Installation, Operation, and Maintenance Manual

SENQ Series

Air-Cooled and Water-Cooled

Portable Temperature Control Units

3 to 15 tons

S-SW-IOM-00271-Rev 02

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Foreword

The temperature control unit consists of a refrigeration circuit and coolant circuit to provide cooling and temperature control of the coolant.

The manual is to serve as a guide for installing, operating, and maintaining the equipment. Improper installation, operation, and maintenance can lead to poor performance and/or equipment damage. Use qualified installers and service technicians for all installation and maintenance of this equipment.

Due to the ever-changing nature of applicable codes, ordinances, and other local laws pertaining to the use and operation of this equipment, we do not reference them in this manual.

The equipment uses a hydrofluorocarbon (HFC), R-410A, as a chemical refrigerant for heat transfer purposes. This chemical is sealed and tested in a pressurized system containing ASME coded vessels; however, a system failure will release it. Refrigerant gas can cause toxic fumes if exposed to fire. Place these units in a well-ventilated area, especially if open flames are present. Failure to follow these instructions could result in a hazardous condition. We recommend the use of a refrigerant management program to document the type and quantity of refrigerant in the equipment. In addition, we recommend only licensed and EPA certified service technicians work on our refrigeration circuits.

Safety Guidelines

Observe all safety precautions during installation, start-up, and service of this equipment. The following is a list of symbols used in this manual and their meaning.


General Warning


Electricity Warning


Sharp Element Warning


Hot Surface Warning


Flammable Material Warning


Explosive Material Warning


General Mandatory Action


Wear Eye Protection


Wear Protective Gloves


Wear Ear Protection


Disconnect Before Carrying Out Maintenance or Repair


Connect an Earth Terminal to Ground

Only qualified personnel should install, start-up, and service this equipment. When working on this equipment, observe precautions in this manual as well as tags, stickers, and labels on the equipment.

WARNING: Any use or misuse of this equipment outside of the design intent may cause injury or harm.

WARNING: Vent all refrigerant relief valves in accordance to ANSI/ASHRAE Standard 15, Safety Code for Mechanical Refrigeration. Locate this equipment in a well-ventilated area. Inhalation of refrigerant can be hazardous to your health and the accumulation of refrigerant within an enclosed space can displace oxygen and cause suffocation.

WARNING: This equipment contains hazardous voltages that can cause severe injury or death.

WARNING: This equipment contains refrigerant under pressure. Accidental release of refrigerant under pressure can cause personal injury and or property damage.

WARNING: This equipment may contain fan blades or other sharp edges. Make sure all fan guards and other protective shields are securely in place.

WARNING: The exposed surfaces of motors, refrigerant piping, and other fluid circuit components can be very hot and can cause burns if touched with unprotected hands.

CAUTION: Disconnect and lock out incoming power before installing, servicing, or maintaining the equipment. Connecting power to the main terminal block energizes the entire electric circuitry of the unit. Shut off the electric power at the main disconnect before opening access panels for repair or maintenance.

CAUTION: Wear eye protection when installing, maintaining, or repairing the equipment to protect against any sparks, debris, or fluid leaks.

CAUTION: The equipment will exceed 70 dBA sound pressure at 1 meter distance and 1 meter elevation when operating. Wear ear protection as required for personal comfort when operating or working in close proximity to the TCU.

CAUTION: Wear protective gloves when installing, maintaining, or repairing the equipment to protect against any sparks, debris, or fluid leaks.

General Data

Air-Cooled Temperature Control Unit (TCU) General Data (60 Hz)

Model	SENQA03	SENQA05	SENQA08	SENQA10	SENQA15
Cooling Capacity (tons)[1]	3	5	8	10	15
Set Point Range (°F)	20 to 80	20 to 80	20 to 80	20 to 80	20 to 80
Refrigerant	R410A	R410A	R410A	R410A	R410A
Condenser Air Flow (cfm)	4,000	4,000	8,000	8,000	10,450
Sound Pressure @ 1 meter (dBA)	73.5	74.0	75.8	76.2	82.2
Pump Motor Size (hp)	2	3	5	7.5	10
Pump Flow (gpm)	30	50	75	100	150
Net Available Pump Pressure (psi)[2]	25	23	34	32	32
Unit MCA @ 460/3/60 (amps)[3] – (units without heat)	14.0	19.9	30.8	39.1	53.4
Optional heater kW	3	6	9	12	18
Units MCA @ 460/3/60 (amps)[3] – (units with heat)	17.8	27.3	42.2	53.8	76.2
Length (inches)	48	48	75	75	87
Width (inches)	35	35	35	35	41
Height w/standard fans (inches)	61	61	61	61	94
Process Connections (inches)	2	2	2.5	2.5	3
Shipping Weight (lbs)	720	720	1,195	1,195	3,200

[1]Cooling tons based on 12,000 BTU/Hr/ton with 50°F leaving coolant and 95°F ambient air.
[2]Net available pressure at outlet of TCU is pump discharge pressure less the internal coolant-circuit pressure loss.
[3]MCA is minimum circuit amps (for wire sizing).

Water-Cooled Condenser Temperature Control Unit (TCU) General Data (60 Hz)

Model	SENQW03	SENQW05	SENQW08	SENQW10	SENQW15
Cooling Capacity (tons)[1]	3	5	8	10	15
Set Point Range (°F)	20 to 80	20 to 80	20 to 80	20 to 80	20 to 80
Refrigerant	R410A	R410A	R410A	R410A	R410A
Condenser Water Flow (gpm)	11	17	24	36	48
Sound Pressure @ 1 meter (dBA)	69.5	69.8	70.3	71.3	73.3
Pump Motor Size (hp)	2	3	5	7.5	10
Pump Flow (gpm)	30	50	75	100	150
Net Available Pump Pressure (psi)[2]	25	23	34	32	32
Unit MCA @ 460/3/60 (amps)[3] – (units without heat)	12.2	18.1	27.2	35.5	48.8
Optional heater kW	3	6	9	12	18
Units MCS @ 460/3/60 (amps)[3] – (units with heat)	16.0	25.5	38.6	50.2	71.6
Length (inches)	48	48	75	75	75
Width (inches)	35	35	35	35	35
Height (inches)	54	54	54	54	54
Process Connections (inches)	2	2	2.5	2.5	3
Condenser Connections (inches)	1.5	1.5	1.5	1.5	1.5
Shipping Weight (lbs)	720	720	1,195	1,195	1,315

[1]Cooling tons based on 12,000 BTU/Hr/ton with 50°F leaving coolant and 85°F condenser water.
[2]Net available pressure at outlet of TCU is pump discharge pressure less the internal coolant-circuit pressure loss.
[3]MCA is minimum circuit amps (for wire sizing).

Remote Air-Cooled Condenser Temperature Contol Unit (TCU) General Data (60 Hz)

Model	SENQR03	SENQR05	SENQR08	SENQR10	SENQR15
Cooling Capacity (tons)[1]	3	5	8	10	15
Set Point Range (°F)	20 to 80	20 to 80	20 to 80	20 to 80	20 to 80
Refrigerant	R410A	R410A	R410A	R410A	R410A
Sound Pressure @ 1 meter (dBA)[2]	69.5	69.8	70.3	71.3	73.3
Pump Motor Size (hp)	2	3	5	7.5	10
Pump Flow (gpm)	30	50	75	100	150
Net Available Pump Pressure (psi)[3]	25	23	34	32	32
Unit MCA @ 460/3/60 (amps)[4] – (units without heat)	12.2	18.1	27.2	35.5	48.8
Optional heater kW	3	6	9	12	18
Units MCS @ 460/3/60 (amps)[4] – (units with heat)	16.0	25.5	38.6	50.2	71.6
Length (inches)	48	48	75	75	75
Width (inches)	35	35	35	35	35
Height (inches)	54	54	54	54	54
Process Connections (inches)	2	2	2.5	2.5	3
Refrigerant Liquid Line (inches)	0.625	0.625	0.625	0.875	0.875
Refrigerant Suction Line (inches)	0.625	0.625	0.625	0.875	0.875
Shipping Weight (lbs)	720	720	1,195	1,195	1,315

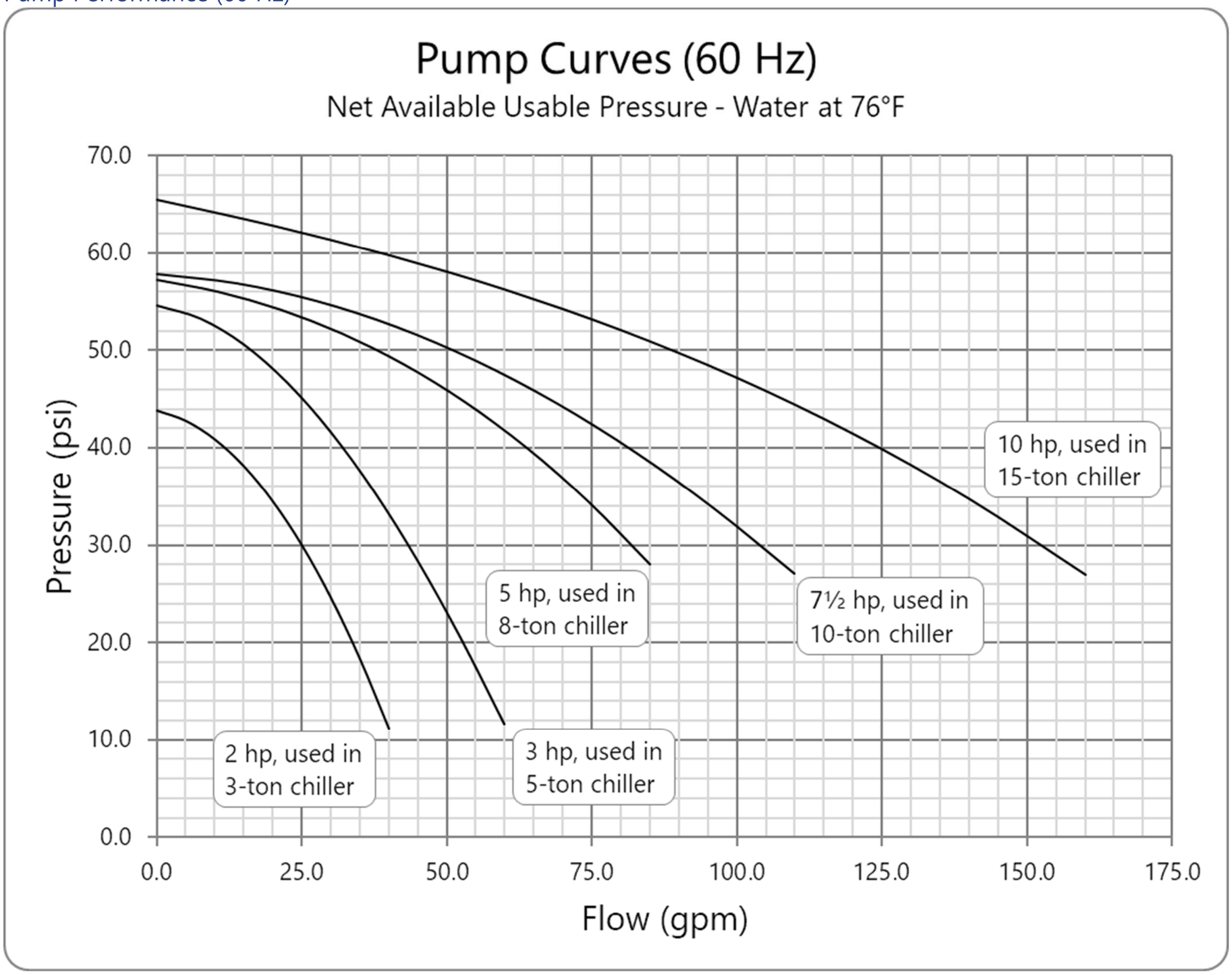
[1]Cooling tons based on 12,000 BTU/Hr/ton with 50°F leaving coolant and 95°F ambient air.
[2]Sound pressure is for TCU only, see Remote Air-Cooled Condenser table for the remote-condenser sound pressure ratings.
[3]Net available pressure at outlet of TCU is pump discharge pressure less the internal coolant-circuit pressure loss.
[4]MCA is minimum circuit amps (for wire sizing).

