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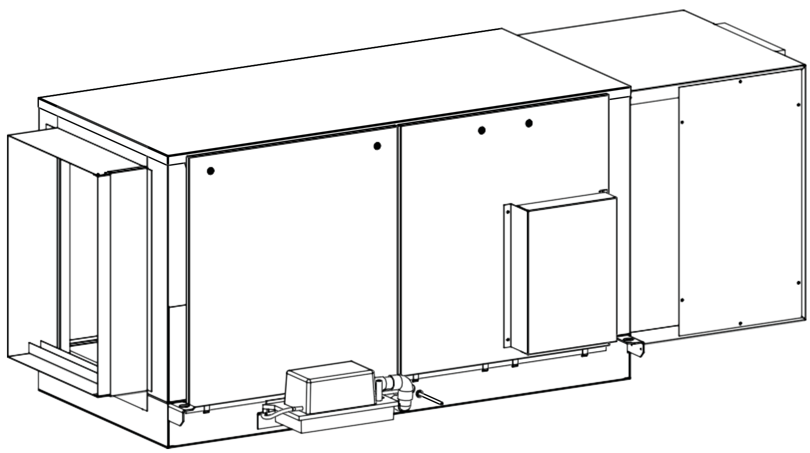

CeilAiR Series

Supplemental Air Conditioners
3.5 – 35 kW Systems
Ceiling Mounted, 60Hz Data

Installation, Operation and Maintenance Manual

Notice

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Table of Contents

Figures

Tables

Nomenclature				
OHS-XXX-XX-XX				
System	**Nominal Capacity in 1,000's of BTU/Hr**	**Configuration**		**Options**
OHS = CeilAiR Overhead System	012, 018, 024, 032, 040, 048, 060, 072, 084, 120	D( ) = Dual Circuit H( ) = Horizontal Discharge ("H-Series")	AHU = Air Handling Unit AR = Air-Cooled Remote (Split) AS = Air-Cooled Self-Contained C = Chilled Water System G = Glycol-Cooled W = Water Cooled	AWS = Alternate Water Source FC = Free Cooling LP = Low Profile Configuration SF = Same-Face Air Pattern SP = Special Configuration*
OHS	040	H	G	FC

Call 888 520 1266 for additional information.

Example: CHS-040-HG-FC, Overhead System, 40,000 BTU/H Capacity, Horizontal Discharge, Glycol Cooled with optional Free Cooling OHS-040-G-FC

1.0 INTRODUCTION

1.1 General

The CeilAiR® ceiling-mounted air conditioning system documented in this manual is designed and manufactured by STULZ Air Technology Systems, Inc. (STULZ).

STULZ CeilAiR overhead air conditioning systems (OHS) are constructed using the finest available materials/components, state-of-the-art technology and quality craftsmanship. The unit will provide years of trouble free service if installed and maintained in accordance with this manual. Damage to the unit from improper installation, operation or maintenance is not covered by the warranty. Due to advances in technology, components described herein are subject to change without notice.

All STULZ CeilAiR OHS systems and CyberAiR centrifugal condensers are designed to be installed indoors, unless otherwise noted on the equipment. Propeller-type condensers, condensing units, drycoolers and pump packages are designed for outdoor use.

1.2 Product Description

STULZ CeilAiR OHS systems are designed to be the most versatile and flexible ceiling-mounted air conditioning systems in the industry. The unit is available in air-cooled, water-cooled, glycol-cooled and chilled-water configurations. The cooling capacity in BTU/H will depend on the unit size, which can range from 1 to 10 tons (3.5–35 kW), and can be either a single stage or dual stage unit.

In addition to cooling, other functional modes of operation include heating, humidification, dehumidification and filtration to provide complete environmental control of a conditioned space. The cabinet configuration is available in a 2 ft x 4 ft frame for units ranging from 12,000 to 40,000 BTU/H (spot cooler or ducted) or a larger frame for units ranging from 48,000 to 120,000 BTU/H (ducted only). For ducted units, there are three basic configurations of airflow patterns: 90°/right angle, straight-through and in/out-same-face (see Figure 9 on page 11). Refer to the installation drawing provided with the unit for the type of cabinet configuration and for the layout dimensions.

1.3 Control Devices

STULZ offers a variety of control devices for CeilAiR OHS series systems. Control interfaces are typically remotely mounted to a wall or control panel.

The default control device for OHS units is the A-Tech digital thermostat, which provides basic control of the system. Slightly different wiring is used with the thermostat in single- and dual-stage units, as shown in Figure 14 on page 20. The single-stage version is the A-Tech 1.1. The two-stage version is the A-Tech 1.2. An operating manual for the thermostat is provided with the unit under separate cover.

Figure 1. A-Tech Digital Thermostats

The advanced STULZ E^2 microprocessor controller is also available for OHS systems. This controller provides enhanced features for more comprehensive control of the unit. These features include: full alarm system; input/output monitoring status; full integrated control of heating, cooling, humidification, and dehumidification and remote communication with building management systems. An operating manual for the controller is provided with the unit under separate cover.

Figure 2. E^2 Microprocessor Controller and Display

1.4 Safety

1.4.1 General

STULZ Air Technology Systems, Inc. uses notes, cautions and warnings in its manuals to draw attention to important operating and safety information.

A bold text NOTE alerts you to an important detail.

A bold text CAUTION provides information that is important for protecting your equipment and performance. Be especially careful to read and follow all cautions that apply to your application.

A bold text WARNING provides information important for protecting you from harm. Pay very close attention to all warnings that apply to your application.

⚠ precedes a general WARNING or CAUTION safety statement.

precedes an electrical shock hazard WARNING or CAUTION safety statement.

1.4.2 Safety Summary

The following warnings and cautions appear in this manual. Before performing any installation, operation, maintenance or troubleshooting procedure, read and understand all relevant cautions and warnings. Maintenance and/or repair procedures must be performed by a journeyman refrigeration mechanic or air conditioning technician.

WARNING

Never work on electrical equipment unless another person who is familiar with the operation and hazards of the equipment and competent in administering first aid is nearby.

WARNING

All personnel working on or near equipment should be familiar with hazards associated with electrical maintenance. Safety placards/stickers have been placed on the unit to call attention to all personal and equipment damage hazard areas.

WARNING

When working on electrical equipment, remove all jewelry, watches, rings, etc.

WARNING 1

Hazardous voltage will still be present inside the electric box at the motor starter protectors and circuit breakers, even with the unit turned off at the E^2 controller. To isolate the unit for maintenance, turn off power at the main power disconnect switch. Always disconnect main power prior to performing any service or repairs.

WARNING

A lock-out/tag-out procedure should be followed to ensure that power is not inadvertently reconnected.

WARNING

To prevent personal injury, stay clear of rotating components, as automatic controls may start them unexpectedly. Turn off power to the unit unless you are performing tests that require power. With power and controls energized, the unit could begin operating at any time.

WARNING ⚠

Never lift any component in excess of 35 lb without help. If a lifting device is used to move a unit, ensure it is capable of supporting the wight of the unit.

WARNING ⚠

Do not allow the unit to swing while suspended from a lifting device. Failure to observe this warning may result in injury to personnel and damage to the equipment.

WARNING ⚠

Never operate the unit with any cover, guard, screen panel, etc., removed unless the instructions specifically state otherwise, then do so with extreme caution to avoid personal injury.

WARNING ⚠

Refrigerant is used with this equipment. Death or serious injury may result if personnel fail to observe proper safety precautions. Great care must be exercised to prevent contact of liquid refrigerant or refrigerant gas, discharged under pressure, with any part of the body. The extremely low temperature resulting from the rapid expansion of liquid refrigerant or pressurized gas can cause sudden and irreversible tissue damage.

At a minimum, all personnel should wear thermal protective gloves and face-shield/goggles when working with refrigerant. Application of excessive heat to any component will cause extreme pressure and may result in a rupture.

Exposure of refrigerant to an open flame or a very hot surface may cause a chemical reaction that forms hydrofluoric acid or carbonyl fluoride, a highly poisonous and corrosive gas commonly referred to as fluorophosgene. In its natural state, refrigerant is a colorless, odorless vapor with no toxic characteristics. It is heavier than air and will disperse rapidly in a well-ventilated area. In an unventilated area it presents a danger as a suffocant.

Always review the manufacturer's Safety Data Sheet (SDS) provided with the unit before performing work involving refrigerant.

WARNING ⚠

Do not use cleaning solvents near open flame or excessive heat. Wear eye protection when blowing solvent from parts. The pressure-wash should not exceed 30 psig. Solvent solutions should be disposed of in accordance with local and state regulatory statutes.

WARNING ⚠

Certain maintenance or cleaning procedures may call for the use and handling of chemicals, solvents, or cleansers. Always refer to the manufacturer's Safety Data Sheet (SDS) prior to using these materials. Clean parts in a well-ventilated area. Avoid inhalation of solvent fumes and prolonged exposure of skin to cleaning solvents. Wash exposed skin thoroughly after contact with solvents.

WARNING ⚠

When performing soldering or desoldering operations, make certain the refrigeration system is fully recovered and purged and dry nitrogen is flowing through the system at the rate of not less than 1-2 CFM.

WARNING ⚠

Cooling coils (and associated piping circuits) are pressurized (up to 100 psi) and sealed when they leave the factory. Before installing the interconnecting piping, observe appropriate safety precautions and release the pressure via an available stem valve or Schrader valve prior to uncapping the pipes.

CAUTION ⚠

When the air conditioner operates in cooling mode the return air intake and discharge (supply) must be free of obstructions. Ensure panels are secure and latched into position.

CAUTION ⚠

After interconnecting piping is installed, the piping system must be cleaned. If solvents/cleaning solutions are used, ensure they are completely flushed from the piping before connecting it to the unit. Failure to do so will result in equipment problems.

CAUTION ⚠

When installing and filling a chilled water or water/glycol loop, all air must be bled from the piping system.

CAUTION ⚠

Do not use chloride-based water conditioning additives in the condensate drain pans. They cause corrosion to occur on the coil fins.

CAUTION ⚠

When transporting and installing the A/C unit, it must be kept in its normal, horizontally-installed position. If the unit is not kept level and horizontal, damage to the compressor(s) will result.

1.5 General Design

The CeilAiR unit is housed in an aluminum frame cabinet and is rated for indoor use. Removable panels are located on the front and rear of the cabinet for easy access to all components. Additional access may be obtained to some components through the bottom of the unit on spot cooler configurations. The unit has an electric box inside the cabinet with a removable panel for accessing the electrical components. Operator controls may be conveniently located on a wall within the space to be conditioned.

NOTE

Customer specified, non-standard features or design variations may not be described in this manual. Refer to the installation and electrical drawings supplied with your unit for details on additional feature(s). In some cases, an addendum to this manual may also be included to further describe the feature(s).

1.5.1 Electric Box Access

Electrical components are protected in an enclosure located in the cabinet behind an access panel. Before opening the access panel, turn off power at the main power service disconnect switch. This removes power from the ***E²*** controller (if present) and shuts the unit off.

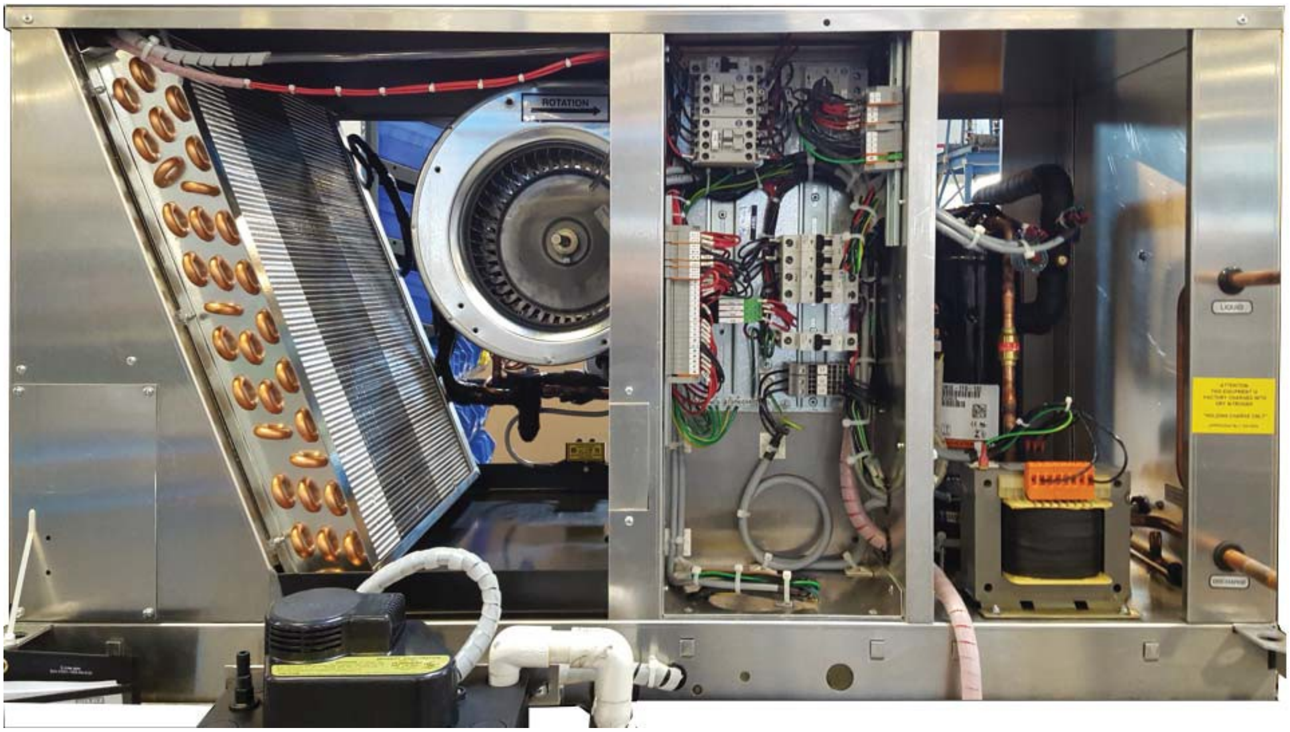

Figure 3. CeilAiR OHS-032-AR (Access Panels Removed)

1.5.2 Coil(s)

The cooling and optional hot water reheating coils are aluminum finned/copper tube construction. The coils are leak tested and cleaned before installation at the factory.

1.5.3 Blower

The unit is equipped with a centrifugal blower with forward curved blades. The blower is contained in a double-width, double-inlet housing. The blower is dynamically and statically balanced to minimize vibration. The blower motor is ODP industrial duty and utilizes permanently lubricated ball bearings.

Smaller CeilAiR units (models OHS-012/040) use direct drive blowers (except "H"-series models configured for horizontal discharge). Larger units (models OHS-048/120) and horizontal discharge units (models OHS-012/040-H), use a belt-driven blower. The belt-driven blower motor is mounted on an adjustable base for belt tensioning and is furnished with an adjustable pitch sheave to adjust blower speed (see Figure 21 on page 33).

1.5.4 Temperature Sensor

As a standard for systems utilizing a wall mounted A-Tech thermostat, the temperature sensor is built into the thermostat for room air control. The sensor monitors the room air conditions and provides input signal(s) to the thermostat.

The thermostat manages the operation of the A/C unit consistent with the setpoints entered.

As an option, the temperature sensor may be shipped loose for field installation in the room to be conditioned. Refer to the electrical drawing supplied with your unit for details specific to your system.

1.6 Optional Equipment

1.6.1 Humidistat/Dehumidistat

As an option for systems employing an A-Tech 1.1 or A-Tech 1.2 thermostat, a room mounted humidistat and/or dehumidistat may be shipped loose for field installation. Each device has an adjustment dial on the front where the operator selects the desired setpoint.

If an optional humidifier is selected, the humidistat is included to control its operation. The humidistat controls the humidifier's operation independently of the control thermostat; however, the blower must be on for the humidifier to operate.

If the heat/reheat option is selected, a dehumidistat is provided. If room humidity rises above setpoint when the demand for cooling is satisfied, the dehumidistat signals the compressor to turn on, removing humidity. At the same time, the heater(s) are turned on to offset the cooling effect, thus maintaining the temperature of the space to be conditioned. Refer to the electrical drawing supplied with your unit for details specific to your system.

1.6.2 Temperature/Humidity Sensor

As a standard for systems that use the E^2 microprocessor controller, a temperature/humidity (T/H) sensor is typically factory mounted in the return airstream for room air control. As an option, the T/H sensor may be shipped loose for field installation. See 2.7.6.5 on page 25 and the electrical drawing supplied with your unit for details specific to your system.

1.6.3 Heaters

The OHS unit may incorporate heaters for reheating the supply air as required to offset the sensible cooling of the system during the dehumidification cycle and for the automatic heating mode. Electric resistance heating elements are factory installed in the supply airstream to heat the supply air. The heating elements are protected with line fuses (manual and/or automatic), thermal fuse links and over-temperature safety switches which automatically reset.

As an option, hot water reheat may be selected for automatic sensible reheating during the dehumidification cycle. A hot water heating coil is factory installed in the supply airstream. A valve is provided to control the flow of hot water through the coil to maintain the correct reheat temperature.

Hot gas reheat may be selected (for CeilAiR units with DX cooling only) for automatic sensible reheating during the dehumidification cycle. Hot compressor discharge gas is diverted from the condenser to a hot gas heating coil mounted in the supply airstream.

1.6.4 Humidifier

CeilAiR systems may utilize an optional electrode steam humidifier. The humidifier is factory installed inside the air conditioner and includes fill and drain valves and associated piping. Operation of the humidifier's fill and drain cycles is based on water conductivity and is maintained by the humidifier controller. An operating manual for the humidifier is provided with the unit under separate cover. Refer to that manual for detailed information about operating the humidifier.

1.6.5 Condensate Pump

An optional, factory-installed condensate pump may be provided. The pump automatically eliminates condensate and humidifier flush water (if applicable) from the drain pan. Should an overflow occur in an E^2-based system, the pump overflow safety switch triggers a contact signal to the controller that indicates the alarm condition, and the controller automatically shuts down the compressor and optional humidifier until the condition is corrected. The blower(s) will continue to operate. In an A-Tech system, the pump safety switch is wired directly to the OHS remote stop/start terminals to cut power to the system.

1.6.6 Smoke Detector

A smoke detector may be mounted in the return airstream to sense the presence of smoke and, when smoke is detected, shut down the air conditioner, either via the E^2 controller or in A-Tech systems via connection to the OHS remote stop/start terminals.

1.6.7 Firestat

A fire detector (firestat) may be mounted in the return airstream to sense high return air temperature indicative of a fire. The system shuts down, either via the E^2 controller or, in an A-Tech system, via connection to the OHS remote stop/start terminals. Following activation, the firestat must be manually reset using the reset button on the firestat before restarting the unit.

1.6.8 Water Detector

As an option, STULZ offers spot type or strip/cable type water detectors. In units equipped with an E^2 controller, when water is detected the controller turns off cooling and humidification, while the blower(s) continue to operate. The unit will automatically restart when the condition is corrected. In units equipped with an A-Tech thermostat, the water detector is wired to the OHS remote stop/start terminals and power to the system is cut when water is detected.

1.7 Free-cooling Operation

The free-cooling (FC) configuration illustrated in Figure 4 is available to minimize the use of compressor operation during low ambient conditions for system energy savings. An FC system utilizes a remote drycooler to provide water/glycol coolant to a free-cooling coil positioned within a DX refrigerant system. If outdoor air temperatures permit free-cooling operation (adjustable user setpoint), the free-cooling mode is enabled to take advantage of the low ambient conditions to provide cooling with partial use or without the use of the system compressor(s). Free-cooling provides an excellent opportunity for reduced operational cost by reducing the compressor operating hours. The free-cooling sequence is enabled if the entering fluid temperature is below the user adjustable free-cooling-enable setpoint and the return air temperature rises to the free-cooling setpoint plus dead band. The drycooler pump activates and the 3-way control valve directs chilled water/glycol coolant to the FC coil. The outdoor fluid cooler is controlled by first switching the leaving fluid control setpoint from typical DX heat rejection to free-cooling control (adjustable setpoint, ambient air) and by controlling the leaving fluid to its user-adjustable setpoint. The free-cooling control valve opens proportionally to the demand for cooling based on the return air temperature's deviation from setpoint.

If the return air temperature continues to rise, the free-cooling valve position eventually reaches 100% open, maximizing the flow of coolant through the free-cooling coil. Continued operation in this position indicates the A/C unit is unable to lower the air temperature to the desired setpoint in the free-cooling mode.

