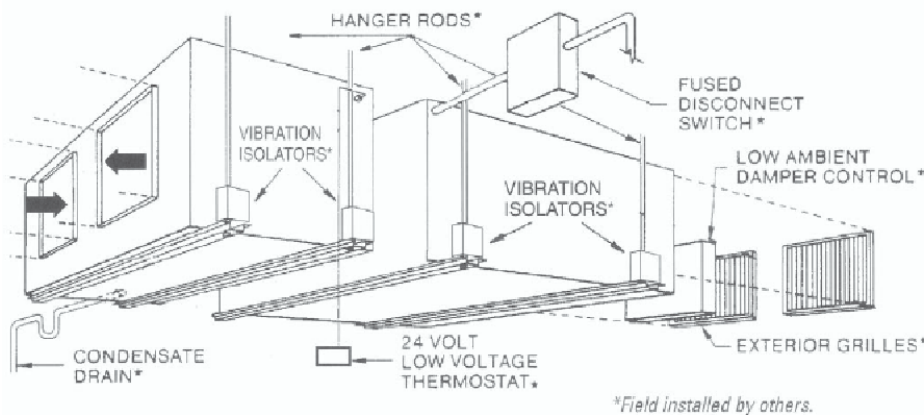


Installation, Operations, and Maintenance *Convertible DX Systems*

Ver 2021 / May 10 2021



IOM MANUAL

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1. INTRODUCTION

1.1 General

Thank you for your purchase of this Tithe Corp. equipment. Tithe Corp. is a woman owned and operated innovative Maryland based manufacturer of air conditioning systems. Specializing in precision, high percentage outside air, and supplemental applications, Tithe Corp. utilizes high quality craftsmanship and materials to produce equipment capable of providing years of trouble free service.

This Tithe Corp. manual is provided as one component of the documentation for your equipment. The product data sheet (submittal or as-built) and wiring diagram should be referenced for specific performance, technical, and physical data. Supplemental manuals for microprocessors and other system components may be included with your unit based on the features requested.

The information contained in this manual provides basic instructions for the installation, operation, and maintenance of your equipment. The directions contained herein will prevent damage to the system from an improper installation and ensure that your unit performs at its peak efficiency. Deviation from these instructions may result in degraded performance, damage to the system, and potentially void the system warranty.

Note: The information contained in this manual in no way absolves the installer of their obligation to meet all applicable codes and comply with other project documentation. In the event of a conflict between these instructions and other project requirements, always observe the strictest requirement

1.2 Safety Information

Tithe Corp. mechanical equipment presents multiple potential hazards, including high voltage electrical services, rotating components, and high pressure fluids. Only professionally trained, qualified, and licensed (where required) personnel should install and/or service this equipment. Property damage and serious injury or death may result from improper installation or maintenance of this equipment.

Prior to performing any service on this unit, familiarize yourself with this manual, the material safety data sheets (MSDS) for any refrigerant or glycol used in this unit, and the location of the main power switch. Before opening the cabinet to perform any service, always lock out the main power disconnect unless power is required for the procedure/diagnostic being performed.

1.3 Warranty

1-Year Limited Warranty Policy

The Seller warrants against defect in materials and workmanship in products which it manufactures for (1) year from the date of installation or up to 15 (fifteen) months from the date of shipment, whichever event occurs first, when properly installed and operated under normal use. This warranty does not include any labor, transportation or other charges made outside of the Seller's factory for replacement or repair of defective parts unless specifically stated in the body of the Seller's invoice. This warranty does not cover failures caused by improper installation, abuse, misuse, misapplication,

improper or lack of maintenance, negligence, accident, normal deterioration including wear and tear or the use of improper parts or improper repair.

The Seller's only liability under this warranty or otherwise shall be the repair or replacement (at Seller's option) of nonconforming goods or parts. Seller assumes no liability for incidental or consequential damages such as injury to persons or property, or lost profits.

This warranty is in lieu of all other warranties, expressed or implied, including warranties of merchantability and fitness for a particular purpose and there are no warranties which extend beyond the description on the face hereof.

Four-Year Extended Warranty
(Motor-Compressor Assembly Only)

Va@Á[!] Also has available a four year extended warranty for the Motor-Compressor Assembly which follows the expiration of the standard Va@Á[!] ES Warranty. In the event of a defective motor-compressor assembly this warranty would provide replacement to the original purchaser-user, following an inspection by a reputable refrigeration contractor. Contact Va@Á[!] For complete details on pricing and general conditions and information on this warranty.

Unit Nos.: _____

Evap Model No.: _____

Cond Unit Model No.: _____

Unit Serial Nos.: _____

Va@Á[!] Job No.: _____

End User: _____

Warranty Begin Date: _____

2. INSTALLATION

2.1 Receiving, Unpacking, Inspecting, Handling, and Storing

To ensure that your equipment has been delivered without any external or internal indications of damage, make a visual inspection, including inside all access panels, immediately upon delivery. If there is any shipping damage, it must be noted on the freight carrier's delivery forms before signing for the equipment. If the unit has been damaged, obtain a claim form from the carrier. All freight claims and/or lost material claims must be processed through the freight carrier, typically within 5 business days of receipt of equipment. Tithe Corp. should be notified of any damage prior to repair.

Components and accessories that are shipped loose will be shipped in separate container(s) and may be found within the unit as space allows. Units must remain in the normal upright position at all times. Units should only be moved by pallet jack or similar device on original or correctly sized pallet (pallet must extend beyond the unit on all sides). Units must never be stacked.

If the equipment is not scheduled for immediate installation upon its arrival at the job site, it should be completely inspected per the instructions above, then repacked in the original or equivalent packaging and stored in a clean, dry area.

2.2 Site Location Selection, Preparation, Indoor and Outdoor

2.2.1 Site Selection Considerations

Before the unit is installed, a thorough study of the installation site should be made to verify that the structure is adequate to support the unit's weight. The routing of electrical services, ductwork, condensate piping, and refrigerant piping must be coordinated in order to maintain accessibility to the unit for maintenance and servicing.

A minimum clearance of 24" is recommended at all access panels to allow for equipment service. Clearances for electrical panels are as required by all applicable codes (typical minimum is 36"); contact your authority having jurisdiction for specific local requirements. Refer to your submittal drawings for specific unit layout.

2.2.2 Split System Distance & Elevation Considerations

Long distances and elevation changes can reduce the overall efficiency of refrigerant based systems. Extended piping runs also increase the required line size, increasing the cost of refrigerant piping and increasing the amount of refrigerant required for the system. In order to minimize piping costs and maximize unit performance, it is recommended to select component placement to minimize the length of the piping run.

2.2.3 Preparing the Site

One of the most significant site factors that can affect the performance of your unit and its ability to maintain space conditions is the insulation and vapor barrier installed in the space. Tithe Corp.

recommends that the insulation and air/vapor barrier installation meet the standards of ASHRAE/ANSI 90.1 or the local code as a minimum for optimum unit operation. In particular, the air/vapor barrier is vital to properly maintaining space conditions - leakage causes increased heating, cooling, humidification, and dehumidification loads. Failure to provide adequate insulation and a proper air/vapor barrier can lead to unstable room conditions and increased operational costs.

2.2.4 Duct Connections

Installation

1. Air conditioner is shipped assembled and ready for operation.
2. Unit contains a full charge of R-410a refrigerant.
3. Evaporator section must be mounted so that there is a 0.375" to 0.5" tilt down toward the condensate drain connection. This is to ensure that the water drains to the condensate removal point.
4. Install unit so that controls and side panels are accessible to the operator and maintenance personnel.
5. Run the condensate drain line by following the guidelines on page 15.

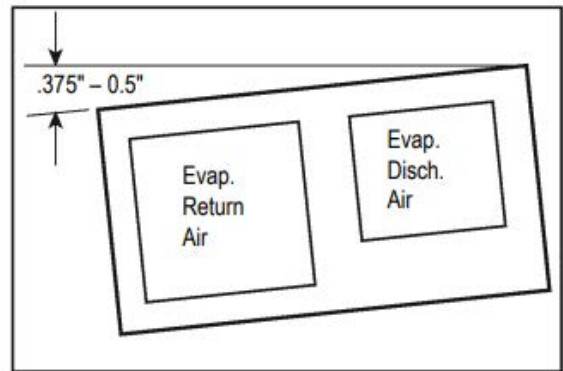


Figure 2.2.4.0 Tilting The Evaporator Section

Duct At Fan Outlet

The design of the duct at the fan outlet has a great effect on the system performance. Outlet duct is the concern not only of the system designer but also of the technician who may have to modify the system after it is installed.

For the most efficient fan performance, the duct at the fan outlet should be straight and the same size as the fan outlet. It should be long enough so that the air velocity becomes uniform across the face of the duct. Achieving a uniform air velocity in the duct involves a process commonly called static regain.

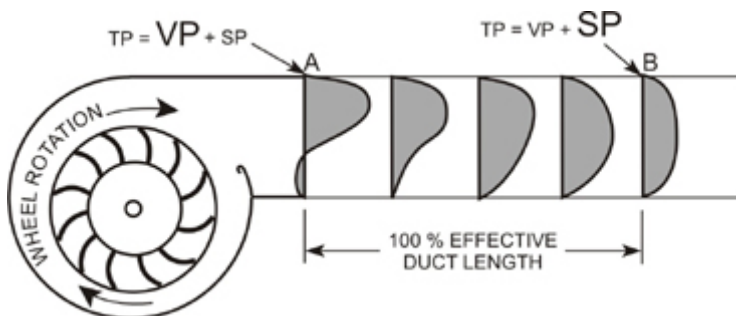


Figure 2.2.4.1 Duct velocity profiles showing static regain.