Remote Air-Cooled Condenser General Data (60 Hz)

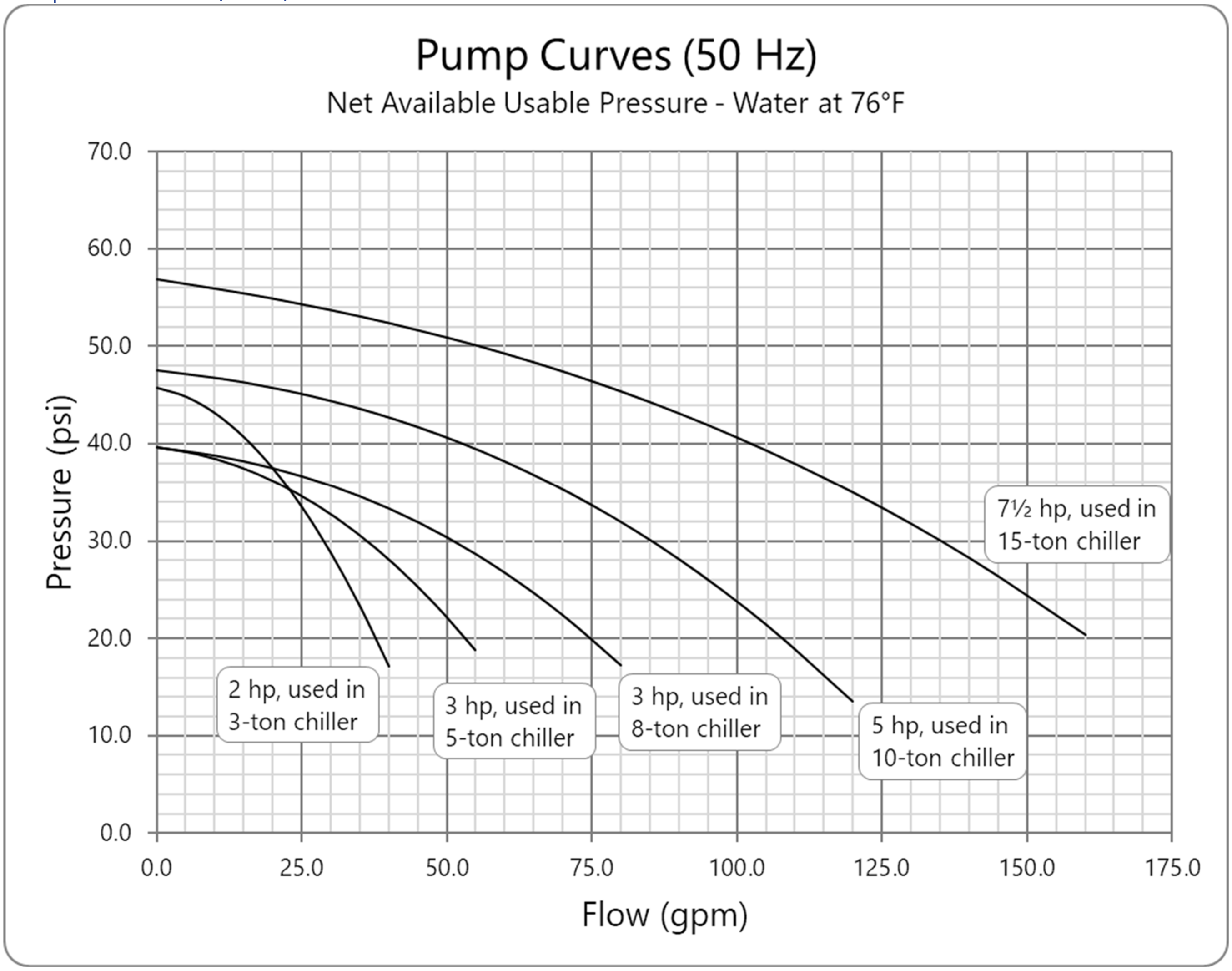
Condenser Model	TCU Used With	Dimensions (in)			Weights (Lbs)		Total Air Flow (cfm)	Sound Pressure (dBA)[1]	MCA @ 460/3/60 (amps)[2]	Refrigerant Connections (in)	
		L	W	H	Ship	Oper				Inlet	Outlet
KCM009	SENQR03	53.625	43.625	48.125	245	Varies with system charge and operating conditions	6,870	60	2.1	0.875	1.125
KCM009	SENQR05	53.625	43.625	48.125	245		6,870	60	2.1	0.875	1.125
KCM011	SENQR08	53.625	43.625	48.125	265		6,620	60	2.1	0.875	1.125
KCM014	SENQR10	93.625	43.625	48.125	415		14,400	62	3.3	1.375	1.125
KCL023	SENQR15	125.750	45.625	54.000	670		24,000	72	5.6	2.125	1.375

[1]Sound pressure at 3 meters.
[2]MCA is minimum circuit amps (for wire sizing).

Pump Performance (60 Hz)



Pump Performance (50 Hz)



Pre-Installation

Receiving Inspection

When the unit arrives, verify it is the correct unit by comparing the information on the unit nameplate with the order acknowledgement and shipping papers. Inspect the equipment condition for any visible damage and verify all items on the bill of lading are present. If damage is evident, document it on the delivery receipt by marking damaged items as "unit damage" and notify the carrier. Photographs of damaged equipment are excellent documentation for your records. Shipping damage is the responsibility of the carrier. To protect against possible loss due to damage incurred during shipping and to expedite payment for damages, it is important to follow proper procedures and keep records.

Unpack the unit, inspect for concealed damages, and take photos of any damages found. Once received, equipment owners have the responsibility to provide reasonable evidence damage did not occur after delivery. Photos of the equipment damage while the equipment is still partially packed will help in this regard. Refrigerant lines can be susceptible to damage in transit. Check for broken lines, oil leaks, damaged controls, or any other major component torn loose from its mounting point. Record any signs of concealed damage and file a shipping damage claim immediately with the shipping company. Most carriers require concealed damages be reported within 15 days of receipt of the equipment.

Our Customer Service Department can provide assistance in preparing and filing your shipping damage claims, including arranging for an estimate and quotation on repairs; however, filing the claim is the responsibility of the receiving party. Do not install damaged equipment.

A full refrigerant charge is included in TCUs with an integral water-cooled condenser. TCUs designed for use with a remote air-cooled condenser and the remote condensers themselves ship with a nitrogen holding charge. Check the remote condenser for signs of leaks prior to rigging. This will ensure no coil damage has occurred after the unit left the factory. The condenser ships with the legs removed. Mount the legs to the condenser using the provided nuts, bolts, and washers.

Unit Storage

When storing the unit it is important to protect it from damage. Blow out any water from the unit; cover it to keep dirt and debris from accumulating or getting in, and store in an indoor sheltered area that does not exceed 145°F.

Installation – Temperature Control Unit Mechanical

Foundation

Install the unit on a rigid, non-warping mounting pad, concrete foundation, or level floor suitable to support the full operating weight of the equipment. When installed the equipment must be level within ¼ inch over its length and width.

Unit Location

Locate TCUs designed for indoor installation in an area where the temperature is between 40°F and 120°F. TCUs with an integral air-cooled condenser and the optional outdoor-duty construction may be located in an area where the temperature is between -20°F and 110°F. For TCUs with a remote air-cooled condenser, locate the remote condenser outside with the TCU located inside the building. Allow a minimum of 48 inches of clearance between the remote condenser and any walls or obstructions. For installations with multiple condensers, allow a minimum of 96 inches between condensers placed side-by-side or 48 inches for condensers placed end-to-end. In all cases, install the equipment on a rigid surface suitable to support the full operating weight of the unit. Level all equipment to ensure proper operation.

Serviceability is an important factor in the design of our equipment. Do not compromise this feature by locating the TCU in an inaccessible area. When locating the TCU it is important to consider accessibility to the components to allow for proper maintenance and servicing of the unit. In general, allow a minimum of 36 inches of clearance around all sides and above the unit. Avoid locating piping or conduit over the unit. This ensures easy access with an overhead crane or lift when replacing or servicing heavier components.

Proper ventilation is another important consideration when locating the unit. Locate the unit in an area that will not rise above 120°F. In addition, ensure the condenser and evaporator refrigerant pressure relief valves can vent in accordance with all local and national codes.

TCUs with an integral air-cooled condenser require a minimum of 36 inches of clearance at both the condenser air inlet and condenser air discharge. They are not designed to have the condenser air discharge ducted. Improper clearance or poor ventilation will reduce the cooling capacity of the TCU and may cause high refrigerant pressure problems. In order to avoid possible low refrigerant pressure safety trips during start-up, maintain the inlet air temperature above 50°F. If outside air is ducted into an indoor TCU with integral air-cooled condenser there is an option for low ambient heat pressure controls which allow for incoming air temperatures down to 0°F. Cooler temperatures than this require custom modifications.

Rigging

The TCU has a structural steel frame to facilitate easy movement and positioning. Follow proper rigging methods to prevent damage to components. Avoid impact loading caused by sudden jerking when lifting or lowering the TCU. Use pads where abrasive surface contact may occur. Use the frame supporting the unit for positioning it with a crane or a forklift.

Chilled Water Piping

Proper insulation of chilled water piping is crucial to prevent condensation. The formation of condensation on TCU water piping, the state change of the water from gas to liquid, adds a substantial heat load to the system and becomes an additional burden for the TCU.

The importance of properly sized piping between the TCU and process cannot be overemphasized. See the ASHRAE Fundamental Handbook or other suitable design guide for proper pipe sizing. In general, run full size piping out to the process and then reduce the pipe size to match the connections on the process equipment. One of the most common causes of unsatisfactory TCU performance is poor piping system design. Avoid long lengths of hoses, quick disconnect fittings, and manifolds wherever possible as they offer high resistance to water flow. When manifolds are required, install them as close to the use point as possible. Provide flow-balancing valves at each machine to assure adequate water distribution in the entire system.