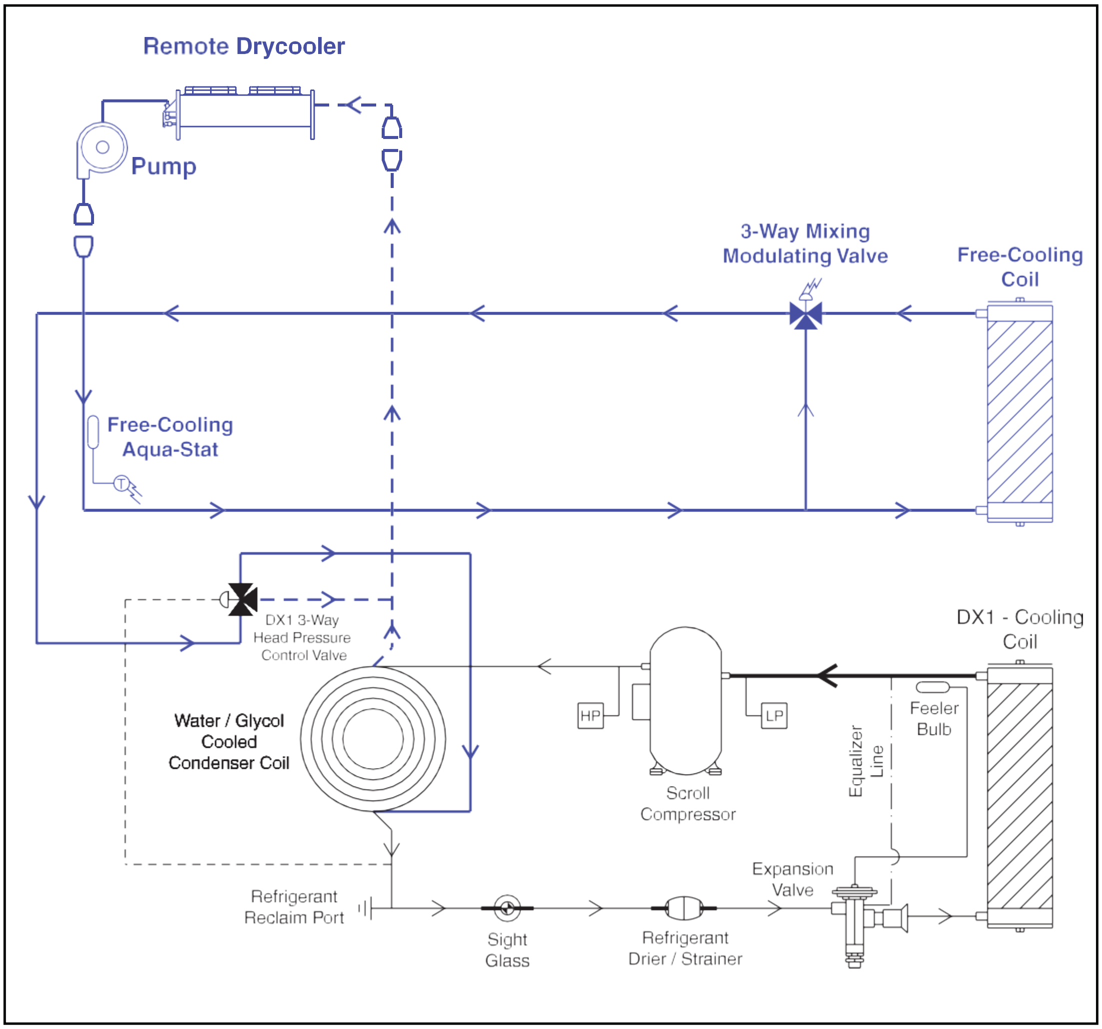

Figure 4. Free Cooling Diagram

The compressor activates if the DX cooling stage enable-temperature setpoint has been reached or if the control valve position reaches 100% open for 240 seconds (default compressor-on time delay). The free-cooling circuit and the compressor operate in parallel on dual-circuit units to provide maximum cooling. The 3-way control valve continually modulates the flow of coolant in response to temperature with the compressor running.

The compressor cycles off based on the normal compressor temperature cut-out settings once the setpoint is maintained.

As the outside air temperature increases above the ambient air switch-over setting, the fluid cooler controls cycle back to typical DX heat rejection allowing the leaving fluid control setpoint to increase above the prevailing ambient conditions. The indoor unit's inlet fluid temperature sensor monitors the fluid temperature and deactivates the free-cooling mode once the fluid temperature increases above the user adjustable enable setpoint. The compressor system becomes the primary cooling source and will activate if the return air temperature increases above the setpoint.

1.8 AWS Operation

The AWS (Alternate Water Source) configuration illustrated in Figure 5 utilizes an independent chilled water source to provide coolant to an AWS cooling coil in the A/C unit. If AWS cooling is unable to handle the load, the separate DX refrigeration circuit can be utilized to assist. Similar to FC operation (see Section 1.7), when return air temperature rises to the AWS cut-in temperature setpoint and if the chilled water inlet temperature is 55 °F or less (adjustable), AWS cooling activates (the AWS control valve opens) and remains on while the activation conditions exist.

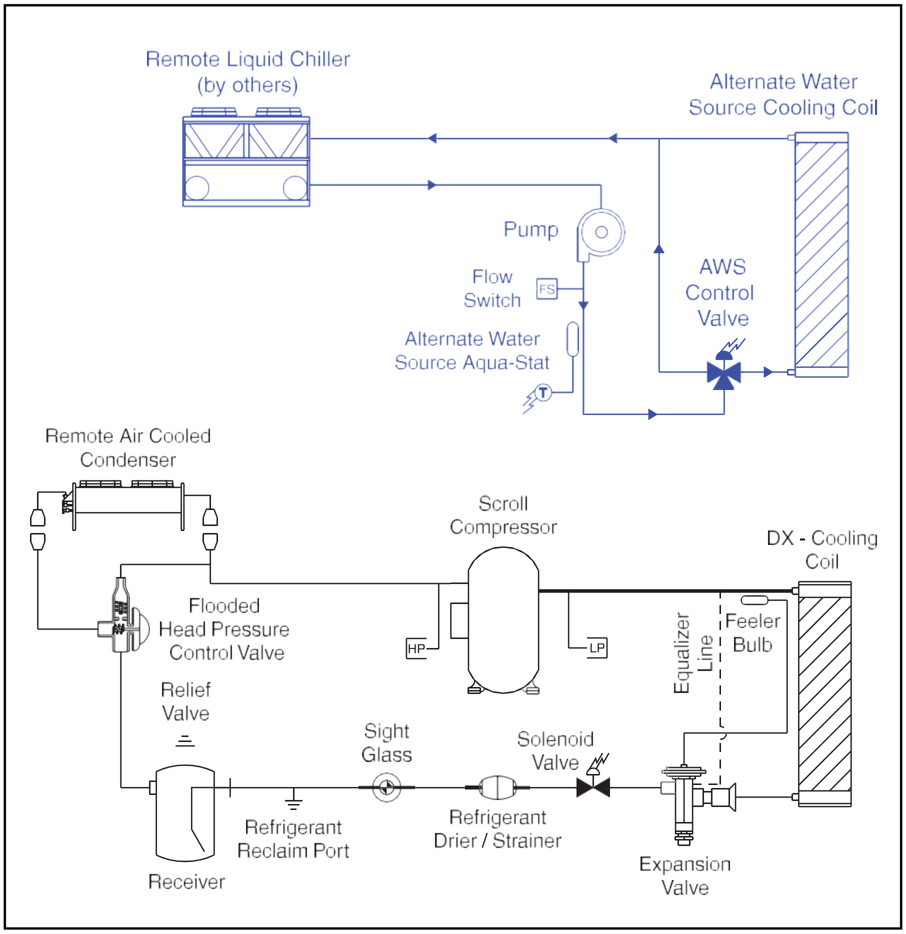

Figure 5. Alternate Water Source Diagram

If the return air temperature rises to the compressor cut-in setpoint or if the AWS control valve reaches 100% open for 240 seconds (default compressor-on time delay), the compressor turns on and operates in parallel with AWS cooling. The compressor runs until the normal compressor cut-out setpoint temperature is reached provided the minimum run time expires.

If the chilled water inlet temperature rises above 55 °F, AWS cooling turns off (the control valve closes). When the DX cooling stage-enable temperature setpoint is reached, the compressor turns on and becomes the primary source of cooling.

In the event of loss of water flow during AWS operation, the AWS control valve is closed and the compressor system becomes the primary cooling source. It will activate if the return air temperature increases above the setpoint.

2.0 INSTALLATION

2.1 Receiving the Equipment

Your CeilAiR OHS system has been tested and inspected prior to shipment. To ensure the equipment is received in excellent condition, visually inspect the equipment immediately upon delivery. Carefully remove the shipping container and all protective packaging. Remove the access panels and thoroughly inspect the unit interior for any signs of transit-incurred damage. If there is shipping damage, it must be noted on the freight carrier's delivery forms before signing for the equipment. Any freight claims must be done through the freight carrier. STULZ ships all equipment Factory FOB. STULZ can assist in the claim filing process with the freight carrier. Should any damage be present, notify STULZ Product Support prior to attempting any repairs. Refer to section 5.0 on page 45 of this manual for instructions.

A data package is included with your unit. It contains this manual, system drawings, applicable material SDS's, other component manuals, warranty registration and other applicable instructions based on the configuration and options provided with the unit. The data package has been placed in the unit in a clear plastic bag. The documents need to be retained with the unit for future reference.

NOTE

Items that have been shipped loose, such as remote sensors, vibration isolators, and so on, are shipped inside the air conditioner unless specified otherwise by the customer. Grilles (if applicable) are placed on top of the air conditioner inside the unit's carton. Remove and store these items in a safe place unless you are using them immediately.

2.2 Site Preparation

CeilAiR systems are designed with easy service access in mind. Component access panels are located on the front and rear sides of the equipment. Additional access to some components may be obtained through the bottom of the unit on spot cooler configurations. These units can be fully serviced in the ceiling plenum. In order to have full service access, the air conditioner must be located so that adequate space is provided in front of all access panels.

NOTE

Working clearance requirements need to be established prior to the mounting of the unit. Refer to the National Electrical Code and local codes.

To minimize the effects of the environment surrounding the conditioned space, certain steps must be taken. This is especially true for critical/precision room preparation (computer rooms/labs) requiring close tolerance control of temperature and humidity. The conditioned space should be well insulated and include a vapor barrier. The installer should ensure that the proper insulation rating is used based on the design of the space that was the basis for the system selected. The following table is a recommended minimum R-value (thermal resistance) to ensure optimum equipment operation.

STRUCTURE	R-VALUE
Ceiling	R-38
Wall	R-21
Floor	R-19
Door	R-5

The vapor barrier is the single most important requirement for maintaining environmental control in the conditioned space. The vapor barrier in the ceiling and walls can be polyethylene film. Concrete walls and floors should be painted with a rubber or plastic-based paint. Doors and windows should be properly sealed and a door sweep used to minimize leakage. Outside or fresh air should be kept to a minimum (as it adds to the cooling, heating, dehumidification and humidifying loads), while maintaining the requirement of the Indoor Air Quality (IAQ) standard. Lack of these steps can cause erratic operation, unstable room control and excessive maintenance costs.

2.3 Rigging

CeilAiR systems are designed to be kept in a horizontal position. The unit is shipped on a skid to facilitate moving prior to installation. A suitable lifting device should be used to lift the unit from the bottom. A weight table is provided for reference on the installation drawing. The unit should always be stored indoors in a dry location prior to installation.

CAUTION

When moving the unit, it must be kept horizontal and level to prevent damage.

2.4 Mounting

CeilAiR OHS systems are designed for ceiling mounting in a suspended ceiling grid (spot cooler) or above the suspended ceiling for ducted systems. See Figure 6.

NOTE: These units use welded frame construction for unit rigidity. The system is designed to be installed on a roof curb, which is provided by others and ducted into a singular space to be conditioned. Ensure the curb is sealed to prevent air leakage. See the detail drawing provided with the unit for interface dimensions. These units are designed to be ducted to a space to be conditioned and are intended to condition only one room.

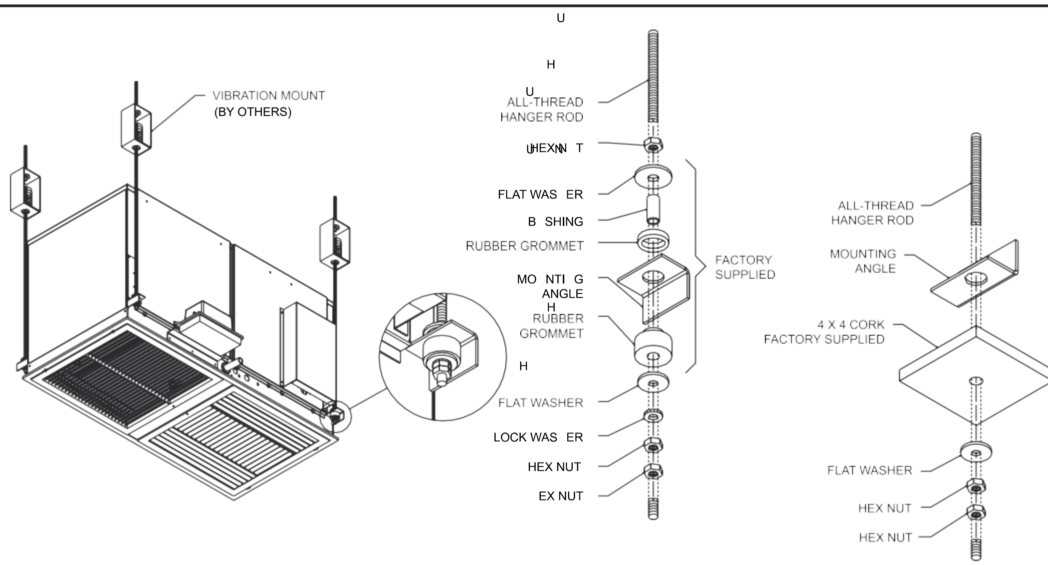

Figure 6. Typical Installation

NOTES

- Do not install the A/C system directly above electronic equipment that may hinder serviceability.
- Equipment must be level to operate properly

2.4.1 Indoor Equipment

CeilAiR OHS systems have a frame and panel construction for unit rigidity and full service accessibility while the unit is mounted in place. The unit is lifted from underneath and secured into place using all-thread rods passing through rubber grommets or a 4 in. x 4 in. neoprene cork pad in the mounting arms on the sides of the unit. Threaded rods, nuts and washers (field supplied by others) must be secured so they do not loosen. (See Figure 6 on page 9.)

Before mounting the unit, ensure the mounting structure is able to support the weight of the equipment. Refer to the weight table provided on the installation drawing. Secure the unit via the predrilled mounting bolt holes with suitable hardware for the application. An auxiliary drain pan is recommended and can be mounted directly under the cabinet (only on ducted models; see Figure 9 on page 11).

2.4.2 Outdoor Equipment

Install remote condensers/condensing units in a secure location where the unit cannot be tampered with and the power service switch cannot be inadvertently turned off. Locate the remote condenser/condensing unit where the fan is not likely to draw dirt and debris into the coil fins.

There should be at least one equipment-width of clearance around the condenser to ensure adequate airflow to the coil. Secure the condenser/condensing unit so the system will not move during operation. Refer to the installation drawing for the non-charged system weight. It is recommended that the remote condenser/condensing unit be mounted with vibration mounts to reduce the amount of vibration transmitted to the mounting surface.

2.4.3 Controls

NOTE

Thermostats and control sensors should not be located near a doorway, supply air register or area where they would be exposed to direct sunlight or other external heat sources.

2.4.3.1 A-Tech Programmable Thermostats

Mount the thermostat upright on an inside wall within the conditioned room at a location that best represents the average room temperature. In most cases, the thermostat should be located near the common return air grille. Mount the thermostat at least 18 in. from an outside wall and approximately 5 ft above the floor. Follow the steps below for mounting. Instructions for wiring the thermostat are found in Section 2.7.2 on page 20.

1. Open the case with a flathead screwdriver. Place blade in slot and gently pry forward at the numbered locations shown in Figure 7.

Figure 7. A-Tech Controller Installation

2. Place the base temporarily over the wire hole opening in the wall. Level the base and mark the screw locations through the two provided mounting slots.

CAUTION ⚠

Do not touch the temperature sensor on the bottom left corner of the thermostat. The sensor can be damaged if handled improperly.

3. If using the supplied anchors, drill two 3/16 in. holes and tap in the wall anchors. If only the screws are being used, drill two 3/32 in. holes.
4. Fasten the base to the wall using the supplied screws.
5. Connect wiring between the thermostat and equipment. See the A-Tech wiring instructions in Section 2.7.2 on page 20.
6. Reinstall thermostat cover to base.

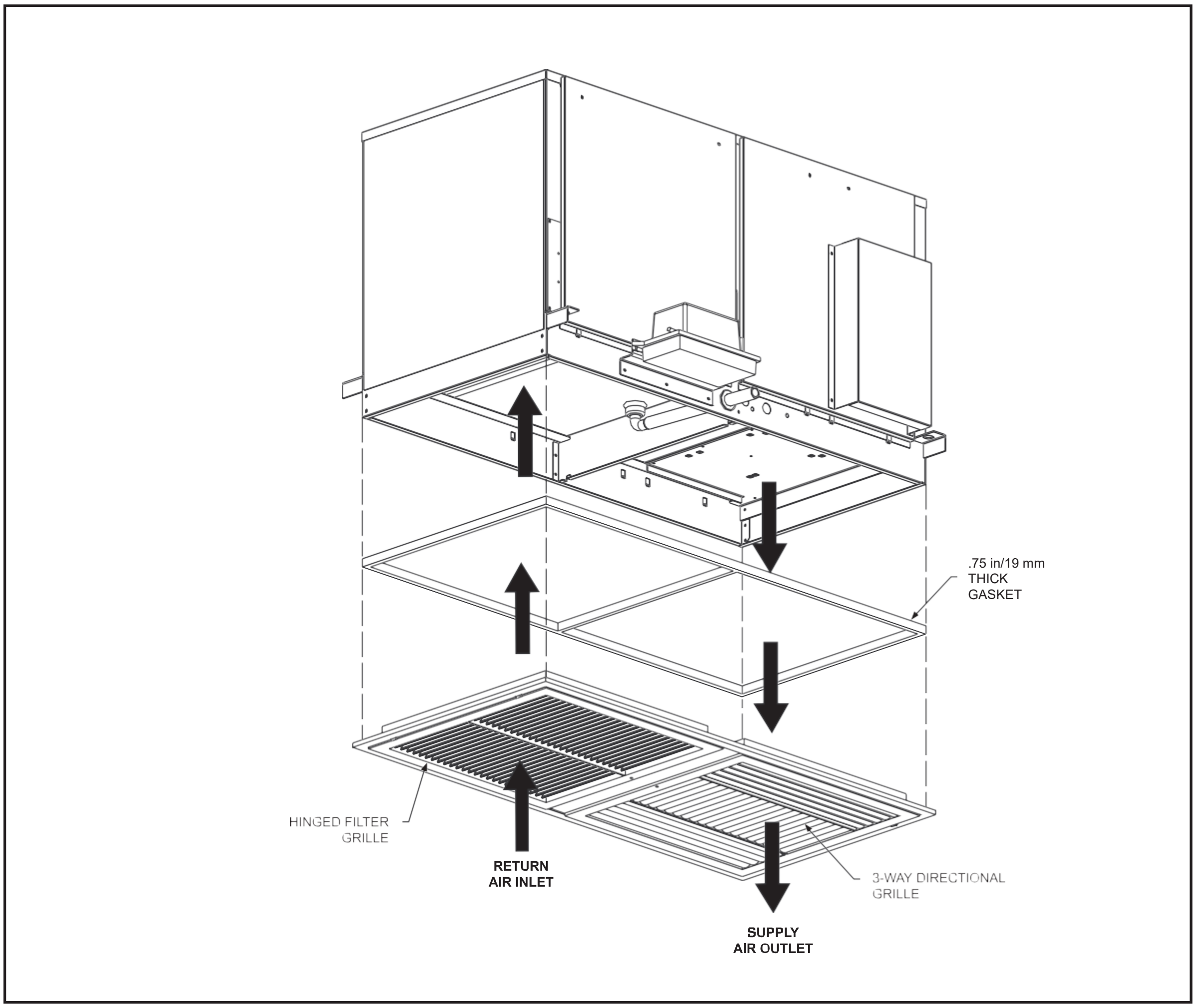

Figure 8. Spot Cooler Grille

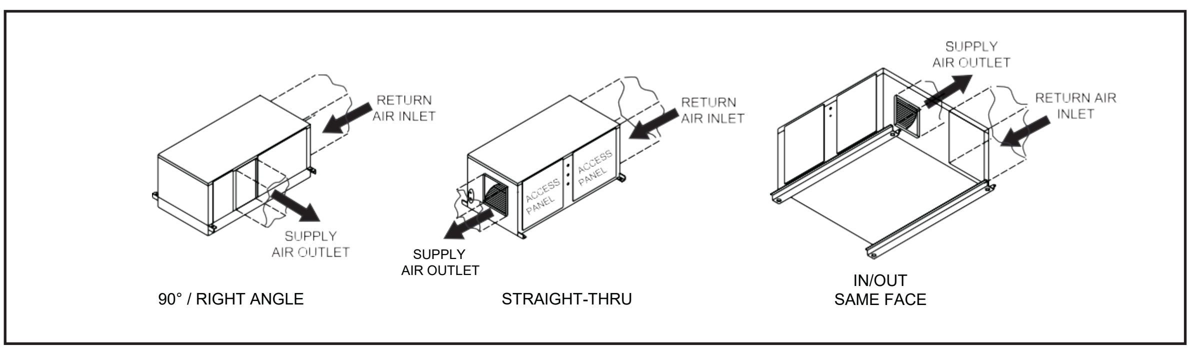

Figure 9. Ducted System Typical Air Patterns

2.4.3.2 Advanced STULZ E^2 Controller

If the optional STULZ E^2 controller is furnished, a separate manual is included in the unit data package provided with the unit. The controller user interface display may be field mounted to a wall within the conditioned space or it may be located outside the conditioned space if desired. Refer to the supplemental instructions provided with the mounting kit when mounting the controller display. When locating the display panel, consider the length of wire to be used. As an option, a 30 ft, 75 ft or 150 ft long cable may be provided by STULZ.

