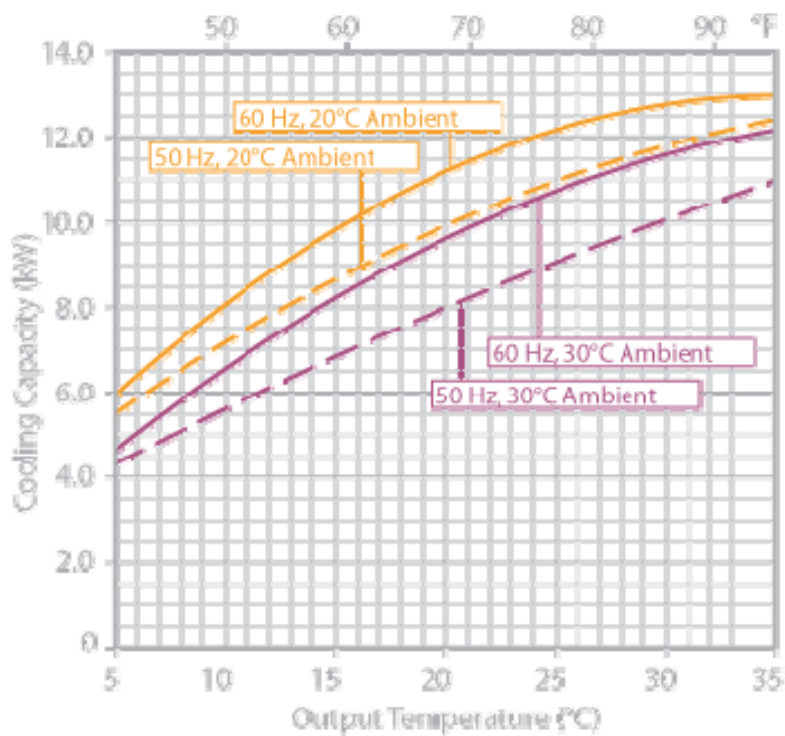


PERFORMANCE GRAPHS

RC095 Performance

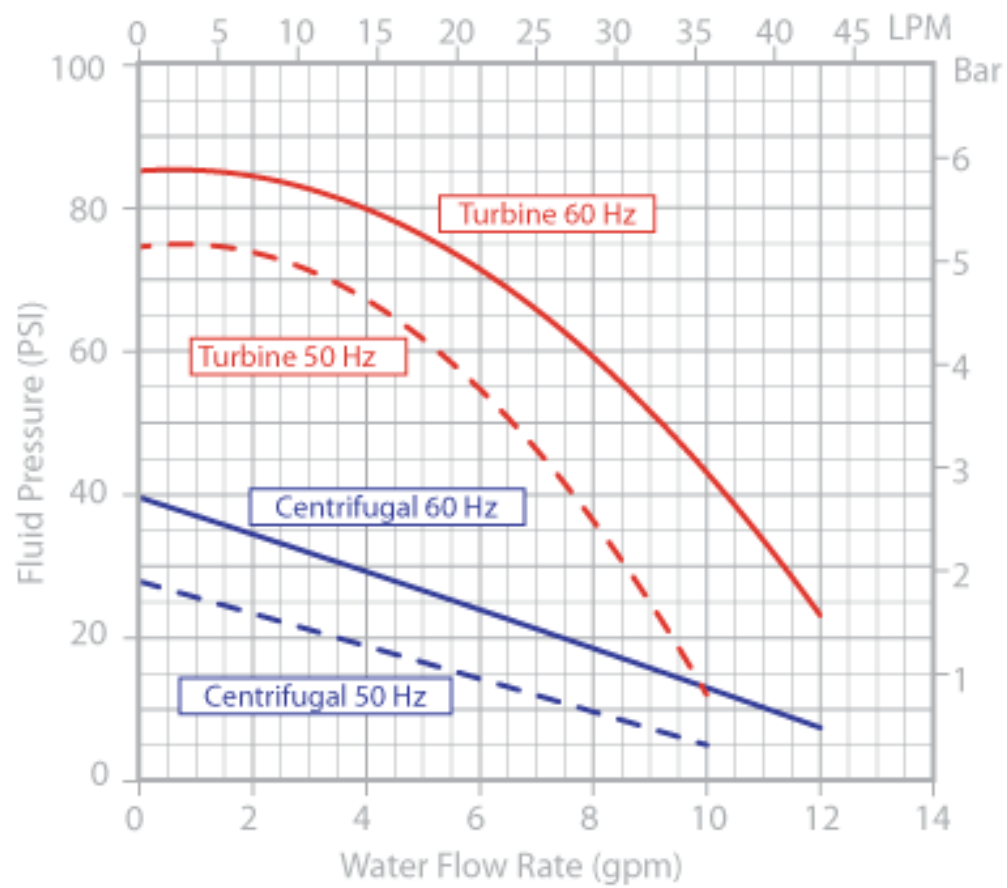


RC115 Performance



Performance graphs (continued)

RC095-RC115 Centrifugal & Turbine Pumps



EQUIPMENT PRECAUTIONS

Tools required to perform inspection and maintenance on this unit are:

- screwdriver
- multimeter (including AC voltmeter)
- safety glasses
- gloves

Training requirement: All information contained in this manual must be read, understood, and followed before operating or performing maintenance on this chiller.

Failure to adhere to these precautions will void the warranty and may damage the unit.

1. The unit has been shipped without process fluid. Do not run the unit without the fluid lines connected and filled with the proper fluid. **Never run the pump dry** because it will be quickly damaged without liquid.
2. This unit is designed to use water or a propylene glycol / water or ethylene glycol / water mix. Consult Boyd Corporation prior to using any other fluid. Other coolants may not be compatible with the components in the unit's coolant loop.
3. Do not use automotive antifreeze in this chiller. Additives in automotive antifreeze may not be compatible with seals in this chiller and may cause premature failure. Use of automotive antifreeze in a Boyd Corporation chiller will void the warranty.
4. This unit must be stored between 7°C (45°F) to 52°C (125°F).
5. Heat generated by motors and electrical components must be dissipated. Allow sufficient clearance around the unit to dissipate this heat.
6. This chiller is designed for indoor use only. Do not operate the chiller in ambient temperatures below 7°C (45°F) or above 40°C (94°F). If the chiller has been exposed to temperatures below 7°C, allow 24 hours at ambient temperatures above 7°C to warm the oil in the compressor as well as the refrigerant before starting.
7. This unit contains refrigerant, there is an oxygen depletion risk that should be considered. It must be placed in a room with adequate volume based on the amount of refrigerant in the unit. If additional refrigeration equipment is in the room, additional space must be provided. In the **Placement** section, under **Installation**, refer to the **Warning: Oxygen Depletion Risk** for more details.
8. The unit should never be operated or stored in other than a level position.
9. The compressor in this unit has been charged with a Polyolester lubricant. Polyolester lubricants (POE) will quickly absorb moisture from the ambient surroundings. Since moisture levels greater than 100 ppm will result in system corrosion and ultimate failure, it is imperative that compressors, components, containers and the entire system be kept sealed as much as possible. Lubricants will be packaged in specially designed, sealed containers. After opening, all the lubricant in a container should be used at once since it will readily absorb moisture if left exposed to ambient air. Work on systems and compressors must be carried out with the open time as short as possible. Leaving the system or compressor open during breaks or overnight **MUST BE AVOIDED!** Copeland Ultra 22 CC, Copeland Ultra 32 CC, Copeland Ultra 32-3MAF, Mobil EAL™ Arctic 22 CC, Uniqema Emkarate RL32CF or Uniqema RL32-3MAF are acceptable oils.

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10. As received, the POE lubricant will be clear or straw colored. After use, it may acquire a darker color. This merely reflects the activity of the lubricant's protective additive. Oil level must not fall below ¼ sight glass (if equipped).
 11. Do not operate with damaged or leaking equipment.
 12. When shipping, no fluids should be present in any of the systems. To remove fluid, remove the side panel and then remove the drain cap from the drain line. Have a nearby drain or canister to capture the fluid. After flow has ceased, purge the circuit and reservoir with low pressure air. Refer to **Draining the Unit** under the **Operation** section for more information.
 13. When shipping the unit, it must be protected from shock and vibration or the warranty will be void. Original factory packaging in good condition or equivalent is required. Request air-ride trucks when transporting over land. If the unit is carried with a forklift, proceed slowly and carefully to avoid damage.
 14. Do not modify the chiller without express written consent from Boyd Corporation, or the warranty will be void.
 15. **Note:** Upon installation and initial startup, if the chiller faults on "high pressure", it could be caused by the oil inside the compressor settling during storage and shipping. The oil may not initially flow fast enough to provide good lubrication. Please try to restart the machine, *several times if necessary*, not to exceed 5 times, in order to have the oil flow correctly. If the chiller continues to fail on "high pressure" after 5 repeated attempts to restart, contact Boyd Corporation Service.

SAFETY PRECAUTIONS

Heed all warning labels. No warning label should ever be removed from the unit.

Connect the chiller to a fused disconnect box in compliance with the National Electric Code (NFPA-70) as well as state and local codes for American usage, or national and local codes for European usage.

Maximum fuses must not exceed the maximum rating found on the serial tag on the electrical box. **To reduce the risk of electric shock:**

- Disconnect electric power before opening the electrical box of the unit.
 - Do not operate with electrical box door open.
 - Refer servicing of electrical box components to qualified/certified personnel.
 - Do not operate equipment with damaged electrical power cords.
 - Turn off the unit and disconnect electrical power before servicing or moving.
 - Properly ground the unit.
1. The servicing of the refrigeration system or components should be performed only by properly certified refrigeration technicians.
 2. Coolant lines, filters, and other components which connect to the unit must be capable of withstanding the maximum pressure that the pump in the chiller can deliver at the maximum expected temperature.
 3. The coolant loop has not been designed for potable water applications. Do not use the chiller for potable water. Never hook the water lines of a water-cooled unit to a potable water source or immerse a hose connected to a potable water source in the reservoir without providing back flow protection. A loss of pressure in the water source could lead to a back flow of the fluid in the unit, resulting in a possible contamination of the potable water source.
 4. Fluids can be extremely hot or cold. Use appropriate precautions when contact with fluids is possible.

WARNING AND CAUTION SYMBOLS

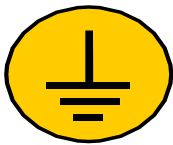
The following symbols may appear on the unit for your protection. Take note of their location on the unit and their definitions as listed below.



Danger, Warning, or Caution: Carefully read and understand the associated label text and/or refer to this manual for more information.



This symbol is to alert you to the presence of “dangerous voltage” within the unit’s enclosure. The voltage is of sufficient magnitude to constitute a risk of electrical shock.