The connection labeled "Chilled Water Supply" delivers fluid to the process and the connection labeled "Chilled Water Return" receives water back from the process. We recommend the installation of an air vent in both the supply and return lines at the highest point in the line to allow for proper purging of all air from the system prior to operation.

Condenser Water Piping

(Water-Cooled Condenser Units Only) The performance of a condenser is dependent on maintaining the proper flow and temperature of water through the heat exchanger. Insufficient water flow or high condenser water supply temperature will result in the reduction of cooling capacity of the TCU. Extreme conditions will eventually result in the TCU shutting down due to high refrigerant pressure. Allowing the condenser to plug up from contaminants in the condenser water stream adversely affects performance. In order to reduce maintenance costs and TCU downtime, a water treatment program is highly recommended for the condenser cooling water. Contact our Customer Service Department for assistance in the proper procedure for cleaning out any plugged condenser.

The nominal TCU design is for 85°F condenser cooling water supply. Under normal operation under full load there will be about a 10°F rise through the condenser resulting in 95°F exiting water temperature from the condenser. To ensure proper water flow through the condenser, the condenser water pump should be able to provide at least 25 psi.

Each condenser has a two-way condenser water-regulating valve. Under varying loads and condenser inlet water temperatures the amount of cooling water needed varies. The condenser water-regulating valve controls the amount of water allowed to pass through the condenser in order to maintain proper refrigeration pressures in the circuit.

To prevent damage to the condenser or regulating valve, the condenser water pressure should not exceed 150 psig. The condenser water-regulating valve controls the condenser water flow in order to maintain the pressure set point. The TCU load, condenser-water inlet temperature, and pressure set point determine the actual flow.

Installation – Remote Air-Cooled Condenser

TCUs designed for use with a remote air-cooled condenser include a factory-selected remote condenser. The remote air-cooled condenser ships separately and in most cases will ship from a different location than the TCU so it will most likely be on a separate truck shipment from the TCU.

Location

The remote air-cooled condenser is for outdoor use. A primary concern when designing your unit was serviceability; therefore, the condenser should be located in an accessible area. Install the unit on a firm, level base no closer than their width from walls or other condensers. Avoid locations near exhaust fans, plumbing vents, flues, or chimneys. Fasten the mounting legs at their base to the steel or concrete of the supporting structure. For units mounted on a roof structure, the steel support base holding the condenser should be elevated above the roof and attached to the building.

Whenever possible locate the remote condenser away from occupied spaces and above or outside of utility areas, corridors, and auxiliary spaces to reduce the transmission of sound and vibration to occupied spaces. To prevent transmission of vibrations, use isolation hangers when suspending refrigerant lines from building structures. Where refrigeration piping passed through a wall, it is highly recommended to pack fiberglass and sealing compound around the lines to minimize vibration and retain flexibility in the lines.

Rigging and Assembly

Follow the remote condenser manufacturer's recommendations for locating and installing the remote condenser.

Interconnecting Refrigerant Piping

The remote condenser ships with a nitrogen holding charge. Evacuation of this charge is required before charging with refrigerant. Use a qualified refrigeration contractor to design and install the refrigeration piping system between the TCU and the remote condenser.

The discharge and liquid lines leaving the TCU have caps. These line sizes do not necessarily reflect the actual line sizes required for the piping between the TCU and the air-cooled condenser. The installing contractor need only provide the interconnecting piping between the TCU and the air-cooled condenser.

Refrigerant piping size and piping design have a significant effect on system performance and reliability. All piping should conform to the applicable local and state codes.

CAUTION: Use refrigerant grade copper tubing ASTM B280 only and isolate the refrigeration lines from building structures to prevent transfer of vibration. All copper tubing must have a pressure rating suitable for R-410A: tubing that is ¾" OD or larger must be Type K rigid tubing. ACR annealed tubing coil may be used for sizes ⅝" ODS or smaller.

Do not use a saw to remove end caps. This might allow copper chips to contaminate the system. Use a tube cutter or heat to remove the caps. When sweating copper joints, it is important to evacuate all refrigerant present if any and flow dry nitrogen through the system. This prevents the formation of toxic gases, corrosive acids, and the formation of scale within the copper tube.

CAUTION: Do not use soft solders. For copper-to-copper joints use a copper-phosphorus braze alloy (BCuP per the American Welding Society) with 5% (BCuP-3) to 15% (BCuP-5) silver content. Only use a high silver content brazing alloy (BAg per AWS) for copper-to-brass or copper-to-steel joints such as a 45% (BAg-5) silver content. Only use oxy-acetylene brazing.

WARNING: The POE oil contained within the compressor is hygroscopic and has the ability to absorb water vapor from the atmosphere. Take necessary steps to prevent an open system from exposure to the atmosphere for extended periods while installing the interconnecting refrigerant tubing.

Refrigeration Piping Design

The system is configurable in any of the arrangements as shown in Figure 1, Figure 2, and Figure 3. The configuration and its associated elevation, along with the total distance between the TCU and the air-cooled condenser are important factors in determining the liquid line and discharge line sizes. This will also affect the field refrigerant charges. Consequently, it is important to adhere to certain physical limitations to ensure the system operates as designed.

General design considerations are:

1. The total distance between the TCU and the air-cooled condenser must not exceed 200 actual feet or 300 equivalent feet. Keep the distance as short as possible.
2. Liquid line risers must not exceed 15 feet in height from the condenser liquid line connection.
3. Discharge line risers cannot exceed an elevation difference greater than 100 actual feet without a minimum of 2% efficiency decrease.
4. To form a proper liquid seal at the condenser, immediately drop at least 15 inches down from the liquid outlet before routing the piping to the TCU. Make the drop leg before any bends or angles connecting to the remainder of the liquid connection piping.

Figure 1 – Condenser Located with No Elevation Difference

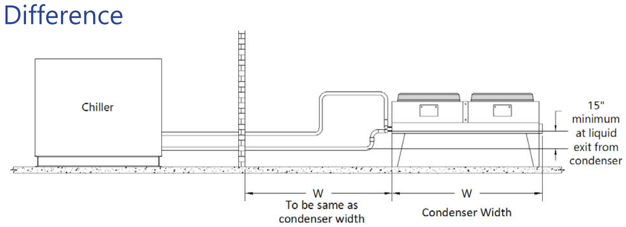


Figure 2 – Condenser Located above Temperature Control Unit

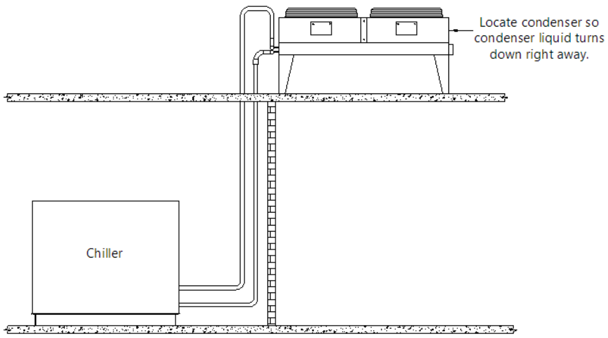
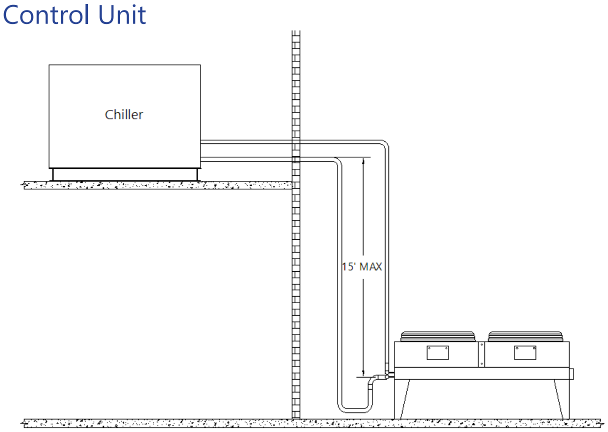


Figure 3 - Condenser Located Below Temperature Control Unit



CAUTION: Liquid line sizing for each TCU capacity is in Table 2. These line sizes are listed per circuit and apply where leaving water temperature (LWT) is 40°F or higher. For applications where the LWT is below 40°F, size lines using the ASHRAE Refrigeration Handbook or other suitable design guide.

Determining Equivalent Line Length

To determine the appropriate size for field installed liquid and discharge lines, it is first necessary to establish the equivalent length of pipe for each line. The equivalent length is the approximate friction loss from the combined linear run of pipe and the equivalent feet of elbows, valves, and other components in the refrigeration piping. The sum total is the equivalent length of pipe that would have the same pressure loss. See the ASHRAE Refrigeration Handbook for more information.

Follow these steps when calculating line size:

1. Start with an initial approximation of equivalent length by assuming that the equivalent length of pipe is 1.5 times the actual pipe length.
2. Determine approximate line sizes by referring to Table 2 for liquid lines and Table 4 for the discharge lines.
3. Check the line size by calculating the actual equivalent length using the equivalent lengths as shown in Table 1.

CAUTION: When calculating the equivalent length, do not include piping of the TCU. Only field piping must be considered.

Table 1 – Equivalent Lengths of Elbows

Line Size OD (in)	Equivalent Lengths of Refrigerant Pipe (feet)				
	90° Standard	90°Long Radius	90° Street	45° Standard	45° Street
7/8	2.0	1.4	3.2	0.9	1.6
1 1/8	2.6	1.7	4.1	1.3	2.1
1 3/8	3.3	2.3	5.6	1.7	3.0
1 5/8	4.0	2.6	6.3	2.1	3.4
2 1/8	5.0	3.3	8.2	2.6	4.5
2 5/8	6.0	4.1	10.0	3.2	5.2
3 1/8	7.5	5.0	12.0	4.0	6.4
3 5/8	9.0	5.9	15.0	4.7	7.3
4 1/8	10.0	6.7	17.0	5.2	8.5

Liquid Line Sizing

The liquid line diameter should be as small as possible while maintaining acceptable pressure drop. This is necessary to minimize refrigerant charge. The total length between the TCU and the air-cooled condenser must not exceed 200 actual feet or 300 equivalent feet.

Liquid line risers in the system will require an additional 0.5 psig pressure drop per foot of vertical rise. When it is necessary to have a liquid line riser, make the vertical run immediately after the condenser before any additional restrictions. The liquid line risers must not exceed 15 feet in height from the condenser liquid line connection (see Figure 3). The liquid line does not require pitching. Install a pressure tap valve at the condenser to facilitate measuring pressure for service.

Liquid lines do not typically require insulation. However, if exposing the lines to solar heat gain or temperatures exceeding 110 °F, there is a negative effect on sub-cooling. In these situations, insulate the liquid lines.

