AQUAZONE™
50VS
Vertical Stack Water Source Heat Pump
with PURON® (R-410A) Refrigerant

Installation, Start-Up, and Service Instructions

CONTENTS

IMPORTANT: Read the entire instruction manual before starting installation.

SAFETY CONSIDERATIONS

Installation and servicing of air-conditioning equipment can be hazardous due to system pressure and electrical components. Only trained and qualified service personnel should install, repair, or service air-conditioning equipment.

Untrained personnel can perform basic maintenance functions such as cleaning coils and filters and replacing filters. All other operations should be performed by trained service personnel. When working on air-conditioning equipment, observe precautions in the literature, tags and labels attached to the unit, and other safety precautions that may apply.

Improper installation, adjustment, alteration, service, maintenance, or use can cause explosion, fire, electrical shock or other conditions which may cause personal injury or property damage. Consult a qualified installer, service agency, or a local distributor or branch for information or assistance. The qualified installer or agency must use factory-authorized kits or accessories when modifying this product. Refer to the individual instructions packaged with the kits or accessories when installing.

Follow all safety codes. Wear safety glasses and work gloves. Use quenching cloth for brazing operations. Have fire extinguisher available. Read these instructions thoroughly and follow all warnings or cautions attached to the unit. Consult local building codes and the National Electrical Code (NEC) for special installation requirements.

Understand the signal words — DANGER, WARNING, and CAUTION. DANGER identifies the most serious hazards which will result in severe personal injury or death. WARNING signifies hazards that could result in personal injury or death. CAUTION is used to identify unsafe practices, which would result in minor personal injury or product and property damage.

Recognize safety information. This is the safety-alert symbol (⚠). When this symbol is displayed on the unit and in instructions or manuals, be alert to the potential for personal injury.

⚠ WARNING

Electrical shock can cause personal injury or death. Before installing or servicing system, always turn off main power to system. There may be more than one disconnect switch. Turn off accessory heater power if applicable.

GENERAL

This installation and start-up instructions literature is for Aquazone™ water source heat pump systems.

The 50VS water source heat pump (WSHP) is a vertically stacked unit with electronic controls designed for year-round cooling and heating.

IMPORTANT: The installation of water source heat pump units and all associated components, parts, and accessories which make up the installation shall be in accordance with the regulations of ALL authorities having jurisdiction and MUST conform to all applicable codes. It is the responsibility of the installing contractor to determine and comply with ALL applicable codes and regulations.

INSTALLATION

Step 1 — Check Jobsite — Installation, operation and maintenance instructions are provided with each unit. Before unit start-up, read all manuals and become familiar with the unit and its operation. Thoroughly check out the system before operation. Complete the inspections and instructions listed below to prepare a unit for installation. See Table 1 for unit physical data.

IMPORTANT: This equipment is designed for indoor installation ONLY. Extreme variations in temperature, humidity and corrosive water or air will adversely affect the unit performance, reliability and service life.

The 50VS units are designed for indoor installations. Units are typically installed in a floor-level closet or a small mechanical room. Be sure to allow adequate space around the unit for servicing. See Fig. 1-5 for unit dimensions.

⚠ CAUTION

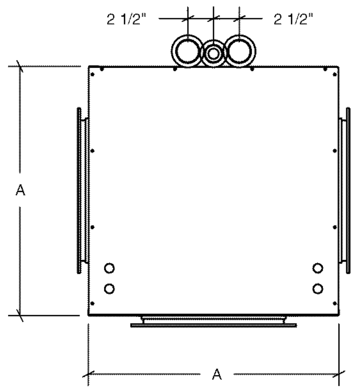
To avoid equipment damage, do not use units as a source of heating or cooling during the construction process. The mechanical components and filters used in these units quickly becomes clogged with construction dirt and debris which may cause system damage.

Table 1 — Physical Data — 50VS Unit

UNIT	50VSA,B	50VSC,D	50VSE,F	50VSG,H	50VSI,J	50VSK,L	50VSM,N
COOLING CAPACITY (Btuh)	9,200	11,700	16,500	18,000	22,500	28,500	32,700
HEATING CAPACITY (Btuh)	12,500	16,000	22,500	24,500	31,000	38,000	45,000
CABINET WEIGHT (lb)	120				170		
CHASSIS WEIGHT (lb)	99	105	119	122	187	198	205
COMPRESSOR (1 each)	Rotary						Scroll
High Side Pressure (psig)	550						
Low Side Pressure (psig)	170						
FACTORY REFRIGERANT CHARGE R-410A (oz)	27.5	27.5	36.7	41.6	49.4	63.5	61.8
FAN DATA							
Fan Motor Type/Speeds	PSC/2 speed						
Blower Wheel Size (Depth x Width) (in.) Std/High Static	7.08 x 6.69				9.21 x 9.99		
Airflow (cfm)	370	450	540	640	820	1120	1300
Static Pressure (in. wg)	0						
WATER/CONDENSATE SIDE DATA							
Flow Rate (gpm)	2.6	3.2	4.5	5.2	6.5	8.5	9.5
Water Connection Size (FPT) (in.)	1/2		3/4				
Water Side Pressure Drop (psi)	5.8	5.8	11.5	11.8	4.8	7.2	10.2
Condensate Connection Size (in.)	3/4						
AIR COIL DATA							
Total Face Area (sq ft)	1.48	1.48	1.81	1.48	1.48	1.81	1.48
Tube Size (in.)	3/8						
Fin Spacing (FPI)	12		14		10		
Number of Rows	2		3		2	3	
CABINET DATA							
Depth (in.)	18				24		
Height (in.)	88				88		
Width (in.)	18				24		
Standard Filter -- 1 in. Washable	14-1/4 x 18-1/2		14-1/4 x 22-1/2		19 x 28-3/4		

LEGEND

FPI — Fins Per Inch
PSC — Permanent Split Capacitor



UNIT	DIMENSION A (in.)	WATER CONNECTION SIZE (FPT) (in.)	COIL CONNECTION SIZE (in.)
50VSA,B	18	1/2	1/2
50VSC,D	18	1/2	1/2
50VSE,F	18	3/4	3/4
50VSG,H	18	3/4	3/4
50VSI,J	24 1/4	3/4	3/4
50VSK,L	24 1/4	3/4	3/4
50VSM,N	24 1/4	3/4	3/4

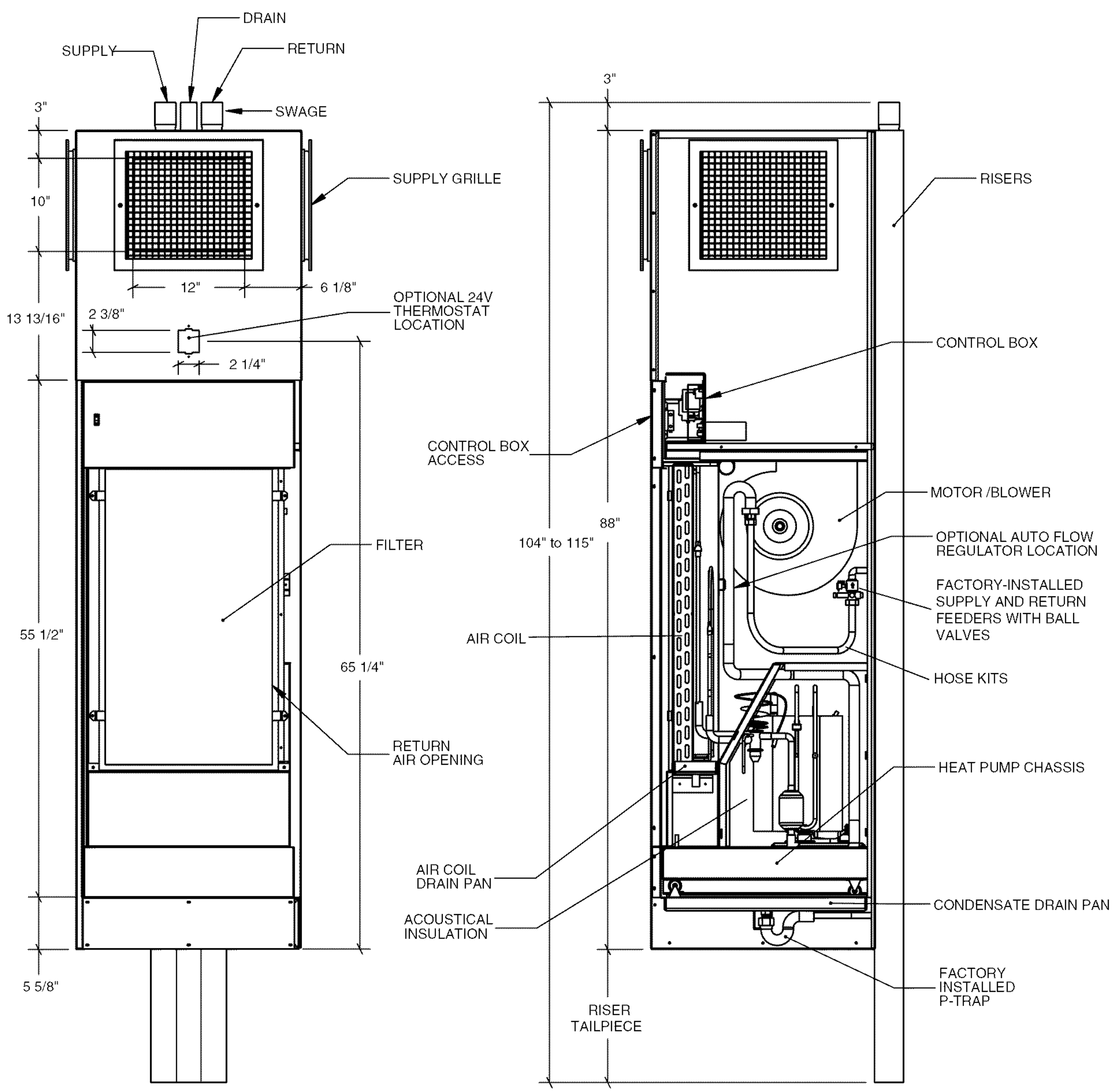
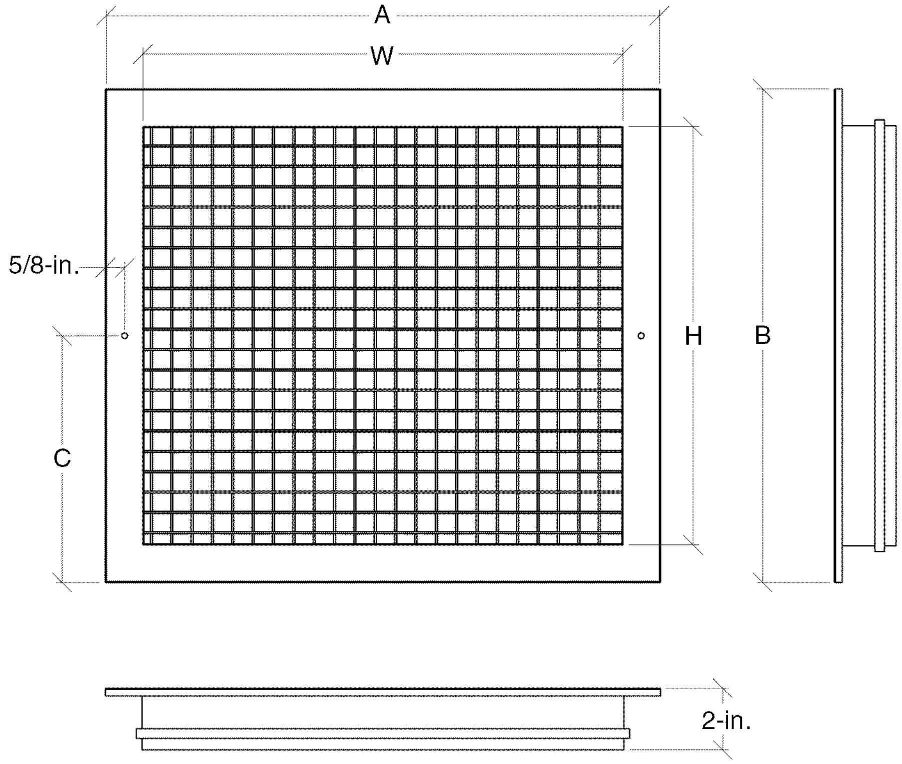


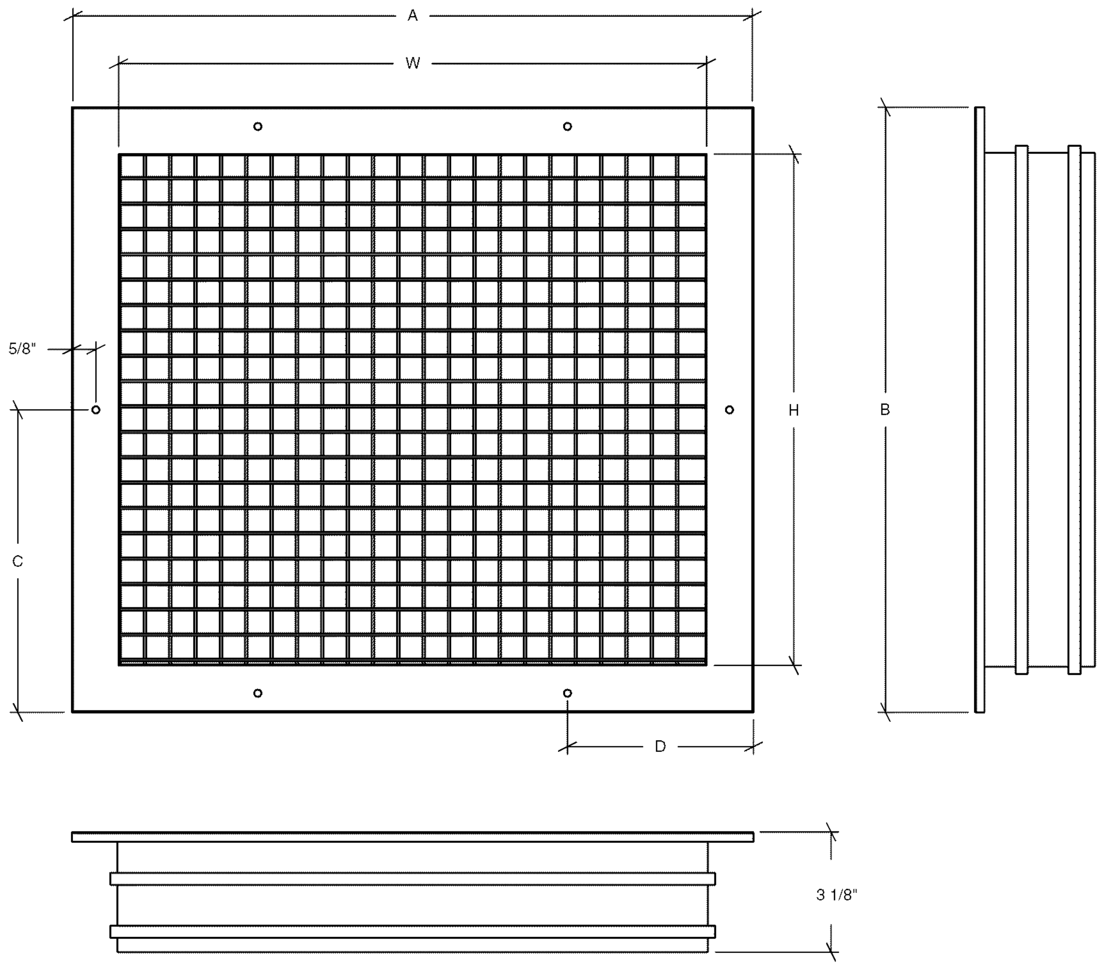
Fig. 1 — 50VS Unit Dimensional Data



DIMENSIONAL DATA						
Grille Size (in.)	**Cabinet Height**	**W (in.)**	**H (in.)**	**A (in.)**	**B (in.)**	**C (in.)**
16 x 14	STD	$15^{7}/_{16}$	$13^{7}/_{16}$	18	16	8
14 x 12	STD	$13^{3}/_{8}$	$11^{3}/_{8}$	16	14	7
12 x 10	STD	$11^{7}/_{16}$	$11^{7}/_{16}$	14	12	6
10 x 8	STD	$9^{7}/_{16}$	$9^{7}/_{16}$	12	10	5