This symbol appears on the unit next to a protective earth ground terminal.



This caution symbol indicates a hot surface in the vicinity or inside the cover panel where the label is located. Do not touch surfaces, including piping in the area around this warning label. To avoid possible skin burns, disconnect and lockout power, then allow surface to cool completely before servicing.

Eye Protection Required



Wear Protective Gloves



Read the Manual



INSTALLATION

Transporting

The chiller rolls easily on its four swivel casters. The brakes must be off on the two locking casters when moving the chiller. Roll the chiller gently to its operating location. The cushioned casters will help to dampen shock. Lock the casters when the chiller is in place. If the chiller will be carried with a lift truck, proceed slowly and carefully to prevent jarring the chiller.

If the chiller will be shipped, protect it from shock and vibration or the warranty will be void. The chiller must not be transported unless suitably protected. Original factory packaging in good condition or equivalent is required. Request air-ride trucks when transporting over land.

Before shipping or storing the unit, it must be thoroughly drained and blown dry with low pressure air. Boyd Corporation will not accept any unit containing measurable amounts of fluid. Fluid left in the unit during shipping may damage components within the unit. Such damage is not covered by warranty.

Placement

Select a level location near the application, free from dripping or spraying moisture and excessive dust. Keep the coolant lines short to allow the pump to provide maximum pressure and flow to the application. If the chiller will be placed more than 25 feet from the application, call Boyd Corporation to discuss placement and how it might affect performance.

Three feet of free space should be provided around the chiller to allow for unrestricted airflow. Restricting airflow can degrade unit performance.



WARNING: Oxygen Depletion Risk

In the event of a refrigerant leak, refrigerant gas may displace oxygen that could result in suffocation and death. Never place the chiller in a room that is smaller than the minimum room volume requirement as defined below. If the room is ventilated, the air distribution system must be analyzed to determine the worst case distribution of leaked refrigerant. A leak detector alarm device is always required in a ventilated room that does not meet the minimum room volume given below. Assure adequate and sufficient room volume and ventilation before placing a chiller that contains refrigerant in a room. Contact Boyd Corporation at 1-781-933-7300 if you have any concerns or questions.

Pounds of refrigerant charge can be read directly from the nameplate on your chiller. Remember to include in your calculation any refrigerant that may be stored in any other containers.

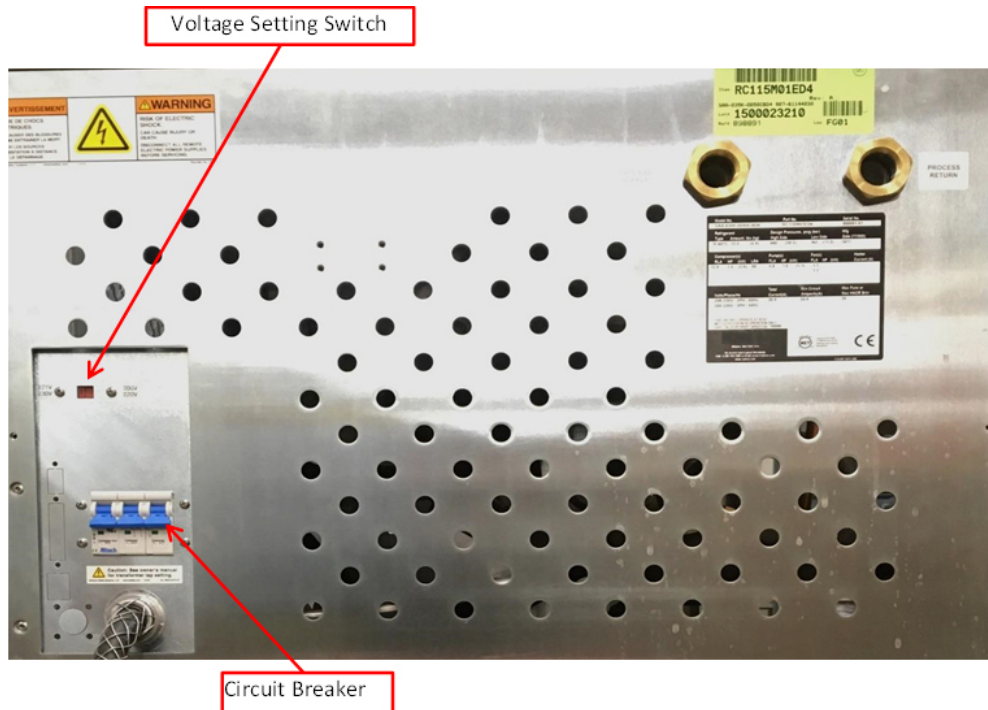
$$\text{Minimum Room Volume} = \text{Pounds of refrigerant} \times 110 \text{ cubic feet}$$

Example: Two chillers are placed in a room, each containing 6 pounds of refrigerant. The minimum room volume shall be 12 x 110 cubic feet, or 1,320 cubic feet.

Electrical Requirements

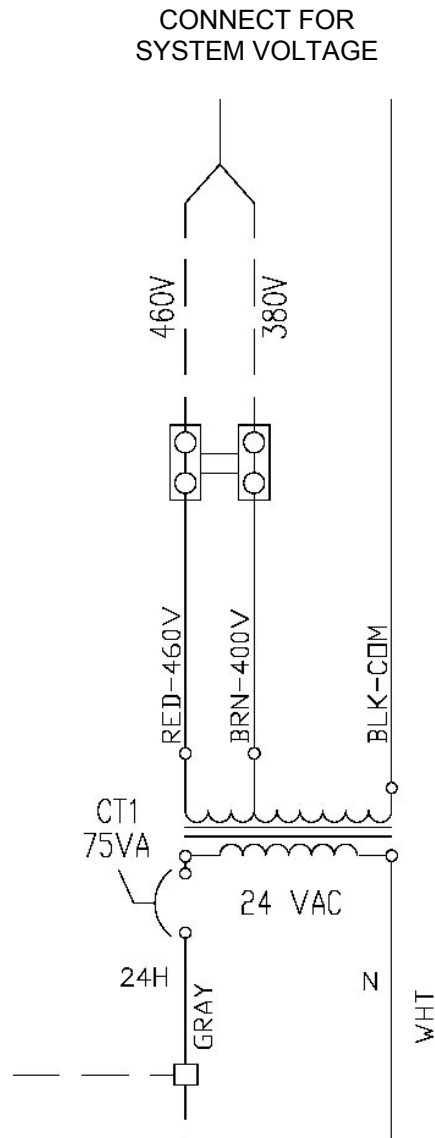
Connect the chiller to a properly fused disconnect box in compliance with the National Electric Code (NFPA-70) as well as state and local codes for American usage, or national and local codes for European usage. Maximum fuse sizes in the disconnect box must not exceed the maximum ratings specified on the serial tag (usually found on the electrical box). The voltage, phase, and frequency of the power source must also match the requirements specified on the serial tag.

Note for M01 voltages: This model has been set at the factory for 200-220 volt operation. If the unit will be operated at greater than 220 volts, first turn off the circuit breaker on the rear of the chiller and then slide the voltage setting switch to the appropriate marked position.



.Warning: To reduce the risk of electric shock, do NOT remove cover from the electrical box. It contains exposed high voltage wires. Refer servicing to qualified personnel. Disconnect power to the chiller before servicing

Note for R01 voltages: This model has been set at the factory to run at 460 volts, and is configured for 460Y power service (277 volts maximum to ground). Other voltages may be possible for this unit. See the chiller's serial tag for the specified voltage range. If this unit will be run at 380-400 volts, 50 Hertz, a qualified electrician should remove the red wire from the contactor and replace it with the brown wire taken from the dummy fuse block or terminal block as provided. Attach the red wire to the dummy fuse block or terminal block as provided.



Warning: To reduce the risk of electric shock, do NOT remove cover from the electrical box. It contains exposed high voltage wires. Refer servicing to qualified personnel. Disconnect power to the chiller before servicing

Lock Out/Tag Out Procedure

Safe electrical service requires **Lock Out/Tag Out** of customer supplied power source and/or disconnection of the power cord from the supply source outlet.

Other energy sources requiring Lock Out/Tag Out are the facility water (if applicable), process fluid, and stored heat sources. Each of these should be isolated and/or disconnected prior to servicing. In the case of stored heat sources, process lines and components that contain fluids above the fluid's boiling point should not be opened until the temperature is reduced to a point well below the boiling point of the fluid. Any other energy sources external to the chiller should be considered and isolated or disconnected if applicable.

Do not perform service or maintenance tasks on this unit until this Lock-out/Tag-out Procedure is complete.

1. Before performing any service to the unit, the process temperature should be allowed to stabilize at approximately 20°C. If this is not possible and the unit had been running at high temperatures, allow the unit to cool down before proceeding. Refer to Step 7 below for more information regarding lock-out/tag-out of energy sources other than electrical sources.
2. Locate the POWER switch and set to the OFF position.
3. Disconnect the power cord from the power source and apply a proper Lock Out/Tag Out device.
4. Other energy sources requiring lockout/ tag out are:
 - facility water (if applicable)
 - process fluid
 - stored heat sources

Each of these should be isolated and/or disconnected prior to servicing:

Energy Source	Required action
Facility water	Locate facility valves external to chiller and lockout/tagout.
Process fluid	Locate process fluid valves external to chiller and lockout/tagout.
Stored Heat Sources	Process lines and components that contain fluids near or above the fluid's boiling point should not be opened until the temperature is reduced to a point well below the boiling point of the fluid.

Facility Water Loop

This section applies to water cooled models only which can be identified by the presence of facility water supply and return ports located on the lower right hand corner of the rear panel. Water cooled units are equipped with an internal water control valve that will maintain a preset condenser head pressure by modulating the amount of facility water provided to the condenser. See specification section for minimum facility water requirement.

Connect as follows

1. connect the facility supply to the $\frac{3}{4}$ " NPT port marked "facility in"
2. connect the facility return to the $\frac{3}{4}$ " NPT port marked "facility out"

Priming the Pump and Connecting the Coolant Loop

Units optional without a pump



CAUTION: MAX PRESSURE TO THE CHILLER SHOULD NOT EXCEED 80PSIG (5.5 bar)

For units optional without a pump a bleeder line is provided to aid in priming the process coolant loop. A low flow switch and alarm are provided to indicate a loss of process fluid flow from the external pump. MAX PRESSURE TO THE CHILLER SHOULD NOT EXCEED 80PSIG. An internal bypass is NOT provided in the unit, an external bypass in the process lines is recommended.

Refer to pump manufacturer's instructions on proper priming procedure.

Units with pumps

DO NOT RUN THE PUMP DRY. If the pump does not establish prime, the pump shaft seal may overheat and be damaged in less than a minute. Use the following instructions when filling and assembling the coolant lines to prevent damage to the pump shaft seal.

