

DX Remote & Self-Contained A/C ❖ INSTALLATION • OPERATION



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DX Remote & Self-Contained A/C Systems • Introduction

Warning

This manual contains essential information concerning the safe and proper installation and operation of your Cruisair air conditioning system. If there are any statements or procedures in this manual that you do not understand, contact the Dometic Corporation Applications Department for assistance. Phone 804-746-1313 (8 am - 5 pm US Eastern Time), Fax 804-746-7248, or email sales@tmenviro-va.com.

Notice

US federal law prohibits the intentional release of refrigerant gases into the environment, including the R-22 refrigerant used in most Cruisair air conditioning systems. Special care must be taken when installing, charging, and servicing Cruisair equipment to prevent any loss of equipment. Only EPA certified technicians with the proper equipment should perform service on the refrigerant circuit of the system.

Drawings and Diagrams

The figures that are referenced throughout this manual can be found immediately after the warranty section of the manual. In addition, some Cruisair equipment will be shipped with specific installation sheets or wiring diagrams that may supercede the information located in this manual.

Air Conditioning Basics

The basic principle of an air conditioner is the movement of heat. In a direct expansion (DX) water-cooled air conditioner, heat is transferred from the cabin air to the refrigerant gas, which then releases the heat into the seawater. In reverse cycle heating (heat pump), the refrigerant flow is reversed and heat is extracted from the seawater and then discharged into the cabin.

The heat exchange process relies on the movement of both cabin air and seawater to effectively work. If air flow or seawater flow is compromised, the efficiency of the system will drop, and the unit could eventually be damaged, or at least shut down on one of its safety protection devices.

Part of the cooling process, in addition to lowering the air temperature, is the removal of moisture from the air. This lowers the humidity, which makes the area feel more comfortable and helps keep the boat dry, reducing mold growth and other moisture related problems.

The Effect of Seawater Temperature

The efficiency of the system is dependent on both the seawater and cabin temperatures. In cooling, the air conditioner works

best when the seawater temperature is below 90°F (32°C). At higher water temperatures the unit will operate, but at reduced capacity. As the water temperature rises, so does the refrigerant gas pressure. A high-pressure safety switch will shut the unit down if the water temperature gets too hot, or there is a loss of cooling water flow.

In heat mode, the opposite is true. As the seawater temperature gets colder, there is less heat available and heating performance drops. Full heating capacity is available in water temperatures as low as 55°F (13°C), but drops to about 50% capacity in 40°F (4.4°C) water. Below this, the refrigerant pressure can be so low that the unit will not produce heat, (or may shut down on low-pressure fault, if this option is installed).

Types of DX Systems

Self-contained units have all major mechanical components of an air conditioning system mounted on one chassis, including the compressor, seawater condenser, evaporator coil, blower, electrical box and related parts.

The self-contained unit is normally mounted low in the living area - under a settee or berth, or in a closet or locker. Cabin air is pulled into the unit, where it is cooled or heated, then discharged through ducting to a grill usually located on a bulkhead high in the compartment.

The refrigerant circuit in a self-contained unit is pre-charged and sealed at the factory, and no additional charging is needed at installation. A typical self-contained unit is shown in Figure 1.

Remote systems, also called split-gas, have the air conditioning components mounted on two separate chassis that are installed in different locations and are connected by copper refrigerant tubing.

The condensing unit consists of the compressor, seawater condenser, and electrical components, and is mounted in the engine room or other mechanical space.

The cooling/heating unit includes the evaporator coil and a fan or blower mounted on a drip pan. It is installed in the living area in a similar manner to a self-contained unit. Two or three cooling/heating units can be connected to one condensing unit so that multiple or large cabins can be cooled.

A remote system must be charged with refrigerant after installation by a certified technician. A typical condensing unit is shown in Figure 2, and Figure 3 is a typical draw-through type cooling/heating unit.

Subsystems

Both self-contained units and remote condensing systems require subsystems that are purchased separately because of the many variations and options available. These include the seawater, air distribution, and control subsystems.

Seawater System

The seawater cooling system consists of an inlet through-hull fitting, seacock (water shut-off valve), strainer, pump, and overboard discharge fitting all connected by hose or piping. If multiple air conditioning units are served by a single seawater pump, then a pump relay and water manifold are required.

Air Distribution System

Cabin air is drawn into the self-contained unit or cooling/heating unit through a return air grill. It is then cooled or warmed and blown back into the cabin through a ducting system. The air should be discharged high in the cabin and away from the return air grill to ensure good circulation. An air filter is located on the cooling unit or on the return air grill and must be cleaned regularly.

System Controls

Two different types of controls are available, either an electro-mechanical rotary knob switch assembly or one of the Cruisair SMX series of microprocessor controls.

The electromechanical switch assemblies are typically 3-knob switches that control mode (OFF, FAN, RUN), thermostat (temperature setting), and fan speed. Other versions include 1 and 2 knob switches for control of "slave" cooling units, and a 4-knob switch for use on systems with auxiliary electric heat.

Cruisair SMX controls are advanced microprocessor systems that provide a more comfortable environment and better system protection than mechanical controls. In addition, over 20 pro-

grammable functions allow the user to customize the system to suit the specific needs of their boat and boating environment.

The two SMX control systems available are SMX II and the SMX Net. Each system consists of:

- **Power/Logic (P/L) board** - Monitors and controls all functions of the air conditioning unit. SMX II and SMX Net have different P/L boards and are not interchangeable.
- **Keypad/Display** - The SMXir is a 10-button user interface with a digital readout and LED indicators. It is used with SMX II or SMX Net systems.
- **Temperature-Sensing Element** - Air temperature is monitored by a temperature-sensing element (TSEP) that plugs into the power/logic board.
- **Connecting Cable** - The keypad/display connects to the P/L board with a CX or CXP connecting cable.

SMX Net systems may also have additional network cables and an outside temperature sensor that plug into the P/L board.

Condensate Drain

When the air conditioner is running in the cooling mode, moisture is removed from the air by the evaporator coil. This condensation is then caught in a drain pan and must be drained off to a sump or overboard. In humid climates the system can produce a large amount of condensate water that could cause significant damage to your boat if the drain system doesn't work properly.

DX Remote & Self-Contained A/C Systems • Installation

Installation Procedures

This first section covers installation procedures for Cruisair direct expansion (DX) air conditioning systems, both self-contained units and remote systems. Please read and understand the manual before attempting to install any equipment.

SMX Installation

For installation instructions for your SMX Control, refer to SMX II Control Systems (L-2066) or the SMX Net Control Systems (L-2067) manuals.

Electrical System

Cruisair air conditioning systems are available for use with common power supplies throughout the world. In the United States and most of North and South America, the systems are 115V or 230V, 60Hz, single phase AC (alternating current). In Europe and most of Asia, power systems are typically 230V 50Hz single phase.

Compressors larger than 20,000 Btu/hr are only available in 230V single phase, 230V or 380/460V 3 phase. On 380/460V 3-phase units there is often a separate, lower voltage circuit for the controls and blower, either 115V or 230V. On some power systems this can be supplied by using one input line and the neutral. If not, a separate control power feed or a transformer will be required.

Running and starting loads of an air conditioning system are often the largest electrical loads on a boat. It is important that the power supply system is large enough to handle these loads, and is installed properly. Contact an electrician if you are not sure about the proper wiring procedures. Always follow local codes or ABYC codes for proper wiring guidelines.

Voltage and Frequency

The voltage rating of a unit is a nominal rating. The actual voltage in a given location may be higher or lower by as much as 10% and the system will still operate fine. For example, at 60 Hz, you will sometimes see 110VAC to 120VAC, or 208VAC to 240VAC, or 440VAC to 480VAC. In a 50Hz environment, common voltages range from 220V to 240V, or 380V to 415V.

When choosing a system, the voltage and frequency must be known. While standard 60Hz equipment can often be run at 50Hz, it will experience a 17% drop in performance, however, 50Hz equipment can not be run at 60Hz because the 50Hz motor will run too fast and cause damage. Seawater pumps will lose even more performance at 50 Hz due to the nature of centrifugal pumps.

Dedicated 50Hz units will give full performance at 50Hz, and should be used when the system is going to be run exclusively

at 50Hz. If a boat is traveling in 50Hz and 60Hz environments, then 60Hz equipment should be installed, with special attention to sizing (especially the pumps) so that the system performs up to expectations. When running 60Hz equipment at 50Hz, the voltage should be reduced 17% to prevent overheating a motor.

Installing The Self-Contained A/C Unit

Safety Warning

A Cruisair self-contained unit should never be placed such that it can circulate carbon monoxide, fuel vapors or other noxious fumes into the boat's living spaces. Do not install or operate a self-contained unit in the engine room or near an internal combustion engine. Failure to follow this precaution could result in serious injury or death.

Selecting the Site

Self-contained units are designed for built-in installation low in a closet, under a dinette seat or bunk, or any other convenient location, with discharge air ducted to a grill high in the compartment. See Figure 4 for a typical installation.

Ignition Protection Warning

Self-contained units do not meet federal requirements for ignition protection. Do not install in spaces containing gasoline engines, tanks, LPG/CPG cylinders, regulators, valves or fuel line fittings. Failure to comply may result in injury or death.

The self-contained unit must be mounted in a space large enough to provide clearance on all sides for air circulation. It is not necessary that the coil be placed directly behind the return air grill, but an unobstructed path must be provided for the air to get to the coil. A 2" (50 mm) space in front of the evaporator coil must be maintained.

Measure carefully for horizontal and vertical clearance prior to proceeding with installation. It is a good practice to place each component physically in the area you have selected to ensure that there is enough space and that connections can be easily made.

Note that some Cruisair self-contained units have a detachable electrical box, which can be remotely mounted to save space in the installation.

Site Location Checklist

- Unit is not located in an engine room or near an internal combustion engine
- There is no obstruction of airflow from return air grill to coil
- Seawater can be piped to the unit with no loops, dips, or kinks
- Accessible for service and maintenance, including the return air filter
- Adequate space for seawater and condensate drain connections
- Flat, horizontal and sturdy mounting location
- Condensate drain can be run continuously downhill from unit to overboard fitting or sump
- Space is sealed from the bilge or outside air

Mounting the Self-Contained Unit

Before mounting the unit, rotate the blower for discharge in the desired direction by removing the screws from the blower mounting flange and any supporting the rear of the blower, then replacing all screws and remounting the electrical box (if needed).

Mount the unit on a horizontal surface, and fasten securely with the hold-down clips provided. If the unit has a detachable electrical box and you wish to mount it remotely, it should be securely fastened to a bulkhead or deck.

Route the condensate drain so that it flows freely to an overboard fitting or sump. Do not permit condensate to puddle in the bilge. Note that most Cruisair self-contained units have two condensate drains, one at each end. It is recommended that you use both drains for best results, but if you choose to use only one condensate drain, place the included plug in the other hole.

Once the unit is correctly mounted, proceed to section titled *“Installing The Seawater Cooling System.”*

Installing The Condensing Unit

This section applies only to remote condensing unit systems. If you are installing a self-contained unit, skip this section and go to *“Installing The Seawater Cooling System.”*

Selecting the Site

Cruisair condensing units are designed to be installed in any convenient location. The unit is normally placed in the engine room or other machinery space, but it can be located in the living areas. The condensing unit will produce condensation so a drip pan may be needed. The space around the unit can be insulated to reduce noise if desired. The unit is internally cooled and does not require ventilation.

Ignition Protection Warning

Most Cruisair remote condensing units meet federal requirements for ignition protection. However, there are some condensing units, such as those with 3-phase compressors, that are not ignition protected. Do not install non-ignition protected units in spaces containing gasoline engines, tanks, LPG/CPG cylinders, regulators, valves or fuel line fittings. Failure to comply may result in injury or death.

Site Location Checklist

- Adequate space for access to refrigerant, and seawater and electrical connections
- Accessible for service and maintenance
- Flat, horizontal surface
- Away from direct spray from engine air intakes or water washdown
- Maximum refrigerant tube run is 50ft (15m)

Mounting the Remote Condensing Unit

Orient the unit so the refrigerant, electrical connections and service ports are accessible.

On models with a plywood base, simply drill 4 mounting holes through the base in appropriate locations and fasten the unit with screws or bolts. Do not remove the plywood base or shock mounts as they are part of the vibration and noise isolation built into the unit.

Some models utilize a drain pan with bottom or side condensate drains. Screw or bolt through all corner holes of the pan to mount the unit.

Do not remove any covers, caps or fittings that may expose any wiring or refrigerant. Only remove these items when you are ready to complete the installation. Removal of any covers may result in damage to the electrical components. Removal of the caps or fittings may result in refrigerant loss.

Installing The Cooling/Heating Unit

This section applies only to remote condensing unit systems. If you are installing a self-contained unit, skip this section and go to “*Installing The Seawater Cooling System*”.

Safety Warning

A Cruisair cooling/heating unit should never be placed such that it can circulate carbon monoxide, fuel vapors or other noxious fumes into the boat's living spaces. Failure to follow this precaution could result in serious injury or death.

Ignition Protection Warning

Cooling/heating units do not meet federal requirements for ignition protection. Do not install in spaces containing gasoline engines, tanks, LPG/CPG cylinders, regulators, valves or fuel line fittings. Failure to comply may result in injury or death.

Safety Warning

Do not terminate air handler condensate drain lines within 3 feet (1m) of any outlet of engine exhaust systems, nor in a compartment housing an engine or generator, nor in a bilge, unless the drain is properly connected to a sealed condensate or shower sump pump. Exhaust and/or bilge fumes can travel up a drain line and mix with the return air blowing into living areas.

Selecting the Site

Because of the diversity of available cooling/heating units, there is a great deal of flexibility in selecting the location. Typically the unit is located low in the cabin, with the discharge grill as high as possible for good cooling performance and away from the return air for proper air circulation.

There are basically 2 types of cooling/heating units, draw-through and blow-through. Figures 5 and 6 show typical cooling/heating unit installations.

1. Draw-through units typically have squirrel-cage blowers that are strong enough to push air through ducting to the discharge grill.
2. Blow-through units use a fan or blower to blow air across the evaporator coil for direct discharge through a grill. The discharge air from these units should not be ducted.

Some cooling/heating units are designed for overhead use, and may be mounted below a flybridge console or seating. This setup will draw return air through the overhead, with discharge air either directly blown back down into the area or ducted to overhead grills.

It is not necessary for the evaporator coil to be placed directly in front of the return air grill, but an unobstructed path must be available for the air to get to the coil. A 2” (50mm) space in front of the evaporator coil must be maintained.

Site Location Checklist

- Unit is not located in an engine room or near an internal combustion engine
- There is no obstruction of airflow from return air grill to coil
- Accessible for service and maintenance, including the return air filter
- Adequate space for and condensate drain connections
- Flat, horizontal and sturdy mounting location
- Condensate drain can be run continuously downhill from unit to overboard fitting or sump
- Space is sealed from the bilge or outside air
- Maximum copper tubing run between condensing unit and cooling unit is 50 ft. (15m)

Mounting the Cooling/Heating Unit

Mount the cooling/heating unit so that the condensate drip pan is beneath the unit. Some models require a mounting frame or mounting leg kit, which is supplied separately. Other models have integral mounting frames or the condensate pan itself is the mounting base. See individual spec sheets for specific guidelines.

Route the condensate drain hose steadily downhill so that the condensate flows freely to an overboard fitting or sump. Do not permit condensate to puddle in the bilge. Some Cruisair cooling/heating units have two condensate drains, one at each end. It is recommended that you use both drains for best results. If you choose to use only one condensate drain, plug the other.

Be careful when bending the extension tubes on the evaporators. Do not allow the tubing to kink and do not twist or bend the tubing at the connection point close to the coil or the joints may crack. If bending by hand make large radius bends. Use a tube bender if a tight bend is required.

Installing the Refrigerant Tubing

Use refrigerant-grade soft copper tubing of the correct sizes to connect the cooling/heating unit to the condensing unit. Note that tee-joints will be needed if more than one cooling/heating unit is used with a single condensing unit. The tees must be properly oriented to provide best efficiency. (See Figure 7, Refrigerant Line Size Chart.)

Only use refrigerant-grade seamless soft copper tubing. Never use any type of plastic or rubber hose or tubing.

The refrigerant tubes can run uphill, downhill or sloping as required and can have as many bends as necessary. Avoid sharp bends that could result in kinks in the tubing. The cooling/heat-

ing unit has additional tubing to help with installation. Take care when bending this tubing as it can easily kink or crack a weld joint resulting in refrigerant loss.

Both refrigerant lines should be insulated individually.

When putting the recommended closed cell foam insulation over the tubes, cover the ends of the copper tubes to prevent foreign material and moisture from getting inside the copper tubing. After checking for leaks, insulate the connecting flare nut joints and tee-joints to prevent secondary condensation. Secure tubing every 3 feet (1m) as necessary for support.

The copper tubing is connected to the condensing unit and cooling/heating unit with flare joints. To prevent refrigerant leaks, flares must be formed correctly with the proper flaring tool. Only 45-degree single flares should be used.

Flares should be made following the instructions of the particular flaring tool. Make sure to slide the flare nut onto the tube before flaring. A drop of oil on the tube can ease the flaring process. The surface of the flare face must be smooth and free of defects to ensure that the joint won't leak. The flare should be large enough in diameter to fill the flare nut completely.

Once you have completed installing the cooling/heating unit and have made the refrigerant connections between the cooling/heating unit and the condensing unit, proceed to on to the next section "*Installing The Seawater Cooling System*."

Installing the Seawater Cooling System

The following installation instructions apply to both self-contained and remote condensing units.

Importance of a Self-Draining System

Along with restricted ducting, a poorly plumbed seawater system is one of the most common installation problems on marine air conditioners. When water flow is lost, not only will the air conditioning units no longer cool or heat, the units and the pump could be damaged from running with no water flow.

