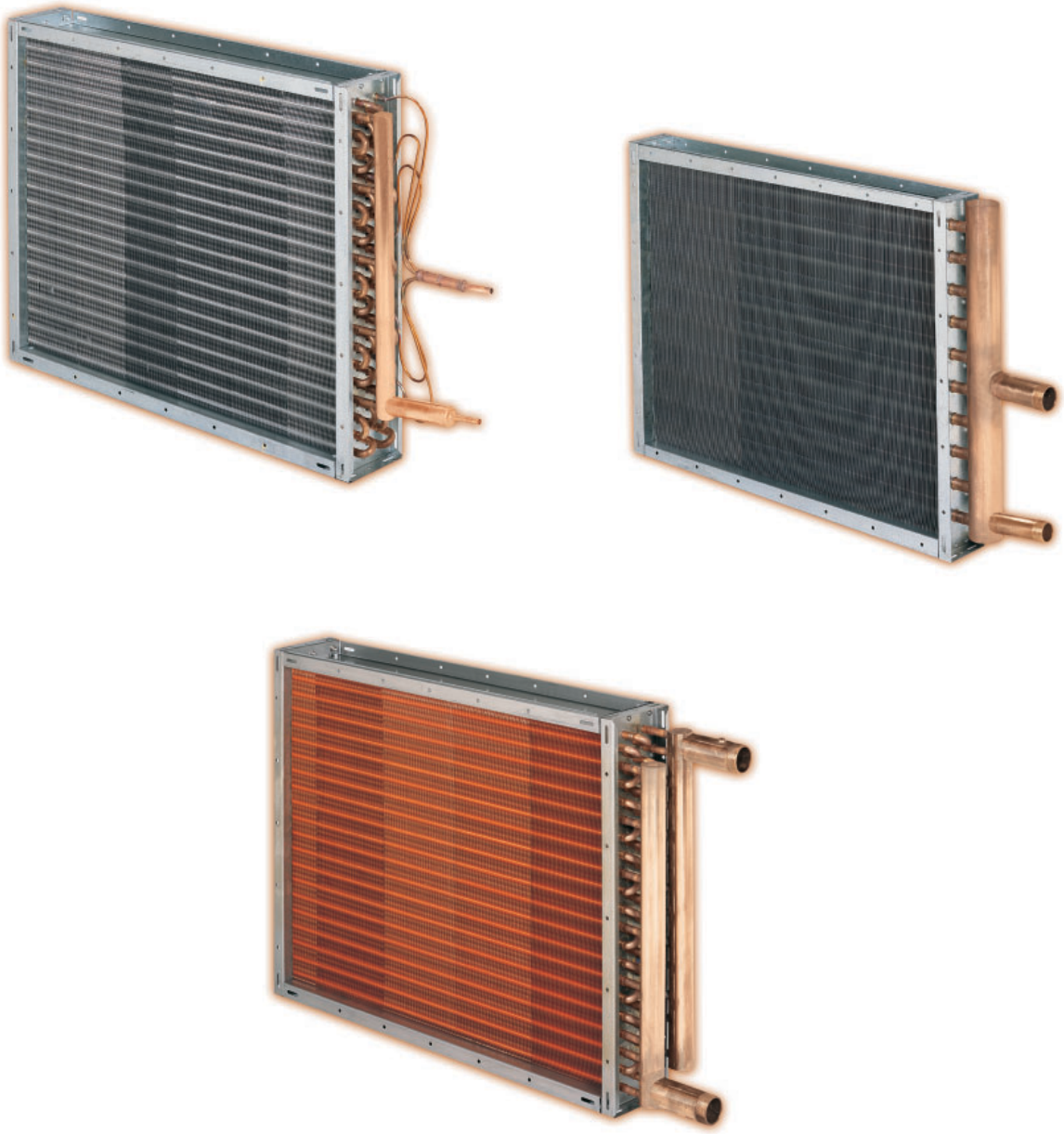
Johnson Controls	LOOSE COILS	
INSTALLATION, OPERATION & MAINTENANCE	New Release	Form 105.00-NOM1 (408)

WATER, DX, STEAM & BOOSTER COILS



IMPORTANT!
READ BEFORE PROCEEDING!
GENERAL SAFETY GUIDELINES

During installation, operation, maintenance or service, individuals may be exposed to certain components or conditions including, but not limited to: refrigerants, oils, and materials under pressure, rotating components, and both high and low voltage. Each of these items has the potential, if misused or handled improperly, to cause bodily injury or death. It is the obligation and responsibility of operating/service personnel to identify and recognize these inherent hazards, protect themselves, and proceed safely in completing their tasks. Failure to comply with any of these requirements could result in serious damage to the equipment and the property in which it is situated, as well as severe personal injury or death to themselves and people at the site.

This document is intended for use by owner-authorized operating/service personnel. It is expected that this individual possesses independent training that will enable them to perform their assigned tasks properly and safely. It is essential that, prior to performing any task on this equipment, this individual shall have read and understood this document and any referenced materials. This individual shall also be familiar with and comply with all applicable governmental standards and regulations pertaining to the task in question.

SAFETY SYMBOLS

The following symbols are used in this document to alert the reader to areas of potential hazard:

DANGER indicates an imminently hazardous situation, which if not avoided, will result in death or serious injury.

WARNING indicates a potentially hazardous situation, which if not avoided, could result in death or serious injury.