1. Ensure the unit drain is in closed or cap is in place.
2. Fully open any external flow control valves.
3. Have extra coolant to add as the pump primes and the coolant loop fills.
4. Remove the reservoir cap and fill the reservoir with coolant. Fill the reservoir until the sight glass level is completely full.

-
5. Connect the coolant lines from the application to the FPT (female pipe thread) fittings on the rear of the chiller as follows. Do not over tighten the insert and do not use a sealant that will lock the male threads to the female threads.
 - a. Connect the coolant line coming back from the application to the **RETURN** fitting.
 - b. Connect the coolant line going to the application to the **SUPPLY** fitting.



6. When the previous steps are complete, turn the chiller on by placing the ON/OFF switch/ circuit breaker in the ON position. On the front user interface panel push the POWER button. Immediately check for flow. If within five seconds if no turbulence is visible in the reservoir shut the chiller off by pushing the POWER button on the user interface. If flow is established, top off the reservoir until the reservoir sight glass indication is full. Do not allow the reservoir to overflow.
7. If the pump does not establish prime, disconnect the SUPPLY coolant line to vent any trapped air, reconnect the line, and repeat step 7.
8. If the pump still does not prime, use the following steps:
 - a. Disconnect both coolant lines (have a container handy to catch any overflow from the RETURN fitting).
 - b. Force coolant into the SUPPLY fitting. The fluid will force the air out of the lines in the chiller and out of the pump head, causing it to escape into the reservoir. Elevate the coolant a few feet above the chiller, connect to the SUPPLY fitting, and let gravity force the air out into the reservoir. Remember to have a container handy to catch any overflow from the RETURN fitting.
 - c. Reconnect the coolant lines and repeat step 7. Stop filling when the reservoir sight glass indication is 2/3rds full. Do not allow the reservoir to overflow.

Note: Upon installation and initial startup, if the chiller faults on "high pressure", it could be caused by the oil inside the compressor settling during storage and shipping. The oil may not initially flow fast enough to provide good lubrication. Please try to restart the machine, *several times if necessary*, not to exceed 5 times, in order to have the oil flow correctly.

If the chiller continues to fail on "high pressure" after 5 repeated attempts to restart, contact Boyd Corporation Service.

An external water particle filter is strongly recommended to be installed in the process loop. Boyd recommends the use of a 5 micron filter to protect the pump and other critical components used in this chiller.

OPERATION

Start-Up

Before Start-Up, perform electrical and fluid connections as directed in the Installation section of this manual.

1. Inspect the unit inside and out to be sure that there is no water, fluid, oil or refrigerant leaks.
2. Do not attempt to operate the unit unless the system appears secure and dry.
3. All cable connections must be in place and secure.

3A. NOTE: When chiller is equipped with remote set point/ re-transmission configured for 4- 20mA, no driving voltage is provided by the chiller. If the application requires the control board provide 24 V+ power, jumper J58 on the control board should be moved to "4-20mA". The pin polarity as shown will then be reversed.

3B. NOTE: When a chiller is equipped with a 25 pin connector, a jumper is required between pins 5 and 6 in order to operate the chiller in local mode (i.e. using the display panel on the chiller). The wire for the jumper must be appropriately sized for the connector and rated for 1 amp max. This note is applicable unless the chiller is provided with a 25 pin connector and RS-485 communications.

4. Ensure that the proper power (voltage, breaker, and phase) is applied.
5. Turn the ON/OFF switch on the rear panel to the OFF position.
6. Fill the reservoir with coolant.
7. Close the Main Breaker. Turn the ON/OFF switch to the ON position.
8. Other than the flow fault light, no warning or alarm lights should be lit.
9. If necessary, jog the pump by pressing the power button located on the user interface panel for 2-3 seconds. This step may need to be repeated several times. If there is difficulty priming the pump, refer to "*Priming the Pump and Connecting the Coolant Loop*" in the *Installation* section.
10. Once the pump is primed ensure the reservoir cap in place and secured.
11. Push the POWER button on the user interface panel. The unit should begin operation.

Note: Upon installation and initial startup, if the chiller faults on "high pressure", it could be caused by the oil inside the compressor settling during storage and shipping. The oil may not initially flow fast enough to provide good lubrication. Please try to restart the machine, *several times if necessary*, in order to have the oil flow correctly.

If the chiller continues to fail on "high pressure" after several repeated attempts, contact Boyd Corporation Service.

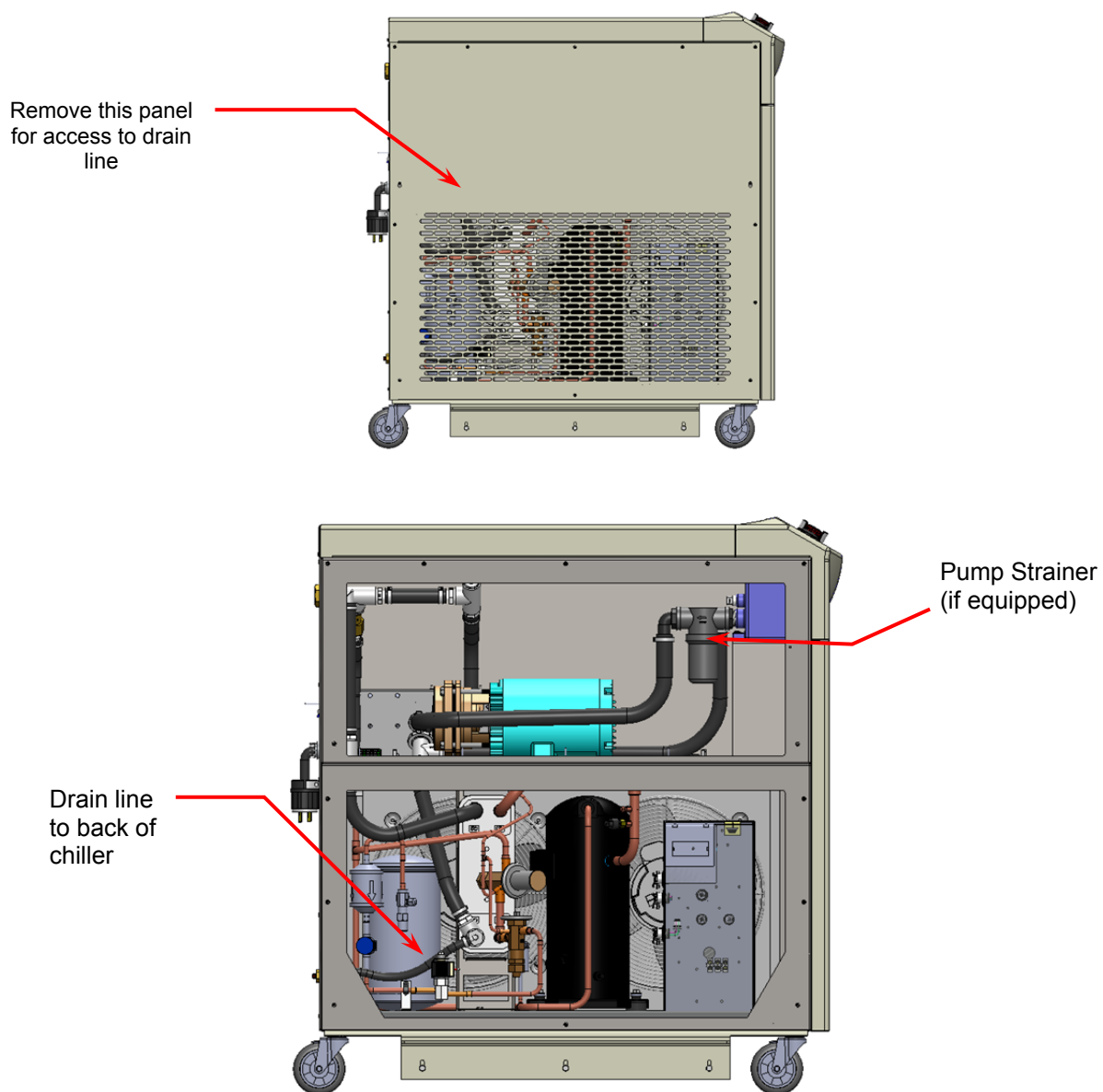
Shutdown

Push the POWER button on the user interface panel. The unit should stop. For extended shut downs or storage, place the ON/OFF switch on the rear of the unit to OFF.

Draining the Unit

Note: The unit ships with a basic shipping plug which is intended to prevent debris from entering the drain line. It is recommended that a customer supplied drain line and valve be attached to facilitate easy draining of the unit.

1. To drain the chiller, locate the drain connection on the back of the chiller.
2. Have a nearby drain or canister to capture the fluid.
3. Remove the drain cap from the drain line.
4. In order to completely remove fluid from the system, remove the left hand side panel. Use a Phillips head screw driver to completely remove the upper 4 screws. 2 screws are in keyholes. Leave these 2 screws partially installed to aid with re-installing the panel.
5. Unscrew the pump strainer cup to remove any residual fluid in the strainer. Replace once done.
6. After flow has ceased, purge the circuit and reservoir with low pressure air through the supply and return ports to remove any residual process fluid.



Preventive Maintenance (PM)

Boyd Corporation requires that PM be done on this unit at least once every year. This is above and beyond the normal cleaning of strainers and filters as may be described elsewhere in this manual. Only qualified service personnel are permitted to perform preventative maintenance. Contact Boyd Corporation at 1-781-933-7300 if you have any concerns or questions about any of the required maintenance. The following items must be serviced during the annual PM.



WARNING: Before proceeding with the PM, disconnect power to the unit and follow a lock-out and tag-out procedure.

Electrical Enclosures (including the main electrical control enclosures, and pump, compressor and heater junction boxes where applicable).

All power-carrying terminal screws must be checked for tightness and tightened if necessary. These include all components that supply power to pumps, compressors, and heaters. Examples of components that must be checked are main circuit breaker and other circuit breakers, contactors, motor overloads or manual motor circuit protectors, terminal blocks, transformers, solid-state relays, motor drives, and power receptacles.

Pump Motor

The pump and motor should be inspected to make sure the unit is running smoothly at its desired performance level. Follow the motor manufacturer's recommendations to keep motor bearings lubricated properly.

- On a continuing basis the unit must be kept clean and dry inside and out.
- Reservoir fluid should be kept at a satisfactory level.
- A stainless steel mesh strainer is provided between the pump suction port and reservoir. It can easily be accessed by removing the side panel. First turn the pump off, drain the unit partially using the provided drain line located inside the unit until no liquid can be seen in the clear strainer bowl. Unscrew the strainer bowl with strainer mesh and rinse both clean. Reinstall the strainer bowl and refill the unit.
- To protect the pump, routinely inspect the strainer to be sure it is clean and properly attached. Failure to clean a clogged strainer can restrict flow, causing the FAULT light to illuminate. Turn the chiller off for a few seconds after correcting the condition to reset the alarm.
- All warning/alarm conditions should be addressed immediately.

