



Modular Air Tower Split System

Installation, Operation, & Maintenance Manual

NOTICE

Installer:

Please take the time to read and understand the instructions contained inside this manual prior to any installation. The installer must give a copy of this manual to the unit owner.

Owner:

Keep this manual in a safe place in order to provide service technicians with necessary unit information.

NOT FOR RESIDENTIAL USE

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Section 1: Safety Introduction and Labeling Guide:

Your Safety is Important to Us!

Please follow and understand the rules and the instructions contained herein carefully. Failure to do so could cause a malfunction of the HVAC equipment, resulting in injury, death and/or property damage.

Throughout this manual, and in specific places on the unit itself, the signal words **DANGER**, **WARNING** and **CAUTION** are used to identify levels of hazard seriousness. **NOTICE** will be used in areas where there is important information but not hazard related.

- **DANGER** – Immediate hazards which **WILL** result in severe personal injury or death.
- **WARNING** – Hazards or unsafe practices which **COULD** result in severe personal injury or death.
- **CAUTION** – Hazards or unsafe practices which **COULD** result in minor personal injury or product or property damage.
- **NOTICE** – Information to consider that might result in poor operation, or equipment damage/failure.

DANGER

DANGER labels will feature white text on a red background.

WARNING

WARNING labels will feature white text on an orange background.

CAUTION

CAUTION labels will feature white text on a yellow background.

NOTICE

NOTICE labels will feature white text on a black background.

WARNING

Improper installation, service, or maintenance can result in death, injury, or property damage. Read this installation, operation, and maintenance manual thoroughly before installing or servicing this equipment.

Installation must be done by a registered installer/contractor qualified in the installation and service of HVAC equipment.

These instructions, local codes and ordinances and applicable standards that apply to piping, electrical wiring, ventilation, etc. must be thoroughly understood before proceeding with the installation.

Protective gear is to be worn during installation, operation and service in accordance to the Occupational Safety and Hazard Administration (OSHA). Gear must be in accordance to NFPA 70E, latest revision when working with electrical components. Thin sheet metal parts have sharp edges. To prevent injury, the use of work gloves is recommended.

This equipment must be applied and operated under the general concepts of reasonable use and installed using best building practices.

This equipment is not intended for use by persons (including children) with reduced physical, sensory or mental capabilities, or lack of experience and knowledge, unless they have been given supervision or instruction concerning use of the equipment by a person responsible for their safety.

Children should be supervised to ensure that they do not play with the equipment.

To obtain additional copies of the Installation, Operation and Maintenance Manual, please contact Global IFS.

For detailed information regarding specifications, dimensional drawings, and weight information, contact your local Global IFS manufacturer's representative.

Section 2: Introduction and Pre-Installation:

2.1 - Description of Operation

The MAT Series is a split air handler HVAC system that can operate within a broad range of ambient conditions and introduce conditioned air into a building at desired temperatures. It consists of either a chilled water coil or a matched refrigeration system, and air moving components designed to treat outside air and/or recirculated air. This system has the ability to filter, cool, or heat air.

The unit may be provided with several different options and/or controls to meet various application requirements, including optional supplemental hot water heat and variable air volume delivery. Be sure to read this entire manual before installation and start-up.

2.2 Inspection and Setup

Immediately upon receipt of the unit, check the electrical supply and characteristics of the unit and verify that they match the electrical supply available. Verify that the specifications on the unit rating plate match your order. Check the unit for any damage that may have occurred during shipment, including internal piping. ***If any damage is found, file a claim with the transporting agency. Do not refuse shipment.*** Check the installation location to ensure proper clearances. See Section 4.

Any small options (if so equipped) which do not come attached to the unit (i.e. sensors) will be found inside the condensing unit control enclosure.

If the unit must be temporarily stored (i.e. job site is not ready for installation of the unit), the unit should be covered to be protected from the environment. Indoor air handler sections cannot be stored outside.

2.3 - Unit Nomenclature Example

| Digit: | Description: | Feature: |
|--------|----------------------|--|
| 1 - 2 | Product Family | MA = Modular Air Handler |
| 3 | Application | T = Air Tower |
| 4 | Operation Type | F = Chilled Water Coil D = DX Coil |
| 5 - 8 | Coil Size | 0000 = None 0007 = DX Coil - 7sqft 0016 = DX Coil - 16sqft 0028 = DX Coil - 28sqft 0008 = Chilled Water Coil - 8sqft 0014 = Chilled Water Coil - 14sqft 0029 = Chilled Water Coil - 29sqft |
| 9 | Cabinet Size | A = A Cabinet B = B Cabinet C = C Cabinet |
| 10 | Controls | 0 = None (Non-DX) |
| 11 | Voltage | 2 = 208/60/3 3 = 230/60/3 4 = 460/60/3 |
| 12 | Vintage | A = Current |
| 13 | Air Flow Orientation | L = Right Hand Coil, Top OA Inlet, Downflow M = Right Hand Coil, Top and Right Side OA Inlet, Downflow N = Right Hand Coil, Right Side OA Inlet, Downflow P = Right Hand Coil, No OA Inlet, Downflow Q = Left Hand Coil, Top OA Inlet, Downflow R = Left Hand Coil, Top and Right Side OA Inlet, Downflow S = Left Hand Coil, Right Side OA Inlet, Downflow T = Left Hand Coil, No OA Inlet, Downflow |
| 14 | Blower Type | A = EC 350mm B = EC 450mm C = EC 500mm D = EC 560mm E = Dual EC 450mm F = Dual EC 500mm G = Dual EC560mm H = EC 500mm High Static J = Dual EC 500mm High Static |
| 15 | Frame Construction | 3 = Thermal Break Frame with 8" Base F = Thermal Break Frame with 10" Base H = Thermal Break Frame with 12" Base |
| 16 | Supply Motor Control | 0 = None 1 = EC Motor CV 3 = EC Motor with Air Monitoring Station (CAV Only) |

Note: See unit data plate for specific configuration and options.

2.3 - Unit Nomenclature Example

| Digit: | Description: | Feature: |
|---------|----------------------|---|
| 17 - 18 | Future Use | 00 = None |
| 19 | Future Use | 0 = None |
| 20 | Future Use | 0 = None |
| 21 - 22 | Future Use | 00 = None |
| 23 | Heating Type | 0 = None |
| | | B = Hot Water Coil |
| 24 | Heating Capacity | 0 = N/A |
| 25 | Heating Control | 0 = None |
| | | 5 = Hot Water Coil Heating Control |
| 26 | Ventilation | 0 = None |
| | | C = OA Position Damper without Actuator |
| | | D = Dual OA Position Dampers without Actuators |
| 27 - 28 | Corrosion Protection | 00 = None |
| | | A1 = Corrosion Protection Coating - Cabinet |
| | | B1 = Corrosion Protection Coating - Evaporator Coil |
| | | E1 = Corrosion Protection Coating - Hot Water Coil |
| | | F1 = Corrosion Protection Coating - Chilled Water Coil |
| | | AA = A1 + B1 |
| | | AD = A1 + E1 |
| | | AE = A1 + F1 |
| | | BC = B1 + E1 |
| | | CC = A1 + B1 + E1 |
| | | HA = A1 + E1 + F1 |
| | | JA = E1 + F1 |
| 29 | Maintenance Options | 0 = None |
| | | 2 = Condensate Overflow Switch |
| 30 | Safety Controls | 0 = None |
| 31 | Return Air Filter | A = 2" Pleated Surface - MERV 13 |
| 32 - 33 | Future Use | 00 = None |

Note: See unit data plate for specific configuration and options.

Section 3: Installer Responsibility:

The installer is responsible for the following:

- To install and commission the unit, as well as the electrical supplies, and chilled/hot water (if equipped), in accordance with applicable specifications and codes. Global IFS recommends the installer contact a local building inspector for guidance.
- To use the information given in a layout drawing and in the manual together with the cited codes and regulations to perform the installation.
- To furnish all needed materials not furnished as standard equipment, including all interconnecting refrigerant piping.
- To plan location of supports.
- To provide access to unit for servicing.
- To provide the owner with a copy of this Installation, Operation and Service Manual.
- To ensure there is adequate air circulation around the unit and to supply air for ventilation and distribution in accordance with local codes.
- To assemble or install any accessories or associated duct work using best building practices.
- To properly size supports and hanging materials.
- To verify that the unit is delivering design airflow by having an air balancing test performed.
- To have refrigerant technician certification per Section 608 of the US Environmental Protection Agency (EPA) Clean Air Act of 1990 or equivalent certification program.
- To have all required equipment to work on direct expansion and/or chilled water air conditioning system.
- Install any ship loose parts.

3.1 Corrosive Chemicals

Global IFS cannot be responsible for ensuring that all appropriate safety measures are undertaken prior to installation; this is entirely the responsibility of the installer. It is essential that the contractor, the subcontractor, or the owner identifies the presence of combustible materials, corrosive chemicals or halogenated hydrocarbons* anywhere in the premises.



** Halogenated Hydrocarbons are a family of chemical compounds characterized by the presence of halogen elements (fluorine, chlorine, bromine, etc.). These compounds are frequently used in refrigerants, cleaning agents, solvents, etc. If these compounds enter the air supply of the burner, the life span of the unit components will be greatly reduced. An outside air supply must be provided to the burners whenever the presence of these compounds is suspected. Warranty will be invalid if the unit is exposed to halogenated hydrocarbons.*

3.2 Required Equipment and Materials

When lifting of the unit is required, the installing contractor is responsible for supplying or arranging for the appropriate lifting equipment so that the unit may be placed in a safe manner.

The qualified installing / service technician is responsible for having the appropriate equipment and materials for the safe installation and start-up of a unit. Tools and materials required to commission the unit include, but are not limited to, the following:

- Various screwdriver types and sizes
- Various wrench types and sizes
- Drill motor and various drill bits
- Voltmeter
- Clamp style ammeter
- Butyl caulk
- Gauges and accessories
- Direct expansion and/or chilled water gauges and accessories.
- Refrigerant
- Refrigerant oil

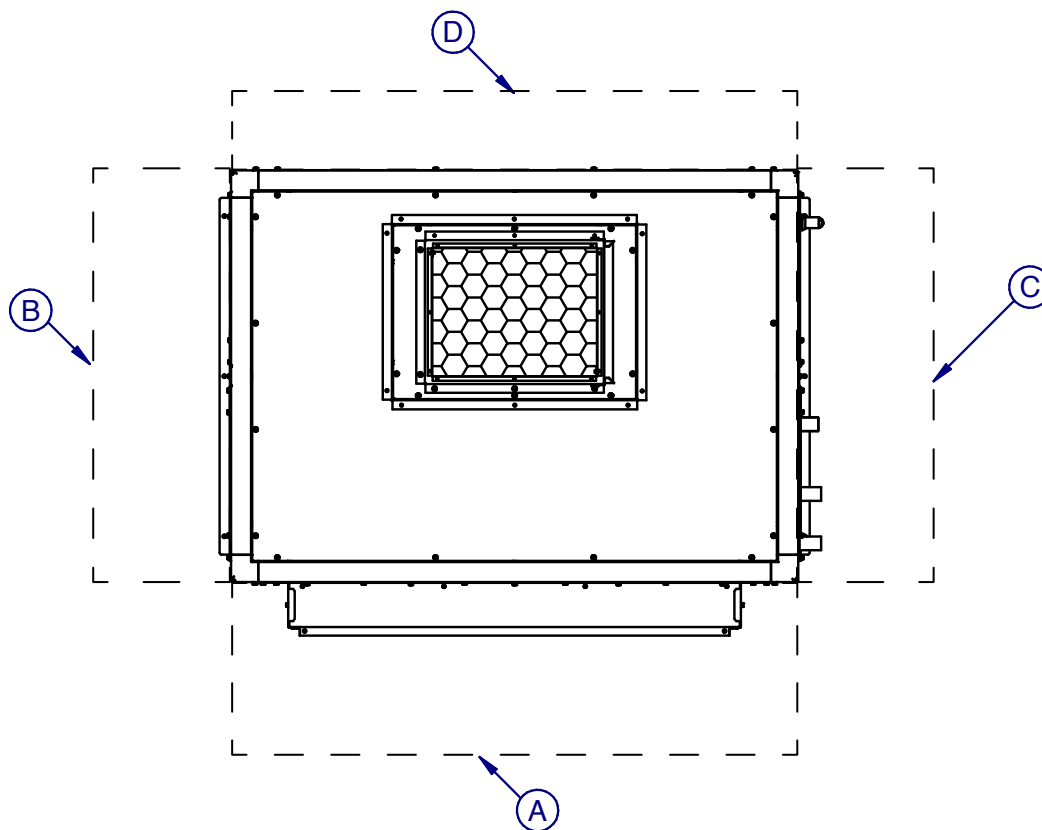
Section 4:

Critical Considerations:

4.1 Required Clearances

Clearances are the required distances that the unit must be away from objects and other units to allow service access and proper operation of the unit.

Figure 1: Air Handler Clearances



TOP VIEW

| UNIT CLEARANCES | | | | |
|-----------------|-----|-------------------------|--------------------|--|
| AREA | DIM | DESCRIPTION | REQUIRED/SUGGESTED | NOTE |
| A | 36" | SUPPLY BLOWER ACCESS | REQUIRED | MINIMUM CLEARANCE FROM GROUNDED AND UNGROUNDED STRUCTURES. |
| C | | AIR COIL ACCESS | | |
| B | 12" | BACK OF AIR COIL | SUGGESTED | |
| D | | ALTERNATE BLOWER ACCESS | | |

4.2.1 Air Handler Placement Considerations

When locating the air handlers, make sure there is sufficient free area to allow for adequate airflow to the filters. The air handler must be situated so that it can be serviced and the filters changed. Access panels are located on four sides of vertical units and two sides of horizontal units. However, consideration for access of the supply fan are important when locating the units adjacent to walls or other units.