CAUTION identifies a hazard which could lead to damage to the machine, damage to other equipment and/or environmental pollution. Usually an instruction will be given, together with a brief explanation.

NOTE is used to highlight additional information that may be helpful to you.

CHANGEABILITY OF THIS DOCUMENT

In complying with Johnson Controls policy for continuous product improvement, the information contained in this document is subject to change without notice. While Johnson Controls makes no commitment to update or provide current information automatically to the manual owner, that information, if applicable, can be obtained by contacting the nearest Johnson Controls Service office.

It is the responsibility of operating/service personnel to verify the applicability of these documents to the equipment in question. If there is any question in the mind of operating/service personnel as to the applicability of these documents, then prior to working on the equipment, they should verify with the owner whether the equipment has been modified and if current literature is available.

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LIST OF FIGURES

SECTION 1 - INSTALLATION

COIL PIPING

Do not test, clean and flush piping through this equipment.

Isolate this equipment from pressure testing of water, steam, gas and air piping.

Consult the job specifications and submittal drawings for specific piping requirements, coil connection sizes and location. The coil should be level to assure proper venting and draining of coils. The piping arrangements must provide for a balanced flow in multiple coil installations (*see Fig. 1 showing factory coil connections*).

Support all connecting piping independently of the coils. Provide swing joints or flexible fittings in all piping connections, particularly adjacent to heating coils, to absorb expansion and contraction strains. Rigid piping connections can cause coil damage

The coil supply and the return pipe connections are labeled. When attaching piping to the coil header, make the connection only tight enough to prevent leaks. Excessive tightening may cause damage to the header. A backup wrench must be firmly held on the coil connection so that in tightening the connecting piping the torque is not transmitted to the coil header, thus damaging the coil connection.

Application Notes - Drain and vent taps on water coils are pipe thread shipped with plugs installed. These taps are installed approximately two inches back from the end of the threaded connections and require a hexagon (Allen) wrench to remove.

WATER

Water Coils - Drainable Water

Connect the water supply to the header connection on the leaving air side of the coil to achieve the counter flow of water and air. The return pipe will be connected to the remaining coil connection.
Install an air vent in place of the top pipe plug on the return header. In order to provide for drainage, install a drain line and shutoff valve in the supply near the coil or in place of the plug in the supply connection.

Hot Water Coils

The temperature rise of the air leaving the coil is dependent on the airflow across the coil, the gallons of water flow through the coil and the entering water temperature into the coil. Consult the submittal for each specific job for the above information.

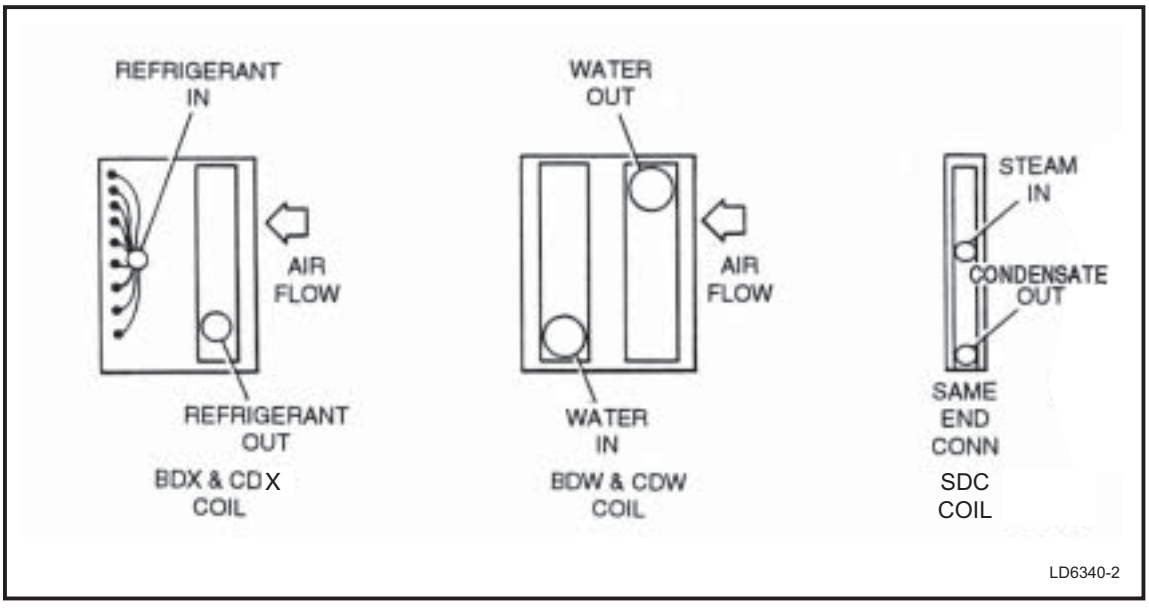

FIG. 1 – FACTORY COIL CONNECTIONS

Chilled Water Coils

See Fig. 2 for piping diagram.

Water Treatment

Any copper tube coils may be attacked by acid condensate. The practice of boiler water treatment should include CO_2 removal to assure longer tube life.