Decommissioning

Decontamination procedures are not required or applicable as there are no hazardous materials used within the unit. The refrigerant used in this unit is environmentally friendly (a non-ozone depleting HFC) and poses no hazard to the environment. However, the refrigerant must be recovered by a qualified refrigeration service technician in accordance with all applicable laws.

When decommissioning, remove all fluids by opening all drains and placing the fluid in appropriate containers. After all flow has ceased, purge the lines with low pressure air. HFE fluids must be cleaned up with vermiculite or similar absorbent and disposed of in accordance with federal, state, and local regulations.

This unit is comprised of metals that may be recycled. The significant metals which make up the unit are as follows:

- Cold-rolled steel
- Stainless steel
- Copper

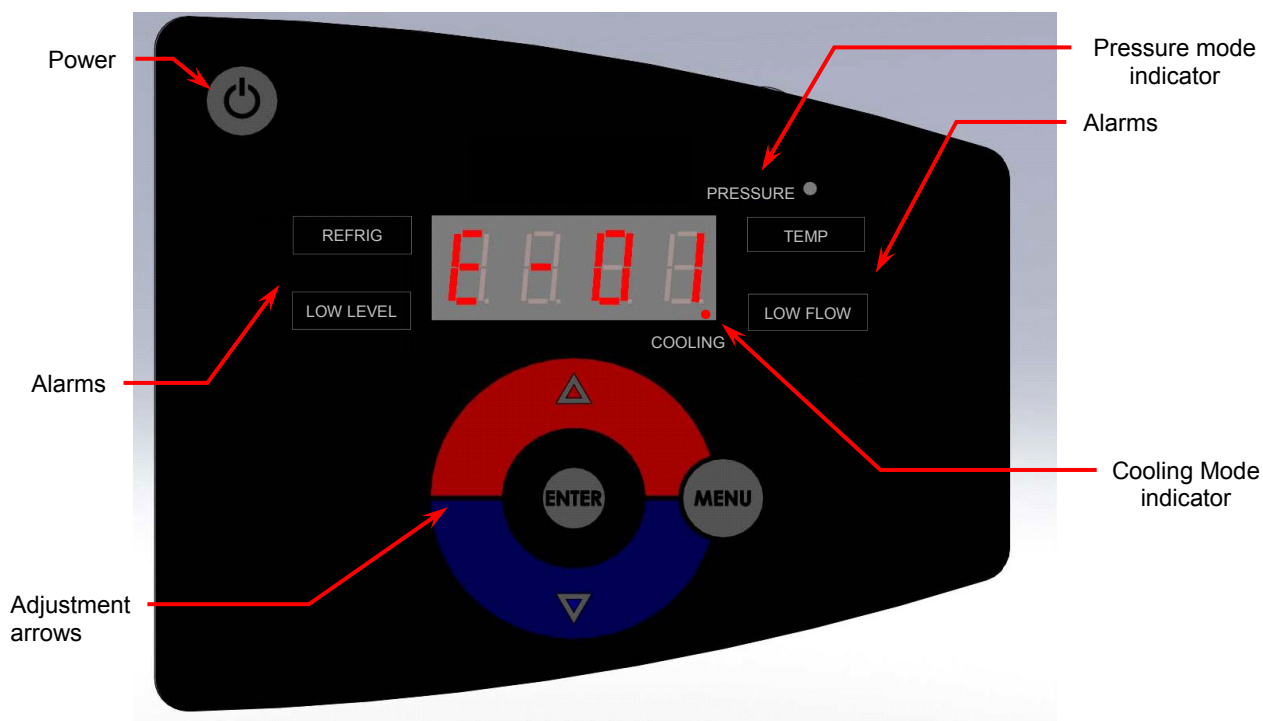
There are no significant amounts of plastics or other materials incorporated into this unit. Recycle metals appropriately.

CONTROL PACKAGES

Controller options	RC095	RC115
Package 4: Digital temperature and pressure display, low level, low/high temp, low/high refrigerant pressure visual alarms, low coolant flow and low refrigerant pressure shut off, auto-restart, and °C/°F toggle.	x	x
Package 5: Same as package 4 with 25 pin D connector with DC signal for low flow, low level, low/high temperature alarms.	o	o
Package 6: Same as package 4 with 9 pin D connector with RS-232 communication.	o	o
Package 7: Same as package 5 with RS-485 communication.	o	o
Package 8: Same as package 5 with 4-20mA remote set point and retransmission.	o	o
Package 9: Same as package 5 with 0-10VDC remote set point and retransmission.	o	o
Package A: Same as package 4 plus RJ45 connector with Ethernet communication.	o	o

x = standard **o** = available option

CONTROL/MONITORING



Operating the Chiller

Your chiller is equipped with a state of the art user interface that combines all control and alarm functions onto one simple panel. The multi-function display panel is used to show current process temperature, set value, cooling mode, supply pressure as well as any error codes and memory parameters. Temperature, low flow, low level, and refrigeration alarms each have a dedicated backlit LED. These features are also available through communications (optional) using the Boyd Corporation provided graphical user interface.

When the power is first applied to the chiller the controller will go through a self-check. All the lights will illuminate and the software version will display shortly. After approximately 3 seconds the display will go blank. At this point the chiller can be started using the POWER button in the upper left hand corner of the control panel, parameters in memory can be changed or the set point can be adjusted. If the chiller is configured for AUTO RESTART please refer to the auto restart section of this manual.

To adjust the set point simply depress the up (red) or down (blue) arrows. Once the set point has been adjusted to the desired value press ENTER.

While the chiller is on, the default value shown in the display is the process value. To view the set point value, momentarily press either up or down arrow button. To change the set point locally, hold down either the up or down arrow until you reach the desired set point and then press ENTER.

A cooling indicator light is provided in the lower right hand corner of the user interface display window. This light will come on while the chiller is actively cooling. It is normal for this light to switch on / off when the chiller has satisfied the set point / heat load.

The supply pressure is displayed on the front control panel. To access the pressure display press the ENTER button. A LED will light up indicate the unit is in pressure display mode. To return to reading the process values press the ENTER button again and the LED will go off. To change the units that pressure

is displayed in refer to “Accessing / Changing parameters” section.

The MENU button is used to access the parameter sub menus for changing parameters. Holding it down for 5 seconds will access the parameter menus. Pressing ENTER takes you into a parameter. Pressing MENU takes you back until you are out of the parameter menus. Refer to “Accessing / Changing parameters” section for more details.

Alarms

An audible alarm is standard on this chiller series. If any of the 4 standard warning/ alarm LEDS are lit the audible buzzer will sound. An audible buzzer will also sound if a system error code is displayed. To cancel the audible buzzer press the ENTER button. Note upon startup with the chiller not running a low flow alarm will be lit indicating no flow from the chiller. This is normal and will turn off once the chiller is operating normally. If a low flow fault does occur when the chiller is on an alarm will sound.

The four standard alarm lights on the front control panel are as follows:

1. LOW LEVEL Warning, indicates reservoir level is low and should be topped off.
2. TEMP Warning, indicates process temperature has gone above or below preset alarm limits. These alarm limits can be set by the user. See the “Accessing/ Changing Parameters” section for instruction.
3. LOW FLOW Alarm, indicates a loss of adequate flow internal to the chiller.
4. REFRIG alarm, indicates the refrigeration system has tripped on either high or low pressure.

See the troubleshooting guide and “error codes for possible causes and remedies to clear any of the above alarms and warnings.

Auto Restart

The chillers come with a configurable auto-restart feature which can be accessed through the front panel display (parameter P13, Ar E). This feature allows the chiller to automatically start after interruption of mains power.



CAUTION: *It is recommended to disable Auto Restart for initial setup and priming of chiller pump to avoid possibly running pump dry. Make sure all process plumbing is connected and the pump has established prime before enabling Auto Restart.*

Auto restart can be configured to start immediately after power cycle or can be configured to start after a user selectable delay. The delay is user configurable by setting P14, Ar d, to the desired delay time in seconds.

If a delayed start is configured the front panel will display a countdown timer. This countdown timer starts from the second power is applied to the chiller. It *includes* the time the control board takes to boot up/ run through it's internal diagnostics. In setting a delayed start, this should be taken into consideration.

For example; A user configures the delayed auto start to start the chiller after 10 seconds. After applying mains power the display will only show approximately 7 seconds on the countdown. This is because it takes the chiller approximately 3 seconds to run through it's boot up/ internal diagnostics.

As a precaution, a warning beep will chime every 3 seconds for the last minute before starting to alert any operator to the pending. To disable the delay feature simply set parameter P14 (Ar d) to 0 seconds.

To cancel auto restart the Power button can be depressed at any time. This will stop any delay timer countdown. Press the Power button again to start the chiller normally.

Units ship from the factory with the following default settings

Auto Restart disabled (P13= 0). To enable change this parameter to 1.
Auto Restart Delay = 0 seconds (P14= 0). The valid range is 0 to 9999 seconds.

Pressure Transducer

A pressure transducer is provided in this chiller series.

To view the supply pressure, press the “ENTER” key on the front user interface panel while the unit is operating. If the “ENTER” key is pressed while the unit is not operating “Perr” will display indicating the pump is not running or the unit is not optioned with this feature.

The pressure transducer range is 0 to 101 psig.

Error Codes

The front panel user interface can also display error codes. Refer to the table below for a list of errors the chiller will report. To clear an error code from the user interface display cycle to power to the chiller after the cause of the error has been cleared.