Static Regain

Static regain is the process of converting velocity pressure (VP) to static pressure (SP). Remember that the total pressure (TP) in a duct system is the sum of velocity pressure plus static pressure ($TP = VP + SP$). Therefore, for a given TP, if the VP is high (usually because the duct area is small), then the static pressure (SP) must be low.

Minimizing System Effect - Technical -

SP is the pressure that **causes** the air in the duct to flow, and VP is the pressure that **results** from the air movement. This means that it is desirable to have a high value of static pressure (SP) compared to the total pressure (TP) developed by the fan.

Figure 2.2.4.1 shows the air velocity profiles in a duct at various distances from the outlet of a centrifugal fan. The air in the fan is pushed against the outside of the scroll by the movement of the fan wheel. Therefore, at the fan outlet, there is a high velocity at the top of the fan outlet. However, at the bottom of the fan outlet, there is a negative velocity, because the air is swirling back to the fan at the cut-off, attempting to re-enter the fan.

At point A in Figure 2.2.4.1, the VP is high and the available SP is low. As the air moves down the duct, the velocity of the air becomes more uniform across the duct, and the static pressure increases as the velocity pressure decreases. At point B in Figure 1, the air velocity is uniform across the duct and low compared to the outlet velocity (point A).

Remember that $TP = VP + SP$. Since the total pressure (TP) in the duct at point B is about the same as it was at point A, as the VP has decreased, the SP has increased. In other words, the system has gained static pressure. This is static regain. The system now has more potential to overcome the resistance in the system and thus the system can deliver more air.

100 Percent-Effective Duct Length

At point B in Figure 2.2.4.1, the air velocity is uniform across the duct area and has slowed. This is the point of highest static regain. The distance from A to B is called the 100 percent-effective duct length. If possible, the fan outlet should be designed with straight duct for the 100 percent effective duct length in order to eliminate system effect at the outlet. The technician should try to maintain straight duct at the outlet. If possible, avoid putting a fitting near the fan outlet.

Calculating the 100 percent-effective duct length depends upon the air velocity at the fan outlet:

- If the outlet velocity is **less** than 2,500 fpm:

100 percent-effective duct length = $2.5 \times$ Duct diameter

- If the outlet velocity is **more** than 2,500 fpm:

100 percent-effective duct length = $\text{fpm}/1000 \times$ Duct diameter

Side Rectangular Duct	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	22
6	6.6															
7	7.1	7.7														
8	7.6	8.2	8.7													
9	8.0	8.7	9.3	9.8												
10	8.4	9.1	9.8	10.4	10.9											
11	8.8	9.5	10.2	10.9	11.5	12.0										
12	9.1	9.9	10.7	11.3	12.0	12.6	13.1									
13	9.5	10.3	11.1	11.8	12.4	13.1	13.7	14.2								
14	9.8	10.7	11.5	12.2	12.9	13.5	14.2	14.7	15.3							
15	10.1	11.0	11.8	12.6	13.3	14.0	14.6	15.3	15.8	16.4						
16	10.4	11.3	12.2	13.0	13.7	14.4	15.1	15.7	16.4	16.9	17.5					
17	10.7	11.6	12.5	13.4	14.1	14.9	15.6	16.2	16.8	17.4	18.0	18.6				
18	11.0	11.9	12.9	13.7	14.5	15.3	16.0	16.7	17.3	17.9	18.5	19.1	19.7			
19	11.2	12.2	13.2	14.1	14.9	15.7	16.4	17.1	17.8	18.4	19.0	19.6	20.2	20.8		
20	11.5	12.5	13.5	14.4	15.2	16.0	16.8	17.5	18.2	18.9	19.5	20.1	20.7	21.3	21.9	

Figure 2.2.4.2 Partial equivalent diameter table.

The 100 percent-effective duct length is always given in **equivalent duct diameters**. However, centrifugal fan outlets are almost always rectangular. To find the equivalent diameter for a rectangular duct of specific dimensions, consult a table (Figure 2.2.4.2) or a duct calculator (Figure 2.2.4.3). An equivalent diameter is the diameter of round duct that will handle the same amount of air (cfm) at the same friction loss as a given size of rectangular duct. Note that these are **NOT equal areas** — they have **equal resistance** to airflow. (Rectangular and round duct with equal areas have different perimeters and thus offer different resistance to airflow.)

Figure 2.2.4.2 shows only a part of a table for equivalent duct diameters. For a full table for duct up to 90 inches x 88 inches, see the SMACNA publication *HVAC Systems and Duct Design*. To use the table (Figure 2.2.4.2), locate one of the duct dimensions in the column on the left, and the other duct dimension in the row at the top. The intersection of the vertical and horizontal columns shows the equivalent diameter. For example, to find the equivalent diameter of a 14-inch x 12-inch duct in the table in Figure 2.2.4.2:

1. Locate 14 in the column on the left.
2. Locate 12 in the row on the top.
3. The intersection of the vertical column and the horizontal row shows 14.2, so the equivalent round duct for a 14-inch x 12-inch duct is a 14.2-inch diameter.

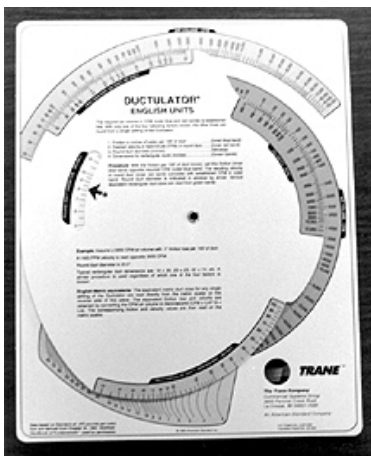


Figure 2.2.4.3. Duct calculator.

A duct calculator (Figure 2.2.4.3) works in much the same way. Align the marks for two duct dimensions for rectangular duct. Another scale will indicate the equivalent round duct diameter.

Example:

What is the 100 percent-effective duct length for a fan outlet that measures 20 inches x 14 inches if the air velocity is 3,500 fpm?

1. The table in Figure 2.2.4.2 shows that the equivalent duct diameter for a 20-inch x 14-inch duct is 18.2 inches.
2. Calculate the 100 percent-effective duct length:

$$100 \text{ percent-effective duct length} = \text{fpm}/1000 \times \text{Duct diameter}$$

$$100 \text{ percent-effective duct length} = 3,500/1,000 \times 18.2 \text{ inches}$$

$$100 \text{ percent-effective duct length} = 63.7 \text{ inches}$$

		Percent of effective duct length				
		No Duct	12%	50%	90%	100%
Percent of static regain	0%	0%	50%	80%	90%	100%
	100%	0%	50%	80%	90%	100%

Figure 2.2.4.4 Relation of static regain to effective duct length.

Straight Duct Length

Even if a 100 percent-effective duct length is not possible, make the straight duct as long as possible. The closer it is to 100 percent-effective duct length, the more static regain occurs. The table in Figure 2.2.4.4 illustrates the percentage of static regain for a centrifugal fan at different percentages of effective duct length. For example, at 50 percent of the effective duct length, the duct has 80 percent of the static regain.

2.3 Rigging

Units are shipped on a skid in order to ease movement and are designed to be kept in the orientation in which they are shipped. This orientation must be maintained at all times during installation. Tithe Corp. units should only be moved by pallet jack or other similar device. Refer to unit documentation for weights.

2.4 Mounting

2.4.1 Indoor Equipment

2.4.1.1 Ceiling Mounted Equipment

For detailed dimensional data, refer to your submittal drawings. Packaged units are shipped as an integral unit with a cross-member angle attached to both sides of the unit at each of the six mounting channels. Refer to submittal dimensions for mounting system if the evaporator system is separated from the condensing section.

Use 3/8" minimum diameter threaded rod (field-supplied) with proper washers and locknuts to hang equipment. Consult the authority having jurisdiction and/or your project documentation for other requirements. Unit should be lifted into place from underneath. Refer to unit documentation for the unit weight.

2.4.1.2 Floor Mounted Equipment

Floor mounted equipment is designed to be mounted directly on to a slab floor. Consult the local authority having jurisdiction and/or your project documentation for other requirements.

2.4.1.3 Vibration Isolation

While various internal components may have their own internal vibration isolation, Tithe Corp. recommends that all of its equipment be provided with external vibration isolation to maximize equipment life and to minimize noise generation.

Floor-mounted units may be mounted on vibration isolation pads or spring isolators. Spring isolators are recommended for ceiling hung units. Vibration isolators may be provided with your unit or field-supplied. Refer to your unit submittal and packing list to determine if vibration isolators have been supplied by the manufacturer.

2.4.2 Outdoor Equipment

Tithe Corp. recommends mounting all outdoor equipment on a concrete housekeeping pad or equipment supports.

2.5 Condensate Line

2.5.1 Gravity (Units without condensate pumps)

Units have a 3/4" or 1" OD copper condensate drain connection stubbed out through the side of the cabinet. A P-trap is required on the drain line (refer to Figure 1). Note that dimension A must be equal to at least twice the negative static pressure for the unit in order to ensure proper drain operation. The negative static pressure is approximately equal to the unit's fan static pressure minus the ESP allowance. Improperly sizing the trap may result in water being entrained in the air stream or cause the drain pan to overflow. The drain line pipe size should match the connection size. Slope all drain piping away from the unit in accordance with local code and project requirements.

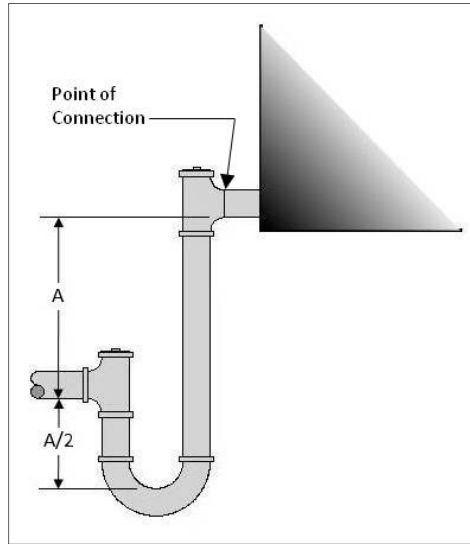


Figure 1 - Gravity Condensate Drain

2.5.2 Condensate Pump (Installed in Unit)

Units with a factory mounted condensate pump have a 1/2" OD copper drain stubbed out through the cabinet. A 1/2" copper sweat connection or 1/2" ID vinyl tubing may be used for connection.