The cabinets of these units are well insulated. In most installations, this construction will prevent sweating on the outside of the unit. However, in cases where units are installed in areas where high humidity conditions are prevalent, it is recommended that an insulated watertight pan with adequate drain connection be constructed and installed under the air handler. This separate drain pan should extend approximately 2" beyond the unit on all sides to ensure collection of any condensate forming on the outside of the cabinet. When this additional pan is used, the unit must not be supported by the pan.

Air handlers are designed for a ducted supply application. Inlet air may be ducted as required.

4.2.2 Ventilation Clearances - Outdoor Condensing Units (If Applicable)

In order to help ensure proper operation of an air-source constructed unit, a 24" (61.0 cm) clearance for ventilation must be maintained.

In addition, read and follow the additional ventilation clearance guidelines below:

- Do not locate the condensing unit under an overhang or near a wall/other equipment that will short circuit hot air to the coil intakes.
- Do not locate condensing unit within 10' (3.0 m) of exhaust fans or flues.
- Do not locate the condensing unit within 48" of another condensing unit to allow air recirculation.

4.3 Hardware

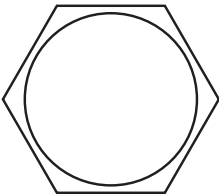
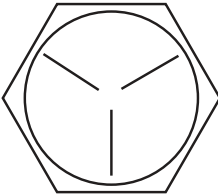
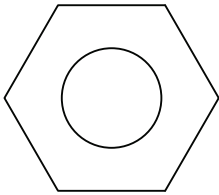
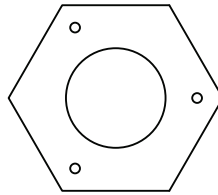
Unless otherwise specified, all hardware (except sheet metal screws) must be torqued to settings from Table 1.



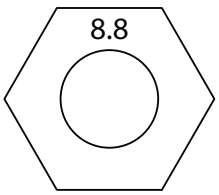
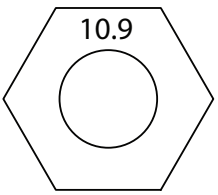
4.4 Ship-With Parts

Some options (if selected) may include parts that will require field installation. These parts are included loose with the shipment of the unit, inside the control panel.

- Dampers
- Damper Actuators

Table 1: Recommended Torque Settings

| | | |
|------------------------------------|--|---|
| Bolt Head Grade Marking |  |  |
| Nut Grade Marking |  |  |
| Bolt Size: | Grade 2: | Grade 5: |
| 10-24 | 27 in-Lb | 42 in-Lb |
| 1/4-20 | 65 in-Lb | 101 in-Lb |
| 5/16-18 | 11 ft-Lb | 17 ft-Lb |
| 3/8-16 | 19 ft-Lb | 30 ft-Lb |

| | | |
|------------------------------------|--|---|
| Bolt Head Grade Marking |  |  |
| Nut Grade Marking |  |  |
| Bolt Size: | Grade 2: | Grade 5: |
| M5 | 6Nm | 9Nm |
| M6 | 10Nm | 15Nm |
| M8 | 25Nm | 35Nm |
| M10 | 50Nm | 75Nm |
| M12 | 85Nm | 130Nm |
| M16 | 215Nm | 315Nm |

Section 5: National Standards and Applicable Codes:

5.1 Refrigerant Handling Practices

The handling, reclaiming, recovering and recycling of refrigerants as well as the equipment to be used and the procedures to be followed must comply with the national and local codes.

United States: Refer to Federal Clean Air Act - latest revision.

Canada: Refer to Canadian Environmental Protection Act - latest revision.

5.2 Installation Codes

Installations must be made in accordance with NFPA 90A - latest revision, Standard for the Installation of Air-Conditioning and Ventilation Systems.

5.3 Aircraft Hangars

Installation in aircraft hangars must be in accordance with the following codes:

United States: Refer to Standard for Aircraft Hangars, NFPA 409 - latest revision.

Canada: Refer to Standard CSA B149.1 - latest revision, Natural Gas and Propane Installation Code.

5.4 Parking Structures and Repair Garages

Installation in garages must be in accordance with the following codes:

United States: Standard for Parking Structures NFPA 88A - latest revision or the Code for Motor Fuel Dispensing Facilities and Repair Garages, NFPA 30A - latest revision.

Canada: Refer to CSA B149.1 - latest revision, Natural Gas and Propane Installation Code.

5.5 Electrical

Electrical connection to unit must be in accordance with the following codes:

United States: Refer to National Electrical Code®, NFPA 70 - latest revision. Wiring must conform to the most current National Electrical Code®, local ordinances, and any special diagrams furnished.

Canada: Refer to Canadian Electrical Code, CSA C22.1 Part 1 - latest revision.

Section 6:

Lifting a Air Handling Unit:

The unit must be installed in compliance with all applicable codes. The qualified installer or service technician must use best building practices when installing the unit.

6.1 Moving/Lifting the Unit

6.1.1 Preparing to Move/Lift the Unit:

Prior to moving/lifting the unit, the following steps must be performed.

1. Remove all packaging or blockers.
2. Remove all packages that were shipped inside the unit.
3. Inspect the unit to:
 - Verify that there is no damage as a result of shipping.
 - Ensure that it is appropriately rated for the utilities available at the installation site.
 - Ensure factory-installed hardware is torqued as specified.
4. Prepare the installation location to be ready to accept the unit.
5. Verify that the moving/lifting equipment can handle the unit's weight. Verify that forklift forks extend through the unit frame and that crane has required reach.

6.1.2 Moving the Unit with Forklift

Move the unit using forklift pockets in the shipping pallets. Insure that the forklift forks are evenly spaced, and go completely through both sides. Weight should be evenly balanced and centered with the forklift.

| | |
|--|--|
|  | |
| WARNING | |
|  | CRUSH HAZARD Use proper lifting equipment and practices. Failure to follow these instructions can result in death, injury, or property damage. |

6.2 Moving the Unit Into Position

The MAT unit is comprised of three sections; the unit base frame, the supply blower section, and the air coil section. These sections are shipped split on two pallets to better facilitate moving into the installation space.

Each section should be moved into place either via an overhead wench, or a hand-crank lift table.

Flanges are provided along the side of each section for alignment, and to secure each section together. Once the unit is in-place, and properly aligned, use the supplies screws to fasten.

Table 2: MAT Air Handler Unit Weights

| Cabinet | Coil Section | Blower Section | Base Frame |
|---------|--------------|----------------|------------|
| A | 550 | 280 | 39 |
| B | 580 | 295 | 43 |
| C | 911 | 443 | 62 |

Note: All weights in pounds.

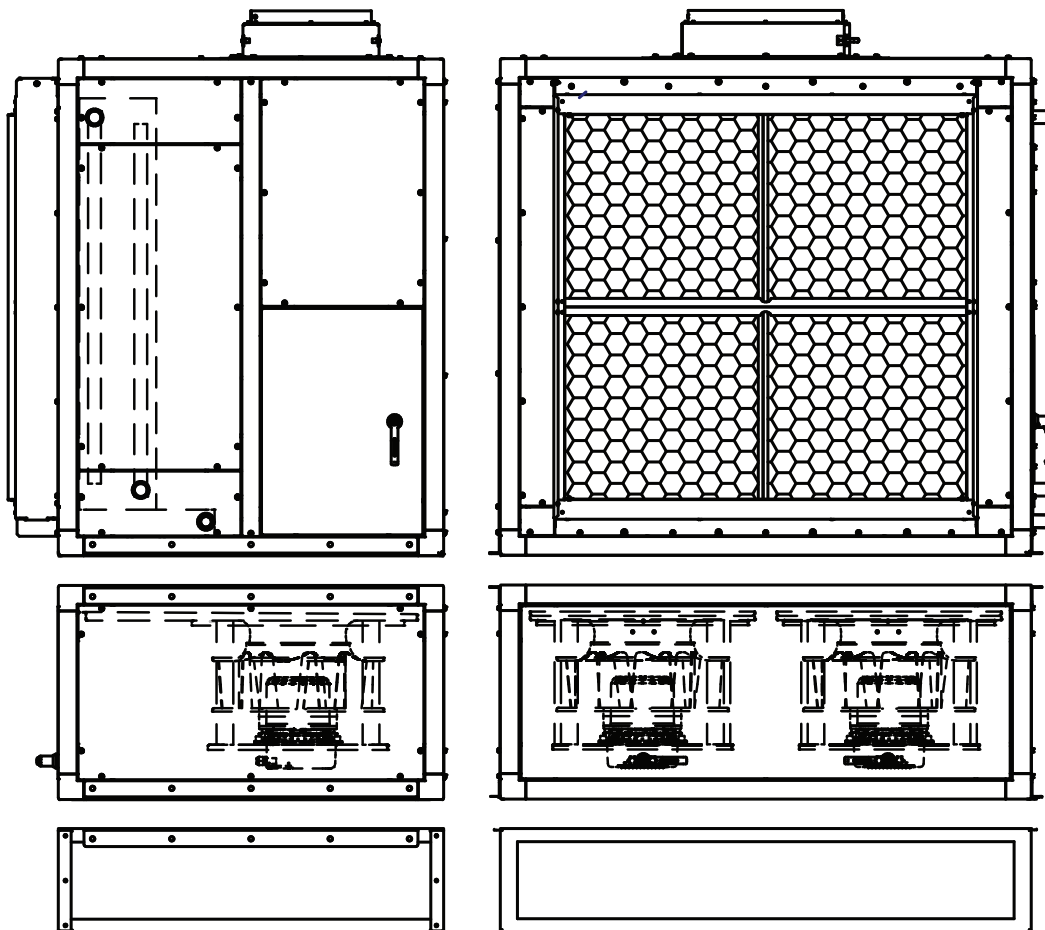

WARNING



CRUSH HAZARD

Use unit lifting points for rigging only. Failure to follow these instructions can result in death, injury, or property damage.

Figure 2: Unit Separation



6.4 Leveling The Unit

In the case of un-level floors under the MAT, there are two options for leveling the unit.

1. Using the provided holes in the base frame, use a series of bolts, washers, and nuts as leveling feet to bring the unit to level.
2. Utilize leveling shims to bring the unit to level.
3. Utilize seismic isolators to bring the unit to level.