NOTES:
1. Single deflection grilles include adjustable vertical blades for controlling horizontal path of discharge.
2. Double deflection grilles include adjustable vertical and horizontal blades for controlling horizontal and vertical path of discharge air (recommended).
3. Dimensions are in inches.
4. All dimensions are ± $^{1}/_{4}$ inch.
5. Discharge grilles are shipped loose for field installation.
6. Construction is roll formed aluminum frame and blades.
7. Standard finish is powder coated and will be the same color as the return grille.
8. Installation of grille on adjacent unit sides may require a duct extension to prevent air bypass around discharge grilles.
9. Mounting hardware included.

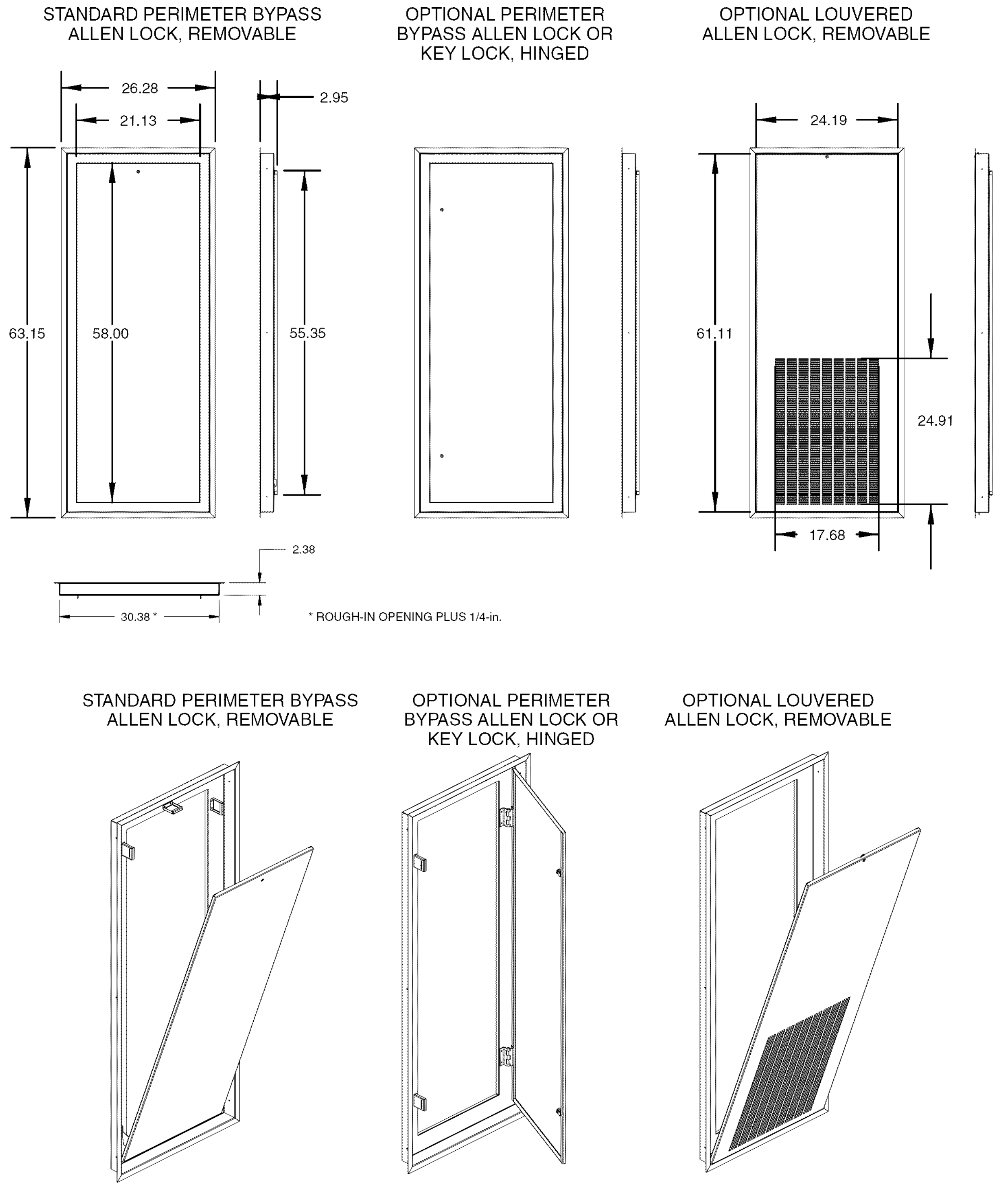
Fig. 2 — Single and Double Deflection Aluminum Discharge Grille



DIMENSIONAL DATA							
Grille Size (in.)	**Cabinet Height**	**W (in.)**	**H (in.)**	**A (in.)**	**B (in.)**	**C (in.)**	**D (in.)**
16 x 14	STD	$15^{3}/_{16}$	$13^{3}/_{16}$	$17^{3}/_{4}$	$15^{3}/_{4}$	N/A	$4^{7}/_{8}$
14 x 12	STD	$13^{3}/_{16}$	$11^{3}/_{16}$	$15^{3}/_{4}$	$13^{3}/_{4}$	$6^{7}/_{8}$	N/A
12 x 10	STD	$11^{3}/_{16}$	$9^{3}/_{16}$	$13^{3}/_{4}$	$11^{3}/_{4}$	$5^{7}/_{8}$	N/A
10 x 8	STD	$9^{3}/_{16}$	$7^{3}/_{16}$	$11^{3}/_{4}$	$9^{3}/_{4}$	$4^{7}/_{8}$	N/A

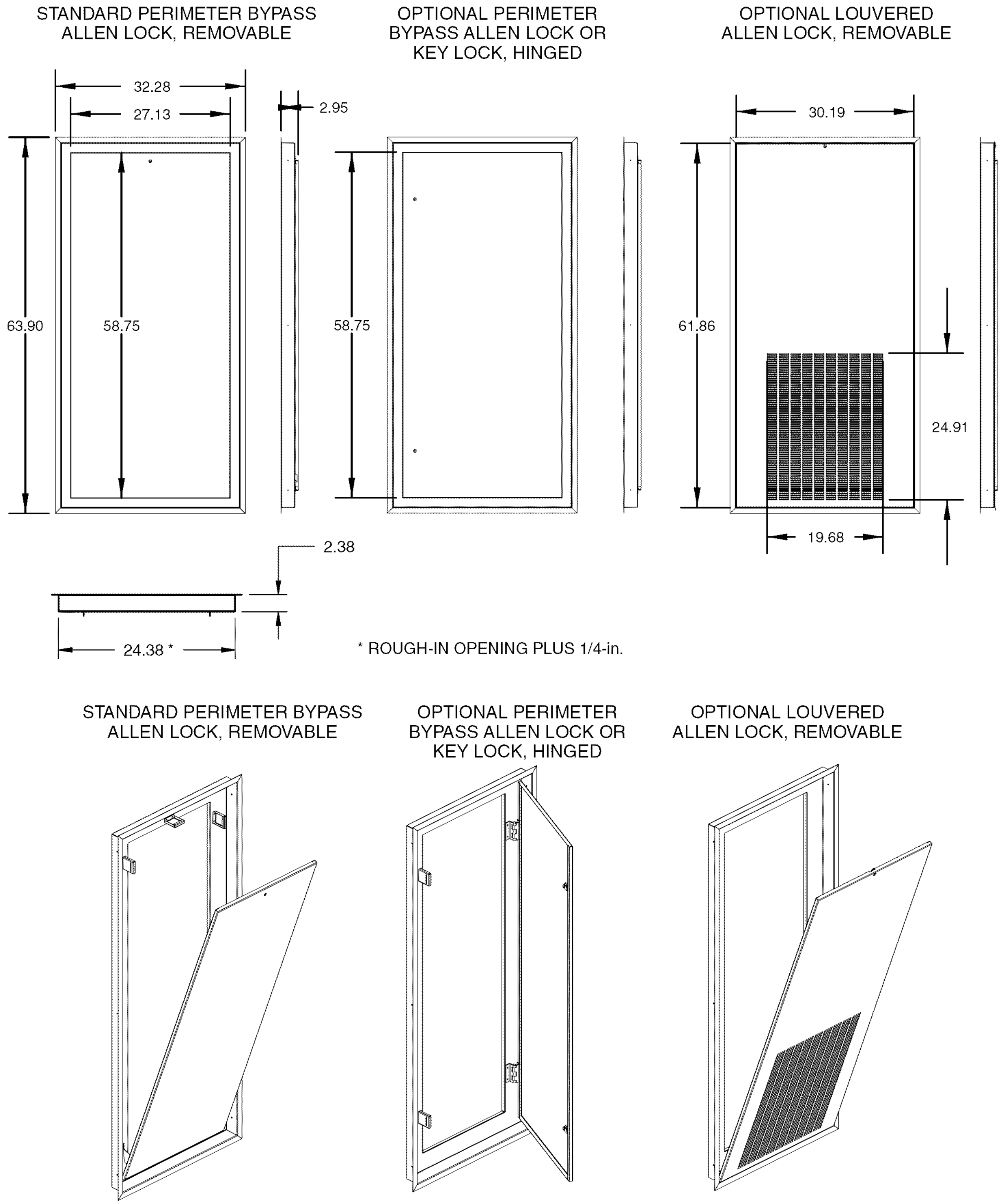
NOTES:
1. The opposed blade damper allows control of air volume (cfm) and path of discharge air. Recommended for applications requiring unequal airflow or side discharge grille(s) with additional top discharge air opening.
2. Dimensions are in inches.
3. All dimensions are ± $^{1}/_{4}$ inch.
4. Discharge grilles are shipped loose for field installation.
5. Construction is roll formed aluminum frame and blades.
6. Standard finish is powder coated and will be the same color as the return grille.
7. Installation of grille on adjacent unit sides may require a duct extension to prevent air bypass around discharge grilles.
8. Mounting hardware included.

Fig. 3 — Double Deflection with Opposed Damper Aluminum Discharge Grille



NOTE: All dimensions are in inches.

Fig. 4 — Return Panel and Frame Dimensions — 50VSA-VSH Units



NOTE: All dimensions are in inches.

Fig. 5 — Return Panel and Frame Dimensions — 50VSI-VSN Units

Step 2 — Check Unit — Upon receipt of shipment at the jobsite, carefully check the shipment against the bill of lading. Make sure all units have been received. Inspect the carton or crating of each unit, and inspect each unit for damage. Ensure the shipping company makes proper notation of any shortages or damage on all copies of the freight bill. Concealed damage not discovered during unloading must be reported to the shipping company within 15 days of receipt of shipment.

NOTE: It is the responsibility of the purchaser to file all necessary claims with the shipping company.

1. Be sure that the location chosen for unit installation provides ambient temperatures maintained above freezing. Well water applications are especially susceptible to freezing.
2. Be sure the installation location is isolated from sleeping areas, private offices and other acoustically sensitive spaces.

   NOTE: A sound control accessory package may be used to help eliminate sound in sensitive spaces.
3. Check local codes to be sure a secondary drain pan is not required under the unit.
4. Be sure unit is mounted at a height sufficient to provide an adequate slope of the condensate lines. If an appropriate slope cannot be achieved, a field-supplied condensate pump may be required.
5. Provide sufficient space for duct connection. Do not allow the weight of the ductwork to rest on the unit.
6. Provide adequate clearance for filter replacement and drain pan cleaning. Do not allow piping, conduit, etc. to block filter access.
7. Provide sufficient access to allow maintenance and servicing of the fan and fan motor, compressor and coils. Removal of the entire unit from the closet should not be necessary.
8. Provide an unobstructed path to the unit within the closet or mechanical room. Space should be sufficient to allow removal of unit if necessary.
9. Provide ready access to water valves and fittings, and screwdriver access to unit side panels, discharge collar, and all electrical connections.
10. Where access to side panels is limited, pre-removal of the control box side mounting screws may be necessary for future servicing.

STORAGE — If the equipment is not needed immediately at the jobsite, it should be left in its shipping carton and stored in a clean, dry area of the building or in a warehouse. Units must be stored in an upright position at all times. If carton stacking is necessary, stack units a maximum of 3 cartons high. Do not remove any equipment from its shipping package until it is needed for installation.

PROTECTION — Once the units are properly positioned on the jobsite, cover them with either a shipping carton, vinyl film, or an equivalent protective covering. Cap open ends of pipes stored on the jobsite. This precaution is especially important in areas where painting, plastering, or spraying of fireproof material, etc. is not yet complete. Foreign material that accumulates within the units can prevent proper start-up and necessitate costly clean-up operations.