Table 2 – Liquid Line Sizes for R-410A

3 and 5 Ton Circuit (R-410A) Liquid Line Size (Inch OD)				
Equivalent Length (Ft)	Horizontal or Down Flow	Up Flow (Feet of Run)		
		0 to 5	6 to 10	11 to 15
25	½	½	½	½
50	½	½	½	½
75	½	½	½	½
100	½	½	½	¾
125	½	½	½	⅝
150	½	½	⅝	⅝
175	½	⅝	⅝	⅝
200	½	⅝	⅝	⅝
225	⅝	⅝	⅝	⅝
250	⅝	⅝	⅝	⅝
275	⅝	⅝	⅝	⅝
300	⅝	⅝	⅝	⅝

8 Ton Circuit (R-410A) Liquid Line Size (Inch OD)				
Equivalent Length (Ft)	Horizontal or Down Flow	Up Flow (Feet of Run)		
		0 to 5	6 to 10	11 to 15
25	⅝	⅝	⅝	⅝
50	⅝	⅝	⅝	⅝
75	⅝	⅝	⅝	⅝
100	⅝	⅝	⅝	⅝
125	⅝	⅝	⅝	¾
150	⅝	⅝	⅝	¾
175	⅝	⅝	⅝	¾
200	⅝	⅝	⅝	¾
225	⅝	⅝	⅝	¾
250	⅝	⅝	¾	¾
275	⅝	⅝	¾	¾
300	⅝	⅝	¾	¾

10 Ton Circuit (R-410A) Liquid Line Size (Inch OD)				
Equivalent Length (Ft)	Horizontal or Down Flow	Up Flow (Feet of Run)		
		0 to 5	6 to 10	11 to 15
25	⅝	⅝	⅝	¾
50	⅝	⅝	¾	¾
75	⅝	⅝	¾	¾
100	⅝	¾	¾	¾
125	¾	¾	¾	⅞
150	¾	¾	¾	⅞
175	¾	¾	¾	⅞
200	¾	¾	¾	⅞
225	¾	¾	¾	⅞
250	¾	¾	¾	⅞
275	¾	¾	¾	1⅛
300	⅞	⅞	⅞	1⅛

15 Ton Circuit (R-410A) Liquid Line Size (Inch OD)				
Equivalent Length (Ft)	Horizontal or Down Flow	Up Flow (Feet of Run)		
		0 to 5	6 to 10	11 to 15
25	⅞	⅞	⅞	⅞
50	⅞	⅞	⅞	⅞
75	⅞	⅞	⅞	⅞
100	⅞	⅞	⅞	1⅛
125	⅞	⅞	⅞	1⅛
150	⅞	⅞	⅞	1⅛
175	⅞	⅞	⅞	1⅛
200	⅞	⅞	⅞	1⅛
225	⅞	⅞	⅞	1⅜
250	⅞	⅞	⅞	1⅜
275	⅞	⅞	⅞	1⅜
300	⅞	⅞	⅞	1⅜

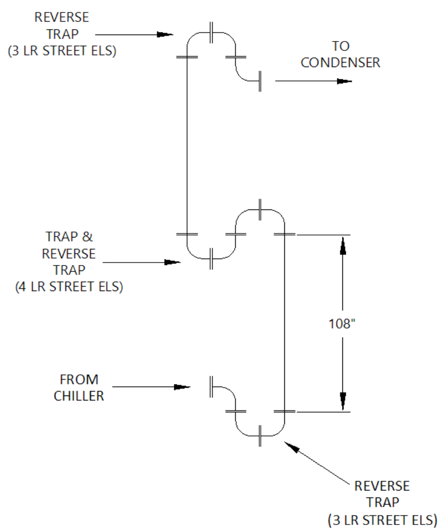
Discharge (Hot Gas) Line Sizing

The discharge line sizes depend on the velocity needed to obtain sufficient oil return. It is very important to minimize line length and restrictions to reduce pressure drop and maximize capacity.

The Upflow hot gas risers need to have a trap at the bottom and reverse trap at the top. In addition, a trap and reverse trap arrangement needs to be spaced every 15 feet in the rise for oil management (see Figure 4).

The discharge lines should pitch downward, in the direction of the hot gas flow, at the rate of ½ inch per each 10 foot of horizontal run. If the TCU is below the condenser, loop the discharge line to at least 1 inch above the top of the condenser. Install a pressure tap valve at the condenser to facilitate measuring pressure for service. Take careful consideration in the design of the discharge gas riser.

Figure 4 – Vertical Riser Traps



Check the oil level sight glass in the compressor if trapping of oil in the piping is suspected. The TCU is equipped with hot-gas bypass capacity control and the gas in the upflow discharge lines may have problems moving the oil against gravity when completely unloaded is a single rise system is used. We recommend a double riser system to ensure proper oil return under low load operation. See Figure 5 and Table 4 for double riser constructions.

Figure 5 - Double Discharge Riser

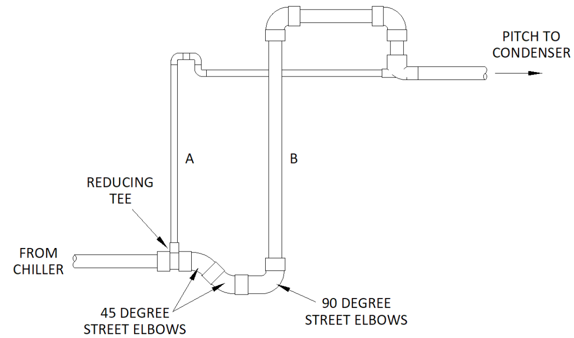


Table 3 - Horizontal or Downflow Discharge Line Sizes for R-410A (inches OD)

Circuit Tons	Total Equivalent Length (Ft)											
	25	50	75	100	125	150	175	200	225	250	275	300
3 & 5	⅝	⅝	⅝	⅝	¾	¾	¾	¾	¾	¾	¾	⅞
8	⅞	⅞	⅞	⅞	⅞	⅞	⅞	⅞	⅞	⅞	⅞	⅞
10	⅞	⅞	⅞	⅞	⅞	⅞	⅞	1⅛	1⅛	1⅛	1⅛	1⅛
15	⅞	⅞	1⅛	1⅛	1⅛	1⅛	1⅛	1⅛	1⅛	1⅛	1⅜	1⅜

Table 4 - Upflow Discharge Line Sizes for R-410A (inches OD)

Circuit Tons	Total Equivalent Length (Ft)											
	25	50	75	100	125	150	175	200	225	250	275	300
3 & 5	A - ⅜ B - ½	A - ⅜ B - ½	A - ⅜ B - ½	A - ⅜ B - ½	A - ⅜ B -⅝	A - ⅜ B -⅝	A - ⅜ B -⅝	A - ⅜ B -⅝	A - ⅜ B -⅝	A - ⅜ B -⅝	A - ⅜ B -⅝	A - ⅜ B - ¾
8	A - ⅜ B - ¾	A - ⅜ B - ¾	A - ⅜ B - ¾	A - ⅜ B - ¾	A - ⅜ B - ¾	A - ⅜ B - ¾	A - ⅜ B - ¾	A - ⅜ B - ¾	A - ⅜ B - ¾	A - ⅜ B - ¾	A - ⅜ B - ¾	A - ⅜ B - ¾
10	A - ⅜ B - ¾	A - ⅜ B - ¾	A - ⅜ B - ¾	A - ⅜ B - ¾	A - ⅜ B - ¾	A - ⅜ B - ¾	A - ⅜ B - ¾	A - ⅜ B - ⅞	A - ⅜ B - ⅞	A - ⅜ B - ⅞	A - ⅜ B - ⅞	A - ⅜ B - ⅞
15	A - ⅜ B - ¾	A - ⅜ B - ¾	A - ⅜ B - ⅞	A - ⅜ B - ⅞	A - ⅜ B - ⅞	A - ⅜ B - ⅞	A - ⅜ B - ⅞	A - ⅜ B - ⅞	A - ⅜ B - ⅞	A - ⅜ B - ⅞	A - ½ B - 1⅛	A - ½ B - 1⅛

Calculating Refrigerant and Oil Charge

To determine the approximate charge, first refer to Table 5 and establish the require charge for the condenser and TCU. Then refer to Table 6 to determine the charge required for the field-installed piping per circuit. The approximate charge per circuit is therefore the sum of the values from Table 5 and Table 6.

Table 5 – TCU and Condenser Refrigerant Charge

Circuit Capacity (tons)	Total Combined TCU and Condenser Summertime Refrigerant Charge (Lbs. of R-410A)
3	7.6
5	7.6
8	11.1
10	15.3
15	22.2

Table 6 - Field Piping R-410A Refrigerant Charges

Line Size OD (inches)	Discharge Line (Lbs./100' run)	Liquid Line (Lbs./100' run)
3/8	0.4	3.7
1/2	0.7	6.8
5/8	1.1	11
3/4	1.6	16.4
7/8	2.2	22.8
1 1/8	3.6	36.7
1 3/8	5.6	57.4
1 5/8	7.9	81.2
2 1/8	13.9	142.1
2 5/8	21.4	219.5

Oil Charge Determination

The TCU is factory charged with the amount of oil required by the TCU only and not the total system. The amount of oil required is dependent upon the amount of refrigerant added to the system for the field-installed piping. Use the following to determine the amount of oil needed for the system.

Pints of Oil = Pounds of refrigerant in system / 100

Oil level should be checked after the TCU has run for 15 minutes.

Setting Condenser Fan Controls

Depending on the number of condenser fans present there will be different fan cycling pressure control setting requirements. It is important that these setting be correct in order to maintain proper capacity control and operation of the system. Each refrigerant circuit has a separate head-pressure control circuit. Refer to Table 7 for the proper pressure settings.

Table 7 - Fan Control Pressure Settings (psig)

Stage Number	Setting	Number of Fan Stages			
		1	2	3	4
Stage 1	Max Speed	410	410	410	410
	Min Speed	320	320	320	320
Stage 2	Fan On		400	400	370
	Fan Off		340	340	305
Stage 3	Fan On			435	385
	Fan Off			375	325
Stage 4	Fan On				400
	Fan Off				340

Installation - Electrical

All wiring must comply with local codes and the National Electric Code. Minimum circuit amps (MCA) and other unit electrical data are on the unit nameplate. A unit specific electrical schematic ships with the unit. Measure each leg of the main power supply voltage at the main power source. Voltage must be within the voltage utilization range given on the drawings included with the unit. If the measured voltage on any leg is not within the specified range, notify the supplier and correct before operating the unit. Voltage imbalance must not exceed two percent. Excessive voltage imbalance between the phases of a three-phase system can cause motors to overheat and eventually fail. Voltage imbalance is determined using the following calculations.

% Imbalance = (Vavg – Vx) x 100 / Vavg

Vavg = (V1 + V2 + V3) / 3

Vx = phase with greatest difference from Vavg

For example, if the three measured voltages were 442, 460, and 454 volts, the average would be:

(442 + 460 + 454) / 3 = 452

The percentage of imbalance is then:

(452 – 442) x 100 / 452 = 2.2 %

This exceeds the maximum allowable of 2%.

There is a terminal block for main power connection to the main power source. The main power source should be connected to the terminal block through an appropriate disconnect switch. There is a separate lug in the main control panel for grounding the unit. Check the electrical phase sequence at installation and prior to start-up. Operation of the compressor with incorrect electrical phase sequencing will result in mechanical damage to the compressors. Check the phasing with a phase sequence meter prior to applying power. The proper sequence should read "ABC" on the meter. If the meter reads "CBA", open the main power disconnect and switch two line leads on the line power terminal blocks (or the unit mounted disconnect). Do not interchange any load leads that are from the unit contactors or the motor terminals.