Figure 3: Unit Leveling

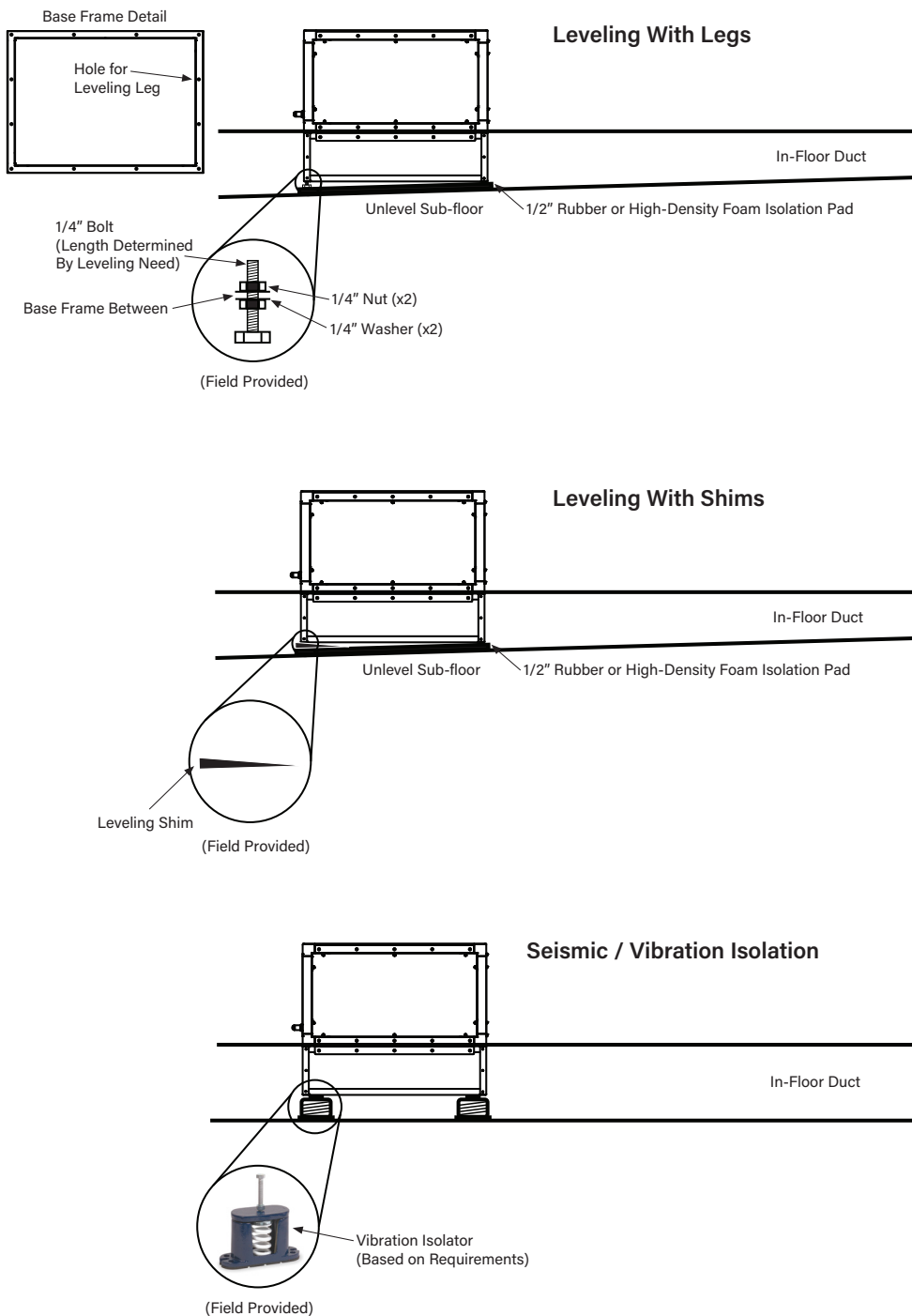
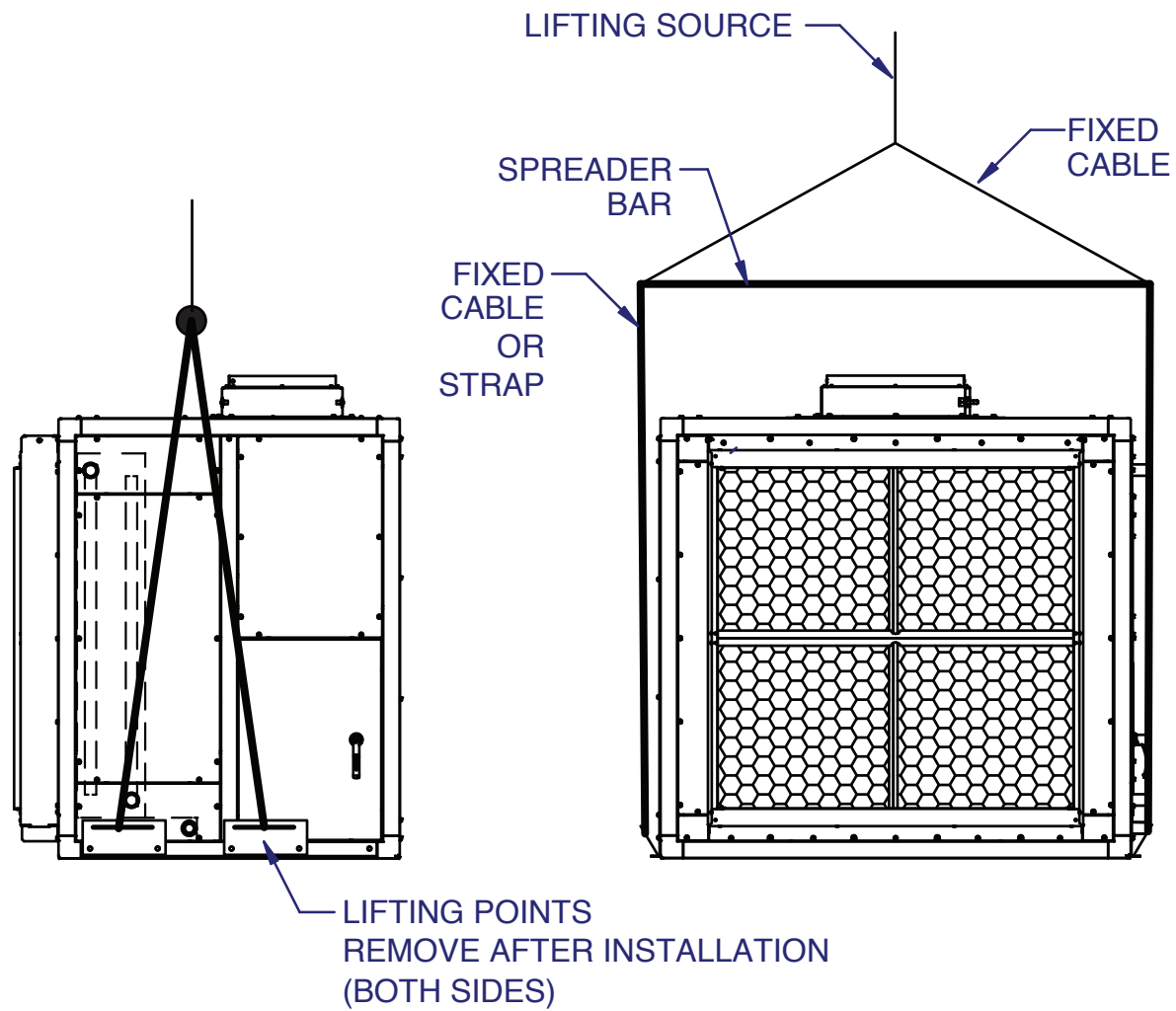


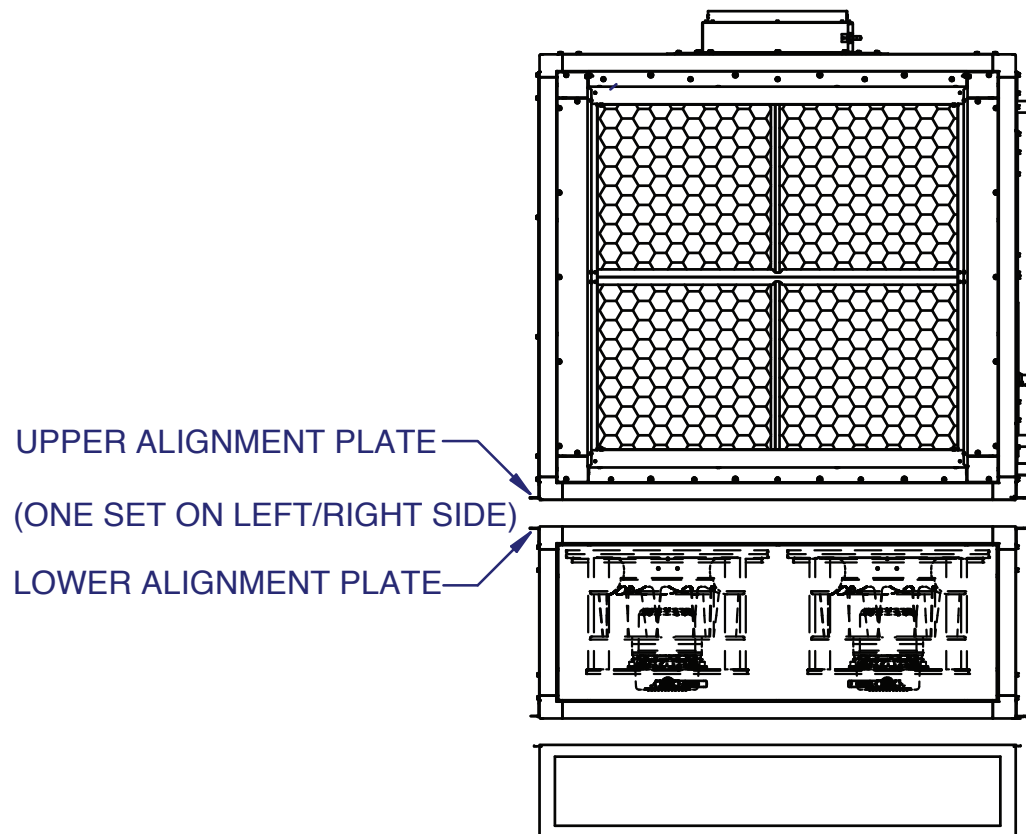
Figure 4: Air Handler Rigging



6.4 Securing The Unit

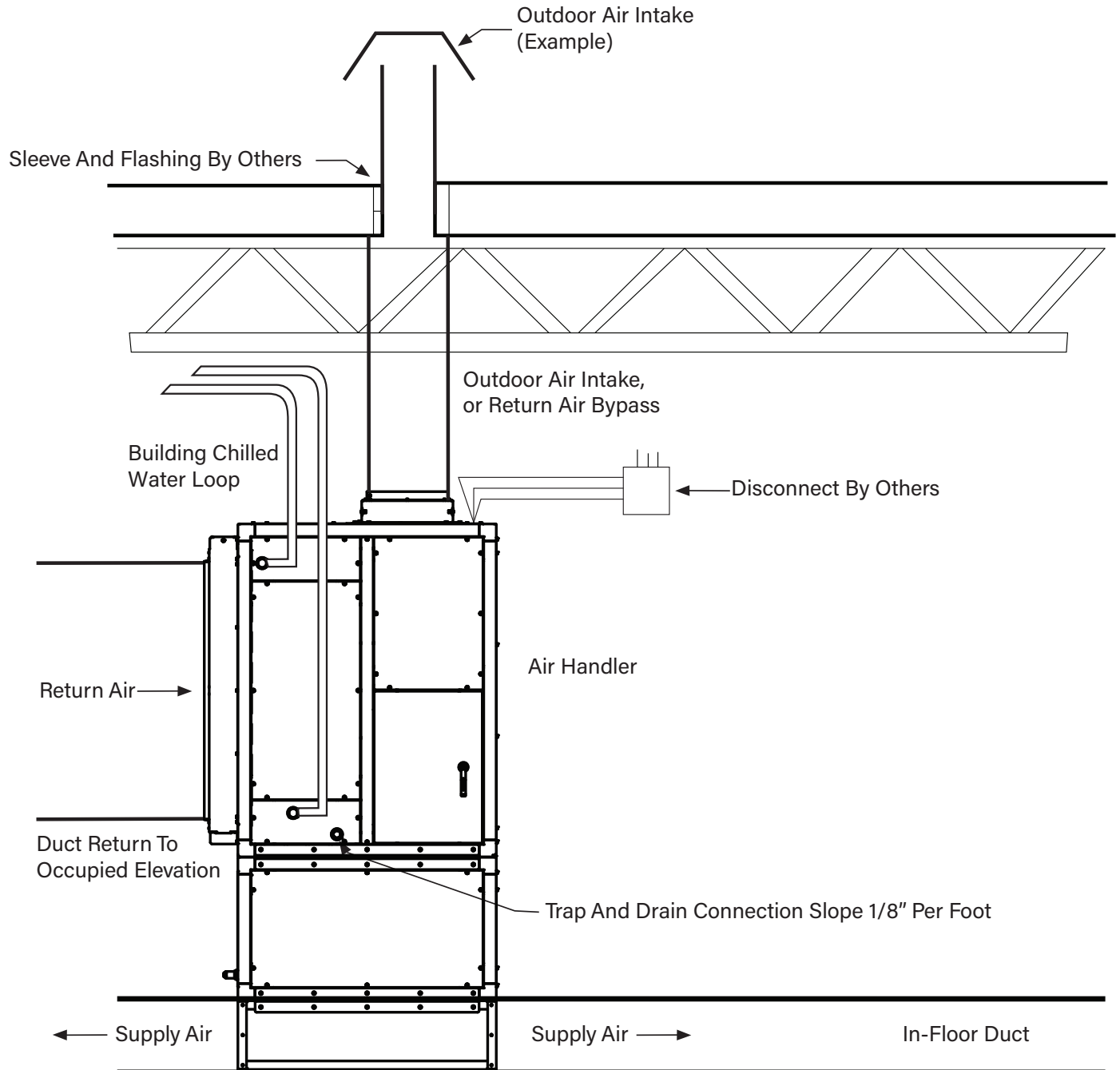
The MAT features two sets of alignment and fastening plates on the lower part of the air handler section, and the blower section. Once these sections are placed together, align the boltholes and corners together, and then fasten utilizing threaded bolts, washers, and nuts.

Figure 5: Unit Joining



Section 7: Unit Placement:

Figure 6: Unit Installation Example



Section 8: Ductwork Consideration:

The unit has been designed to operate at the specific air volume and external static pressure that was ordered. This static pressure is generated by any additional components that are added to the unit (i.e. ductwork, etc). Additional static pressure beyond that ordered will affect the performance of the air conditioning unit and lessen the air volume that can be delivered.

Proper engineering methods need to be employed when calculating duct and component static pressure.

The system ductwork must comply with Sheet Metal and Air Conditioning Contractors National Association (SMACNA) or any other recognized standards.

It is recommended that flexible duct connections be incorporated into the ductwork design to prevent the transmission of any vibrations, either mechanical or harmonic.

As a general rule, all ducts should have a straight run of at least 3 hydraulic duct diameters immediately before and after the unit before adding any fittings, elbows, restrictions, etc.

Hydraulic duct diameter for round ducts (in inches):

$$D_h = d$$

D_h: hydraulic diameter

d: round duct inside diameter

Hydraulic duct diameter for rectangular ducts (in inches):

$$D_h = (2 \cdot H \cdot W) / (H + W)$$

D_h: hydraulic diameter

H: rectangular duct inside height

W: rectangular duct inside width

The unit is not designed to support the weight of ductwork. Ductwork must be constructed in a fashion that is self-supporting.

Depending on the options ordered with the unit, flanges (either external or internal) may be provided to facilitate connection of ductwork. In cases where flanges are not provided, flat surfaces on the exterior skin of the unit are provided to facilitate connection of ductwork.

Neither the flanges nor exterior skin of the unit are capable of supporting the load of the ductwork. Ductwork support must come from the structure itself that the unit is servicing. Ductwork passing through unconditioned spaces must be insulated (including a vapor barrier) to prevent unnecessary energy losses and/or condensation.

8.1 Outside or Return Air Ductwork

Return air ductwork height and width must be no smaller than the unit return air opening height and width.

8.2 Discharge Ductwork

Discharge air ductwork height and width must be no smaller than the unit discharge air opening height and width.

Section 9:

Chilled Water Coil Piping:

The MAT Series standard configuration utilizes a chilled water coil for air conditioning. The following section covers building loop piping to the unit, and other considerations for this unit and system configuration.

9.1 Components and Configurations

There are many different building water loop variations available. Depending on the configuration, the unit may require the following components:

- Water piping
- Piping insulation
- Manual isolation ball valves
- Motorized isolation ball valves
- Stainless steel hoses
- Strainers (Y or Basket)
- Intermediate heat exchanger
- Pumps
- Antifreeze

9.2 Water Piping

When designing the building loop water piping that supplies the MAT, there are several considerations to take into account.