E-XX	DEFINITION IN SOFTWARE	VALUE	DESCRIPTION
E-00	WATCHDOG_FAULT	0x00000001	Watchdog Fault / General Fault
E-01	FLOW_FAULT	0x00000002	Flow fault input detected (active)
E-02	PHASE_FAULT	0x00000004	Phase fault input detected (active)
E-03	PUMP_OVERLOAD_FAULT	0x00000008	Pump overload fault detected (active)
E-04	HIGH_PRESS_FAULT	0x00000010	High pressure fault detected (active)
E-05	LOW_PRESS_FAULT	0x00000020	Low pressure fault detected (active)
E-06	LOW_TEMP_ALARM	0x00000040	Low temperature alarm (active) ; TEMP LED is on ; Error code not displayed
E-07	HIGH_TEMP_ALARM	0x00000080	High temperature alarm (active) ; TEMP LED is on ; Error code not displayed
E-08	LEVEL_ALARM	0x00000100	Reservoir low level alarm input detected (active)
E-09	DRIP_TRAY_ALARM	0x00000200	Drip tray alarm input detected (active)
E-12	HTR_SSR_OCD_FAULT	0x00001000	Heater relay output fault
E-13	PRESS_PWR_OCD_FAULT	0x00002000	Pressure sensor power fault detected (active)
E-14	RTD_FAULT_HIGH	0x00004000	RTD input resistance too high (open)
E-15	RTD_FAULT_LOW	0x00008000	RTD input resistance too low (short)
E-24	BOARD_TEMPERATURE	0x01000000	Control board temperature high
E-25	24V_SENSE	0x02000000	Internal PCB error, contact Boyd Corporation Service
E-26	5V_SENSE	0x04000000	Internal PCB error, contact Boyd Corporation Service
E-27	2V5_SENSE	0x08000000	Internal PCB error, contact Boyd Corporation Service
E-28	PRESSURE	0x10000000	Pressure fault input detected (active)
E-29	RTD_FAULT	0x20000000	RTD fault input detected (active)
E-30	THERMOCOUPLE	0x40000000	Thermocouple fault input detected

Communications

The chiller is equipped with a printed circuit board (PCB) which handles all chiller control and communication.

Depending on which communication package has been ordered, the PCB is capable of RS-485, RS-232, or Ethernet communications. The chiller is also capable of providing remote set point and retransmission of the process variable using either a 4-20mA or 0-10V signal.

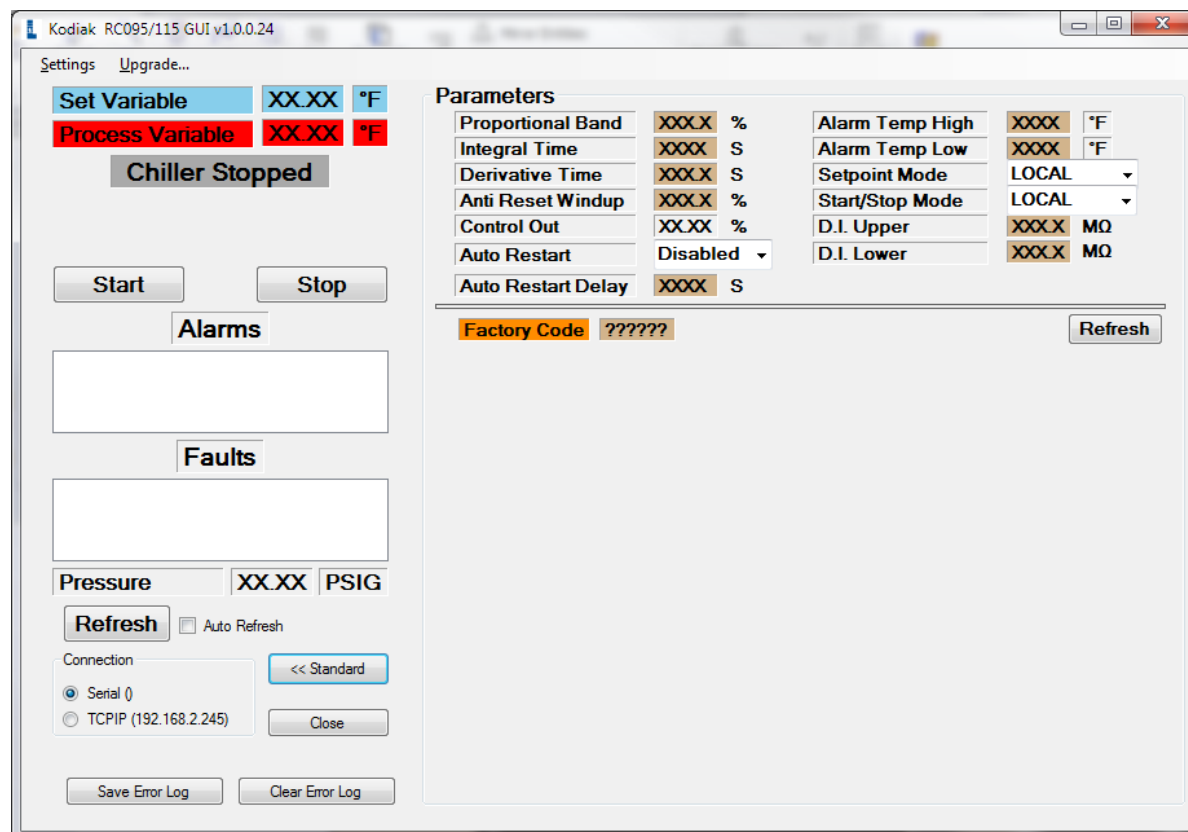
The user may use the display mounted to the chiller for local control as the standard interface. In addition, if the chiller shipped with a communications option, the graphical user interface (GUI) allows the end user to change set point, monitor process variable, change low and high alarm set points, monitor alarms and faults, and change P&ID settings. Any changes made through the GUI will update the stored parameter settings in the chiller.

The graphical user interface can be obtained on the Boyd's website. Go to <http://www.Boyd.com/Tools-and-Technical-Reference/Application-Notes> and then click on "[Chiller Remote Monitoring and Control User Interface](#)"

The Graphical User Interface (GUI)

Below is a screen shot of the Boyd Corporation graphical user interface. It displays current chiller status, set values alarms values P&ID settings and can log faults and alarms. Units can be easily changed by double clicking on them to switch between SI and IP.

Versions of the GUI prior to version 1.0.0.24 are similar except for the exclusion of the Auto Restart and Auto Restart Delay feature as shown below.



25 Pin D-Sub Connector

The chiller is offered with a 25 pin D-sub communication connection. It is set up and tested at Boyd Corporation prior to shipment. Communications via the 25 pin provides dry contact alarms. RS-485 is an available option on the 25 pin connection. Refer to your sales representative for all options questions.

The pin outs for the 25 pin connector are as follows.

PINS	FUNCTION
1	Ground
2*	RS-485 positive or Remote Set-point (4-20 mA or 0-10 VDC)
3*	RS-485 negative or Remote Set-point (4-20 mA or 0-10 VDC)
4	Not Used
5 & 6	Remote ON/OFF
7	Not Used
8, 9 & 10	Temperature control alarm contact outputs, NC - open on fault - Alarm State pin 9-10 will open, pin 9-8 will close - Pin 9 is the common pin
11, 12, & 13	Remote level indication - Alarm state pin 12-13 will open, pin 12-11 will close - Pin 12 is the common pin
14, 15, & 16	Remote flow indication - Alarm state pin 14-15 will open, pin 15-16 will close - Pin 15 is the common pin
17	Not Used
18	Not Used
19	Not Used
20	Not Used
21	Not Used
22*	Remote retransmission negative signal, either 0-10VDC or 4-20ma.
23*	Remote retransmission positive signal, either 0-10VDC or 4-20ma.
24	Drip Tray Sensor (SEMI S2 option – when no communications)
25	Drip Tray Sensor (SEMI S2 option – when no communications)

*** NOTE:** When chiller is equipped with remote set point/ re-transmission configured for 4-20mA, no driving voltage is provided by the chiller. If the application requires the control board provide 24 V+ power, jumper J58 on the control board should be moved to “4-20mA”. The pin polarity as shown will then be reversed.

25 Pin Connector and Remote / Local Chiller Operation

NOTE: When a chiller is equipped with a 25 pin connector, a jumper is required between pins 5 and 6 in order to operate the chiller in local mode (i.e. using the display panel on the chiller). The wire for the jumper must be appropriately sized for the connector and rated for 1 amp max. This note is applicable unless the chiller is provided with a 25 pin connector and RS-485 communications.

9 Pin D-Sub Connector

The chiller is offered with a 9-PIN D-sub communication connection. It is set up and tested at Boyd Corporation prior to shipment. Communications via the 9 Pin provides RS-232.

The pin outs for the 9 Pin are as follows.

PINS	FUNCTION
1	Not Used
2	RS232 positive
3	RS232 negative
4	Not Used
5	Ground
6	Not Used
7	Not Used
8	Not Used
9	Not Used

Ethernet

In order to use the Ethernet communication option the end user will need to obtain the software from Boyd Corporation engineering or customer service. The Ethernet default TCPIP address is:

Default IP address is 192.168.2.40,
Gateway is 192.168.2.2,
Sub-Net Mask is 255.255.255.0.

If the default values above are inadvertently changed, they can be reset to the factory settings. With the on/off switch or circuit breaker at the back of the unit set to the off position, depress the UP and DOWN arrows simultaneously while powering up the unit. IPdF will flash on the display upon successful reset of the values.

Additional details:

Modbus RTU
Data speed rate = 19.2 kbps
N = No stop bit
8 = 8 data bits
1 = even parity

Under the settings tabs on the GUI, the TCPIP setting can be changed to suit any required communications protocol string.

In order to communicate over a serial connection with either RS-232 or RS-485, the customer merely selects the 'Serial' radio button on the GUI and connects to the 9 Pin or 25 Pin connector per the electrical schematic.

MODBUS Memory Map

Modbus Address	Name	Register Type	Range of Values	R/W	Units	Multiplier	Notes
(4000)1	Reserved						
(4000)2	WATCHDOG FAULT	16-bit Integer	0-1	R	Boolean	N/A	
(4000)3	FLOW FAULT	16-bit Integer	0-1	R	Boolean	N/A	
(4000)4	PHASE REVERSAL FAULT	16-bit Integer	0-1	R	Boolean	N/A	
(4000)5	PUMP OVERLOAD FAULT	16-bit Integer	0-1	R	Boolean	N/A	
(4000)6	REFRIG HIGH PRESS FAULT	16-bit Integer	0-1	R	Boolean	N/A	
(4000)7	REFRIG LOW PRESS FAULT	16-bit Integer	0-1	R	Boolean	N/A	
(4000)8- (400)10	Reserved						
(400)11	TEMPERATURE ALARM	16-bit Integer	0-1	R	Boolean	N/A	
(400)12	LEVEL ALARM	16-bit Integer	0-1	R	Boolean	N/A	
(400)13	DRIP TRAY LEVEL ALARM	16-bit Integer	0-1	R	Boolean	N/A	
(400)14	ERROR PROCESS TEMP HIGH	32-bit Integer (MSB)	See Process Errors	R	N/A	N/A	Reading the MSB register latches the 32-bit register and reports the MSB. Reading the LSB register reports the LSB.
(400)15	ERROR PROCESS TEMP LOW	32-bit Integer (LSB)					
(400)16	Reserved						
(400)23	RTD TEMPERATURE	16-bit Integer	-500 - 1150	R	C	x10	-500 = -50 C, 1150 = 115 C
(400)24	PRESSURE INPUT	16-bit Integer	0 - 1015	R	PSI	x10	1015 = 101.5 PSI
(400)26	MANUAL INPUT LOCAL REMOTE	16-bit Integer	0-1	R/W	N/A	N/A	0 = Local, 1 = Remote
(400)27	RUN COMMAND FROM KEYPAD	16-bit Integer	0-1	R/W	N/A	N/A	0 = Stop, 1 = Run
(400)28	SET VARIABLE	16-bit Integer	FACTORY INPUT RANGE LIMITS	R/W	C	x10	-400 = -40.0 C, 1050 = 105.0 C
(400)29	PROCESS VARIABLE	16-bit Integer	-500 - 1150	R	C	x10	-500 = -50, 1150 = 115
(400)30	SPARE INPUT	16-bit Integer	0-1	R	N/A	N/A	