2.4.4 Optional Equipment

NOTE

Do not mount any optional equipment on the A/C unit's access panels.

2.4.4.1 Condensate Pump (Field Installed)

If the unit was not purchased with the factory-installed condensate pump option, the shipped-loose condensate pump should be mounted as near to the air conditioning system as possible. The inlet hole in the pump must be below the lowest part of the drain from the A/C unit. The pump has two mounting supports so it can be hung on an adjacent wall. Ensure that the pump is level for proper operation.

CAUTION ⚠

Always follow manufacturer's instructions when installing a field-installed condensate pump. If manufacturer's instructions were not provided with the pump, contact STULZ product support for the pump documentation. Do not install the pump without first reading the manufacturer's instructions. Failure to exactly follow manufacturer's instructions may on rare occasions result in serious damage to the OHS unit and the surrounding facility.

A P-trap must be installed between the pump and the unit. The height of the trap must be a minimum of 2 in. to exceed the total static pressure of the system and ensure proper water drainage from the drain pan.

CAUTION ⚠

Properly size and vent the P-trap according to applicable codes and best practices.

2.4.4.2 Non-Fused Service Switch

The non-fused service switch may be used to disconnect main power and isolate the unit during maintenance and service. The switch has a lockable handle to lock power out during maintenance periods. The switch is typically mounted to the A/C cabinet; however, it may be shipped loose for field installation. The case has a top keyhole mounting slot and two holes in each bottom corner for mounting. The hardware for mounting the switch is field supplied. Select suitable fasteners for the intended mounting surface.

The non-fused service switch can be mounted near the unit or in a central location. Non-fused service switches are rated for either indoor or outdoor use. Ensure that the proper type is used for your application.

NOTE

Refer to the National Electrical Code and local codes for the appropriate mounting location.

2.4.5 Remote Sensors

The remote temperature sensor or temperature/humidity (T/H) sensor must be located so that it will properly sense the temperature and/or humidity conditions to be controlled. The sensor should not be mounted near a doorway or an area where it would be exposed to direct sunlight. When locating the sensor, consider the length of wire to be used. As an option, a 75 ft or 150 ft cable may be provided by STULZ. Refer to the applicable section that follows to mount the sensor. For wiring details, refer to Section 2.7.2 on page 20 and to the electrical drawing provided with the unit.

2.4.5.1 Remote Temperature Sensor (A-Tech)

Figure 10. Temperature Sensor for A-Tech

NOTE

The remote temperature sensor has a maximum range of 330 ft.

1. Install shielded or nonshielded two wire twisted cable from the thermostat to the remote sensor location.
2. Open the sensor case by grasping the side and pulling the two halves apart.

3. Use the sub-base as a template to mark the mounting hole locations on the mounting surface. Drill size for the wall anchors is 1/4 in. Mount the sub-base over the wires coming out of the wall using the two screws and anchors provided. Do not use hex head screws.

4. Strip 1/4 in. of insulation from the two wires at the remote sensor. Install the wires in the terminals. The wires can be connected with either polarity. Seal the hole in the wall around the cable to eliminate any draft that might affect the sensor.

5. Make the wiring connections. Refer to section 2.7.6.4 on page 25 and to the wiring diagram supplied with your unit.

6. Replace the sensor cover.

2.4.5.2 Remote Temperature/Humidity Sensor (E²)

Figure 11. Temperature/Humidity Sensor for E² Con-troller

1. Remove the cover from the base of the sensor by squeezing it at the top and bottom.

CAUTION ⚠

Take care not to damage the exposed temperature/humidity sensor elements on the PC board when the cover is removed. The sensor elements can be damaged if handled improperly.

2. Place the base temporarily against the mounting surface.

3. Level the base. Mark and drill mounting holes through at least two of the available slotted holes. Also, mark through the large opening in the base and drill a hole into the mounting surface for a control cable to pass through the back of the base.

4. Run a three-conductor shielded cable through the opening in the base, then secure the base with screws, ensuring the word TOP on the PC board is oriented upward.

5. Route the sensor control cable up to the control terminal block in the electric box and terminate the control wire. Refer to section 2.7.6.5 on page 25 and to the wiring diagram supplied with your unit.

6. Seal the hole in the wall behind the sensor.

7. Replace the cover plate on the base.

2.4.6 Humidistat/Dehumidistat (Used with A-Tech1.1/1.2 Thermostat)

Mounting the humidistat and/or dehumidistat is performed in the same manner as described in section 2.4.5.1. It should be mounted to a wall within the conditioned room at a location that best represents the average humidity of the space. In most cases, the humidistat and/or dehumidistat should be located near the common return air grille. Mount the humidistat and dehumidistat at least 18 in. from an outside wall and approximately 5 ft above the floor.

Controls may be installed either on a flush switch box or on a surface switch box. Follow the steps below for mounting. Instructions for wiring the unit are provided in Section 2.7.6.2 on page 24.

1. Pull dial knob off, loosen screw (located at bottom of unit) and remove cover.

2. Make wiring connections according to the wiring diagram provided with your unit.

3. Mount the base with the two #6 screws provided.

4. For external setpoint, reinstall cover, tighten screw, and replace dial knob.

5. For internal setpoint:

   a. Turn dial plate to desired setting and tighten dial lock screw.

   b. Break off dial shaft at undercut.

   c. Remove insert from cover.

   d. Remove protective backing from adhesive on the blank insert provided and press firmly in place on cover.

   e. Reinstall cover assembly and tighten screw. (If additional security is required an Allen screw and wrench are provided.)

   f. Remove protective cover from face of cover insert.

2.4.7 Spot Water Detector

The spot water detector is normally placed on the floor or in a field-supplied auxiliary drain pan located beneath the unit.

It may be attached using double sided tape or with the mounting holes provided in the flanges (one on each side). Once it's in place, loosen the screws provided on the mounting legs to adjust the height of the sensing probes. When water is present, current will flow between the two probes.

CAUTION ⚠

The probes must not touch the mounting surface. Failure to adhere to this may result in improper operation of equipment.

For wiring details, refer to Section 2.7.6.3 on page 25 and to the electrical drawing provided with the unit.

2.4.8 Cable Type Water Detector

CAUTION ⚠

Do not allow the cable water detector to contact metal (frame or condensate pan). It must be mounted on the plastic stand-offs provided with the water detector.

Lay the cable water detector across the surface where water could collect. When water is present, current will flow between the two wires. A two conductor wire harness is provided with a quick connect fitting on the end. The harness mates to the fitting on the water detector cable and connects it to the terminal block inside the electric box.

2.5 Air Distribution Connection

2.5.1 Spot Cooler

For units that are not ducted (see Figure 9), the air conditioner should be mounted above the ceiling grid, leaving sufficient space for the air grilles to rest on the ceiling T-bar.

NOTE

Placement of the grilles is important. The hinged filter grille goes on the return air side of the unit. The 3-way directional grille goes on the conditioned air discharge side of the air conditioner. Gasketing is factory-supplied for the air seal between the bottom flange of the air conditioner and the grille. After mounting the air conditioner, attach the gasket to the bottom flange, then lower the air conditioner until the gasket meets the grille, as shown in Figure 8 on page 11.

2.5.2 Ducted Systems

There are three basic configurations of airflow patterns: 90°/right angle, straight-through and in/out-same-face (see Figure 9). When determining ducting requirements, always consult your local and state codes. The duct system should be designed to allow the air to move with as little resistance as possible. Several factors determine ducting material and size. These factors are predetermined, refer to your ducting system schematic.

The connection of ducting to the unit is typically accomplished with a 1 in. duct flange. Supply air outlet and return air inlet ducts will require a field-provided duct flange (refer to the installation drawing provided with the unit). The connection of ductwork to the unit may be made with either pop rivets or self-tapping screws.

2.6 Piping Connections

2.6.1 Refrigerant

2.6.1.1 Self-Contained Systems

No refrigeration connections are required for self-contained air, water or glycol-cooled systems (Models OHS-012/040-AS, OHS-012/120-C and OHS-012/120-W/G-( )).

2.6.1.2 Split Systems

Split air-cooled systems will require field refrigeration piping. All split systems are shipped with a dry nitrogen charge of 100 psig. Systems utilizing a remote condenser will require a copper liquid line and discharge line (see section 2.6.1.3). Systems utilizing a remote condensing unit (RCU) will require a copper liquid line and suction line (see section 2.6.1.4).

All refrigeration piping should be installed with high temperature brazed joints. Use standard refrigeration practices for piping supports, leak testing, dehydration and charging of the refrigeration circuits. The refrigerant piping should be isolated by the use of vibration isolating supports. Provide supports (clamps or hangers) as necessary every 5 to 10 ft along piping runs to minimize vibration and noise transmission. To reduce vibration transmission and prevent pipe damage, use a soft flexible material to pack around the piping when sealing openings in walls.

Wrap wet rags around the pipes between the areas to be soldered and any nearby refrigeration components to keep excessive heat from traveling through the pipe and causing damage. Clear all pipe connections of debris and prep connections for soldering. Use only "L" or "K" grade refrigerant copper piping. Be careful not to allow solder/piping debris to get inside refrigerant lines. Silver solder containing a minimum of 15% silver is recommended. Dry nitrogen should be flowing through the tubing while soldering at a rate of not less than 1-2 CFM.

Refrigerant lines for split systems must be sized according to the piping distance between the evaporator and the condenser/condensing unit. Each valve, fitting and bend in the refrigerant line must be considered in this calculation. Pipe sizes are given for "equivalent feet", not linear feet. Do not confuse the terminologies. For example, a 7/8 in. standard 90° elbow has an equivalent length of 1.5 ft; a 7/8 in. branch Tee has an equivalent length of 3.5 ft. These corrections must be accounted for when sizing your piping. Refer to the following table for standard equivalent lengths, in feet, of straight pipe.

Table 1. Pipe Equivalent Lengths

Equivalent Length (ft) of Straight Pipe						
O.D. (in.) Line Size	**Globe Valve**	**Angle Valve**	**90° Elbow**	**45° Elbow**	**Tee Line**	**Tee Branch**
1/2	9.0	5.0	0.9	0.4	0.6	2.0
5/8	12	6.0	1.0	0.5	0.8	2.5
7/8	15	8.0	1.5	0.7	1.0	3.5
1 1/8	22	12	1.8	0.9	1.5	4.5
1 3/8	28	15	2.4	1.2	1.8	6.0

Oil traps must be included every 20 ft in the vertical risers and the refrigerant lines must be sloped in the horizontal lines to ensure proper oil return to the compressor. An inverted trap is required on the discharge line of the remote condenser to help prevent oil and liquid from flooding back to the compressor.

NOTE

In the following tables:

- The line sizes represent the correct size for individual refrigeration circuits. Dual circuit units, (models 048D to 120D), have two separate pairs of refrigeration lines, one per compressor.
- All pipe lengths are "Equivalent Length," which accounts for the linear pipe length as well as equivalent length of valves, elbows and Tee's as shown in Table 1.

Table 2. Recommended Discharge Line Sizes For R407C Refrigerant

Model No./Total BTU/H Capacity	Compressor to Condensor O.D. (inches)		
	50 ft or less	100 ft or less	150 ft or less
012 / 12,000	1/2	5/8	5/8
018 / 18,000	1/2	5/8	5/8
024 / 24,000	5/8	5/8	3/4
032 / 32,000	5/8	3/4	3/4
040 / 40,000	3/4	3/4	7/8
048 / 48,000	3/4	7/8	7/8
048D / 48,000	5/8	5/8	3/4
060 / 60,000	3/4	7/8	1-1/8
072D / 72,000	5/8	3/4	3/4
084D /84,000	3/4	7/8	7/8
120D / 120,000	3/4	7/8	1-1/8

Table 3. Recommended Discharge Line Sizes For R410A Refrigerant

Model No./Total BTU/H Capacity	Compressor to Condensor O.D. (inches)		
	50 ft or less	100 ft or less	150 ft or less
012 / 12,000	1/2	5/8	5/8
018 / 18,000	1/2	5/8	5/8
024 / 24,000	5/8	5/8	5/8
032 / 32,000	5/8	5/8	3/4
040 / 40,000	5/8	3/4	3/4
048 / 48,000	3/4	3/4	7/8
048D / 48,000	5/8	5/8	5/8

Model No./Total BTU/H Capacity	Compressor to Condensor O.D. (inches)		
	50 ft or less	100 ft or less	150 ft or less
060 / 60,000	3/4	7/8	7/8
072D / 72,000	5/8	5/8	3/4
084D /84,000	3/4	3/4	7/8
120D / 120,000	3/4	7/8	7/8

Table 4. Recommended Liquid Line Sizes For R407C Refrigerant (Condenser to Receiver)

Model No./Total BTU/H Capacity	Receiver to Evaporator O.D (inches)		
	50 ft or less	100 ft or less	150 ft or less
012 / 12,000	1/2	1/2	1/2
018 / 18,000	1/2	1/2	1/2
024 / 24,000	1/2	1/2	5/8
032 / 32,000	1/2	5/8	5/8
040 / 40,000	5/8	5/8	5/8
048 / 48,000	5/8	5/8	3/4
048D / 48,000	1/2	1/2	5/8
060 / 60,000	5/8	3/4	3/4
072D / 72,000	1/2	5/8	5/8
084D /84,000	5/8	5/8	3/4
120D / 120,000	5/8	3/4	3/4

Table 5. Recommended Liquid Line Sizes For R410A Refrigerant (Condenser to Receiver)

Model No./Total BTU/H Capacity	Receiver to Evaporator O.D. (inches)		
	50 ft or less	100 ft or less	150 ft or less
012 / 12,000	1/2	1/2	1/2
018 / 18,000	1/2	1/2	1/2
024 / 24,000	1/2	5/8	5/8
032 / 32,000	1/2	5/8	5/8
040 / 40,000	5/8	5/8	5/8
048 / 48,000	5/8	5/8	3/4
048D / 48,000	1/2	5/8	5/8
060 / 60,000	5/8	3/4	3/4
072D / 72,000	1/2	5/8	5/8

Model No./Total BTU/H Capacity	Receiver to Evaporator O.D. (inches)		
	50 ft or less	100 ft or less	150 ft or less
084D /84,000	5/8	5/8	3/4
120D / 120,000	5/8	3/4	3/4

Table 6. Recommended Suction Line Sizes For R407C Refrigerant

Model No./Total BTU/H Capacity	Line O.D. (inches)			
	50 ft or less		100 ft or less	
	H	V	H	V
012 / 12,000	3/4	3/4	3/4	3/4
018 / 18,000	3/4	3/4	3/4	3/4
024 / 24,000	3/4	3/4	7/8	7/8
032 / 32,000	7/8	7/8	7/8	3/4
040 / 40,000	7/8	7/8	1-1/8	1-1/8
048 / 48,000	1-1/8	1-1/8	1-1/8	1-1/8
048D / 48,000	3/4	3/4	7/8	7/8
060 / 60,000	1-1/8	1-1/8	1-1/8	1-1/8
072D / 72,000	7/8	7/8	7/8	3/4
084D /84,000	1-1/8	1-1/8	1-1/8	1-1/8
120D / 120,000	1-1/8	1-1/8	1-1/8	1-1/8

Table 7. Recommended Suction Line Sizes For R410A Refrigerant

Model No./Total BTU/H Capacity	Line O.D. (inches)			
	50 ft or less		100 ft or less	
	H	V	H	V
012 / 12,000	5/8	5/8	5/8	5/8
018 / 18,000	5/8	5/8	5/8	5/8
024 / 24,000	5/8	5/8	3/4	3/4
032 / 32,000	3/4	3/4	3/4	5/8
040 / 40,000	3/4	3/4	7/8	7/8
048 / 48,000	7/8	7/8	7/8	7/8
048D / 48,000	5/8	5/8	3/4	3/4
060 / 60,000	7/8	7/8	1-1/8	1-1/8
072D / 72,000	3/4	3/4	3/4	5/8
084D /84,000	7/8	7/8	7/8	7/8
120D / 120,000	7/8	7/8	1-1/8	1-1/8

Suction line sizes are for 50 °F through 30 °F suction temp at 48 through 26 psig.

CAUTION ⚠

Do not exceed the maximum line lengths for the system configurations listed below:

RCU with hot gas bypass	50 ft
Remote condensing unit	100 ft
Remote air cooled condenser	150 ft

Vertical runs are based on a total rise of 30 equivalent ft. For longer rises, individual calculations should be made. Sizes assume the use of single risers; double rises may be necessary.

2.6.1.3 Remote Air Cooled Condensers (AR Models)

Systems utilizing air cooled condensers must not have a refrigerant line pressure drop over 14 psig across the condenser and the interconnecting piping to the condenser sections.

NOTE

Ensure proper condenser selection to maintain reasonable sub-cooling temperatures.

If the condenser is installed above the evaporator, the discharge line should include a P-trap at the lowest point in the piping. The highest point in the discharge line should be above the condenser coil and should include an inverted trap to help prevent oil and liquid from flooding back to the compressor during off cycles.

If the condenser is installed below the evaporator, an inverted trap the height of the evaporator coil is required on the liquid line to help prevent oil and liquid from flooding back to the compressor during off cycles.

Refer to the refrigerant-appropriate Recommended Discharge Line Sizes table (Table 2 or Table 3), Recommended Liquid Line Sizes table (Table 4 or Table 5) and Recommended Suction Line Sizes table (Table 6 and Table 7).

2.6.1.4 Remote Air Cooled Condensing Units (AHU Models)

When installing a remote condensing unit above the evaporator, the suction line should be P-trapped at the evaporator.

When installing remote condensing units below the evaporator, the suction line should be trapped with an inverted trap the same height as the evaporator coil. This prevents migration of liquid refrigerant to the compressor during off cycles.

NOTE

Do not exceed 15 ft of vertical distance when installing the condensing unit below the evaporator.

All suction lines must be insulated to prevent condensation from forming on the pipes. Refer to the Recommended Suction Line and Recommended Liquid Line sizing tables.

2.6.2 Chilled Water, Water/Glycol and Hot Water Reheat Piping

The piping connections for water/glycol, chilled water and systems with hot water reheat are sweat connections. Pipe sizes may not necessarily be the same as the unit connection. Piping should be sized to match the required system pressure drop and pump capacity (if applicable) and may require reducing fittings to match the connection size on the air conditioner.

CAUTION

⚠

Fluid coils and associated piping circuits are pressurized and sealed when they leave the factory. When installing and filling water/glycol, chilled water and optional hot water reheat loops, all air must be bled from the piping system.

CAUTION

⚠

The piping system must be flushed prior to operating the system. Failure to do so will result in equipment problems.

The recommended ethylene glycol solution ratio is 40% glycol to 60% water. (STULZ recommends Dowtherm SR1 manufactured by Dow Chemical Co.) Glycol-cooled systems with a low entering fluid temperature and all chilled water systems should have insulated piping.

WARNING ⚠

Glycol is hazardous. Review the manufacturer's SDS before use.