Before installing any of the system components, be sure to examine each pipe, fitting, and valve, and remove any dirt or foreign material found in or on these components.

⚠ CAUTION

DO NOT store or install units in corrosive environments or in locations subject to temperature or humidity extremes (e.g., attics, garages, rooftops, etc.). Corrosive conditions and high temperature or humidity can significantly reduce performance, reliability, and service life. Always move units in an upright position. Tilting units on their sides may cause equipment damage.

INSPECT UNIT — To prepare the unit for installation, complete the procedures listed below:

1. Compare the electrical data on the unit nameplate with ordering and shipping information to verify that the correct unit has been shipped.
2. Do not remove the packaging until the unit is ready for installation.
3. Verify that the unit's refrigerant tubing is free of kinks or dents, and that it does not touch other unit components.
4. Inspect all electrical connections. Be sure connections are clean and tight at their terminations.
5. Remove any blower support cardboard from inlet of the blower.
6. Locate and verify any accessory kit located in compressor and/or blower section.
7. Remove any access panel screws that may be difficult to remove once unit is installed.

Step 3 — Locate Unit — The following guidelines should be considered when choosing a location for a WSHP:

- Units are for indoor use only.
- Locate in areas where ambient temperatures are between 39 F and 102 F and relative humidity is no greater than 75%.
- Provide sufficient space for water, electrical and duct connections.
- Locate unit in an area that allows easy access and removal of filter and access panels.
- Allow enough space for service personnel to perform maintenance.
- Return air must be able to freely enter the space if unit needs to be installed in a confined area such as a closet.

Step 4 — Install Drywall — All rough-in instructions and drawings are designed for a single layer of $^5/_8$ in. thick drywall. Refer to Fig. 6. Rough-in dimensions will be affected if drywall thickness is different than $^5/_8$ in., the return panel will not fit snugly to the wall and form a tight seal. Install drywall using conventional construction methods. Drywall cannot be fastened to the studs with adhesive alone; a mechanical fastener such as drywall screws must be used.

Vacuum all drywall dust and construction debris from coils, drain pans and blower discharge plenum after cutting out supply and return holes for grilles. When installation is complete, cover cabinet supply and return air openings.

Do not allow paint or wall texture over-spray to contact coil, fan or other unit components. Warranties are void if paint or other foreign debris is allowed to contaminate internal unit components.

Step 5 — Install Cabinet and Riser

SYSTEM PIPING ARRANGEMENTS — Figure 7 shows some of the common piping layouts for water source heat pumps. 2-pipe systems are depicted but the same methods can be applied to 4-pipe systems.

The direct return system shows the most common piping arrangement. This is the most cost effective method of piping to install since the water is supplied and returned to a riser column at the same place, at the bottom or top of the building. However, this type of system requires more effort to individually balance water flow to the units. The risers are normally capped at the ends opposite the main supply and return piping and may require a field-installed flush and vent loop.

The first reverse return system shows a system, which is commonly used to minimize individual unit water flow balancing and is often referred to as "self balancing." This riser arrangement has a natural affinity to balance the flow to each unit in the riser column. However, individual unit balancing may still be required. This piping system is used on 2-pipe systems only and has an individual return for each riser column.

The second reverse return system shows a system with a common reverse return riser installed separately from the individual unit riser columns. This riser arrangement allows for more flexibility in individual unit riser sizing but has the same general characteristics as the "reverse return" system described above. It may also be a better fit for the particular structural and architectural requirements of the building. This piping system may also be used on 4-pipe systems.

Regardless of the system selected, optimum performance can only be achieved through adjustment to the recommended water flow at each individual unit (see Table 1 for individual unit water flow requirements).

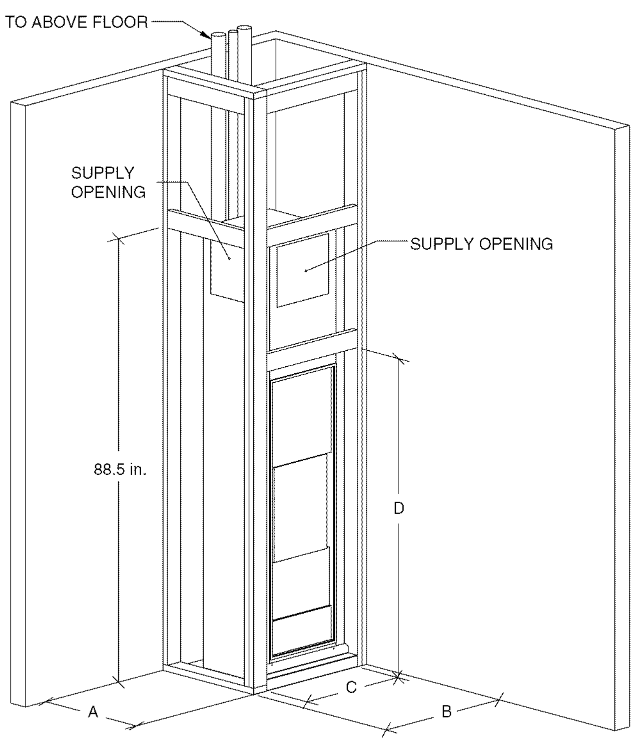
RISER MATERIAL, SIZING, AND INSULATION — Some of the factors affecting riser application and sizing are noise, tube erosion and economics. Water source heat pumps maybe supplied with factory-installed risers; the riser material, diameter, length and insulation thickness must be determined for each unit based on its positioning within the building. Figure 8 displays riser tube diameter sizes as a function of flow (gpm), friction loss and water velocity. For maximum riser velocity on pressure drop per 100 ft, refer to ASHRAE (American Society of Heating, Refrigeration, and Air Conditioning Engineers) Fundamentals Handbook for Riser Sizing. Generally, riser copper type, size, length and insulation thickness are determined by the location of the water source heat pump unit in the building. Chilled water and hot water risers are available in Type-M, Type-L copper, varying diameters from $^{3}/_{4}$ to $2^{1}/_{2}$ in., and with either no insulation, $^{1}/_{2}$ or $^{3}/_{4}$ in. thick closed cell foam insulation. Condensate risers are available in Type-M copper, varying diameters from $^{3}/_{4}$ to $1^{1}/_{4}$ in., and with no insulation, $^{1}/_{2}$ or $^{3}/_{4}$ in. thick closed cell foam insulation. All factory-supplied risers and riser extensions are insulated for the full length of the riser, eliminating the need for field insulation. Insulation is not required on loop water piping except where the piping runs through unheated areas, outside the building or when the loop water temperature is below the minimum expected dew point of the pipe ambient conditions. Insulation is required if loop water temperature drops below the dew point (insulation is required for the ground loop applications in most climates).

Riser sizing is generally based on the water flow requirements of each unit and the units on higher and lower floors that tie into the same riser column depending on the piping system chosen. Water piping is often designed at approximately 5 ft/s. Keeping this in mind, risers can be reduced in size as the water flow decreases from floor to floor. For low-rise buildings, riser sizes can be of a single diameter.

The reduced material handling on site will often offset the extra costs associated with the larger risers.

RISER EXPANSION — Generally, in medium to high-rise buildings, allowances must be made for pipe expansion. In applications supplemented with factory (or field) supplied between the floor riser extensions, assemble and install extensions before installing cabinet.

NOTE: Riser assemblies are designed to accommodate a maximum of $1^{1}/_{8}$ in. expansion and contraction up to a total movement of $2^{1}/_{4}$ inches. If the total calculated rise expansion exceeds $2^{1}/_{4}$ in., expansion devices must be used (field provided).



50VS UNIT SIZE	DIMENSIONS (in.)			
	A	B	C	D
50VSA-VSH	$24^{5}/_{8}$	$30^{11}/_{16}$	$24^{5}/_{8}$	$63^{11}/_{16}$
50VSI-VSN	$30^{7}/_{8}$	$36^{11}/_{16}$	$30^{5}/_{8}$	$64^{7}/_{16}$

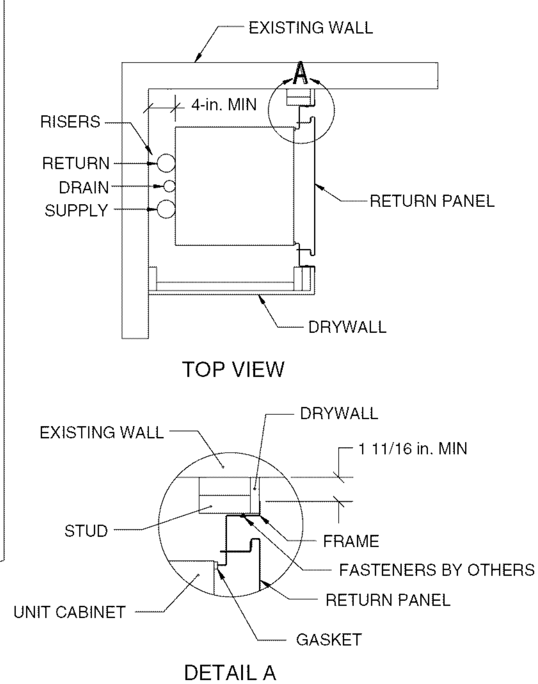


Fig. 6 — Framing Rough-In Detail

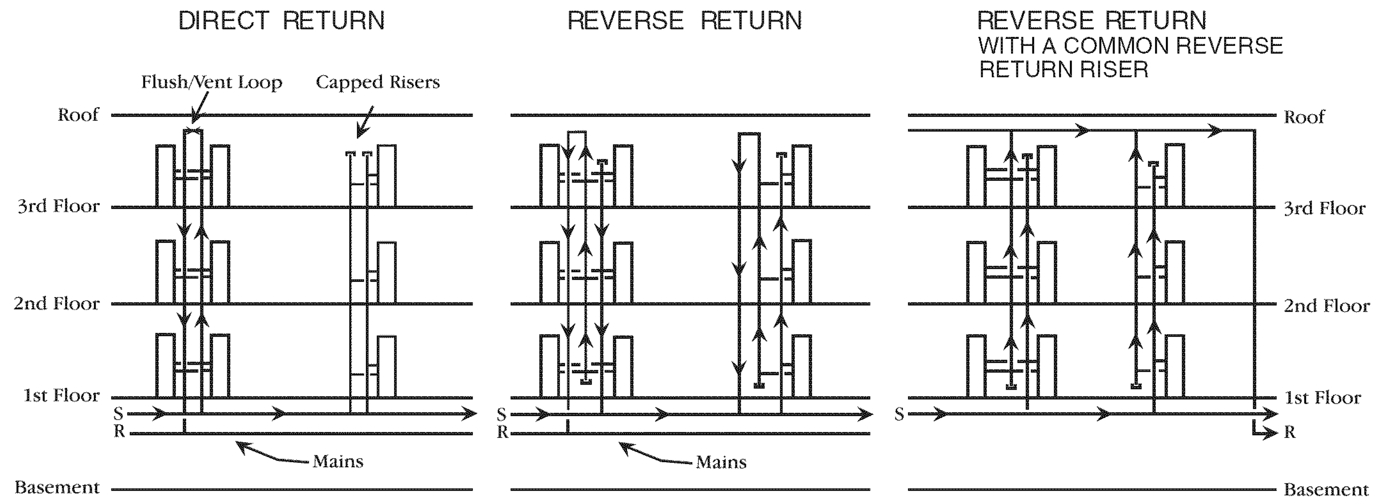


Fig. 7 — System Piping Arrangements

All riser modifications necessitated by variations in floor-to-floor dimensions including cutting off or extending risers is the sole responsibility of the installing contractor.

Additional expansion compensation must be made in the riser system in the field where movement is expected to exceed the factory allowances. Figure 9 displays the expansion characteristics of risers compared to water temperature differential. Assuming a minimum water temperature of 20 F and a maximum water temperature of 120 F, the temperature difference of 100 F indicates 90 feet of riser will expand or contract 1 inch. To eliminate stress, a riser system must be anchored at least once to the building structure. Technical information on pipe expansion, contraction and anchoring can be found in the ASHRAE HVAC Systems and Equipment Handbook and various other technical publications. Riser expansion and the anchoring of each unit is the responsibility of the design engineer and installing contractor.

RISER CONNECTIONS — Install cabinet with risers as follows:

1. Move cabinet into position.

⚠ CAUTION

Keep risers off the floor while moving the cabinet. Failure to heed this warning could result in equipment damage.

2. Be sure that all the copper fittings are clean and free of dirt. Raise the cabinet upright and lower it into the riser from the floor below.

   NOTE: The top of each riser is equipped with a 3 in. deep swaged connection. There is sufficient extension at the bottom to allow insertion of approximately 2 in. of the riser into the swaged top of the riser below.
3. Center risers in the pipe chase and shim the cabinet level. Plumb risers in two planes to assure proper unit operation and condensate drainage.
4. Attach the cabinet assembly to the floor and the building structure on at least two sides using sheet metal angles (field provided). A field-provided base vibration dampening pad can be used to help eliminate transfer of any vibration to the structure. If vibration dampening pads are used some rough-in dimensional changes will need to be considered before installation due to style and thickness of the pads. Additional anchorage can be provided by installing brackets at the top of the cabinet (field provided).
5. DO NOT attach drywall studs to the equipment cabinet.