Freeze Protection

Chilled water, hot water and steam coils can be damaged during freezing weather. Precautionary measures must be taken to prevent freezing such as:

- Positive coil freeze protection must be used in installations where any part of the water coil is subjected to temperatures of 32 degrees or lower. This may be accomplished by using a suitable antifreeze solution. If the coil is not in use, it is recommended that the coil be completely drained and the inside of the tubes blown dry with compressed air.
- After draining, flush coils with an antifreeze solution such as ethylene glycol. A solution of 50% ethylene glycol and 50% water will protect from freezing to approximately 35 degrees F below zero at sea level. *Also refer to ASHRAE and ARI guidelines.*
- During winter operation due to the possibility of shutdowns such as power failure, night shutdown and weekend shutdown, the controls should be installed so the return air dampers will go to the full open position, and all fresh air dampers go to the full closed position. A source of auxiliary heat must be maintained inside the unit cabinet.
- Other means of protection such as various electro-mechanical switches and the full constant flow of water can be used; however, Johnson Controls will not be responsible for water coils damaged by freezing.

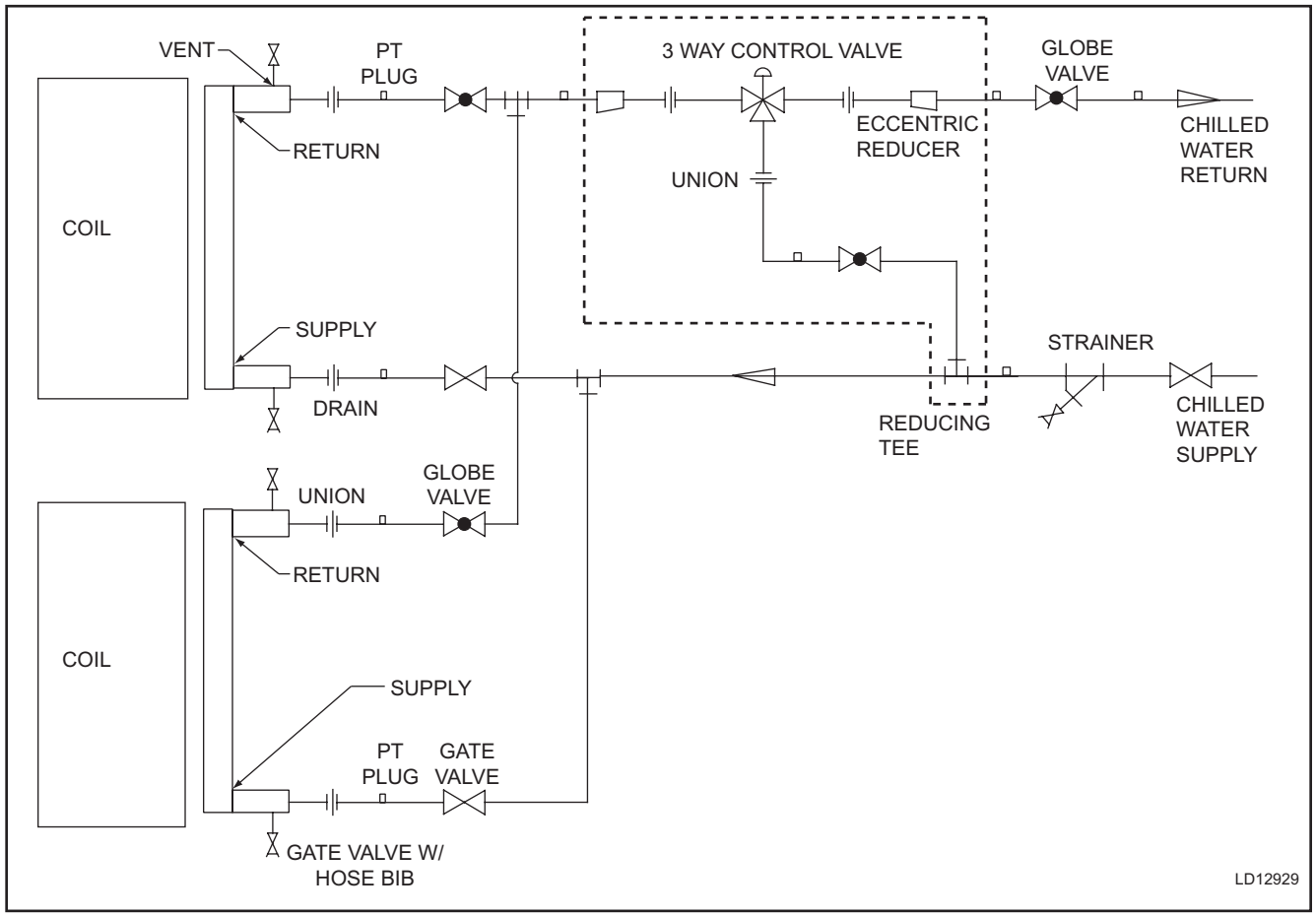

FIG. 2 – CHILLED WATER COIL CONNECTIONS

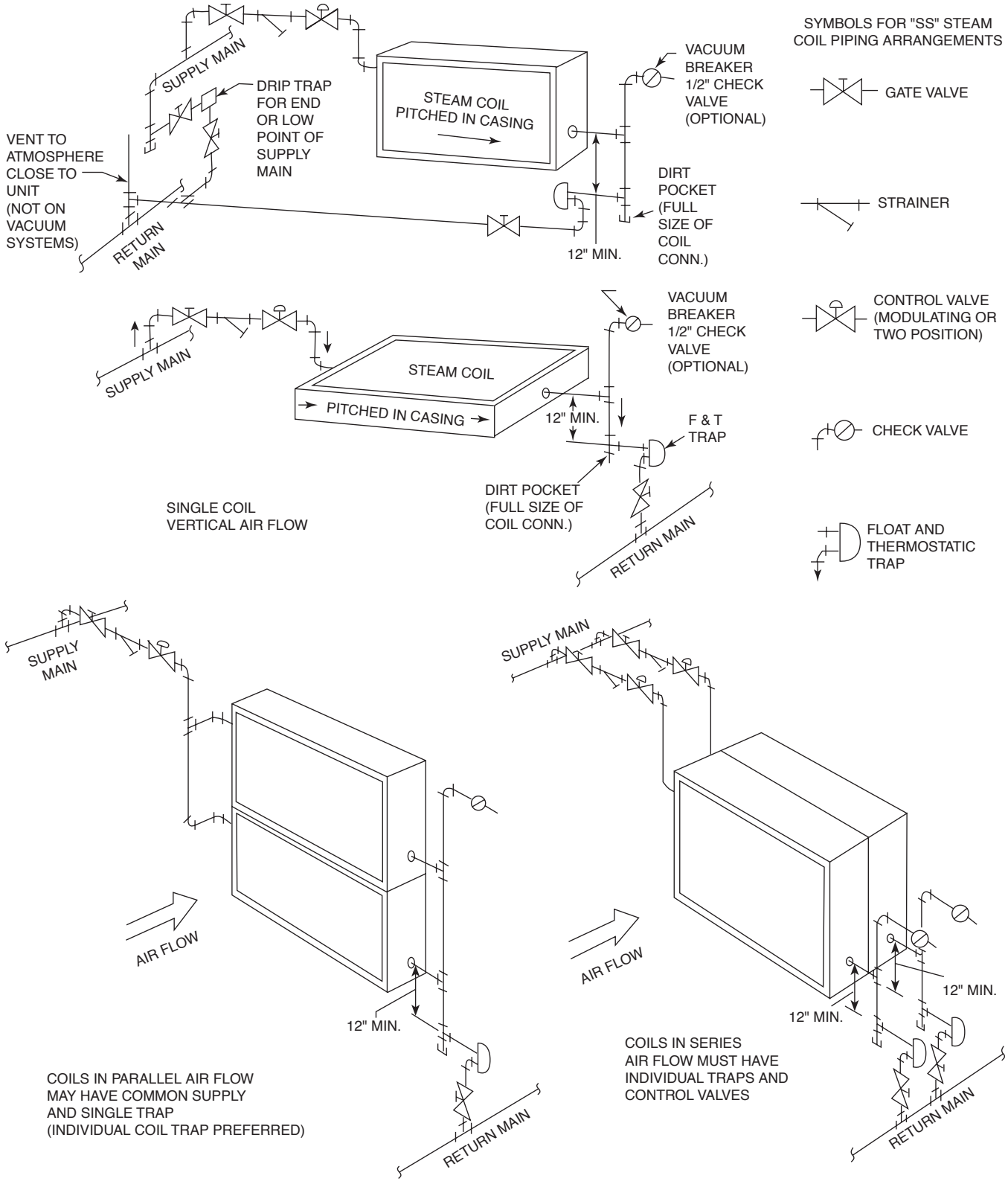

FIG. 3 – STEAM COIL PIPING ARRANGEMENTS

STEAM

Refer to Fig. 3 "Steam Coil Piping Arrangements."

Steam Coils

The operation of steam coils is dependant on airflow quantity and temperature. Consult the submittal issued for each specific unit for above information.

Steam Distributing Coils

Do not bush or reduce the coil return pipe size. Use a full size return pipe to the bottom of a dirt pocket. The supply pipe may be reduced at the coil connection if necessary. Install the coil casing level with the return down. A coil must be sufficiently elevated to allow a 12 inch minimum drop between the return connection on the coil and the trap. A greater than 2 inch drop is required for protection from freezing. The return main should be located below the trap. *Refer to Fig. 3.*