2.5.3 Condensate Pump (Field Installed)

Units have a 3/4" or 1" OD copper condensate drain connection stubbed out through the side of the cabinet. A 2" p-trap is required on the drain line. In order to ensure proper drainage, the top of the pipe at the inlet to the condensate pump must be below the top of the drain pan. Condensate pump discharge may be 1/2" OD copper or vinyl tubing.

The condensate pump must be independently supported and level. Do not support pump from piping. Do not support from unit panels - supporting from unit structure is acceptable, if other piping requirements can be met.

2.6 Controls

Tithe Corp. units are available with a variety of controls options, from standard thermostats to advanced microprocessor controls systems. Refer to the supplemental documentation included with your unit for specific information based on the options selected with your unit.

2.7 Optional Remote Sensors

Remote sensors are shipped loose from the equipment for field installation and wiring. Refer to the packing list, submittal, and electrical wiring diagram to identify sensors included with your unit.

2.7.1 Remote Temperature and Temperature/Humidity Sensors

Wall-mounted temperature sensors should be mounted in the space the unit is serving, on an internal wall, and away from direct sunlight. Sensors should be placed so that they will not be obstructed by furniture or any other equipment. Do not place sensors in close proximity to heat generating equipment such as computers, coffee makers, or ovens. Do not mount sensors directly over sinks. Sensors should be mounted 60 inches above the finished floor, unless otherwise directed.

2.7.2 Duct-Mounted Temperature and Temperature/Humidity Sensors

Refer to the specific project documentation to determine whether duct mounted sensors are to be installed in the supply or return ductwork.

Install sensors on the supply side of the unit in a straight length of duct at least 36 inches away from the unit or any duct-mounted heaters. Do not install the sensors in elbows or any other fittings. Install the sensor in the duct main, prior to any take-offs.

Install sensors on the return side of the unit in a straight length of duct at least 36 inches away from any heater installed in the unit intake. Do not install the sensor in elbows or any other fittings. Install the sensor downstream of all return air and outdoor air connections.

2.7.3 Remote Water Detector

Install the remote water detector in the unit's auxiliary drain pan. Adjust the height of the sensing probes as required, ensuring that they do not come into direct contact with the drain pan.

2.8 Optional Equipment

Tithe Corp. units air available with a variety of optional equipment, including electric heaters, hot-water heating coils, steam heating coils, and humidifiers. This equipment may be unit mounted or duct mounted. Refer to your system's submittal to identify additional equipment and supplemental documentation for additional requirements for options not listed in this manual.

2.9 Electrical Connections

2.9.1 High Voltage Power Wiring

Tithe Corp. units are shipped from the factory with components selected and internally wired for the specified electrical requirements. Refer to the unit's nameplate for the voltage, phase, and frequency information. Prior to beginning wiring, verify that the main electrical service to be routed to the unit and the nameplate information are properly coordinated

2.9.1.1 Wire & Fuse Sizing

Check the unit specification plate for the full load amps (FLA), minimum circuit ampacity (MCA), and maximum overcurrent protection (MOP). Select wire and fuse sizes in accordance with Local and National code requirements.

2.9.1.2 Connections

The main power connections to packaged units or split unit sections must be made through a fused disconnect. The disconnect switches may be factory provided or field provided - refer to the submittal for more information.

Refer to the wiring diagram included with the unit for connection to the power distribution block and unit ground lug. Verify that the hot and neutral legs (single phase) or L1, L2, and L3 supply wires (three phase) are connected to the corresponding points on the power block.

Note: Improper wiring of the main power service may result in the unit's compressor(s) and fan operating backwards. This can cause damage to the compressor(s) and may void the unit's warranty.

2.9.2 Low Voltage Control Wiring

Tithe Corp. units are shipped from the factory with all internal components pre-wired. Terminals are provided for all field-wired connections. Refer to the electrical wiring diagram included with the unit for specific information.

2.9.2.1 Wire Sizing

Tithe Corp. control wiring is 24 V. Select wire sizes in accordance with Local and National code requirements.

2.9.2.2 Connections

Refer to the wiring diagram included with the unit to identify the components to be field wired and for the terminal connections.

2.9.3 Optional Connections

Your Tithe Corp. unit may include a variety of features depending on the configuration. These features may include dedicated terminals or relays for control wiring and dedicated power/fuse blocks for power wiring.

2.9.3.1 Remote On/Off

Units may be wired to a field provided, normally closed switch in order to provide remote shutoff control. The two wires from the switch must be routed to the electrical box and connected to the appropriate terminals. Refer to the wiring diagram for the points of connection for the remote shutdown switch.

2.9.3.2 Compressor Lockout

Units may be wired to a field-provided, normally closed switch in order to provide compressor lockout. The two wires from the switch must be routed to the electrical box and connected to the appropriate terminals. Refer to the wiring diagram for the points of connection for the compressor lockout switch.

2.9.3.3 Field Installed Condensate Pump

Field installed condensate pumps require power and control wiring to be connected to the unit. The control wiring must be run to the terminals for the overflow switch (NC and ground terminals) in the condensate pump housing. Two power wires and a ground wire must be connected to the dedicated power terminals on the fuse block and to the ground stud, respectively. Refer to the wiring diagram included with the unit for wiring termination at the unit and the wiring diagram included with the condensate pump for wiring at the pump. Note: Condensate pump overflow switch control wiring will be wired in series with the remote water detector, if provided.

2.9.3.4 Remote Water Detector

The remote water detector requires control wiring to be run to the NC and ground terminals and may require an additional power connection (provided from the 24 V control wiring). Refer to the wiring diagram included with the water detector for more information. Refer to the unit wiring diagram for wiring configuration. Note: Remote water detector control wiring will be wired in series with the condensate pump overflow switch, if provided

2.9.3.5 Remote Temperature & Temperature/Humidity Sensors

Use shielded, multi-core cable with 3-5 wires for all sensor connections. Wire should be 16-20 AWG. Use the largest acceptable gage wire in order to minimize signal noise. Avoid running the sensor wiring near power cables or near cables running to contactors. Where possible, minimize the length of the cable run. Refer to the wiring diagram for points of connection.

2.9.3.6 Duct Heaters

Duct heaters may be powered through the unit or powered separately. Control wiring must be connected to the unit. Refer to the documentation included with the duct heater for additional requirements. Refer to the wiring diagram for points of connection and to determine if a dry contact is provided for power from the unit.

2.9.3.7 Damper Actuators

Damper actuators are generally powered separately. A dry contact may be provided for power wiring (typically labeled EDR on the wiring diagram). Refer to the wiring diagram for more information.

2.9.3.8 Pump Enable

For units with the pump enable feature, a dry contact may be provided (typically labeled PER on the wiring diagram). Refer to the wiring diagram for more information.

2.9.3.9 Smoke/Fire Detector

Smoke/fire detectors may be field-wired or factory-wired. Terminals are provided for connection. Refer to the wiring diagram for more information.

2.10 Refrigerant Piping

2.10.1 General

Use Type L or K copper refrigerant grade piping for all refrigerant lines. Securely mount all refrigerant lines to the building structure with brackets intended for use with refrigerant/copper piping. Where refrigerant lines pass through walls or floors, provide a sleeve to prevent the line from rubbing. Select refrigerant piping routes through chases, ceiling plenums, wall cavities, conduit, or similarly protected areas to minimize the possibility of damage to piping and surrounding materials. Ensure that installation takes into account potential pipe expansion.

Piping should be insulated as indicated in Table 1:

Table 1 - Refrigerant Piping Insulation Requirements

Liquid Line	Typical temperatures are 110-120°F. Insulation is recommended on external installations and where piping is routed through non-conditioned spaces. Insulation is also recommended where the hot pipe may present a hazard.
Suction Line	Typical temperatures are in the vicinity of 40-50°F. Insulation is required to prevent condensation and to minimize temperature loss to the environment.
Hot Gas Discharge Line	Typical temperatures may be in excess of 150°F. Insulation is not required. Insulation is recommended where the hot pipe may present a hazard.

2.10.2 Pipe Connections

Braze all piping connections with a high quality, high temperature brazing compound of 15% silver suitable for use with the refrigerant used in your unit and in accordance with all local, national and ASHRAE code requirements. Take care to avoid introducing debris to the piping system. Run dry nitrogen through the piping continuously during the brazing process.

2.10.3 Pipe Routing

For best unit performance, pipe should be routed in the most direct, shortest path possible with as few fittings as possible.

Slope all refrigerant piping in the direction of flow at 1/4" per ten feet: slope the liquid line towards the evaporator, the hot gas discharge line towards the condenser, and/or the suction line towards the compressor. Piping should be installed without sags or bends.

2.10.4 Pipe Sizing

Pipe sizing is based on the method detailed in the 2010 ASHRAE Refrigeration Handbook. The following charts and recommendations are provided for your convenience - Tithe Corp. recommends all refrigerant pipe sizes be calculated by an engineer in accordance with the latest ASHRAE Refrigeration sizing guidelines.

For optimal unit operation, a maximum total equivalent length (linear feet of pipe + equivalent lengths of fittings) of 150 feet is permissible. The allowed vertical component varies depending on system configuration. Refer to Table 2 for maximum total equivalent piping lengths including vertical components and fittings. Installations that exceed these lengths without consultation with the manufacturer prior to the submittal phase of the project may result in degraded unit performance.