9.2.1 Piping Materials

All interior piping to the unit must be made of a material that is rated to handle the flow rate, temperature, and pressure of the building loop. Materials such as steel or HDPE are recommended. PVC of any type must not be used on these systems.

9.2.2 Flow Rates and Temperatures

All piping to the unit must be designed and sized for proper flow rates. Consult the submittal document for the flow ranges and temperatures for the specific project the unit is applied to. For operation outside of the submittal document, consult the factory.

9.2.3 Piping Insulation

In areas where the water temperature in the building loop is regularly below the dew point, all water piping must be insulated to prevent condensation. A closed-cell Armaflex-type insulation of at least 3/8" wall thickness that completely encircles the piping is recommended.

9.2.4 Hose Kits and Valving

Water piping to the unit should be designed with provisions for installation, service and annual maintenance taken into consideration. Components such as isolation valves and hose kits make for easier installation, and easier service should the unit need to be taken off the building loop. A set of isolation valves is recommended outside of the unit.

Additionally, other components such as flow meters, temperature sensors, strainers, should be installed in such a manner that they can be isolated from the building loop for easier service.

9.3 Antifreeze

In applications where the expected building loop temperature will fall below 40°F during operation, or in buildings where loop piping could be exposed to freezing temperatures, some form of antifreeze is required for unit operation.

Antifreeze is commonly available in several different varieties such as propylene glycol, methanol, and ethanol. Each type has its advantages and disadvantages in regards to safety, cost, performance, and stability. Additionally, state and local codes may restrict which antifreeze is allowed to be used in your application. Consult with the project engineer to insure the proper antifreeze is chosen, and the proper percentage for the application is calculated.

Use a hydrometer specific to your antifreeze type/solution to determine the percentage found in the building water loop. Each antifreeze type has a specific gravity that will indicate the percentage in solution, and amount of provided freeze protection.

Failure to properly select and apply antifreeze to the system could not only lead to unit damage, but damage to other parts of the building loop system as well.

9.4 Flushing

Prior to unit startup and commissioning, the building loop, and unit coil must be purged of any debris or air that may be present. Debris that remains in the system could erode or plug the unit air coil, or damage pumps. Additionally, trapped air could impact unit performance and cause unwanted turbulence noise.

9.5 Water Quality

For consistent unit performance, and longevity, proper water quality is essential for every installation. Poor water quality can lead to water coil scaling, corrosion, or other issues that could require additional maintenance, or lead to premature unit failure.

The table below outlines Global IFS's prescribed water quality requirements.

Table 3: Water Quality Standards

| Potential Failure Mode | Water Chemistry Parameter | Copper Heat Exchanger (Standard) |
|------------------------------|---|---|
| Corrosion and Scaling | pH Level | 7 - 9 |
| | Hardness (Calcium or Magnesium Carbonate) | < 350 ppm |
| | Langelier Saturation Index (LSI) | -0.5 to 0 |
| | Ryznar Stability Index (RSI) | 6.2 - 6.8 |
| | Hydrogen Sulfide | < 0.5 ppm |
| | Sulfates | < 125 ppm |
| | Chlorine | < 0.5 ppm |
| | Chlorides | < 20 ppm |
| | Carbon Dioxide | < 5 ppm |
| | Ammonia | < 2 ppm |
| | Ammonia Chloride, Nitrate, Hydroxide, Sulfate | < 0.5 ppm |
| | Total Dissolved Solids (TDS) | < 1000 ppm |
| Iron Fouling | Iron, Iron Bacteria | < 0.2 ppm |
| | Iron Oxide | < 1 ppm |
| Erosion | Suspended Solids | < 10 ppm, < 600 micron or 30 mesh filter size |
| | Design Water Velocity | 3 GPM per Ton |

Section 10: Refrigeration Circuits and Piping:

10.1 Refrigerant

If equipped, this unit will utilize R-410A, a refrigerant with a zero ozone depletion rating, and POE or PVE refrigerant oil. Equipment utilizing R-410A refrigerant operates at higher pressures than other typical refrigerants. System components should be sized and match together for the best possible performance.

The unit has a broad application range. For optimum performance and efficiency, it may be necessary to adjust the refrigerant charge to maintain desired subcooling and superheat at operating temperature extremes.

10.2 Components and Configurations

There are many different refrigeration circuit variations available. Depending on the configuration, the unit may include, but is not limited to, the following components:

- Coil
 - Chilled water coil
 - Evaporator coil
 - Hot water coil



WARNING



EXPLOSION HAZARD

Direct expansion systems contain R-410A refrigerant. Operating pressures may exceed limits of R-22 service equipment. Use proper refrigerant handling practices, tools, and equipment. Failure to follow these instructions can result in death, injury, or property damage.



NOTICE



PRODUCT DAMAGE HAZARD

Verify compressor and refrigerant oil type of the system before installation. POE and PVE oil cannot be mixed, and will result in equipment damage.

10.3 Lineset Piping Installation

Read these instructions completely before proceeding with piping.

Prepare to connect the two sections with clean dehydrated refrigeration grade tubing. Recommended line sizes can be found in Tables 3A-3F. In order to assure oil return a velocity of 1,000 FPM must be maintained.

Locations where copper tubing will be exposed to mechanical damage should be avoided. If it is necessary to use such locations, the tubing should be enclosed in rigid or flexible conduit.

Horizontal piping runs should be supported enough to prevent high binding stresses in the tubing. The weight of vertical piping may be either supported with riser clamps bearing on structural members of the building or by a platform at the bottom of the riser.

Supports should be strong enough to handle any load by thermal expansion or contraction of the pipe so that stresses will not be placed on the equipment to which the piping is connected.

The suction line and both hot gas reheat lines (if included) should be insulated with 5/8" minimum thickness closed cell foamed insulation, to prevent sweating or heat loss. **All lines, except the liquid line, must be insulated.** However, on installations where the liquid line is exposed to high ambient areas the liquid line must be insulated to prevent sub-cooling loss. Refrigerant lines run underground should be insulated with 3/4" minimum thickness closed cell foamed insulation. Suction horizontal lines must be pitched toward the compressor unit, see Figure 7.

Filter driers (supplied with the unit) should be installed at the air handler.

When the air handler is installed at a higher elevation than the compressor, provide a vertical loop in the suction line adjacent to the air handler to a point at least to the top of the evaporator coil. Do not insulate the refrigerant or condensate drain lines until all joints in these lines are leak tested, see Figure 7.

For long vertical risers in both suction and discharge lines, additional traps are recommended for each full length of pipe (approximately 20 feet) to insure proper oil movement.

Purge holding charge from the condensing unit by opening both the high and low pressure gauge ports on the condensing unit and allow holding charge to bleed off to atmospheric pressure.

Drill a 1/16" bleed hole in the cap on the suction line fitting of the air handler (larger of the two fittings) and allow holding charge to reduce to atmospheric pressure.

Remove caps on the suction and liquid lines of the inside section by drilling a small hole in the caps and then apply heat to caps to remove. The caps are soldered to the fittings with soft solder.

Carefully clean the suction line and liquid line fittings on the outside and braze the refrigerant lines to these fittings. Leave gauge port open until all brazing is completed. Low pressure nitrogen purging is recommended while brazing.

| | |
|---|--|
|  CAUTION | |
|  | PRODUCT DAMAGE HAZARD |
| | Excessive oil within the system can cause potential issues with operation. The objective is to provide a proper system oil charge that is based on requirements. |

Table 4a: Lineset Recommended Sizes

| Indoor Unit Located Below Outdoor Unit | | | | | | |
|--|------------------------------------|---------------|------------------------------|-------------------------------------|---------------|------------------------------|
| Nominal Btu/h per refrigerant circuit | Equivalent length up to 25' | | | Equivalent length 26' to 50' | | |
| | Size inches O.D. | | | Size inches O.D. | | |
| | Suction(1) | Liquid | Hot gas reheat(4) | Suction(1) | Liquid | Hot gas reheat(4) |
| 42,000 | 5/8 - 5/8 | 3/8 | 1/2 | 3/4 - 3/4 | 3/8 | 1/2 |
| 48,000 | 5/8 - 5/8 | 3/8 | 1/2 | 3/4 - 5/8 | 1/2 | 5/8 |
| 60,000 | 3/4 - 3/4 | 1/2 | 5/8 | 3/4 - 3/4 | 1/2 | 5/8 |
| 72,000 | 3/4 - 3/4 | 1/2 | 5/8 | 7/8 - 3/4 | 1/2 | 5/8 |
| 84,000 | 7/8 - 3/4 | 1/2 | 5/8 | 1-1/8 - 3/4 | 1/2 | 3/4 |
| 96,000 | 7/8 - 7/8 | 1/2 | 5/8 | 1-1/8 - 7/8 | 5/8 | 3/4 |
| 120,000 | 1-1/8 - 1-1/8 | 5/8 | 5/8 | 1-1/8 - 1-1/8 | 5/8 | 3/4 |
| 150,000 | 1-1/8 - 1-1/8 | 5/8 | 3/4 | 1-1/8 - 1-1/8 | 5/8 | 7/8 |
| 180,000 | 1-3/8 - 1-3/8 | 3/4 | 3/4 | 1-3/8 - 1-1/8 | 5/8 | 7/8 |
| 220,000 | 1-3/8 - 1-3/8 | 3/4 | 7/8 | 1-3/8 - 1-3/8 | 3/4 | 1-1/8 |
| 250,000 | 1-3/8 - 1-3/8 | 7/8 | 7/8 | 1-3/8 - 1-3/8 | 7/8 | 1-1/8 |
| 300,000 | 1-3/8 - 1-3/8 | 7/8 | 7/8 | 1-5/8 - 1-3/8 | 7/8 | 1-1/8 |
| 350,000 | 1-5/8 - 1-5/8 | 7/8 | 1-1/8 | 1-5/8 - 1-5/8 | 1-1/8 | 1-1/8 |
| 400,000 | 1-5/8 - 1-5/8 | 1-1/8 | 1-1/8 | 1-5/8 - 1-5/8 | 1-1/8 | 1-1/8 |

| Nominal Btu/h per refrigerant circuit | Equivalent length 51' to 75' | | | Equivalent length 76' to 100' | | |
|--|-------------------------------------|---------------|------------------------------|--------------------------------------|---------------|------------------------------|
| | Size inches O.D. | | | Size inches O.D. | | |
| | Suction(1) | Liquid | Hot gas reheat(4) | Suction(1) | Liquid | Hot gas reheat(4) |
| 42,000 | 3/4 - 3/4 | 3/8 | 1/2 | 7/8 - 3/4 | 3/8 | 5/8 |
| 48,000 | 3/4 - 5/8 | 1/2 | 5/8 | 7/8 - 5/8 | 1/2 | 5/8 |
| 60,000 | 7/8 - 3/4 | 1/2 | 5/8 | 7/8 - 3/4 | 1/2 | 3/4 |
| 72,000 | 7/8 - 3/4 | 1/2 | 3/4 | 7/8 - 3/4 | 1/2 | 3/4 |
| 84,000 | 1-1/8 - 7/8 | 5/8 | 7/8 | 1-1/8 - 7/8 | 5/8 | 3/4 |
| 96,000 | 1-1/8 - 7/8 | 5/8 | 7/8 | 1-1/8 - 7/8 | 5/8 | 3/4 |
| 120,000 | 1-1/8 - 1-1/8 | 5/8 | 7/8 | 1-1/8 - 1-1/8 | 5/8 | 7/8 |
| 150,000 | 1-1/8 - 1-1/8 | 3/4 | 7/8 | 1-3/8 - 1-1/8 | 3/4 | 7/8 |
| 180,000 | 1-3/8 - 1-3/8 | 3/4 | 1-1/8 | 1-3/8 - 1-3/8 | 3/4 | 1-1/8 |
| 220,000 | 1-3/8 - 1-3/8 | 3/4 | 1-1/8 | 1-5/8 - 1-3/8 | 3/4 | 1-1/8 |
| 250,000 | 1-3/8 - 1-3/8 | 3/4 | 1-1/8 | 1-3/8 - 1-3/8 | 7/8 | 1-1/8 |
| 300,000 | 1-5/8 - 1-5/8 | 7/8 | 1-1/8 | 1-5/8 - 1-5/8 | 7/8 | 1-1/8 |
| 350,000 | 1-5/8 - 1-5/8 | 7/8 | 1-1/8 | 2-1/8 - 1-5/8 | 1-1/8 | 1-1/8 |
| 400,000 | 2-1/8 - 1-5/8 | 1-1/8 | 1-1/8 | 2-1/8 - 1-5/8 | 1-1/8 | 1-1/8 |

(1) Maximum vertical lift = 60 feet with suction riser sized traps every 20 feet on the vertical line starting at the lowest point. First size is horizontal run; second size is for riser.

(4) Hot gas reheat, if ordered, requires one line per circuit. Pitch hot gas (discharge) lines in direction refrigerant flow - minimum 1/8" per foot.

Example for dual circuit unit: if total system capacity is 240,000 Btu/h, divide by 2 and use the line sizes for 120,000 Btu/h for each circuit. Follow industry standard refrigeration recommendations for piping. Suction (Vapor) and hot gas reheat lines must be insulated.