Steam Control

Continuous steam supply ensures long coil life and minimizes potential trapping, venting and freezing problems. A rapid cycling of the modulating steam supply or a frequent on-off steam supply control results in repeated thermal and piping stresses which will shorten the coil life. Modulating steam control valves must not be oversized but must be carefully selected, and cannot be used on 100% outside air applications. A substantial variation in the supply pressure will require the installation of a pressure-reducing valve ahead of the automatic control valve.

Light load operation with a modulated steam supply can be improved by the installation of a vacuum breaker check valve. An open relief line to the atmosphere from the return line near the coil is desirable, except on vacuum systems.

With a modulated steam supply, it is not practical to lift the condensate to an overhead return. Locate the coil well above the return, or provide condensate unit, or a boiler return trap below the coil.

Individual control valves are required on each coil installed in series with respect to airflow. When a modulating steam valve supplies two or more coils in parallel, with respect to airflow, the piping must be designed to provide for uniform steam distribution to each of the coils.

Steam Traps

Float and Thermostatic (F. & T.) traps are recommended for all low or medium pressure applications. Use thermostatic traps only for air venting, for outdoor applications where an F. & T. trap might be subject to freezing. Use bucket traps only for a non-modulated steam supply. Size the steam traps in accordance with the manufacturer's recommendations (usually several times the steady state steam flow). Use the actual operating conditions (coil pressure vs. return pressure) for the selection of a trap.