Modbus Address	Name	Register Type	Range of Values	R/W	Units	Multiplier	Notes
(400)31	REMOTE SETPOINT	16-bit Integer	Scaled between FACTORY INPUT RANGE LIMITS	R	C	x10	-400 = -40.0 C, 1050 = 105.0 C
(400)32	RUN COMMAND FINAL	16-bit Integer	0-1	R	N/A	N/A	
(400)33- (400)34	Reserved						
(400)35	USER ALARM TEMP HIGH	16-bit Integer	-45 - 105	R/W	C	x1	-45 = -45 C, 105 = 105 C
(400)36	USER ALARM TEMP LOW	16-bit Integer	-45 - 105	R/W	C	x1	-45 = -45 C, 105 = 105 C
(400)37	USER STARTSTOP MODE	16-bit Integer	0-1	R/W	N/A	N/A	
(400)38	USER SETPOINT MODE	16-bit Integer	0-1	R/W	N/A	N/A	
(400)39	USER PROPORTIONAL BAND	16-bit Integer	0 - 1000%	R/W	%	x10	1000 = 100.0 %
(400)40	USER INTEGRAL TIME	16-bit Integer	0 - 3200	R/W	seconds	x1	
(400)41	USER DERIVATIVE TIME	16-bit Integer	0 - 999.9	R/W	seconds	x10	
(400)42	USER ANTI RESET WINDUP	16-bit Integer	0 - 100%	R/W	%	x10	1000 = 100.0%
(400)43	USER TEMPERATURE UNITS	16-bit Integer	0-1	R/W	F/C	N/A	0 = F, 1 = C
(400)44	USER DI LOWER	16-bit Integer	0-255	R/W	M-ohm*cm	x10	255 = 25.5 M-ohm*cm
(400)45	USER DI UPPER	16-bit Integer	0-255	R/W	M-ohm*cm	x10	255 = 25.5 M-ohm*cm
(400)46	USER PRESSURE UNITS	16-bit Integer	0-1	R/W	N/A	N/A	0 = PSI, 1 = Bar
(400)47	USER AUTO RESTART	16-bit Integer	0-1	R/W	N/A	N/A	0 = auto restart disabled, 1 = auto restart enabled
(400)48	USER AUTO RESTART DELAY	16-bit Integer	0-9999	R/W	SECONDS	X1	
(400)49- (40)830	Reserved						

Accessing / Changing Parameters

The MENU push button is used to access the parameter sub menus for changing parameters. Pressing UP or DOWN changes the display option. Pressing ENTER takes you into a parameter. Pressing MENU takes you back until you are out of the PARAMETER menus.

NOTE: Parameter P9 (F or C units display) only changes the set value and present value units. Alarm limits (ALtH and ALtL) are always displayed/entered in units of Degrees Celsius.

Accessing / Changing Parameters Cont.

Key	Display	Menu Parameter Description	Key	Display	Key	Key	Display
MENU	P1	Alarm Temp High	ENTER	ALtH	ENTER	UP	XX.X
						DOWN	XX.X
	P2	Alarm Temp Low	ENTER	ALtL	ENTER	UP	XX.X
						DOWN	XX.X
	P3	Remote Start/Stop	ENTER	rSt	ENTER	UP	RE
						DOWN	LOC
	P4	Remote Setpoint	ENTER	rSP	ENTER	UP	RE
						DOWN	LOC
	P5	Proportional Band	ENTER	PrOP	ENTER	UP	XX.X
						DOWN	XX.X
	P6	Integral Time	ENTER	Intg	ENTER	UP	XX.X
						DOWN	XX.X
	P7	Derivative time in seconds	ENTER	dErV	ENTER	UP	XX.X
						DOWN	XX.X
	P8	Anti-reset Windup	ENTER	AntI	ENTER	UP	XX.X
						DOWN	XX.X
	P9	Fahrenheit or Celsius	ENTER	F-C	ENTER	UP	0
						UP	1
TBD	P10	D.I. Lower	ENTER	d.I.LO	ENTER	UP	
OPTIONS						DOWN	
TBD	P11	D.I. Upper	ENTER	d.I.UP	ENTER	UP	
OPTIONS						DOWN	
	P12	Pressure Units	ENTER	PrSU	ENTER	UP	PSIG
						UP	BAR
	P13	Auto Restart Enable	ENTER	Ar E	ENTER	UP	0
						UP	1
	P14	Auto Restart Delay	ENTER	Ar d	ENTER	UP	X
						DOWN	XXXX

OPTIONAL SYSTEM FEATURES

Coolant Water Filter

The factory installed water filter removes particulate from the coolant water. For replacement filters, call Boyd's Customer Service at 781-933-7300.

Deionization Package

The polishing loop DI is designed to maintain a resistivity of 1M-Ohm*cm until the color changing cartridge is exhausted. An exhausted cartridge is indicated by the cartridge completely changing from dark violet to amber. The polishing DI option has been selected to be compatible with the materials used in the construction of your Boyd Corporation chiller. Although this option has been design to maintain 1 M-Ohm*cm resistivity the level it will maintain greatly depends on the materials in the process loop connected to your chiller. The use of ultrapure water is not recommended in chillers that contain copper or brass.

For replacement cartridges, Call Boyd's Customer Service at 781-933-7300.

External Manually Adjustable Flow Valve

This option allows the flow rate to the equipment to be controlled with a globe valve. Opening the valve allows the flow to bypass from the supply to the return. By adjusting the valve a precise flow rate can be set. To be sure the process equipment is receiving the appropriate flow install a flow meter at the outlet from the process equipment.

External Pressure Relief Valve

This option is for applications with a maximum allowable pressure. It can also be used where flow to the equipment being cooled needs to be shut off without stopping the chiller. In this case the pressure relief valve will open and allow the flow to bypass from the supply to the return. The standard valve has an adjustment range from 50 psi to 100 psi.

High Purity Plumbing

This option is intended for use with deionized water. Only stainless steel and/or plastic components and a nickel-brazed heat exchanger come in contact with the coolant. This option must be specified before the chiller is purchased. It cannot be upgraded in the field.

SEMI S2 Package

The optional SEMI S2 package comes with seismic brackets, a drip tray sensor and EMO circuit.

The EMO is designed to provide maximum flexibility and can operate in four different modes.

1. Chiller EMO Shuts Down the Chiller Only - The momentary EMO has two sets of normally closed contacts. Both contacts must be closed to operate the unit. Continuity between pins 1 and 2 of the 4 pin AMP connector external to the unit must also be present. Boyd Corporation provides a jumper (shipped loose) in order to run the chiller in this operating mode. To start the unit, ensure that the EMO is not depressed, then press the POWER button located on the user interface.

2. Customer EMO Shuts Down the Chiller and the Customer Equipment Connected to the EMO Circuit - Connect the customer EMO to pins 1 and 2 of the 4 pin AMP connector. This will provide the same functionality described above, but also allow the customer EMO to shut down the chiller.

3. Chiller EMO Shuts Down the Chiller and the Customer Equipment Connected to the EMO Circuit - The customer can use pins 3 and 4 of the 4 pin AMP connector to allow the unit's EMO to turn off other equipment when properly connected.

4. Chiller EMO or Customer EMO Shut Down the Chiller and the Customer Equipment Connected to the EMO Circuit – Follow the instructions for both Mode 2 and Mode 3.

Seismic brackets are shipped in a temporary shipping position. They need to be removed and flipped around so that they are flush to the floor before being bolted down. Refer to the seismic calculations section bolting hardware size.

A factory installed drip tray sensor is provided in the integrated drip tray. Once the drip tray fills to a certain level, the sensor will provide a local alarm on the user interface display as well as via the optional Ethernet communications. Refer to the Control / Monitoring section for more detail.

For more information, refer to the seismic calculations section at the end of this manual.

F47 Compliance

Models RC095 and RC115 are designed to meet the intent of SEMI F47-0706 voltage sag immunity. It is included when the SEMI S2 option is selected. Voltage sag immunity is defined in standard F47-0706 as *“the ability of equipment to withstand momentary electrical power interruptions or sags”*. These models are designed to be immune to the voltage sag levels specified in the following table:

<i>Sag depth^{#1}</i>	<i>Duration at 50 Hz</i>	<i>Duration at 60 Hz</i>
50%	10 cycles	12 cycles
70%	25 cycles	30 cycles
80%	50 cycles	60 cycles

^{#1} Sag depth is expressed in percent of remaining nominal voltage. For example, during a 70% sag on a 200 volt nominal system, the voltage is reduced during the sag to 140 volts (not 60 volts).

Anti-Siphon Option

This option prevents backflow of cooling fluid into the chiller when the pump is powered off. It consists of a solenoid valve and check valve in return and supply lines of the chiller. The solenoid is energized when the chiller is turned on.

Low Temperature Option

This option provides additional insulation on the pump, process lines and reservoir. This allows the chiller to operate down to -10°C when used with an appropriate water-glycol mixture. If ordered with the Anti-Siphon Option the customer must provide expansion compensation in his plumbing system. This will help avoid hoses being split due to fluid expansion as the fluid warms up after the system is shut down.

WETTED MATERIAL LIST

Component	Materials
Turbine Pump (Option)	Brass with Brass impeller, GLSC seals, Viton o-ring
Relief Valve	Brass with Nitrile o-ring
Reservoir	Polyethylene body, Polypropylene float ball, PVC, Acetal fittings, Nitrile grommets, Nylon 6 cap, Cork & Buna-N gasket
Level Switch	Polypropylene
Flow Switch	Polypropylene with Viton o-ring
Strainer	20% Glass Polypropylene, 304SS, Nylon, Nitrile
Evaporator (Plate HX)	304SS with Copper Braze
Fittings	Nylon, Polypropylene, HDPE, PVC, CPVC, Brass, Copper, 304SS, 304LSS, 316SS, 316LSS
Hoses	EPDM
Sealants	Teflon Tape, Teflon Thread Paste
Pressure Transducer	Monolithic Silicon PT, Nylon and HDPE fittings, PVC hose
Particle Filter (Optional)	Polypropylene with EPDM o-ring
DI Filter (Optional)	Polypropylene with Mixed Bed resin

SPARE PARTS

This manual is a general purpose document covering the correct un-packaging, installation, operation and troubleshooting for RC095 & RC115 model chillers. Due to the variety of pump, electrical and condenser configurations, please contact the Boyd service department at 781-933-7300 with the chiller serial number and model number for assistance with spare parts inquiries.