Table 4b: Lineset Recommended Sizes

| Indoor Unit Located Below Outdoor Unit, Cont. | | | | | | |
|--|---------------------------------------|---------------|------------------------------|---------------------------------------|---------------|------------------------------|
| Nominal Btu/h per refrigerant circuit | Equivalent length 100' to 125' | | | Equivalent length 126' to 150' | | |
| | Size inches O.D. | | | Size inches O.D. | | |
| | Suction(1) | Liquid | Hot gas reheat(4) | Suction(1) | Liquid | Hot gas reheat(4) |
| 42,000 | 3/4 - 5/8 | 3/8 | 1/2 | 3/4 - 5/8 | 1/2 | 1/2 |
| 48,000 | 7/8 - 5/8 | 1/2 | 5/8 | 7/8 - 3/4 | 1/2 | 5/8 |
| 60,000 | 7/8 - 3/4 | 1/2 | 5/8 | 7/8 - 3/4 | 1/2 | 5/8 |
| 72,000 | 7/8 - 3/4 | 1/2 | 5/8 | 7/8 - 3/4 | 1/2 | 5/8 |
| 84,000 | 1-1/8 - 7/8 | 5/8 | 3/4 | 1-1/8 - 7/8 | 5/8 | 3/4 |
| 96,000 | 1-1/8 - 7/8 | 5/8 | 3/4 | 1-1/8 - 7/8 | 5/8 | 3/4 |
| 120,000 | 1-1/8 - 1-1/8 | 5/8 | 3/4 | 1-1/8 - 1-1/8 | 5/8 | 3/4 |
| 150,000 | 1-3/8 - 1-1/8 | 5/8 | 7/8 | 1-1/8 - 1-3/8 | 3/4 | 7/8 |
| 180,000 | 1-3/8 - 1-1/8 | 3/4 | 7/8 | 1-3/8 - 1-1/8 | 3/4 | 1-1/8 |
| 220,000 | 1-3/8 - 1-3/8 | 3/4 | 1-1/8 | 1-3/8 - 1-3/8 | 3/4 | 1-1/8 |
| 250,000 | 1-3/8 - 1-3/8 | 7/8 | 1-1/8 | 1-5/8 - 1-3/8 | 7/8 | 1-1/8 |
| 300,000 | 1-5/8 - 1-3/8 | 7/8 | 1-1/8 | 1-5/8 - 1-3/8 | 7/8 | 1-1/8 |
| 350,000 | 1-5/8 - 1-5/8 | 1-1/8 | 1-1/8 | 1-5/8 - 1-5/8 | 1-1/8 | 1-1/8 |
| 400,000 | 1-5/8 - 1-5/8 | 1-1/8 | 1-3/8 | 2-1/8 - 1-5/8 | 1-1/8 | 1-3/8 |

| Nominal Btu/h per refrigerant circuit | Equivalent length 151' to 175' | | | Equivalent length 176' to 200' | | |
|--|---------------------------------------|---------------|------------------------------|---------------------------------------|---------------|------------------------------|
| | Size inches O.D. | | | Size inches O.D. | | |
| | Suction(1) | Liquid | Hot gas reheat(4) | Suction(1) | Liquid | Hot gas reheat(4) |
| 42,000 | 3/4 - 5/8 | 1/2 | 1/2 | 3/4 - 5/8 | 1/2 | 5/8 |
| 48,000 | 7/8 - 3/4 | 1/2 | 5/8 | 7/8 - 3/4 | 1/2 | 5/8 |
| 60,000 | 7/8 - 3/4 | 1/2 | 5/8 | 7/8 - 3/4 | 1/2 | 5/8 |
| 72,000 | 1-1/8 - 3/4 | 1/2 | 5/8 | 1-1/8 - 3/4 | 5/8 | 5/8 |
| 84,000 | 1-1/8 - 7/8 | 5/8 | 3/4 | 1-1/8 - 7/8 | 5/8 | 3/4 |
| 96,000 | 1-1/8 - 7/8 | 5/8 | 3/4 | 1-1/8 - 7/8 | 5/8 | 3/4 |
| 120,000 | 1-1/8 - 1-1/8 | 5/8 | 3/4 | 1-3/8 - 1-1/8 | 5/8 | 3/4 |
| 150,000 | 1-3/8 - 1-1/8 | 3/4 | 7/8 | 1-3/8 - 1-1/8 | 3/4 | 7/8 |
| 180,000 | 1-3/8 - 1-1/8 | 3/4 | 1-1/8 | 1-3/8 - 1-1/8 | 3/4 | 1-1/8 |
| 220,000 | 1-3/8 - 1-3/8 | 7/8 | 1-1/8 | 1-5/8 - 1-3/8 | 7/8 | 1-1/8 |
| 250,000 | 1-5/8 - 1-3/8 | 7/8 | 1-1/8 | 1-5/8 - 1-3/8 | 7/8 | 1-1/8 |
| 300,000 | 1-5/8 - 1-3/8 | 7/8 | 1-1/8 | 1-5/8 - 1-3/8 | 7/8 | 1-1/8 |
| 350,000 | 1-5/8 - 1-5/8 | 1-1/8 | 1-1/8 | 1-5/8 - 1-5/8 | 1-1/8 | 1-1/8 |
| 400,000 | 2-1/8 - 1-5/8 | 1-1/8 | 1-3/8 | 2-1/8 - 1-5/8 | 1-1/8 | 1-3/8 |

(1) Maximum vertical lift = 60 feet with suction riser sized traps every 20 feet on the vertical line starting at the lowest point. First size is horizontal run; second size is for riser.

(4) Hot gas reheat, if ordered, requires one line per circuit. Pitch hot gas (discharge) lines in direction refrigerant flow - minimum 1/8" per foot.

Example for dual circuit unit: if total system capacity is 240,000 Btu/h, divide by 2 and use the line sizes for 120,000 Btu/h for each circuit. Follow industry standard refrigeration recommendations for piping. Suction (Vapor) and hot gas reheat lines must be insulated.

Table 4c: Lineset Recommended Sizes

| Indoor Unit Located Level With, or Above Outdoor Unit | | | | | | |
|---|-----------------------------|-----------|----------------------|------------------------------|-----------|----------------------|
| Nominal Btu/h per refrigerant circuit | Equivalent length up to 25' | | | Equivalent length 26' to 50' | | |
| | Size inches O.D. | | | Size inches O.D. | | |
| | Suction(2) | Liquid(3) | Hot gas reheat(4) | Suction(2) | Liquid(3) | Hot gas reheat(4) |
| 42,000 | 3/4 | 3/8 | 1/2 | 3/4 | 1/2 | 1/2 |
| 48,000 | 3/4 | 1/2 | 1/2 | 3/4 | 1/2 | 5/8 |
| 60,000 | 3/4 | 1/2 | 5/8 | 3/4 | 1/2 | 5/8 |
| 72,000 | 3/4 | 1/2 | 5/8 | 7/8 | 5/8 | 5/8 |
| 84,000 | 3/4 | 5/8 | 5/8 | 7/8 | 5/8 | 3/4 |
| 96,000 | 7/8 | 5/8 | 5/8 | 1-1/8 | 5/8 | 3/4 |
| 120,000 | 7/8 | 5/8 | 5/8 | 1-1/8 | 5/8 | 3/4 |
| 150,000 | 1-1/8 | 3/4 | 3/4 | 1-1/8 | 3/4 | 7/8 |
| 180,000 | 1-1/8 | 3/4 | 3/4 | 1-1/8 | 3/4 | 7/8 |
| 220,000 | 1-1/8 | 3/4 | 7/8 | 1-3/8 | 7/8 | 7/8 |
| 250,000 | 1-3/8 | 3/4 | 7/8 | 1-3/8 | 7/8 | 1-1/8 |
| 300,000 | 1-3/8 | 7/8 | 7/8 | 1-3/8 | 7/8 | 1-1/8 |
| 350,000 | 1-5/8 | 7/8 | 1-1/8 | 1-5/8 | 1-1/8 | 1-1/8 |
| 400,000 | 1-5/8 | 1-1/8 | 1-1/8 | 1-5/8 | 1-1/8 | 1-1/8 |

| Nominal Btu/h per refrigerant circuit | Equivalent length 51' to 75' | | | Equivalent length 76' to 100' | | |
|---|------------------------------|-----------|----------------------|-------------------------------|-----------|----------------------|
| | Size inches O.D. | | | Size inches O.D. | | |
| | Suction(2) | Liquid(3) | Hot gas reheat(4) | Suction(2) | Liquid(3) | Hot gas reheat(4) |
| 42,000 | 3/4 | 1/2 | 1/2 | 7/8 | 1/2 | 5/8 |
| 48,000 | 7/8 | 1/2 | 5/8 | 7/8 | 1/2 | 5/8 |
| 60,000 | 7/8 | 5/8 | 5/8 | 1-1/8 | 1/2 | 3/4 |
| 72,000 | 7/8 | 5/8 | 3/4 | 1-1/8 | 5/8 | 3/4 |
| 84,000 | 1-1/8 | 5/8 | 7/8 | 1-1/8 | 5/8 | 7/8 |
| 96,000 | 1-1/8 | 5/8 | 7/8 | 1-1/8 | 5/8 | 7/8 |
| 120,000 | 1-1/8 | 3/4 | 7/8 | 1-1/8 | 7/8 | 7/8 |
| 150,000 | 1-1/8 | 3/4 | 7/8 | 1-3/8 | 3/4 | 7/8 |
| 180,000 | 1-3/8 | 3/4 | 1-1/8 | 1-3/8 | 3/4 | 1-1/8 |
| 220,000 | 1-3/8 | 3/4 | 1-1/8 | 1-3/8 | 7/8 | 1-1/8 |
| 250,000 | 1-3/8 | 1-1/8 | 1-1/8 | 1-5/8 | 7/8 | 1-1/8 |
| 300,000 | 1-5/8 | 1-1/8 | 1-1/8 | 1-5/8 | 1-1/8 | 1-1/8 |
| 350,000 | 1-5/8 | 1-1/8 | 1-1/8 | 1-5/8 | 1-1/8 | 1-1/8 |
| 400,000 | 1-5/8 | 1-1/8 | 1-1/8 | 1-5/8 | 1-1/8 | 1-1/8 |

(2) Loop piping to top of coil.

(3) Based on maximum vertical separation of 10 feet. Submit sketch for factory review if greater.

(4) Hot gas reheat, if ordered, requires one line per circuit. Pitch hot gas (discharge) lines in direction refrigerant flow - minimum 1/8" per foot.

Example for dual circuit unit: if total system capacity is 240,000 Btu/h, divide by 2 and use the line sizes for 120,000 Btu/h for each circuit. Follow industry standard refrigeration recommendations for piping. Suction (Vapor) and hot gas reheat lines must be insulated.

Table 4d: Lineset Recommended Sizes

| Indoor Unit Located Level With, or Above Outdoor Unit | | | | | | |
|---|--------------------------------|-----------|----------------------|--------------------------------|-----------|----------------------|
| Nominal Btu/h per refrigerant circuit | Equivalent length 100' to 125' | | | Equivalent length 126' to 150' | | |
| | Size inches O.D. | | | Size inches O.D. | | |
| | Suction(2) | Liquid(3) | Hot gas reheat(4) | Suction(2) | Liquid(3) | Hot gas reheat(4) |
| 42,000 | 3/4 | 1/2 | 1/2 | 3/4 | 1/2 | 5/8 |
| 48,000 | 7/8 | 1/2 | 5/8 | 7/8 | 1/2 | 5/8 |
| 60,000 | 7/8 | 1/2 | 5/8 | 7/8 | 1/2 | 5/8 |
| 72,000 | 7/8 | 5/8 | 5/8 | 7/8 | 5/8 | 5/8 |
| 84,000 | 7/8 | 5/8 | 3/4 | 7/8 | 5/8 | 3/4 |
| 96,000 | 1-1/8 | 5/8 | 3/4 | 1-1/8 | 5/8 | 3/4 |
| 120,000 | 1-1/8 | 7/8 | 3/4 | 1-1/8 | 3/4 | 3/4 |
| 150,000 | 1-3/8 | 3/4 | 7/8 | 1-3/8 | 3/4 | 7/8 |
| 180,000 | 1-1/8 | 3/4 | 7/8 | 1-1/8 | 7/8 | 1-1/8 |
| 220,000 | 1-3/8 | 7/8 | 1-1/8 | 1-3/8 | 7/8 | 1-1/8 |
| 250,000 | 1-3/8 | 7/8 | 1-1/8 | 1-5/8 | 7/8 | 1-1/8 |
| 300,000 | 1-5/8 | 1-1/8 | 1-1/8 | 1-5/8 | 1-1/8 | 1-1/8 |
| 350,000 | 1-5/8 | 1-1/8 | 1-1/8 | 1-5/8 | 1-1/8 | 1-1/8 |
| 400,000 | 1-5/8 | 1-1/8 | 1-3/8 | 1-5/8 | 1-1/8 | 1-3/8 |

| Nominal Btu/h per refrigerant circuit | Equivalent length 151' to 175' | | | Equivalent length 176' to 200' | | |
|---|--------------------------------|-----------|----------------------|--------------------------------|-----------|----------------------|
| | Size inches O.D. | | | Size inches O.D. | | |
| | Suction(2) | Liquid(3) | Hot gas reheat(4) | Suction(2) | Liquid(3) | Hot gas reheat(4) |
| 42,000 | 3/4 | 1/2 | 1/2 | 3/4 | 1/2 | 1/2 |
| 48,000 | 7/8 | 1/2 | 5/8 | 7/8 | 1/2 | 5/8 |
| 60,000 | 7/8 | 1/2 | 5/8 | 7/8 | 5/8 | 5/8 |
| 72,000 | 7/8 | 5/8 | 5/8 | 7/8 | 3/4 | 5/8 |
| 84,000 | 1-1/8 | 5/8 | 3/4 | 1-1/8 | 5/8 | 3/4 |
| 96,000 | 1-1/8 | 5/8 | 3/4 | 1-1/8 | 3/4 | 3/4 |
| 120,000 | 1-1/8 | 3/4 | 3/4 | 1-1/8 | 3/4 | 3/4 |
| 150,000 | 1-3/8 | 3/4 | 7/8 | 1-3/8 | 7/8 | 7/8 |
| 180,000 | 1-3/8 | 7/8 | 1-1/8 | 1-3/8 | 7/8 | 1-1/8 |
| 220,000 | 1-5/8 | 7/8 | 1-1/8 | 1-5/8 | 7/8 | 1-1/8 |
| 250,000 | 1-5/8 | 7/8 | 1-1/8 | 1-5/8 | 7/8 | 1-1/8 |
| 300,000 | 1-5/8 | 1-1/8 | 1-1/8 | 1-5/8 | 1-1/8 | 1-1/8 |
| 350,000 | 1-5/8 | 1-1/8 | 1-1/8 | 1-5/8 | 1-1/8 | 1-1/8 |
| 400,000 | 1-5/8 | 1-1/8 | 1-3/8 | 1-5/8 | 1-1/8 | 1-3/8 |

(2) Loop piping to top of coil.