It is preferable to provide an individual trap for each coil but a single trap may be used for coils operating in parallel with respect to the airflow. Coils in series with respect to airflow must be supplied with individual traps. Locate the trap at least 12 inches below the coil return connection and even lower when freeze protection is required. Do not attempt to lift condensate modulated steam supply.

REFRIGERATION

Direct Expansion Coils (DX)

DX coils are divided into splits depending upon the unit size and coil circuiting. Each split requires its own distributor nozzle, expansion valve and suction piping. Suction headers are on the air entering side with suction connection at bottom end of headers when the coil is properly installed. Matching distributor connections for each coil refrigeration circuit are on the air leaving side. *See certified drawing and/or connection labeling to ensure correct matching of suction and distributor connections.*

CAUTION

Direct-expansion coils are shipped charged with nitrogen.

Do not leave piping open to the atmosphere unnecessarily. Water and water vapor are detrimental to the refrigerant system. Until the piping is complete, recap the system and charge with nitrogen at the end of each workday. Clean all piping connections before brazing joints. Use nitrogen when brazing connections to prevent scaling.

The orientation of the refrigerant distributor is not critical but the distributor tubes must not be kinked or bent in a non-uniform configuration. For this and other piping & sundry tips, *refer to Fig. 4.*

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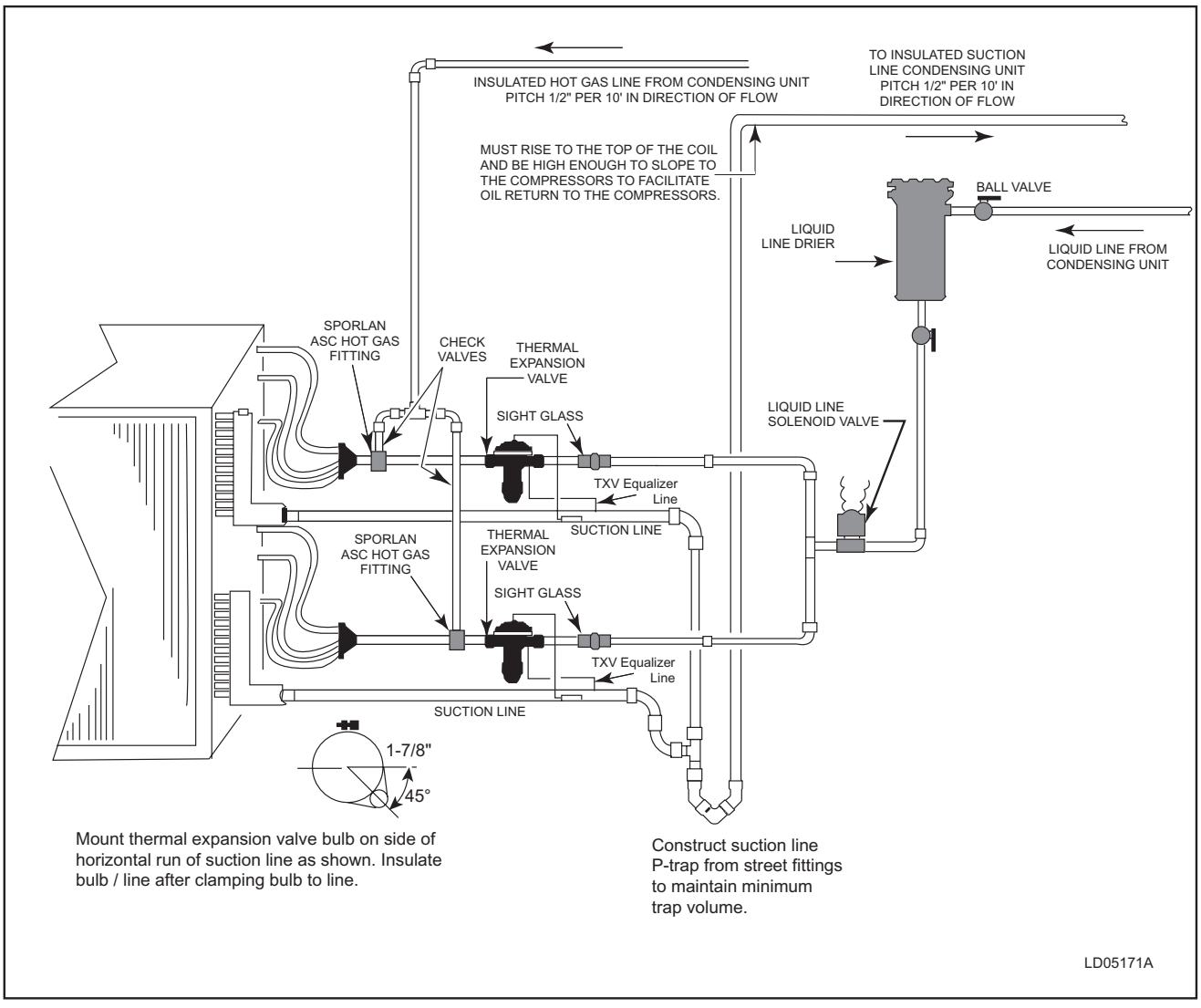

FIG. 4 – TYPICAL PIPING AND SUNDRIES AT THE DX COIL

DX Coil Types

There are three basic types of coil arrangements used in field erected split systems, interlaced, row split and face split.