WARNING: This equipment contains hazardous voltages that can cause severe injury or death.

WARNING: This equipment contains refrigerant under pressure. Accidental release of refrigerant under pressure can cause personal injury and or property damage.

WARNING: This equipment may contain fan blades or other sharp edges. Make sure all fan guards and other protective shields are securely in place.

WARNING: The exposed surfaces of motors, refrigerant piping, and other fluid circuit components can be very hot and can cause burns if touched with unprotected hands.

CAUTION: Disconnect and lock out incoming power before installing, servicing, or maintaining the equipment. Connecting power to the main terminal block energizes the entire electric circuitry of the unit. Electric power at the main disconnect should be shut off before opening access panels for repair or maintenance.

CAUTION: Wear eye protection when installing, maintaining, or repairing the equipment to protect against any sparks, debris, or fluid leaks.

CAUTION: Wear protective gloves when installing, maintaining, or repairing the equipment to protect against any sparks, debris, or fluid leaks.

CAUTION: Wire the unit ground in compliance with local and national codes.

CAUTION: The unit requires the main power to remain connected during off-hours to energize the compressor's crankcase heater. Disconnect main power only when servicing the TCU. The crankcase heater should remain on when the compressor is off to ensure liquid refrigerant does not accumulate in the compressor crankcase. Connect main power at least 24 hours prior to initial startup.

Operating Principles

Chilled Water Circuit

The chilled water pump circulates chilled water through the process piping and then back to the TCU. Upon entering the TCU, the chilled water will pass through a Y-Strainer that filters the process fluid before entering the evaporator. Heat transferred from the chilled water to the refrigerant occurs in the evaporator. Varying the amount of heat transferred in the evaporator determines the loading of the compressor, which maintains the temperature set point of the chilled water delivered to the process. A "Process Return" temperature sensor senses the temperature of the chilled water as it enters the evaporator.

After leaving the evaporator, the chilled water passes by a flow switch and the "Process Supply" temperature sensor. The sensor senses the temperature of the chilled water delivered to process and communicates this temperature to the PLC controller. This sensor is the control sensor for the PLC control system.

Refrigerant Circuit

The heat transferred in the evaporator from the chilled water to the refrigerant changes the state of the refrigerant from a liquid to a gas. This refrigerant gas then moves from the evaporator to the compressor.

The compressor is the heart of the refrigeration circuit. Cool, low-pressure gas enters the compressor and hot, high-pressure gas exits the compressor. Since the compressor is not 100% efficient, some extra heat gain occurs as the refrigerant is compressed.

The hot, high-pressure gas exiting the compressor goes to the condenser. In water-cooled condenser units (SENQW models), the heat is transferred from the refrigerant flow around the tubes to the water that is flowing through the tubes. In air-cooled condenser units (SENQA & SENQR models), the heat is transferred from the refrigerant in the finned tubes to the air that is flowing across the finned tubes. As the heat transfer occurs, the refrigerant changes from a gas to a liquid. The condenser removes the heat from the process load and the heat added by the compressor.

After leaving the condenser, the liquid refrigerant passes through the filter dryer and sight glass. The filter dryer filters out any particles and/or moisture from the refrigerant. Use the sight glass to monitor the stream of liquid refrigerant. The liquid refrigerant then passes through the thermostatic expansion valve, which meters the flow into the evaporator where the process begins again.

Capacity control and heating occurs by redirecting some of the hot gas from the compressor outlet away from the condenser. This gas is metered through an electronically controlled, stepper motor driven Hot Gas Bypass Valve. The hot gas is injected into the evaporator inlet, reducing the TCU's cooling capacity during light loading. The Hot Gas Bypass Valve is opened by the controller when the supply water temperature is below the Temperature Set Point.

PLC Controller Navigation

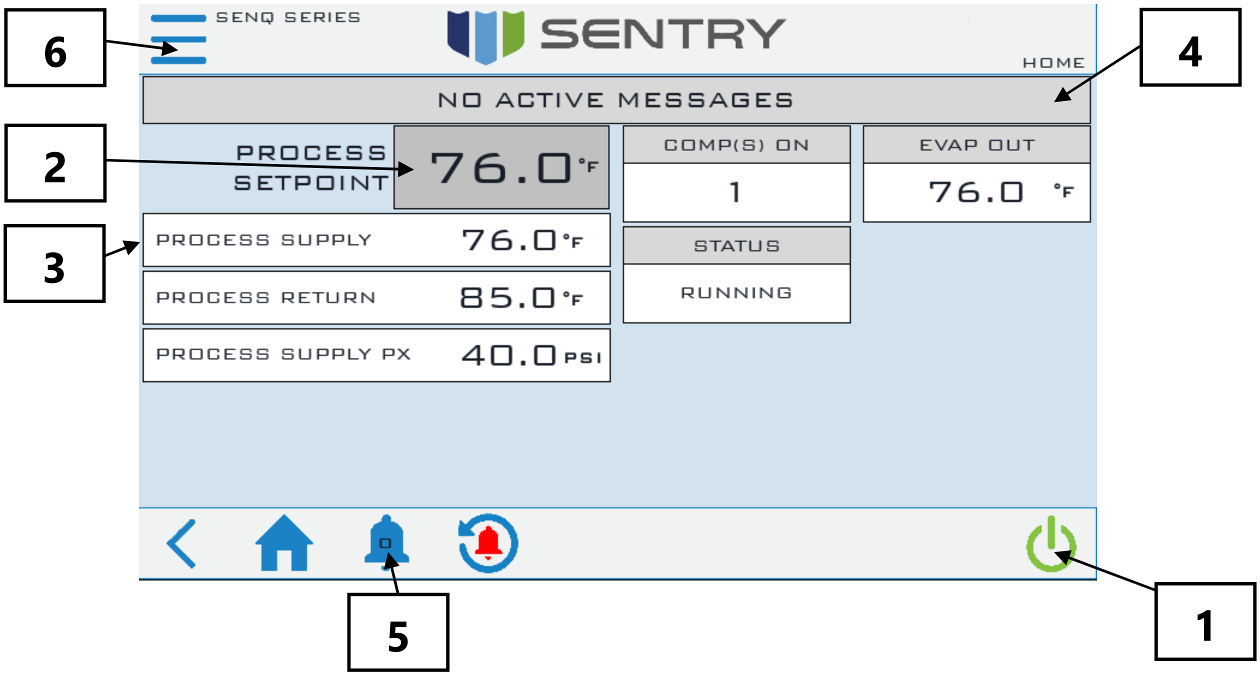
Startup Screen

The Startup Screen is the first screen displayed after the TCU's control circuit is energized.

The Startup Screen will automatically switch to the Main screen once communication to the controller is active.

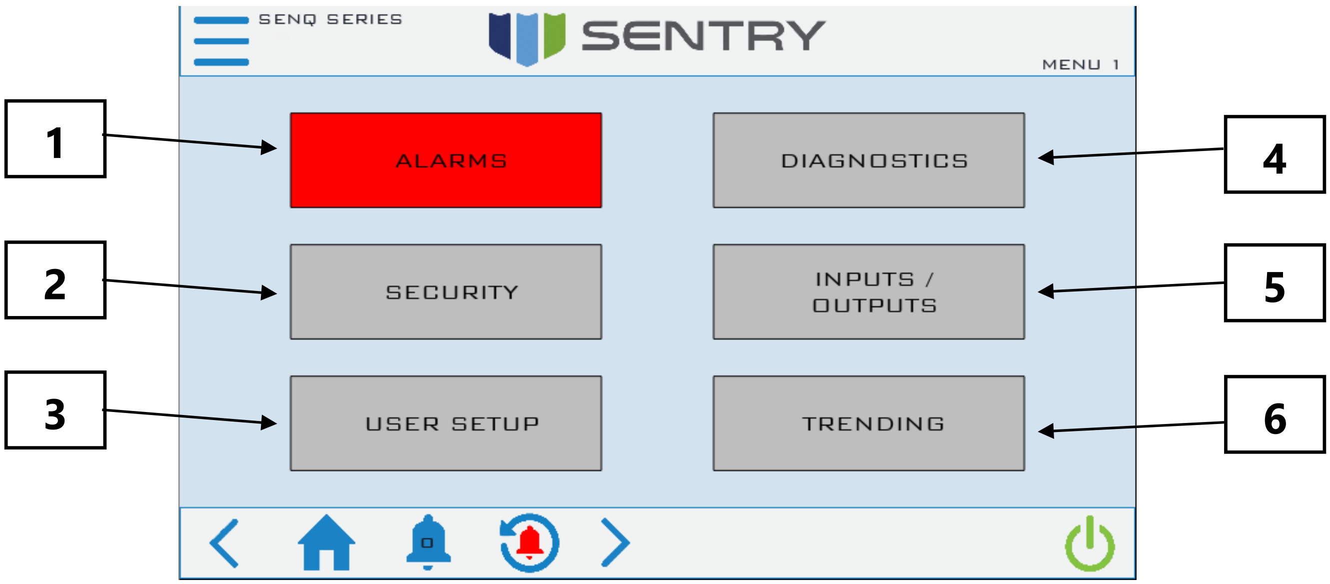
Home Screen

On this screen, the user has On/Off control of the TCU. The user may change the temperature set points of the TCU.



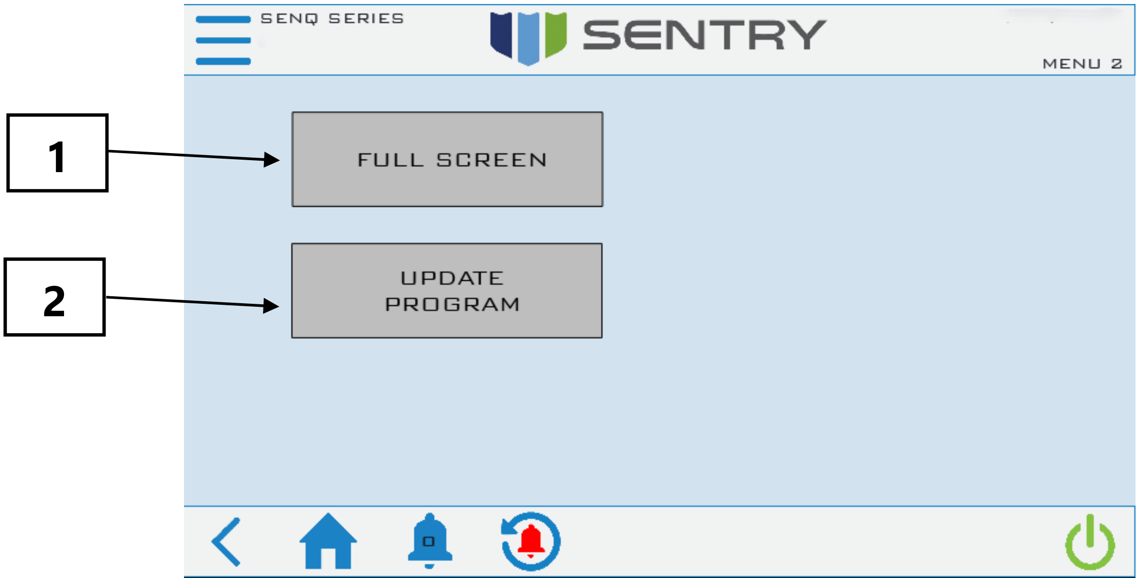
1. System Start/Stop - Pressing this button will provide the ability to start or stop the TCU.
2. Temperature Set Point Display & Entry
    a. To change the set point, press the set point display. This will bring up a numeric keypad screen. Use the keypad to enter your desired temperature and press "Enter" to confirm or "Esc" to cancel.
3. Actual Supply Fluid Temperature Display
    a. The measured supply temperatures of water going to the process are displayed.
4. Alarm Notification - This box will display the warning, alarm or fault if one exists.
5. Alarms - Press this button to access the active alarms list, view alarm history, and view troubleshooting information. *This appears on multiple screens and has the same functionality.*
6. Menu Screen - Pressing this button will bring up a list of other screens that may be accessed.