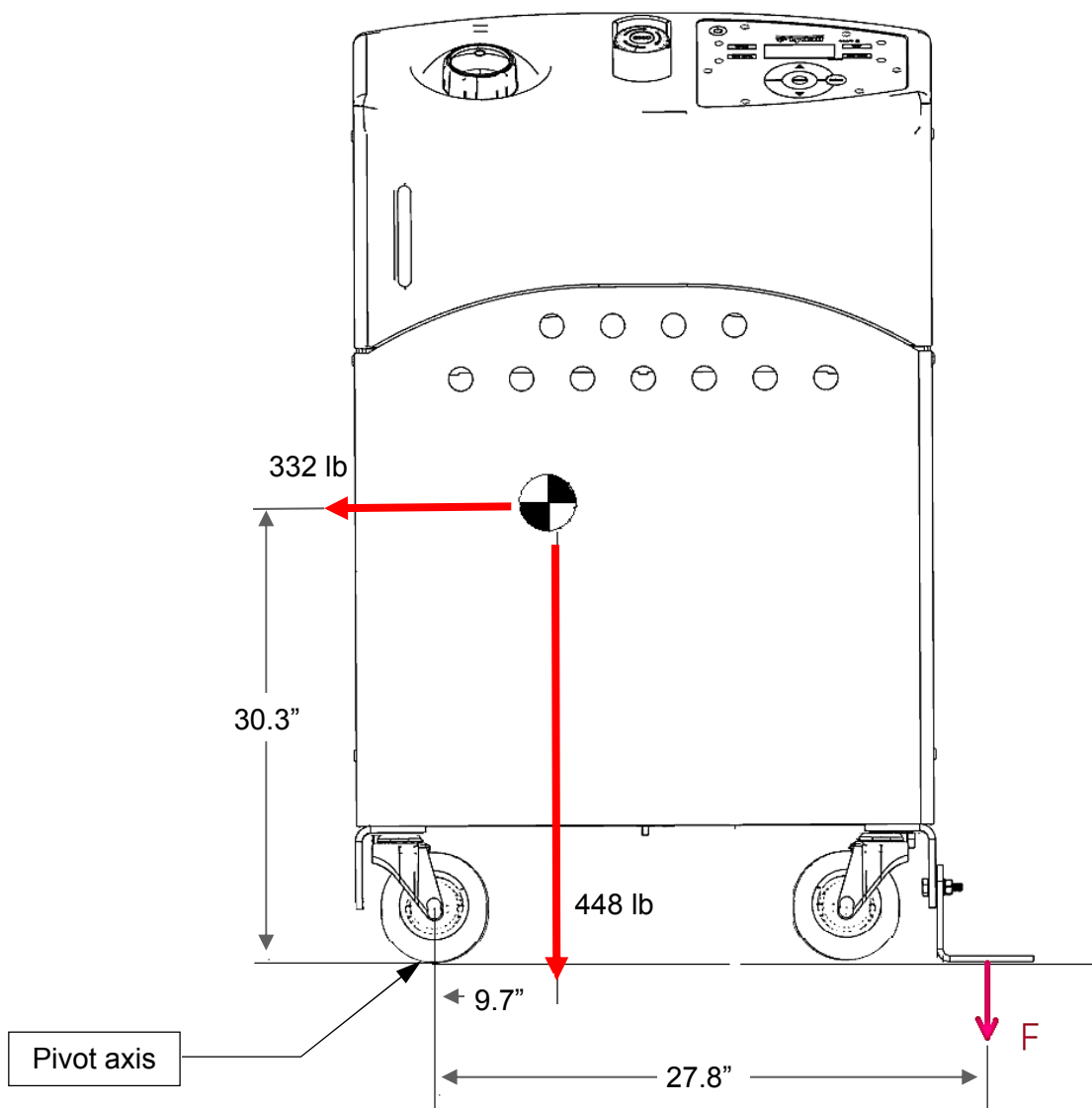
Seismic Load Calculations

Semi S2-0200 requires that equipment not containing hazardous production materials (HPMs) be able to withstand a horizontal seismic load equal to 63 percent of the equipment weight, acting at the center of mass (CG). Additionally, only 85 percent of the equipment weight may be considered to resist overturning.

Refer to the mechanical drawings of the unit included in this section and to page 62 of SEMI S2-0709 when reviewing the following information.

The chiller weighs 527 lbs when filled with fluid. Therefore, it must be able to withstand a 332 lb ($527 \text{ lb} * 0.63$) force applied to its center of gravity in a horizontal direction.

The scenario which creates the largest forces on the mounting brackets and fasteners is illustrated in the figure below.



The total reaction force required by the mounting hardware to resist tipping is

$$F = [27.8 \text{ in} \cdot (332 \text{ lb}) - 9.7 \text{ in} \cdot (448 \text{ lb})] / 27.8 \text{ in} = 176 \text{ lb}$$

Fasteners:

There is one continuous bracket on each side of the machine which must withstand 176 lb.

With 3 1/4" fasteners on each bracket, each fastener must withstand 59 lb (176 lb / 3).

The tensile stress for each 1/4" fastener is calculated as the load divided by the area:

$$\text{Tensile Stress} = 59 \text{ lb} / [3.14 \cdot (.125)^2] = 1,202.5 \text{ psi}$$

1/4" Grade 8 hex head bolts and 1/4" Stainless steel hex head bolts have minimum yield strengths of 120,000 psi and 70,000 psi respectively, both providing very large safety factors.

The shear load on the anchorages is equal to the horizontal seismic load (332 lb) divided by 3, or 111 lb. The shear loading is small, and is most significant when applied perpendicular to the direction considered above for overturning. Therefore, this calculation does not consider shear force separately.

Bending Resistance of Seismic Brackets

Bracket Boyd Corporation P/N 043-50032-002

The weakest part of the bracket is the centerline of the (3) holes for the fasteners, but due to geometry the bracket must bend in at least two places to completely fail. This means it must also fail in the second weakest point which is most likely to be at the 90 degree bend.

25 in width minus the 3x 0.281 in hole equals 24.157 in.

The thickness of the bracket is 0.19 in.

$$\text{Moment of Inertia } I = bh^3/12 = 24.157 \cdot 0.19^3 / 12 = 0.0014 \text{ in}^4$$

$$\begin{aligned} \text{Stress} &= Mc/I \\ c &= \frac{1}{2} \text{ thickness} = 0.095 \text{ in} \end{aligned}$$

$$\text{Allowable moment (M)} = \text{allowable stress} \cdot I/c$$

Because the bracket is only required to prevent the chiller from moving (i.e., some deformation of the bracket would be acceptable), allowable stress can be equal to yield strength, approximately 36,000 psi.

$$M = 36,000 \text{ lb/in}^2 \cdot 0.0014 \text{ in}^4 / 0.095 \text{ in} = 5,232 \text{ in-lb}$$

This moment would be generated when there is a net upward force on the chiller at the attachment point of the bracket (i.e., when the bracket is in tension resisting overturning). The moment arm for the bracket to apply this load is 1.7 inches, so the upward force required to generate this moment is

$$5,232 \text{ in-lb} / 1.7 \text{ in} = 3,078 \text{ lbs per bracket}$$

Max force applied to each bracket: 176 lb (from previous calculations) giving us a safety factor of well over 5 times.

TROUBLESHOOTING GUIDE

The following trouble shooting guide is limited to faults that are evidenced by lack of machine performance or by panel alarm. Of course, many other indications of malfunction are possible. For example, the operator should be alert to unusual sounds, vibration, or odors. Visually, the presence of any oil, water, or fluid leakage should be cause for immediate investigation.

Although the trouble shooting guide is limited to difficulties that may be encountered with the chiller itself, the operator should be alert to the reservoir low level alarm because this could be evidence of serious coolant leakage in the piping to the process tool or within the process tool itself.

In all cases where action is required under the Possible Remedy column of the trouble shooting guide, it should be understood that **ONLY** properly qualified technicians are to perform service work in connection with refrigeration or electrical systems.

Problem	Possible Cause	Possible Remedy
Unit does not start	No power to unit, breaker tripped	Verify supply power is on, close breaker after correcting fault
	Low voltage	Check electrical service to chiller
	High pressure cut-out tripped	Will automatically reset after correcting fault
	Loose wire	Check wiring after disconnecting power
	Defective contactor or coil	Repair or replace contactor or coil
	Loss of refrigerant	Repair leak, recharge with type and amount of refrigerant specified on serial tag
	Compressor damaged	Replace - Call Boyd Corporation
Unit does not cool	Compressor internal thermostat tripped	Allow time for compressor to cool and automatically reset
	Compressor damaged	Replace - Call Boyd Corporation
	Room temperature exceeds 30°C, causing cooling capacity to be de-rated	Improve ventilation/air-conditioning to maintain room temperature < 30°C
	Evaporator damaged	Call Boyd Corporation
	Temperature Controller failure	Replace Temperature Controller
	Cooling load exceeds capacity of unit	Reduce cooling load
	Temperature Controller programmed incorrectly	Call Boyd Corporation
	Loss of refrigerant	Locate and repair leak, recharge with type and amount of refrigerant specified on serial tag
	Refrigeration solenoid coil failure	Replace solenoid coil
	Solenoid valve stuck in closed position	Repair or replace solenoid valve

Problem	Possible Cause	Possible Remedy
Unit does not cool (continued)	Defective refrigeration low pressure cut-out Malfunctioning thermal expansion valve Pump damaged, loss of flow Hot gas bypass valve setting too high Hot gas bypass valve stuck open Dirty condenser coils	Repair or replace low pressure cut-out Replace thermal expansion valve Replace pump Call Boyd Corporation Repair or replace valve Clean condenser coils
Pump leaks	Faulty pump casing Shaft seal damaged Pump housing O-Ring damaged Improper fluid	Replace pump assembly Replace shaft seal Remove pump and rebuild Call Boyd Corporation
Excessive noise on Start-Up	Low voltage Wrong voltage taps used on transformer Contactor or coil failure	Check electrical service to unit Connect to proper taps Replace contactor or coil
Pump motor overheats	Pump thermal overload protection set too high Improper voltage supplied	Reset pump thermal overload relay, replace if faulty Correct voltage
Noisy compressor	Flooding of refrigerant into crankcase Worn compressor	Warm crankcase if unit has been off for a long period or has been left in a cool ambient for more than a few hours Replace - Call Boyd Corporation