When using a centrifugal seawater pump, it is imperative that the seawater piping be routed continually uphill from the through-hull inlet to pump and to the condenser, then smoothly up or down to the overboard discharge, without any dips or loops, and with only one high point in the system. This is said to be self-draining because all water would drain out of the piping if the boat were lifted out of the water.

Whenever air gets into the system, which can happen in heavy seas or a sharp turn, it can become trapped in the pump. Because a centrifugal pump cannot pump air, flow through the system is lost.

A self-draining seawater system will allow air in the piping to rise naturally through the pump and then be expelled. It will also make winterizing the system much easier.

Figure 8 shows a properly plumbed system and some common mistakes.

Through-Hull Inlet Fitting

A separate through-hull fitting must be installed for each air conditioning seawater pump. Do not attempt to draw water from an engine, generator, or other through-hull fitting.

A scoop-type through hull should be installed facing forward, and as far below the water line and close to the keel as possible.

Drill a properly sized hole for the through-hull fitting. Bed the scoop with marine sealant designed for underwater use, and tighten the nut onto the through-hull to secure it.

Seacock

A full flow seacock should be installed directly onto the through-hull fitting. Use Threaded-seal tape or other sealant on the threads. The seacock must be accessible and easy to close in case of emergency, or to clean the strainer.

Strainer

A seawater strainer must be installed between the seacock and the pump, and should be situated to provide easy access for cleaning. The strainer must be located vertically above the seacock and below the pump so any air that gets into the strainer can get out.

Make sure the water flow through the strainer is in the correct direction. Some strainers have an arrow that shows correct flow direction.

Mount the strainer to a bulkhead so it is properly supported before connecting hoses. Use Threaded-seal tape or other sealant on pipe threads.

Seawater Pump

Centrifugal pumps are not self-priming, and must be mounted so that they are below the heeled waterline in any given operating condition. The pump should be accessible for future service.

Mount the pump so the outlet is directed upward so air can escape. The head on some pumps can be rotated to allow mounting on a vertical bulkhead. See Figure 9.

Self-priming pumps are available if the pump cannot be mounted below the waterline.

Required seawater flowrate is 4 gpm per ton (12,000 Btu/hr) of total system capacity.

Manifolds

If a pump is serving multiple units, then a seawater manifold will be needed to supply water to all units. This can be as simple as a TEE for 2 units, or a custom made manifold for up to 7 or 8 units.

It is very important to consider manifold orientation so that all air conditioning units get the proper flow of water. See Figure 10 for manifold information.

A manifold can also be used on the outlets of the air conditioning units when using a single overboard discharge.

Overboard Discharge

The overboard fitting should be located between 1 to 2 inches (25 - 50 mm) above the water line. This is to facilitate visual confirmation of water flow, but also close enough to the water to minimize splashing noise.

If the overboard fitting must be installed below the heeled water line, then a valve must be installed per ABYC standards.

Seawater Piping

- Only use reinforced marine grade hose or other suitable piping (PVC, CPVC, Cupronickle, or Stainless steel).
- Double clamp all hose connections.
- Use only plastic, bronze, or stainless steel fittings (do not use brass).
- Avoid loops or dips in the hose runs.
- Make sure enough hose is used to allow future removal of components.
- Use the correct size hose, fittings, and components. See the table below for proper seawater sizing. Note that the pump inlet piping (including through-hull and strainer) may

Recommended Seawater Pipe Sizes

Flow Rate (gpm)	Pump Inlet	Pump Discharge
1 - 4	5/8"	5/8"
4 - 7	3/4"	5/8"
7 - 11	1"	3/4"
11 - 15	1"	1"
15 - 20	1 1/4"	1"
20 - 25	1 1/4"	1 1/4"
25 - 30	1 1/2"	1 1/4"
30 - 40	1 1/2"	1 1/2"
40 - 45	2"	1 1/2"
45 - 65	2"	2"

need to be larger than the outlet pipe size. Do not use pump connections to determine hose size.

- The "Pump Inlet" recommended pipe size includes all fittings and hose (through-hull, seacock, strainer, etc.) up to the pump inlet connection. The "Pump Discharge" includes all piping/hose and fittings from the pump to the air conditioning unit or manifold, and to the overboard discharge.
- Use larger hose when the run is longer than 16 feet (5m).

Bonding

Bond all metallic parts (through-hull fittings, valves, strainer, manifolds, etc.) that are in contact with seawater to the vessel's bonding system in accordance with ABYC standards E-8 and E-9. Items should only be bonded or grounded once. If an item is in contact with an electrically grounded part (pump head or seawater condenser) then it should not be bonded again.

Installing The Air Distribution System

The following instructions apply to both self-contained units and remote condensing systems, except as noted. Refer to Figure 11 for proper grill and duct sizes.

Return Air Grill (RA Grills)

The return air grill should be located so there is unobstructed airflow to the unit's evaporator coils. Installing ducting between the return air grill and the air conditioning unit is not normally necessary and should be avoided. The grill may be located on a side opposite the evaporator coil so long as airflow to the coil is unobstructed.

An air filter must be used to prevent the evaporator coil from collecting dirt and lint. The filter can be located at the evaporator coil or at the grill. Only one filter should be used. Most self-contained units and cooling units are supplied with an air filter, but if the filter is not easily accessible, use a filter on the return air grill.

Ducts

Insulated flexible ducting or built-in ducting may be used to route air from the blower to the discharge grill. Note that blow through cooling units are installed directly behind the discharge grill, and ducts are unnecessary. Likewise, with some overhead cooling/heating units, air is discharged directly into the compartment without ducts.

Ducting Guidelines

Secure duct to blower or transition box (plenum) with screws and duct tape. When using insulated flexible ducting, make sure inner duct is secured and sealed to adapter before pulling insulation over connection.

Plenums, or transition boxes are used with flexible ducting to split and route the discharge air as needed. Figure 12 shows several plenum configurations.

- Ducting must be properly sized for the airflow. If the duct run is longer than 10 feet (3m), use the next larger duct size.
- Use of insulated duct is recommended, and is mandatory when used in high heat areas or where condensation would be a problem.
- Run flexible ducting tightly and smoothly, with as few bends as possible.
- Keep ducts as short as possible.
- Support ducting to prevent sagging during boat operation.
- Trim excess ducting before attaching to transition adapters.
- Make sure ducting is not crushed or kinked.
- Use a flexible transition duct between blower and any built-in ducting.
- If possible, rotate blower to keep duct run as short and direct as possible.

Discharge Air Grill

When used with flexible ducts, a grill plenum should be incorporated behind the discharge grill. Location of this grill should be as high as possible in the cabin, and oriented so that air flow between discharge and return encompasses as great an area as possible in the cabin. Care should be taken to avoid “short cycling,” a situation where the conditioned air is returned to the coil without being substantially affected by the cabin air.

Installing the Control Unit

The SMX Control

If your system has SMX controls, refer to the appropriate SMX II or SMX Net Control System Installation/Operation Manual.

The Rotary Knob Switch Assembly

The following instructions apply to both self-contained and remote condensing unit systems using a rotary-knob switch assembly.

Warning

The rotary knob switch assembly switches line voltage (115 or 230VAC) and in many case full power of the unit. The selected mounting location must be safe in regards to voltage as well as heat produced by the switch assembly.

Location

The switch assembly should be mounted on a vertical bulkhead where it can easily be seen and reached. There should

be rear access with sufficient clearance for the wiring and the protective cover. The thermostat bulb is on a 10 ft (3m) long capillary tube, and the switch assembly must be installed close enough to the unit so the bulb can be mounted in the return air path.

Remote condensing systems use SA type switches which have terminal strips that must be mounted to the back of the bulkhead where all field wiring terminates. This location must be easily accessible for wiring connections and service.

One and two-knob slave switch assemblies should be installed in the cabin where the slave cooling unit is operating.

Mounting

Cut a hole in the bulkhead using the template shipped with the switch, or one from the back of this manual. See Figures 13a and 13b for templates and switch dimensions.

Attach the terminal strip to an accessible location on the back of the bulkhead (remote systems only). Self-contained systems have a 10-foot (3m) harness with a plug that connects to the self-contained unit.

Carefully route the thermostat bulb from the switch to the return air path of the unit so the capillary tube does not get kinked. The large bulb must sense the return air, and not touch the evaporator coil. If a second smaller “anticipator” bulb is attached to the main bulb, it should be installed into the discharge duct.

After making all wire connections, install the protective plastic cover (remote systems only) over the terminal strip. Next install the plastic cover over the back of the switch assembly (remote and self-contained systems) and mount the switch to the bulkhead with the 4 screws provided.

Installing the Pump Relay

The following instructions apply to both self-contained and remote condensing unit systems that have multiple A/C units served by a single seawater pump. If you only have one A/C unit, or each unit has it's own seawater pump, then skip to the next section.

Location

The pump relay is generally located in the engine room near the seawater pump, but it can be mounted anywhere that is convenient and accessible. It must be in a dry location, away from any possible water spray, with room for some heat dissipation.

Warning

PR3X and PR8X pump relays are certified ignition protected. However, pump relays with electromechanical relays or contactors (such as 3-phase pump relays) are not ignition protected and must never be installed in spaces containing gasoline engines, tanks, LPG/CPG cylinders, regulators, valves or fuel line fittings. Failure to comply may result in injury or death.

Voltage and Triggers

PR3X and PR8X pump relays are identical in operation. When the first A/C unit turns on, the pump relay will turn on the seawater pump, and the pump will stay on until the last A/C unit shuts down.

The PR3X can operate up to 3 A/C units, and the PR8X can operate up to 8 A/C units. Both can operate 115V and 230V pumps.

Triggers are used in the pump relays to isolate the signals from each A/C unit. Some pump relays come with pre-installed triggers, or you can buy triggers separately. Triggers come in 115V and 230V, and must match the control voltage of the A/C unit. Both 115V and 230V triggers can be used in a single pump relay if the system requires it.

The trigger is simply a relay that closes when the A/C unit turns on. Because each trigger is isolated, the polarity of the signals from the A/C units does not matter.

Electrical Connections

Warning

Make sure all power is off before opening any electrical box.

The following guidelines apply to both self-contained and remote condensing unit systems:

- Failure to properly ground and bond the system will void warranty.
- All electrical connections should be made within the electrical junction boxes supplied with the units. Most units have terminal strips that are labeled or have color-coded wiring. Open terminal strips (such as supplied with switch assemblies) require that the included terminal strip covers be installed over the strip and switch back after installation is complete.
- Wiring diagrams are included in the back of this manual and under the cover of the electrical boxes on all units. Contact Dometic Corporation if you are not sure if you have the correct diagrams.
- Each air conditioning unit requires it's own dedicated circuit breaker, of the appropriate size. See the table below for suggested circuit breaker and wire sizing.

- If there is only one a/c unit, the seawater pump does not require a separate breaker, but make sure the breaker is sized for the combined load of the unit and the pump. If multiple a/c units are supplied by a single pump, then a pump relay will be needed, and will require it's own circuit breaker.
- All units must be grounded to minimize the potential hazard of electrical shock and personal injury.
- All metallic fittings in the seawater system that are isolated from the a/c unit or pump by rubber hose should be bonded per ABYC standards E-8 and E-9.
- On larger F-type condensing units a fuse can be added to protect the fan and control wires.

Recommend Breaker and Wire Sizes				
Unit Size (BTU/Hr)	Unit Voltage	Breaker (Amps)	Wire Size (AWG) (mm ²)	
5,000	115V	15 A	14	2.5
7,000	115V	15 A	14	2.5
10,000	115V	20 A	12	4
12,000	115V	20 A	12	4
16,000	115V	30 A	10	6
18,000	115V	30 A	10	6
7,000	230V	10 A	14	2.5
10,000	230V	15 A	14	2.5
12,000	230V	15 A	14	2.5
16,000	230V	20 A	12	4
18,000	230V	20 A	12	4
20,000	230V	20 A	12	4
24,000	230V	20 A	12	4
30,000	230V	30 A	10	6
36,000	230V	30 A	10	6
48,000	230V	40 A	8	10
60,000	230V	60 A	6	16

Note

Always follow ABYC guidelines or local codes when selecting breakers and wire sizes.

Three Phase Power

Some larger compressors and pumps have 3 phase motors that will run forwards or backwards depending on the wire connections. Reciprocating (piston type) compressors can run either way without any problem, but scroll compressors and centrifugal pumps are direction sensitive and must be wired so the motors run the correct direction. If running backwards, Scroll compressors will usually make loud, unusual noises and will not perform properly.

Safety Warning

To prevent a possible electrical shock in the event a component has an electrical breakdown, which could result in serious injury or death, always ground the system in the following manner:

- Use proper wire size with a ground to feed power from the ship's electrical panel to each cooling unit junction box. Make sure the ground wire is properly connected to the ground buss in the ship's service distribution panel and to the ground lug in the cooling unit's junction box
- Connect the junction box ground lug to the P/L box green wire (or to the switch assembly terminal strip).
- Use proper wire size with a ground to feed the power from the ship's electrical panel to the condensing unit's junction box. Make sure the ground wire is properly connected to the ground buss in the ship's service distribution panel and to the condensing unit's ground lug.
- Ground the seawater pump, and pump relay (if used) to the condensing unit's ground lug.
- Bond the ground lug on the condensing unit to the ship's grounding system.
- Check the continuity of the ground system before the system is energized.

Note

Always follow ABYC guidelines or local codes when selecting breakers and wire sizes. ABYC standards are available from: American Boat and Yacht Council, 3069 Solomon's Island Rd., Edgewater, MD 21036, Telephone: (410) 956-1050.

Final Inspection

Prior to charging or energizing the system, conduct a final inspection, using the following checklist.

Inspecting the Seawater Cooling System

- Is the seawater pump properly sized for the system?
- Is the pump oriented correctly and mounted securely with the pump outlet directed vertically upwards?
- Is the centrifugal seawater pump located so it is below the water line at all times?
- Are the inlet and outlet thru-hulls secure, properly sealed and properly oriented?
- Are all hose clamps tight?
- Are seawater hoses double clamped?
- Are there any loops or dips in the seawater plumbing that might cause the system to become air locked?
- Is the strainer located between the seacock and the pump, and is it correctly oriented?
- Are all metallic seawater fittings properly bonded?

Inspecting the Self Contained Unit

- Is the air conditioning unit securely mounted?
- Is the unit located so that it will not draw fumes from the engine room and discharge them into the compartment?
- Are condensate drains properly routed to an overboard discharge or sump?
- If only one condensate drain is being used, has the hole at the other end of the tray been plugged?

Inspecting the Condensing Unit (Remote Condensing Unit Systems Only)

- Is the condensing unit mounted securely using the integral wooden baseboard or drain pan?
- Are the fasteners accessible if it is necessary to remove the unit for service later?

Inspecting the Cooling/Heating Unit (Remote Condensing Unit Systems Only)

- Is the unit securely mounted?
- Are condensate drains properly routed to an overboard discharge or sump?
- If only one condensate drain is used, have any other drain holes in the drip tray been plugged?

Inspecting the Refrigerant Connections (Remote Condensing Unit Systems Only)

- Are flare joints made with forged flare nuts and properly tightened?
- Are flare joints and tees properly insulated?
- Are copper refrigerant tubes individually insulated?
- Are tubes fastened securely to the boat every three feet or as needed throughout their length?

Inspecting the Air Distribution System

- Is there unobstructed airflow from the return air grill to the coil?
- Is there a lint screen or filter in the return air path where it is accessible for regular cleaning?
- Have flexible ducts been pulled tight to remove bends and constrictions?
- Are grills correctly sized for the system?

Inspecting the Control/Switch Assembly and Electrical Wiring

- Is the thermostat sensor or thermistor properly located and secured in the return air path and not in direct contact with any metal objects? (For switch assemblies with two sensing bulbs, the large one goes in the return air path and the small one in the discharge air path.)
- Are all wiring harnesses properly secured?
- Are wiring connections made, color to color, correctly at terminal strips?
- Are plugs properly aligned and securely connected?
- Are all components properly grounded and bonded?
- Are proper sized circuit breakers used?
- Are terminal strips located in a dry, safe place and properly covered?

Charging the System with Refrigerant

Self-contained units are precharged from the factory and do not need further charging. If you are installing a self-contained system, skip this section and proceed to “Initial Startup”.

The following instructions should be followed in evacuating and charging a Cruisair remote condensing unit system with R-22. Some special ordered units contain refrigerant other than R-22. Please follow the special charging procedures included with the unit.

Notice

US federal law prohibits the intentional release of refrigerant gases into the environment, including the R-22 refrigerant used in most Cruisair air conditioning systems. Special care must be taken when installing, charging, and servicing Cruisair equipment to prevent any loss of equipment. Only EPA certified technicians with the proper equipment should perform service on the refrigerant circuit of the system.

Charging a New System

There are three refrigerant circuit components in a Cruisair remote condensing unit system: the condensing unit, the cooling/heating unit and the copper refrigerant lines. The condensing unit is shipped from the factory charged with approximately the right amount of refrigerant needed for the whole system.

The procedure will be to evacuate the nitrogen and air from the cooling unit and the copper tubing, then release the refrigerant from the condensing unit into the entire system. To facilitate this procedure, there is a special evacuation port (red cap) located on the base valve of the condensing unit. This port has a schrader valve so you can evacuate and vapor charge the lines and cooling unit without releasing the refrigerant in the condensing unit.