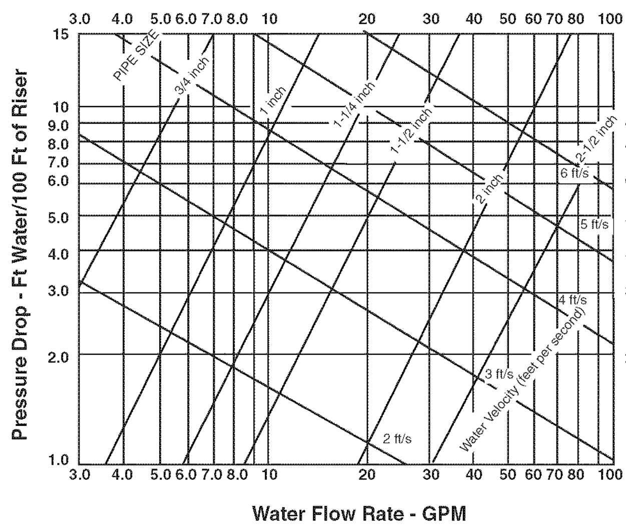


Fig. 8 — Friction Loss of Risers

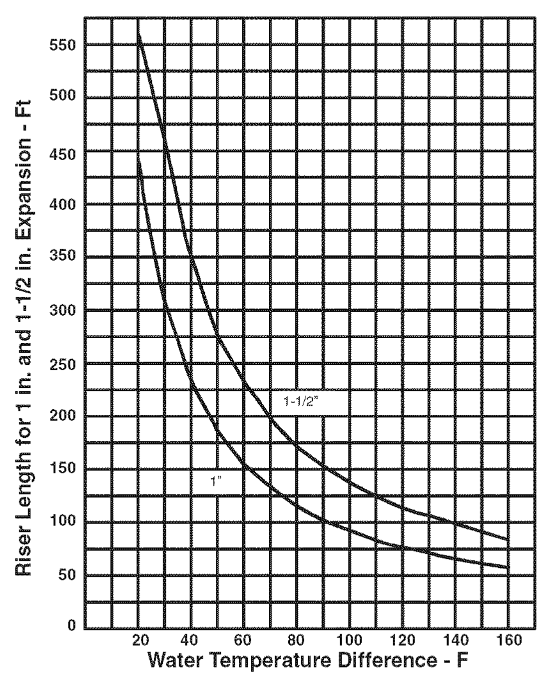


Fig. 9 — Allowable Riser Lengths Between System Expansion Loops

6. When all units on a riser are anchored into place, complete riser joints as follows:
   a. Verify that all riser joints are vertically aligned and that risers penetrate at least 1 in. into the swaged joint of the riser below. DO NOT let riser joint bottom out.
   b. Braze riser joints with a high-temperature alloy using proper Phos-copper of Silfos. Soft solder 50-50, 60-40, 85-15, or 95-5 or low temperature alloys are not suitable riser weld materials.
   c. Anchor built-in risers to the building structure with at least one contact point. To accommodate vertical expansion and contraction DO NOT fasten risers rigidly within the unit.
   d. Verify that unit shut-off valves are closed. DO NOT OPEN VALVES until the system has been cleaned and flushed.
   e. Flush system; refer to System Cleaning and Flushing section for more information.
   f. Install vents in piping loop as required to bleed the system of air accumulated during installation.
7. Install supply duct extension(s) provided with the cabinet by folding the tabs down to secure extension(s) to cabinet.

COMMERCIAL WATER LOOP APPLICATION — Commercial systems typically include a number of units connected to a common piping system. Any unit plumbing maintenance work can introduce air into the piping system; therefore, air elimination equipment is a major portion of the mechanical room plumbing. In piping systems expected to utilize water temperatures below 50 F, $^{1}/_{2}$ in. closed-cell insulation is required on all piping surfaces to eliminate condensation. Metal to plastic threaded joints should never be used due to their tendency to leak over time.

Teflon tape thread sealant is recommended for use in system piping to minimize internal fouling of the heat exchanger. Do not over tighten connections and route piping so as not to interfere with service or maintenance access. Hose kits include shut off valves, pressure/temperature (P/T) plugs for performance measurement, high pressure stainless steel braided hose, and hose adaptors.

Balancing valves and variable speed pumping systems my also be used.

The piping system should be flushed to remove dirt, pipe shavings, chips, and other foreign material prior to operation. See System Cleaning and Flushing section. The flow rate is usually set between 2.25 and 3.5 gpm per ton for most applications of water loop heat pumps. To ensure proper maintenance and servicing, P/T ports are imperative for temperature and flow verification, as well as performance checks.

Water loop heat pump (cooling tower/boiler) systems typically utilize a common loop, maintained between 60 to 90 F. The use of a closed circuit evaporate cooling tower with a secondary heat exchanger between the tower and the water loop is recommended. If an open type cooling tower is used continuously, chemical treatment and filtering will be necessary.

GROUND-LOOP HEAT PUMP APPLICATION

NOTE: In most commercial building applications using a frame style or plate style heat-exchanger should be used to isolate the water source heat pump units from the ground water loop increasing system performance, equipment longevity.

Pre-Installation — Prior to installation, locate and mark all existing underground utilities, piping, etc. Install loops for new construction before sidewalks, patios, driveways, and other construction has begun. During construction, accurately mark all ground loop piping on the plot plan as an aid in avoiding potential future damage to the installation.

Piping Installation — All earth loop piping materials should be limited to polyethylene fusion only for in ground sections of the loop. Galvanized or steel fittings should not be used at any time due to their tendency to corrode. All plastic to metal threaded fittings should be avoided due to their potential to leak in earth coupled applications. A flanged fitting should be substituted. P/T plugs should be used so that flow can be measured using the pressure drop of the unit heat exchanger.

Earth loop temperatures can range between 25 and 110 F. Flow rates between 2.25 and 3.0 gpm per ton of cooling capacity is recommended in these applications.

Test individual horizontal loop circuits before backfilling. Test vertical U-bends and pond loop assemblies prior to installation.

Pressures of at least 100 psi should be used when testing. Do not exceed the pipe pressure rating. Test entire system when all loops are assembled.

Flushing the Earth Loop — Upon completion of system installation and testing, flush the system to remove all foreign objects and purge to remove all air.

Antifreeze — In areas when minimum entering loop temperatures drop below 40 F or where piping will be routed through areas subject to freezing, antifreeze is required. Alcohols and glycols are commonly used as antifreeze; however your local Carrier distributor should be consulted for the antifreeze best suited to your area. Freeze protection should be maintained to 15 F below the lowest expected entering loop temperature. For example, if 30 F is the minimum expected entering loop temperature, the leaving loop temperature would be 25 to 22 F and freeze protection should be at 15 F. Calculation as follows:

30 F – 15 F = 15 F.

All alcohols should be premixed and pumped from a reservoir outside of the building when possible or introduced under the water level to prevent fumes. Calculate the total volume of fluid in the piping system. Then use the percentage by volume shown in Table 2 for the amount of antifreeze needed. Antifreeze concentration should be checked from a well mixed sample using a hydrometer to measure specific gravity.

Table 2 — Antifreeze Percentages by Volume

TYPE	MINIMUM TEMPERATURE FOR LOW TEMPERATURE PROTECTION			
	10 F	15 F	20 F	25 F
Methanol	25%	21%	16%	10%
100% USP Food Grade Propylene Glycol	38%	25%	22%	15%
Ethanol*	29%	25%	20%	14%

*Must not be denatured with any petroleum based product.

OPEN - LOOP GROUND WATER SYSTEMS — Shut off valves should be included for ease of servicing. Boiler drains or other valves should be "tee'd" into the lines to allow acid flushing of the heat exchanger. P/T plugs should be used so that pressure drop and temperature can be measured. Piping materials should be limited to copper or PVC SCH80.

NOTE: Due to the pressure and temperature extremes, PVC SCH40 is not recommended.

Water quantity should be plentiful and of good quality. Consult Table 3 for water quality guidelines and recommendations. Copper is recommended for closed loop systems and open loop ground water systems that are not high in mineral content or corrosiveness. In ground water situations where scaling could be heavy or where biological growth such as iron bacteria will be present, an open loop system is not recommended. Heat exchanger coils may over time lose heat exchange capabilities due to build up of mineral deposits. Heat exchangers must only be serviced by a qualified technician, as acid cleaning agents and special pumping equipment are required.

In areas with extremely hard water, the owner should be informed that the heat exchanger may require additional system maintenance and occasional acid flushing.

Water Supply and Quality — Check water supply. Water supply should be plentiful and of good quality. See Table 3 for water quality guidelines.

IMPORTANT: Failure to comply with the above required water quality and quantity limitations and the closed-system application design requirements may cause damage to the tube-in-tube heat exchanger. This damage is not the responsibility of the manufacturer.

In all applications, the quality of the water circulated through the heat exchanger must fall within the ranges listed in the Water Quality Guidelines table. Consult a local water treatment firm, independent testing facility, or local water authority for specific recommendations to maintain water quality within the published limits.

Table 3 — Water Quality Guidelines

<table>
<tr><th>CONDITION</th><th>HX MATERIAL*</th><th>CLOSED RECIRCULATING†</th><th colspan="3">OPEN LOOP AND RECIRCULATING WELL**</th></tr>
<tr><td colspan="6">Scaling Potential — Primary Measurement
Above the given limits, scaling is likely to occur. Scaling indexes should be calculated using the limits below.</td></tr>
<tr><td>pH/Calcium Hardness Method</td><td>All</td><td>N/A</td><td colspan="3">pH < 7.5 and Ca Hardness, <100 ppm</td></tr>
<tr><td colspan="6">Index Limits for Probable Scaling Situations (Operation outside these limits is not recommended.)</td></tr>
<tr><td colspan="6">Scaling indexes should be calculated at 150 F for direct use and HWG applications, and at 90 F for indirect HX use. A monitoring plan should be implemented.</td></tr>
<tr><td>Ryznar Stability Index</td><td>All</td><td>N/A</td><td colspan="3">6.0 - 7.5
If >7.5 minimize steel pipe use.</td></tr>
<tr><td>Langelier Saturation Index</td><td>All</td><td>N/A</td><td colspan="3">–0.5 to +0.5
If <–0.5 minimize steel pipe use.
Based upon 150 F HWG and direct well, 85 F indirect well HX.</td></tr>
<tr><td colspan="6">Iron Fouling</td></tr>
<tr><td>Iron Fe^{2+} (Ferrous) (Bacterial Iron Potential)</td><td>All</td><td>N/A</td><td colspan="3"><0.2 ppm (Ferrous)
If Fe^{2+} (ferrous) >0.2 ppm with pH 6 - 8, O_2<5 ppm check for iron bacteria.</td></tr>
<tr><td>Iron Fouling</td><td>All</td><td>N/A</td><td colspan="3"><0.5 ppm of Oxygen
Above this level deposition will occur.</td></tr>
<tr><td colspan="6">Corrosion Prevention††</td></tr>
<tr><td>pH</td><td>All</td><td>6 - 8.5
Monitor/treat as needed.</td><td colspan="3">6 - 8.5
Minimize steel pipe below 7 and no open tanks with pH <8.</td></tr>
<tr><td>Hydrogen Sulfide (H_2S)</td><td>All</td><td>N/A</td><td colspan="3"><0.5 ppm
At H_2S>0.2 ppm, avoid use of copper and cupronickel piping or HXs.
Rotten egg smell appears at 0.5 ppm level.
Copper alloy (bronze or brass) cast components are okay to <0.5 ppm.</td></tr>
<tr><td>Ammonia Ion as Hydroxide, Chloride, Nitrate and Sulfate Compounds</td><td>All</td><td>N/A</td><td colspan="3"><0.5 ppm</td></tr>
<tr><td rowspan="7">Maximum Chloride Levels</td><td></td><td></td><td colspan="3">Maximum allowable at maximum water temperature.</td></tr>
<tr><td></td><td></td><td>50 F (10 C)</td><td>75 F (24 C)</td><td>100 F (38 C)</td></tr>
<tr><td>Copper</td><td>N/A</td><td><20 ppm</td><td>NR</td><td>NR</td></tr>
<tr><td>CuproNickel</td><td>N/A</td><td><150 ppm</td><td>NR</td><td>NR</td></tr>
<tr><td>304 SS</td><td>N/A</td><td><400 ppm</td><td><250 ppm</td><td><150 ppm</td></tr>
<tr><td>316 SS</td><td>N/A</td><td><1000 ppm</td><td><550 ppm</td><td><375 ppm</td></tr>
<tr><td>Titanium</td><td>N/A</td><td>>1000 ppm</td><td>>550 ppm</td><td>>375 ppm</td></tr>
<tr><td colspan="6">Erosion and Clogging</td></tr>
<tr><td>Particulate Size and Erosion</td><td>All</td><td><10 ppm of particles and a maximum velocity of 6 fps. Filtered for maximum 800 micron size.</td><td colspan="3"><10 ppm (<1 ppm “sandfree” for reinjection) of particles and a maximum velocity of 6 fps. Filtered for maximum 800 micron size. Any particulate that is not removed can potentially clog components.</td></tr>
<tr><td>Brackish</td><td>All</td><td>N/A</td><td colspan="3">Use cupronickel heat exchanger when concentrations of calcium or sodium chloride are greater than 125 ppm are present. (Seawater is approximately 25,000 ppm.)</td></tr>
</table>

LEGEND

HWG — Hot Water Generator
HX — Heat Exchanger
N/A — Design Limits Not Applicable Considering Recirculating Potable Water
NR — Application Not Recommended
SS — Stainless Steel

*Heat exchanger materials considered are copper, cupronickel, 304 SS (stainless steel), 316 SS, titanium.
†Closed recirculating system is identified by a closed pressurized piping system.
**Recirculating open wells should observe the open recirculating design considerations.
††If the concentration of these corrosives exceeds the maximum allowable level, then the potential for serious corrosion problems exists.
Sulfides in the water quickly oxidize when exposed to air, requiring that no agitation occur as the sample is taken. Unless tested immediately at the site, the sample will require stabilization with a few drops of one Molar zinc acetate solution, allowing accurate sulfide determination up to 24 hours after sampling. A low pH and high alkalinity cause system problems, even when both values are within ranges shown. The term pH refers to the acidity, basicity, or neutrality of the water supply. Below 7.0, the water is considered to be acidic. Above 7.0, water is considered to be basic. Neutral water contains a pH of 7.0.
To convert ppm to grains per gallon, divide by 17. Hardness in mg/l is equivalent to ppm.

Step 6 — Wire Field Power Supply Connections

> **⚠ WARNING**
>
> Electrical shock can cause personal injury or death. When installing or servicing system, always turn off main power to system. There may be more than one disconnect switch.

ELECTRICAL–LINE VOLTAGE — All field-installed wiring, including electrical ground, must comply with the National Electrical Code (NEC) as well as all applicable local codes. Refer to Tables 4 and 5 for fuse sizes. Refer to Table 6 for blower speed wiring. See Fig. 10 for field connections or the electrical diagram located on the back of the electrical compartment front panel. All electrical connections must be made by the installing (or electrical) contractor. All final electrical connections must be made with a length of flexible conduit to minimize vibration and sound transmission to the building.

General Line Voltage Wiring — Be sure the available power is the same voltage and phase shown on the unit serial plate. Line and low voltage wiring must be done in accordance with local codes or the NEC, whichever is applicable.

POWER CONNECTION

Units Equipped with Disconnect — Connect incoming line voltage to the disconnect switch and ground wire to the ground lug provided inside the electrical compartment.