Interlaced

Interlaced coils are the most desirable type of coil "field erected" designs. Interlaced coils ensure the entire face of the coil is active with any number of compressors operating. Interlaced circuitry interweaves coil tubing in both circuits across the entire face of the coil assuring uniform cooling of the air by the refrigerant. This type of coil also allows one circuit to operate while the other circuit is turned off. Interlaced coils provide excellent temperature control at full and part loads as well as good TXV superheat control. TXV control is essential for compressor reliability.

Row Split

Row split coils arrangements place coils back to back in the air stream. Air passes through one coil before passing through the next. Generally, the last coil in the air stream is activated first. Each circuit may be controlled independently in this arrangement. When both coils are operating, the coil closest to the leaving air will operate at a lower temperature. This type of coil may not permit lead lag of the circuits and it may be difficult to balance the capacity between the coils.

Face Split

On a face split coil, the circuiting is divided between two separate coils. In field-erected systems, this arrangement may suffer from TXV superheat control problems and compressor reliability. At low airflow, low load situations, the TXV may have difficulty controlling system superheat.

Air stratification, poor humidity control and condensation on downstream components can also occur when using face split coils. One way to address TXV control at part load is to provide a face damper to shutoff airflow when a coil face is inactive.

Combined Coil Types

Coil types may be combined in some systems. This requires special care. Control sequences and piping tying the multiple systems and coils together should be well thought out and advice from an experienced design engineer is necessary.

DX Coil Circuiting

On many coil banks, two, or even all three of the methods of circuiting may be combined depending upon the cooling capacity and the level of control required. However, coil sections must be married or combined so that they provide for full-face operation (*see Fig. 5*).

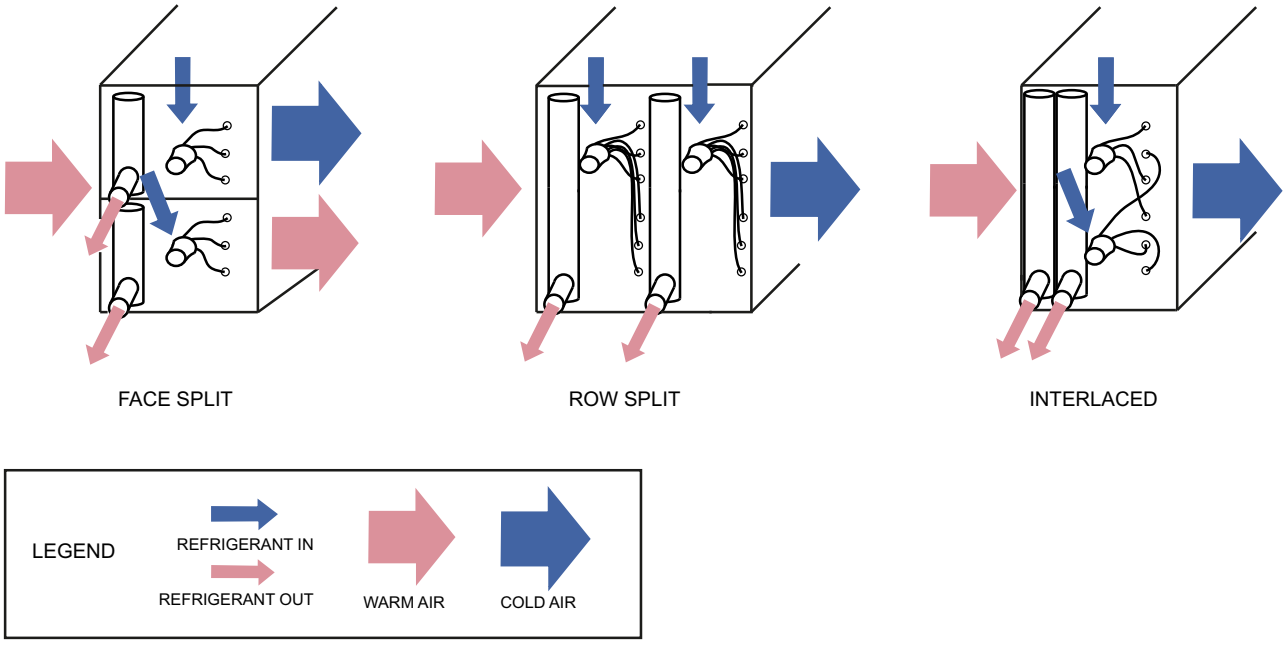

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FIG. 5 – DX COIL CIRCUITING TYPES

The coil designs fall into the two following categories.

Coil Design	Fin Height
Non-Stacked	48" and less
Stacked	Greater than 48"

Fig's. 6 through 8 illustrate the available coil arrangements.

NOTE

Face-split DX coils must be configured to provide full-face coverage at all condensing unit load steps. Johnson Controls assumes no responsibility for compressor failure if full-face coverage is not applied. Consult the factory, if application assistance is needed to convert split face to full-face operation.