A strainer should be included in the water/glycol, chilled water and optional hot water reheat line. Once the system is operational, the fluid runs through the strainer, which removes any foreign objects. The strainer screen should be cleaned periodically.

2.6.3 Condensate Drain Line

2.6.3.1 Gravity Drain

A 7/8 in. O.D. copper (sweat type) line is provided to drain the condensate drain pan. This line also drains the humidifier, if applicable. A "P" type condensate trap must be installed. The height of the trap must be at least 2 in. to exceed the total static pressure of the system and ensure proper water drainage from the drain pan. The drain line must be located so it will not be exposed to freezing temperatures. The drain line should be the full size of the connection. See the installation drawing provided with your unit for the size and location of the condensate drain line.

CAUTION ⚠

Do not use chloride-based water conditioning additives in the condensate drain pans. They cause corrosion on the coil fins.

CAUTION ⚠

Properly size and vent the P-trap according to applicable codes and best practices.

NOTE

During normal operation the optional humidifier drains hot water into the condensate drain line. As an option, a separate drain line may be provided for the humidifier.

2.6.3.2 Condensate Pump

A condensate pump (Figure 12) is used to automatically remove condensate from the air conditioner and flush water from the humidifier (if applicable). A P-trap is installed for proper condensate drainage. The height of the trap is a minimum of 2 in. on most standard systems to ensure proper water drainage of the drain pan. The condensate pump discharge line should be 1/2 in. I.D. (maximum) vinyl tubing or 1/2 in. O.D. (maximum) copper pipe to prevent excessive back flow to pump.

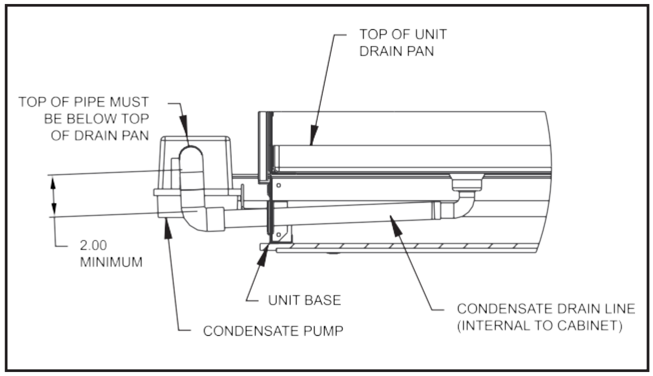

Figure 12. Condensate Pump

NOTE

Pour some water into the condensate drain(s) prior to start-up. This fills the trap and prevents air from being drawn up the drain lines.

2.6.4 Humidifier (Optional)

CeilAiR systems may include an optional electrode steam humidifier. The humidifier empties into the condensate drain pan during the flush/drain cycle. A water supply line must be connected to the humidifier copper tubing inlet connection supplied by the factory. Refer to the installation drawing provided with your unit for the size and location of the connection. The humidifier requires normal tap water as the water supply. If the supply water is high in particulates, an external filter may be needed.

CAUTION ⚠

Do not use demineralized water in the humidifier.

Refer to the humidifier operator's manual supplied with the OHS unit for complete manufacturer's information on the humidifier and for supply water recommendations.

2.7 Utility Connections

2.7.1 Main Power

CeilAiR units are available in single- or three-phase variations and a wide range of voltages. Examine the unit nameplate, located on the outside of the cabinet in close proximity of the electric box, to determine the operating voltage, frequency and phase of the system (see Figure 13). (Note that the unit serial and model numbers are also found on the nameplate.) Provided power must meet the listed specifications. The supply voltage measured at the unit must be within ±10% of the voltage specified on the system nameplate, with the exceptions noted below.

The nameplate also provides the full load amps (FLA) the unit will draw under full design load, the minimum circuit ampacity (MCA) for wire sizing, and the maximum fuse size (MAX FUSE) for circuit protection.

NOTE

If the nameplate states MAX FUSE/CKT BKR, fuses or an HACR type circuit breaker are required to protect the system. Other protection devices are not allowed based upon the product listing.

The unit is provided with terminals for all required field-wiring. It is important to identify the options that were purchased with the unit in order to confirm which field connections are required. Refer to the electrical drawing(s) supplied with the unit for information about power and control field-wiring.

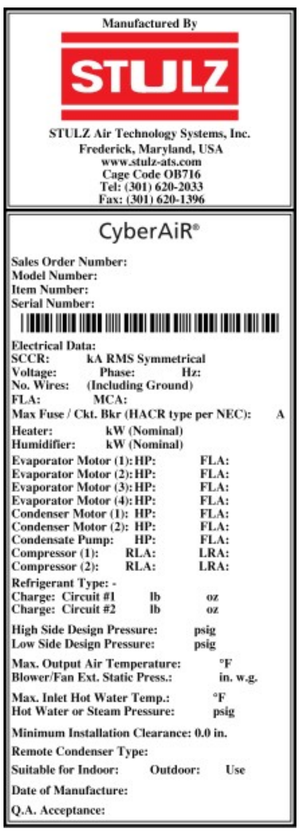

Figure 13. Sample Nameplate

WARNING

Verify power is turned off before making electrical connections to the equipment.

NOTE

All wiring must be provided in accordance with National Electrical Code and local code requirements. Use copper conductors only. Wiring terminations may become loose during transit of the equipment; verify all wiring terminations are secure.

A manual fused disconnect switch must be provided per the National Electrical Code and local codes for servicing the equipment. Do not mount a shipped-loose, non-fused service switch or customer supplied disconnect switch to the surface of the unit. If a factory installed, non-fused service switch option was purchased, the main power and ground connection is located at the switch; otherwise, the main power connection is located as stated below.

The unit is provided with pilot hole(s) in the main power and control panel for routing field-wiring. These pilot holes are located near the electric box and a label stating “MAIN POWER INPUT” is in close proximity. Terminate the main power wires at the line side of the main power distribution block located within the electric box. A separate equipment ground lug is provided inside the electric box for terminating an earth ground wire.

NOTE

Prior to operation, an adequate unit-to-Earth ground must be connected to the unit.

2.7.1.1 Single-Phase Units 208/230V

The supply voltage for units designed to operate at 208V must be within -5% and +10% tolerance. If the measured supply voltage is 230V, the unit can operate with a tolerance of ±5% if the following change is performed: The control transformers within the system must have the primary wire connected to its respective 240V tap instead of the 208V tap.

2.7.1.2 Single-Phase Units 277V

Single-phase units require that the hot leg of power be connected to terminal L1 and the neutral wire to terminal L2 of the main power distribution block.

2.7.1.3 Three-Phase Units

Three-phase units are designed to have the L1, L2 and L3 supply wires connected to corresponding L1, L2 and L3 line terminals of the main power distribution block. The unit will operate correctly if the supply wires are connected in this manner. A ground lug is provided in each unit near the distribution block.

CAUTION

Improper wire connections will result in reverse rotation ofthe blower motors and compressor (if applicable) and may eventually result in damage to the compressor. To correct this problem, exchange any two of the incoming main power wires at the main power distribution block. Do not rewire the unit's individual components.

2.7.2 Controls

STULZ offers a wide range of control systems to meet air conditioning control/alarm requirements. If the unit is equipped with an A-Tech controller, see the *Robertshaw 9701i/9725i2 User's Manual* shipped with the unit for programming instructions. Wiring contacts on the single- and dual-stage versions of the A-Tech controller are shown in Figure 14. If the unit is equipped with an E^2 controller, see the *STULZ E^2 Series Microprocessor Controller IOM* manual shipped with your unit. For utility connections refer to the appropriate manual above and the wiring diagram(s) provided with the unit.

The unit is provided with a pilot hole for a conduit connection for control wiring. The hole is located near the electric box in close proximity to the main power pilot hole. The sizing of the conduit must be per the National Electrical Code and local code requirements.

NOTE

Customer-provided wiring must be in accordance with the National Electrical Code and local code requirements for Class 2 circuits.

2.7.2.1 A-Tech 1.1 Programmable Thermostat

The thermostat requires four conductors wired to the control terminal board located within the unit electric box. The thermostat has a terminal strip with box type lugs for wire connections. See Figure 14 and refer to the electrical drawing for proper wire terminations.

2.7.2.2 A-Tech 1.2 Programmable Thermostat

The thermostat requires seven conductors wired to the control terminal board located within the unit electric box. The thermostat provides a terminal strip with box type lugs for wire connections. See Figure 14 and refer to the supplied electrical drawing for proper wire terminations.

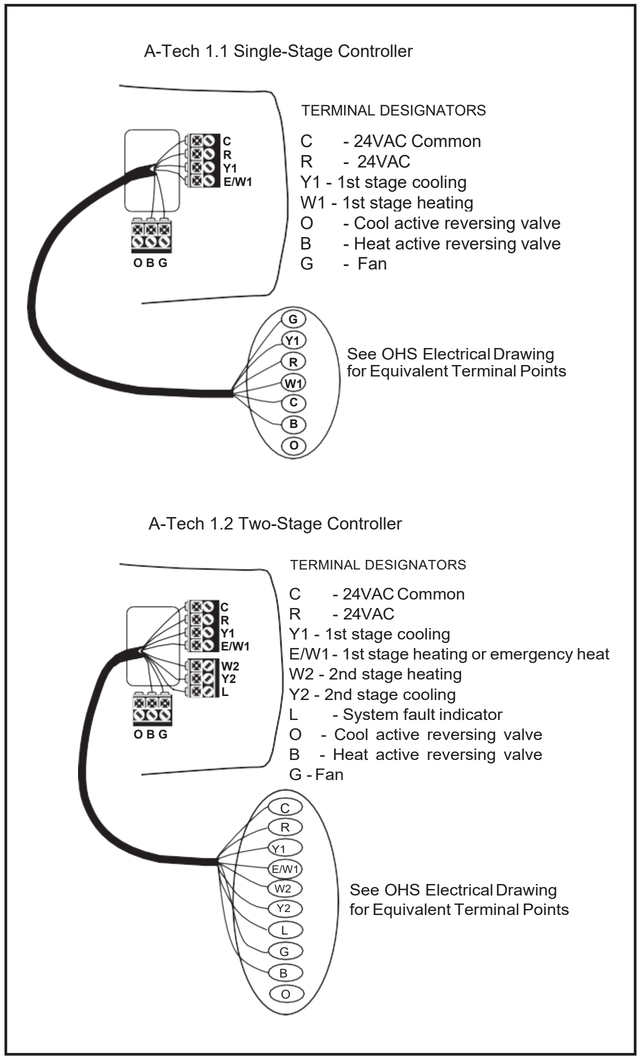

Figure 14. A-Tech 1.1 (top) and 1.2 (bottom) Controller Wiring Contacts

2.7.3 Air-Cooled Split Systems

The system interconnecting field wiring illustrations in Figure 17 through Figure 20 detail the number of conductors required for a typical system. Additional control conductors may be required depending on the options purchased with the equipment. Refer to the electrical drawing to determine the total number of interconnecting conductors required for your system. It is important to note that the control transformer(s) supplied with the equipment have been sized and selected based upon the expected loads for the system.