(3) Based on maximum vertical separation of 10 feet. Submit sketch for factory review if greater.

(4) Hot gas reheat, if ordered, requires one line per circuit. Pitch hot gas (discharge) lines in direction refrigerant flow - minimum 1/8" per foot.

Example for dual circuit unit: if total system capacity is 240,000 Btu/h, divide by 2 and use the line sizes for 120,000 Btu/h for each circuit. Follow industry standard refrigeration recommendations for piping. Suction (Vapor) and hot gas reheat lines must be insulated.

10.4 Leak Testing and Evacuation

Charge system with R-410A trace gas and dry nitrogen. Pressurize to 150 PSIG.

Check inside unit, and interconnecting piping with suitable leak detector. Relieve testing charge and connect a good vacuum pump to the gauge connections.

Do not open any other valves at this time. Connect a micron gauge to the vacuum pump. A deep vacuum of at least 500 microns is required.

Wait 15 minutes, if there is no rise on the micron gauge the system is sealed.

10.5 Additional Piping Considerations

10.5.1 Leaks

Leaks occur at incorrectly made joints. Very small scratches or particles of dirt in a joint can cause a refrigerant leak. The leak may be so small that it is difficult to detect on a Halide leak detector. Leaks can develop even years after the joint is made unless flux and solder specifically developed for refrigerant work are used. Any improper made joint will cause trouble in time, as it will eventually leak enough refrigerant to reduce capacity of the system.

10.5.2 Moisture

Moisture in the refrigeration system will combine with fluorine in the refrigerant and form hydrofluoric acid which will corrode and pit the system. Hydrofluoric acid also decomposes the compressor lubrication oil causing sludge. Great care should be exercised in keeping moisture out of the refrigeration system when installing tubing, because an extremely small amount can cause trouble. For this reason, except on large sizes, only refrigeration grade, seamless annealed, sealed copper tubing should be used. This tubing is available at refrigeration supply stores and has been dehydrated, cleaned inside and sealed at each end. Exposure of the inside of the tubing to the atmosphere must be kept to minimum. Do not use tubing that has been exposed.

10.5.3 Dirt

Dirt and metal chips must be kept out of the refrigeration system, since they will accumulate at strainers and clog them, restricting the flow of refrigerant.

Table 5: Equivalent Lengths of Fittings and Valves

| Equivalent Length in Feet of Pipe for Valves and Fittings | | | | | |
|---|--------------------|-------------------|----------|------------|-------------|
| Tubing Size: O.D. | Short Radius Elbow | Long Radius Elbow | Tee Line | Tee Branch | Angle Valve |
| 1/2 | 1.6 | 1.0 | 1.0 | 3.1 | 8.3 |
| 5/8 | 1.9 | 1.2 | 1.2 | 3.6 | 10.4 |
| 3/4 | 2.1 | 1.4 | 1.4 | 4.2 | 12.5 |
| 7/8 | 2.4 | 1.6 | 1.6 | 4.8 | 14.6 |
| 1-1/8 | 3.0 | 2.0 | 2.0 | 6.0 | 18.8 |
| 1-3/8 | 3.6 | 2.4 | 2.4 | 7.2 | 22.9 |
| 1-5/8 | 4.2 | 2.8 | 2.8 | 8.4 | 27.1 |
| 2-1/8 | 5.3 | 3.5 | 3.6 | 10.7 | 35.4 |

Figure 7: Lineset Piping with the Air Handler Above the Condensing Unit

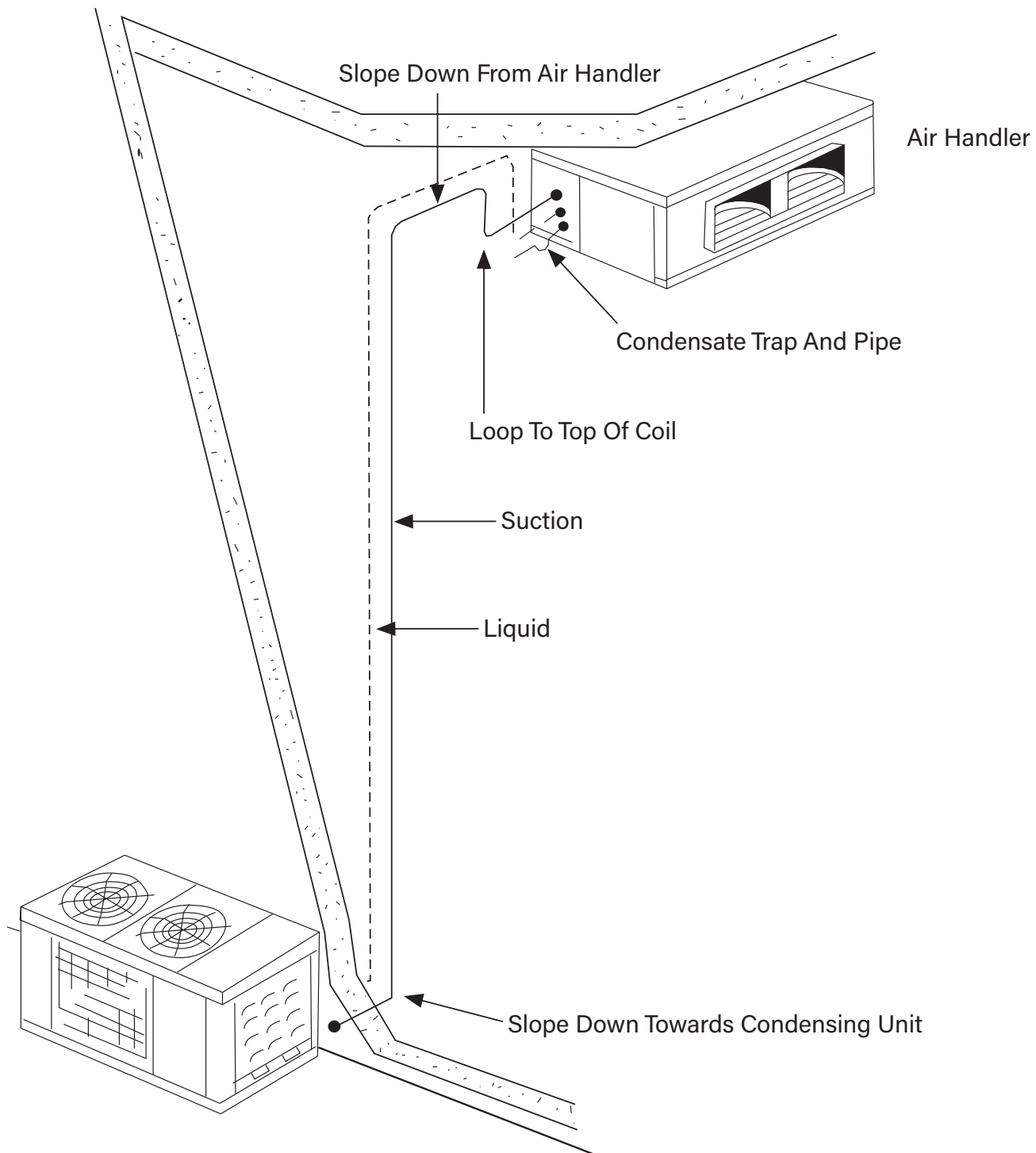
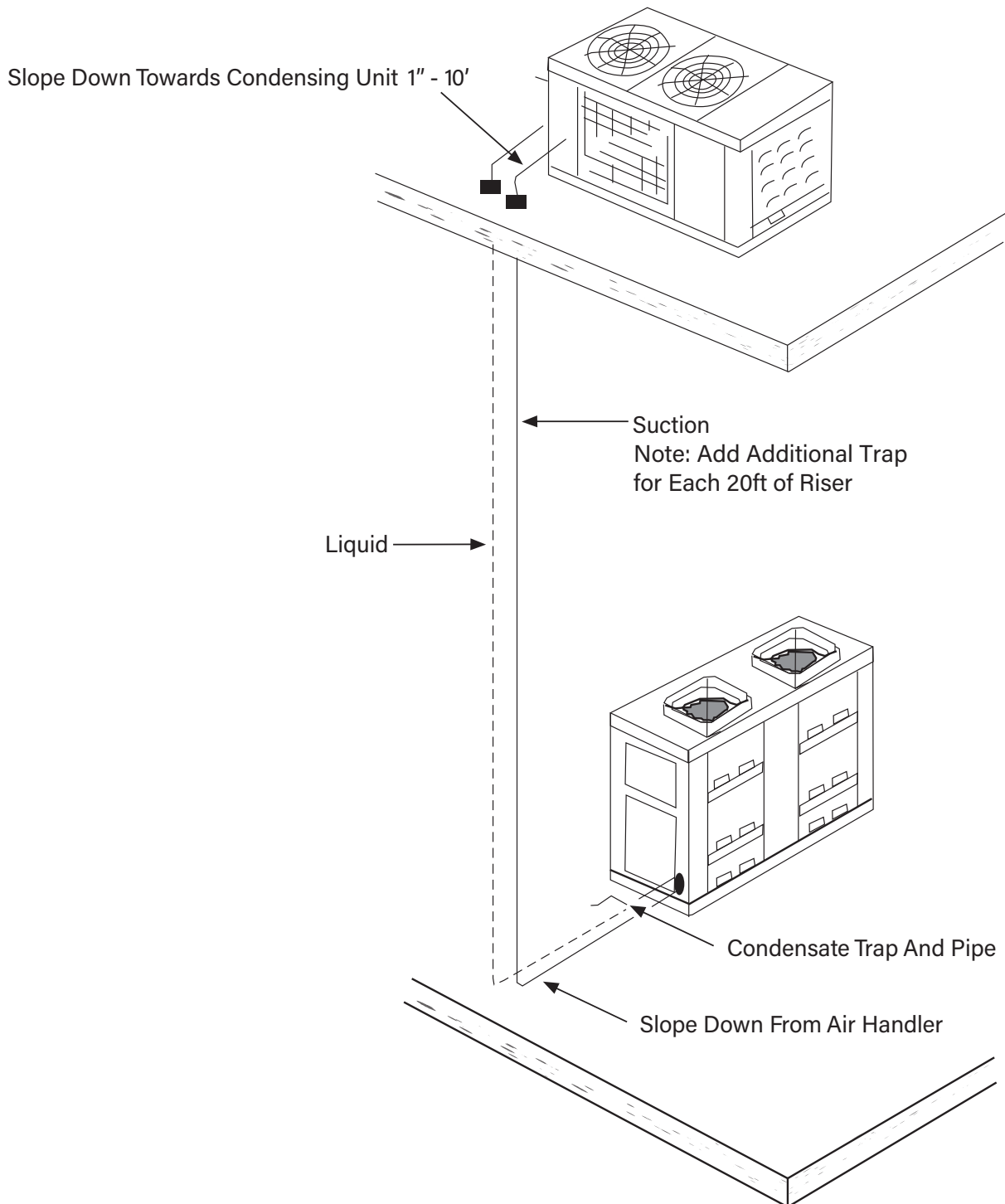


Figure 8: Lineset Piping with the Air Handler Below the Condensing Unit



Section 11: Unit Electrical:

Each unit is equipped with a wiring diagram (permanently attached behind clear view plastic on the inside of the control compartment door or on laminated sheets in an inside compartment) which will vary depending on the type of controls and options supplied. Check unit data plate for unit electrical data.

Note: Spark testing or shorting of the control wires by any means will render the transformers inoperative.

11.1 Wiring and Electrical Connections

All electrical wiring and connections, including electrical grounding, must comply with;

United States: Refer to National Electrical Code®, NFPA 70 - latest revision. Wiring must conform also to local ordinances and any special diagrams furnished.

Canada: Refer to Canadian Electrical Code, CSA C22.1 Part 1 - latest revision.

Check rating plate on unit for supply voltage and current requirements.

If any of the original control wire supplied with the unit must be replaced, replace it with type THHN 221° F [105°C], 600 V, 16 gauge wire or equivalent. For all other wires, replace with the equivalent size and type of wire that was originally provided with the unit.

11.2 Disconnect

An external weather-tight disconnect switch properly sized for the unit total load is required for each unit. This disconnect can be supplied by the factory or supplied by others. Do not use the unit disconnect as a method of on/off control. Use the operating controller or thermostat to shut down the unit.

11.3 Current Draw

For current requirements of the unit, refer to the unit rating plate.

11.4 Wiring Connections

Power wiring should be connected to the main power terminal block located within the unit main control section. Power wiring connections on units with factory-mounted disconnects should be made at the line side of disconnect. Main power wiring should be sized for the minimum wire ampacity shown on the unit rating plate.

For your safety, make sure that the unit has been properly grounded at ground lug connection. Do not obstruct service panels or service areas with electrical gear.



DANGER



ELECTRICAL SHOCK HAZARD

Disconnect electric before service. More than one disconnect switch may be required to disconnect electric from equipment. Equipment must always be properly grounded.