Table 2 - Maximum Total Equivalent Lengths for Refrigerant Piping

Condenser or Condensing Unit, Same Level	150 total equivalent feet.
Condenser above Evaporator	150 total equivalent feet, including up to 100 feet vertical.
Condenser below Evaporator	150 total equivalent feet, including up to 20 feet vertical.
Condensing Unit above Evaporator	150 total equivalent feet, including up to 50 feet vertical.
Condensing Unit below Evaporator	150 total equivalent feet, including up to 50 feet vertical.

To calculate the required line sizes for your system and for future reference, note the refrigerant type, unit tonnage, and number of circuits in the table below.

Table 3 - Record of Tonnage per Refrigerant Circuit

Refrigerant Type:	
Unit Tonnage:	
Number of Circuits:	
Tonnage per Circuit:	

Calculate the tonnage per circuit by dividing the unit tonnage by the number of circuits; record this value above.

To determine the pipe size to be used for installation, the total equivalent length must be determined. The following worksheets in Tables 4-6 provide a basic walk through of the method to determine pipe size. Start by recording the total length of piping to be installed, including any risers, in box a. for each pipe type on your project. For an initial estimated total equivalent length, multiply this value by 1.5. Using Tables 11 and 12 for R-407c or R-410a, round up to the nearest 25 feet and record the initial line sizes in the worksheets.

Record the total number of any 90 degree, 45 degree, and traps/180 degree fittings in the worksheets. Refer to Table 7 to find the equivalent length for the fitting at the initial line size and record all applicable values in the indicated space on the worksheet. Multiply the quantity of fittings times the equivalent length for the fitting type and record the value in boxes b, c, and d. Add boxes a, b, c, and d together to determine the total equivalent feet of piping for your system; use this value with the R-407c or R-410a sizing table to determine the line size and record this final line size in the worksheet. *Note: this calculation should be repeated with the new line size as a new initial value if there are significant changes in the line size.* Record the final total equivalent feet and line sizes in Table 8 for future reference.

Table 4 - Discharge Line Sizing

Discharge Line Sizing Worksheet							
Total Line Length (ft)	Total length of all piping, including any risers.			a.	Initial Line Size (in)		
Length for estimating initial line size (ft)	a.	x	1.5	=		Final Line Size (in)	
Fitting Type	Qty	x	Equivalent Length (Table 5)	=			
90 Degree fittings		x		=			b.
45 Degree fittings		x		=			c.
Traps/180 fittings		x		=			d.
Total Equivalent Length (ft)	a + b + c + d =			e.			

Table 5 - Suction Line Sizing

Suction Line Sizing Worksheet							
Total Line Length (ft)	Total length of all piping, including any risers.			a.	Initial Line Size (in)		
Length for estimating initial line size (ft)	a.	x	1.5	=		Final Line Size (in)	
Fitting Type	Qty	x	Equivalent Length (Table 5)	=			
90 Degree fittings		x		=			b.
45 Degree fittings		x		=			c.
Traps/180 fittings		x		=			d.
Total Equivalent Length (ft)	a + b + c + d =			e.			

Table 6 - Liquid Line Sizing

Liquid Line Sizing Worksheet						
Total Line Length (ft)	Total length of all piping, including any risers.			a.	Initial Line Size (in)	
Length for estimating initial line size (ft)	a.	x	1.5	=	Final Line Size (in)	
Fitting Type	Qty	x	Equivalent Length (Table 5)	=		
90 Degree fittings		x		=		b.
45 Degree fittings		x		=		c.
Traps/180 fittings		x		=		d.
Total Equivalent Length (ft)	a + b + c + d =			e.		

Table 7 - Equivalent Feet for Pipe Fittings

Equivalent Feet for Common Fittings			
Pipe Size	Fitting Type		
	90°	45°	180°
3/8	0.9	0.7	2.3
1/2	1.0	0.8	2.5
5/8	1.2	0.9	2.9
3/4	1.4	0.9	3.2
7/8	1.6	1.1	3.7
1 1/8	2.0	1.4	4.9
1 3/8	2.5	1.8	6.0
1 5/8	2.8	2.2	6.8
2 1/8	3.5	2.8	8.7

Table 8 - Line Set Information

	Hot Gas Discharge	Suction	Liquid
Total Equivalent Feet			
Installed Pipe Size			
Riser Length (ft)			
Riser Size			

2.10.4.1 Flooded Condenser to Receiver Sizing

Pipes from a remote flooded condenser to a receiver should be sized for a maximum of 100 fpm. Refer to the following table for the required pipe sizes.

Table 9 - Flooded Condenser to Receiver

Flooded Condenser to Receiver Sizing Chart (100 fpm max flow rate)												
Refrigerant Type	Circuit Tonnage											
	1	1.5	2	2.5	3	4	5	6	7.5	8	10	15
R-407c	3/8	1/2	1/2	5/8	5/8	3/4	3/4	7/8	1 1/8	1 1/8	1 1/8	1 3/8
R-410a	3/8	1/2	1/2	5/8	5/8	3/4	3/4	7/8	1 1/8	1 1/8	1 1/8	1 3/8

2.10.4.2 Riser Sizing

Vapor piping must be sized to maintain a minimum velocity of 1,000 fpm for oil transport. Refer to the following table for the maximum pipe sizes to maintain this velocity; if your horizontal piping run is larger than the indicated pipe size, use the value from the table for the risers. Note that this may increase system pressure drop and degrade unit performance - long risers should be avoided, if possible. Record riser sizes in Table 8 for future reference.

Table 10 - Riser Sizing

Riser Sizing Chart (Maximum pipe size to maintain 1,000 fpm for oil return)													
Refrigerant Type	Line Type	Circuit Tonnage											
		1	1.5	2	2.5	3	4	5	6	7.5	8	10	15
R-407c	Discharge	3/8	1/2	1/2	5/8	5/8	3/4	7/8	7/8	7/8	1 1/8	1 1/8	1 3/8
	Suction	5/8	3/4	7/8	7/8	1 1/8	1 1/8	1 3/8	1 5/8	1 5/8	1 5/8	1 5/8	2 1/8
R-410a	Discharge	3/8	3/8	1/2	1/2	5/8	5/8	3/4	7/8	7/8	7/8	1 1/8	1 3/8
	Suction	1/2	5/8	3/4	7/8	7/8	1 1/8	1 1/8	1 1/8	1 3/8	1 3/8	1 5/8	2 1/8

Table 11 - R-407c Line Sizing Chart

Refrigerant Line Sizing Chart for R-407c													
Total Equivalent Length	Line Type	Tonnage per Circuit											
		1	1.5	2	2.5	3	4	5	6	7.5	8	10	15
< 25 ft (7.6 m)	Discharge	3/8	1/2	1/2	5/8	5/8	5/8	3/4	3/4	7/8	7/8	7/8	1 1/8
	Suction	1/2	5/8	5/8	3/4	3/4	7/8	7/8	1 1/8	1 1/8	1 1/8	1 1/8	1 3/8
	Liquid	3/8	3/8	3/8	3/8	3/8	1/2	1/2	1/2	5/8	5/8	5/8	3/4
< 50 ft (15.2 m)	Discharge	1/2	1/2	5/8	5/8	3/4	3/4	7/8	7/8	7/8	1 1/8	1 1/8	1 1/8
	Suction	5/8	3/4	3/4	3/4	7/8	1 1/8	1 1/8	1 1/8	1 1/8	1 3/8	1 3/8	1 5/8
	Liquid	3/8	3/8	3/8	3/8	1/2	1/2	1/2	5/8	5/8	5/8	5/8	3/4
< 75 ft (22.9 m)	Discharge	1/2	5/8	5/8	3/4	3/4	7/8	7/8	7/8	1 1/8	1 1/8	1 1/8	1 3/8
	Suction	5/8	3/4	3/4	7/8	7/8	1 1/8	1 1/8	1 1/8	1 3/8	1 3/8	1 3/8	1 5/8
	Liquid	3/8	3/8	3/8	1/2	1/2	1/2	5/8	5/8	5/8	5/8	3/4	7/8
< 100 ft (30.5 m)	Discharge	1/2	5/8	3/4	3/4	3/4	7/8	7/8	1 1/8	1 1/8	1 1/8	1 1/8	1 3/8
	Suction	3/4	3/4	7/8	7/8	1 1/8	1 1/8	1 1/8	1 3/8	1 3/8	1 3/8	1 5/8	2 1/8
	Liquid	3/8	3/8	1/2	1/2	1/2	1/2	5/8	5/8	3/4	3/4	3/4	7/8
< 125 ft (38.1 m)	Discharge	**	5/8	3/4	3/4	7/8	7/8	1 1/8	1 1/8	1 1/8	1 1/8	1 3/8	1 3/8
	Suction	3/4	3/4	7/8	1 1/8	1 1/8	1 1/8	1 3/8	1 3/8	1 3/8	1 3/8	1 5/8	2 1/8
	Liquid	3/8	3/8	1/2	1/2	1/2	5/8	5/8	5/8	3/4	3/4	3/4	7/8
< 150 ft (45.7 m)	Discharge	**	5/8	3/4	3/4	7/8	7/8	1 1/8	1 1/8	1 1/8	1 1/8	1 3/8	1 5/8
	Suction	3/4	7/8	7/8	1 1/8	1 1/8	1 1/8	1 3/8	1 3/8	1 5/8	1 5/8	1 5/8	2 1/8
	Liquid	3/8	3/8	1/2	1/2	1/2	5/8	5/8	5/8	3/4	3/4	3/4	7/8