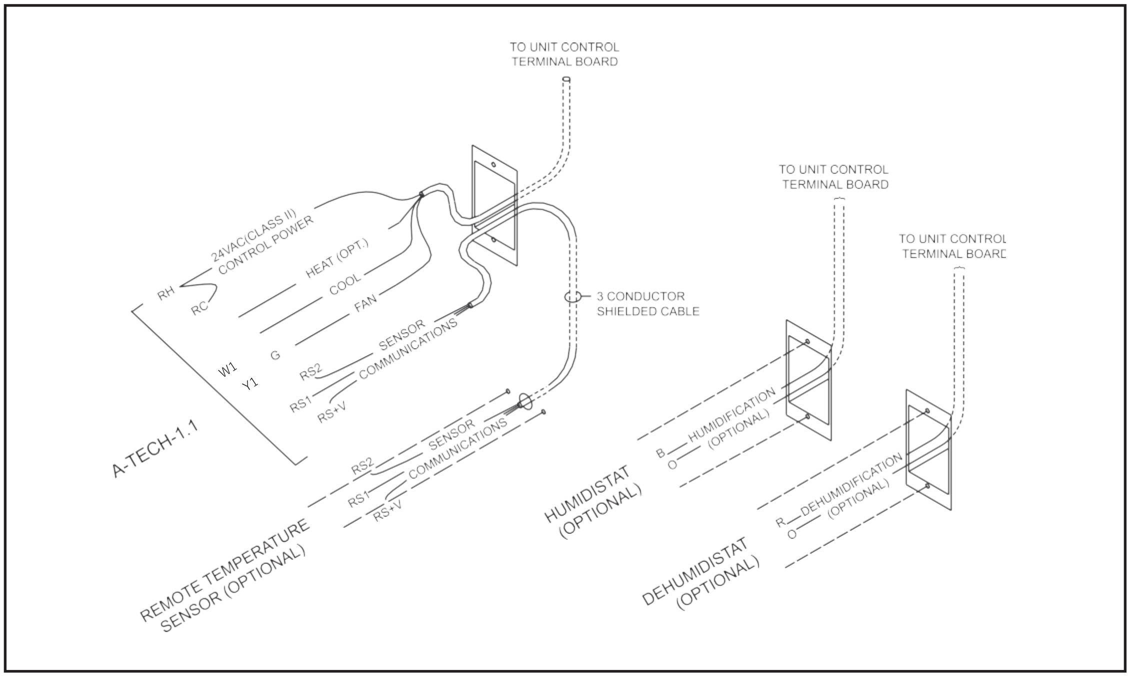

Figure 15. A-Tech 1.1 Control Wiring

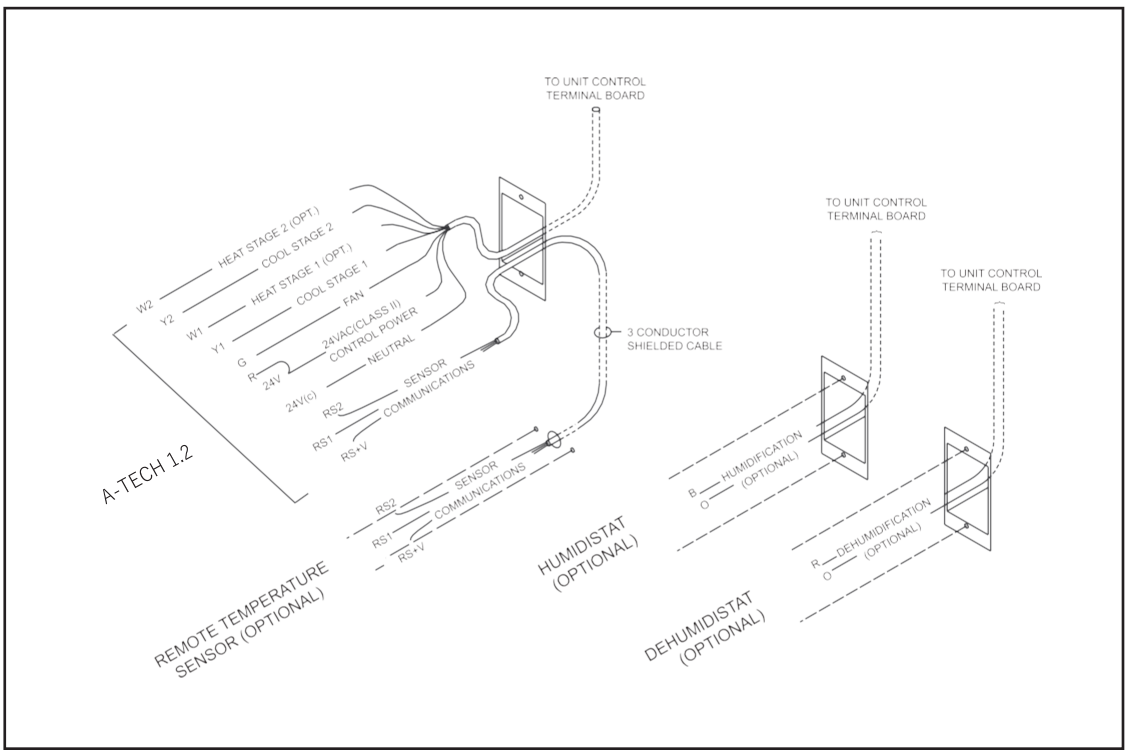

Figure 16. A-Tech 1.2 Control Wiring

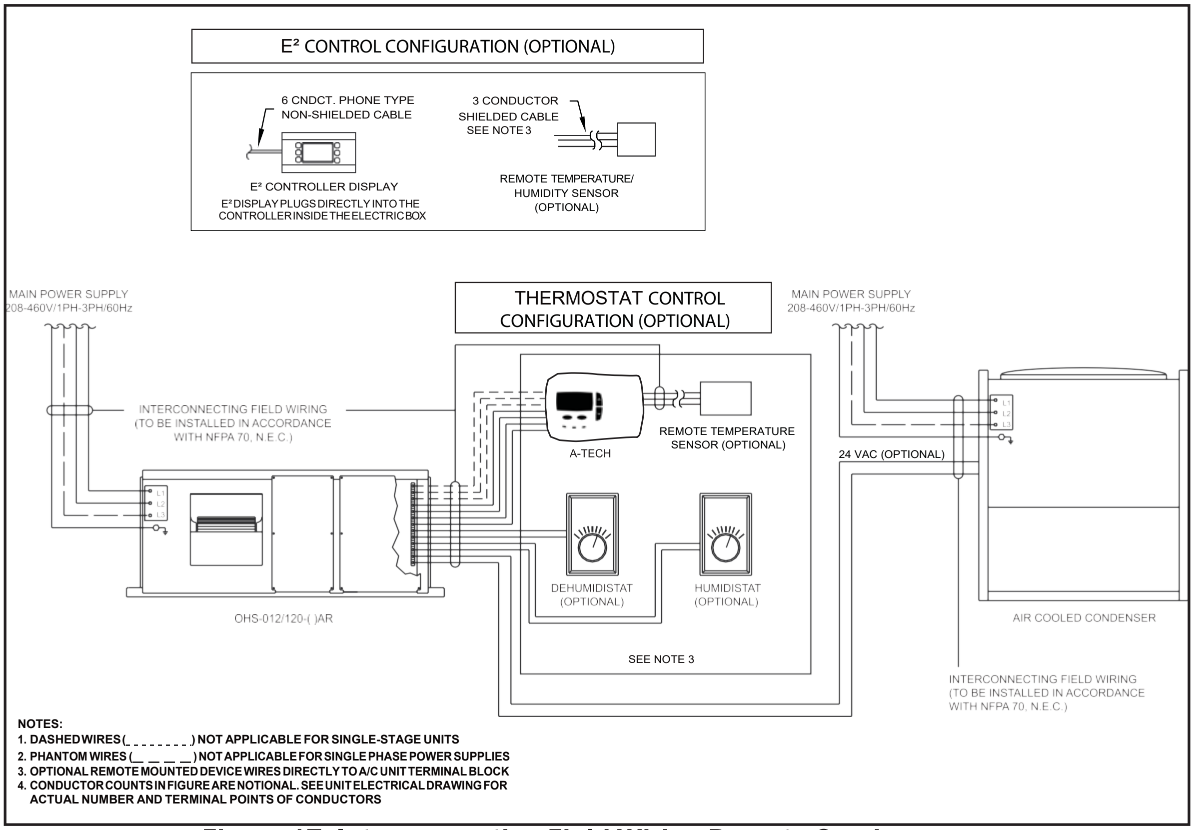

Figure 17. Interconnection Field Wiring Remote Condenser

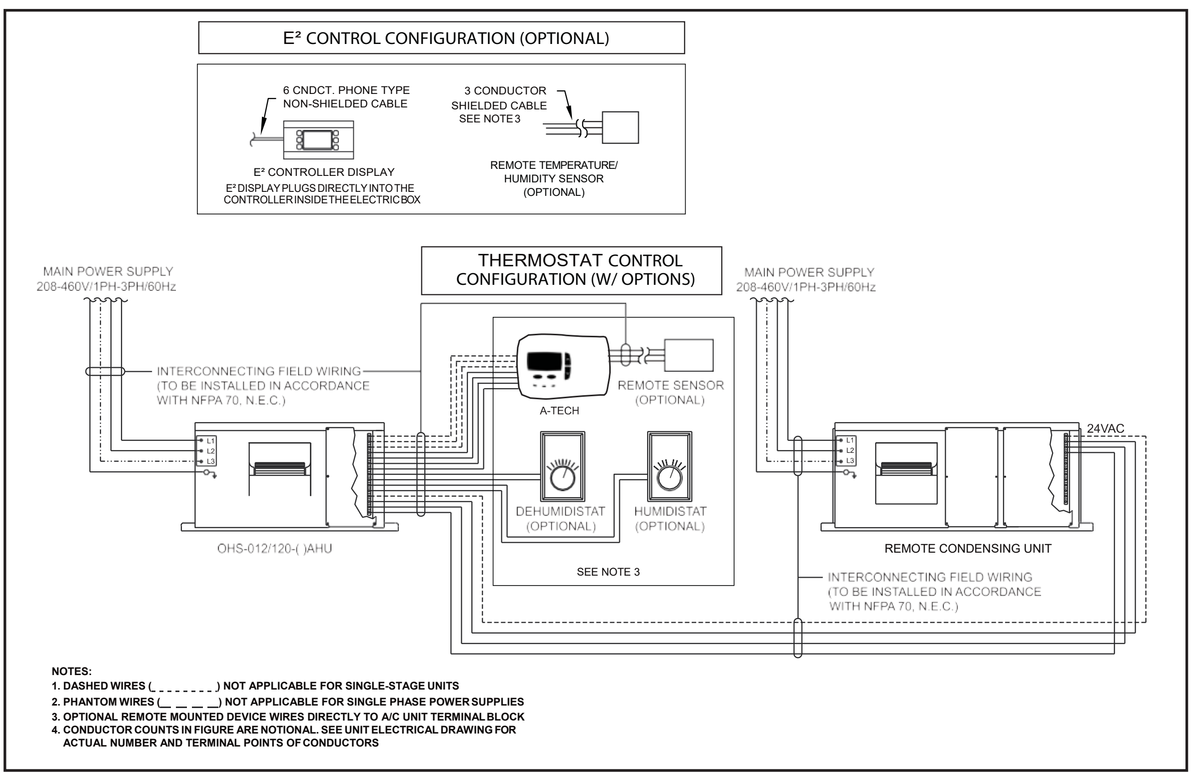

Figure 18. Interconnection Field Wiring Remote Condensing Unit

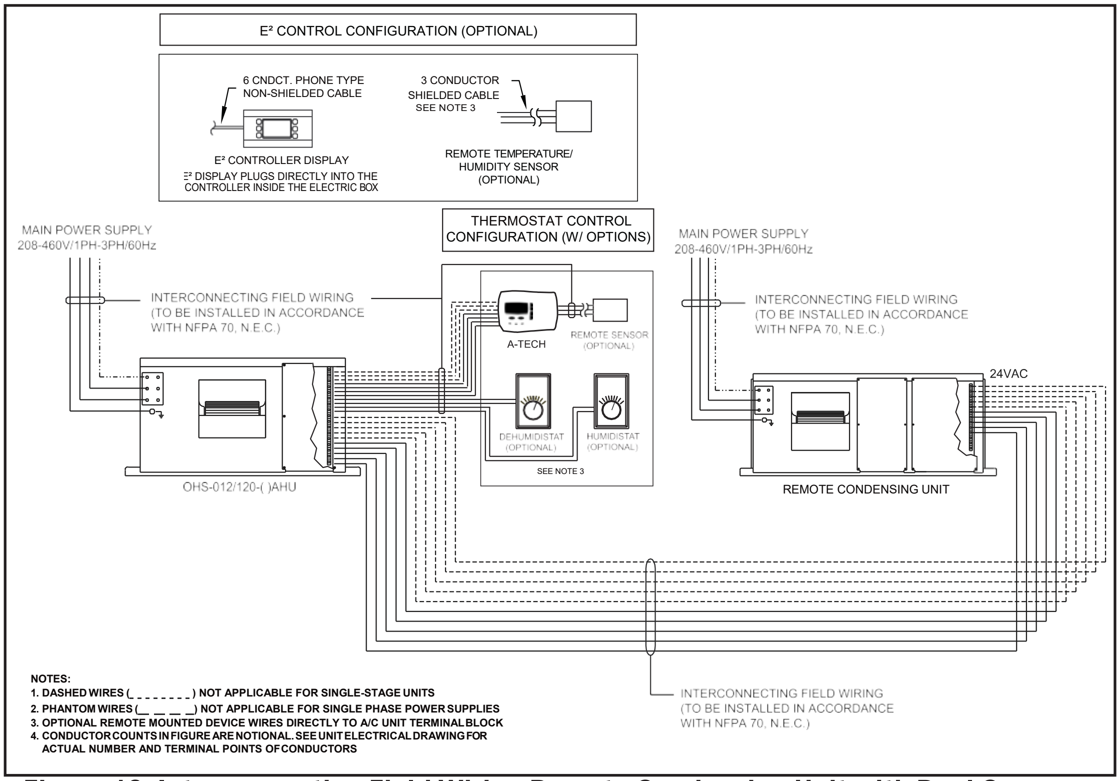

Figure 19. Interconnection Field Wiring Remote Condensing Unit with Dual Compressors

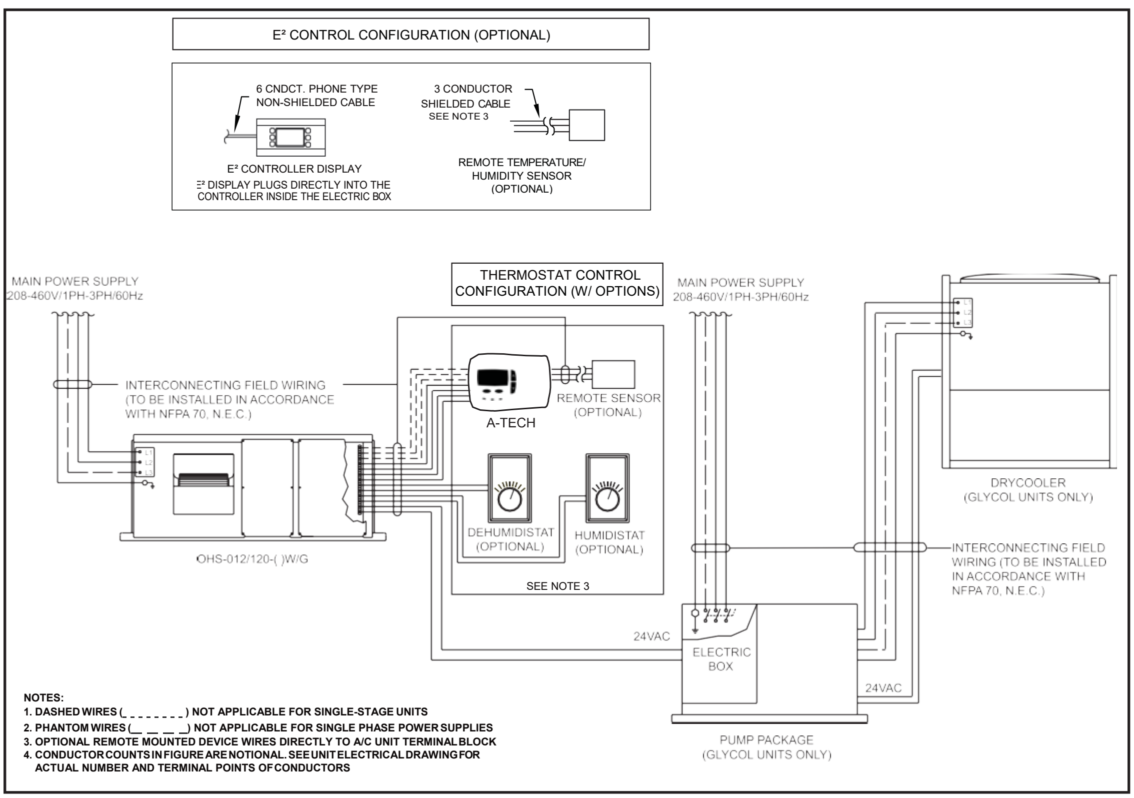

Figure 20. Interconnection Field Wiring Glycol Systems

CAUTION ⚠

Do not connect any additional loads to the system control transformers. Connecting additional load to a factory supplied control transformer may result in overloading the transformer.

2.7.3.1 Remote Condenser

For systems equipped with a remote condenser, the installer must provide main power wiring to the remote condenser control box. A separate equipment ground lug is provided within the control box for termination of the earth ground wire. Refer to the electrical drawing supplied with your system and the wiring diagram supplied with the condenser (typically located in the condenser electric box).

As an option, control wiring may be installed between the A/C system and the condenser for the system controller to enable condenser operation only when the compressor is running.

You must remove the jumper from the remote condenser terminal board (see the condenser wiring diagram). Wire 24 VAC control conductors from the terminal board within the A/C unit to the remote condenser terminal board. If control wires aren't installed (and the jumper remains in place), the condenser is always enabled and will turn on and off based on the condenser's pressure control settings.

2.7.3.2 Remote Condensing Unit

Systems equipped with a remote condensing unit require field wiring between the evaporator system and the remote condensing unit. The number of conductors required varies based upon the options provided. Refer to the electrical drawing(s) supplied with your unit to determine the exact number of field wires and proper wire terminations required specifically for your system.

Glycol-cooled systems equipped with a pump package require field wiring between the A/C unit and pump package. The installer must wire two control conductors from the terminal board within the A/C unit to the pump package electric box. Refer to the electrical drawing(s) supplied with your unit to determine the exact number of field wires and proper wire terminations required specifically for your system.

2.7.4 Water/Glycol Systems

Glycol-cooled systems equipped with a pump package require field wiring between the A/C unit and pump package. The installer must wire two control conductors from the terminal board within the A/C unit to the pump package electric box. Refer to the electrical drawing(s) supplied with your unit to determine the exact number of field wires and proper wire terminations required specifically for your system.

2.7.5 Remote Shut Down

The unit provides an interface that allows for remote shut down. A normally-closed switch rated at 5 amperes at 24VAC is required for this purpose. Two conductors from the normally closed switch must be connected to the control terminal board located within the unit electric box. Refer to the supplied electrical drawing for the appropriate wire terminations.

NOTE

All wiring must be provided in accordance with National Electrical Code and local code requirements for Class 2 circuits.

2.7.6 Optional Equipment

2.7.6.1 Condensate Pump

Systems supplied with a field installed condensate pump require power and control field wiring. The control wires from the terminal board in the electric box should be run through the overflow switch in the condensate pump housing.

After installing the condensate pump, connect two power conductors from the condensate pump main power terminals to the air conditioning unit and a ground wire to the unit ground stud located within the unit electric box. Two control conductors must be wired to the control terminal board located within the unit electric box. The condensate pump is provided with pigtail leads for splice-type wire connections with twist-on connectors (wire caps). Refer to the supplied electrical drawing for proper wire terminations.

2.7.6.2 Humidistat/Dehumidistat

The humidistat/dehumidistat are mounted in the same manner but are wired differently. The humidistat/dehumidistat both require two conductors for connection to the air conditioning system. The controls have pigtail leads for splice type wire connections with twist on connectors (wire caps). Refer to the supplied electrical schematic for proper wire terminations.

2.7.6.3 Remote Water Detector

There are two types of water detector available with OHS units: Spot type and strip/cable type.

Spot Type:

A remote spot type water detector requires three conductors to be wired to the control terminal board in the unit electric box. The wire insulation must be rated at 600V. The water detector has pig-tail leads for splice type wire connections with twist on connectors (wire caps). Refer to the supplied electrical drawing for proper wire terminations.

Strip/Cable Type:

A remote strip/cable type water detector is provided with a two conductor cable harness with a quick connect fitting on the end. The harness mates to the fitting on the water detector and connects it to the control board inside the electric box. Refer to the electrical drawing supplied with your unit for proper wire terminations.

CAUTION ⚠

Do not allow the cable water detector to contact metal (frame or condensate pan). It must be mounted on the plastic stand-offs provided with the water detector.

2.7.6.4 Remote Temperature Sensor (A-Tech)

The remote temperature sensor requires a three-conductor shielded cable with the shield terminated at the thermostat. Both the thermostat and the sensor are provided with a terminal strip with box type lugs for wire connections. Refer to the electrical drawing supplied for proper wire terminations.

2.7.6.5 Remote Temperature/Humidity Sensor (E^2)

The remote temperature/humidity sensor requires a shielded cable with the shield terminated at the unit electric box. The number of conductors needed depends on which system controller is used. Three control conductors are required for systems using an E^2 controller. Both the electric box and the sensor include a terminal strip with box type lugs for wire connections. Refer to the electrical drawing supplied with your unit for the number of conductors required and for the appropriate wire terminations.

NOTE

All wiring must be provided in accordance with National Electrical Code and local code requirements for Class 2 circuits.

2.8 System Charging Procedures

2.8.1 Water/Glycol Systems

All self-contained water/glycol cooled units (units that require no refrigerant field piping) are factory charged with refrigerant. No field refrigerant charging is required. The following precautions must be observed when installing and filling the water/glycol loop:

- The piping system must be cleaned prior to adding water/glycol to the system.
- Glycol must be mixed with water before it is added to the system. All air must be bled from the piping system. Use only water/glycol solution with inhibitors for corrosion protection.

1. Open the vent valve at highest point of the system.
2. Fill the system until the solution is discharging from the vent with minimal signs of foaming due to air in the system.

2.8.1.1 Pump

If a pump is used, ensure the system is filled before turning the pump on. If the pump is not self-priming, it is important that there is pressure at the suction inlet.

CAUTION ⚠

Do not run the pump when dry.

If the pump has no pressure on the discharge side, leave the discharge valve partially shut to create a back pressure in the pump so that liquid can build up in the impeller housing to keep the impeller housing from getting too hot. Make sure there is always liquid flowing through the pump to cool the impeller and housing. If there is no liquid leaving the pump, shut the pump off immediately to prevent damage to the pump. Check for proper rotation of the motor, observing the arrow on the side of the impeller.

2.8.2 DX Unit Charging Requirements

When performing the specific DX charging procedures in this section, follow these best practices:

- Ensure that contamination of different refrigerants does not occur when using charging equipment. Hoses or lines must be as short as possible to minimize the amount of refrigerant contained in them.
- Keep cylinders upright.
- Ensure the refrigeration system is grounded to Earth before charging the system with refrigerant.

- Label the system when charging is complete (if it is not labeled already).
- Exercise extreme care to avoid overfilling the refrigeration system.

Before recharging the system, it must be pressure tested with oxygen-free nitrogen (OFN). The system must be leak tested upon completion of charging but prior to commissioning. A follow-up leak test must be carried out prior to leaving the site.

2.8.3 Remote Air-Cooled Systems (AR/AHU)

Remote air-cooled units are provided with a dry nitrogen holding charge which must be removed before piping and charging the unit.

CAUTION ⚠

POE oil is used in systems with R407C or R410A refrigerant. POE oil quickly absorbs moisture when exposed to air. High POE oil moisture levels react with refrigerant to form acid which results in system contamination. Keep the entire system sealed as much as possible and minimize exposure of the POE oil to outside air.

NOTE

Refrigerant charging must be performed by a qualified air conditioning technician.

2.8.4 R407C/R410A Refrigerant

CeilAiR OHS systems use either R407C or R410A refrigerant. Refrigerant charging pressures vary depending on the type of refrigerant used in the unit. Before charging, check the unit nameplate to confirm the type of refrigerant to use. Tables are provided in Section 2.9 on page 30 showing the temperature/pressure characteristics for R407C and R410A.

CAUTION ⚠

R407C and R410A can contribute to the greenhouse effect if released. Avoid releasing the refrigerant into the atmosphere.

WARNING ⚠

R407C and R410A refrigerant released in an enclosed space can become a suffocant.

R407C and R410A are multi-component blends whose component parts have different volatilities that result in a change in composition and saturation temperature as evaporation and condensation occur. Typically, the composition of R407C vapor is different than that of R407C liquid within a contained system. The composition of liquid R407C refrigerant remains relatively constant, however, the refrigerant vapor tends to separate into its component parts even when circulating.

Refrigerant R410A is similar to R407C in that it is a blended refrigerant that consists of component parts, however, the component parts of R410A refrigerant have the same composition at various operating temperature/pressures in the liquid phase and gas phase, reducing the temperature glide effect experienced with R407C. R410A operates at higher pressures than R407C, which must be considered when checking the operating temperatures/pressures while charging or troubleshooting the system.

2.8.5 Estimating Refrigerant Charge

When charging a system with R407C or R410A refrigerant it will be necessary to weigh in the refrigerant and confirm by checking the superheat and sub-cooling temperatures (see Section 2.9.1 on page 30). Calculate the minimum amount of refrigerant needed by adding the amount of refrigerant required for the condenser (see the condenser manual provided separately) plus the refrigerant piping (Table 8) plus the refrigerant for the A/C unit (Table 9). The values in Table 9 are the estimated weights for the compressor circuit. In the case of dual compressor systems, the values are estimated weights for each compressor circuit. The values shown in Table 9 are conservative for the purpose of preventing the system from being overcharged.

Table 8. Weight (lb) of Refrigerant per 100 ft of Type L Tubing

Line Size (in.)		Liquid Line		Discharge Line	
O.D.	I.D.	R407C	R410A	R407C	R410A
3/8	0.315	3.42	3.04	0.70	0.80
1/2	0.43	6.37	5.66	1.30	1.50
5/8	0.545	10.24	9.09	2.10	2.41
7/8	0.785	21.24	18.86	4.35	4.99
1-1/8	1.025	36.21	32.15	7.41	8.51
1-3/8	1.265	55.15	48.97	11.29	12.96

Table 9. Weight (lb) of Refrigerant by OHS Model

OHS Model Number	Base Charge (Per Circuit)	Flooded HP Control Charge Adder
Approximate R407C Charge		
-012-AR	0.9	8.0
-018-AR	0.9	8.0
-024-AR	0.9	8.0
-032-AR	1.9	9.8
-040-AR	1.9	9.8
-048-AR	3.6	15.3
-048-DAR	1.0	9.8
-060-AR	3.6	15.3
-072-DAR	2.5	9.8
-084-DAR	2.5	9.8
-120-DAR	3.9	15.3
Approximate R410A Charge		
-012-AR	0.9	7.3
-018-AR	0.9	7.3
-024-AR	0.9	7.3
-032-AR	1.9	8.9
-040-AR	1.9	8.9
-048-AR	3.0	13.9
-048-DAR	0.7	8.9
-060-AR	3.0	13.9
-072-DAR	2.0	8.9
-084-DAR	2.0	8.9
-120-DAR	3.0	13.9

Example: Estimate the amount of refrigerant required in a system using R407C refrigerant consisting of a 5 ton (OHS-060-AR) A/C unit with Flooded Head Pressure Control connected with a 1/2 in. x 30 ft liquid line and 7/8" x 30 ft discharge line to a STULZ Model SCS-096-SAA condenser:

Condenser $= 3.6$ lb

+1/2" Liquid Line: $30.0 \times \frac{6.37}{100} = 1.911$ lb

+ 7/8" Discharge Line: $30.0 \times \frac{4.35}{100} = 1.305$ lb

+ A/C Unit: $(3.6 + 15.3) = 18.9$ lb

Estimated Refrigerant Charge = 25.715 lb

Round off to nearest lb = 26 lb

2.8.6 Preparing System For Charging

1. With all the system piping connections made, perform a dry nitrogen leak detection test on the system. Using dry nitrogen only, pressurize the system to 150 psig. Ensure all service and solenoid valves are energized open and that no part of the system is isolated from the pressurized nitrogen (liquid, suction or discharge lines and reheat coil).

2. Since there is no refrigerant in the system to detect at this point, leaks may be detected by observing if there's been a change in the standing pressure after 12 hours. A significant drop in pressure (>10 psig) indicates a leak in the system that needs to be repaired. After the system is determined to be free of leaks, you may evacuate the system.

2.8.6.1 Evacuate the System

CAUTION ⚠

A proper vacuum must be drawn on the refrigerant system to remove moisture prior to charging. If this is not done, the refrigerant charge will combine with moisture in the pipes to form an acid that will eventually lead to compressor failure. A triple evacuation procedure with dry nitrogen is recommended, especially for systems with newly installed refrigerant piping.

NOTE

A vacuum pump should be used that is capable of evacuating the entire volume of the A/C system, including newly installed or existing piping. It is essential to use a well maintained pump that is in good operating condition. Always ensure it contains clean, fresh oil. You may need to change vacuum pump oil more than once during the procedure.

NOTE

Use high quality hoses, ensuring they are free of defects and don't leak. It is recommended to use copper tubing instead of hoses if possible due to the low vacuum that must be attained when evacuating the system. The use of short, large diameter hoses helps reduce evacuation time.

3. After ensuring there are no leaks, relieve pressure and evacuate the entire system while maintaining all the solenoids (and hot gas reheat valve) open. Pull an initial vacuum of 1500 microns or lower using the suction

and discharge service ports and the service port of the receiver (if applicable).