You will need the following tools to complete the charging procedure:

- R-22 container (typically the disposable-type container color-coded green for R-22)
- four-valve gauge manifold with self-closing fittings on the charging hoses
- vacuum pump
- base valve wrench and hand tools
- accurate thermometer

Proceed as follows:

1. Make sure all flare joints are well made and tight.
2. Do not touch the condensing unit base valve stem covers or white port caps. Remove the red port cap on the discharge (right side) base valve (or on a field-installed in-line tee fitting).
3. Connect the vacuum pump hose to the vacuum pump. Connect the refrigerant supply line to the refrigerant container (making sure the refrigerant container valve is OFF). Connect the low pressure gauge hose, to the red capped port. At this point, do not connect the high pressure charging hose to anything.
4. Close all four gauge manifold valves.
5. Energize the vacuum pump and open the manifold valves for the vacuum pump, the refrigerant container and the red-capped access port.
6. As the pump operates, you will see the low pressure test gauge fall to a vacuum. When the vacuum reaches 28 in. Hg close the vacuum pump valve and turn the vacuum pump off. Leave the system for 15 minutes and then observe the gauge. If any vacuum has been lost, look for leaks, especially at flare joints. Then return to step #3 above and re-evacuate the system.
7. Open the vacuum pump valve and leave the vacuum pump operating for at least 6 hours, until a vacuum of at least 29 in. Hg is achieved. Close the vacuum pump valve and turn the vacuum pump off. Wait one hour. If no vacuum is lost, proceed with charging. If any leaks are indicated, reinspect flare joints for leakage, and return to step #3 above to re-evacuate the system.
8. Open the refrigerant container valve slowly and allow gas to enter the system until the low pressure gauge rises to zero. You have now vapor charged the evacuated lines and cooling/heating unit with refrigerant to a gauge pressure of zero. Close the refrigerant container valve.
9. Remove the low pressure gauge hose from the red capped port. Replace and tighten the red cap.

10. Remove both condensing unit base valve stem caps. Open both base valves fully by turning the valve stems fully counterclockwise. This will allow the refrigerant in the condensing unit to enter the system. Replace and tighten the valve stem caps.

At this point, the system is basically charged and ready for final gas charge adjustment once the boat is in the water.

Field Charging the System

To field charge a new unit, which has been evacuated and basically charged, proceed as follows:

1. Remove both base valve stem caps and confirm that both valve stems are in the back-seated or full counterclockwise position.
2. Remove the white gauge port caps from both base valves. No gas should escape. If it does, retighten the cap and call Dometic Corporation for assistance.
3. Close all gauge manifold valves.
4. Attach the gauge manifold hoses to the gauge ports: high pressure on the right and low pressure on the left. Connect the hose to the refrigerant container.
5. Open both base valves to the test position by rotating the stems one turn clockwise.
6. Start the unit in the cooling mode, and observe the system pressures. Use the charging curves shown in Figure 29 to determine the proper pressures. These charts are to be used as a GUIDE to setting pressures. **They are NOT designed to give EXACT pressure settings.** There are conditions that may cause pressures to vary. Head pressures may vary $\pm 10\%$.
Accurate Suction Pressure settings are more critical for proper functioning of the system. Through the gauge manifold, adjust the gas charge to obtain the proper system pressures.
7. To remove the gauge manifold, backseat the base valves by turning the stems fully counterclockwise. Tighten the stem packing gland nuts. Replace and tighten the stem caps. Remove the gauge hoses and replace and tighten the port caps.

Note

It is recommended to charge the system in the cool mode (as described above). If conditions are such that charging must be done in the heat cycle, the gauge connections must be reversed on the base valves. Also note that in the heat mode the same pressures can be observed at two different charge levels. This could lead to an overcharge condition.

Removing Refrigerant from the System

When adjusting the charge in the refrigerant system, you may have to remove refrigerant. It is a violation of federal law to vent refrigerant to the atmosphere, and it is necessary that you capture any refrigerant that is removed from the system. There are two methods of doing this.

1. Use an approved refrigerant recovery unit and refillable refrigerant container.
2. Allow refrigerant to escape from the high pressure side into a refillable refrigerant container.

Initial Start Up

The following instructions apply to both self-contained and remote condensing systems.

1. Open the seacock (seawater inlet valve).
2. Turn on the circuit breaker for the air conditioner. If a pump relay is installed, the breaker for the pump must also be turned on.
3. Following directions in the Operation manual, set the system for cooling or heating at the switch or SMX keypad, and adjust temperature setting so the unit will turn on.
4. Verify that water is flowing from the overboard discharge. Check all overboards if more than one unit is installed.
5. Allow unit to run for 10 minutes at high fan speed. Check the temperature differential between discharge and return air by placing an accurate thermometer in front of the discharge grill and then in front of the return air grill.






In cooling, the difference between the discharge and return should be 15 - 20°F (8.3 - 11.1°C), with normal ambient air and water temperatures. In the heating mode the differential can be as high as 25°F (13.9°C).

If everything checks out, the system is ready to go.

DX Remote & Self-Contained A/C Systems • Operation

Operating Instructions - Rotary Controls

SA & SSA Models

1. Open the seawater inlet valve.
2. Set the OFF -  - ON knob to the OFF position.
3. Turn on the main circuit breakers on your boat's electrical panel designated for the air conditioning unit. If there is more than one air conditioning system on board, you must also turn on the breaker for the seawater pump.
4. Set the thermostat by turning the  knob (WARMER/COOLER) to the desired mode of operation.
5. Set the fan speed control to  (HIGH).
6. Turn the top control knob to  to energize the blower.
7. Turn the top control knob to ON. The compressor will start, and the unit will begin to cool or heat, depending on which mode of operation you have selected. Verify that water is flowing from the overboard discharge.
8. To set the thermostat, allow the unit to operate until the area is cooled or heated to the desired temperature. At this point, turn the  knob (WARMER/COOLER) slowly toward the center position until you hear it "click" once. The thermostat is now set to maintain the desired temperature.
9. Set the fan speed to provide the desired flow of air, using the center knob.
10. If you turn the system off, or if you wish to switch between cooling and heating, wait three minutes to allow the system's internal pressures to equalize before attempting to restart.

Hint

It is good practice to check for seawater flow by observing the overboard discharge when the system is first turned on. If you do not observe steady water flow, shut the system down and check for obstructions in the seawater cooling system.

Operation Instructions - SMX Controls

There are two different SMX control systems available, SMX II and SMX Net. The following are basic operation instructions for both systems. For complete installation and operation information, consult the appropriate manual, L-2066 for SMX II or L-2067 for SMX Net.

SMX II/SMX Net Operation

1. Open seacock (seawater inlet valve).
2. Turn on main circuit breakers for the air conditioning system. If there is more than one unit on board, you must also turn on the breaker for the seawater pump.
3. Adjust SMX settings as desired.

Hint

It is good practice to check for seawater flow by observing the overboard discharge when the system is first turned on. If you do not observe steady water flow, shut the system down and check the seawater system.

Power On

When AC power is applied to the system at the circuit breaker, the SMX microprocessor retrieves from permanent memory the last operating configuration. This process takes about four seconds, after which the system will begin operating just as it had been when power was last turned off.

System Off

Press the OFF key to turn the system off. Note that the data display remains energized even when the system is off. The fan can be turned on manually when the system is in the off mode.

Note

The SMX has built-in protection against sudden power interruptions. The system automatically stores the current operating configuration in permanent memory every time you make changes. (The new operation mode must be in affect for 10 seconds before it is saved into permanent memory.) When AC power is lost, the SMX system retains these settings, and when AC power is restored it resumes operation using the same settings as before.

Selecting Setpoint

Press the SET key and the current setpoint will be displayed. Press the UP or DOWN key to change the setpoint.

Displaying Temperature

To display cabin temperature, press the TEMP key.

SMX II Only

Press TEMP a second time for an alternating display of inside temperature and setpoint. Press a third time to return to inside temperature only.

SMX Net Series

If your boat is equipped with the optional outside thermistor, press TEMP a second time to display outside temperature. Press a third time for an alternating display of setpoint, inside temperature and outside temperature. Note that the inside and outside indicators show you which temperature is being displayed.

Cool Mode

To enter the COOL mode, press the COOL key. The Cool Mode Indicator will light to show that you have selected the cooling mode.

The Cooling Indicator will be lit whenever the system is in the cooling mode and the compressor is actually running. When the compressor cycles off, the Cooling Indicator goes off, but the Cool Mode Indicator stays on.

Heat Mode

Press the HEAT key to select HEAT Mode. The Heat Mode Indicator will light to show that you have selected the heating mode.

The Heating Indicator will be lit whenever the system is in the heating mode and the compressor is actually running. When the compressor cycles off, the Heating Indicator goes off, but the Heat Mode Indicator stays on.

Automatic Changeover

Press the COOL and HEAT keys simultaneously for AUTOMATIC CHANGEOVER between COOL and HEAT Modes. The mode indicators will light, to show that the system is in the automatic changeover mode.

For the SMXir Remote Control only - Press the Auto Switchover key to enter automatic changeover mode.

Note that the Cooling or Heating Indicator will come on when the compressor is running to show when the system is running in the cooling or heating mode.

Manual Fan Speed Control

Press the FAN key to select manual fan control. The Manual Fan Indicator will light to show that it is in the manual mode. Then use the SLOW and FAST keys to select the desired fan speed.

Note that you can use the manual fan control to circulate air even when the system is in the OFF mode.

Automatic Fan Speed Control

If in manual fan mode, press FAN key to select automatic fan control. The Manual Fan Indicator goes off, and the system will automatically adjust fan speed as the actual cabin temperature deviates from the setpoint. As setpoint is approached, the fan

speed automatically slows. Once setpoint is reached, the compressor cycles off and the fan keeps running on low speed.

Adjusting Brightness

Pressing the SET key repetitively will dim the LED display. Keep pressing SET to return to full brightness.

Note

SMXLB keypads automatically adjust according to cabin lighting.

Using The Humidity Control Routine

When engaged, the SMX humidity control routine automatically turns the air conditioning system on at timed intervals to remove moisture from the air. The system is programmed at the factory for average values. To change the factory settings, see "Humidity Control Program."

To start the dehumidification program:

- Press OFF.
- Press COOL, HEAT and FAN keys simultaneously.
For the SMXir Remote Control only - Press the Dehumid key to enter dehumidification mode.
- The data display will flash HU, indicating that the program is active.
- To halt the dehumidification program, press any key. The HU message will stop flashing.

Safety Note

Whenever the SMX system is in the dehumidification mode, all of the system safeguard controls remain active. If the seawater flow fails or if line voltage falls below preset limits, the system will automatically shut down. If AC power is interrupted, the system will automatically resume operation in the dehumidification mode when power is restored.

Anti-Ice Routine

The SMX control will occasionally shut down the compressor in the cooling mode to allow any ice that may have formed on the evaporator coil to melt. The anti-ice shutdown only occurs at inside temperatures lower than 70°F (21°C).

In a 10 minute cycle period, the compressor will shut off for 15 seconds per degree (°F) below 70°F. For example, if the inside temperature is 67°F, the compressor will shut off for 45 seconds every 10 minutes.

Owner Maintenance - Routine

Condensate Drains

Every three months, check the condensate drains for obstructions by pouring a quart of water rapidly into the condensate pan. If it does not drain completely within 30 seconds, check the drain outlets for clogging. Remember that many Cruisair systems have two drains and hoses, one at each end of the unit.

Air Filters

At least once a month, check the lint screen or filter behind the return air grill or on the face of the cooling/heating unit and clean if necessary.

Seawater Connections

Verify that all seawater connections are tight, and check for water flow from each unit's overboard discharge.

Seawater Pump

If your system uses a rubber-impeller seawater pump, you should inspect the impeller after 300 hours of operation. Replace it if worn. If you have a centrifugal pump, regular maintenance is not needed.

Seawater Strainer

Check the seawater strainer daily. Remove any debris.

Refrigerant Gas

The refrigerant gas (most likely R-22) used in your Cruisair air conditioning system is adequate for the life of the system. Routine "seasonal" charging of the system is not typically necessary.

Winterizing the System

Close the seacock and remove the inlet water hose from the air conditioner. Allow all water to drain from the system. Loosen the screws on the pump head to allow the water to drain from the pump. Drain and clean the seawater strainer.

Trouble Shooting

Before you call for service, review this list. It may save you time and expense. This list contains common occurrences that are not a result of defective workmanship or materials. If you need service after trying these procedures, call your nearest Cruisair dealer.

Situation

The unit will not operate at all.

Solution

1. Blown fuse or tripped circuit breaker. Replace fuse with time delay type or reset breaker. Check for correct sizing.
2. Low voltage to unit. Check shoreside power supply and rating of electrical power cord to boat.

Situation

Air from the unit does not feel cool (or warm in the heating mode).

Solution

1. The selector switch is set for FAN only. Switch the system into the cooling or heating mode.
2. The thermostat is set incorrectly. Set the thermostat for a cooler or warmer setting.
3. Water flow is restricted. Clear restriction. Clean strainer.

Situation

The unit operates but the cabin fails to cool normally.

Solution

1. Dirty air filter. Clean lint screen or air filter.
2. The thermostat is set too high. Reset the thermostat to a cooler setting.
3. The evaporator has iced. Turn the system to FAN only for 5 minutes, then restart.

Situation

Compressor cycles on and off.

Solution

1. Dirty air filter. Clean lint screen or air filter.
2. Water flow restriction. Clear restriction. Clean strainer.

Situation

Water dripping inside cabin.

Solution

1. Condensate drain is clogged. Clean out drain holes.
2. Blockage in hose. Clear hose. Check downhill routing of hose.

Descriptions of Figures

- Fig. 1 Typical Self-Contained Unit
- Fig. 2 Typical Remote Condensing Unit
- Fig. 3 Typical Draw-Through Cooling Unit
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- Fig. 5 Typical Draw-Through Cooling Unit Installation
- Fig. 6 Typical Blow-Through Cooling Unit Installation
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- Fig. 8 Seawater Piping, Proper System and Common Mistakes
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- Fig. 33 Refrigerant Charging Curves (R22)
- Fig. 34 Charging Systems with Alternative Refrigerants

Fig. 1 - Typical Self-Contained Unit

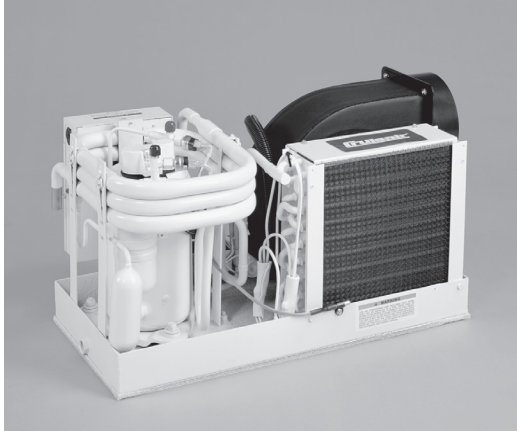


Fig. 4- Typical Self-Contained Installation

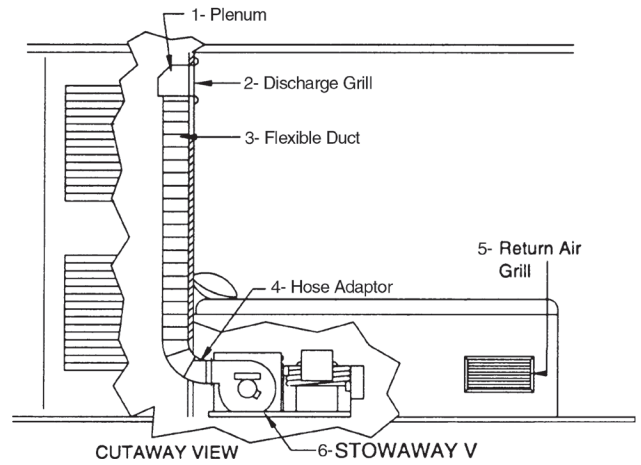


Fig. 2 - Typical Remote Condensing Unit



Fig. 5 Typical Cooling Unit Installation (draw-through)

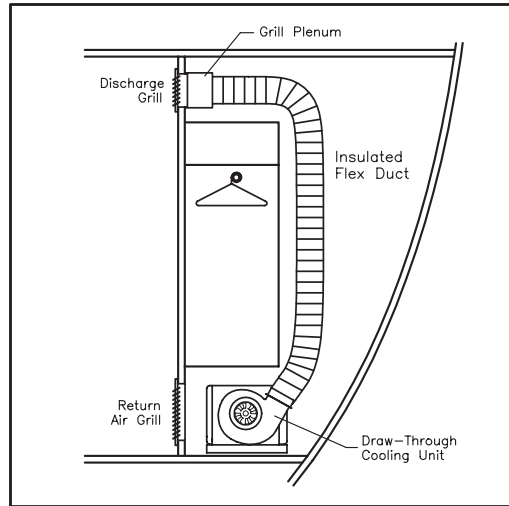


Fig. 3 - Typical Draw-through Cooling Unit

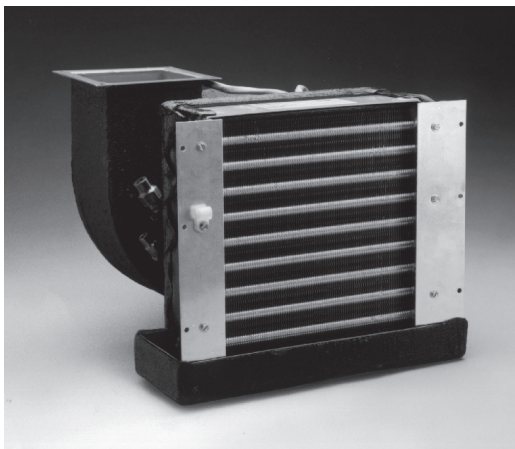


Fig. 6 Typical Cooling Unit Installation (blow-through)