**Installation not recommended.

Table 12 - R-410a Line Sizing Chart

Refrigerant Line Sizing Chart for R-410a													
Total Equivalent Length	Line Type	Tonnage per Circuit											
		1	1.5	2	2.5	3	4	5	6	7.5	8	10	15
< 25 ft (7.6 m)	Discharge	3/8	1/2	1/2	1/2	5/8	5/8	5/8	3/4	3/4	3/4	7/8	1 1/8
	Suction	1/2	1/2	5/8	5/8	5/8	3/4	3/4	7/8	7/8	7/8	1 1/8	1 1/8
	Liquid	3/8	3/8	3/8	3/8	3/8	1/2	1/2	1/2	5/8	5/8	5/8	3/4
< 50 ft (15.2 m)	Discharge	1/2	1/2	5/8	5/8	5/8	3/4	3/4	7/8	7/8	7/8	1 1/8	1 1/8
	Suction	1/2	5/8	5/8	3/4	3/4	7/8	7/8	7/8	1 1/8	1 1/8	1 1/8	1 1/8
	Liquid	3/8	3/8	3/8	3/8	3/8	1/2	1/2	1/2	5/8	5/8	5/8	3/4
< 75 ft (22.9 m)	Discharge	1/2	1/2	5/8	5/8	3/4	3/4	3/4	7/8	7/8	1 1/8	1 1/8	1 1/8
	Suction	1/2	5/8	3/4	3/4	3/4	7/8	1 1/8	1 1/8	1 1/8	1 1/8	1 3/8	1 3/8
	Liquid	3/8	3/8	3/8	3/8	1/2	1/2	1/2	5/8	5/8	5/8	5/8	3/4
< 100 ft (30.5 m)	Discharge	1/2	5/8	5/8	5/8	3/4	3/4	7/8	7/8	1 1/8	1 1/8	1 1/8	1 3/8
	Suction	5/8	5/8	3/4	3/4	7/8	7/8	1 1/8	1 1/8	1 1/8	1 1/8	1 3/8	1 3/8
	Liquid	3/8	3/8	3/8	1/2	1/2	1/2	5/8	5/8	5/8	5/8	3/4	7/8
< 125 ft (38.1 m)	Discharge	**	5/8	5/8	3/4	3/4	7/8	7/8	1 1/8	1 1/8	1 1/8	1 1/8	1 3/8
	Suction	5/8	3/4	3/4	7/8	7/8	1 1/8	1 1/8	1 1/8	1 1/8	1 3/8	1 3/8	1 5/8
	Liquid	3/8	3/8	3/8	1/2	1/2	1/2	5/8	5/8	5/8	5/8	3/4	7/8
< 150 ft (45.7 m)	Discharge	**	5/8	5/8	3/4	3/4	7/8	7/8	1 1/8	1 1/8	1 1/8	1 1/8	1 3/8
	Suction	5/8	3/4	3/4	7/8	7/8	1 1/8	1 1/8	1 1/8	1 3/8	1 3/8	1 3/8	1 5/8
	Liquid	3/8	3/8	1/2	1/2	1/2	5/8	5/8	5/8	3/4	3/4	3/4	7/8

**Installation not recommended.

2.10.5 Traps

Riser traps should be sized as small as possible. Trap risers as indicated in the following table:

Liquid Line	No traps required.
Suction Line	Provide vertical risers with a trap at the bottom of the riser and an inverted trap at the top of the riser.
Hot Gas Discharge Line	Provide vertical risers with a trap at the bottom of the riser and an inverted trap at the top of the riser.

In addition to these requirements, any vapor riser not sized for 1,000 fpm minimum pipe velocity should be trapped every 20 feet. Traps may be omitted for risers less than 5 feet in height.

2.11 Water/Glycol Piping

2.11.1 General

Tithe Corp. recommends Type L copper or Schedule 40 steel for all chilled water, condenser water, or glycol water installations. Weld or sweat joints should be used where possible. Support pipe with hangers designed for the appropriate pipe type. Comply with all national and local code requirements.

Insulation is required on chilled water piping. Glycol and condenser water piping do not require insulation unless fluid temperature will be below the ambient dewpoint temperature. Refer to project documentation, local, and national codes for additional requirements, insulation types, and thicknesses.

Tithe Corp. units are available with a variety of control valves when designed for chilled water service; refer to the documentation included with your control valve for installation requirements.

2.12 Air Distribution

2.12.1 Ducted Units

Tithe Corp. produces units with a variety of airflow patterns, including same-face, straight-thru, and 90° configurations. Connections to the unit should be made with a 1-inch flange. The duct connection to the unit should be the same size as the connection on the unit - do not blank off any portion of the inlet or outlet. Refer to the project documentation for size, material, and other connection requirements.

Note: The unit's blower has been selected based on static pressure requirements included in the project documentation. While the unit is provided with adjustable pulleys for adjustment, significant deviations from the design external static pressure may result in blower stability issues or inadequate airflow. Consult the factory prior to making any changes that might cause significant changes in the external static pressure.

2.12.2 Free Discharge

Tithe Corp. s units are available in a variety of free discharge options. When locating the unit, pay careful to the airflow pattern. Ensure the grille or air device is directed so that airflow is not directed into walls or corners.

2.13 System Charging

The procedures for charging your Tithe Corp. unit will vary according to the system features and refrigerant used in the system. Refer to your system documentation and the unit's nameplate prior to beginning system charging.

Packaged units and units with water or glycol condensers installed in the same cabinet as the evaporator ship pre-charged with the specified refrigerant and ready for operation - field charging is not required during initial installation. Refer to the nameplate for system operating parameters, including the system charge and system operating pressures.

Split systems ship with a dry nitrogen holding charge. Prior to piping and charging the unit, this charge must be removed.

Note: Your unit utilizes an HFC refrigerant and POE compressor oil. POE oil readily absorbs moisture - excessive moisture levels in the POE oil may react with the refrigerant to form acid and contaminate the system. Maintain the holding charge for as long as possible and keep the system sealed as much as possible during installation to minimize the exposure to outside air.

2.13.1 R-407C Refrigerant

R-407C is a blended refrigerant (a zeotropic of R-32, R-125, and R-134a) formulated as a non-ozone depleting replacement for R-22 in residential and commercial air conditions and heat pumps, with operating temperatures and pressures similar to R-22.

Your equipment is designed specifically for use with this refrigerant, if indicated on the unit nameplate. The coil(s), compressor(s), and other components are selected specifically for R-407c refrigerant. In order to protect the compressor(s), the system is shipped with normally closed, automatically resetting low pressure switches (25 psi open, 50 psi reset) and high pressure switches (400 psi open, 200 psi reset) installed on each refrigeration circuit.

R-407C's component refrigerants remain well blended in its liquid phase, but tend to separate in the vapor phase. In order to ensure that your unit is charged with the proper composition of refrigerant, the system must be charged with liquid refrigerant only. Refer to the instructions printed on your refrigerant cylinder to verify that the cylinder is oriented properly for charging.

1. After completing all system piping connection and prior to introducing any refrigerant to the system, pressurize the system to 150 psig with dry nitrogen. Once the system has been pressurized, monitor the pressure to verify there are no leaks in the system.

2. In order to dehydrate the system, a high vacuum pump must be used to pull vacuum. Draw a vacuum of at least 50 micron (0.05 torr) and hold the vacuum for at least 2 hours. Proper system evacuation is essential because the formation of acid within the system can reduce the life of the compressor.
3. To break the vacuum on the system, supply R-407C to the discharge port near the compressor. Supply liquid refrigerant slowly until the pressure is raised to approximately 50 psig.
4. Remove the refrigerant cylinder connection from the discharge side of the system and reconnect it to the suction side.
5. Turn the system on.
 - a) Thermostat controlled systems: Set the system setpoint 5°F below room temperature to the compressor operates while the unit is charged.
 - b) Microprocessor controlled systems: Refer to the supplemental controller manual included with your system. Compressors should be set for manual control and run continuously while the unit is charged.
6. Allow the discharge pressure to rise to 225-280 psig. Refer to the unit nameplate for the unit's high side design pressure.
7. Supply liquid R-407C to the system to the suction side of the system slowly. Monitor the sight glass to clear of bubbles.
8. Measure the system superheat near the thermal expansion valve's sensing bulb - the superheat should be 12-15°F and must not exceed 20°F.
9. Measure the system sub-cooling near the outlet of the condenser. The sub-cooling should be between 10°F and 20°F.
10. Continue to add liquid refrigerant as necessary to maintain adequate sub-cooling temperature at the outlet of condenser.
11. (UNITS WITH HOT GAS REHEAT) If the unit is equipped with hot gas reheat, the unit must be charged with the reheat valve open to obtain the proper system charge. Refer to the supplemental controller manual included with your system. Heater 1 should be set for manual control and set to open while the unit is charged. After charging with the hot gas reheat valve open, verify charge with valve closed.
12. (UNITS WITH FLOODED CONDENSER CONTROL) Units utilizing flooded condenser control for low ambient conditions contain a receiver for storing extra refrigerant to flood the condenser. After charging the system, additional refrigerant must be added to the receiver.
13. Return thermostat or microprocessor to their normal settings.

2.13.2 R-410a Refrigerant

R-410A is a blended refrigerant (a near azeotropic of R-32 and R-125) formulated as a non-ozone depleting replacement for R-22 in residential and commercial air conditions and heat pumps. R-410A exhibits higher operating pressures and refrigerant capacity than R-22. Due to the higher pressures, ensure that all service tools used for charging an R-410A system are designed for use with R-410A.

Your equipment is designed specifically for use with this refrigerant, if indicated on the unit nameplate. The coil(s), compressor(s), and other components are selected specifically for R-407c refrigerant. In order to protect the compressor(s), the system is shipped with normally closed, automatically resetting low pressure switches (50 psi open, 90 psi reset) and high pressure switches (600 psi open, 475 psi reset) installed on each refrigeration circuit.