11.5 Voltage Unbalance

The power supply should be checked against the unit nameplate characteristics. It must be within 10% of rated voltage and not more than 2% phase unbalance. The power supply cables must be sized to carry the minimum circuit ampacity listed on the nameplate.

Once it is established that supply voltage is within the utilization range; check and calculate if an unbalanced condition exists between phases. Calculate percent voltage unbalance as follows:

| | |
|----------------|---------------------------|
| Percent | Maximum Voltage Deviation |
| Voltage = 100x | From Average Voltage |
| Unbalance | Average Voltage |

For Example – With voltage of 220, 215 and 210
(Measure L1-L2, L1-L3, L2-L3)

$$\text{Average voltage} = 645 \div 3 = 215$$

$$\text{Maximum voltage deviation from}$$

$$\text{Average voltage} = 220 - 215 = 5$$

| | |
|-------------------|--|
| Percent | $\frac{100 \times 5}{215} = \frac{500}{215} = 2.3\%$ |
| Voltage Unbalance | |

Percent voltage unbalance must not exceed (2%) two percent. Contact Power Company if phase unbalance exceeds 2%. A means of disconnecting power from the unit must be placed adjacent to the unit in accordance with national electrical code or local codes. Aluminum power wire is not recommended.

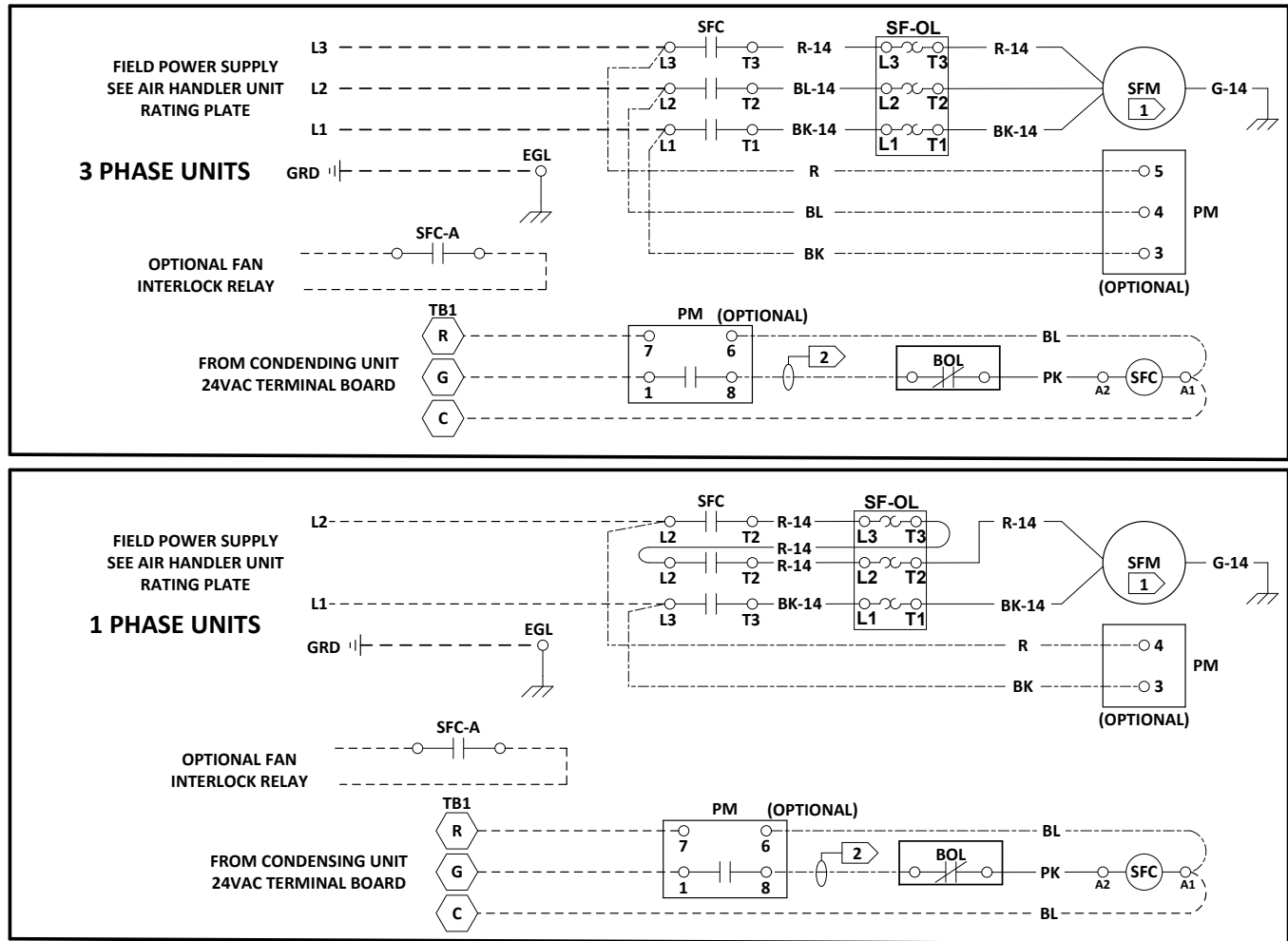
11.6 Low Voltage Wiring

For commercial equipment the following table lists the minimum size of 24-volt class 2 wire to be used.

Table 6: Low Voltage Wiring Lengths

| Wire Size | Distance From Unit, or Longest Run |
|-----------|------------------------------------|
| 18 AWG | Maximum Run - 50 Feet |
| 16 AWG | Maximum Run - 75 Feet |
| 14 AWG | Maximum Run - 100 - 125 Feet |
| 12 AWG | Maximum Run - 150 - 200 Feet |

Figure 9: Typical Air Handler Wiring Diagram



1 TYPICAL MOTOR SHOWN; SEE CONNECTION DIAGRAM ON MOTOR FOR ACTUAL WIRING DETAIL.

2 THIS WIRE CONNECTS DIRECTLY TO TERMINAL G OF "TB1" WHEN OPTIONAL POWER MONITOR IS NOT USED.

| LEGEND | |
|------------------------|---------------------------|
| FUNCTIONAL DESIGNATION | DESCRIPTION |
| SFC | SUPPLY FAN CONTACTOR |
| SFC-A | "SFC"- AUXILIARY CONTACT |
| SFM | SUPPLY FAN MOTOR |
| EGL | EQUIPMENT GROUNDING LUG |
| PM | POWER MONITOR |
| SF-OL | SUPPLY FAN OVERLOAD RELAY |
| TB | TERMINAL BOARD |

| SYMBOL LEGEND | |
|---------------|------------------------|
| | FACTORY WIRING |
| | FIELD WIRING |
| | FACTORY WIRING |
| | EARTH GROUND |
| | CHASSIS (PANEL) GROUND |
| | NORMALLY OPEN CONTACT |
| | NORMALLY CLOSE CONTACT |

Section 12:

Sequence of Operation:

12.1 Unit Configuration

Based on the unit's application, the unit may be configured in any number styles to achieve the described functionality. Refer to the unit's model number to see which configuration the unit was supplied with.

12.2.1 Factory-Mounted Terminal Strip for Field-Mounted DDC Controls (by others)

Field-supplied DDC controls can be connected to the factory-mounted and factory-wired terminal strip.

12.2.1 Factory-Mounted Terminal Strip for Remote Thermostat (by factory or by others)

A factory-supplied or field-supplied thermostat can be connected to the factory-mounted and factory wired terminal. The 24V factory-supplied thermostat has the following capabilities:

- Up to 4 heat/2 cool with humidity control - for heat pump
- Up to 3 heat/2 cool with humidity control - for straight cool

The thermostat features a 45-90 °F [7-32 °C] temperature control range with a +/- 1 °F [0.5 °C] accuracy and are capable of connecting to optional factory-supplied remote indoor air and outdoor air temperature sensors.

|  DANGER | |
|--|--|
|  | ELECTRICAL SHOCK HAZARD Disconnect electric before service. More than one disconnect switch may be required to disconnect electric from equipment. Equipment must always be properly grounded. |

Section 13: Start-Up Procedure:

Installation Code and Quarterly Inspections:

All installation and service of Global IFS equipment must be performed by a contractor qualified in the installation and service of equipment sold and supplied by Global IFS and conform to all requirements set forth in the Global IFS manuals and all applicable governmental authorities pertaining to the installation, service operation and labeling of the equipment.

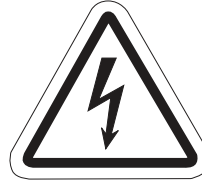
To help facilitate optimum performance and safety, Global IFS recommends that a qualified contractor conduct, at a minimum, quarterly inspections of your Global IFS equipment and perform service where necessary, using only replacement parts sold and supplied by Global IFS.

Check installation site to ensure all codes and engineering specifications are correct. This section of the manual is intended to be used as an instructional guide to the commissioning of the unit. Fill out the attached start up sheet (located at the back of the manual) as each step of the procedure is performed. This procedure should be completed by the commissioning contractor and returned to Global IFS.

13.1 Tools & Supplies Required

1. 5/16" Allen Key to Unlock Unit Doors
2. Equipment Touch
3. Refrigeration Manifold Gages
4. Refrigeration Wrench
5. Multimeter
6. Temperature Sensors
7. Clamp-On Temperature Probe
8. Socket Wrenches
9. Small Flat Heat Screwdriver
10. Refrigerant Oil
11. R-410A Refrigerant

DANGER



ELECTRICAL SHOCK HAZARD
Disconnect electric before service. More than one disconnect switch may be required to disconnect electric from equipment. Equipment must always be properly grounded.



SEVERE INJURY HAZARD
Do not enter equipment while in operation. Equipment may start automatically. Do not operate with access doors open. Installation, operation, and maintenance must be performed by a trained technician only.

Failure to follow these instructions can result in death, electrical shock, or injury.

WARNING



FALLING HAZARD
Use proper safety equipment and practices to avoid falling. Do not use any part of the equipment as a support.

Failure to follow these instructions can result in death, injury, or property damage.

13.2 Pre-Start Checks

13.2.1 Ductwork and Electrical Connections

Ensure that the following ductwork and electrical connections have been made:

- Ductwork: Supply and return air connections.
- Electrical: Line voltage power, control voltage power and remote sensor connections.

13.2.2 Condensate Drain

Units are provided with condensate drain connection(s). Do not operate unit unless a P-Trap is constructed and attached to drain connection. Unit must be level or slightly inclined towards drain. Drain should pitch down and away from the unit. P-Trap pipe diameter should be the same as the drain connection diameter. Units with high internal and external static pressure drops will require a deeper trap. Prime the trap before operating the unit.

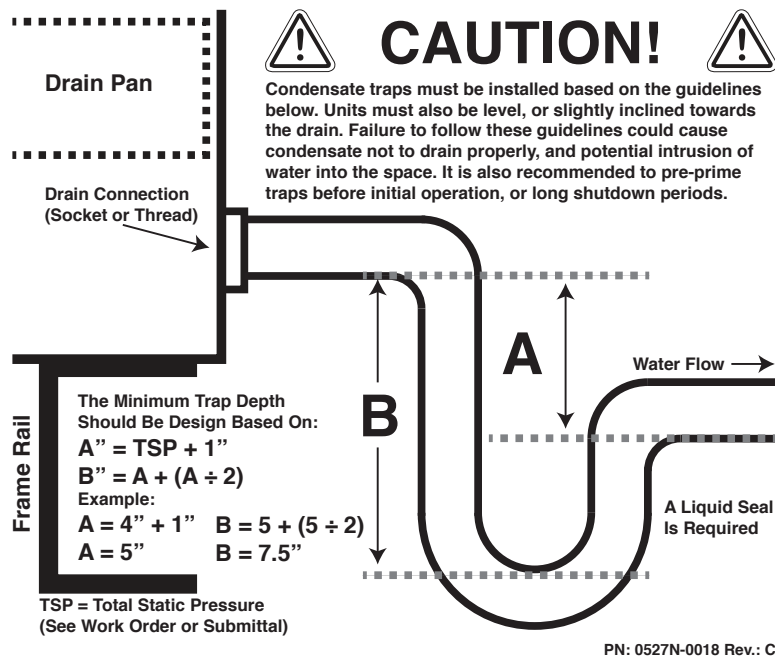
13.2.3 Supply Fans

1. Make sure electrical power is isolated.
2. Check power settings for voltage and verify that they correspond with the data on the motor plate.
3. Check that the motor is grounded (earthed).
4. Check that all electrical leads are sufficiently insulated.
5. Check that all electrical and system connections are properly made and tightened.
6. Check that all nuts, bolts and setscrews are tightened.
7. Check that the blower wheel turns freely without rubbing.
8. Bump the motor.
9. Check rotation.

13.2.4 Hot Water Heating Coils (Optional)

1. Check all plumbing to the hot water heating coil is complete and free of leaks.
2. Check that all air has been eliminated from the water loop and coil.
3. Check that flow rates match the nominal GPM listed in the table below.

Figure 10: P-Trap Configuration



Pre-Start Checklist:

- ☐ Documentation to properly start the unit including the sequence of operation, and a copy of the work order listing complete unit configuration.
- ☐ Pre-Start visual check of the unit, and a copy of the unit start up form to document the operation and performance of the unit.
- ☐ Unit checked for debris.
- ☐ Gages placed on each circuit to make sure the circuit has a refrigerant charge before circuit is enabled for operation. (if applicable)
- ☐ Supply power (line voltage) is connected to the unit, and is correct.
- ☐ All ductwork is connected to the unit.
- ☐ All condensate piping is connected to the unit.
- ☐ All refrigerant lineset piping is connected to the unit. (if applicable)
- ☐ All control wiring is connected to the unit.
- ☐ Filed installed parts (if applicable) that shipped loose are installed.
- ☐ Electrical connections are tight.
- ☐ Overloads are adjusted.
- ☐ Fan wheel(s) rotate freely.
- ☐ O/A dampers (if applicable) move freely.
- ☐ Safety switches are adjusted properly.
- ☐ Verify any field installed safeties (I.E. Fire (SD) or Condensate Overflow (COS)) are installed correctly. (if applicable)
- ☐ 80% of the calculated unit charge should be charged into the system before starting compressor. (if applicable)

Notes:

1. Start-up technician will need to fill out the Start-Up Form with date of start-up and all information.

Section 14

Start-Up:

Field start-up should be performed by a qualified technician.