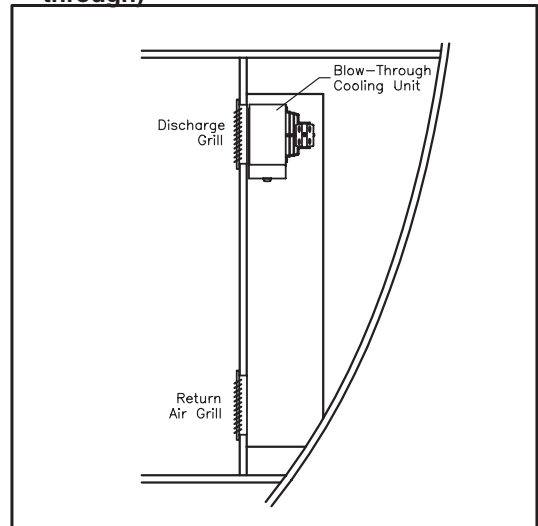
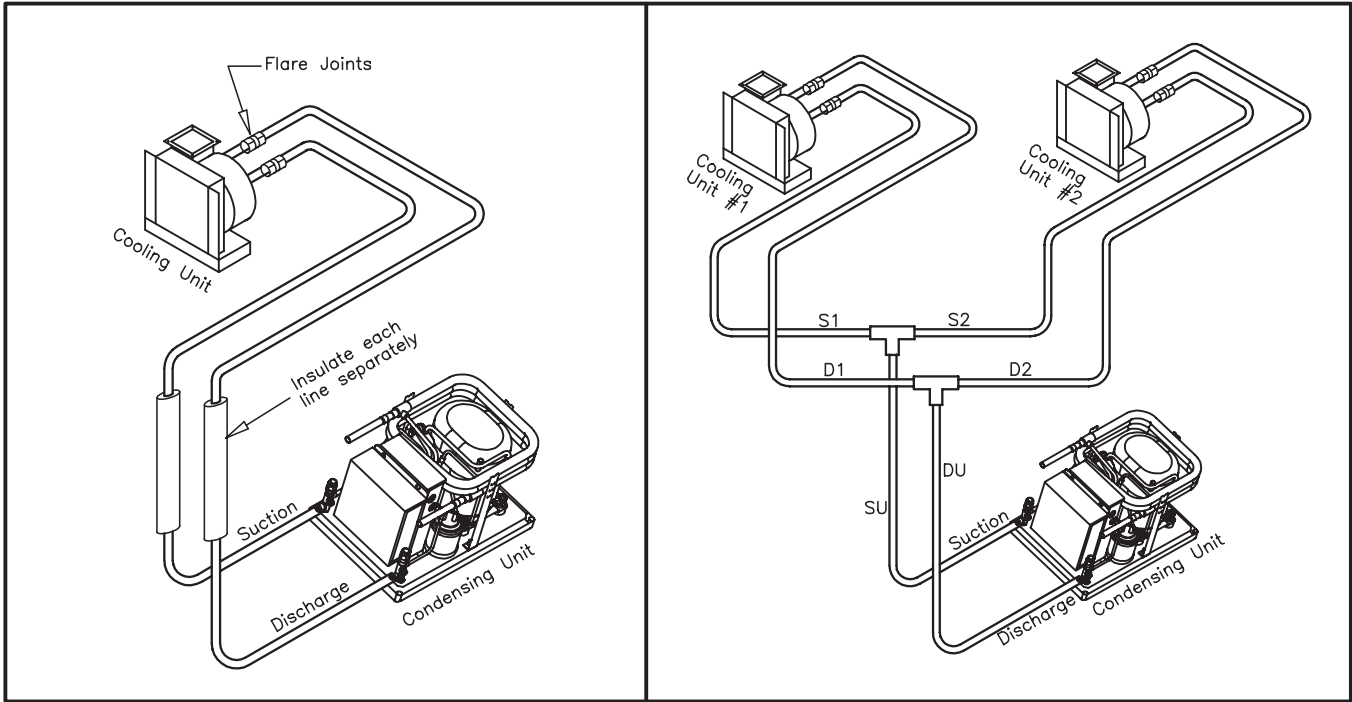


Fig.7 - Refrigeration Line Sizes

Typical Remote System

Typical Split System with 2 Cooling Units



Unit or Line Capacity (Btu/hr)	Recommended Line Sizes	
	Discharge	Suction
4,000 - 12,000	1/4"	3/8"
16,000	1/4"	1/2"
20,000 - 24,000	3/8"	1/2"
30,000 - 48,000	3/8"	3/4"
60,000 - 72,000	1/2"	3/4"

Notes:

- Maximum length of refrigerant line between condensing unit and cooling unit is 50 feet (15m).
- Only use seamless refrigeration grade copper tubing.
- Insulate discharge and suction tubes separately.
- Use minimum 3/8" (10mm) thick closed cell insulation.
- Seal (glue and/or tape) all insulation seams.
- Use "dead-head" orientation of TEEs on multiple cooling unit systems to help ensure proper distribution of refrigerant.

Refrigerant Line Sizes for Typical 2-Unit Split Systems

Cond. Unit (Btu/hr)	Evap.#1 (Btu/hr)	Evap.#2 (Btu/hr)	Discharge Lines			Suction Lines		
			DU	D1	D2	SU	S1	S2
10,000	5,000	5,000	1/4"	1/4"	1/4"	3/8"	3/8"	3/8"
16,000	8,000	8,000	1/4"	1/4"	1/4"	1/2"	3/8"	3/8"
16,000	12,000	4,000	1/4"	1/4"	1/4"	1/2"	3/8"	3/8"
20,000	10,000	10,000	3/8"	1/4"	1/4"	1/2"	3/8"	3/8"
24,000	12,000	12,000	3/8"	1/4"	1/4"	1/2"	3/8"	3/8"
24,000	16,000	8,000	3/8"	1/4"	1/4"	1/2"	1/2"	3/8"
30,000	16,000	16,000	3/8"	1/4"	1/4"	3/4"	1/2"	1/2"
36,000	20,000	16,000	3/8"	3/8"	1/4"	3/4"	1/2"	1/2"
48,000	24,000	24,000	3/8"	3/8"	3/8"	3/4"	1/2"	1/2"
60,000	30,000	30,000	1/2"	3/8"	3/8"	3/4"	3/4"	3/4"
72,000	36,000	36,000	1/2"	3/8"	3/8"	3/4"	3/4"	3/4"

Fig. 8 - Seawater Piping - Proper System and Common Mistakes

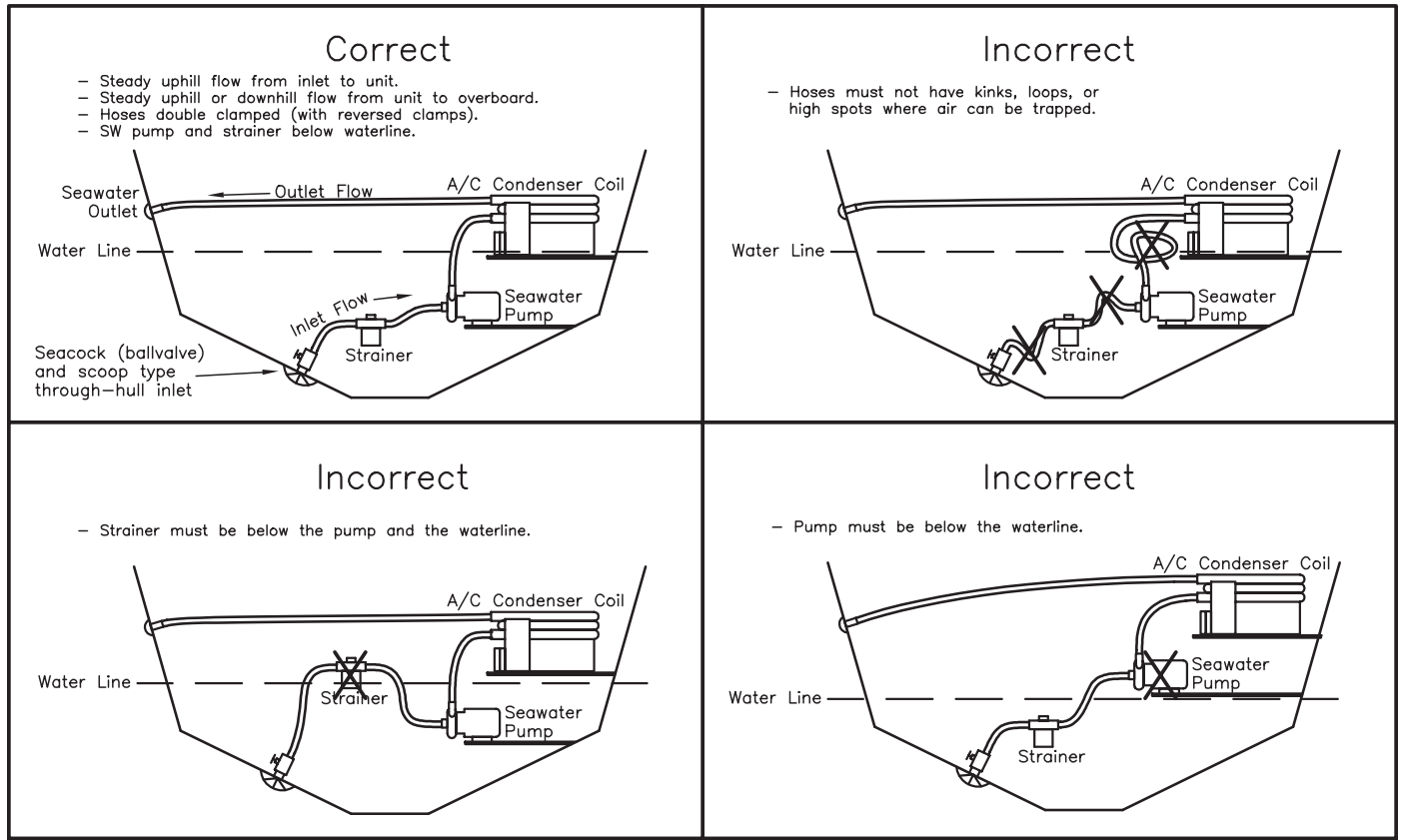


Fig. 9 - Pump head orientation

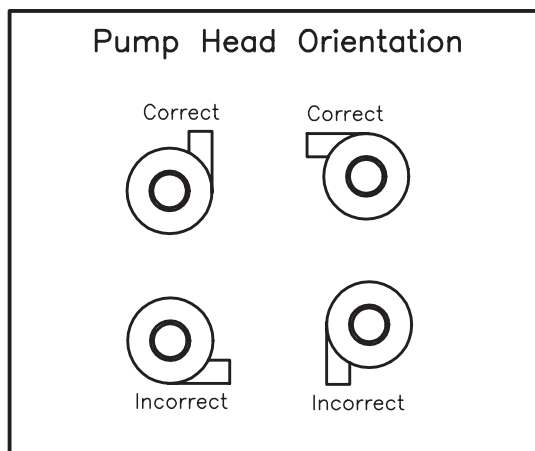


Fig.10 - Seawater manifolds

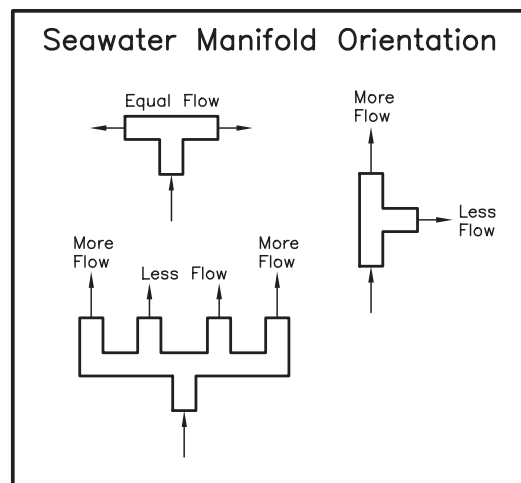


Fig. 11 - Duct and Grill Sizes Tables

Draw-through & Self-Contained Unit Capacity (Btu/hr)	Minimum Return Air Grill Area		Minimum Supply Air Grill Area		Minimum Recommended Duct Size	
	(sq in)	(sq cm)	(sq in)	(sq cm)	(in)	(mm)
4K	64	413	32	206	4	102
5K	64	413	32	206	4	102
6K	70	452	35	226	5	127
7K	80	516	45	290	5	127
9K	98	632	49	316	6	152
10K	100	645	60	387	6	152
12K	130	839	70	452	6	152
16K	160	1032	80	516	7	178
18K	200	1290	100	645	7*	178
24K	240	1548	140	903	9	229
30K	350	2258	170	1097	10	254
36K	360	2323	196	1265	10	254
48K	480	3097	256	1652	12	305
60K	570	3677	290	1871	12	305
72K	690	4452	350	2258	14	356

* Exception: Cruisair 18K Remote Evaporators use 8" (203mm) duct.

Overhead Cooling Unit	Return Air Grill Size (inches)	Minimum Discharge Grill Area (in ² /cm ²)	Minimum Recommended Duct Size (in/mm)
EB(U)LP12	22" x 6"	(2x) 50/320	(2x) 5/125
EB(U)LP16	22" x 6"	(2x) 50/320	(2x) 5/125
EBULP24	-	(2x) 70/450	(2x) 6/150
ESS12	10" x 12"	70/450	6/150
ESS16	12" x 12"	80/520	7/175
ETB16	12" x 12"	(2x) 12" x 6"	-
ETBD30	22" x 14"	(2x) 80/520	(2x) 7/175
EDS24	22" x 14"	(2x) 70/450	(2x) 6/150
EDS30	22" x 14"	(2x) 80/520	(2x) 7/175

Blow-Through Cooling Unit (Btu/hr)	Minimum Return Air Grill Area (in ² /cm ²)	Minimum Discharge Grill Area (in ² /cm ²)	Minimum Recommended Duct Size (in/mm)
4-5,000	60/390	60/390	None
7-8,000	70/450	70/450	None
10,000	100/650	100/650	None
12,000	120/780	120/780	None
16,000	144/930	144/930	None