Even though R-410A retains a similar composition in both the liquid and vapor phases, it is recommended that the system be charged with liquid refrigerant only. Refer to the instructions printed on your refrigerant cylinder to verify that the cylinder is oriented properly for charging.

1. After completing all system piping connection and prior to introducing any refrigerant to the system, pressurize the system to 150 psig with dry nitrogen. Once the system has been pressurized, monitor the pressure to verify there are no leaks in the system.
2. In order to dehydrate the system, a high vacuum pump must be used to pull vacuum. Draw a vacuum of at least 50 micron (0.05 torr) and hold the vacuum for at least 2 hours. Proper system evacuation is essential because the formation of acid within the system can reduce the life of the compressor.
3. To break the vacuum on the system, supply R-410A to the discharge port near the compressor. Supply liquid refrigerant slowly until the pressure is raised to approximately 90 psig.
4. Remove the refrigerant cylinder connection from the discharge side of the system and reconnect it to the suction side.
5. Turn the system on.
 - a) Thermostat controlled systems: Set the system setpoint 5°F below room temperature to the compressor operates while the unit is charged.
 - b) Microprocessor controlled systems: Refer to the supplemental controller manual included with your system. Compressors should be set for manual control and run continuously while the unit is charged.
6. Allow the discharge pressure to rise to 335-420 psig. Refer to the unit nameplate for the unit's high side design pressure.
7. Supply liquid R-410A to the system to the suction side of the system slowly. Monitor the sight glass to clear of bubbles.
8. Measure the system superheat near the thermal expansion valve's sensing bulb - the superheat should be 12-15°F and must not exceed 20°F.
9. Measure the system sub-cooling near the outlet of the condenser. The sub-cooling should be between 10°F and 20°F.
10. Continue to add liquid refrigerant as necessary to maintain adequate sub-cooling temperature at the outlet of the condenser.
11. (UNITS WITH HOT GAS REHEAT) If the unit is equipped with hot gas reheat, the unit must be charged with the reheat valve open to obtain the proper system charge. Refer to the supplemental controller manual included with your system. Heater 1 should be set for

manual control and set to open while the unit is charged. After charging with the hot gas reheat valve open, verify charge with valve closed.

12. (UNITS WITH FLOODED CONDENSER CONTROL) Units utilizing flooded condenser control for low ambient conditions contain a receiver for storing extra refrigerant to flood the condenser. After charging the system, additional refrigerant must be added to the receiver.
13. Return thermostat or microprocessor to their normal settings.

2.13.3 Adding POE Oil

Depending on the length of your piping installation, additional POE oil may be required. After your system has been fully charged with refrigerant, this can be calculated using the equations below. If b is larger than a, then no adjustment to the compressor's oil charge is necessary.

$$\begin{array}{rclcl}
 \underline{\hspace{2cm}} & \times & 0.352 & = & \text{a. } \underline{\hspace{2cm}} \\
 \text{Refrigerant Charge} & & & & \\
 \\
 \underline{\hspace{2cm}} & \times & 0.1 & = & \text{b. } \underline{\hspace{2cm}} \\
 \text{Oil Charge} & & & & \\
 \\
 \text{a.} & - & \text{b.} & = & \underline{\hspace{2cm}} \\
 & & & & \text{Fl. Oz. of oil required}
 \end{array}$$

3. START-UP

3.1 Pre-Start-Up Checks

3.1.1 Electrical/Check Rotation

The unit has been shipped from the factory wired properly phased for all of the components. Verify proper power wiring to ensure that the fan and compressor will operate as designed. Note that improper wiring may result in the compressor being operated backwards and this will void the compressor warranty.

3.1.2 Refrigerant Charge

If the unit is a refrigerant based system, verify that the unit has been fully charged prior to attempting start-up.

3.1.3 Water/Glycol Source

If the unit utilizes water or glycol, verify that the water or glycol system is fully installed and all pumps, dry coolers, chillers, and other associated equipment are active prior to equipment start-up. Verify that interlocks with pumps have been wired, if required.

3.1.4 Blower Belts

Drive belts should be inspected prior to start-up for correct tension. Refer to the Maintenance section of this manual for information on belt tensioning.

3.2 Step-by-Step Start-Up Instructions

Refer to the supplemental controller IOM manual or the pamphlet included with the thermostat in order to complete the following procedures.

1. After completing the installation procedure and final pre-start-up checks, ensure that all tools, meters, and other items are cleared from the unit case. Replace all access panels and ceiling tiles. After verifying fan operation, panels and tiles can be removed as necessary to verify component operation.
2. Move the disconnect switch to the ON position.
3. (MC controller systems only) Verify that all system components are enabled. Refer to controller IOM manual. Note that there may be a delay of up to a minute before the fan activates.
4. Verify that the fan is operating. Airflow should be felt at the unit outlet or air device.
5. Verify cooling operation (if applicable). Set the unit's setpoint approximately 2°F above room temperature.
 - a) DX units: The compressor should activate and the air discharged from the unit should be cooler than room temperature. For units with multiple compressors, increase set point in 0.5°F increments to activate all compressors in succession.

- b) Chilled water units: The chilled water valve should be energized and the air discharge from the unit should be cooler than room temperature. Use a volt meter to check the voltage from the chilled water valve actuator and ground to verify the circuit is operational. Verify that the water temperature has increased after passing through the coil.
6. Verify heating operation (if applicable). Set the unit's setpoint approximately 5°F below room temperature. The air discharge from the unit should be warmer than room temperature.
 - a) Electric Heaters: Apply an amp meter to the electric heater circuit to verify the heater is operational.
 - b) Steam or Heating Water Heaters: Use a volt meter to check the voltage from the chilled water valve actuator to ground to verify the circuit is operational. Verify temperature has decrease after passing through the coil.
7. Verify dehumidification operation (if applicable). Set the unit's heating setpoint 2°F below room temperature to create a heating demand. Increase the unit's dewpoint temperature setpoint to create a call for dehumidification. Verify that a compressor or the chilled water valve is energized.
 - a) Hot Gas Reheat: Use a volt meter to verify the control signal to the hot gas reheat coil.
8. Verify humidifier operation (if applicable). Set the unit's humidification setpoint 10% below the current room humidity to create a call for humidification. Verify that the humidifier is activate (cylinder should be warm) with an amp meter applied to the humidifier circuit.

3.3 Thermostat Programming

Your unit may have been provided with a thermostat. Refer to the documentation accompanying the thermostat for any supplemental instructions.

3.4 Microprocessor Programming

Your unit may have been provided with a MS-100, MS-200, or MS-2015 microprocessor or other controller. Refer to the supplemental instruction manual included with the unit for programming instructions.

4. MAINTENANCE

Performing routine maintenance and inspection of your Tithe Corp. unit is imperative for maintaining peak operation condition.

4.1 Filters

A dirty filter results in increased static pressure and leads to less efficient operation. Do not wait for the dirty filter switch alarm for filter maintenance. Examine the filter monthly, as a minimum, and replace when necessary. Frequency of filter replacement will vary based on specific local conditions and outside air percentage. High outside air units will typically require filter replacement monthly.

4.2 Electrical Panels

Biannually, inspect the components in the electrical panel. Confirm that all electrical connections are tight. Check all contacts for pitting.

4.3 Blowers

Checks of the blower system should be performed biannually at minimum. Check the blower wheel for any signs of damage. Verify that the blower wheel is mounted tightly on the shaft and does not make contact with the unit housing. The squirrel cage should rotate freely. Check that the blower motor mounts, all housing bolts, and all electrical connections are secure.

The blower motor features permanently lubricated bearings and should not require lubrication during the useful life of the equipment.

4.4 Belts

Drive belts should be examined prior to start-up and then checked monthly for wear and correct tension. An over tensioned belt can cause wear; an under tensioned belt can cause slippage and excessive noise. If the two legs of the belt are pressed in midway between the pulley and the sheave, a properly tensioned belt will result in 1 to 1-1/2 inches of movement. Belt tension can be adjusted by means of the adjusting bolt attached to the motor bracket. Larger units may have motors mounted to a support on the bottom pan, which requires loosening of four nuts to adjust the motor location and change belt position.

4.5 Coils

All cooling and heating coils should be maintained biannually. Inspect the coil for bent or damaged fins and repair if necessary. Clear all debris from the coil(s) using industry standard coil cleaning techniques. Check all coil connections for signs of damage or leakage and repair as necessary.

4.6 Drain Pan

Prior to start-up, pour a small amount of water into the drain to fill the p-trap to ensure proper drainage and trap seal. Inspect the drain pan monthly to verify it is free from debris and leaks. Verify that the drain is clear and that the drain pan is draining properly.

4.7 Refrigeration System

Biannually, inspect the refrigerant system. Check the sight glass to verify adequate charge and to verify that the system is moisture free. Check the suction and discharge pressures to verify proper system operation. Inspect refrigerant piping for signs of damage or leaking.

4.7.1 Air Cooled System

Follow the maintenance recommendations for blowers, belts, and coils. During winter operation with a remote outdoor condenser/condensing unit, do not allow snow to build up on or around the unit.

4.7.2 Water/Glycol System

Biannually, inspect the water or glycol piping and any valves for signs of leakage or corrosion. Check the glycol solution concentration to ensure it meets the system requirements.

4.8 Chilled Water System

Biannually, inspect the water piping and control valve for any signs of leakage or corrosion.

4.9 Optional Features

4.9.1 Condensate Pump

Verify that the float operates freely on a monthly basis. Biannually, clean the condensate pump.

4.9.2 Humidifier

Examine the humidifier cylinder on a monthly basis for build-up. Refer to the supplemental humidifier IOM manual for further information.

4.10 COMPRESSOR FAILURE

In DX units, the compressor is the centerpiece of the system; all other refrigerant components are selected and designed to maximize compressor life. Tithe Corp. units contain a number of features to protect the compressor, including filter-driers, high and low pressure switches, and minimum run times. In spite of these protective measures, compressors are still susceptible to failure through a variety of mechanisms.