Units without Disconnect — Line voltage connection is made by connecting the incoming line voltage wires to the line side(s) of the contactor.

208/230-VAC OPERATION — All commercial 208/230-v units are factory wired for 208-v single-phase operation. For 230-v single-phase operation the primary voltage to the transformer must be changed. Remove the red lead from the compressor contactor capping it with a wire nut and connecting the orange 230-vac lead wire from the transformer to the compressor contactor.

NOTE: Failure to change the primary voltage lead when using 240-vac line voltage may result in electrical component damage and intermittent system failure.

Table 4 — Cabinet Electrical Data — 50VS Unit

UNIT	SUPPLY VOLTAGE V-Hz-Ph	MOTOR VOLTAGE V-Hz-Ph	FAN MOTOR FLA (A)	MOTOR POWER (W)	MIN CIRCUIT AMP	MAX FUSE SIZE (A)
50VSA,B	208/230-1-60	208/230-1-60	0.30	130	6.5	15
50VSC,D	208/230-1-60	208/230-1-60	0.40	142	8.6	15
50VSE,F	208/230-1-60	208/230-1-60	0.88	180	11.9	20
50VSG,H	208/230-1-60	208/230-1-60	1.18	240	12.5	20
50VSI,J	208/230-1-60	208/230-1-60	1.60	304	16.2	30
50VSK,L	208/230-1-60	208/230-1-60	1.80	368	19.5	30
50VSM,N	208/230-1-60	208/230-1-60	2.06	442	21.0	35

LEGEND

FLA — Full Load Amps

Table 5 — Chassis Electrical Data — 50VS Unit

UNIT	SUPPLY VOLTAGE V-Hz-Ph	MIN CIRCUIT AMP	MAX FUSE SIZE (A)	COMPRESSOR (LRA)	COOLING CURRENT (A)	MAX COOLING CURRENT (A)	HEATING CURRENT (A)	MAX HEATING CURRENT (A)
50VSA,B	208/230-1-60	6.5	15	20	3.27	4.0	3.75	4.60
50VSC,D	208/230-1-60	8.6	15	27	4.40	4.0	5.25	6.25
50VSE,F	208/230-1-60	11.9	20	42	6.30	5.4	7.07	8.80
50VSG,H	208/230-1-60	12.5	20	42	6.70	7.6	7.50	9.00
50VSI,J	208/230-1-60	16.2	25	46	8.20	8.0	9.20	11.70
50VSK,L	208/230-1-60	19.5	30	70	11.00	10.4	12.20	14.10
50VSM,N	208/230-1-60	21.0	30	79	12.70	16.0	13.65	16.50

LEGEND

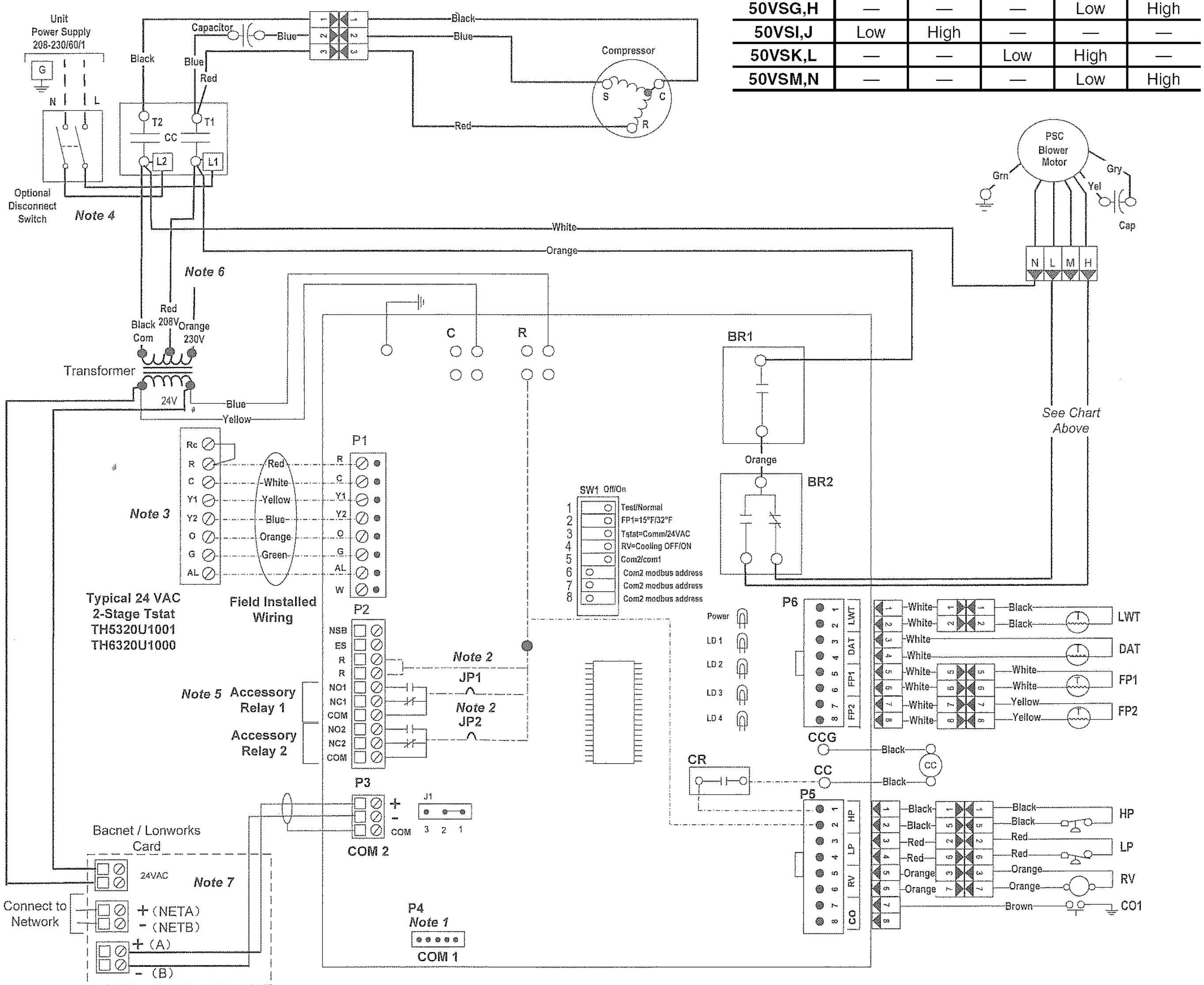
LRA — Locked Rotor Amps

Table 6 — 50VS Unit Blower Performance and Speed Wiring

UNIT	FAN SPEED AND WIRING	RATED CFM	MIN CFM	EXTERNAL STATIC PRESSURE (in. wg)											
				0	0.01	0.05	0.1	0.15	0.2	0.25	0.3	0.35	0.4	0.45	0.5
50VSA,B	LOW (Black)	360	260	361	358	341	321	294	268	235	177				
	HI (Blue)			316	310	294	278	262	233	206					
50VSC,D	LOW (Blue)	420	300	424	421	398	376	350	315	280	240				
	HI (Red)			361	358	341	321	305							
50VSE,F	LOW (Black)	540	390	551	549	535	521	509	490	476	460	441	420	400	
	HI (Blue)			470	465	455	439	428	412	397					
50VSG,H	LOW (Blue)	630	455	626	622	604	592	577	561	548	530	513	495	476	
	HI (Red)			551	549	535	521	509	490	476	460				
50VSI,J	LOW (Orange)	820	600	821	817	814	812	802	790	775	747	684	654	621	
	HI (Brown)			768	765	762	759	751	742	722	683	653	625		
50VSK,L	LOW (Black)	1080	780	1081	1075	1070	1049	1024	931	880	843	801			
	HI (Blue)			956	951	942	928	911	835	809					
50VSM,N	LOW (Blue)	1220	850	1222	1219	1194	1160	1129	1088	1057	1017	961			
	HI (Red)			1102	1096	1091	1070	1044	949	897	860				

NOTE: Operation not recommended in shaded area.

BLOWER SPEED WIRING					
Unit	Orange	Brown	Black	Blue	Red
50VSA,B	Low	High	—	—	—
50VSC,D	—	Low	High	—	—
50VSE,F	—	—	Low	High	—
50VSG,H	—	—	—	Low	High
50VSI,J	Low	High	—	—	—
50VSK,L	—	—	Low	High	—
50VSM,N	—	—	—	Low	High



LEGEND

- **BR1** — Fan Relay Speed 1
- **BR2** — Fan Relay Speed 2
- **CC** — Compressor Contactor
- **CO** — Condensate Overflow
- **CR** — Compressor Relay
- **DAT** — Discharge Air Temperature
- **FP1** — Freeze Protection Water Side
- **FP2** — Freeze Protection Air Side
- **HP** — High Pressure Switch
- **LP** — Low Pressure Switch
- **LWT** — Leaving Water Temperature
- **RV** — Reversing Valve
- Factory Low Voltage Wiring
- Factory High Voltage Wiring
- Field Low Voltage Wiring
- Field Line Voltage Wiring
- Optional Block
- Internal PCB Connection

- Quick Connect Terminal
- Screw Terminal
- Relay Coil
- Capacitor
- High Pressure Switch
- Low Pressure Switch
- Temperature Thermistor
- Condensate Switch
- Relay Contacts

NOTES:
1. Used for optional communicating thermostat.
2. Cut JP1 or JP2 for dry contact output accessory relay 1 and 2.
3. If a single stage thermostat is used, place a jumper wire between Y1 and Y2 at P1 terminal.
4. If the disconnect option is not installed, connect the power to the L1 and L2 lugs on the compressor contactor.
5. Accessory relays 24-vac maximum, activated by compressor output.
6. For 230-v operation, remove the red wire and replace with the orange wire.
7. Before connecting BacNet™ or LonWorks® card, connect communicating thermostat, then short J1 (2-3). If adding terminating resistance, short J1 (1-2).

Fig. 10 — Typical 50VS Unit Control Wiring

Step 7 — Wire Field Control Connections

STANDARD 24-V THERMOSTAT CONNECTIONS — The thermostat should be wired directly to the microprocessor board terminals labeled P1 to the corresponding terminals (R,C,Y1,Y2,O,G).

Installation of Optional Wall-Mounted Thermostat — The unit can be controlled with a remote 24-volt surface mounted thermostat such as the Honeywell TH5320U1001 or TH6320U1000 series thermostat. Refer to instructions provided with remote thermostat for wiring instructions using 2 stages of heating and 2 stages of cooling for a heat pump system.

Below are typical thermostat connections and color codes.

Rc Power (Red)

R R+Rc joined by factory jumper wire (Red)

Y Compressor Contactor (Stage 1) (Yellow)

Y2 Compressor Contactor (Stage 2) (Blue)

C 24-vac Common (White)

O Reversing Valve (Orange)

G Fan Relay (Green)

NOTE: The terminal block on the microprocessor board is removable for ease of thermostat wiring installation.

Low-voltage wiring between the unit and the wall thermostat must comply with all applicable electrical codes (i.e., NEC and local codes), and be completed before the unit is installed. Use of six-wire, color-coded, low-voltage cable is recommended.

Table 7 lists recommended wire sizes and lengths to install the thermostat. The total resistance of low voltage wiring must not exceed 1 ohm. Any resistance in excess of 1 ohm may cause the control to malfunction because of high voltage drop.

Table 7 — Recommended Wire Gage — Low Voltage Thermostat

WIRE SIZE (gage)	MAXIMUM RUN (UNIT TO THERMOSTAT) (ft)
22	30
20	50
18	75
16	125
14	200

Step 8 — Clean and Flush System — Cleaning and flushing the unit is the most important step to ensure proper start-up and continued efficient operation of the system. Follow the instructions below to properly clean and flush the system.

1. Verify that electrical power to the unit is off.
2. Verify that supply and return riser service valves are closed at each unit.
3. Fill the system with water, leaving the air vents open. Bleed all air from the system but do not allow the system to overflow. Check the system for leaks and make any required repairs.
4. Adjust the water and air level in the expansion tank.
5. With strainers in place, start the pumps. Systematically check each vent to ensure that all of the air is bled from the system.
6. Verify that make-up water is available and adjusted to properly replace any space remaining when all air is purged. Check the system for leaks and make any additional repairs if needed.
7. Set the boiler to raise the loop temperature to approximately 85 F. Open the drain at the lowest point in the system. Verify that make-up water replacement rate equals rate of bleed. Continue to bleed the system until the water appears clean or for at least three hours whichever is longer.
8. Completely drain the system.

Flush risers as follows:

1. Close shut-off valves at each unit on the riser except the shut-off valve on the top floor.
2. Flush solution through supply riser.

   NOTE: The solution passes through the top floor connection down the return riser.
3. When the building has more than 10 floors, connect the supply and return run outs on the top two floors to divide the water flow and reduce pressure drop at the pump.
4. Repeat flushing procedure for each set of risers in the building.
5. Refill the system and add in a proportion of trisodium phosphate approximately one pound per 150 gallons of water. Reset the boiler to raise the loop temperature to about 100 F.
6. Circulate the solution for between 8 and 24 hours. At the end of this period, shut off the circulating pump and drain the solution. Repeat system cleaning if needed.
7. Open the supply and return riser service valves at each unit. Refill the system and bleed off all air.
8. Test the system pH with litmus paper. The system water should have a pH of 6 to 8.5. Add chemicals as appropriate to maintain pH levels.
9. When the cleaning process is complete, remove the short-circuited hoses. Reconnect the hoses to the proper supply, and return the connections to each of the units. Refill the system and bleed off all air.

   NOTE: DO NOT use "Stop Leak" or similar chemical agent in this system. Addition of chemicals of this type to the loop water will foul the heat exchanger and inhibit unit operation.

Step 9 — Install Hose Kit

1. Refer to Fig. 11 for an illustration of a typical supply/return hose kit assembly.
2. Pipe joint compound or Teflon tape is not necessary when using factory-supplied hose kits.

   NOTE: When anti-freeze is used, ensure that it is compatible with Teflon tape and pipe joint compound that may have been applied to other pipe fittings in the system.
3. Attach the flex hoses. Unpack and examine hose kit. Remove all shipping and/or packing material such as rubber bands, plastic caps, and styrofoam. Hose kit should contain 2 hoses, one balancing valve with shutoff, one shutoff, and 2 hose adaptors.
4. Locate the valves inside the unit cabinet marked WATER IN and WATER OUT. Attach the hoses to the water valve. Always use a back-up wrench when tightening the hose to the valve.
5. If the valves are removed to attach the hoses, be sure the O-ring is in the valve before attaching to the union in the cabinet.