Fig. 12 - Plenum Configurations

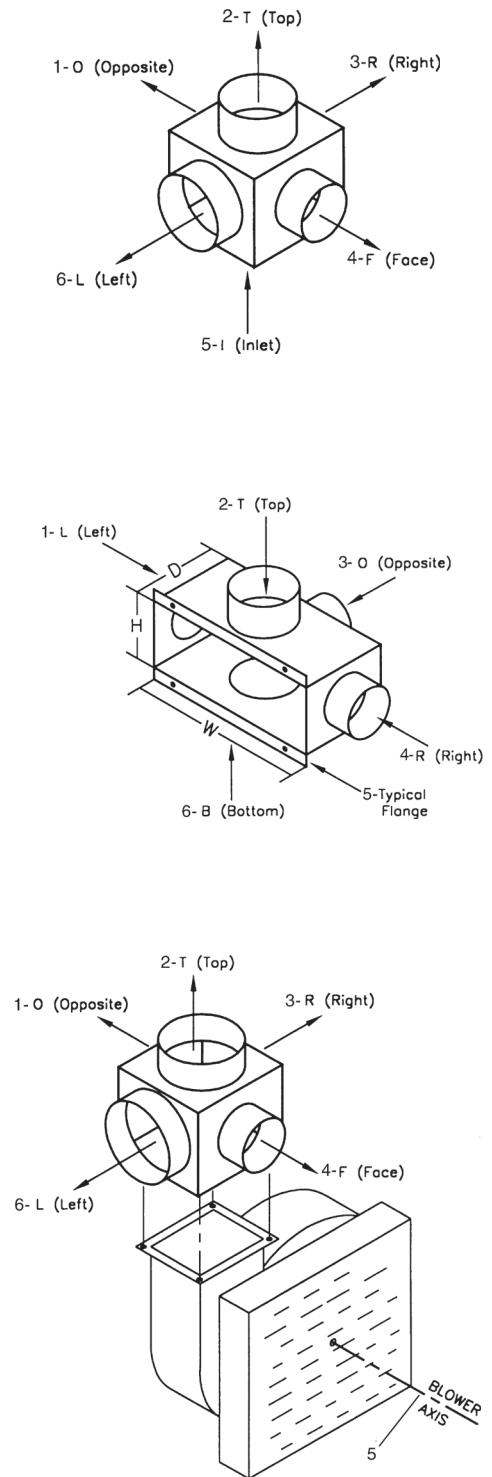
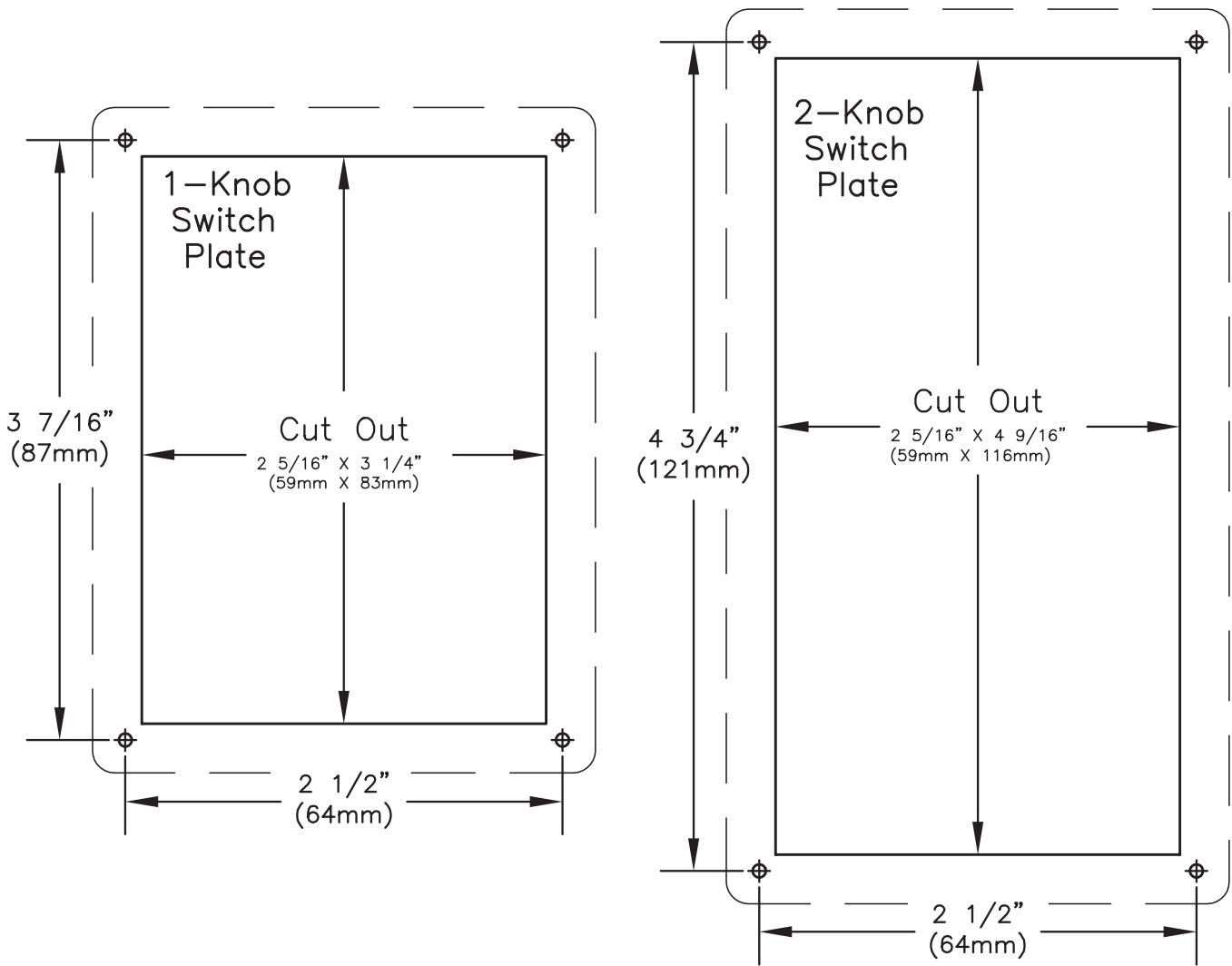
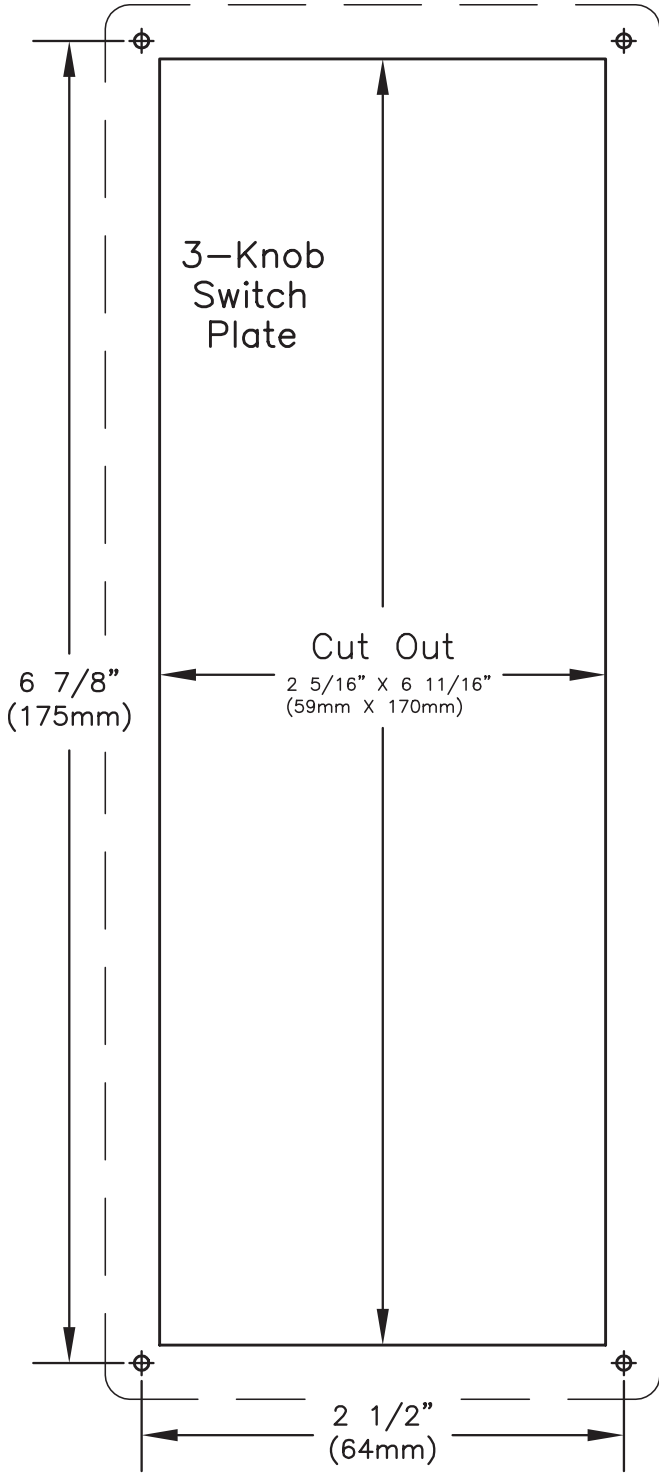


Fig. 13a - Switch Dimensions and Templates



Drill 3/32" (2mm) holes for mounting screws.

Fig. 13b - Switch Dimensions and Templates



Drill 3/32" (2mm) holes for mounting screws.