The technician is responsible for assuring that all of the items on the unit start-up checklist are properly installed and operating.

Installation Code and Quarterly Inspections:

All installation and service of Global IFS products must be performed by a contractor qualified in the installation and service of equipment sold and supplied by Global IFS and conform to all requirements set forth in the installation manuals and all applicable governmental authorities pertaining to the installation, service, operation and labeling of the equipment.

To help facilitate optimum performance and safety, Global IFS recommends that a qualified contractor conduct, at a minimum, quarterly inspections of your equipment and perform service where necessary, using only replacement parts sold and supplied by Global IFS.

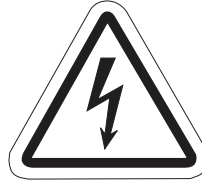
Further Information:

Applications engineering and detailed guidance on systems design, installation and equipment performance is available through Global IFS representatives. Please contact us for any further information you may require, including the Installation, Operation and Service Manual.

This product is not for residential use. This document is intended to assist licensed professionals in the exercise of their professional judgment.



DANGER



ELECTRICAL SHOCK HAZARD

Disconnect electric before service. More than one disconnect switch may be required to disconnect electric from equipment. Equipment must always be properly grounded.



SEVERE INJURY HAZARD

Do not enter equipment while in operation. Equipment may start automatically. Do not operate with access doors open. Installation, operation, and maintenance must be performed by a trained technician only.

Failure to follow these instructions can result in death, electrical shock, or injury.



WARNING



EXPLOSION HAZARD

Direct expansion systems contain R-410A refrigerant. Operating pressures may exceed limits of R-22 service equipment. Use proper refrigerant handling practices, tools, and equipment. Failure to follow these instructions can result in death, injury, or property damage.



FALLING HAZARD

Use proper safety equipment and practices to avoid falling. Do not use any part of the equipment as a support.

Failure to follow these instructions can result in death, injury, or property damage.

Section 15: Unit Maintenance:

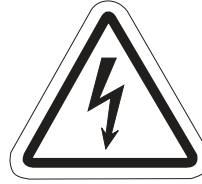
Prior to any maintenance or service to the unit, shut off, lockout and tagout the electrical disconnect and fuel valve (if applicable) that supplies the unit in accordance with OSHA regulations and, if the unit includes electric or gas heat, allow ample time for the unit to cool. After maintenance is performed or the unit is serviced, the unit shall be re-commissioned per the start-up procedure as outlined in Section 13.

Installation Code and Quarterly Inspections:

All installation and service of Global IFS equipment must be performed by a contractor qualified in the installation and service of equipment sold and supplied by Global IFS and conform to all requirements set forth in the Global IFS manuals and all applicable governmental authorities pertaining to the installation, service, operation and labeling of the equipment.

To help facilitate optimum performance and safety, Global IFS recommends that a qualified contractor conduct, at a minimum, quarterly inspections of your Global IFS equipment and perform service where necessary, using only replacements parts sold and supplied by Global IFS.

DANGER



ELECTRICAL SHOCK HAZARD
Disconnect electric before service. More than one disconnect switch may be required to disconnect electric from equipment. Equipment must always be properly grounded.



SEVERE INJURY HAZARD
Do not enter equipment while in operation. Equipment may start automatically. Do not operate with access doors open. Installation, operation, and maintenance must be performed by a trained technician only.

Failure to follow these instructions can result in death, electrical shock, or injury.

WARNING



EXPLOSION HAZARD
System contains R-410A refrigerant. Operating pressures may exceed limits of R-22 service equipment. Use proper refrigerant handling practices, tools, and equipment. Failure to follow these instructions can result in death, injury, or property damage.



BURN HAZARD
Allow equipment to cool before service. Internal components of equipment may still be hot after operation.



FALLING HAZARD
Use proper safety equipment and practices to avoid falling. Do not use any part of the equipment as a support.

Failure to follow these instructions can result in death, injury, or property damage.

Table 7: Maintenance Guidelines

| | |
|--|---|
| 15.1 General | |
| Quarterly | Follow the entire start-up procedure at this time and check settings (controls, operating temperatures, operating pressures, power and control voltages) and operation. |
| 15.2 Unit Exterior | |
| Cabinet Exterior | After installation, touch up scratches. Periodic painting should be done thereafter as required. The caulk should be inspected annually. Re-apply caulk as needed to maintain integrity. |
| Unit Location | Verify that no flammable objects, liquids or vapors are present near the unit. If unit includes gas furnace, clearances to combustibles around the vent must be adhered to. Do not hang anything from or place anything on the unit. Keep the area around the unit free of all objects. |
| 15.3 Supply Fans | |
| Motors | Inspection: 1. Inspect motor every 3 months. Keep the motor clean and vent openings clear. |
| 15.4 Chilled Water Components | |
| Chilled Water Coil | Check for dirt and bent fins. Clean with water from blower side towards filter side. |
| 15.5 Refrigeration Circuit Components (if equipped) | |
| Evaporator Coil | Check for dirt and bent fins. Clean with water from blower side towards filter side. |
| 15.6 Condensate Drain Pan and Drain | |
| Assembly | Check for blockages. Clean as necessary with mixture of 1/2 cup [0.1 L] bleach and 1 gallon [1.9 L] warm water if signs of mold or algae are present. |
| 15.7 Dampers | |
| Dampers | Check and clean blades. |
| Damper Motor/Linkages | Verify that all damper linkages move freely. Lubricate if necessary. |
| 15.8 Filters | |
| Assemblies | Filters should be checked for dirt restriction on a monthly basis (or as required). Replace filters with filters of equal specification when they appear dirty. |

Section 16: Replacement Parts:

Before ordering replacement parts, please contact factory to make sure that the replacement parts are the direct replacement for your specific unit.

Replacement parts used in units with the harsh environment coating option must be coated before being installed.

Only genuine Global IFS replacement parts should be used.

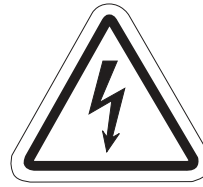
Table 8: Air Filters

| Main Unit | Filter Size | Quantity |
|-------------|-------------|----------|
| "A" Cabinet | 25 x 20 x 2 | 4 |
| | 20 x 18 x 2 | 2 |
| "B" Cabinet | 25 x 25 x 2 | 4 |
| "C" Cabinet | 24 x 20 x 2 | 3 |
| | 24 x 24 x 2 | 6 |

| Return Damper | Filter Size | Quantity |
|---------------|-------------|----------|
| 14 x 14 | 12 x 12 x 2 | 1 |
| 30 x 30 | 25 x 25 x 2 | 1 |



DANGER



ELECTRICAL SHOCK HAZARD
Disconnect electric before service. More than one disconnect switch may be required to disconnect electric from equipment. Equipment must always be properly grounded.



SEVERE INJURY HAZARD
Do not enter equipment while in operation. Equipment may start automatically. Do not operate with access doors open. Installation, operation, and maintenance must be performed by a trained technician only.

Failure to follow these instructions can result in death, electrical shock, or injury.



WARNING



**EXPLOSION
HAZARD**



**FIRE
HAZARD**




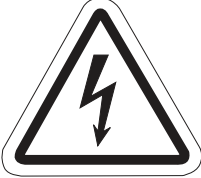
**CARBON
MONOXIDE
HAZARD**

Section 17:
Troubleshooting:


The following tables outline typical unit troubleshooting techniques for each section of the system.

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**DANGER**



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Failure to follow these instructions can result in death, electrical shock, or injury.

**WARNING**



**EXPLOSION
HAZARD**



**FIRE
HAZARD**



**CARBON
MONOXIDE
HAZARD**

Table 9: Supply Fan

| Problem | Probable Cause | Solution |
|---|--|---|
| Blower Motor Does Not Run | Damper limit switch not closed or inoperative | Repair or replace switch |
| | Motor thermal overloads tripped | For tripped condition-reset |
| | Fuses blown or missing | Replace |
| | External power source lacking | Have incoming power lines checked |
| | Motor inoperative | Repair or replace |
| Blower Motor Runs, But Fans Do Not Supply Enough Make-Up Air | Intake filters dirty | Replace or clean |
| | Obstruction in intake | Check dampers for proper operation Clear all intake passages of obstructions |
| | Access doors and panels not closed | Close |
| | Excessive discharge resistance from: Dirty filters in discharge External dampers | Clean filters and/or readjust dampers |
| Excessive Fan Noise | Fan bearing | Replace |
| | Fan wheel dirty | Clean |
| | Loose duct | Tighten or reinforce |
| | Foreign article in fan or duct | Remove |

Section 18

Global IFS Warranty:



GLOBAL IFS FLOOR PRODUCT LIMITED WARRANTY POLICY

Limited Warranty

Except as stated below, Global IFS warrants to the Owner of the building in which the Global IFS products have been installed (the "Owner") that the TecCrete panels, stringers, pedestal bases and heads will be free from defects in material and workmanship under normal use and service for a period of three (3) years from the date of shipment. All other Global IFS products will be free from defects in material and workmanship under normal use and service for a period of one (1) year from the date of shipment. Regarding Global IFS Architectural Grade panels, Global IFS disclaims any warranty with respect to aesthetic consistency of the product, including, without limitation, the consistency of appearance among flooring panels, consistency with any samples provided by Global IFS, or consistency with other Global IFS projects. The Architectural Grade TecCrete is made from natural products and moderate shade and color tone differences will occur. Global IFS warrants materials or components supplied by third parties and incorporated into the Global IFS products only to the extent of the express warranties made by the suppliers of such components. This warranty covers only the Global IFS material and not any installation labor.

This limited warranty is extended only to the Owner and no other party, including the party that purchased the product from Global IFS (the "Buyer").

This limited warranty does not cover normal wear and tear of parts or damage or loss resulting from misuse, accident, neglect, improper installation or maintenance. In order to qualify for this warranty coverage, the Global IFS products must be installed, used and maintained strictly in accordance with the instructions and recommendations contained in Global IFS's literature.

If Owner claims that the Global IFS products do not conform to this limited warranty, it must, at Global IFS's option, either return any defective parts to Global IFS with freight or other transportation costs prepaid or allow Global IFS's personnel to inspect the Global IFS products at the site of their installation or use. If, after inspection, Global IFS determines that the Global IFS products do not conform to this limited warranty, Global IFS in its sole discretion will choose to (a) repair the Global IFS products without charge to Owner, (b) replace the Global IFS products without charge to Owner, or (c) repay to Owner an amount equal to the purchase price paid by Buyer to Global IFS. The warranty period for repaired or replaced components shall be the remainder of the original warranty period. Owner understands and agrees that its sole and exclusive remedy for breach of warranty is the remedy of repair, replacement or refund as set forth herein.

THE WARRANTY ISSUED TO OWNER HEREUNDER IS THE ONLY WARRANTY PROVIDED BY GLOBAL IFS AND IS STRICTLY LIMITED TO ITS TERMS AND IS IN LIEU OF ALL OTHER EXPRESS OR IMPLIED WARRANTIES (WHETHER TO OWNER OR THE BUYER), INCLUDING WITHOUT LIMITATION THE **WARRANTIES OF MERCHANTABILITY** OR FITNESS FOR A PARTICULAR PURPOSE OR OTHER WARRANTIES OF QUALITY, AND OF ALL OTHER LIABILITIES AND OBLIGATIONS, ALL OF WHICH ARE HEREBY DISCLAIMED. BUYER AND OWNER HEREBY WAIVE ALL OTHER CONDITIONS, REPRESENTATIONS AND WARRANTIES, EXPRESS OR IMPLIED BY STATUTE, USAGE, CUSTOM OF THE TRADE OR OTHERWISE NOTWITHSTANDING ANY PRIOR STATEMENT, WRITTEN OR ORAL. GLOBAL IFS MAKES NO OTHER WARRANTIES REGARDING THE QUALITIES OF ITS PRODUCTS OR THE MATERIALS INCORPORATED THEREIN.

Buyer and Owner understand and agree that in no event shall Global IFS be liable to either of them or to any third party for any incidental, special, consequential or other similar damages arising, directly or indirectly, out of or occasioned by the purchase, use, installation, repair, replacement of the Global IFS products, whether such damages are based on a claim for breach of express or implied warranty, tortious conduct, or any other cause of action, whether or not foreseeable and whether or not Global IFS has been advised of the possibility of such damages. Under no circumstances will Global IFS's liability exceed the purchase price paid by Buyer to Global IFS for the defective Global IFS products.

This limited warranty shall be construed and the obligations of Global IFS shall be interpreted in accordance with the laws of the State of Michigan without regard to the conflicts of laws thereof. Any controversy or dispute arising out of or related to this limited warranty shall be addressed and settled in accordance with the process set forth in Global IFS's Terms and Conditions of Sale (U.S.) (the "Sales Terms"). This Limited Warranty is issued pursuant to, and in connection with, the Sales Terms, and, except to the extent, if any, that this Limited Warranty directly conflicts with the Sales Terms, this Limited Warranty is subject to all applicable provisions of the Sales Terms.

Notes:

Revision Guide:

| Date: | Page: | Description: | By: |
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| 04 Sept 20 | All | First Published | DS |

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