   NOTE: The valve union is to be hand tight plus an additional $^{1}/_{4}$ of a turn; always use back-up wrench on the fittings being tightened.
6. Attach flex hoses. Let the universal ends of the hoses hang inside the cabinet. See Table 8 for bend allowances.

   NOTE: Be sure the valve handles and P/T ports are in a position that enables them to be opened and closed and used for system readings. Check the swivel ends of the hoses. Gaskets must be in the hose for proper seal.

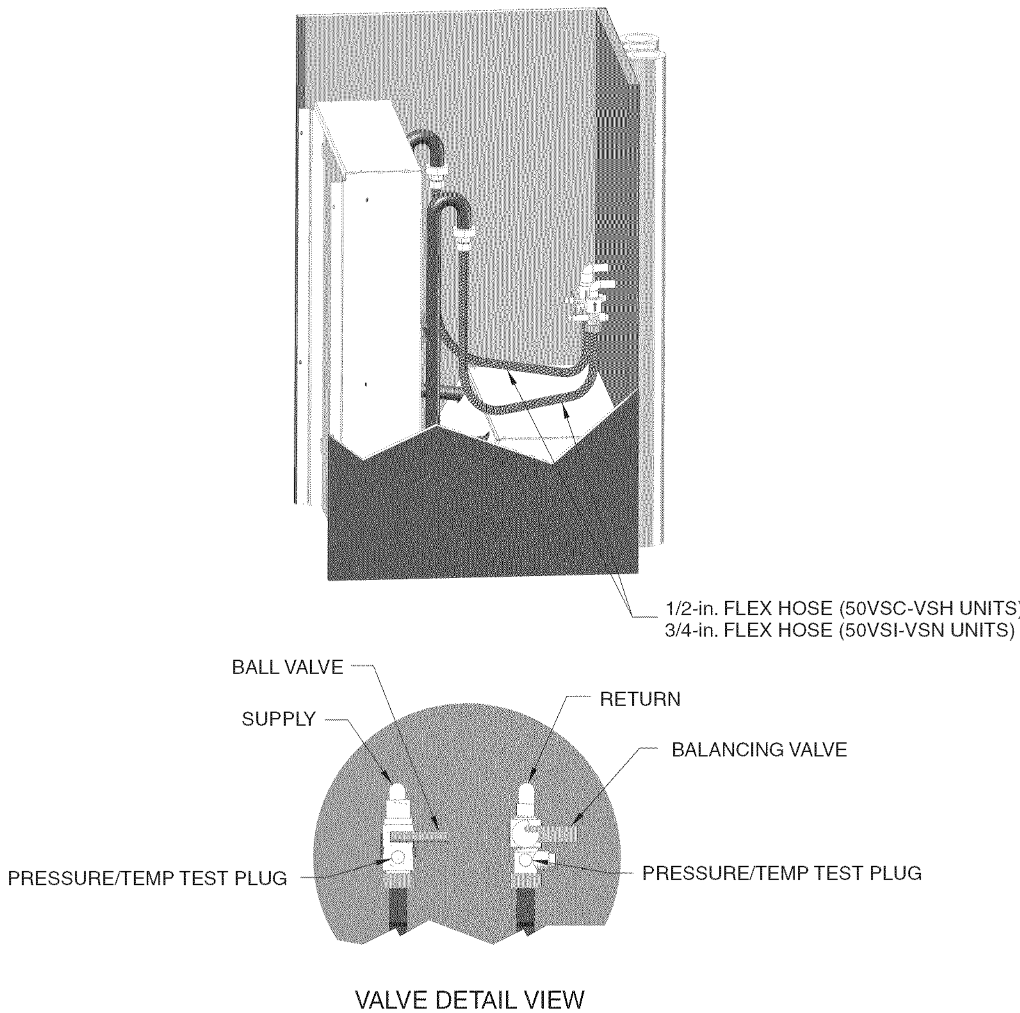


Fig. 11 — Hose Kit Installation

Table 8 — Braided Water Hose Bend Allowances

HOSE DIAMETER (in.)	BEND ALLOWANCE (in.)
$^{1}/_{2}$	$2^{5}/_{8}$
$^{3}/_{4}$	$4^{1}/_{2}$

NOTE: Do not allow hoses to rest against sharp edges or structural building components. Compressor vibration may cause hose failure and vibration transmission through the hoses to the structure, causing noise complaints.

7. Slide the chassis part way into the cabinet. Match the WATER IN hose to the WATER IN tube on the chassis and the WATER OUT hose to the WATER OUT tube. Tighten the swivel connection keeping the copper tube parallel to the sides of the chassis, and then tighten the hose to the copper making sure the hose hangs straight without twisting or turning.

   NOTE: The copper union and the hose union is to be hand tight plus an additional $^{1}/_{4}$ of a turn, always use back-up wrench on the fittings being tightened.

Step 10 — Install Chassis into the Cabinet

1. Open the unit water valves and check piping for leaks.
2. Complete electrical connections between cabinet and chassis by mating the quick-connect plugs on the chassis cable to the plugs located in the bottom surface of the blower deck, directly under the control box.
3. Before installing the return panel, perform the following checks:
   a. Ensure that fan wheel rotates freely and does not rub against housing. If rough handling during shipping has caused fan wheel to shift, adjust as necessary.
   b. Verify that water piping connections to the chassis are complete and that unit service valves which were closed during flushing have been opened.
   c. Verify that power between the cabinet and chassis is properly connected.
   d. After the system has been filled and system pump is started, all connections should be re-checked for water leaks. Carrier WILL NOT be responsible or liable for damage caused by any water leaks from a field-installed water connection(s).
4. Re-attach the upper electrical access panel. Do not start the unit with access panel removed; system lockout and possible equipment damage can occur.

Step 11 — Install Return Panel

1. Install the provided adhesive-backed gasket material on the outer perimeter of the cabinet to seal the return panel to the cabinet.
2. Install the cabinet return panel. Refer to Fig. 4 and 5.

Step 12 — Install Supply Grille

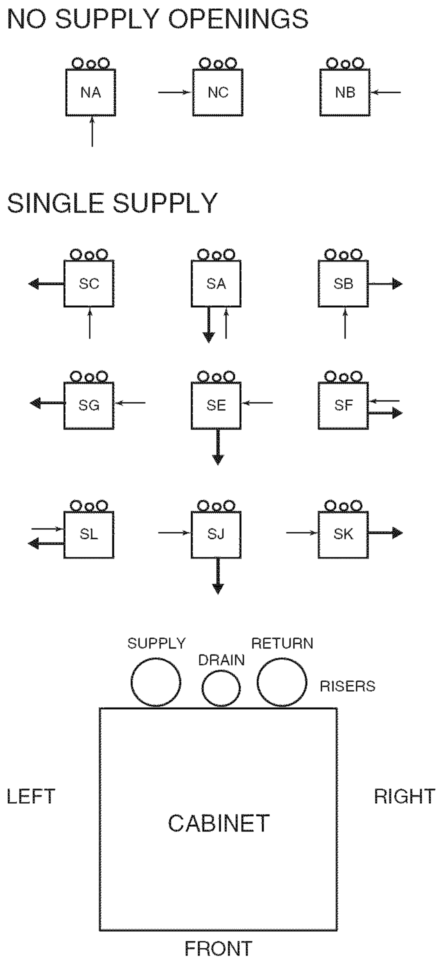
Refer to Fig. 2, 3, and 12 to determine grille size and location based on the type and size of the unit cabinet/chassis combination. Perform the following to install supply grilles over the cabinet discharge openings.

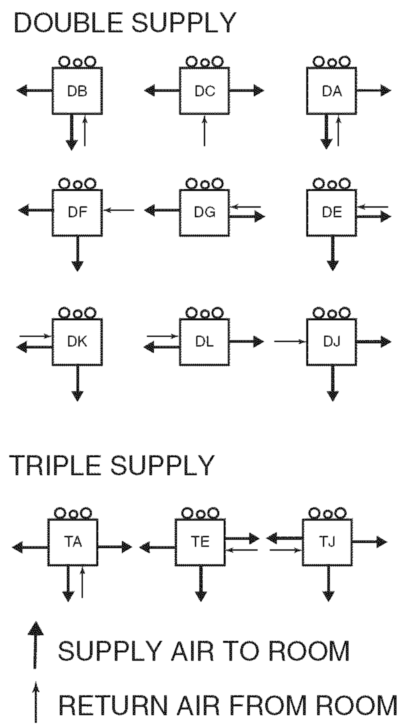
1. To prevent supply air from short circuiting back into the return air panel a supply duct extension(s) is provided with each cabinet.
2. Insert the grille into the cabinet supply duct extension(s). Assure that the grille flange rests against the drywall covering the cabinet.
3. Secure the grille to the drywall with the screws provided.

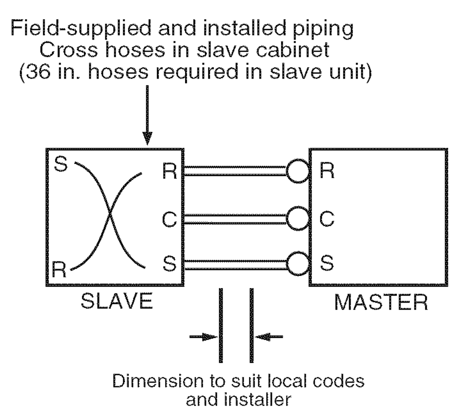
PRE-START-UP

Check the following before system start-up.

1. Balancing/shutoff valves: Ensure that all isolation valves are open and water control valves are wired.
2. Line voltage and wiring: Verify that voltage is within an acceptable range for the unit and wiring and fuses/breakers are properly sized. Verify that low voltage wiring is complete.
3. Entering water and air: Ensure that entering water and air temperatures are within operating limits of Table 9.







LEGEND
C — Condensate Drain
R — Return
S — Supply

Supply Grille Sizes and Arrangements

UNIT	DISCHARGE (in.)		
	Single	Double	Triple
50VSA,B (Small Cabinet)	14x12	10x8	10x8
50VSC,D (Small Cabinet)	14x12	10x8	10x8
50VSE,F (Small Cabinet)	14x12	10x8	10x8
50VSG,H (Small Cabinet)	14x12	10x8	10x8
50VSI,J (Large Cabinet)	16x14	12x10	12x10
50VSK,L (Large Cabinet)	16x14	12x10	12x10
50VSM,N (Large Cabinet)	16x14	12x10	12x10

NOTES:
1. Refer to the table and the airflow arrangements above to determine grille size and location based on the type and size of the unit cabinet/chassis combination.
2. The riser compartment is defined as being the rear of each unit. Supply air grilles and return air/access panel can be any side except rear.
3. Return air location also denotes the control location and servicing access.
4. Single discharge openings are not recommended for 50VSI-VSN units. Triple discharge openings are not recommended for 50VSA-VSD units.

Fig. 12 — 50VS Unit Airflow Arrangements

Table 9 — Limits of Operation

Air Limits	Cooling (F)	Heating (F)
Ambient Air Maximum	50	50
Ambient Air Minimum	100	85
Rated Ambient Air	80.6	68
Rated Entering Air (db/wb)	80.6/66.2	68
Entering Air Maximum (db/wb)	100/83	80
Entering Water Minimum*	30	20
Entering Water (Normal)	50-110	30-70
Entering Water Maximum	120	90

LEGEND
db — Dry Bulb
wb — Wet Bulb

*Requires additional insulation when operating below the dew point.

4. Unit fan: Manually rotate fan to verify free rotation and ensure that blower wheel is secured to the motor shaft. Be sure to remove any shipping supports if needed. DO NOT oil motors upon start-up. Fan motors are pre-oiled at the factory. Check unit fan speed selection and compare to design requirements.
5. Condensate line: Verify that condensate line is open and properly pitched toward drain.
6. Water flow balancing: Record inlet and outlet water temperatures for each heat pump upon start-up. This check can eliminate nuisance trip outs and high velocity water flow that could erode heat exchangers.
7. Unit controls: Verify that the microprocessor DIP (dual in-line package) switches are set for proper operation and system configuration.

System Checkout

1. System water temperature: Check water temperature for proper range and also verify heating and cooling set points for proper operation.
2. System pH: Check and adjust water pH if necessary to maintain a level between 6 and 8.5. Proper pH promotes longevity of hoses and fittings.
3. System flushing: Verify that all hoses are connected end to end when flushing to ensure that debris bypasses the unit heat exchanger, water valves and other components. Water used in the system must be potable quality initially and clean of dirt, piping slag, and strong chemical cleaning agents. Verify that all air is purged from the system. Air in the system can cause poor operation or system corrosion.
4. Cooling tower/boiler: Check equipment for proper set points and operation.
5. Standby pumps: Verify that the standby pump is properly installed and in operating condition.
6. System controls: Verify that system controls function and operate in the proper sequence.
7. Low water temperature cutout: Verify that low water temperature cutout controls are provided for the outdoor portion of the loop. Otherwise, operating problems may occur.
8. System control center: Verify that the control center and alarm panel have appropriate set points and are operating as designed.

FIELD SELECTABLE INPUTS

Jumpers and DIP switches on the control board are used to customize unit operation and can be configured in the field. See Tables 10 and 11 for heat pump and BacNet control board DIP switch settings.

IMPORTANT: Jumpers and DIP switches should only be clipped when power to control board has been turned off.

Table 10 — Heat Pump Control Board (PCB)

DIP SWITCH NUMBER	PROTOCOL			
	No Network	BacNet	LonWorks	Modbus (PC)
1 — Test/Normal	ON	ON	ON	ON
2 — FP1 15 F/32 F	ON	ON	ON	ON
3 — Tstat Comm/ 24-vac	ON or OFF	OFF	OFF	OFF
4 — RV Cooling Off/On	ON	ON	ON	ON
5 — Com2/Com1	ON	OFF	OFF	OFF
6 — Com2 Modbus Address	OFF	OFF	OFF	OFF
7 — Com2 Modbus Address	OFF	OFF	OFF	OFF
8 — Com2 Modbus Address	OFF	OFF	OFF	OFF

LEGEND
DIP — Dual In-Line Package
PC — Personal Computer
PCB — Printed Circuit Board

Table 11 — BacNet™ Control Board (PCB)

DIP SWITCH NUMBER	POSITION OFF/ON
1	ON
2	OFF
3	OFF
4	OFF
5	OFF
6	OFF
7	OFF
8	OFF

LEGEND
DIP — Dual In-Line Package
PCB — Printed Circuit Board

DIP Switch Settings and Operation

DIP SWITCH 1 (Test Mode = Off/Normal Mode = On)

Test Mode — Test mode is used to speed up the operation sequence of the unit, therefore creating a more timely troubleshooting technique. All time delays are shorted by 10 times with the exception of the high-pressure lockout which is instantaneous regardless of which mode the switch is positioned. DIP switch 1 must be placed into the Normal mode to resume proper operation of the unit.