Compressors may fail by either mechanical or electrical means. The mode of failure will determine the steps necessary to return your Tithe Corp. unit to working order. Electrical failures will be accompanied by a pungent odor at the compressor and the motor will not run. A mechanical failure will not be

accompanied by an odor. The motor may run, but operation may be accompanied by abnormal and/or excessive noise. In either case, a new compressor will be required.

In order to determine the proper method of cleaning prior to installing the new compressor, an analysis of the oil in the failed system is recommended. Procure a commercially available acid test kit and follow the instructions to determine if there is acid in the system. In lieu of performing an acid test, a visual comparison of a pristine sample of oil to the oil in the failed compressor may be made. If no acid is detected in the system, perform the following Standard Cleanout Procedure. If the system tests positive for acid contamination, perform the following Acidic Cleanout Procedure.

Note: Improper refrigeration system cleaning following a failure will void the warranty on the replacement compressor. Always consult the factory prior to replacing the compressor.

4.10.1 Standard Cleanout Procedure

Parts required: new compressor, new liquid line filter-drier one size larger than the original.

1. Reclaim the refrigerant from the system.
2. Remove the old compressor and filter-drier.
3. Verify that the replacement compressor is filled with POE oil. Install the new compressor.
4. Install a new filter-drier.
5. Recharge the unit - refer to the System Charging instructions under the Installation section of this IOM manual.
6. Follow the standard Start-Up procedures to restart the unit.

4.10.2 Acidic Cleanout Procedure

Parts required: new compressor, new liquid line filter-drier one size larger than the original, new suction line filter-drier (acid removal model).

1. Reclaim the refrigerant from the system.
2. Remove the old compressor and filter-drier.
3. Examine the sight glass, thermal expansion valve, and all other valves for proper operation. Clean if necessary.
4. Verify that the replacement compressor is filled with POE oil. Install the new compressor.
5. Install the new liquid line filter-drier.
6. Install the new suction line filter-drier designed for acid cleanup duty in the suction line near the inlet of the compressor.
7. Recharge the unit - refer to the System Charging instructions under the Installation section of this IOM manual.
8. Follow the standard Start-Up procedures to restart the unit.
9. Check the pressure drop across the suction line filter-drier at the end of the first hour of operation. If the pressure drop is excessive (refer to documentation included with the suction line filter-drier for guidelines), replace filter-drier.

10. After 24 hours of operation, take an oil sample. Test oil for acidity. If the sample is acidic, replace the suction line filter-drier.
11. After 2 weeks of operation, take an oil sample. Test oil for acidity. If the sample is acidic, replace the filter-drier. Repeat test as necessary in two week increments until the sample is no longer acidic.

5. TROUBLESHOOTING

5.1 Common Problems

The following table lists potential problems that you may encounter with the system, probable causes, and steps to follow to diagnose the call. Prior to performing any work in the cabinet, close and lockout the disconnect (unless the unit is required to be operational for the investigative procedure). Follow through each diagnostic step in order, they are ordered from most likely cause/least expensive repair to less likely cause/more expensive repair.

Problem	Possible Cause	Checks & Solutions	
Unit will not start	Display/T-Stat Wiring	Verify Power to Display/T-Stat »If no power: Check that wiring is tight and verify points of connection with wiring diagram.	
	System not enabled (MC Controller only)	Refer to controller IOM	
	System locked out		Check remote on/off and compressor lockout switches.
			Check alarms. »If active alarm: Troubleshoot alarm, then refer to controller IOM to re-enable system.
	No power to the unit		Verify disconnect is on.
			Check disconnect fuses. »If fuse is blown: check for shorts and replace fuse.
			Check voltage at terminal block. »If voltage: check that wiring in unit is tight, fuses are in tact, and circuit breaker on control transformer. »If no voltage: check distribution wiring and circuit breaker/fuse box.
	Unit wiring issue		Examine unit wiring diagram »Verify that all switches are wired NC, or as indicated.
			»Verify all indicated jumpers are in place.

Problem	Possible Cause	Checks & Solutions
Compressor high pressure alarm (DX/heat pump only)	Condenser is obstructed (air-cooled units only)	Check condenser for debris, blockage, or damage. »If damage or blockage, clean condenser and/or repair fins.
	Condenser fan is not operating (air-cooled units only)	Verify that condenser relay is pulling in. »If relay does not pull in: Verify 24 V signal to relay. If proper voltage is applied and relay does not operate, replace relay. »If relay pulls in: Verify voltage to condenser fan.
		Verify power wiring to condenser fan is tight.
		Examine condenser fan for damage.
	No/inadequate fluid flow through the condenser (water/glycol units only)	Verify fluid flow to the condenser. »If fluid flow is low: adjust valve so fluid flow meets design parameters.
		Check entering fluid temperature. »If entering fluid temperature is high: troubleshoot fluid loop.
		Check leaving fluid temperature »If leaving fluid temperature is low: troubleshoot refrigerant system for obstruction.
	Overcharge of refrigerant	Check refrigerant system temperatures and pressures. Reclaim excess refrigerant.
Obstruction in filter-drier	Check filter drier »If significantly colder on leaving side: replace filter-drier.	
Compressor low pressure alarm (DX/heat pump only)	Loss of refrigerant	Check sight glass »If bubbles are visible: Recharge unit. »On multiple recharges: Reclaim refrigerant, leak test unit, repair any leaks, replace filter-drier, recharge unit.
	Expansion valve obstructed or non-operable	Remove expansion valve and clean or replace. Replace filter-drier.

Problem	Possible Cause	Checks & Solutions
No Cooling	No cooling demand	Check system setpoints.
No Cooling (DX system and heat pumps only)	Compressors not enabled (MC Controller only)	Refer to controller IOM to enable compressors.
	Compressor high pressure alarm	Refer to compressor high pressure alarm trouble shooting.
	Compressor short cycle prevention	Wait for three minute time delay for compressor to reset.
	No power to compressor	Verify compressor relay is pulling in. »If relay is not pulling in: Check for 24 V control signal. If proper voltage is applied and relay does not operate, replace relay.
	Low refrigerant charge	Check sight glass for bubbles. Check refrigerant pressure. »If refrigerant is low, recharge unit.
	Obstruction in filter-drier	Check filter drier »If significantly colder on leaving side: replace filter-drier.
No Cooling (Chilled water system)	No/inadequate water flow	Verify chilled water flow to valve »If no flow to to the valve: trouble shoot chilled water system.
	Entering water temperature too high	Check entering water temperature »If high water temperature: trouble shoot chilled water system.
	No control power to actuator	Check for 0-10 V or 24 V signal from controller to chilled water valve actuator. »If refrigerant is low: recharge unit.
	Faulty Actuator	Replace actuator.
Noisy compressor	Unit improperly phased	Verify unit wiring matches wiring diagram. »If incorrectly phased: rewire unit at terminal block.
	Liquid Slugging	System overcharged - verify system charge. »If overcharged: reclaim excess refrigerant
	Worn Bearings	Replace compressor.
	Broken Compressor Valve	Replace compressor.

Problem	Possible Cause	Checks & Solutions
Blower does not start	System locked out on alarm	Verify unit is not in alarm condition.
	Fan set in auto mode (MC controller only)	Refer to controller IOM.
	No control power to fan relay	Verify that all wiring is tight. Verify that condenser relay is pulling in. <i>»If relay does not pull in: Verify 24 V signal to relay. If proper voltage is applied and relay does not operate, replace relay.</i> <i>»If relay pulls in: Verify voltage to blower.</i>
No heat/reheat	No heat/reheat demand	Check system setpoints.
	No power to heater	Verify that heater relay is pulling in. <i>»If relay does not pull in: Verify 24 V signal to relay. If proper voltage is applied and relay does not operate, replace relay.</i> <i>»If relay pulls in: Verify voltage to heater.</i>
	Refer to supplemental manual included with heater.	
Optional humidifier does not operate	No humidification demand	Check system setpoints.
	No power to heater	Verify that humidifier relay is pulling in. <i>»If relay does not pull in: Verify 24 V signal to relay. If proper voltage is applied and relay does not operate, replace relay.</i> <i>»If relay pulls in: Verify voltage to humidifier.</i>
	Refer to supplemental manual included with humidifier.	

5.2 Technical Support

Tithe Corp. is dedicated to supporting its product installations. If a problem arises that cannot be handled through following the directions in this manual or one of the supplemental manuals included with your unit, contact Tithe Corp. at (410) 625-7545 Monday through Friday from 7:00 AM to 4:00 PM Eastern Standard Time. You may also reach us at HelpDesk@TitheCorp.com

So that we can provide prompt and accurate support, please have the following information available when you call:

- Your Name/Company/Phone Number
- Job Number (8 digits printed on the unit nameplate)
- Serial Number (6 digits printed on the unit nameplate)
- Model Number (printed on the unit nameplate)
- Date of Manufacture (printed on the unit nameplate)
- A brief description of the problem

If a problem occurs outside of the business hours, leave a message with the aforementioned information and one of our support staff will return your call as soon as possible.

5.3 Warranty Parts

All warranty inquiries are handled through technical support. After troubleshooting the unit with a qualified field service technician, a determination will be made on whether a part(s) may be defective. If a part is determined to possibly be defective through the troubleshooting process, a replacement part will be shipped to the address provided by the customer.

A purchase order is required for all warranty parts. The following information is required:

- Customer Contact Name
- Customer Billing Address
- Credit Card Authorization or Approved Credit
- Customer Shipping Address
- Customer Telephone Number
- Date of Order
- Unit Serial Number

A Return Material Authorization (RMA) number will be provided for the defective part(s). Clearly note the RMA number on the address label. The customer is responsible for the shipping cost to return the defective part(s) to the Tithe Corp. factory. The defective part(s) must be returned within 30 days for evaluation by the service department. If the part is found to be defective after examination by the technical support team, a credit will be issued. Refer to the warranty certificate included in the Introduction section of this IOM manual for further details.