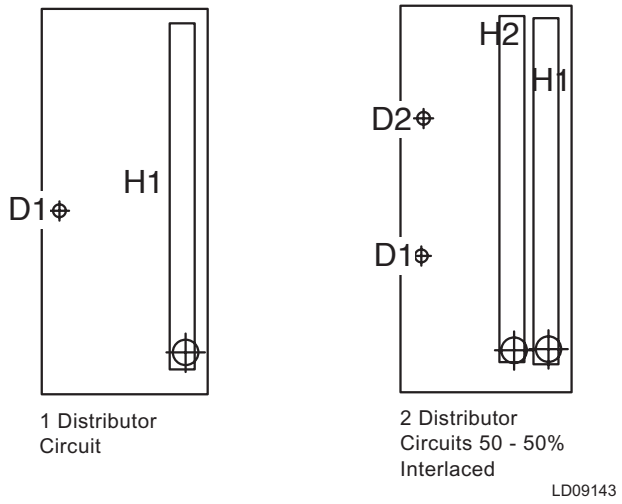

FIG. 6 – NON-STACKED COIL DESIGN

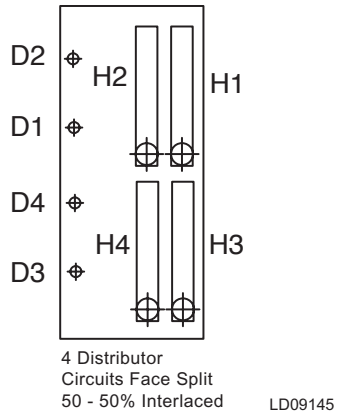

FIG. 7 – STACKED COIL DESIGN

DX Coil Circuiting and Staging

On tall coils, a minimum of four coil circuits should be used to achieve full-face control (Fig. 8). Each coil distributor circuit requires its own Thermostatic Expansion Valve (TXV). Each condensing unit circuit requires its own liquid line solenoid valve (LLSV). When the condensing unit has two compressors per refrigerant circuit, either one or two coil circuits may be used for each refrigerant circuit depending upon the cooling capacity.

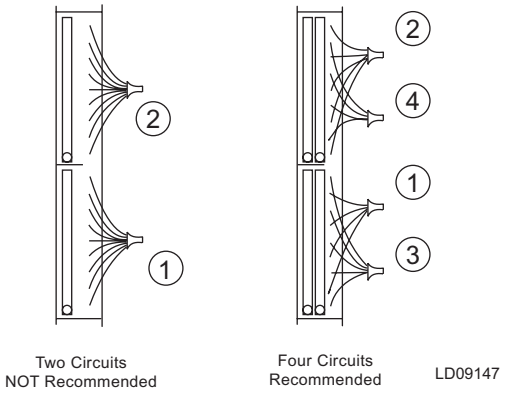

FIG. 8 – STACKED COIL CIRCUITING

If one coil circuit is used (Fig. 9), the LLSV and TXV must be sized to handle the full capacity of the refrigerant circuit. When two coil circuits are used per refrigerant circuit (Fig. 10), each TXV should be sized to handle half of the capacity of the refrigerant circuit and the LLSV should be sized to handle the full capacity of the refrigerant circuit.

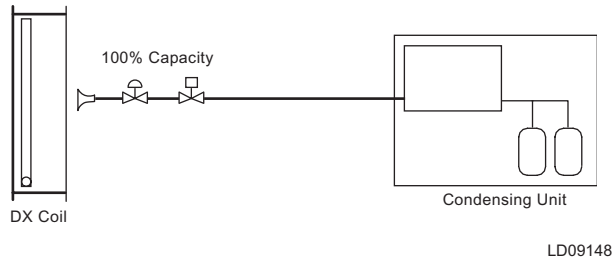

FIG. 9 – ONE COIL CIRCUIT PER REFRIGERANT CIRCUIT

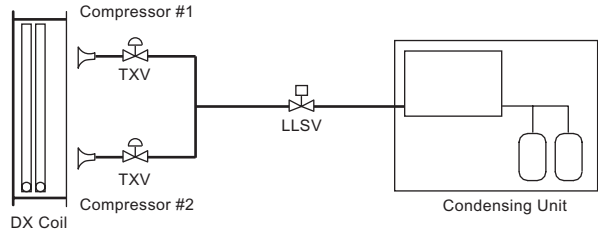

FIG. 10 – TWO COIL CIRCUITS PER REFRIGERANT CIRCUIT

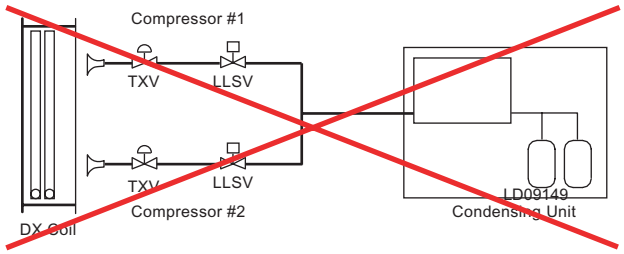

FIG. 11 – DO NOT USE THE ABOVE CONFIGURATION.

When the condensing unit has three compressors per circuit, two coil circuits should be used for each refrigerant circuit (Fig. 12). Each coil circuit must have a dedicated TXV and distributor to handle one coil circuit and the LLSV should be sized to handle the full capacity of the refrigerant circuit. The hot gas bypass line should be connected to all of the distributors in the coil circuit.