DIP SWITCH 2 (FP 1 at 15 F = Off/FP 1 at 32 F = On)

Water Side Freeze Protection Setting — DIP switch 2 is used to determine the loop freeze protection setting. Depending on the brine concentration of the liquid source, the temperature can be set at 15 F or 32 F. The switch MUST be set to the "On" position if pure water is used as the source brine. This is normally the case in open loop systems. Set the DIP switch to the "Off" position for closed loop systems that contain a brine concentration that allows liquid temperatures to fall to, or below, 15 F.

DIP SWITCH 3 (Tstat at Comm = off/tstat at 24-vac = On)

Thermostat Selection — DIP switch 3 is used to select the type of thermostat that will be used to control the unit. A digital communicating thermostat can be purchased with the unit that will allow all fault signals to be displayed on the thermostat. This allows for efficient troubleshooting and does not require that the technician access the electrical control box to determine the unit error. If a digital communicating thermostat is used DIP switch 3 must be set in the "Off" position. If a 24-vac thermostat is used set DIP switch 3 into the "On" position.

DIP SWITCH 4 (RV at Cooling = Off/RV at Cooling = On)

Reversing Valve Operation — DIP switch 4 is used to determine the reversing valve (RV) position in the Cooling mode (deenergized/energized). This function is used only when a 24-vac thermostat is used and is determined by the reversing valve output of the thermostat in the Cooling mode. If the thermostat deenergizes the reversing valve in the Cooling mode then set the DIP switch in the "Off" position. If the thermostat energizes the reversing valve in the Cooling mode set the DIP switch in the "On" position.

DIP Switch 5 (Com2 = Off/BacNet™ or LonWorks®)
(Com1 = On/Communicating Thermostat)

DIP Switch 6 (Com2 modbus address)

DIP Switch 7 (Com2 modbus address)

DIP Switch 8 (Com2 modbus address)

Standard 24-vac Sequence of Operation

RANDOM START DELAY — When the unit is first powered "On" the control microprocessor will generate a random number to determine the start delay of the compressor operation (3 to 5 minutes). This delay is used to prevent multiple units from cycling "On" at the same time. The purpose is to prevent a large power load on the building electrical system after a power outage. After the number, or delay time, is generated the microprocessor will use this time to determine the minimum amount of time that must be delayed before the compressor is cycled "On" after a demand is received from the thermostat.

ANTI SHORT CYCLING DELAY — After the random start delay is generated the microprocessor will use this time to determine the minimum amount of time that must be delayed before the compressor is cycled "On" after a demand is received from the thermostat. This allows the refrigerant system to equalize in pressure and prevents short-cycling of the compressor.

MINIMUM COMPRESSOR RUNTIME — The minimum compressor runtime of each cycle, heating or cooling, is 60 seconds. Once the compressor is energized it will not deenergize, even if the thermostat input is removed, until the minimum runtime is satisfied.

COOLING FIRST STAGE (Y1, O) — When the microprocessor receives (Y1, O) at the 24-vac thermostat input connection the unit will proceed with the cooling first stage sequence. The microprocessor must receive these signals for 2 continuous seconds before it recognizes the inputs as valid. Once the input signals are determined to be valid the reversing valve will energize/deenergize after 5 seconds.

The microprocessor will then verify that the anti-short cycling delay has been satisfied. Once the anti short cycling delay has been satisfied the compressor and will cycle "On." The blower will cycle "On" in low speed 15 seconds after the compressor is cycled "On."

COOLING SECOND STAGE (Y1, Y2, O) — When the microprocessor receives (Y1, Y2, O) at the 24-vac thermostat input connection the unit will proceed with the cooling second stage sequence. The microprocessor must receive these signals for 2 continuous seconds before it recognizes the inputs as valid. Once the input signals are determined to be valid the reversing valve will energize/deenergize after 5 seconds. The microprocessor will then verify that the anti short cycling delay has been satisfied. Once the anti short cycling delay has been satisfied the compressor and will cycle "On." The blower will cycle "On" in high speed 15 seconds after the compressor is cycled "On."

HEATING FIRST STAGE (Y1) — When the microprocessor receives (Y1) at the 24-vac thermostat input connection the unit will proceed with the cooling first stage sequence. The microprocessor must receive these signals for 2 continuous seconds before it recognizes the inputs as valid. Once the input signals are determined to be valid the reversing valve will energize/deenergize after 5 seconds. The microprocessor will then verify that the anti short cycling delay has been satisfied. Once the anti short cycling delay has been satisfied the compressor and will cycle "On." The blower will cycle "On" in low speed 15 seconds after the compressor is cycled "On."

HEATING SECOND STAGE (Y1, Y2) — When the microprocessor receives (Y1, Y2) at the 24-vac thermostat input connection the unit will proceed with the heating second stage sequence. The microprocessor must receive these signals for 2 continuous seconds before it recognizes the inputs as valid. Once the input signals are determined to be valid the reversing valve will energize/deenergize after 5 seconds.

The microprocessor will then verify that the anti short cycling delay has been satisfied. Once the anti short cycling delay has been satisfied the compressor and will cycle "On." The blower will cycle "On" in high speed 15 seconds after the compressor is cycled "On."

FAN ONLY MODE (G) — The fan only mode can be used only with a 24-vac thermostat and will energize the low speed blower when a (G) input has been received at the 24-vac thermostat input connection. When the input is removed the blower will deenergize immediately.

START-UP

1. Turn on the line power to all heat pumps.
2. Turn the thermostat fan position to "ON." Blower should start.
3. Balance airflow at registers.
4. Adjust all valves to their full open positions. Room temperature should be within the minimum-maximum ranges of Table 9. During start-up checks, loop water temperature entering the heat pump should be between 60 and 95 F.
5. Two factors determine the operating limits of the 50VS heat pumps: supply-water temperature and the return-air temperature. When any one of these factors is at a minimum or maximum level, the other factor must be at a normal level to ensure proper unit operation.
   a. Adjust the unit thermostat to the warmest setting. Place the thermostat mode switch in the "COOL" position. Slowly reduce thermostat setting until the compressor activates.
   b. Check for cool air delivery at the unit grille within a few minutes after the unit has begun to operate.

      NOTE: Units have a 3 to 5 minute time delay in the control circuit that can be eliminated on the microprocessor control board. See test mode described in the DIP Switch Settings and Operation section.
   c. Check the elevation and cleanliness of the condensate lines. Dripping may be a sign of a blocked line. Check that the condensate trap is filled to provide a water seal.
   d. Refer to Table 12. Check the temperature of both entering and leaving water. If temperature is within range, proceed with the test. If temperature is outside of the operating range, see Troubleshooting section.
   e. Check air temperature drop across the air coil when compressor is operating. Air temperature drop should be between 15 and 25 F.

f. Turn thermostat to "OFF" position. A hissing noise indicates proper functioning of the reversing valve.
g. Allow 5 minutes between tests for pressure to equalize before beginning heating test.
h. Adjust the thermostat to the lowest setting. Place the thermostat mode switch in the "HEAT" position.
i. Slowly raise the thermostat to a higher temperature until the compressor activates.
j. Check for warm air delivery within a few minutes after the unit has begun to operate.
k. Refer to Table 9. Check the temperature of both entering and leaving water. If temperature is within range, proceed with the test. If temperature is outside of the operating range, check refrigerant pressures.
l. Check air temperature rise across the air coil when compressor is operating. Air temperature rise should be between 20 and 30 F.
m. Check for vibration, noise, and water leaks.

6. If unit fails to operate, perform troubleshooting analysis (see troubleshooting section). If the check described fails to reveal the problem and the unit still does not operate, contact a trained service technician to ensure proper diagnosis and repair of the equipment.
7. When testing is complete, set system to maintain desired comfort level.

NOTE: If performance during any mode appears abnormal refer to the troubleshooting section of this manual. To obtain maximum performance, the air coil should be cleaned before start-up. Use a coil cleaner for use on indoor evaporator refrigeration equipment.

Table 12 — Temperature Change Through Heat Exchanger

WATER FLOW GPM	RISE IN COOLING (°F)	DROP IN HEATING (°F)
For Closed Loop: Ground Source or Closed Loop Systems at 3 gpm per ton	9-12	4-8
For Open Loop: Ground Water Systems at 1.5 gpm per ton	20-26	10-17

Operating Limits

ENVIRONMENT — Units are designed for indoor installation only. Never install units in areas subject to freezing or where humidity levels could cause cabinet condensation (such as unconditioned spaces subject to 100% outside air).

POWER SUPPLY — A voltage variation of ± 10% of nameplate utilization voltage is acceptable.

STARTING CONDITIONS — Starting conditions vary depending upon model number and are based upon the following:

- Conditions in Table 9 are not normal or continuous operating conditions. Minimum/maximum limits are start-up conditions to bring the building space up to occupancy temperatures. Units are not designed to operate under these conditions on a regular basis.
- Voltage utilization range complies with ARI Standard 110.
- Determination of operating limits is dependent primarily upon three factors:
  a. Ambient temperature
  b. Return air temperature
  c. Water temperature
- When any one of these factors is at minimum or maximum levels, the other two factors should be at normal levels to ensure proper unit operation.

Extreme variations in temperature and humidity and/or corrosive water or air will adversely affect unit performance, reliability, and service life.

Lockout Mode — If the microprocessor board is flashing a system warning and the unit is locked out and not running, the lockout can be cleared from the microprocessor by a momentary shutdown of incoming line voltage (208-vac or 230-vac). A lockout that still occurs after line voltage shutdown means that the fault still exists and needs to be repaired.

HIGH-PRESSURE LOCKOUT (HP) — The high-pressure lockout will occur if the discharge pressure of the compressor exceeds 600 psi. The lockout is immediate and has no delay from the time the high-pressure switch opens to the lockout. Upon lockout the compressor will be deenergized immediately. The blower will be deenergized 15 seconds after the compressor is deenergized.

LOW-PRESSURE LOCKOUT (LP) — The low-pressure lockout will occur if the suction pressure falls below 40 psi for 30 continuous seconds. The compressor will then be deenergized and the blower will deenergize 15 seconds after the compressor is deenergized.

FREEZE PROTECTION 1 LOCKOUT — The freeze protection 1 lockout will occur if the liquid line temperature falls below the set point (15 F or 30 F) for 30 continuous seconds. See DIP switch 2 description in the DIP Switch Settings and Operation section. The compressor will then be deenergized and the blower will deenergize 15 seconds after the compressor is deenergized.

FREEZE PROTECTION 2 LOCKOUT — The freeze protection 1 lockout will occur if the air coil temperature falls below the set point 32 F for 30 continuous seconds. See DIP switch 2. The compressor will then be deenergized and the blower will deenergize 15 seconds after the compressor is deenergized.

CONDENSATE OVERFLOW 1 LOCKOUT (CO1) — The unit contains one condensate overflow sensor located in the chassis drain pan below the air coil. A condensate lockout will occur if the sensor senses condensate for 30 continuous seconds. The compressor will then be deenergized and the blower will deenergize 15 seconds after the compressor is deenergized.

OVER/UNDER VOLTAGE PROTECTION — If the unit control voltage is less than 18-vac or greater than 30-vac the unit will shut down all inputs immediately. Once the voltage has reached acceptable levels the unit microprocessor will power "On" automatically and resume previous operation.

LEAVING WATER TEMPERATURE SENSOR FAILURE (LWT) — If the leaving water temperature thermistor fails it will not affect the operation of the unit. This sensor is for monitoring purposes only.

DISCHARGE AIR TEMPERATURE SENSOR FAILURE (DAT) — If the discharge temperature thermistor fails it will not affect the operation of the unit. This sensor is for monitoring purposes only.

FREEZE PROTECTION 1 TEMPERATURE SENSOR FAILURE (FP1) — If the freeze protection 1 thermistor fails for 30 continuous seconds an FP1 lockout will occur. The compressor will then be deenergized and the blower will deenergize 15 seconds after the compressor is deenergized. The sensor must be replaced if this lockout occurs.

FREEZE PROTECTION 2 TEMPERATURE SENSOR FAILURE (FP2) — If the freeze protection 2 thermistor fails for 30 continuous seconds an FP2 lockout will occur. The compressor will then be deenergized and the blower will deenergize 15 seconds after the compressor is deenergized. The sensor must be replaced if this lockout occurs.

SERVICE

> **⚠ WARNING**
>
> Electrical shock can cause personal injury or death. When installing or servicing system, always turn off main power to system. There may be more than one disconnect switch.

> **⚠ WARNING**
>
> The installation and servicing of air-conditioning equipment can be hazardous due to system pressure and electrical components. Only trained and qualified service personnel should install, repair, or service air-conditioning equipment.

Water Coil Maintenance

CLOSED LOOP SYSTEM (All Other Water Loop Applications) — Generally water coil maintenance is not needed for closed loop systems. However, if the piping is known to have high dirt or debris content, it is best to establish a periodic maintenance schedule with the owner so the water coil can be checked regularly. Dirty installations are typically the result of deterioration of iron or galvanized piping or components in the system. Open cooling towers requiring heavy chemical treatment and mineral build-up through water use can also contribute to higher maintenance. Should periodic coil cleaning be necessary, use standard coil cleaning procedures, which are compatible with both the heat exchanger material and copper water lines. Generally, the more water flowing through the unit, the less chance for scaling. However, flow rates over 3 gpm per ton can produce water (or debris) velocities that can erode the heat exchanger wall and ultimately produce leaks.

OPEN LOOP SYSTEM (Direct Ground Water) — If the system is installed in an area with a known high mineral content (125 ppm or greater) in the water, it is best to establish a periodic maintenance schedule with the owner so the coil can be checked regularly. Should periodic coil cleaning be necessary, use standard coil cleaning procedures, which are compatible with the heat exchanger material and copper water lines. Generally, the more water flowing through the unit, the less chance for scaling. Therefore, 1.5 gpm per ton is recommended as a minimum flow. Minimum flow rate for entering water temperatures below 50 F is 2.0 gpm per ton.