5.4 Spare and Replacement Parts

Requests for spare and replacement parts are made through the service department at Tithe Corp. at (410) 625-7545. Quotes will be provided for the specified parts for a specific unit. Visa and Mastercard or approved credit with Tithe Corp. are acceptable forms of payment.

Any returned parts sold as spare/replacement items will be subject to a 25% restocking charge. If the part is not a stocked item, a 50% restocking charge will be applied. In order to return a part, contact Tithe Corp. at (410) 625-7545 for a Return Material Authorization (RMA) number. Parts are eligible for return for 15 days after the original purchase date and must be returned in their original packaging with all associated materials. Spare or replacement parts sales over 15 days are not eligible for return.

GENERAL PROCEDURE TO CLEAN AC COILS

Clean air conditioner coils once a year. Early spring is the best time for cleaning AC coils and can help prevent emergency summer maintenance calls.

AC EVAPORATOR COIL is located in the building and most commonly located inside the blower compartment of the air handler. AC CONDENSING COIL is located in the outdoor unit or inside in a packaged system.

CLEAN AIR CONDITIONER COILS at least once a year during a routine maintenance appointment.

!!!!!!DISCONNECT POWER TO THE AIR CONDITIONER!!!!!!

REMOVE OUTER CASE OR ACCESS PANELS TO ACCESS THE COIL

REMOVE TOP OF AIR CONDITIONER WHEN REQUIRED TO REACH COIL

Some air conditioners are constructed with the fan assembly attached to the top. If the air conditioner is constructed this way, be careful not to stretch or damage any connected or loose wires.

CLEAN AND LUBRICATE ASSEMBLY

Clean any dirt off the fan blades and use a shop vacuum to clean dirt off the fan motor and shaft. If the motor requires any lubrication, a small amount should be applied to each of its lubrication ports.

CLEAN A/C COILS. Dirt will be whisked away from the surface of the coils with a broom.

SPRAY TRAPPED DIRT AWAY FROM COILS. After covering any exposed wires or motors with plastic, using either water or a biodegradable foaming cleaner, spray cleaner onto the coil surface from top to bottom and allow to soak for 10 to 15 minutes on the coils.

REMOVE CLEANER by spraying rinse water from the inside, top to bottom to remove the cleaner and any dirt away from the air conditioner coils.

INSPECT COIL FINS FOR DAMAGE. Using a special comb, a specialist can straighten any bent coil fins to assure optimal airflow through the coil.

REASSEMBLE THE AIR CONDITIONER after the coils are clean.

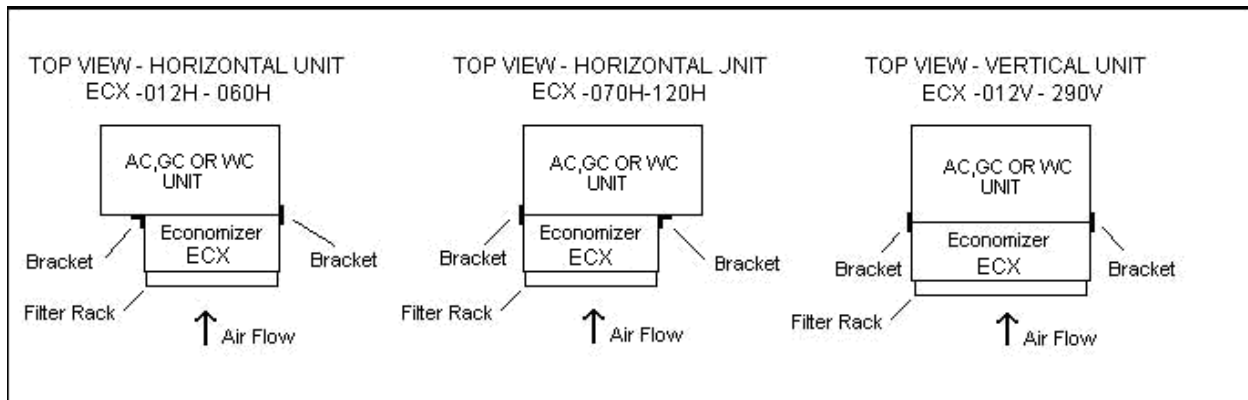
**ECONOMY
COOLING COIL
-ECX-
INSTALLATION AND
OPERATIONS
MANUAL**

ABOUT THE ECONOMY COOLING COIL

The Economy Cooling Coil is designed to be an add-on unit to provides the ability to utilize “free cooling” when the water being used for the condenser is below 45 degrees F (adjustable) and there is a call for cooling. In free cooling mode, the water is redirected through the Economy Cooling Coil and the compressors in the unit are turned off. This saves energy and is an efficient means of providing cooling to the area.

MECHANICAL INSTALLATION - ECONOMIZER:

The Economizer **MUST** be supported separately from the unit, but does install flush against the front of the unit. Horizontal Units (ECX-xxxH): Hangers are attached to provide points for hanging from the structure above. Vertical Units (ECX-xxxV): The unit must be supported from below (optional floor stands are available), or if desired from above (hangers are not included). If the unit has a filter rack installed, it must be removed before installing the Economizer. An optional filter rack can be purchased for the Economizer. The installer could also attempt to remount the filter rack on the Economizer unit. Support the Economizer so that it sits flush against the return air side of the unit. The piping on the economizer should be located on the same side as the piping on the unit. If a filter rack was purchased with the Economizer, then it will be present on the exposed end of the unit. Horizontal Units: The end of the economizer opposite to the piping is to be flush with the side of the unit. The top of the Economizer should be flush with the top of the unit. Vertical Units: The Economizer should be flush with the top of the unit, and flush on both sides.



Once the economizer is supported flush and properly aligned with the unit, attach the mounting brackets to the units to ensure they remain sealed together. There will be (1) angle bracket (only for Horizontal Units) and (1 or 2) flat bracket(s). The angle bracket is to be installed on the piping end of the unit for the horizontal unit.

The flat bracket is to be installed on the flush end(s) of the unit. First, confirm that the units are aligned. If not, adjust the hangers or supports accordingly. To install the brackets, first position the brackets over the mating holes provided on the economizer (the brackets will be located half way up on each side of the Economizer unit. Hold the brackets so that they are aligned with the unit. Confirm that the holes of the Economizer still line up with the slots on the bracket(s). Clean the surfaces of the unit in the areas where the brackets will be mounted with isopropyl alcohol and allow to dry. Mark the position of the brackets on the unit, and remove the brackets. Remove the adhesive backing and place the bracket(s) in the exact marked position. Press firmly to ensure good adhesion. Once the bracket is stuck to the unit, attach the other end to the

Economizer using the screws provided, ensuring that the sealing foam between the units is slightly compressed. If needed due to misalignment, new holes can be drilled in the corner pieces of the Economizer by the installer. **DO NOT DRILL HOLES INTO THE UNIT!!** You may damage the coil at that end!

PIPING INSTALLATION – ECONOMIZER

There are three piping connections on the Economizer: Drain, Water In, and Water Out. The Water In and Water Out lines are Drain: 3/4" FPT gravity drain connection at the bottom of the unit. It is used to remove condensate from the pan. Pipe accordingly. Water In and Water Out: These connections are the same size as the water condenser connections. Follow the piping schematic closely with regard to the piping arrangement and the port connections of the 3-way valve. The Water In pipe of the Economizer is connected to the condensing water inlet piping of the unit. The Water Out pipe of the Economizer is connected to a 3-way valve (included in optional Controls Package). To get the best heat transfer, the connection used for Water In on the Economizer should be the one furthest from the air filter side of the Economizer.

INSTALLATION – CONTROLS PACKAGE (OPTIONAL)

In order to properly control the economizer function, a water temperature sensor, relays, oversized control transformer, and 3-way control valve are required. These are included in the optional controls package. If you did not purchase this option, you may provide your own controls by following the information provided in the wiring schematic.

The Electrical Box should be mounted by the installer within 5 feet of the water inlet piping to the system. The Aqua-stat (temperature sensor) bulb must be firmly attached to the water inlet pipe in order to determine the inlet water temperature. The Economizer coil is sized based on utilizing 45 degree entering water, so the Aqua-stat dial should be set to 45.

The 24VAC (75VA) transformer provided in the controls package is to replace the existing control transformer (40VA) in the unit. This is necessary due to the additional power requirements of the control valve.

CAUTION!!

Ensure that all power is removed from the unit before proceeding.

Make a note of the wire terminations of the existing 40VA transformer. Remove the 40VA transformer from the unit. Install the new 75VA transformer provided and wire to the unit following the transformer instructions and terminating the appropriate wires to the same locations as the previous transformer. Following the provided wiring schematic, run the low voltage (24VAC) wiring from the unit to the Controls Package Electrical Box. Also run the low voltage wiring from the 3-way valve actuator to the Controls Package Electrical Box.

TESTING

Power the unit. Turn the Aqua-stat setting as low as possible at the Controls Package Electrical Box. Temporarily jumper between R and Y1 at the unit low voltage terminal strip (this will simulate a call for cooling). Allow the compressor(s) to come on. Turn the Aqua-stat setting up slowly until you hear it click. The compressor(s) should turn off and the 3-way valve should actuate to allow water to flow freely through the Economizer coil. Remove the temporary jumper between R and Y1 at the unit low voltage terminal strip.

If it does not appear to be working properly, first check that the wiring and piping follow the schematics provided. Read the concept information on the wiring schematic for clarification on the operating principle. If you cannot determine the cause of the problem, please contact the factory for assistance: 1-800-625-7545.

Your Economizer is ready to cool!!