NOTE

When pulling a vacuum, the Schrader valves will unnecessarily restrict the openings, increasing the evacuation time. During the evacuation process it is recommended to remove the Schrader valve cores with a Schrader valve removal tool and draw the vacuum through the port on the removal tool.

4. If you cannot evacuate the system below 1500 microns, close the vacuum pump isolation valve and perform a rate-of-rise test by observing the standing pressure over time. If the pressure rises slowly (up to 200 microns in 15 minutes), moisture is in the system that still needs to be boiled off. Proceed to step #5. If the pressure rises rapidly up to atmospheric pressure (more than 50 microns per minute), there is a leak that wasn't detected during step #2. In this case trouble-shoot the entire system for leaks and repair them. Then begin the initial evacuation process again starting at step #1.

5. If no leaks are detected after the initial vacuum, release the vacuum and pressurize the system with 2-3 lb of dry nitrogen. Allow the system to stand for two hours with the dry nitrogen charge. This gives time for the nitrogen molecules to disperse in the system absorbing moisture.

6. After two hours, release the pressure. Then turn on the vacuum pump and evacuate the system a second time down to 1500 microns or less. Close the vacuum pump isolation valve and pressurize the system again with dry nitrogen and allow the system to stand for two hours as in step #5.

7. After two hours release the pressure. Turn on the vacuum pump and complete the process of evacuating the system, this time with a goal of achieving a 500 micron vacuum or less. Close the vacuum pump isolation valve. When you can hold the vacuum at 500 microns or lower for at least 2 hours with no significant rise in pressure, the system is ready to charge.

8. Replace the Schrader valve cores if you removed them during the evacuation steps. You may now introduce the refrigerant charge through the Schrader valves.

2.8.7 Refrigerant Charging Procedures

R407C and R410A refrigerant must be weighed in when performing the charge. Referring to Section 2.8.5 on page 26, calculate the minimum amount of refrigerant needed for your system.

When charging a system with a blended refrigerant, maintaining the composition of the refrigerant is essential. To ensure correct composition, introduce the refrigerant (R407C or R410A) into the system in liquid form rather than vapor form. Cylinders which are not provided with dip tubes should be inverted to allow only liquid refrigerant to charge the system. Keeping the temperature of the cylinder below 85 °F will help maintain the correct refrigerant composition while the cylinder is emptied.

WARNING

If refrigerant gas is released in an enclosed area, it may accumulate in low areas and near the floor, displacing available oxygen. If a major leak occurs, there is a risk of asphyxiation. In such case, immediately evacuate personnel and ventilate the area. Personnel should remain away from the area until it is determined safe.

2.8.7.1 Initial System Charge

Follow the step-by-step instructions below to charge systems using R407C and R410A refrigerant. The initial charge will be performed by introducing liquid refrigerant (R407C or R410A) to the discharge side of the compressor or an available liquid line port with the A/C unit turned Off.

1. Break the vacuum by supplying liquid refrigerant (R407C or R410A) to the discharge port near the compressor until the pressure is equalized. This holding charge allows the low pressure switch to "hold," enabling the compressor to operate throughout the process of charging the system.

2.8.7.2 Fine Tuning The System Charge

Once the initial charge is completed, additional refrigerant will need to be added with the unit running.

CAUTION

An adequate heat load must be supplied to ensure a proper charge.

2. Disconnect the refrigerant cylinder from the discharge side of the compressor and connect it to the suction side.

3. Start the A/C system and use the system controller to lower the room temperature setpoint 3-5 °F below ac-

tual room temperature, thus ensuring cooling remains on as the unit is charged.

When fine tuning the charge on cool days it will be necessary to restrict the airflow across the condenser coil to raise the pressure. The fan closest to the header must be running. Refrigerant R407C operates at a lower pressure than R410A. When fine tuning the charge, ensure the pressures are correct for the type of refrigerant used. Refer to the tables in Section 2.9 for the operating temperatures and pressures for the type of refrigerant used in your system.

2.8.7.3 0 °F Fan Cycling and -20 °F Variable Speed Control

The following instructions are for charging systems with condenser fan cycling or variable fan speed control using R407C or R410A refrigerant.

1. Partially block the airflow to the condenser with cardboard to raise the discharge pressure. Allow the discharge pressure to rise high enough to start the first fan only, then maintain a constant pressure. This will lower the possibility of overcharging.
   a. R407C Refrigerant- Allow the discharge pressure to rise to 260-315 psig and hold it constant.
   b. R410A Refrigerant- Allow the discharge pressure to rise to 445-480 psig and hold it constant.
2. Slowly meter liquid refrigerant through the suction side while watching the pressure gauges and monitoring superheat and sub-cooling temperatures.

CAUTION ⚠

Add liquid refrigerant slowly to prevent the refrigerant oil from “washing out” of the compressor.

3. Take a superheat temperature reading near the feeler bulb from the thermal expansion valve with the temperature measuring device being well insulated. The ideal amount of superheat is 12–15 °F. Maximum allowable amount of superheat is 20 °F.
4. While monitoring the pressure, take a sub-cooling temperature reading on the output side of the condenser. The amount of sub-cooling should be 10–20 °F.
5. If necessary, (slowly) add liquid refrigerant to the suction side to achieve the sub-cooling temperature.
6. If the unit has hot gas reheat (optional), the previous steps are still followed except the hot gas reheat valve must be open to allow refrigerant to flow into the reheat coil to obtain the proper amount of refrigerant charge. This can be done using the system controller to enable a call for dehumidification (lower the humidity setpoint). This process may need to be repeated several times. After cycling the system through the hot gas reheat cycle, recheck the system charge with the system only in the cooling mode.

CAUTION

⚠

Remove the blockage to the air intake of the condenser.

7. Fill out the applicable sections of Warranty Registration and Start-Up Checklist.

2.8.7.4 -30 °F Flooded Head Pressure Control

NOTE

For units using flooded head pressure control, a receiver is used to store the refrigerant during the time the condenser is not utilizing the extra refrigerant charge.

NOTE

It is important not to exceed 80% of the total condenser and receiver volume to allow room for expansion.

1. Fine tune the charge following steps 1–6 in Section 2.8.7.3.
2. The head pressure control valve setting is printed on the side of the valve body. This setting is the lowest head pressure that will be maintained during system operation. It may be necessary to add additional refrigerant to raise the head pressure to the value printed on the valve (225 psig for R407C; 290 psig for R410A).
3. If a refrigerant level sight glass is included on the side of the receiver, it may be used to assist in charging the air conditioning system. The proper charge can be confirmed by viewing the level of refrigerant in the receiver(s) while the unit is running at an elevated discharge pressure.
4. Add additional refrigerant charge until the refrigerant level in the receiver rises to the center of the sight glass, indicating the receiver is 80% filled.
5. When the refrigerant in the receiver reaches the center of the sight glass, the unit is fully charged.

CAUTION ⚠

Remove the blockage to the air intake of the condenser.

6. Fill out the applicable sections of Warranty Registration and Start-Up Checklist.

2.9 Refrigerant Characteristics

2.9.1 Pressure/Temperature Settings

The following table is provided to assist with the normal settings of the system for R407C and R410A refrigerant. Where applicable, minimum and maximum settings are given along with normal operating pressures.

NOTE

The operating pressures for R410A refrigerant are significantly higher than R407C.

Table 10. Refrigerant Pressure/Temperature Settings

Refrigerant Pressure/Temperature Settings			
	Normal	**Min.**	**Max.**
Sub-cooling °F	10	5	20
Superheat °F	15	10	20
Design Condensing Temp. @ 95 °F Ambient	125	105	140
Suction Pressure (psig)- R407C	70	55	85
Suction Pressure (psig)- R410A	130	105	155
Fan Cycling Control- Fan On (psig)- R407C	320	240	340
Fan Cycling Control- Fan On (psig)- R410A	440	330	480
Fan Speed Control (psig)- R407C	320	-	-
Fan Speed Control (psig)- R410A	440	-	-
Flooded HP Control Valve (psig)- R407C	205		
Flooded HP Control Valve (psig)- R410A	295		

2.9.2 Saturated Refrigerant Pressure Tables

The Table 11 refrigerant pressures are provided for reference for R407C and R410A refrigerant.

Table 11. Saturated Refrigerant Pressure

R410A Refrigerant	
Temp. (°F)	**Pressure (psig)**
Saturated Evaporating Temperature	
20	78.4
22	81.9
24	85.5
26	89.2
28	93.1
30	97.0
32	101
34	105
36	109
38	114
40	118
42	123
44	128
46	133
48	137
50	143
55	155
60	170
65	185
70	201
75	218
80	236
85	255
90	274
95	295
100	318
105	341
110	365
115	391
120	418
125	446
130	477
135	508
140	541

R407C Refrigerant		
Temp. (°F)	**Pressure (psig)**	
Saturated Evaporating Temperature		
20	37.9	
22	40.1	
24	42.3	
26	44.7	
28	47.1	
30	49.6	
32	52.1	
34	54.8	**Dew Point**
36	57.5	(Saturated Vapor)
38	60.3	
40	63.2	
42	66.1	
44	69.2	
46	72.3	
48	75.5	
50	78.8	
Saturated Condensing Temperature		
95	209	
100	225	
105	242	
110	260	
115	279	**Bubble Point**
120	298	(Saturated Vapor)
125	319	
130	341	
135	363	
140	387	

2.10 System Settings and Adjustments

2.10.1 Low/High Pressure Limit Switch

Air conditioning systems using DX refrigerant are equipped with hermetically sealed high-pressure and low-pressure switches. These switches are pre-set by the manufacturer and cannot be adjusted.

R407C Pressure Switch Settings:

High-pressure switch: opens at 410 psig and has a manual reset.
Low-pressure switch: opens at 10 psig (± 4) and closes at 32 psig (± 5) and has an automatic reset.

R410A Pressure Switch Settings:

High-pressure switch: opens at 630 psig and has a manual reset.
Low-pressure switch opens at 10 psig (± 10) and closes at 32 psig (± 10) and has an automatic reset.

2.10.2 Head Pressure Controls—Air Cooled Sys- tems

2.10.2.1 Condenser Fan Cycling (Condenser Model SCS-AA, 0 °F)

Used for outdoor installations where ambient condenser air inlet temperatures are 0 °F or higher, this method utilizes a high-pressure differential control switch with SPST (Single Pole, Single Throw) contacts and an automatic reset. The switch activates the condenser fan contactor when the discharge pressure reaches a predetermined value to maintain the condensing temperature.

See the Head Pressure Controls section of the *STULZ SCS Series Remote Air Cooled Condensers IOM* for information about the fan cycling pressure control settings (cut-in and cut-out pressures) for the supported refrigerants. Note that the pressure values vary according to both the refrigerant type and the number of fans in the SCS unit.

2.10.2.2 Condenser Multi-Speed Fan Switch (Model HES-CAA , 0 °F)

Used for indoor installations where ambient condenser air inlet temperatures are 0 °F or higher, the condenser fan speed switch senses refrigerant discharge pressure and changes the condenser fan speed to maintain proper condenser pressures.

The condenser fan speed switch changes the fan from low to high speed when pressure rises and returns the fan from high speed to low speed when the pressure lowers.

R407C Refrigerant:

Factory setting: On pressure rise, the high fan speed contacts close at 320 psig, increasing the condenser fan speed. A pressure drop to 250 psig will close the low fan speed contacts, reducing the fan speed. The setpoint range is 170 to 400 psig. The differential is nonadjustable and set at 70 psi.

R410A Refrigerant:

Factory setting: On pressure rise, the high fan speed contacts close at 440 psig, increasing the condenser fan speed. A pressure drop to 330 psig will close the low fan speed contacts, reducing the fan speed. The setpoint range is 275 to 620 psig. The differential is nonadjustable and set at 110 psi.

NOTE

This switch and settings do not apply to units designed for a power supply greater than 277V.

2.10.2.3 Variable Condenser Fan Speed (Condenser Model SCS-SA, -20 °F)

Used for outdoor installations where ambient temperatures may fall to -20 °F, a variable speed condenser fan motor control is used to maintain head pressure. The variable speed motor is located closest to the header end of the condenser. The fan speed control is a continual modulation of the motor's speed. The controller is factory installed in the outdoor condenser/condensing unit. The fan speed controller requires no adjustment.

The fan speed controller will automatically control the head pressure at a level to maintain design refrigerant discharge pressures. On systems with more than one fan on the condenser, the remaining motors cycle on and off based on pressure.

2.10.2.4 Intelligent Control (Condenser Model SCS-EC Only, -20 °F)

Used for outdoor installations where ambient condenser air inlet temperatures may fall to -20 °F, intelligent pressure control is designed to maintain discharge pressure by constantly modulating condenser fan speed. SCS outdoor condensers are equipped with highly efficient, electronically commutated (EC), axial fan(s). The EC fan speed is infinitely variable up to full speed. The control system uses refrigerant pressure transducer(s) to monitor refrigerant discharge pressure and control the EC fan(s) to the precise speed needed to maintain design refrigerant discharge pressures.

2.10.2.5 Flooded Head Pressure Control (Condenser Model SCS-AA With Fan Cycling, -30 °F)

Used for outdoor installations where ambient condenser air inlet temperatures may fall to -30 °F, flooded head pressure control is designed to maintain head pressure during low ambient conditions. A head pressure control valve and a receiver are used in the refrigeration circuit to back up liquid refrigerant into the condenser coil. The head pressure control valve is a 3-way modulating valve controlled by discharge pressure.

When the A/C unit begins to operate, the discharge pressure rises (to approximately 320 psig for R407C; 440 psig for R410A) and the condenser fan is cycled on, as described in Section 2.10.2.1. When ambient temperature drops, the discharge pressure drops also. When the discharge pressure drops, the head pressure control valve diverts discharge gas away from the condenser to the receiver. Liquid flow from the condenser is restricted, causing liquid to back up in the condenser.

Flooding the condenser reduces the area available for heat transfer. The desired result is to increase the pressure into the condenser, maintaining a minimum discharge pressure during low ambient operation, thus ensuring proper condensing temperature. The head pressure control valve requires no adjustment.

While the fan is running, the flooded head pressure control valve modulates the amount of discharge gas entering the receiver. As the pressure increases, the valve diverts more discharge gas to the condenser, allowing more liquid to flow from the condenser to the receiver.

When using this method of head pressure regulation there must be enough refrigerant in the system to ensure adequate charge at the lowest expected ambient temperature in which the system will be operating. A receiver is used to store the extra refrigerant when the condenser is not using it.

NOTE

Systems utilizing air cooled condensers must not have a refrigerant line pressure drop greater than 14 psig across the condenser and the interconnecting piping to the condenser sections.

2.10.2.6 Flooded Head Pressure Control (Condenser Model HES-CAA , -30 °F)

Used for indoor installations where ambient condenser air inlet temperatures may fall to -30 °F. First, familiarize yourself with Flooded Head Pressure Control as discussed in Section 2.10.2.5. Instead of cycling the fan on and off, the condenser fan speed is continuous. The head pressure control valve diverts discharge gas to the receiver causing liquid to back up in the condenser, as described in Section 2.10.2.5, while the fan continues to run.

2.10.3 Head Pressure Controls—Water / Glycol Cooled Systems

In a water/glycol-cooled condenser, condensing temperature is maintained by the liquid flowing through a regulating valve and then into a liquid-cooled condenser. The regulating valve opens to increase the liquid flow as the refrigerant pressure rises and closes as the refrigerant pressure falls. The regulating valve is factory set for the correct condensing temperature; however, it can be adjusted to increase or decrease the condensing temperature.

Head pressure regulating valves are available in 2-way or 3-way configurations. Refer to the piping diagram to determine which type of valve is provided. The location and size of regulating valves varies with the size and model of the A/C unit. Methods for adjusting the valves for condensing pressure differ with the valve types, which can be differentiated by the maximum water pressure rating of the valve (150, 350, or 450 psig).

2.10.3.1 150 psig Pressure Valves

Adjustment is made by turning the slotted square stem on top of the valve clockwise to increase the condensing temperature or decrease water/glycol flow and counterclockwise to decrease the condensing temperature or increase the water/glycol flow. A directional arrow is stamped on the metal housing of the valve stem.

2.10.3.2 350 psig and 450 psig High Pressure Valves

Adjustment is made by turning the round-holed knob counterclockwise inside the valve's metal housing to increase condensing pressure or decrease water/glycol flow and clockwise to decrease the condensing temperature or increase the water/glycol flow. A directional arrow is stamped on the metal housing of the valve stem.

2.10.4 Humidifier Adjustment

The humidifier has a capacity adjustment potentiometer on the humidifier control circuit board. The capacity potentiometer may need to be field adjusted if the humidifier does not supply enough capacity for the current room conditions.

It is recommended that if the capacity potentiometer requires adjustment, the adjustment is made and verified in small increments. Refer to the humidifier manual sent with your unit for the location of the capacity potentiometer.

CAUTION ⚠

Adjusting the capacity potentiometer too high may result in condensation within the system.

2.10.5 Blower Adjustment

2.10.5.1 Belt Drive Blower

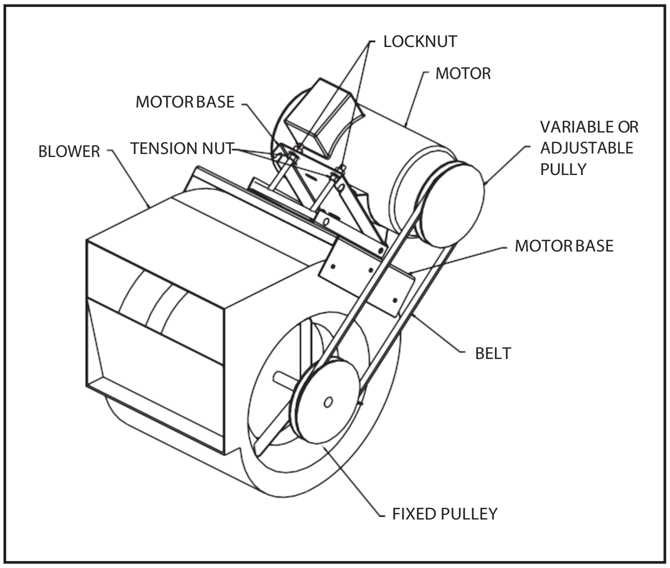

Figure 21. Belt Drive Blower

Systems with belt drive blowers (see Figure 21) are supplied with adjustable sheaves to change the blower speed and adjustable motor bases for belt tensioning. Perform the following procedure to change the blower speed.

1. Turn the system off.
2. Turn off all power to the unit at the non-fused service switch; use a lock-out/tag-out procedure.
3. Remove the blower belt(s).
4. Loosen the set screw in the side of the sheave with an Allen wrench.
5. Remove the sheave key.
6. Adjust the blower speed by closing the sheave one half turn to increase speed or opening the sheave one half turn to decrease speed.
7. Replace the sheave key and tighten the set screw.
8. Proper belt tension is achieved when the belt has a deflection of 1/2 in. per foot of span between the blower and motor pulleys when a firm pressure is placed on the side of the blower belt. Adjust the blower belt tension by raising (to tighten) or lowering (to loosen) the nuts on the adjustment rods of the motor base.

CAUTION ⚠

If the belt tension is too tight, it will cause premature blower and/or motor bearing failure. If the belt is too loose, the belt will slip and cause belt squeals and eventual belt failure.

9. Restore power to the system.
10. Check the current draw on the blower motor to make sure it does not exceed the nameplate rating of the motor.
11. If current draw exceeds the nameplate rating of the motor, repeat steps 1 through 9 to decrease blower speed. If the motor pulls too much current, slow the blower down by opening the adjustable sheave one half turn at a time until the motor current is at or below the nameplate FLA.
12. Check the motor overload on the blower starter to confirm its setting is correct for the FLA of the motor.

2.10.5.2 EC Fan (Optional)

The speed of the EC fan is controlled via a 0 to 10 VDC signal from the system controller. The controller is set by the factory and should not require adjustment. If it is determined that the air flow needs adjustment, this may be done using the controller's programming menu selections. Refer to the operator's manual provided under separate cover for the system controller.

2.10.6 Thermal Expansion Valve

CeilAiR units using DX refrigerant have a thermal expansion valve (TEV). The TEV maintains constant superheat of the refrigerant vapor at the inlet of the evaporator by metering the flow of refrigerant into the evaporator. Superheat is the difference between the refrigerant vapor temperature and its saturation temperature at a given suction pressure. By controlling superheat, the TEV keeps nearly the entire evaporator surface active while preventing liquid refrigerant from returning to the compressor. As a standard, superheat is factory set at 12–15 °F and should not need adjustment.