Fig. 14 - SHR5-16 StowAway Wiring, #082611

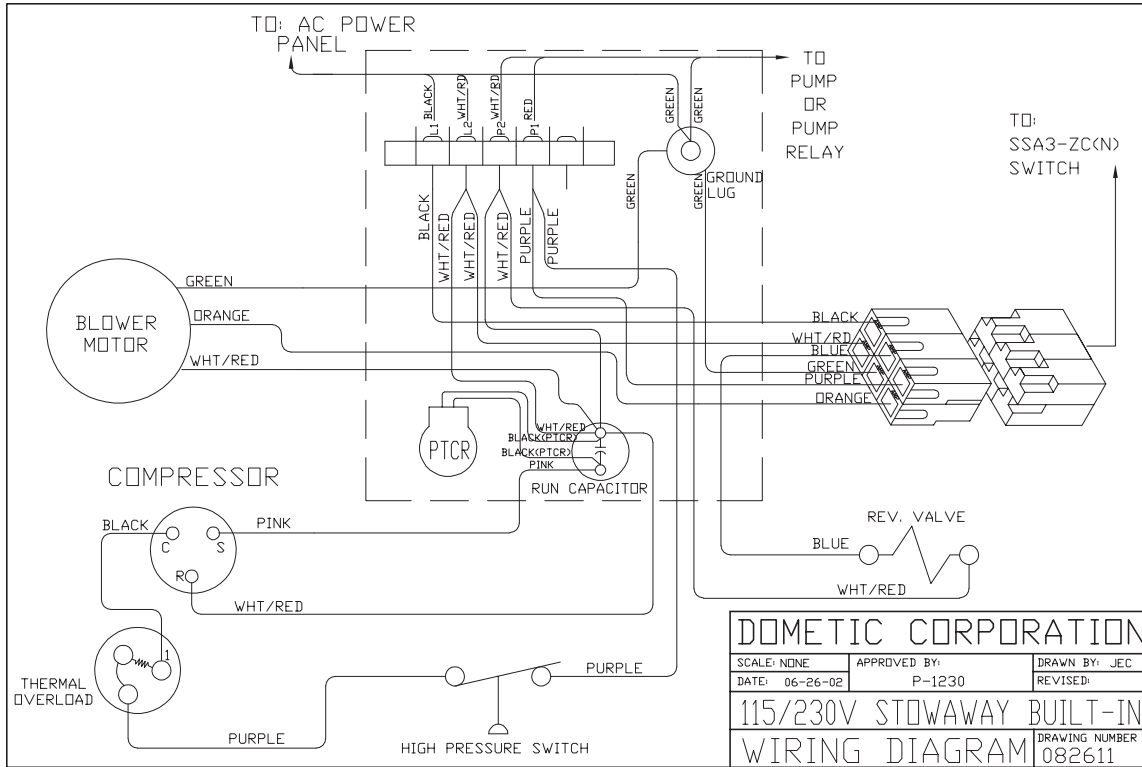


Fig. 15 - SH24C StowAway Wiring, #080264

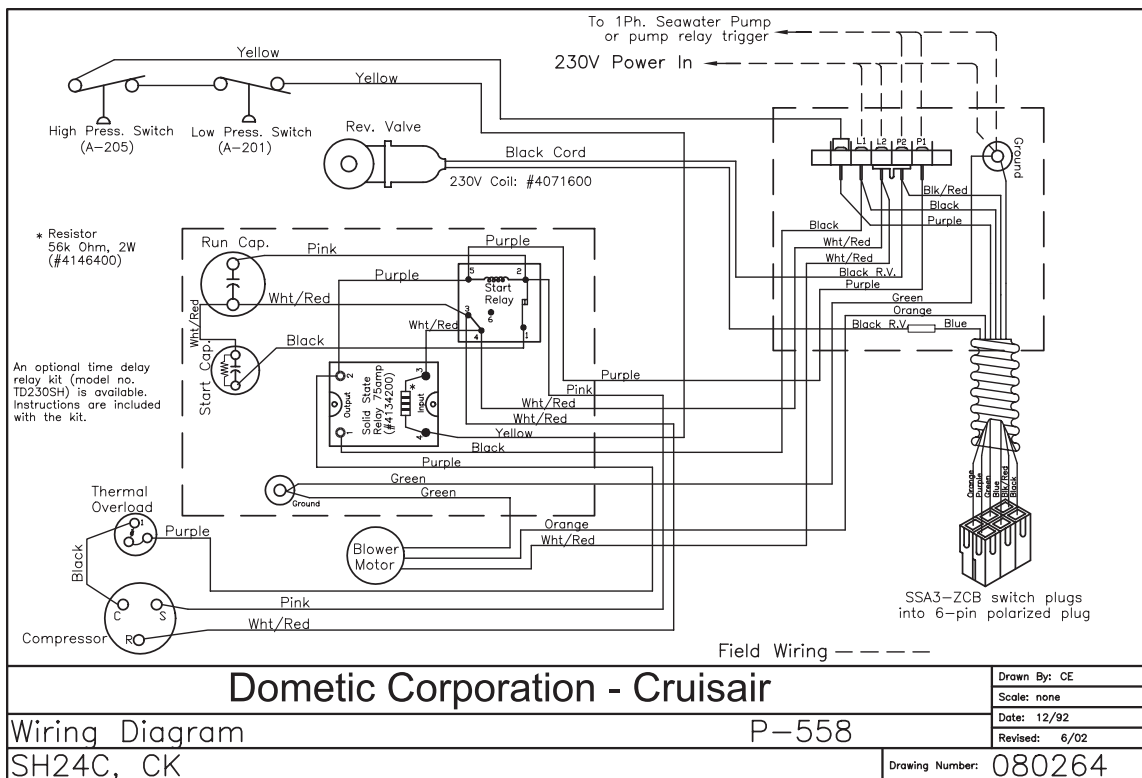


Fig. 16 - SHF5-16-C StowAway Compact w/ 3-knob Control Wiring

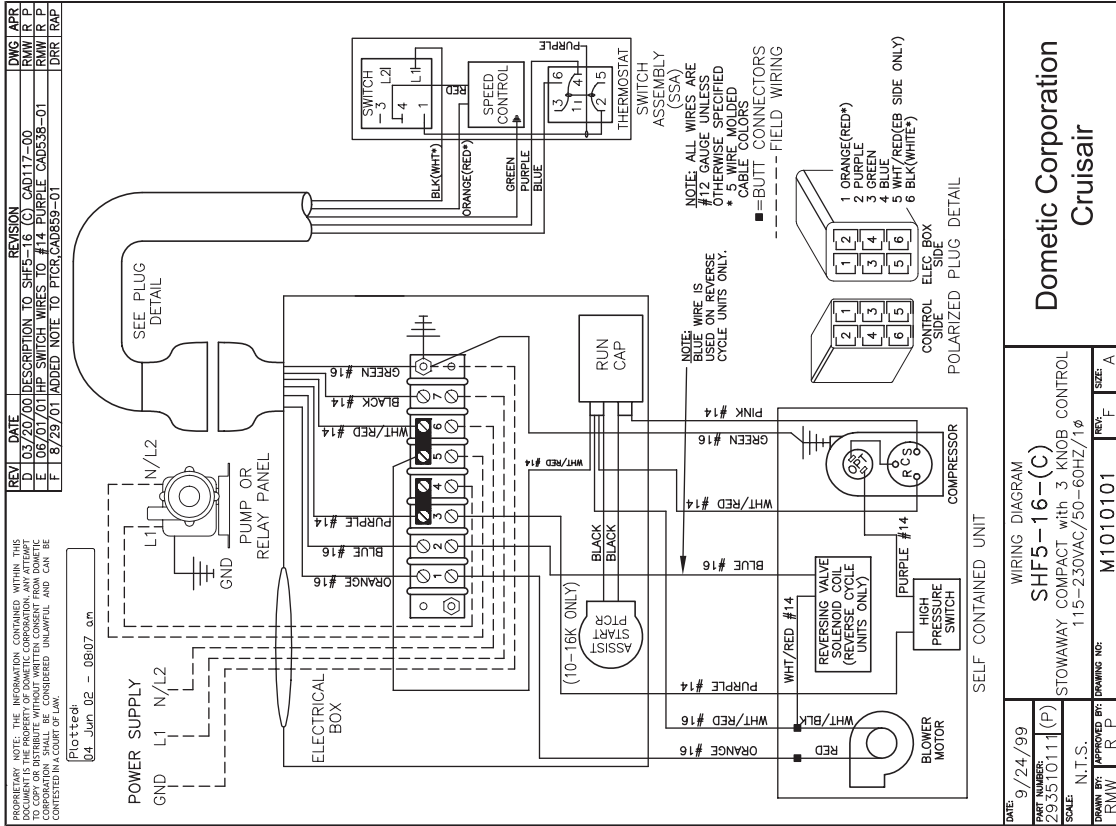


Fig. 17 - SHF24-C StowAway Compact w/ 3-knob Control Wiring

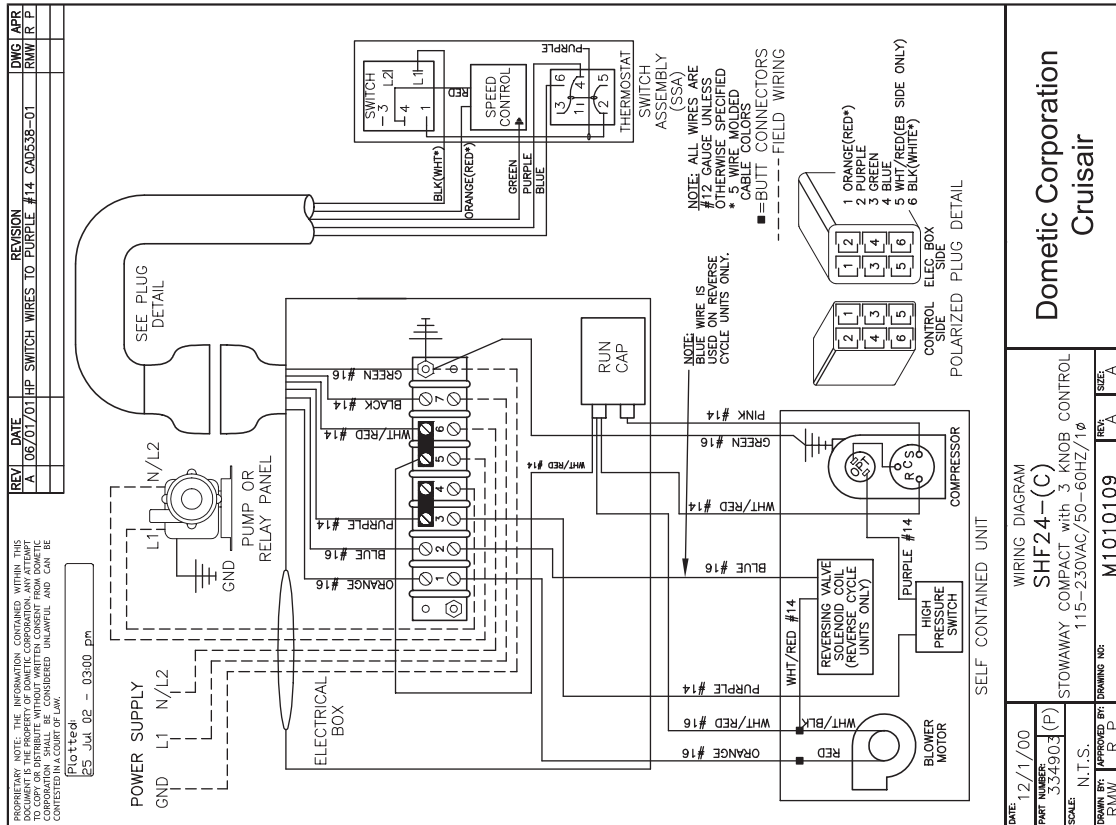
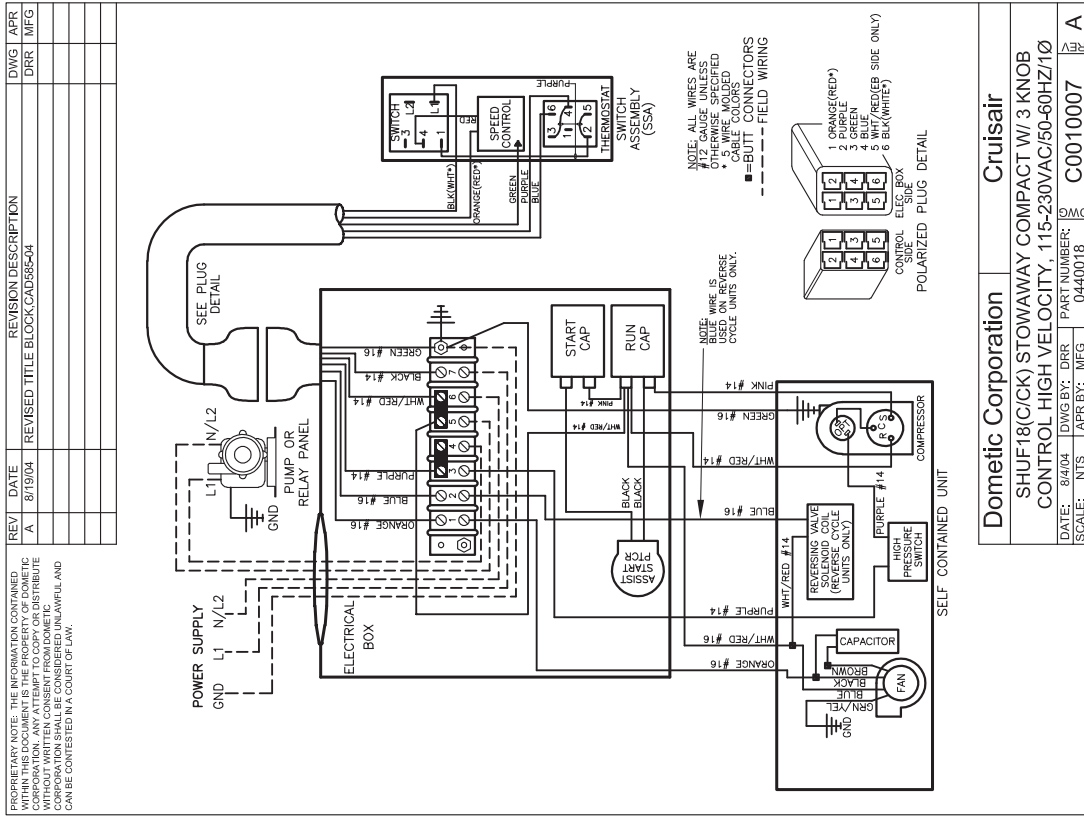
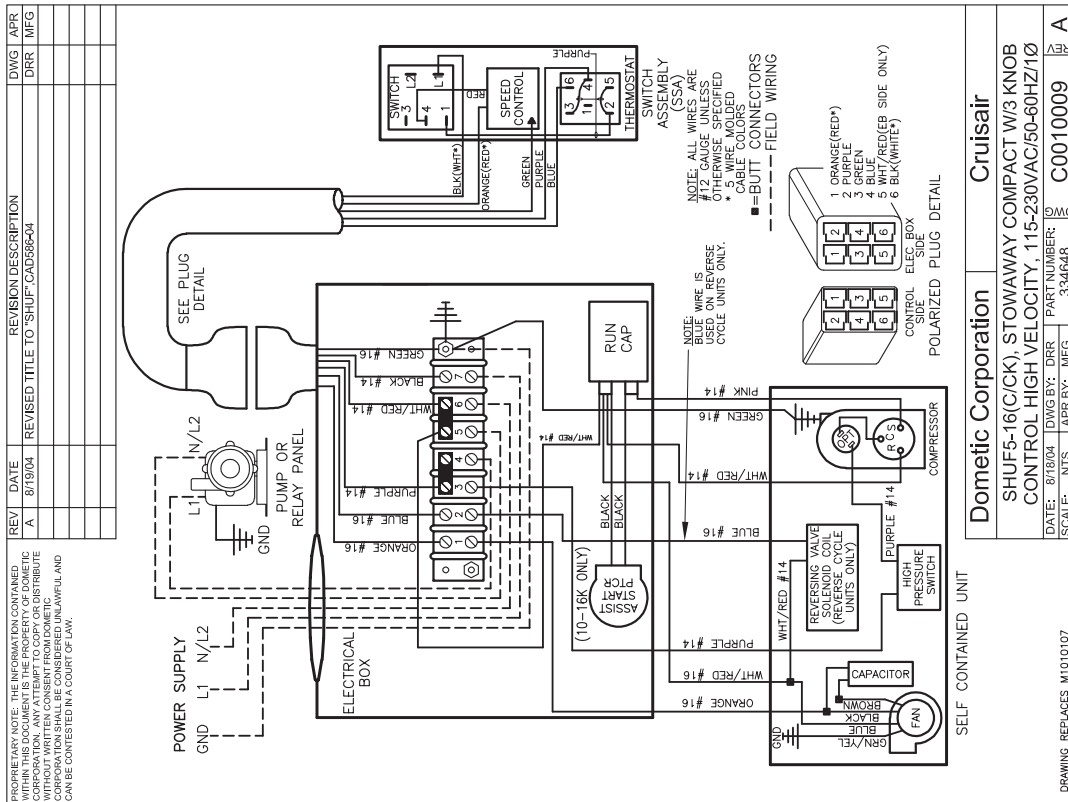


Fig. 18 - SHUF18(C/CK)/1-HV StowAway Compact w/ 3-knob Control Wiring



Domestic Corporation	Cruisair
SHUF18(C/CK) STOWAWAY COMPACT W/ 3 KNOB CONTROL HIGH VELOCITY, 115-230VAC/50-60HZ/1Ø	
DATE: 8/19/04	DWG BY: DRR
SCALE: NTS	APP BY: MFG
PART NUMBER: 0440018	C0010007
A	A

Fig. 19 - SHUF5-16(C/CK)/1-HV StowAway Compact w/ 3-knob Control Wiring



Domestic Corporation	Cruisair
SHUF5-16(C/CK) STOWAWAY COMPACT W/3 KNOB CONTROL HIGH VELOCITY, 115-230VAC/50-60HZ/1Ø	
DATE: 8/19/04	DWG BY: DRR
SCALE: NTS	APP BY: MFG
PART NUMBER: 334648	C0010009
A	A