Menu 1 Screen



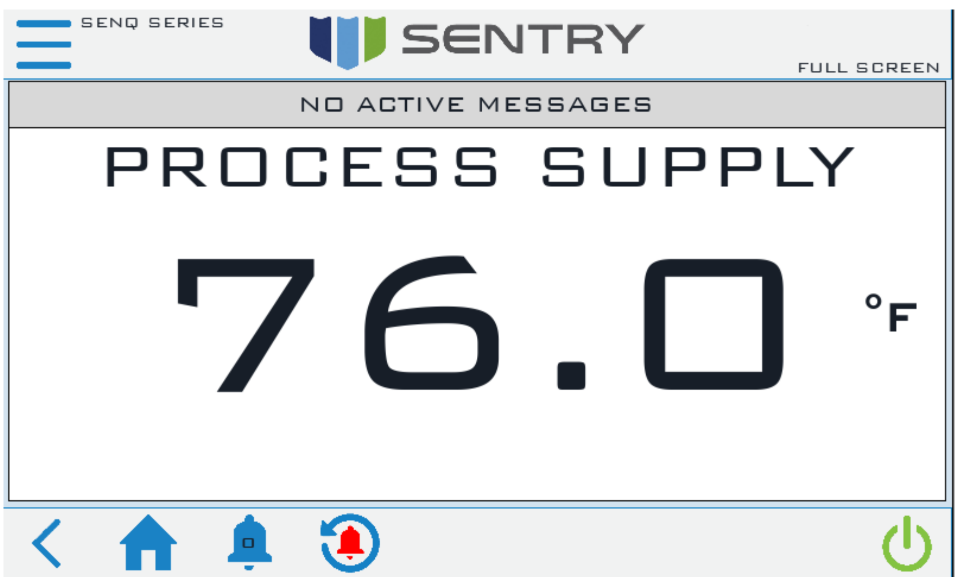
1. Alarms – Pressing this button will present the Active Alarm screen.
2. Security – Pressing this button allows you to log into the system to allow for parameter modifications.
3. User Setup – This button is only visible if the appropriate credentials have been entered. This provides the ability to modify system parameters.
4. Diagnostics – This is a "read only" system variable area used to display operating information.
5. Inputs / Outputs – Press this button to view the controller's inputs and outputs
6. Trending – Press this button to view a graphical chart of system operating data.

Menu 2 Screen

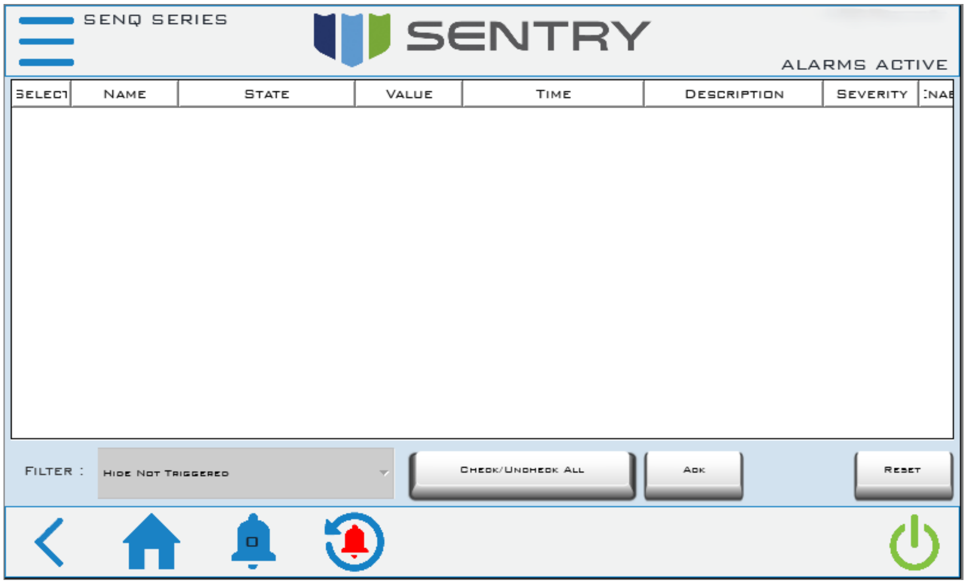


1. Full Screen – Press this button for a consolidated and simplified display.
2. Update Program – In the event that an interface program update is required, pressing this button will initiate the update only after the USB drive has been inserted into the interface.

Full Screen

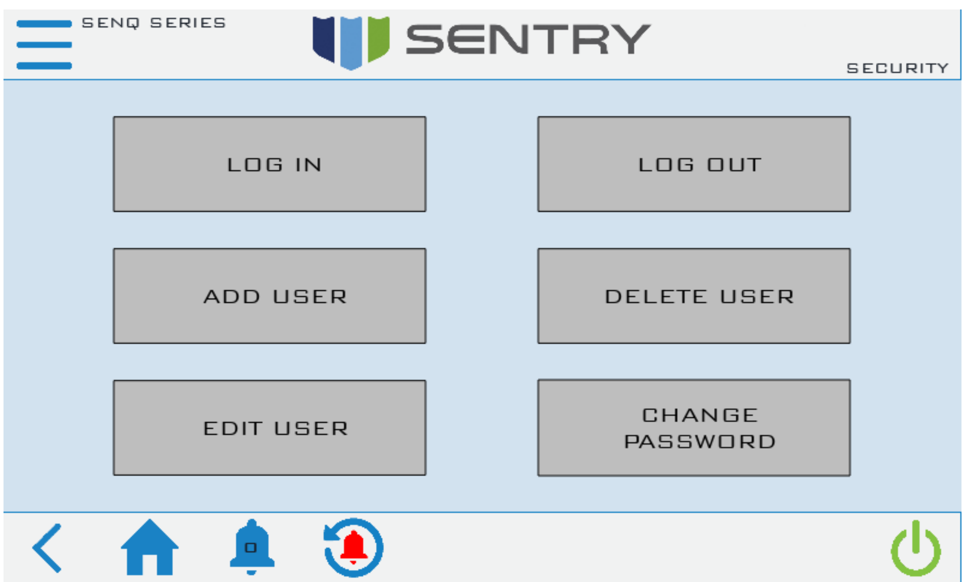


Alarm Screen



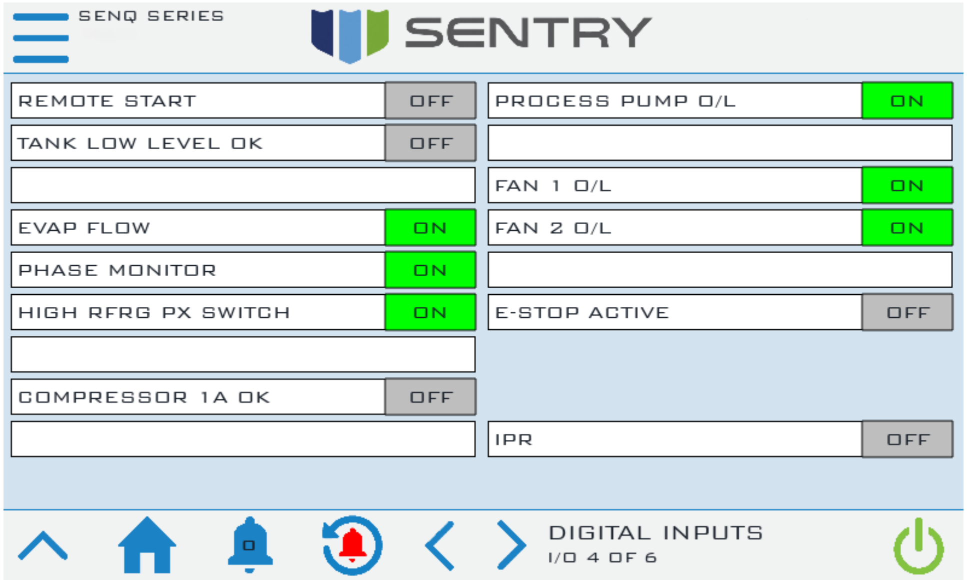
All active alarms will be displayed on the Alarm Screen.

Security Screen



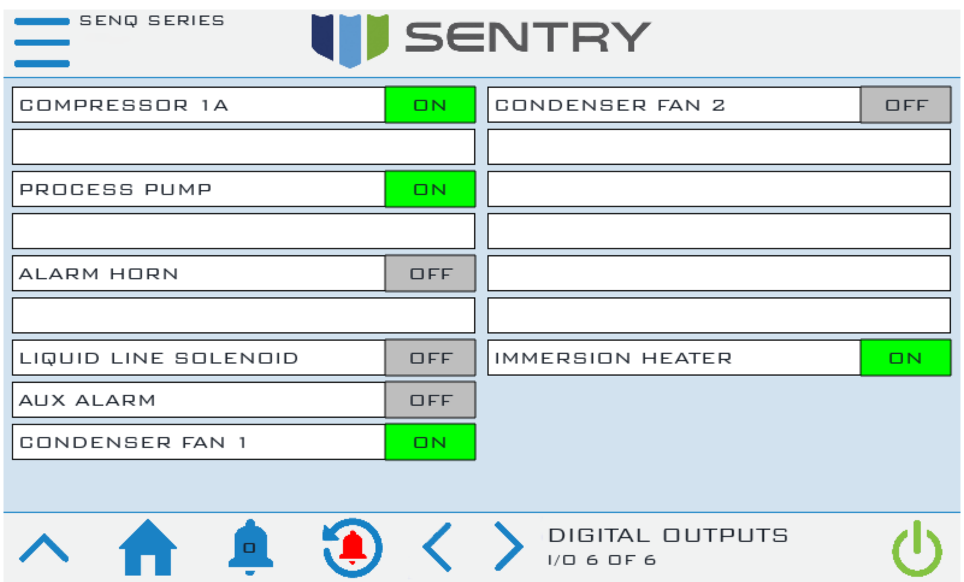
Log In credentials are required to modify set point and TCU parameters.