Problem	Possible Cause	Possible Remedy
Level light remains on	Low coolant level Reservoir level switch float stuck Time delay relay malfunction (where used) Level switch failure	Check for leakage, fill reservoir Clean reservoir and level switch Replace time delay relay Replace level switch
Chiller cools well below the desired Set-Point	Temperature Controller programmed incorrectly Malfunctioning solenoid valve Solid State Relay failure Temperature Controller failure	Reprogram Temperature Controller or call Boyd Corporation Repair or replace solenoid valve Replace Solid State Relay Replace Temperature Controller
Temperature Controller does not work	5 second delay has not timed out Temperature Controller programmed incorrectly Temperature Controller failure	Wait at least 5 seconds after turning on Reprogram Temperature Controller - Call Boyd Corporation Replace Temperature Controller
Fault LED remains on	Low coolant flow No coolant flow	See Problem; Low coolant flow See Problem; No coolant flow

Problem	Possible Cause	Possible Remedy
Low coolant flow	Pump suction strainer clogged	Remove suction strainer, clean and reinstall or replace
	Flow control valve not fully open	Open flow control valve
	Pressure relief valve set too low (unless not adjustable)	Adjust pressure relief valve to specification
	Low coolant level in reservoir	Fill reservoir to proper level
	Restriction in coolant lines external to chiller	Eliminate restriction in coolant lines external to chiller
	Frozen evaporator	Call Boyd Corporation
	Flow switch clogged	Disassemble flow switch, clean and reinstall or replace
No coolant flow	Pump not primed	Prime pump
	Pump suction strainer clogged	Remove and clean pump suction strainer, then reinstall
	No coolant in reservoir	Check for leaks, then fill reservoir
	Pump overload tripped	Wait 5 minutes for the overload to automatically reset
	Pump motor shaft bound to seal	Replace pump or renew seal
	Pump housing improperly torqued	Remove pump, torque to specification, test, and reinstall
	Damaged pump	Replace pump
	Frozen evaporator	Call Boyd Corporation
	Clogged line or closed valve in external piping	Check external piping for dirt or closed valve
	Leak(s) in external piping	Check for leaks and repair as necessary

Problem	Possible Cause	Possible Remedy
Chiller shuts down during operation	Refrigeration high pressure cut-out set too low Refrigeration low pressure cut-out set too high Dirty condenser fins Excess refrigerant charge Pump thermal overload setting too low Pump overload tripped Low voltage	See Problem: Fault light remains on. Reset manual pressure switch, if applicable. If symptom reoccurs, call Boyd Corporation. See Problem: Fault light remains on. Check for low refrigerant charge. If symptom reoccurs, call Boyd Corporation. Gently clean condenser fins Remove excess refrigerant, then charge to specification on serial tag Adjust and reset pump thermal overload relay to specification, replace if faulty Determine cause of trip, if pump is damaged, repair or replace Check electrical service to chiller
Temperature display reads incorrectly	Loose wire Broken RTD Temperature Controller failure	Check wiring after disconnecting power Replace RTD Replace Temperature Controller
Compressor turns on and off automatically	Discharge pressure too high Condenser fan(s) not on Refrigeration high pressure set to automatic Compressor internal thermostat tripped Motor burned out	Check condenser for restrictions Check motor(s) and wiring Check settings Allow time for compressor to automatically reset Replace - Call Boyd Corporation
Too much recirculation pressure to process	Flow control valve set too high Pressure relief valve set too high (unless not adjustable)	Throttle flow control valve Adjust pressure relief valve

BOYD COOLING SYSTEMS SERVICE POLICY

Boyd's cooling systems are the product of over 50 years of thermal engineering and manufacturing experience. We designed them to provide superior reliability, easy maintenance, and worry-free operation. However, occasionally a system may need repair. To ensure your process is back up and running quickly, Boyd has implemented the following cooling system service policy.

Boyd's Standard Warranty

Boyd's warranty is set forth in the Terms and Conditions included with each system quotation and are available here <https://www.boydcorp.com/terms-and-conditions-of-sale.html>

Diagnostic Consultation:

At no cost, Boyd will attempt to diagnose the problem over the phone. Our service department can be reached by calling 781-933-7305 and following the menu or contacting one of our regional [Service-Depots](#). Service technicians are available 24 hours/7 days for consultation. Boyd strongly encourages customers to take advantage of this service before returning a cooling system to Boyd for evaluation. Often a problem with a system can be fixed quickly in-house or it is determined that it is an application problem. By utilizing our service hotline, you can avoid the downtime and expense associated with returning the system to our factory. Phone diagnosis can be difficult and may actually be a trial and error process. Boyd will not assume any liability for misdiagnosis when diagnosing over the phone.

Warranty and Non-warranty Returns:

To return a cooling system, a Boyd Return Material Authorization (RMA) number must be obtained from Boyd's service department which can be reached by calling 781-933-7300, or by completing the [Request-for-RMA](#) form and e-mailing it to service@boydcorp.com. Prior to calling Boyd, the system part number, serial number, and a detailed description of the problem must be collected, as this information is required to assign an RMA number.

A credit card or, for existing customers, a purchase order, (PO), is also required for the evaluation and repair charges if Boyd determines the system is not defective as defined by the warranty (see below for more details). The amount suggested will cover the evaluation fee and most repair charges for non-warranty repairs.

The RMA number should be indicated on the outside packaging of the returned unit. Systems must be returned clean, dry, and free from chemicals to Boyd's factory, shipping costs prepaid. Boyd is not responsible for any damage incurred in the return shipment. Coolant disposal fees may apply for returned units. Please contact your service representative for details.

Debit memos should not be issued for any repair, either warranty nor non-warranty repairs.

Boyd ordinarily will evaluate the unit within 2 or 3 business days of receipt. Boyd will use reasonable effort to repair the unit promptly, in most cases within one week of receiving all of the required parts. Boyd's warranty covers repair of the unit but Boyd's warranty does not cover cosmetic issues. If upon examination Boyd determines the system has not failed as defined by the warranty, an evaluation fee will be charged. The evaluation fee will be charged regardless of disposition (i.e.: scrap) and will be credited towards the total repair cost. Once the unit has been evaluated by our Service Group, all work will be quoted to the customer before proceeding with the repair. This quote will not cover the repair of cosmetic issues unless specifically requested to do so.

Repair warranty:

Boyd warranties the replacement parts and labor for 90 days from the repair date under the terms of our standard warranty or the balance of the original warranty, whichever is longer.

Product Specific, Defined Refurbishment Program:

Boyd warranties the replacement parts and labor per the specific quoted length of time from the refurbishment date under the terms of our standard warranty or the balance of the original warranty, whichever is longer. The refurbishment of the unit(s) must be quoted as such with a defined bill of material listing the items covered and the length of the extended warranty.

Return Shipments:

Boyd's warranty covers payment for standard, ground return shipment of warranted repairs. The incremental difference for expedited return shipments, if requested, are the responsibility of the customer. After non-warranty repair, Boyd will ship the system back using the customer's preferred shipping method.

Field Service/Commissioning Charges

Where available, Boyd can arrange field service for cooling system commissioning or repair. Under no circumstances does Boyd's warranty cover on-site service. All on-site service must be arranged through Boyd's service department. The charges for this service include an administrative fee, a charge for on-site services provided, any related travel charges, and parts not covered under warranty.

All requests for On-Site Services require a PO or credit card authorization before services will be scheduled.

When using Boyd-arranged, on-site service, Boyd warranties the replacement parts and repair labor for 90 days from the repair date under the terms of our standard warranty or for the balance of the original warranty, whichever is longer. If non-authorized labor repairs the system or installs replacement parts, Boyd does not warranty the parts or work and this action potentially voids any remaining warranty.

Boyd is expanding its worldwide service presence. Please contact the Service Department for the latest areas where on-site service is available.

Replacement Parts:

Replacement parts can be ordered using a credit card or purchase order. Parts being returned from systems under warranty should be returned using a Boyd issued RMA number. If the parts are found to be defective and the claim is within the warranty period, credit will be issued for the price of the parts and one-way ground shipping charges. If the parts are not defective or indicate end user damage, no credit will be issued. Boyd will not cover the incremental cost of air shipment of replacement parts, regardless of warranty status.

In-stock parts will normally ship the next business day; non-stocked parts will be shipped as quickly as reasonably possible.

This policy is subject to change. Please check with Boyd's service department for the current policy.

BOYD STANDARD WARRANTY

Boyd agrees that the apparatus manufactured by it will be free from defects in materials and workmanship for the warranty period under normal use and service and when properly installed. The warranty period for Kodiak[®] standard, RM, and XL recirculating chillers is two years from date of shipment of such apparatus to the original purchaser, maintenance items excluded, and one year from date of shipment of such apparatus to the original purchaser for all other products Boyd sells. See Boyd's Cooling System Service Policy (F7.02.25) for additional warranty details on systems. Boyd's obligation under this agreement is limited solely to repair or replacement, at its option, at its factories, of any part or parts thereof, returned to Boyd with transportation charges prepaid, which examination shall disclose to Boyd's satisfaction to have been defective. THE FOREGOING EXPRESS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. BOYD'S OBLIGATION UNDER THIS WARRANTY IS STRICTLY AND EXCLUSIVELY LIMITED TO THE REPAIR OR REPLACEMENT OF DEFECTIVE COMPONENT PARTS AND BOYD DOES NOT ASSUME OR AUTHORIZE ANYONE TO ASSUME FOR IT ANY OTHER OBLIGATION. BOYD ASSUMES NO RESPONSIBILITY FOR INCIDENTAL, CONSEQUENTIAL, OR OTHER DAMAGES INCLUDING, BUT NOT LIMITED TO LOSS OR DAMAGE TO PROPERTY, LOSS OF PROFITS OR REVENUE, LOSS OF THE UNIT, LOSS OF TIME, OR INCONVENIENCE. Boyd's liability does not include any labor charges for replacement of parts, adjustments, repairs, or any other work done outside its factories or service centers and its liability does not include any resulting damage to persons, property, equipment, goods or merchandise arising out of any defect in or failure of its apparatus. Boyd's obligation to repair or replace shall not apply to any apparatus which shall have been repaired or altered outside of its factory or service centers in any way, or which has been subject to negligence, to misuse, or to pressures in excess of stated limits. On parts not of Boyd's manufacture, such as motors, controls, etc., Boyd extends only those warranties given to Boyd, Corporation to the extent Boyd can do so. Boyd's agreement hereunder runs only to the immediate purchaser from Boyd, Corporation and does not extend, expressly or by implication, to any other person.