Fig. 20- WFAH6-16 Condensing Unit Wiring, #082201

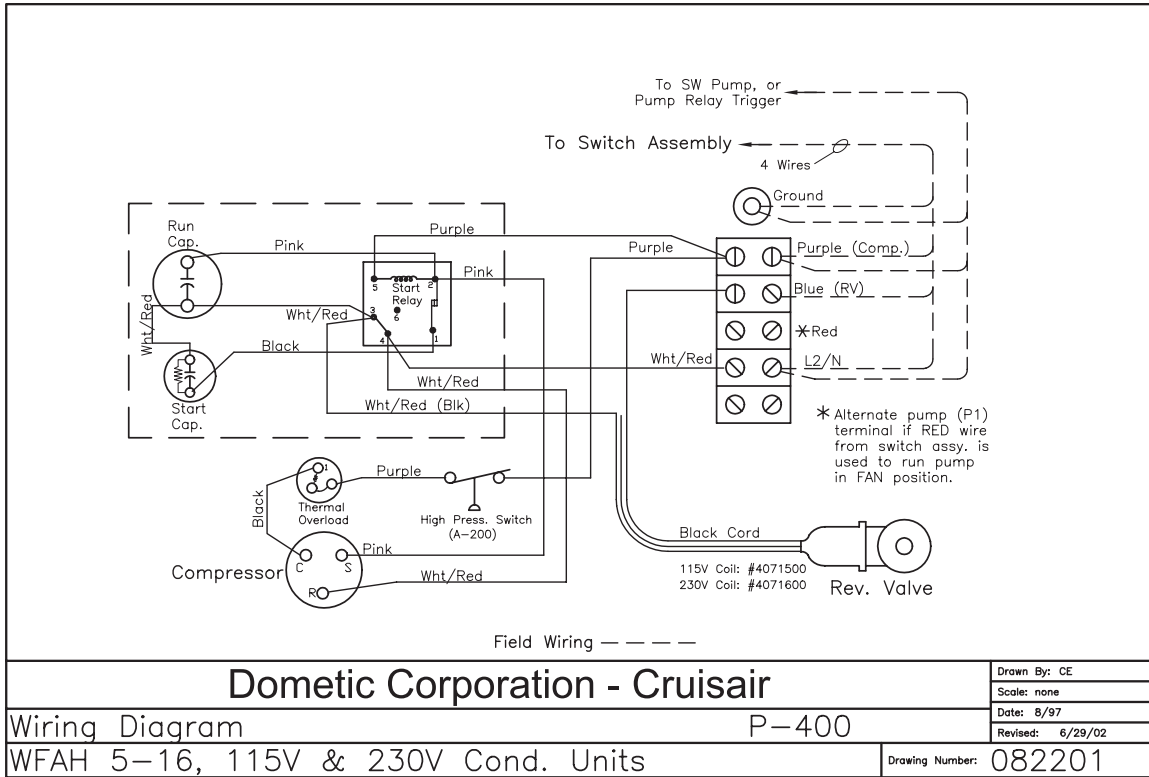


Fig. 21- R/F20-60C 1-Ph. Cond. Unit Wiring, #082534

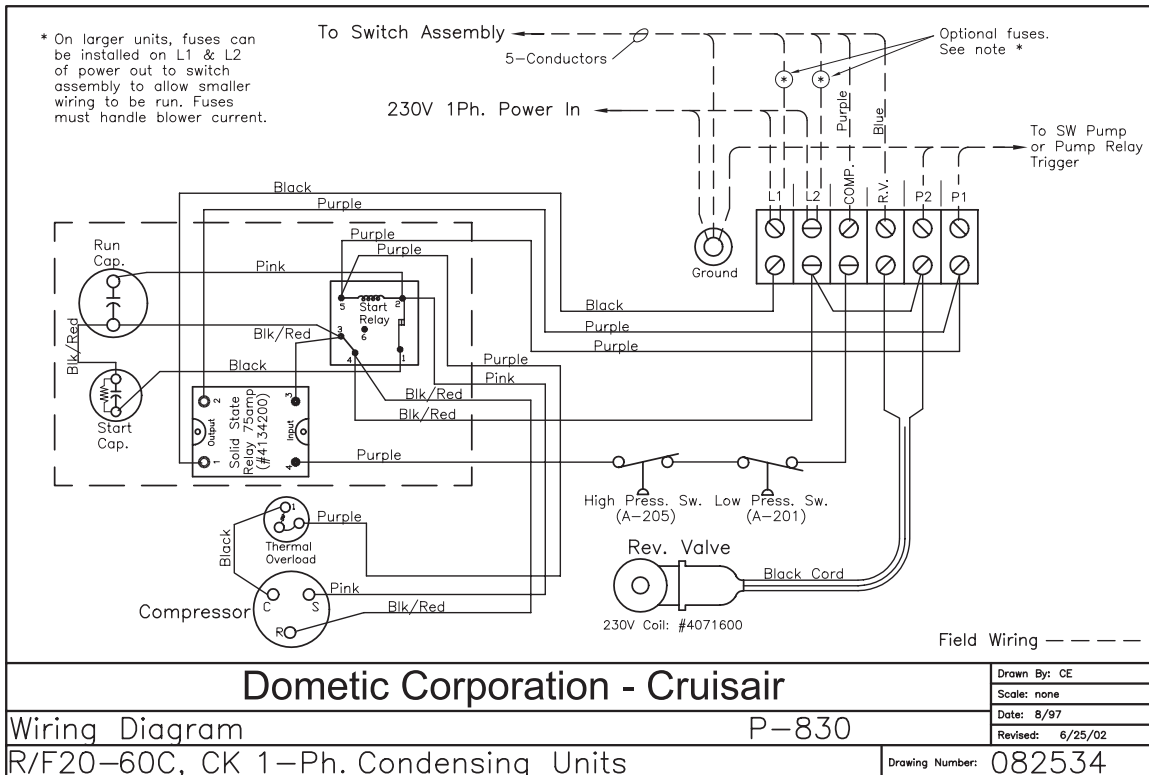


Fig. 22- R/F24-72 3-Ph. Cond. Unit Wiring, #082556

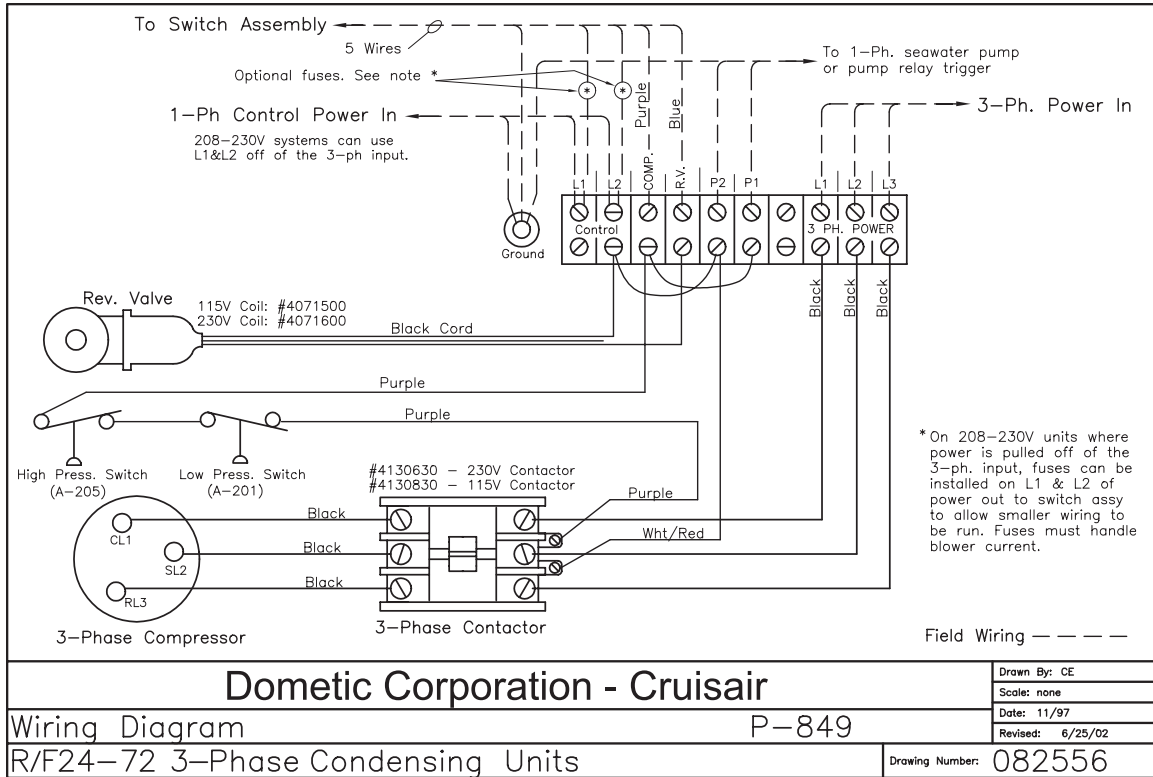


Fig. 23- SA3-Z Switch Wiring

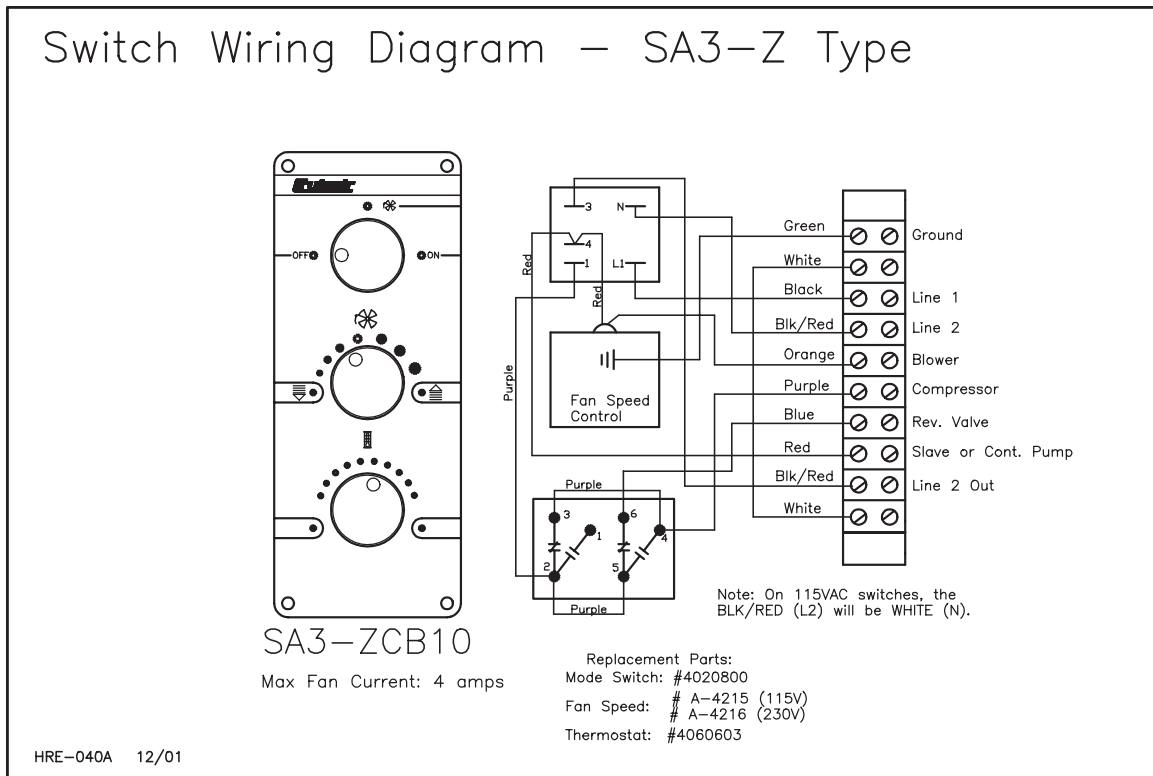


Fig. 24- SA5-Z Switch Wiring

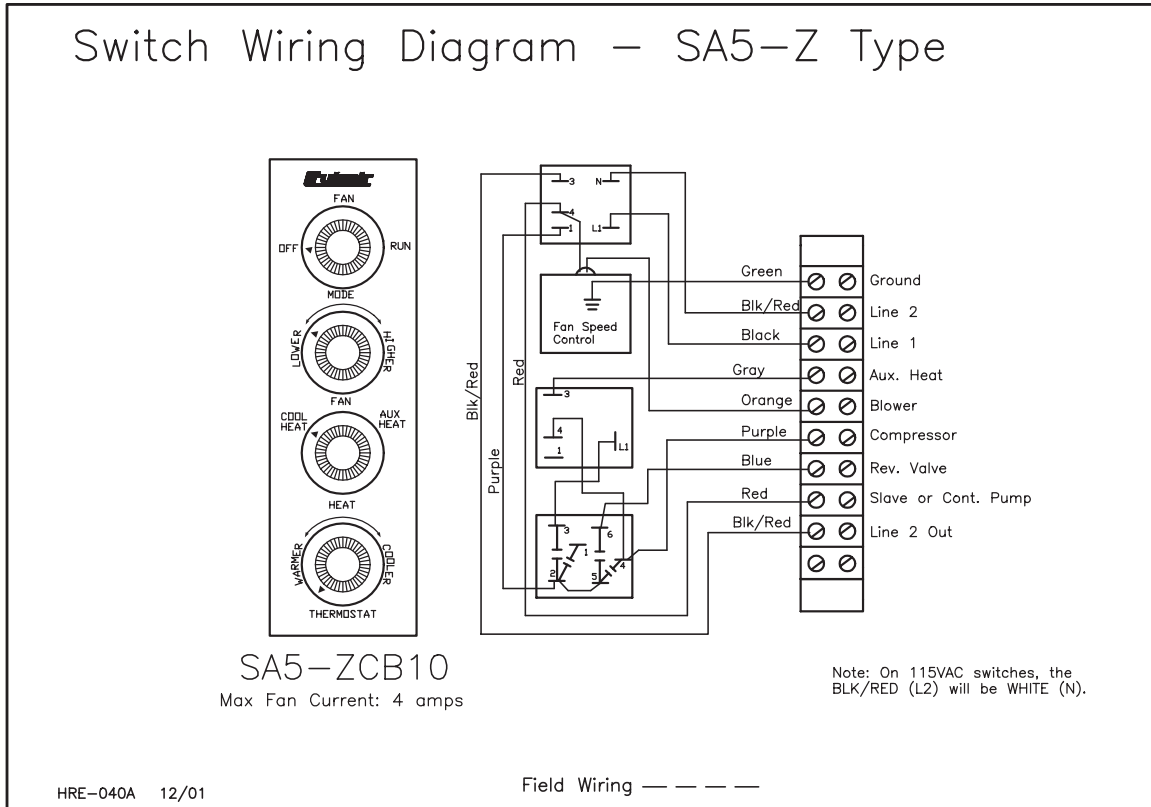


Fig. 25- PR3X Pump Relay Wiring

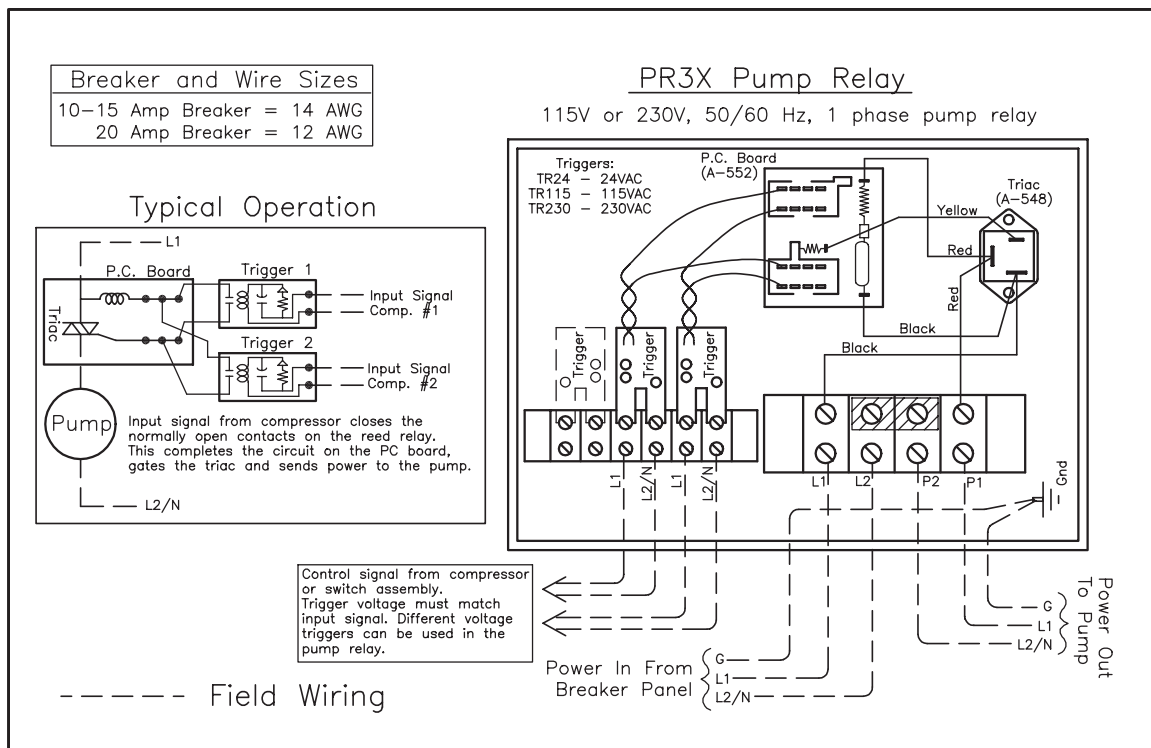


Fig. 26- PR8X Pump Relay Wiring

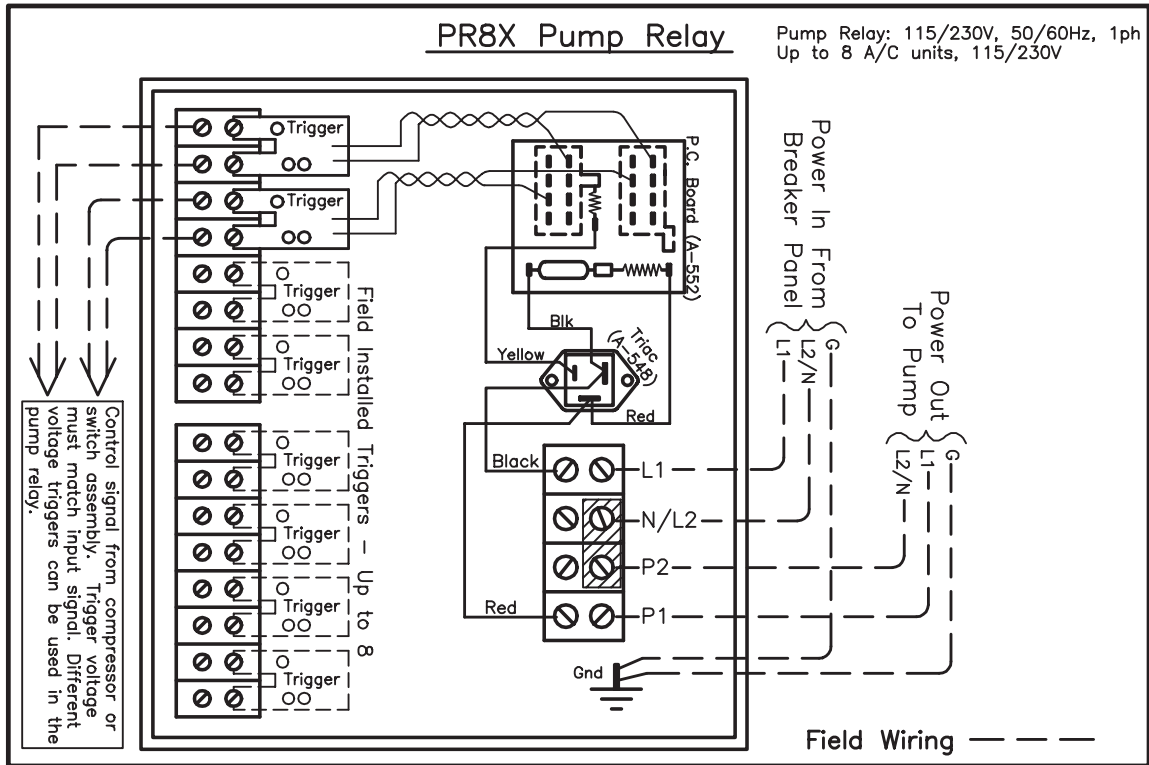


Fig. 27- WFAH System Wiring, 115V

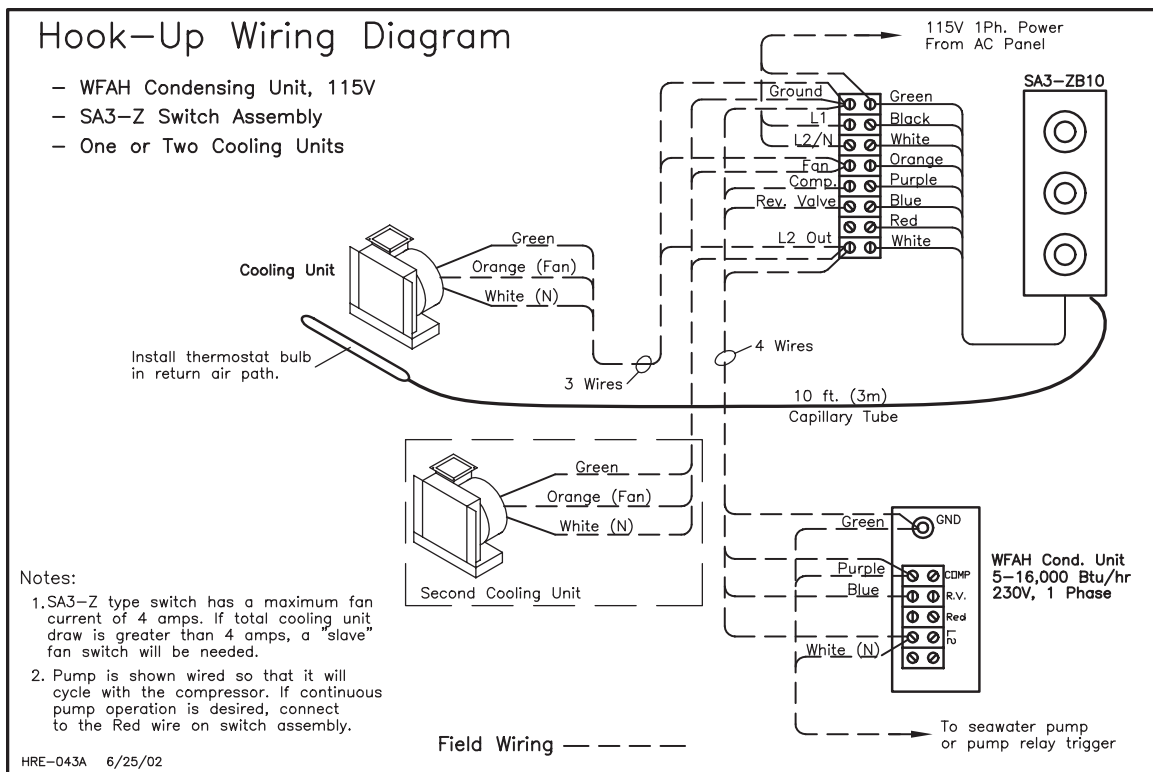


Fig. 28- WFAH System Wiring, 230V

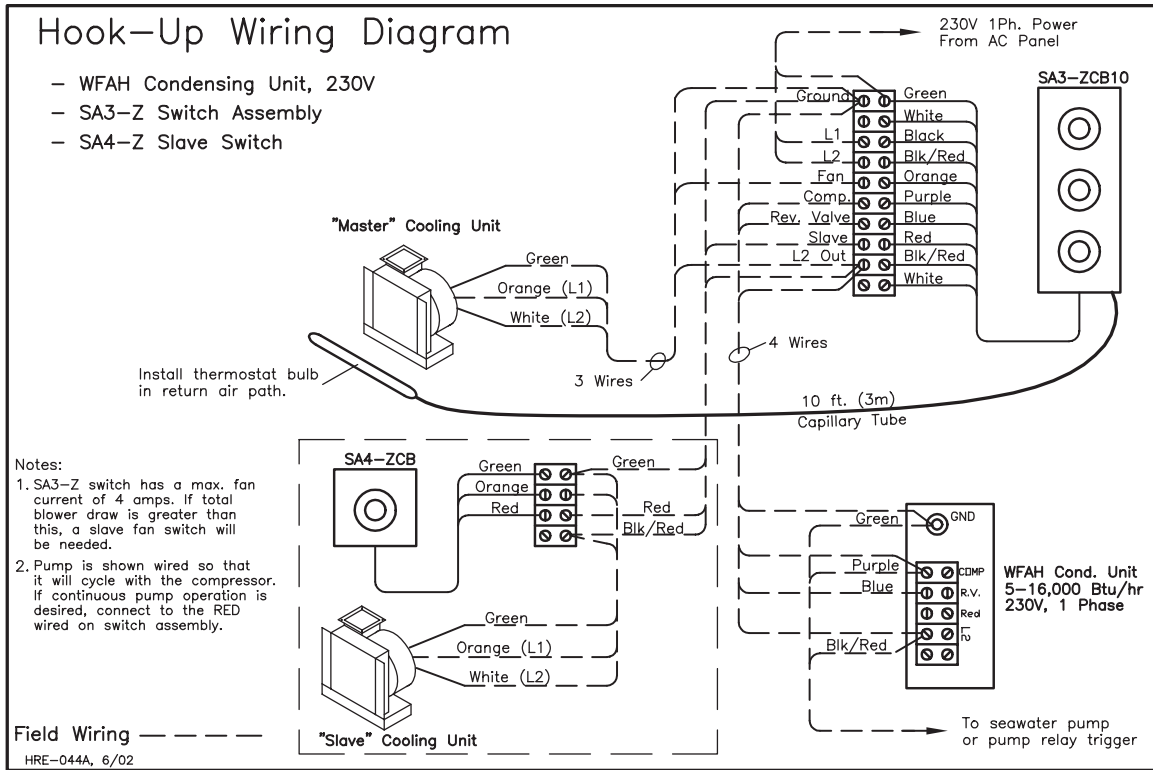


Fig. 29- WFAH System Wiring, 230V, w/ Aux. Heat

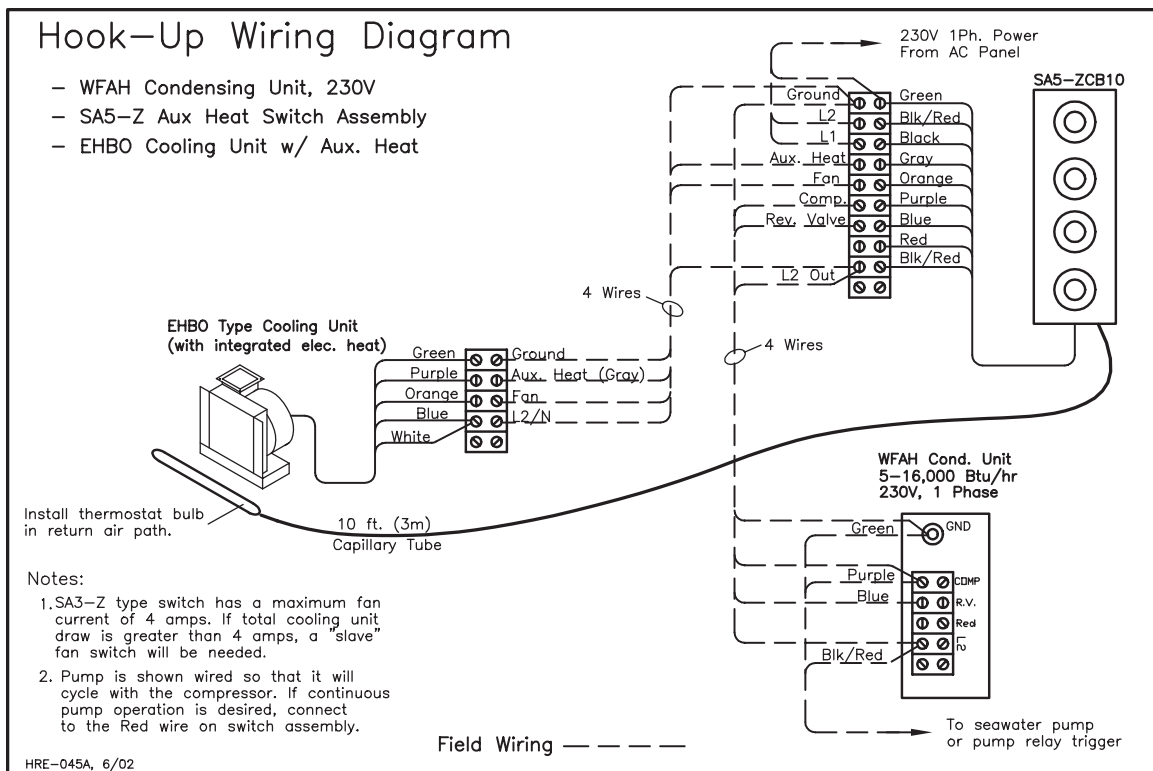


Fig. 30- R/F Type System Wiring, SA3-Z Switch, 1Ph.