Filters — A clean filter must be used to obtain maximum performance. Filters should be inspected every month under normal operating conditions. It is especially important to provide consistent washing of these filters (in the opposite direction of the normal airflow) once per month. Never operate a unit without a filter, severe system damage can occur.

Condensate Drain — In areas where airborne bacteria may produce an algae build-up in the drain pan, it may be necessary to remove and treat the drain pan chemically with an algaecide approximately every three months to minimize the problem. The condensate pan may also need to be cleaned periodically to ensure indoor air quality. The condensate drain can pick up lint and dirt, especially with dirty filters. Inspect the drain twice a year to avoid the possibility of plugging.

Compressor — Conduct annual amperage checks to insure that amp draw is no more than 10% greater than indicated on the serial data plate.

Fan Motors — All units have lubricated fan motors. Periodic maintenance oiling is not recommended, as it will result in dirt accumulating in the excess oil and cause eventual motor failure. Conduct annual dry operation check and amperage check to ensure amp draw is no more than 10% greater than indicated on serial data plate.

Evaporator Coil — The air coil must be cleaned to obtain maximum performance. Check once a year under normal operating conditions and, if dirty, brush or vacuum clean. Care must be taken not to damage the aluminum fins while cleaning.

> **⚠ CAUTION**
>
> Use caution when cleaning the coil fins as the fin edges are extremely sharp. Failure to heed this warning could result in personal injury.

Cabinet — The cabinet can be cleaned using a mild detergent. Do not allow water to stay in contact with the cabinet for long periods of time to prevent corrosion of the cabinet sheet metal.

Refrigerant System — To maintain sealed circuit integrity, do not install service gages unless unit operation appears abnormal. Verify that air and water flow rates are at proper levels before servicing the refrigerant circuit.

TROUBLESHOOTING

Lockout Modes — If the microprocessor board is flashing a system warning and the unit is locked out and not running, the lockout can be cleared from the microprocessor by a momentary shutdown of incoming line voltage (208-vac or 230-vac). A lockout that still occurs after line voltage shudown means that the fault still exists and needs to be repaired.

HIGH-PRESSURE LOCKOUT (HP) — The high-pressure lockout will occur if the discharge pressure of the compressor exceeds 600 psi. The lockout is immediate and has no delay from the time the high-pressure switch opens to the lockout. Upon lockout the compressor will be deenergized immediately. The blower will be deenergized 15 seconds after the compressor is deenergized.

LOW-PRESSURE LOCKOUT (LP) — The low-pressure lockout will occur if the suction pressure falls below 40 psi for 30 continuous seconds. The compressor will then be deenergized and the blower will deenergize 15 seconds after the compressor is deenergized.

FREEZE PROTECTION 1 LOCKOUT — The freeze protection 1 lockout will occur if the liquid line temperature falls below the set point (15 F or 30 F) for 30 continuous seconds. See DIP switch 2 description in the DIP Switch Settings and Operation section. The compressor will then be deenergized and the blower will deenergize 15 seconds after the compressor is deenergized.

FREEZE PROTECTION 2 LOCKOUT — The freeze protection 2 lockout will occur if the air coil temperature falls below the set point (32 F) for 30 continuous seconds. See DIP switch 2 description in the DIP Switch Settings and Operation section. The compressor will then be deenergized and the blower will deenergize 15 seconds after the compressor is deenergized.

CONDENSATE OVERFLOW 1 LOCKOUT (CO1) — The unit contains one condensate overflow sensor located in the chassis drain pan below the air coil. A condensate lockout will occur if the sensor senses condensate for 30 continuous seconds. The compressor will then be deenergized and the blower will deenergize 15 seconds after the compressor is deenergized.

OVER/UNDER VOLTAGE PROTECTION — If the unit control voltage is less than 18-vac or greater than 30-vac the unit will shut down all inputs immediately. Once the voltage has reached acceptable levels, the unit microprocessor will power on automatically and resume previous operation.

LEAVING WATER TEMPERATURE SENSOR FAILURE (LWT) — If the leaving water temperature thermistor fails, it will not affect the operation of the unit. This sensor is for monitoring purposes only.

DISCHARGE AIR TEMPERATURE SENSOR FAILURE (DAT) — If the discharge temperature thermistor fails, it will not affect the operation of the unit. This sensor is for monitoring purposes only.

FREEZE PROTECTION 1 TEMPERATURE SENSOR FAILURE (FP1) — If the freeze protection 1 thermistor fails for 30 continuous seconds an FP1 lockout will occur. The compressor will then be deenergized and the blower will deenergize 15 seconds after the compressor is deenergized. The sensor must be replaced if this lockout occurs.

FREEZE PROTECTION 2 TEMPERATURE SENSOR FAILURE (FP2) — If the freeze protection 2 thermistor fails for 30 continuous seconds an FP2 lockout will occur. The compressor will then be deenergized and the blower will deenergize 15 seconds after the compressor is deenergized. The sensor must be replaced if this lockout occurs.

If unit performance during any mode appears abnormal, refer to Table 13.

Table 13 — Troubleshooting

FAULT DESCRIPTION	ERROR CODE (COMMTSTAT)	SYSTEM WARNING (FLASH)				SYSTEM LOCKOUT (STEADY ON)				POSSIBLE FAULT CAUSE
		LED1	LED2	LED3	LED4	LED1	LED2	LED3	LED4	
High Pressure Lockout < 600 psi	Er 1	OFF	OFF	OFF	FLASH	OFF	OFF	OFF	ON	Low Airflow (Heating), Low Water Flow (Cooling)
Low Pressure Lockout < 40 psi	Er 2	OFF	OFF	FLASH	OFF	OFF	OFF	ON	OFF	Low Refrigerant Charge
Freeze Protection, Air Side	Er 4	OFF	OFF	FLASH	FLASH	OFF	OFF	ON	ON	Water Temperature < 35 F or < 15 F (Heating)
Freeze Protection, Air Side < 35 F	Er 5	OFF	FLASH	OFF	OFF	OFF	ON	OFF	OFF	Blower Failure (Cooling)
Condensate Overflow	Er 9, Er 10	OFF	FLASH	OFF	FLASH	OFF	ON	OFF	ON	Clogged Drain Line
Over/Under Low Voltage Protection, 18-vac > voltage, 30-vac	Er 11	OFF	FLASH	FLASH	OFF	OFF	ON	ON	OFF	Loss of Power, Brown Out
LWT Sensor Failure (Low Water Temperature)	Er 13	FLASH	OFF	OFF	OFF	N/A	N/A	N/A	N/A	Sensor Resistance Above or Below Specification
DAT Sensor Failure (Discharge Air Temperature)	Er 14	FLASH	OFF	OFF	FLASH	N/A	N/A	N/A	N/A	Sensor Resistance Above or Below Specification
FP1 Sensor Failure (Freeze Protection)	Er 15	FLASH	OFF	FLASH	OFF	ON	OFF	ON	OFF	Sensor Resistance Above or Below Specification
FP2 Sensor Failure (Freeze Protection)	Er 16	FLASH	OFF	FLASH	FLASH	ON	OFF	ON	ON	Sensor Resistance Above or Below Specification

LEGEND

LED — Light-Emitting Diode

NOTE: Warning LEDs and error codes are found on the system control board.

START-UP CHECKLIST

CUSTOMER:____________________________ JOB NAME: ____

MODEL NO.:____________________________ SERIAL NO.:_____________________ DATE:_________

I. PRE-START-UP

DOES THE UNIT VOLTAGE CORRESPOND WITH THE SUPPLY VOLTAGE AVAILABLE? (Y/N) ________

HAVE THE POWER AND CONTROL WIRING CONNECTIONS BEEN MADE AND TERMINALS TIGHT? (Y/N) ______

HAVE WATER CONNECTIONS BEEN MADE AND IS FLUID AVAILABLE AT HEAT EXCHANGER? (Y/N) ______

HAS PUMP BEEN TURNED ON AND ARE ISOLATION VALVES OPEN? (Y/N) ______

HAS CONDENSATE CONNECTION BEEN MADE AND IS A TRAP INSTALLED? (Y/N) ______

IS AN AIR FILTER INSTALLED? (Y/N) ______

II. START-UP

IS FAN OPERATING WHEN COMPRESSOR OPERATES? (Y/N) ______

IF 3-PHASE SCROLL COMPRESSOR IS PRESENT, VERIFY PROPER ROTATION PER INSTRUCTIONS. (Y/N) ______

UNIT VOLTAGE — COOLING OPERATION

PHASE AB VOLTS __________	PHASE BC VOLTS__________ (if 3 phase)	PHASE CA VOLTS __________ (if 3 phase)
PHASE AB AMPS __________	PHASE BC AMPS__________ (if 3 phase)	PHASE CA AMPS __________ (if 3 phase)

CONTROL VOLTAGE

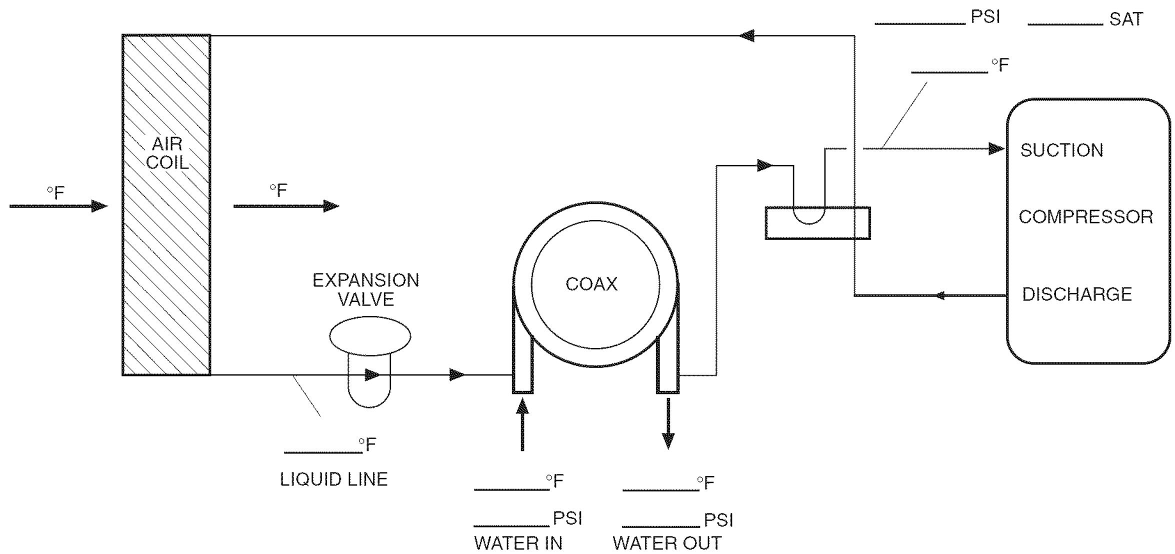
IS CONTROL VOLTAGE ABOVE 21.6 VOLTS? (Y/N) ______.
IF NOT, CHECK FOR PROPER TRANSFORMER CONNECTION.

TEMPERATURES

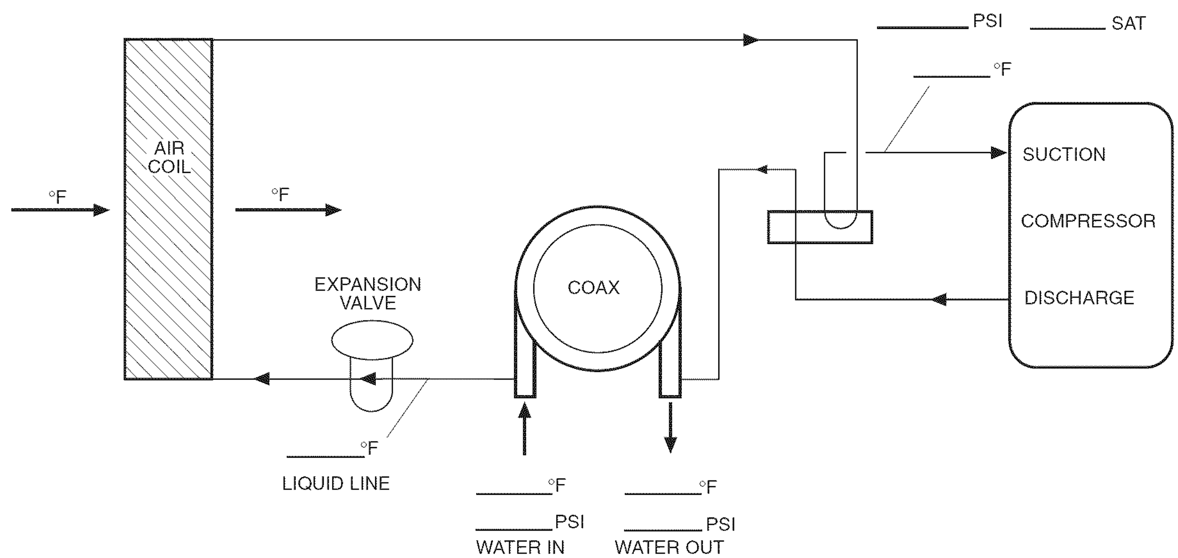
FILL IN THE ANALYSIS CHART ATTACHED.

COAXIAL HEAT EXCHANGER	COOLING CYCLE: FLUID IN	______ F	FLUID OUT ______ F	______ PSI	______ FLOW
	HEATING CYCLE: FLUID IN	______ F	FLUID OUT ______ F	______ PSI	______ FLOW
AIR COIL	COOLING CYCLE: AIR IN	______ F	AIR OUT ______ F		
	HEATING CYCLE: AIR IN	______ F	AIR OUT ______ F		

HEATING CYCLE ANALYSIS



COOLING CYCLE ANALYSIS



CUT ALONG DOTTED LINE

CUT ALONG DOTTED LINE

HEAT OF EXTRACTION (ABSORPTION) OR HEAT OF REJECTION =

_______ FLOW RATE (GPM) x _______ TEMP. DIFF. (DEG. F) x _______ FLUID FACTOR* = ___________ (Btu/hr)

SUPERHEAT = SUCTION TEMPERATURE – SUCTION SATURATION TEMPERATURE
= ____ (DEG F)

SUBCOOLING = DISCHARGE SATURATION TEMPERATURE – LIQUID LINE TEMPERATURE
= ____ (DEG F)

*Use 500 for water, 485 for antifreeze.