Controller Input Status Screen



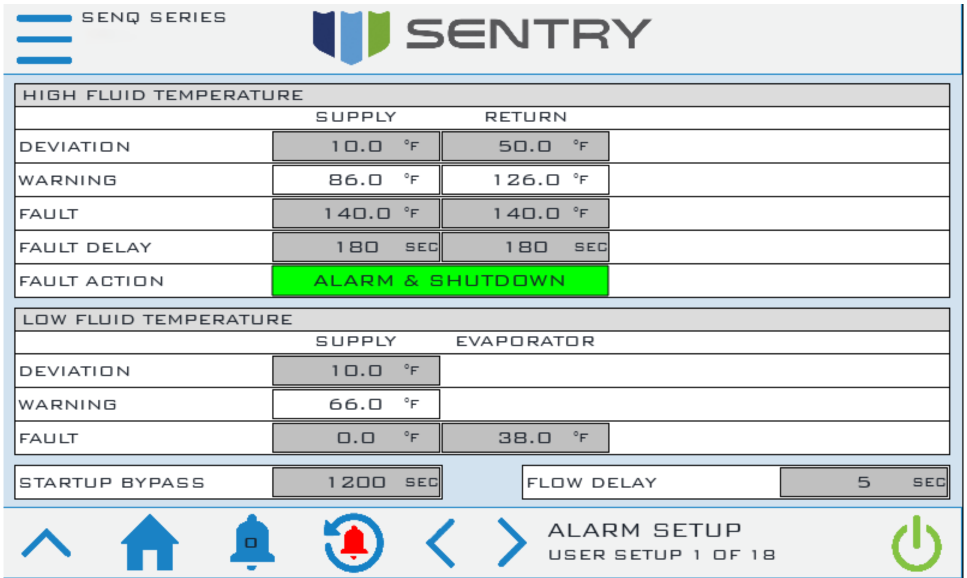
A grey box next to a terminal indicates that there is no voltage present at this terminal. If the box is green, the input is active.

Controller Output Status Screen



A grey box next to a terminal indicates that the output is off. If the box is green, the output is on.

Alarm Setup Screen



Start-Up

Every unit is factory set to deliver chilled water in accordance with the standard operating specifications for that particular TCU. Due to variables involved with different applications and different installations, minor adjustments may be required during the initial start-up to ensure proper operation. Use a qualified refrigeration technician to perform the start-up procedure in sequence. The following serves as a checklist for the initial start-up and for subsequent start-ups if the TCU is out of service for a prolonged time.

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WARNING: This equipment contains refrigerant under pressure. Accidental release of refrigerant under pressure can cause personal injury and or property damage.

WARNING: This equipment may contain fan blades or other sharp edges. Make sure all fan guards and other protective shields are securely in place.

WARNING: The exposed surfaces of motors, refrigerant piping, and other fluid circuit components can be very hot and can cause burns if touched with unprotected hands.

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CAUTION: Wear eye protection when installing, maintaining, or repairing the equipment to protect against any sparks, debris, or fluid leaks.

CAUTION: Wear protective gloves when installing, maintaining, or repairing the equipment to protect against any sparks, debris, or fluid leaks.

CAUTION: Wire the unit ground in compliance with local and national codes.

CAUTION: The unit requires the main power to remain connected during off-hours to energize the compressor's crankcase heater. Disconnect main power only when servicing the TCU. The crankcase heater should remain on when the compressor is off to ensure liquid refrigerant does not accumulate in the compressor crankcase. Connect main power at least 24 hours prior to initial startup.

Step 1 - Connect Main Power

Connect main power properly ensuring it matches the voltage shown on the nameplate of the unit. Check the electrical phase sequence prior to start-up. Operation of the compressor with incorrect electrical phase sequencing will cause damage to the compressor. Check the phasing prior to applying power. The proper sequence is "ABC." If the phasing is incorrect, open the main power disconnect and switch two line leads on the main power terminal blocks (or the unit mounted disconnect). All electrical components are in-phase at the factory. Do not interchange any load leads that are from the unit contactors or the motor terminals. After making proper power connection and grounding, turn the main power on.

Step 2 - Fill Coolant Circuit

Check to make sure all process chilled water piping connections are secure. Open the TCU cabinet and fill the coolant circuit with the proper water or water/glycol solution following the guidelines shown below When using a glycol solution only use glycol with a corrosion inhibitor. When filling the system make sure all air is purged from the piping before starting the system.

System Fill Water Chemistry Requirements

The properties of water make it ideal for heat transfer applications. It is safe, non-flammable, non-poisonous, easy to handle, widely available, and inexpensive in most industrialized areas.

When using water as a heat transfer fluid it is important to keep it within certain chemistry limits to avoid unwanted side effects. Water is a "universal solvent" because it can dissolve many solid substances and absorb gases. As a result, water can cause the corrosion of metals used in a cooling system. Often water is in an open system (exposed to air) and when the water evaporates, the dissolved minerals remain in the process fluid. When the concentration exceeds the solubility of some minerals, scale forms. The life giving properties of water can also encourage biological growth that can foul heat transfer surfaces.

To avoid the unwanted side effects associated with water cooling, proper chemical treatment and preventive maintenance is required for continuous plant productivity.

Unwanted Side Effects of Improper Water Quality

- Corrosion
- Scale
- Fouling
- Biological Contamination

Cooling Water Chemistry Properties

- Electrical Conductivity
- pH
- Alkalinity
- Total Hardness
- Dissolved gases

TCUs at their simplest have two main heat exchangers: one that absorbs the heat from the process (evaporator) and one that removes the heat from the TCU (condenser). All of our TCUs use stainless steel brazed plate evaporators. Our air-cooled TCUs use air to remove heat from the TCU; however, our water-cooled TCUs use either a tube-in-tube or shell-in-tube condenser which has copper refrigerant tubes and a steel shell. These, as are all heat exchangers, are susceptible to fouling of heat transfer surfaces due to scale or debris. Fouling of these surfaces reduces the heat-transfer surface area while increasing the fluid velocities and pressure drop through the heat exchanger. All of these effects reduce the heat transfer and affect the efficiency of the TCU.

The complex nature of water chemistry requires a specialist to evaluate and implement appropriate sensing, measurement and treatment needed for satisfactory performance and life. The recommendations of the specialist may include filtration, monitoring, treatment and control devices. With the ever-changing regulations on water usage and treatment chemicals, the information is usually up to date when a specialist in the industry is involved.

Table 8 – Fill Water Chemistry Requirements

Water Characteristic	Quality Limitation
Alkalinity (HCO_3^-)	70-300 ppm
Aluminum (Al)	Less than 0.2 ppm
Ammonium (NH_3)	Less than 2 ppm
Chlorides (Cl^-)	Less than 300 ppm
Electrical Conductivity	10-500µS/cm
Free (aggressive) Carbon Dioxide (CO_2)†	Less than 5 ppm
Free Chlorine(Cl_2)	Less than 1 PPM
HCO_3^-/SO_4^{2-}	Greater than 1.0
Hydrogen Sulfide (H_2S)*	Less than 0.05 ppm
Iron (Fe)	Less than 0.2 ppm
Manganese (Mn)	Less than 0.1 ppm
Nitrate (NO_3)	Less than 100 ppm
pH	7.5-9.0
Sulfate (SO_4^{2-})	Less than 70 ppm
Total Hardness (dH)k	4.0-8.5

* Sulfides in the water quickly oxidize when exposed to air; therefore ensure agitation does not occur when taking a water sample. Unless tested immediately at the site, the sample will require stabilization with a few drops of one Molar zinc acetate solution, allowing accurate sulfide determination up to 24 hours after sampling. A low pH and high alkalinity cause system problems, even when both values are within the range shown. The term pH refers to the acidity, basicity, or neutrality of the water supply. Below 7.0, water is acidic. Neutral water contains a pH of 7.0.

† Dissolved carbon dioxide calculation is from the pH and total alkalinity values shown below or measured on the site using a test kit.

Dissolved Carbon Dioxide, PPM = TA x 2[(6.3-pH)/0.3] where TA = Total Alkalinity, PPM as CaCO3

Table 9 - Recommended Ethylene Glycol Solutions

Chilled Water Temperature	Percent Ethylene Glycol By Volume
50°F (10°C)	Not required
45°F (7.2°C)	5 %
40°F (4.4°C)	10 %
35°F (1.7°C)	15 %
30°F (-1.1°C)	20 %
25°F (-3.9°C)	25 %
20°F (-6.7°C)	30 %

CAUTION: When your application requires the use of glycol, use industrial grade glycol specifically designed for heat transfer systems and equipment. Never use glycol designed for automotive applications. Automotive glycols typically have additives engineered to benefit the materials and conditions found in an automotive engine; however, these additives can gel and foul heat exchange surfaces and result in loss of performance or even failure of the TCU. In addition, these additives can react with the materials of the pump shaft seals resulting in leaks or premature pump failures.

WARNING: Ethylene Glycol is flammable at higher temperatures in a vapor state. Carefully handle this material and keep away from open flames or other possible ignition sources.

Step 3 - Check Condenser

There are three possible types of condenser present in the TCU: Integral air-cooled, water-cooled, and remote air-cooled. It is important to verify the TCU will have adequate condenser cooling for proper TCU operation.

Air-Cooled Condenser Check

Make sure the TCU is properly installed as described in the mechanical installation section of this manual. Check to make sure the TCU condenser is clear of obstructions and has at least 36 inches of open air on the air inlet and outlets for proper airflow.

Water-Cooled Condenser Check

Check the condenser water lines to make sure all connections are secure. Make sure sufficient condenser water flow and pressure are available, the condenser water supply is turned on, and all shut-off valves are opened.

Remote Air-Cooled Condenser Check

Check the refrigerant lines to make sure all connections are secure and that a proper evacuation of the TCU, the field piping, and the remote condenser has occured. Verify the refrigeration piping has been installed as descibed in the installation section of this manual. Check the remote condenser main power and control wiring to ensure all connections are secure.

Step 4 – Check Refrigerant Valves

During shipment or installation it is possibe valves where closed. Verify that all refrigerant valves are open.

Step 5 – Verify Freezestat Setting

Make sure the Freezestat is set appropriately for the operating conditions of the TCU. The Freezestat setting is in a password protected menu of the TCU controller. Refer to the Controller Operation Section for instruction on how to access this menu, It should be set at 10°F below the minimum chilled water temperature setting that the TCU will be operating. Reference Table 9 to be sure the coolant solution has sufficient freeze protection (glycol) to handle at least 5°F below the Freezestat setting. All TCUs are shipped from the factory with the Freezestat set at 38°F. This is done to protect against a possible freeze-up if no glycol has been added to the coolant. Once the proper glycol solution has been added, the Freezestat can be adjusted to the appropriate setting.

CAUTION: The manufacturer's warranty does not cover the evaporator from freezing. It is vital that the Freezestat is set properly.

Step 6 – Turn On Control Power

Turn on the control power by turning the control power switch to "On". The panel displays should now be illuminated. Due to extreme ambient temperatures that the unit may be exposed to during shipment, the High Refrigerant Pressure switch may have tripped. If this is the case, disconnect the main power and reset the High Refrigerant Pressure by depressing the manual reset button located on the switch. Reconnect the main power and turn the control power on by pressing the Power button. Clear the alarm condition by pressing the Alarm Reset button.