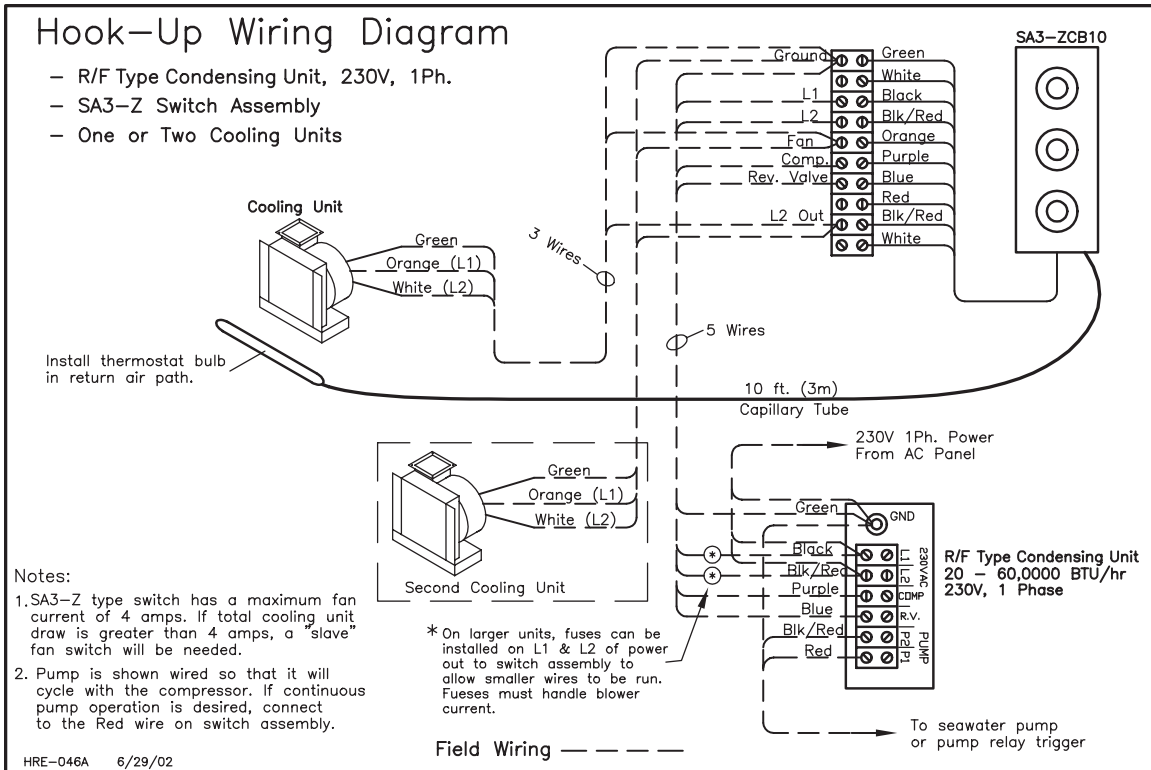


Fig. 31- R/F Type System Wiring, SA3-B Switch, 1Ph.

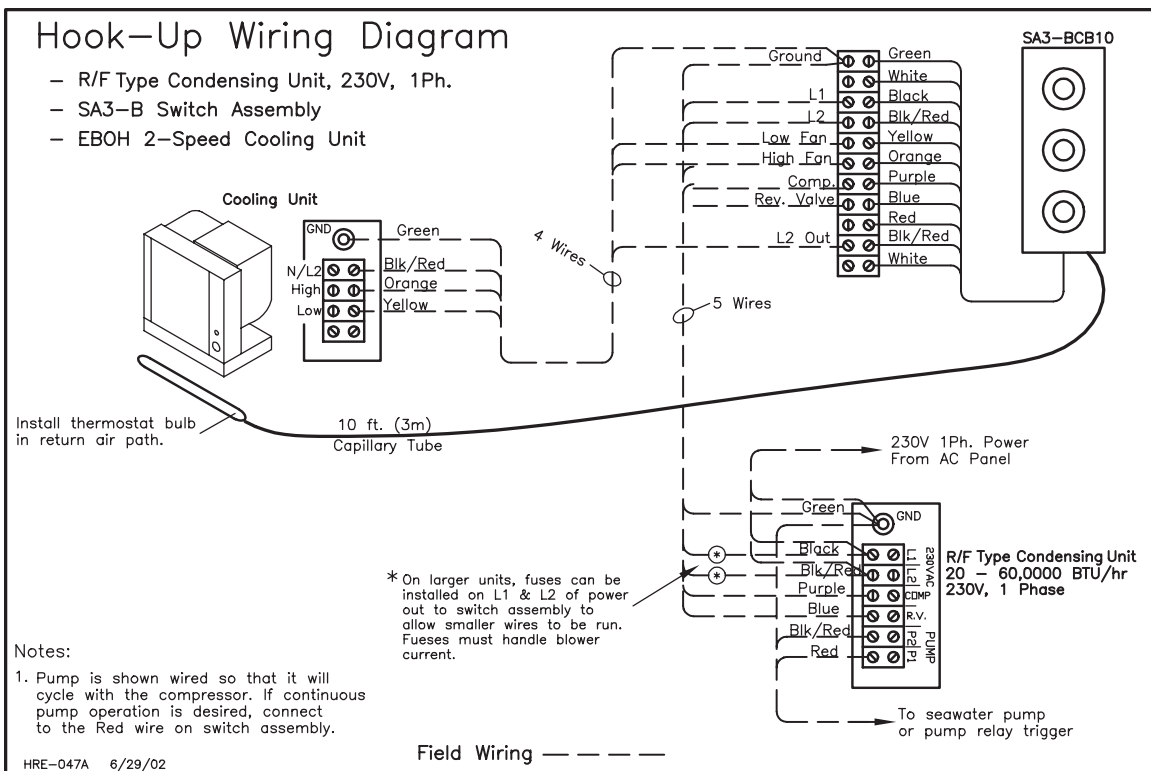


Fig. 32- R/F Type System Wiring, SA3-Z Switch, 3Ph.

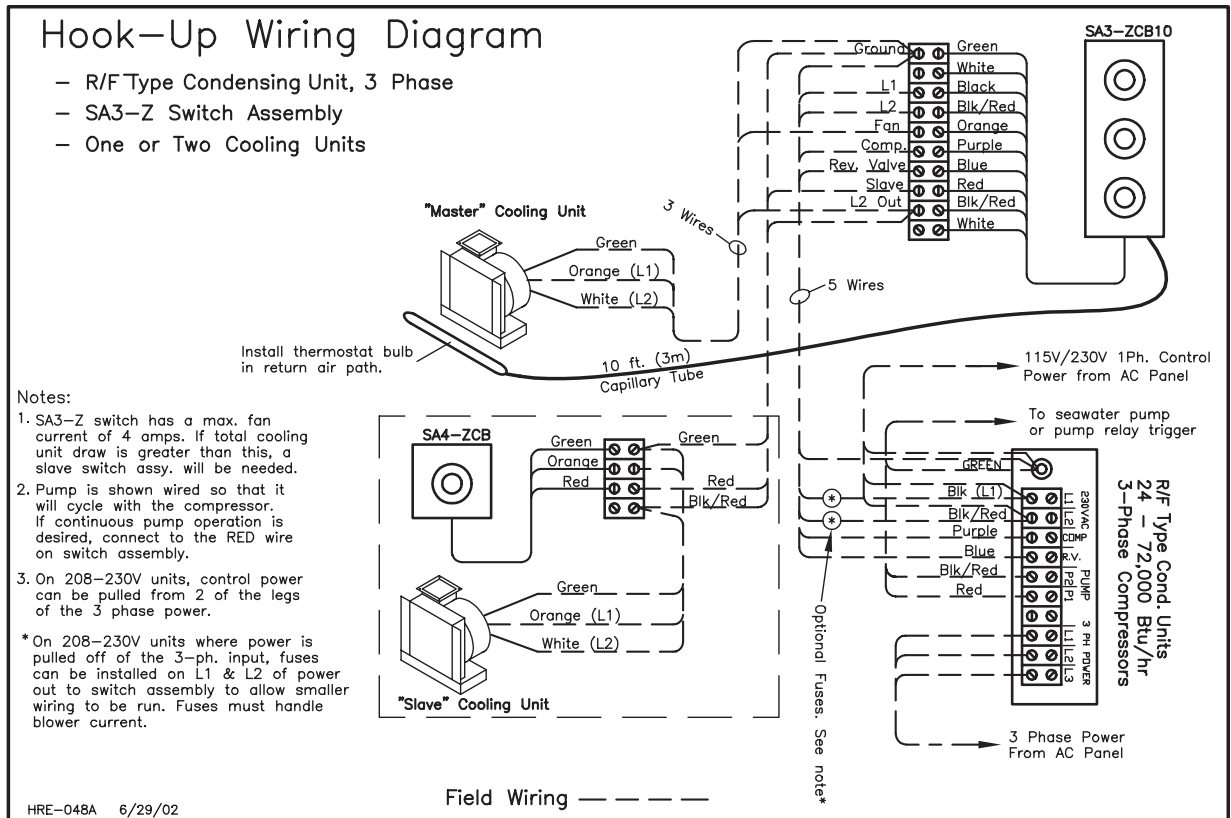


Fig. 33- Refrigerant Charging Curves (R22)

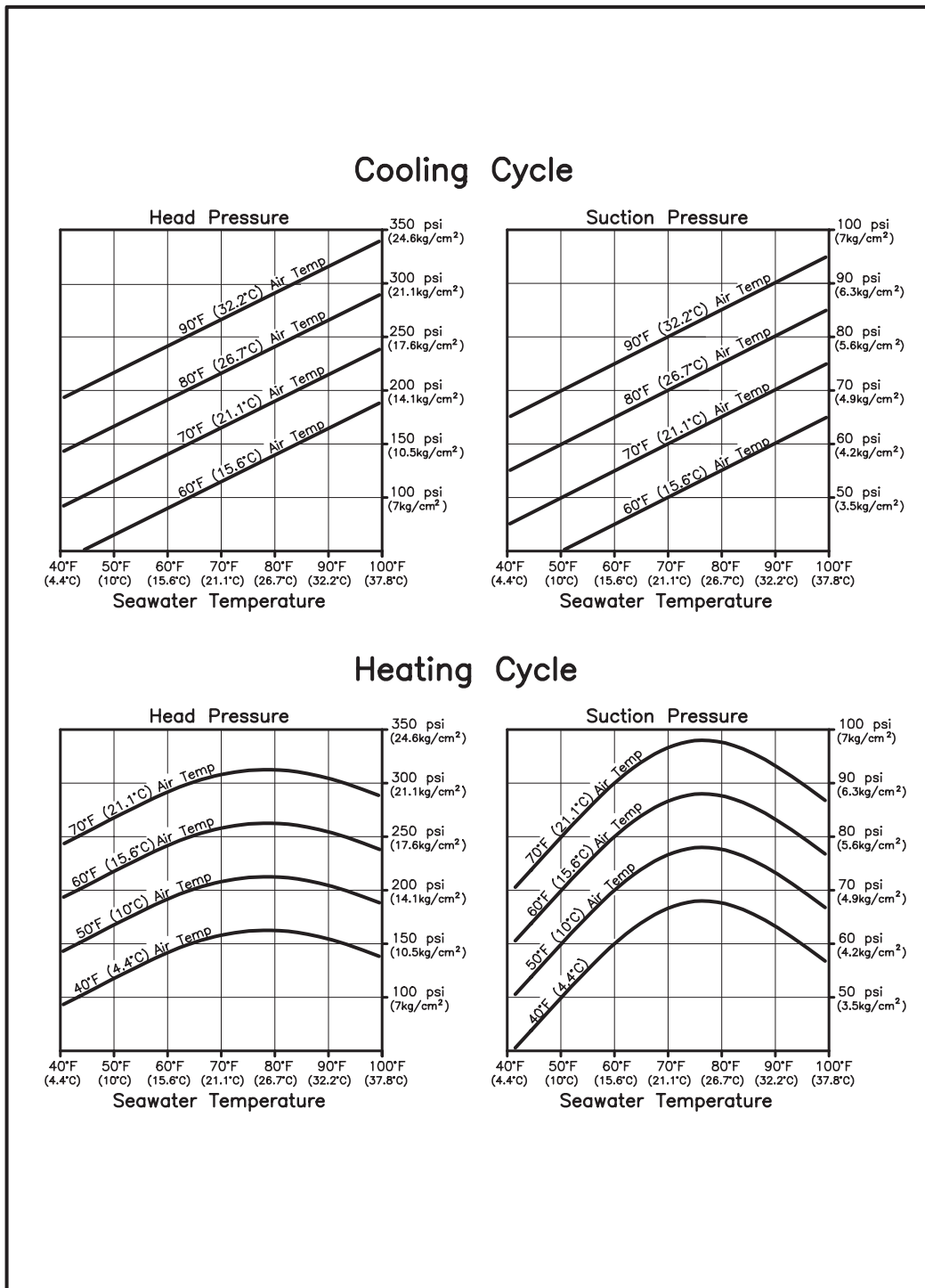


Fig. 34 Charging Systems with Alternative Refrigerants

New A/C units are available from the factory with non-HCFC refrigerants. R-417A (also known as NU-22® or Isceon 59®) is a direct drop-in replacement for R22. It will work with Alkyl Benzene and mineral lubricants so standard compressors can be used. Note that some self-contained units (with rotary compressors) and chillers (with scroll compressors) might have R-407C with POE lubricant.

Both R-417A and R-407C are blended refrigerants, meaning they are made up from multiple component refrigerants. In most cases the user will not notice a change in operation or performance of these systems, but charging a system with a **blend** requires some special considerations.

- We currently don't have charging curves for either gas. A system with a **blend** must be charged by superheat.
- The system should be charged with liquid refrigerant from the tank to prevent **fractionation**. Note that some tanks have a dip tube so the tank is used in the upright position, while other tanks will need to be turned upside down to get liquid. This should be clearly marked on the tank.
- A partial leak in the system doesn't necessarily mean that the refrigerant needs to be removed and recharged. However, it is possible that enough **fractionation** can occur that would require a complete evacuation and recharge. This will be evident when trying to charge the system and the temperature/pressures will not respond correctly.

To charge a split system with a blend:

1. Evacuate lines and evaporator (cooling unit) as normal.
2. Open base valves to release the refrigerant in the condensing unit.
3. Attach an accurate thermometer or temperature sensor to the suction line near the base valve, at the 3 or 9 o'clock position on the line. Insulate over the sensor so that the ambient temperature does not affect the reading.
4. Open the suction base valve to the test position. The low-side gauge should now register a pressure reading.
5. Turn on the system in the cooling mode, and set the thermostat to a low setting so the unit will stay on.
6. Allow the system to run for five minutes so the pressures will stabilize, then measure the superheat. This must be done using the **Dew Point** for conversion.

Note: There is no ideal superheat temperature. It should be in the range of 10° to 20°F (5.6° to 11.1°C), depending on the heat load. On cool days, superheat will be lower, and on hot days it will be higher.

7. To reduce superheat, slowly add liquid refrigerant to the suction line. Do this in very small increments and allow the system to stabilize before taking another reading. **DO NOT OVERCHARGE!** If the system is overcharged, refrigerant must be removed from the liquid line, using an approved recovery cylinder.

Warning: You are charging with liquid refrigerant. To prevent liquid from "slugging" the compressor, open the manifold valve only a small amount to allow the refrigerant to flash from liquid to vapor in the charging hose. **GO SLOWLY!** A special valve is available for charging liquids.

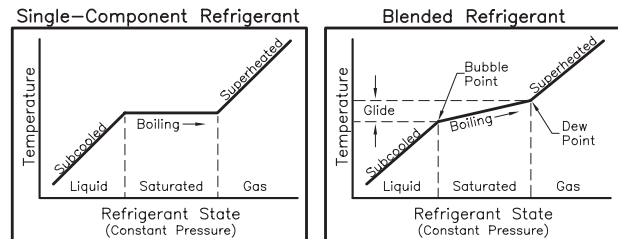
8. Once the superheat is set properly, close the manifold gauge valves, and backseat the discharge base valve. Tighten the stem packing nuts, remove manifold gauges, and replace service port caps.

Glossary

Pressure - Temperature Chart

Temp °F	R-22	R-417A		R-407C		Temp °C
		Bubble	Dew	Bubble	Dew	
0	24	22	18	30	19	-17.8
5	28	26	21	34	23	-15.0
10	33	30	25	40	28	-12.2
15	38	34	29	45	33	-9.4
20	43	39	34	51	38	-6.7
25	49	45	39	58	43	-3.9
30	55	57	44	65	49	-1.1
35	62	56	50	72	56	1.7
40	69	62	56	80	63	4.4
45	76	69	63	89	71	7.2
50	84	76	70	98	79	10.0
55	93	87	77	108	87	12.8
60	116	96	85	118	97	15.6
65	111	105	94	129	107	18.3
70	121	114	103	141	117	21.1
75	132	124	113	154	129	23.9
80	144	134	123	167	140	26.7
85	156	146	134	180	153	29.4
90	168	157	145	195	167	32.2
95	182	170	158	210	181	35.0
100	196	183	170	227	196	37.8
105	211	196	184	244	212	40.6
110	226	211	198	261	229	43.3
115	243	226	212	280	247	46.1
120	260	241	227	300	267	48.9
125	278	258	244	320	285	51.7
130	297	275	261	342	306	54.4
135	317	293	279	365	328	57.2
140	337	312	297	388	351	60.0

All pressures are in psig



Blend - A refrigerant that is made up of two or more single-component refrigerants.

Fractionation - Change in the composition of a blend because one (or more) of the component refrigerants is lost (or removed faster than the others). This happens because the components have different boiling points. It can occur in a tank or system that has lost gas, or locally in a system component such as a coil or accumulator.

Temperature Glide - Because of the different boiling temperatures of the components, a blend will evaporate over a range of temperatures (at a constant pressure). The difference between the Bubble Point and the Dew Point is the Temperature Glide.

Superheat - The "extra" heat (beyond what is required to fully evaporate the refrigerant) that the refrigerant picks up in the evaporator. Superheat is determined by measuring the refrigerant temperature (at the suction line) and then subtracting the saturation temperature (found from the pressure-temperature chart using suction pressure). Use the Dew Point pressure for blends.

Bubble Point - The pressure at which a blend starts to boil. Listed in the pressure-temperature chart.

Dew Point - The pressure at which a blend finishes boiling. Listed in the pressure-temperature chart.

NOTES

NOTES

DOMETIC MARINE DIVISION

2000 N. Andrews Ave. Pompano Beach, FL 33069 USA

Tel +1 954-973-2477

Fax +1 954-979-4414

Mail marinesales@dometicus.com

24/7 TECH SUPPORT FOR UNITED STATES AND CANADA

8:00 AM to 5:00 PM Eastern Time: 800-542-2477

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