2.10.7 Hot Gas Reheat (Optional)

The hot gas reheat feature incorporates a hot gas reheat solenoid valve and a hot gas reheat coil. Under normal operation when no reheat is required, the hot gas reheat valve is de-energized and hot gas flows directly from the compressor discharge to the condenser. When there is a call for reheat, the controller energizes the hot gas reheat solenoid valve. The hot gas reheat solenoid valve diverts hot gas to the reheat coil, mounted directly downstream of the evaporator coil, before it travels to the condenser. No adjustment to the valve is necessary.

2.10.8 Hot Gas Bypass (Optional)

The two most common systems provided by STULZ for hot gas bypass are snap acting and full floating, described below.

2.10.8.1 Snap Acting Hot Gas Bypass

The snap acting hot gas bypass system provides for some modulated capacity control and freeze protection. The hot gas bypass system includes a discharge bypass valve that allows some hot gas from the compressor discharge line to pass into the evaporator coil to maintain a preset suction pressure. The compressor cycles on demand from the controller.

The snap acting hot gas bypass system also provides freeze protection for the evaporator coil by limiting the minimum refrigerant pressure, preventing the surface temperature of the evaporator coil from dropping below 32 °F.

The normal control setting for suction pressure is 75 psig (R407C) and 121 psig (R410A) read from the suction (low) side of the compressor as it operates in full hot gas bypass operation. The valve is factory set and no adjustment should be necessary. If adjustment is required, block one half of the coil and remove the adjustment cap from the end of the valve. Using a 5/16 in. Allen wrench, turn clockwise to increase pressure or counterclockwise to lower the pressure.

2.10.8.2 Full Floating Hot Gas Bypass

A full floating hot gas bypass system is provided for capacity control and freeze protection. The hot gas bypass system may include a quench solenoid valve, a quench solenoid coil, a quench expansion thermal valve, a hot gas (discharge) solenoid valve, a hot gas (discharge) solenoid coil, and a hot gas bypass valve. To ensure a constant running compressor, the hot gas and quench solenoid valves open and the liquid line solenoid valve cycles on the demand of the controller.

The hot gas bypass valve allows refrigerant to flow from the discharge line directly to the suction line. Hot gas entering the suction side of the compressor would raise the operating temperature of the compressor to a point where failure could occur. To prevent this, a small amount of liquid refrigerant passes through the quench valve and mixes with the hot gas entering the compressor, maintaining normal compressor suction pressure and temperature.

The full floating hot gas bypass system provides freeze protection for the evaporator coil by limiting the minimum refrigerant pressure, preventing the surface temperature of the evaporator coil from dropping below 32 °F. The hot gas (discharge) regulating valve has a normal suction pressure control setting at 75 psig (R407C) and 121 psig (R410A) read from the suction (low) side of the compressor as it operates in full hot gas bypass mode. The valve is factory set and no adjustment should be necessary. If adjustment is required, remove the adjustment cap from end of the valve. Using a 5/16 in. Allen wrench, turn clockwise to increase pressure or counterclockwise to lower the pressure.

CAUTION

Do not exceed 20 °F superheat. Exceeding this temperature may cause failure of the compressor.

The normal control setting for the quench valve is 20 °F superheat (when there is no call for cooling). The valve is factory set and no adjustment should be necessary. If adjustment is required, remove adjustment cap from the valve. Turn the adjusting stem clockwise to increase superheat and counterclockwise to decrease the superheat.

3.0 COMMISSIONING, OPERATION AND DECOMMISSIONING

3.1 Commissioning the Unit

For new installations, ensure the unit is ready to operate by going through the Checklist for Completed Installation provided with the unit, prior to start-up.

NOTE

A Warranty Registration and Start-Up Checklist is provided in the unit data package. It should be completed during start-up and sent to STULZ. This checklist should be used as a guideline for items that need to be confirmed during start-up.

Start-up must be performed by a journeyman refrigeration mechanic or air conditioning technician.

3.1.1 Commissioning Steps

CAUTION ⚠

For air-cooled outdoor remote condensing units (RCU), apply power to the RCU eight hours before operating the system. This time is required to allow liquid refrigerant to be driven out of the compressor. The compressor crank case heater is energized as long as power is applied to the unit.

1. Replace all equipment, access panels and ceiling panels that were removed prior to performing start-up checks.

2. Apply power to start the CeilAiR OHS system at the service disconnect switch, then turn the A/C system on at the controller.

3. Ensure that all blowers/fans are rotating correctly and freely without any unusual noise. Water/Glycol-cooled units have a head pressure water regulating valve that has been factory set. A valve adjustment may be required based on water temperatures or water/glycol flow conditions at your site; see section 2.10.3, "Head Pressure Controls—Water / Glycol Cooled Systems". If the system is a dual circuit unit, both refrigeration circuits must be tested at start-up.

4. Test cooling operation by setting the temperature setpoint below the actual room temperature. For dual compressor systems, the setpoint must be lowered below the compressor cut-in setpoints for both cooling circuits. For systems equipped with the E^2 controller, refer to the *STULZ E² Controller Operation Manual* provided with your unit. The compressor(s) should come on and the discharge air should feel cooler than the return air.

NOTE

Compressor may have a time delay on start-up.

5. Test heating operation by setting the temperature setpoint above the actual room temperature. The heater will energize to increase the discharge air temperature.

6. Test humidifier operation by creating a demand for humidification. Use an amp meter to determine the current draw of the humidifier. Visually check for vapor leaving the steam head or feel if the cylinder is warm to verify the humidifier is operational. In all cases, one to six hours might be required to see a desired level or rise in humidity in the conditioned space. Once room conditions have been programmed or set, a repeat visit to the conditioned space may be required to ensure the humidifier is meeting the room's requirements.

   An Operation and Maintenance manual for the humidifier is provided with your unit under separate cover. Refer to that manual for detailed information on humidifier operation.

7. Test dehumidification operation by creating a demand for dehumidification. If necessary, set the dehumidification setpoint 10% below actual room conditions. The cooling circuit(s) will turn on to begin the dehumidification process. While in this mode, room temperature may decrease and the reheat function may activate. As conditions in the room change, you may have to readjust the setpoint as you check operation. An adequate heat load within the space is required.

8. For electric reheat, use an amp meter on the heater circuit to determine if the heater is operational. For hot water reheat, ensure the control signal has energized the control valve and the temperature of the water has decreased as it passes through the unit. In all cases, one to six hours might be required to see a desired level or decrease in humidity in the conditioned space. Once room conditions have been programmed or set, a repeat visit to the conditioned space may be required to ensure the dehumidification mode is meeting the room's requirements.

3.2 Operating the Unit

This section provides simple instructions for powering an OHS unit on and off. The procedures differ depending on the installed controller.

3.2.1 Shutdown Procedure

1. For E^2-equipped units, press and hold the Enter key for 3 seconds.

2. For all units, turn off power at the unit main power disconnect.

3.2.2 Start-up Procedure

1. Power on the unit at the main power disconnect.

2. A-Tech-equipped units will start automatically. For E^2-equipped units, if the controller is programmed for automatic start, the unit will enter an operational state automatically; otherwise, a status message will appear stating manual start-up is required. Press the Enter key to start the unit.

3.3 Programming the Thermostat

3.3.1 A-Tech Controller

The A-Tech controller is a programmable thermostat that provides:

- single- and dual-stage cooling control
- on/auto/intermittent/off modes of operation
- continuous/auto/residual fan
- day/time clock
- service reminders
- language and °C / °F display preference
- security features
- temperature setpoint override

See the *Robertshaw C9701i2 and C9725i2 User's Manual* that accompanied your unit for programming instructions.

3.3.2 E² Controller

If the unit employs an E^2 controller, the controller was factory programmed based on the model of the A/C unit and the optional features selected. Most applications require no field start-up or program adjustment beyond setting the current date and time. Separate operating instructions for the controller have been sent with your unit, including each feature's factory "default" setting and the available adjustment range, if applicable.

3.4 Decommissioning the Unit

Personnel performing the decommissioning must be completely familiar with the unit before starting. Best practice requires all refrigerants be recovered safely; see section 3.4.1 for guidelines. Prior to recovery, an oil and refrigerant sample should be taken in case analysis is required prior to re-use of the reclaimed refrigerant. Electrical power must be available before decommissioning is started.

Follow these decommissioning guidelines:

1. Become familiar with the equipment and its operation.

2. Isolate the system electrically.

3. Before attempting the procedure ensure that:

    - Mechanical handling equipment is available, if required, for handling refrigerant cylinders
    - All required personal protective equipment is available and used correctly
    - The recovery process is supervised at all times by competent personnel
    - Recovery equipment and cylinders conform to the appropriate standards

4. Pump down the refrigerant system, if possible.

5. If a vacuum is not possible, make a manifold so that refrigerant can be removed from various parts of the system.

6. Place the cylinder receiving the refrigerant on the scale before starting recovery.

7. Start the recovery machine and operate in accordance with manufacturer's instructions.

8. Do not overfill cylinders. (They should contain no more than 80 % volume liquid charge).

9. Do not exceed the maximum working pressure of the cylinder, even temporarily.

10. When the cylinders have been filled correctly and the process completed, make sure that the cylinders and the equipment are removed from site promptly and all isolation valves on the equipment are closed off.

11. Recovered refrigerant must not be charged into another refrigeration system unless it has been cleaned and checked.

3.4.1 Recovering Refrigerant

When removing refrigerant from a system, either for servicing or decommissioning, best practice is to remove all refrigerants safely. Use the following recommended guidelines:

- When transferring refrigerant into cylinders, ensure that only appropriate refrigerant recovery cylinders are employed. Ensure that the correct number of cylinders for holding the total system charge are available and that all cylinders to be used are designated for the recovered refrigerant and labelled for that refrigerant (i.e., special cylinders for the recovery of refrigerant). Cylinders must be complete with pressure relief valve and associated shut-off valves in good working order. Empty recovery cylinders must be evacuated and, if possible, cooled before recovery occurs.
- Recovery equipment must be in good working order with a set of instructions concerning the equipment at hand, and the equipment must be suitable for recovering flammable refrigerants. In addition, a set of calibrated weighing scales must be available and in good working order. Hoses must be complete and in good condition with leak-free disconnect couplings. Before using the recovery machine, check that it is in satisfactory working order, has been properly maintained and that any associated electrical components are sealed to prevent ignition in the event of a refrigerant release. Consult manufacturer if in doubt.
- Recovered refrigerant must be returned to the refrigerant supplier in the correct recovery cylinder, and the relevant Waste Transfer Note arranged. Do not mix refrigerants in recovery units and especially not in cylinders.
- If compressors or compressor oils are to be removed, ensure they have been evacuated to an acceptable level to make certain flammable refrigerant does not remain within the lubricant. The evacuation process must be carried out prior to returning the compressor to the suppliers. Only electric heating of the compressor body may be employed to accelerate this process. When oil is drained from a system, it must be carried out safely.

3.4.2 Labeling Decommissioned Equipment

Equipment must be labelled stating that it has been decommissioned and emptied of refrigerant. The label must be dated and signed. Ensure that there are labels on the equipment stating the equipment contains flammable refrigerant.

4.0 MAINTENANCE

4.1 Periodic General Maintenance

Systematic, periodic general maintenance of the CeilAiR unit is required for optimum system performance. General maintenance should include, but not be limited to, the following: Replacing filters and humidifier cylinders; tightening loose fasteners and electrical connections; checking the condensate line to ensure it is free of debris; cleaning the interior of the unit; visually inspecting the units' components; checking belt tension; checking the level of refrigerant; and ensuring no moisture is in the refrigerant.

Use copies of the "OHS Preventive Maintenance Inspection Checklist" in Appendix A to record periodic general maintenance inspections. For assistance, contact STULZ Product Support. Follow all safety instructions while performing any type of maintenance.

STULZ recommends a general schedule of quarterly preventive maintenance inspections. Some items, such as filters or coil fins, may need more frequent inspection and maintenance, depending on environmental conditions.

WARNING

OHS equipment should be serviced and repaired by a journeyman refrigeration mechanic or air conditioning technician only.

WARNING

If refrigerant gas is released in an enclosed area it will displace oxygen and act as a suffocant. Always ensure adequate ventilation during refrigeration repairs.

Always recover all refrigerant prior to any system repairs. Failure to do so may result in system over pressurization and rupture. Follow the guidelines in "Recovering Refrigerant" on page 37.

WARNING

Turn off power to the unit at the service disconnect switch unless you are performing tests that require power. With power and controls energized, the unit could begin operating automatically at any time.

Hazardous voltage will still be present at the evaporator, condenser, heater/reheater and humidifier, even with the unit turned off at the controller. To isolate the unit for maintenance, turn off power at a non-fused service switch.

Always disconnect main power prior to performing any service or repairs. To prevent personal injury, stay clear of rotating components because automatic controls may start them unexpectedly.

WARNING

This unit employs high voltage equipment with rotating components. Exercise extreme care to avoid accidents and ensure proper operation.

4.1.1 A/C Unit

- Check the refrigerant sight glass on a monthly basis while the unit is running. Excessive bubbles in the sight glass indicates a low refrigerant charge or a clogged filter-drier.
- Check for moisture in the refrigerant by viewing the color of the indicator in the center of the sight glass and comparing it to the color scale on the outer ring. If moisture is present, the system must be evacuated and recharged.
- Check the superheat and sub-cooling temperatures semi-annually and ensure they are within the range shown in the refrigerant pressure/temperature table in Section 2.9.1. If necessary, adjust the refrigerant charge to achieve the correct values. If the refrigerant level is low, check the system for leaks.
- Inspect electrical items:
  - fuses
  - internal wiring for discoloration
  - check electrical connections are secure
  - check low voltage connections
  - relays and contactors for serviceability, i.e., pitted contacts, weak coils
- Verify the following:
  - controller operation
  - customer setpoints
  - air safety switch and tubing
  - chilled water valve operation

4.1.1.1 Compressor

Verify compressor operation:

- visually inspect for oil leaks
- check for excessive vibration
- check crankcase heater operation
- if unit has an oil-level sight glass, verify compressor oil level during operation (all compressors)

4.1.1.2 Heater

Inspect heater items:

- heater elements for any damage
- heater overloads for damage

4.1.1.3 Air Filters

Air filters are usually the most neglected item in an air conditioning system. To maintain efficient operation, the filters may require inspection monthly. Replace them as required.

NOTE

Conditions of spaces vary and the frequency of checking air filters should be based on those conditions.

4.1.1.4 Blower

The blower motor is provided with permanently lubricated bearings and should not require lubrication for the lifetime of the unit. Periodic checks of the blower system should include checking the wiring, blower motor mounts, housing bolts and blower wheel set screw. Ensure all electrical connections are tight. Check that all mounts are secure and the blower wheel is tightly mounted on the shaft and does not rub against the fan housing. The blower vanes should be kept free of debris. Inspect motor pulleys and sheaves for excessive grooves. Inspect bearings for excessive wear. Inspect blower section for any loose parts or debris.

4.1.1.5 Coils

The coil(s) should be cleaned as required following standard coil cleaning practices. Using a brush, clean fluid coil fins of all debris that will inhibit airflow. This can also be done with compressed air or with a commercial coil cleaner. Check for bent or damaged coil fins and repair as necessary. Check all refrigerant lines and capillaries for vibration isolation and support if necessary. Check all piping for signs of leaks.

Inspect electric heating elements to ensure they are free of debris.

4.1.1.6 Drain Pan

To assure proper drainage, inspect the drain pan regularly. Make sure the drain pan outlet is always free of debris and ensure the drain pan does not leak. Check the drain pan float switch to verify it is free to move.

4.1.1.7 Condensate Pump

The optional condensate pump should be inspected semi-annually and cleaned. Ensure that the float works freely. Wipe the float with a wet cloth and detergent to remove dirt. Clean the tank bottom. Check that the discharge line is open and water can pass through it freely.

4.1.1.8 Humidifier

The optional humidifier's steam cylinder has a limited lifetime and must be replaced periodically. Because water conditions and humidifier usage rates vary greatly, it is difficult to establish intervals for changing the cylinder. Individual maintenance schedules must be determined for each location based upon periodic examination of the humidifier. A yellow LED on the humidifier cabinet repeatedly flashes four times to indicate the cylinder should be replaced.

NOTE

The yellow LED may illuminate during initial start-up but it doesn't necessarily mean the cylinder needs to be replaced.

Refer to the humidifier operator's manual supplied under separate cover for detailed instructions for changing the cylinder.

Also, perform the maintenance operations described in the humidifier manual.

4.1.2 Condenser/Condensing Unit

Maintenance access to the condensing unit is through one or two removable panels (depending on model). Clean the air-cooled condenser coil of all debris that will inhibit air-flow. This can be done with compressed air or with a commercial coil cleaner. Check for bent or damaged coil fins and repair as necessary. On outdoor units in winter, do not permit snow to accumulate on or around the condensing unit. Check all refrigerant lines and capillaries for vibration isolation and support as necessary. Check all refrigerant and coolant lines for signs of leaks.

CAUTION ⚠

If main power is disconnected for a long period, do not attempt to start a condensing unit until eight hours after applying power. This allows time for all liquid refrigerant to be driven out of the compressor. This is especially important at low ambient temperature conditions.

4.2 Troubleshooting

Troubleshooting steps are listed in Table 12. Turn off all power to the unit before conducting any troubleshooting procedures unless the procedure specifically requires the system to operate. Keep hands, clothing and tools clear of the electrical terminals and rotating components. Equipment located in the ceiling can pose unusual difficulties. Ensure that your footing is stable at all times.

Table 12. Troubleshooting Table

Symptom	Probable Cause	Recommendation
Suction Pressure Too Low	a. Loss of refrigerant (excessive bubbles in sight glass).	Locate leak and repair. Recharge system.
	b. Expansion valve stuck or obstructed (short cycle or continuous running).	Remove and clean or replace valve.
	c. Clogged drier/strainer (feels cold).	Replace with new drier/strainer.
	d. Dirty air filters.	Clean/replace filters.
Chilled Water Valve Fails to Open or Close	a. Temperature setpoint too high/low.	Adjust to correct temperature setting.
	b. No control power to the chilled water valve	Thermostat wired incorrectly. Check wiring diagram and rewire if required.
	c. Actuator failed.	Replace actuator.
Evaporator Coil Ices	a. Low airflow.	1. Check filters. Replace as needed. 2. Check for and clear any obstructions across or in the (supply) discharge airstream. 3. Check correct rotation of evaporator blower.
	b. Temperature setting too low.	Increase temperature setpoint (68 °F minimum.).
	c. Discharge air short cycling back to return.	Check discharge grille orientation.
	d. Low refrigerant charge.	Find leak, repair and recharge system.
Blower Fails to Start	a. Power failure.	Check main voltage power source input cable.
	b. Control transformer circuit breaker tripped.	Check for short circuit or ground fault; if none, reset circuit breaker.
	c. Defective contactor.	Repair or replace.
	d. Thermal overload tripped.	Reset overload and check amperage of motor. Compare to setting on overload and adjust to FLA. All direct-drive motors are internally protected and do not require overload reset.
Control is Erratic	Wiring improperly connected or broken.	Check wiring against electrical drawing.

Symptom	Probable Cause	Recommendation
Condenser Pressure Too High	a. Non-condensable gas or air in system.	Recover system and recharge. Replace drier/strainer. Evacuate to 50 microns and recharge.
	b. Condenser air intake is blocked.	Remove debris and clean condenser.
	c. Overcharge of refrigerant.	Reclaim excess refrigerant from system.
	d. Low water flow to water-cooled condenser.	Reset-determine cause and fix.
	e. Condenser fan not operating.	Check pressure/temperature operating switches and motor. Replace as needed.
	f. Water/glycol temperature too high.	Check flow and operation of drycooler.
	g. Condenser pressure regulating valve setting too high.	Adjust to obtain correct pressure.
	h. Flow of water/glycol too low.	1. Check glycol solution level and concentration. 2. Valves not open or partially open. Repair/replace as needed. 3. Air in system - bleed system. 4. Check all strainers and clean if needed.
	i. Water/glycol solution not mixed prior to adding to system.	Remove solution and premix. Refill system.
Condenser Pressure Too Low	a. Loss of refrigerant (indicated by bubbles in sight glass).	Locate and repair leak. Recharge system.
	b. Condenser fan controls not set.	Adjust or repair controls.
	c. Water regulating valve adjusted too low.	R407C - Readjust to 320 psig. R410A - Readjust to 440 psig.
Noisy Compressor	a. Expansion valve stuck in open position (abnormally cold suction line).	Ensure feeder bulb is tight on suction line. Check operation and superheat.
	b. Worn or scarred compressor bearings.	Replace compressor.
	c. Liquid slugging.	System overcharged. Reclaim excess refrigerant.
	d. Scroll compressor not properly phased.	Phase correctly at main power source. Do not rewire compressor.
Compressor Fails to Start	a. Temperature setpoint too high.	Adjust to desired temperature.
	b. Compressor internal overload protector is open.	Check compressor for short circuit or ground.
	c. Complete loss of refrigerant charge (low pressure safety switch).	Locate and repair leak. Recharge system.
	d. Condenser pressure too high (high pressure safety switch).	Check condenser for obstructions.
	e. Condensate switch open.	1. Ensure unit is level. 2. Check that condensate pan is draining properly. Clear obstructions.