Step 7 – Establish Coolant Flow

Standard units are provided with an internal pump that can be energized by pressing the Start button. If the unit has been customized and does not have an internal pump, the external pump should be energized to establish flow through the TCU.

Note: The compressor will not start as long as the flow switch is open. A positive flow must be established through the evaporator before the compressor can operate.

Set water flow using a discharge throttling valve or flow control valve (by others). The valve should be the same size as the To Process connection of the TCU. Standard TCUs are designed for approximately 10 gpm/ton of nominal capacity. A significant increase in flow beyond this in a standard TCU may result in excessive pressure loss and negatively impact TCU efficiency and in extreme cases may cause premature wear or damage of internal components.

Step 8 – Initial Unit Operation

Entering the desired leaving fluid temperature on the control panel. Unless otherwise specified, the TCU is factory set to deliver coolant at 76°F. Adjust to the desired operating temperature. The TCU should now be controlling to the selected temperature. Please note that if there is insufficient load the compressor may cycle on and off causing swings in temperature.

WARNING: Under no circumstance should the High Refrigerant Pressure or the Low Compressor Pressure switch be deactivated. Failure to heed this warning can cause serious compressor damage, severe personal injury or death.

Operate the system for approximately 30 minutes. Check the liquid line sight glass. The refrigerant flow past the sight glass should be clear. Bubbles in the refrigerant indicate either low refrigerant charge or excessive pressure drop in the liquid line. A shortage of refrigerant is indicated if operating pressures are low and subcooling is low. Normal subcooling ranges are from 10°F to 20°F. If subcooling is not within this range, check the superheat and adjust if required. The superheat should be approximately 10°F. Since the unit is factory charged, adding or removing refrigerant charge should not be necessary. If the operating pressures, sight glass, superheat, and subcooling readings indicate a refrigerant shortage, charge refrigerant as required. With the unit running, add refrigerant vapor by connecting the charging line to the suction service valve and charging through the backseat port until operating conditions become normal.

CAUTION: A clear sight glass alone does not mean that the system is properly charged. Also check system superheat, subcooling, and unit operating pressures. If both suction and discharge pressures are low but subcooling is normal, a problem other than refrigerant shortage exists. Do not add refrigerant, as this may result in overcharging the circuit.

Once proper flow and temperature are achieved, press the Stop button. The unit is now ready to be placed into service.

Preventive Maintenance

Once your portable TCU has been placed into service, the following maintenance procedures should be adhered to as closely as possible. The importance of a properly established preventive maintenance program cannot be overemphasized. Taking the time to follow these simple procedures will result in substantially reduced downtime, reduced repair costs, and an extended useful lifetime for the TCU. Any monetary costs of implementing these procedures will almost always more than pay for it.

To make this as simple as possible, a checklist should be prepared which lists the recommended service operations and the times at which they are to be performed. At the end of this section we have included a checklist that can be used for this purpose. Notice that there are locations for voltage readings, amperages, etc. so that they can be monitored over time. With this information, maintenance personnel may be able to correct a potential problem before it causes any downtime. For best results, these readings should be taken with a full heat load from process, preferably with similar operating conditions each time. The following is a list of suggested periodic maintenance.

Once a Week

1. (Air-Cooled Units Only) Check the surface of the air-cooled condenser coil for dirt and debris. To clean, rinse thoroughly with water. Mild detergent can be used to remove smoke and or grease stains.

2. Check to make sure that the To Process temperature is maintained reasonably close to the Set Point temperature. If the temperature stays more than 5°F away from the set point, there may be a problem with the TCU. If this is the case, refer to the Troubleshooting Chart or contact the Customer Service Department.

3. Check the pump discharge pressure on the HMI. Investigate further if the pressure starts to stray away from the normal operating pressure.

4. Check the coolant level in the circuit. Replenish if necessary making sure to take proper precautions to maintain the appropriate glycol concentration.

5. Check coolant circulation pump for leaks in the seal area. Replace pump seal if necessary.

6. Check refrigerant sight glass for air bubbles or moisture indication. If the sight glass indicates that there is a refrigeration problem, have the unit serviced as soon as possible.

Once a Month

7. With the main disconnect shut off and locked out, check the condition of electrical connections at all contactors, starters and controls. Check for loose or frayed wires.

8. Check the incoming voltage to make sure it is within 10% of the design voltage for the TCU.

9. Check the amp draws to each leg of the compressor (fans or blowers on air-cooled units) and pump to confirm that they are drawing the proper current.

Every Three Months

10. Units are equipped with a Y-strainer between the return connection and the evaporator inlet. The strainer basket should be removed and cleaned if necessary. This may be required more often if contaminants can easily get into the process water.

11. Have a qualified refrigeration technician inspect the operation of the entire unit to ensure that everything is operating properly. Have condenser cleaned out if necessary.

Preventive Maintenance Checklist

Maintenance Activity	Week Number												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Date													
Clean Condenser Coil and Inlet Filter (air cooled units)													
Temperature Control													
Pump Discharge Pressure													
Coolant Level													
Glycol Concentration													
Pump Seal													
Refrigerant Sight Glass													
Electrical Connections													
Incoming Voltage													
Compressor #1 L1 Amps													
Compressor #1 L2 Amps													
Compressor #1 L3 Amps													
Compressor #2 L1 Amps													
Compressor #2 L2 Amps													
Compressor #2 L3 Amps													
Pump L1 Amps													
Pump L2 Amps													
Pump L3 Amps													
Fan #1 L1 Amps													
Fan #1 L1 Amps													
Fan #1 L3 Amps													
Fan #2 L1 Amps													
Fan #2 L2 Amps													
Fan #2 L3 Amps													
Fan #3 L1 Amps													
Fan #3 L2 Amps													
Fan #3 L3 Amps													
Clean Y-Strainer													
Refrigerant Circuit Check													
Refrigerant Suction Pressure													
Refrigerant Discharge Pressure													
Refrigerant Superheat													

Troubleshooting

Problem	Possible Cause	Remedy
Compressor will not start	Compressor overload	Check supply voltage, amperage of each leg, contactor and wiring, and overload set point
	Compressor contactor	Replace if faulty
	Compressor failure	Contact Customer Service for assistance
Pump will not start	Pump overload	Check supply voltage, amperage of each leg, contactor and wiring, and overload set point
	Pump contactor	Replace if faulty
	Pump failure	Replace if faulty
Low refrigerant pressure	Low refrigerant charge	Contact refrigeration service technician
	Refrigerant leak	Contact refrigeration service technician
	Low refrigeration pressure sensor	Check for proper range, replace if faulty
High refrigerant pressure *Note: To clear a high refrigerant pressure alarm, press the button on the high refrigerant pressure sensor.*	Dirty air filters (air-cooled units only)	Clean filters
	Air flow obstruction (air-cooled units only)	Make sure TCU is installed in accordance with recommendations in this manual
	High ambient air temperature (air-cooled units only)	Ambient temperature must be reduced below 110°F
	Condenser fan motor (air-cooled units only)	Replace if faulty
	Condenser fan cycling control (air-cooled units only)	Confirm proper operation, replace if faulty
	Plugged condenser (water-cooled units only)	Clean out tubes
	Insufficient condenser water flow (water-cooled units only)	Make sure TCU is installed in accordance with the recommendations of this manual
	High condenser water temperature (water-cooled units only)	Condenser water temperature must be reduced below 100°F
	Condenser water regulating valve	Check setting, replace if faulty
	Refrigerant circuit overcharged	Contact refrigeration service technician
	High refrigerant pressure sensor	Replace if faulty
Freezestat	Low flow through evaporator	Adjust flow to proper level
	Freezestat control module	Check for proper setting (Protected Setting)
	Freezestat sensor	Replace if faulty
Low pump discharge pressure	Pump running backwards	Switch 2 legs of the incoming power
	Pump pressure gauge	Replace if faulty
	Pump failure	Replace if faulty
	Excessive flow	Reduce flow
High pump discharge pressure	Closed valves in process piping	Open valves
	Obstruction in piping or process	Remove obstruction
	Clogged Y-strainer	Clean strainer
	Pressure gauge	Replace if faulty

Troubleshooting (continued)

Problem	Possible Cause	Remedy
Erratic temperature control	Low coolant flow through evaporator	Adjust flow to proper level
	Intermittent overloading of TCU capacity	Check to make sure TCU is properly sized for process load
	Hot gas bypass valve	Contact refrigeration service technician
	Temperature sensor	Replace if faulty
Insufficient cooling (temperature continues to rise above set point)	Process load too high	Check to make sure TCU is properly sized for process load
	Coolant flow through evaporator too high or low	Adjust flow to proper level
	Insufficient condenser cooling	See "High Refrigerant Pressure"
	Hot gas bypass valve stuck open	Contact refrigeration service technician
	Refrigeration circuit problem	Contact refrigeration service technician
	Temperature sensor	Replace if faulty

Drawings

We have prepared a custom set of drawings for your unit and placed them inside the control panel prior to shipment. Please refer to these drawings when troubleshooting, servicing, and installing the unit. If you cannot find these drawings or wish to have additional copies, please contact our Customer Service Department and reference the serial number of your unit.

Warranty

Sentry Equipment Corp ("Seller") warrants products manufactured by it and supplied hereunder ("Products") to be free from defects in workmanship and, to the extent materials are selected by Seller, to be free from defects in materials, in each case for a period as defined in the table below:

Product Line	Product Category	Warranty Period
Sentry®	1. Automatic Sampling 2. Corrosion Monitoring 3. Manual Sampling 4. Sample Conditioning 5. Sampling & Analysis Systems 6. Replacement Parts (without expiration dates)	Eighteen months from date of shipment or twelve months from startup, whichever occurs first
Waters Equipment	1. Sampling & Analysis Systems 2. Replacement Parts (without expiration dates)	Twelve months from date of shipment

To view the full warranty, go to www.sentry-equip.com/warranty.

Customer Support

With proven sampling expertise since 1924, Sentry products and services provide business operations the critical insights to optimize process control and product quality. We deliver true representative sampling and analysis techniques to customers around the globe, empowering them to accurately monitor and measure processes for improved production efficiency, output, and safety. Standing behind our commitments, we are determined to tackle any application, anywhere.

We know that running an efficient operation isn't easy. It requires thorough, careful analysis of controlled, real-time data achieved through reliable, accurate, and repeatable process monitoring, and measuring. By effectively conditioning, sampling, and measuring gas, liquid, slurry, powder, solids, steam, or water within their production environments, our customers obtain the critical insights they need to control and optimize their processes.

Yet, controlling your processes also means reliable customer support throughout the life cycle of your equipment.

Customer Service—General information, warranty claims, order management.

Installation Service—For systems that require specialized expertise upon installation.

Technical Support—Troubleshooting, training, and technical manuals.

Field Service & Retrofits—When a problem needs immediate attention.

Replacements Parts & Consumables—Order your replacement parts and consumables.

Sentry ProShield Services—Select from four ProShield Guardian service plans providing different levels of support to protect your large system investments with regularly scheduled maintenance.

To learn more, go to www.sentry-equip.com/support.

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