Symptom	Probable Cause	Recommendation
System Short of Capacity	a. Low refrigerant (indicated by bubbles in sight glass).	Check for leaks. Repair and recharge system.
	b. Expansion valve stuck or obstructed (short cycling or continuous running).	Remove valve and clear obstruction or replace valve.
	c. Clogged drier/strainer (feels cold).	Replace with new drier/strainer..
	d. Reduced airflow.	Check belt tension, filters and clear evapo-rator coil of debris.
Compressor Short Cycles	a. Low line voltage causing compressor to overheat.	Check power source for cause of low line voltage.
	b. Dirty or iced over evaporator coil.	Defrost and/or clean coil.
	c. Reduced airflow (when applicable).	Check filter and belt tension.
	d. Lack of refrigerant.	Check for leak. Repair and recharge sys-tem.
	e. Short cycling of conditioned air.	1. Supply and/or return grilles are incorrectly oriented. Re-orient. 2. Supply and return grilles are too close together. Move farther apart. 3. Insufficient heat load. Add temporary heat load to compensate.
	f. Thermostat is improperly located.	Check for supply registers that may be too close to thermostat. Relocate if necessary.
Heater Inoperative	a. Fuses blown/circuit breaker tripped.	Check for short circuit; replace fuses/reset circuit breaker.
	b. Thermostat set too low.	Increase temperature setpoint.
	c. Overheat switch open due to insufficient airflow across heater elements..	Check for dirty filters or obstructions that may reduce airflow. Correct or replace as needed.
	d. Fuse link blown.	Replace fuse link (see item immediately above).
	e. Heater element burned out.	Check continuity with an ohmmeter. Re-place heater element.
Humidifier Inoperative	a. Water supply has been turned off or not connected.	Connect and/or turn on water supply.
Note: See humidifier manual for additional help.	b. Humidifier switch is in "Off" position.	Turn switch to "Auto/On" position.
	c. Electrical connections are loose.	Tighten electrical connections.
	d. Humidifier fuses are blown.	Check for overcurrent by the humidifier electrodes. Drain water from tank and refill. Replace fuses.
	e. Relative humidity is above setpoint.	Adjust humidistat setpoint.
	f. Yellow status LED is flashing.	Consult humidifier manual.
	g. Water conductivity is too low.	Add a teaspoon of table salt to the water through the top of the cylinder. Typically only required on initial start-up.

4.3 Field Service

NOTE

Do not attempt to make repairs without the proper tools.

It may be necessary to perform repairs on the refrigeration system. If field repairs are necessary, the following procedures apply:

WARNING

If refrigerant gas is released in an enclosed area, it will displace oxygen and potentially act as a suffocant. Always ensure adequate ventilation during refrigeration repairs.

WARNING

Always recover all refrigerant prior to any system repairs. Failure to do so may result in system over pressurization and rupture. Follow the guidelines in "Recovering Refrigerant" on page 37.

4.3.1 Leak Detection

Several methods can be used to detect a leak in the refrigeration system. The most modern and easiest method is to use an electronic leak detector. Follow the manufacturer's directions and any leak can be quickly located. A second method is to use soap bubbles. Apply a solution of soapy water with a brush or sponge to the joints and connections in the refrigeration lines. A leak in the lines will cause bubbles to form.

4.3.2 Leak Repair

When a leak is located, properly reclaim the remaining refrigerant charge before beginning repairs. Adjacent piping must be thoroughly cleaned by removing all paint, dirt and oily film. Use a wire brush, sandcloth or sandpaper and wipe the area with clean, dry cloths. Protect nearby parts from heat damage by wrapping with water-soaked cloths.

4.3.3 Refrigerant Piping

When replacing components within the cabinet of the unit the following consumable materials are recommended. Use Silfos alloy for copper-to-copper (piping discharge or suction line repairs). Use silver solder (Stay-Silv #45) and flux on copper-to-brass or copper-to-steel repairs.

When component replacement is complete, remove all traces of flux. After any repair, pressure check the system for leaks prior to recharging the system.

4.3.4 General Common Repairs/Component Replacement

4.3.4.1 Compressor Failure

The compressor is the most important component of the air conditioner. Numerous safety devices are provided to protect the compressor from failing.

If a compressor failure has occurred, determine whether it is an electrical or a mechanical failure. An electrical failure is indicated by a distinct pungent odor when the system is been opened. If a burnout has occurred, the oil will be black and acidic. A mechanical failure will have no burned odor and the motor will attempt to run. An abnormal or excessive noise may be present.

Analysis of the oil is the only way to determine the proper cleaning procedure for the refrigerant system. Acid test kits are available from several manufacturers for measuring the acid level in the oil. These are capable of making quite accurate acid measurements, but if they are not available, a check of the oil by sight and smell can give a quick indication if contamination remains in the system.

All electrical connections should be checked to ensure they are tight and properly made. Check all fuses, contactors and wiring. The contactor should be examined and replaced if contacts are worn or pitted.

If there is acid in the oil, there has been an electrical failure that caused the compressor motor to burn out. The acid diffuses throughout the refrigeration system and must be removed using a burnout filter kit before a new compressor is placed in service. The entire refrigeration circuit must also be cleaned of harmful contaminants left by the burnout. See Section 4.3.4.3 (4.3.4.3, "Burn-Out/Acidic Cleanup Procedure") for the proper procedure.

If there is no acid in the oil, there has been a mechanical failure. See Section 4.3.4.2 (4.3.4.2, "Standard Cleanout Procedure") for the proper cleaning procedure.

CAUTION

Damage to a replacement compressor caused by improper system cleaning constitutes abuse under the terms of the warranty. This will void the compressor warranty. Always consult the factory prior to replacing the compressor.

CAUTION

POE oil is used in systems with R407C and R410A refrigerant. If a replacement compressor is provided, ensure that it is filled with POE oil before installing.

4.3.4.2 Standard Cleanout Procedure

WARNING ⚠

Avoid touching or contacting refrigerant gas and oil with exposed skin. Severe burns will result. Use long rubber gloves when handling contaminated parts.

NOTE

Cleaning operations must be performed by a journeyman refrigeration mechanic or air conditioning technician.

1. If your unit is equipped with an E^2 controller, turn the A/C unit off by pressing and holding the Enter key.
2. Turn off power to the unit at the main power disconnect switch.
3. Remove the old compressor and install the new compressor.
4. Remove the liquid line drier and install the appropriate liquid line filter-drier.
5. Evacuate the system according to standard procedures. Normally, this will include the use of a high-vacuum pump and a low-vacuum micron gauge for measuring the vacuum obtained.
6. Recharge the system.
7. Turn on the power at the main power disconnect switch and start the system.

4.3.4.3 Burn-Out/Acidic Cleanup Procedure

NOTE

Cleaning operations must be performed by a journeyman refrigeration mechanic or air conditioning technician.

1. These systems should be cleaned using the suction line filter-drier method.
2. If your unit is equipped with an E^2 controller, turn the A/C unit off by pressing and holding the Enter key.
3. Turn off power to the unit at the main power disconnect switch.
4. Remove the burned-out compressor and install the new compressor.
5. Install a suction line filter-drier designed for acid removal.
6. Remove the liquid line drier and install the appropriate liquid line filter-drier.
7. Check the expansion valve, sight glass and other controls to see if cleaning or replacement is required.
8. Evacuate the system according to standard procedures. Normally, this will include the use of a high-vacuum pump and a low-vacuum micron gauge for measuring the vacuum obtained.
9. Recharge the system through the access valve on the suction line filter-drier.
10. Turn on power at the main power disconnect switch and start the system.
11. The suction line filter-drier permits small-system cleanup to be completed in one service call. The pressure drop across the suction line filter-drier should be measured during the first hour of operation. If the pressure drop becomes excessive, the suction line filter-drier should be replaced (See Sporlan Bulletin 40-10, for the maximum recommended pressure drop for the suction line filter drier).
12. In 24 hours, take an oil sample. Observe the color and test for acidity. If the oil is dirty or acidic, replace the suction line filter-drier.
13. In two weeks, examine oil to determine if another suction line filter-drier change is necessary.

4.3.4.4 Humidifier Cylinder Replacement

After an extended period of operation, the yellow LED on the humidifier cabinet will repeatedly flash four times indicating that the cylinder is completely used and a replacement cylinder must be installed. The cylinder is disposable and cylinder life is dependent on water supply conditions and humidifier usage. Refer to the humidifier operator's manual supplied under separate cover for detailed instructions on changing the cylinder. The following procedures are to be followed when replacing the cylinder.

CAUTION ⚠

Failure to replace the cylinder at the end of cylinder life may result in humidifier damage.

NOTE

Decrease the humidity setpoint below ambient humidity to allow the cylinder to cool down before removing the cylinder.

1. If your unit is equipped with an E^2 controller, turn the A/C unit off by pressing and holding the Enter key.
2. Turn off the water supply to the humidifier.
3. Turn the main power disconnect switch on the electric box to the Off position. Remove the cover from the electric box.
4. Using a pair of vise grips, turn the shaft of the main power switch to the On position to provide power for the humidifier drain solenoid.
5. Follow the steps of the cylinder replacement procedure in the humidifier installation and operation manual sent under separate cover with your unit.
6. Replace the cover on the electric box and turn the main power disconnect switch to the On position.
7. If your unit is equipped with an E^2 controller, turn the A/C unit on by pressing the Enter key.
8. Readjust the humidity to the desired setpoint.

If the humidifier is to be shut down for an extended period, follow the steps of the Extended Shutdown procedure in the humidifier installation and operation manual.

CAUTION ⚠

Failure to perform the recommended Extended Shutdown procedure before a prolonged shut-down period will drastically shorten the cylinder life.

4.3.4.5 Air Filter Replacement

The air filters are located either internal or external to the cabinet, depending on the configuration of the unit. Regardless of location, the filter is accessed through an access panel labeled “FILTER ACCESS”. Remove the access panel and old filter. Ensuring directional airflow arrows on filter are correct, insert the new filter and replace the access panel.

5.0 PRODUCT SUPPORT

STULZ Product Support provides aftermarket technical and field support, warranty authorization and part sales to contractors and end users. Factory authorized services are available by request and include:

- Factory Authorized Start-up/Warranty Inspection
- Commissioning Assistance
- Break Fix Repair
- Preventive Maintenance Contracts
- Performance Evaluations
- Technician and Owner Training

5.1 Factory Authorized Start Up/Warranty Inspection

STULZ recommends purchasing Factory Authorized Start Up/Warranty Inspection for all new STULZ precision cooling equipment. Factory Authorized Start Up/Warranty Inspection ensures that your equipment is installed and operating per STULZ recommended guidelines. This essential service guarantees that STULZ equipment has the best warranty coverage available.

STULZ Upgraded Parts Warranty and the Labor Warranty applies once Factory Authorized Warranty Inspection/ Start-Up is performed and Start Up Checklists are returned and validated by STULZ Product Support.

STULZ limited parts-only warranty applies if Factory Authorized Start Up/Warranty is not purchased and Start Up Checklists are received from an unauthorized party and validated by STULZ Product Support.

The STULZ Product Support coordinates all Factory Authorized Services and ensures only STULZ certified technicians are dispatched to perform your Factory Authorized Start Up/Warranty Inspection. Please contact the STULZ Product Support with field service requests at (888) 529-1266 Monday through Friday from 8:00 a.m. to 5:00 p.m. EST.

5.2 Technical Support

The STULZ Technical Support Department is dedicated to the prompt reply and resolution of issues experienced with supplied equipment. Please contact (888) 529-1266 Monday through Friday from 8:00 a.m. to 5:00 p.m. EST. After hours support is also available. Please provide your name and contact information and a support technician will return your call.

When calling to obtain support, it is important to have the following information readily available, (information is found on the unit's nameplate):

- Unit Model Number
- STULZ Sales Order Number
- Unit Serial Number
- Description of Problem

5.3 Obtaining Warranty Parts

All Warranty Parts Authorizations are validated and processed through the Technical Support Department at (888) 529-1266 Monday through Friday from 8:00 a.m. to 5:00 p.m. EST. A support technician at STULZ will provide troubleshooting assistance over the telephone. If it can be determined that a part may be defective, a warranty authorization for a replacement part will be processed by STULZ Technical Support. The replacement part will then be shipped via UPS ground. If the customer requests that warranty part(s) be sent by any other method than UPS ground, the customer is responsible for the shipping charges. If you do not have established credit with STULZ you must provide a freight carrier account number.

A written (or faxed) purchase order is required on warranty parts and must be received prior to 12:00 p.m. for same day shipment. The purchase order must contain the following items:

- Purchase Order Number
- Date of Order
- STULZ Stated Part Price
- Customer Billing Address
- Shipping Address
- Customer's Telephone and Fax Numbers
- Contact Name
- Unit Model No. and Serial No

The customer is responsible for the shipping cost incurred for returning the defective part(s) back to STULZ. Return of defective part(s) must be within 30 days at which time an evaluation of the part(s) is conducted and if the part is found to have a manufacturing defect a credit will be issued.

When returning defective part(s), complete the Return Material Authorization Tag and the address label provided with the replacement part. For prompt processing, please affix the RMA in a prominent place on the external packaging of the returned part.

5.4 Obtaining Spare/Replacement Parts

Maintaining a recommended spare parts inventory is an industry best practice for critical facilities. On-site spares kits reduce downtime and can eliminate the cost of expedited freight charges. Recommended spares and replacement parts sales are available through Product Support at (888) 529-1266.

STULZ accepts Visa and MasterCard. STULZ may extend credit to its customers; a credit application must be prepared and approved (this process could take one week).

A 25% minimum restocking charge will be applied on returned stocked parts that were sold as spare/replacement parts. If the returned part is not a stocked item, a 50% restocking charge may be applied. Additionally, a Return Material Authorization Number is required when returning parts. To receive credit for returned repair/replacement parts, the parts must be returned to STULZ within 30 days of the purchase date. Spare part sales over 30 days old will be considered final and the parts will remain the sole property of the ordering party.

Appendix A OHS Preventive Maintenance Inspection Checklist

Complete a copy of this document for each OHS unit.

Site Name		**Site Contact**	
Site Address		**Site Phone**	
City, State		**Service Date**	
Zip		**Technician Name**	
Unit Model		**Unit Serial**	

Current Room Conditions

Room Temperature:		Room Humidity:	

Unit Setpoints

Return Temperature:		Return Humidity:	
Remote/Supply Temperature:		Remote/Supply Humidity:	

Electrical Panel (Safety Note: The following should be performed by Stulz Trained Service Personnel only)

Inspect unit disconnect for proper operation:	❑ Pass	❑ Fail	❑ N/A
Inspect internal wire for discoloration:	❑ Pass	❑ Fail	❑ N/A
Inspect fuses:	❑ Pass	❑ Fail	❑ N/A
Inspect for secure electrical connections;	❑ Pass	❑ Fail	❑ N/A
Inspect low voltage connections:	❑ Pass	❑ Fail	❑ N/A
Inspect relays and contactors for serviceability, i.e. pitted contacts, weak coils:	❑ Pass	❑ Fail	❑ N/A

Record Supply Voltage

L1-GND:		L2-GND:		L3-GND:	
L1-L2:		L2-L3:		L1-L3:	

Record Control Voltage

T-1:		T-2:	

Unit Operation

Verify Control Device Operation:	❑ Pass	❑ Fail	❑ N/A
Verify Customer Setpoints:	❑ Pass	❑ Fail	❑ N/A
Inspect Filter Clog/Air Safety Switches and Tubing:	❑ Pass	❑ Fail	❑ N/A
Chilled Water Valve Operation:	❑ Pass	❑ Fail	❑ N/A
Condensate pump operation:	❑ Pass	❑ Fail	❑ N/A

Blower Section

Inspect motor pulleys and sheaves for excessive grooves:	❑ Pass	❑ Fail	❑ N/A
Inspect bearings for excessive wear:	❑ Pass	❑ Fail	❑ N/A
Inspect Blower Section for any loose parts or debris:	❑ Pass	❑ Fail	❑ N/A
Filter condition:	❑ Replace	❑ Good	❑ N/A
Belt condition:	❑ Replace	❑ Good	❑ N/A

Record Fan Motor Amp Draw

(Fan 1) L1:		L2:		L3:	
(Fan 2) L1:		L2:		L3:	
(Fan 3) L1:		L2:		L3:	

Check Compressor Operation ❑ N/A

Check electrical connections:		❑ Yes		❑ No		❑ N/A	
Visual inspect for oil leaks:		❑ Yes		❑ No		❑ N/A	
Check for excessive vibration:		❑ Yes		❑ No		❑ N/A	
Check crankcase heater operation:		❑ Yes		❑ No		❑ N/A	
Oil level during operation	Compressor 1:	❑ Empty	❑ ¼	❑ ½	❑ ¾	❑ Full	❑ N/A
	Compressor 2:	❑ Empty	❑ ¼	❑ ½	❑ ¾	❑ Full	❑ N/A
Sight glass	Circuit 1:	❑ Green	❑ Yellow		❑ N/A		
	Circuit 2:	❑ Green	❑ Yellow		❑ N/A		

Record Compressor Amp Draw

(Compressor 1) L1:		L2:		L3:	
(Compressor 2) L1:		L2:		L3:	

Record Refrigerant Operating Pressures

Circuit 1	Discharge Pressure:		Suction Pressure:	
	Discharge Line Temp:		Suction Line Temp:	
	Liquid Line Temp:			
	Subcooling:		Superheat:	
	EWT:		LWT:	
Circuit 2	Discharge Pressure:		Suction Pressure:	
	Discharge Line Temp:		Suction Line Temp:	
	Liquid Line Temp:			
	Subcooling:		Superheat:	
	EWT:		LWT:	

Check Humidifier Operation ❑ N/A

Check electrical connections:	❑ Yes	❑ No	❑ N/A
Canister arching replace:	❑ Yes	❑ No	❑ N/A
Test humidifier drain cycle:	❑ Yes	❑ No	❑ N/A
Inspect humidifier section for water leaks:	❑ Yes	❑ No	❑ N/A
Canister capacity:	❑ Good ❑ Replace		

Record Humidifier Amp Draw

L1:		L2:		L3:	

Check Heater Operation ❑ N/A

Check electrical connections:	❑ Yes	❑ No	❑ N/A
Check heater elements for any damage:	❑ Yes	❑ No	❑ N/A
Inspect heater overloads for damage:	❑ Yes	❑ No	❑ N/A

Record Heater(s) Amp Draw

(Heater 1) L1:		L2:		L3:	
(Heater 2) L1:		L2:		L3:	
(Heater 3) L1:		L2:		L3:	

Site Recommendations

1.
2.
3.
4.
5.

Final Verification

Technician Signature:		Date:
QA Verification:		Date:

Appendix B - Acronyms and Abbreviations

BTU/H-	British Thermal Units Per Hour
CFM -	Cubic Feet Per Minute
CNDCT -	Conductor
ESD -	Electrostatic Discharge
°F -	Degrees Fahrenheit
FLA -	Full Load Amps
FOB -	Free on Board
HACR -	Heating, Air Conditioning, Refrigeration
HP -	Horse Power
Hz -	Hertz
IAQ -	Indoor Air Quality
in -	Inches
in. w.g. -	Inches of Water Gauge
kVA -	Kilo Volt Amp
kW -	Kilowatts
LRA -	Locked Rotor Amps
MAX FUSE -	Maximum Fuse
MCA -	Minimum Circuit Ampacity
NEC -	National Electric Code
NFPA -	National Fire Protection Agency
PH -	Phase
PSI -	Pounds Per Square Inch
psig -	Pounds Per Square Inch Gauge
R-Value -	Thermal Resistance
RLA -	Rated Load Amps
SDS -	Safety Data Sheet
SPDT -	Single Pole, Double Throw
STULZ -	STULZ Air Technology Systems, Inc.
TEV -	Thermal Expansion Valve
V -	Volt
VAC -	Volt, Alternating Current
VDC -	Volt, Direct Current

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