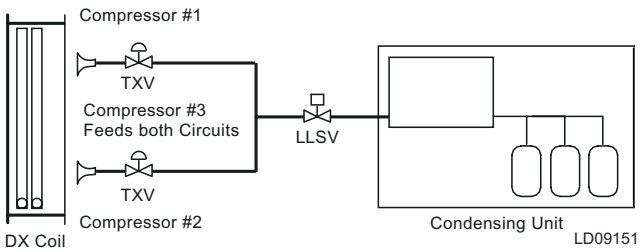

FIG. 12 – THREE COMPRESSOR YCUL

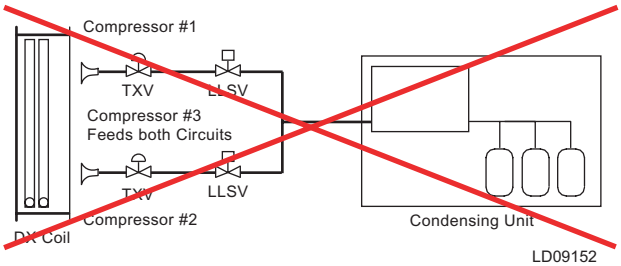

FIG. 13 – DO NOT USE THE ABOVE CONFIGURATION.

In the case of a tall coil with four coil circuits piped to a condenser with six compressors, the coil circuits would be face-split and interlaced with two interlaced circuits on the lower coil section and two on the upper (Fig. 14).

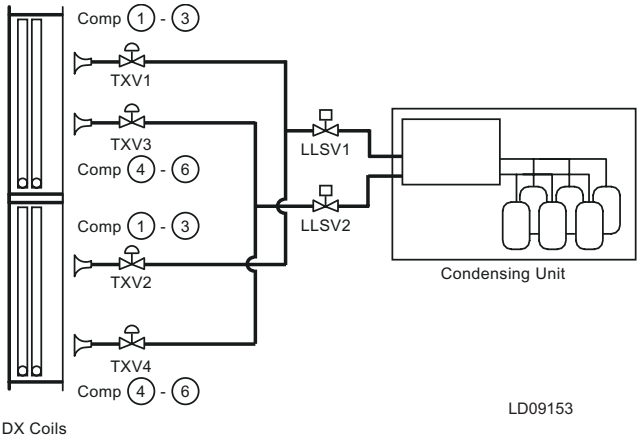

FIG. 14 – SIX COMPRESSOR YCUL

NOTE

When sizing TXV's, each TXV must be sized for the refrigerant circuit tonnage divided by the number of DX coil liquid distributors. The TXV should be equal to or smaller than the calculated value.

The first three compressors (*see Fig. 14*) would be tied into LLSV1, TXV1 and TXV2. This would provide full-face control of the coil at even the lowest cooling loads. Both distributors on each of the coil circuits would include auxiliary side connectors for HGBP.

The second set of 3 compressors would be tied into LLSV2, TXV3 and TXV4 to maintain full-face control at higher loads. *Reference Form 050.40-ES3 Section 9 for compressor staging solutions.*

The more control stages used, the more precise the control of the air temperature will be. Smaller incremental changes in capacity will result in a more consistent DX coil leaving air temperature. This will eliminate temperature swings in the conditioned space and improve the comfort level, but more importantly, a consistent space temperature is crucial to many process applications. The smaller changes in capacity that result from using a greater number of control stages will also extend equipment life. The most important thing to remember is to maintain full-face control of the coil at all cooling loads. When row split coils are used, make sure that the first LLSV is energized with the last coil circuit in the leaving air stream. This is always the last one de-energized too.

Thermostatic Expansion Valves (TXV)

Each coil distributor circuit requires its own Thermostatic Expansion Valve (TXV). Each condensing unit circuit requires its own liquid line solenoid valve (LLSV). TXV's are to be equipped with external equalizer tubes that are field connected to the suction line. The valve should be sized in accordance with the valve manufacturer's recommendations, allowing approximately 35 PSI pressure drop throughout the coil and distributor at full load. Do not oversize the valve. Follow the valve manufacturer's instructions on the location of the thermostatic bulb. Proper expansion valve operation is necessary in order to realize the rated coil capacity.

When a DX type coil is operated with a suction temperature below 32°F, a build up of frost will occur on the finned surface. It is, not recommended therefore, to operate DX coils for air conditioning purposes at below freezing suction temperatures. If the full load operating point for the coil is selected at a “safe” temperature, a system analysis is required to check for the lowest probable suction temperature at light load conditions.

Hot Gas Bypass

When using discharge air temperature control or systems with outside air economizer cooling, always include hot gas bypass (HGBP). It is not as critical to use HGBP with return duct air temperature control, or suction pressure control, but it provides better capacity control at low loads.

The HGBP line should be sized for 100% of the capacity of one compressor and the hot gas lines must be insulated. YCUL discharge head pressure control is required on hot gas bypass applications. At low ambient temperatures, the condensing unit is very efficient and there is very little hot gas available for capacity control. Discharge pressure control assures enough differential pressure to push sufficient hot gas from the high side to the low side of the system.

Typical distributors utilize a selectable nozzle versus the older venturi type. Either device requires the use of an auxiliary side connector (ASC) for introducing the hot gas into the system and mixing it with saturated liquid refrigerant just ahead of the distributor. Most distributors are ordered with an integral ASC. Where multiple coils are stacked (or side by side), and ASC must be provided on all coils for that YCUL system. When ASC’s are field installed, the ASC must be located direct to the distributor, or a maximum of 2” to 3” away. Additionally, the side connection must be positioned upward to eliminate oil and refrigerant logging in the hot gas line when not in operation.

Hot gas must be fed to all coils to assure that full-face operation is achieved. Since all applications have job specific operating characteristics, the hot gas bypass valve setting must be field adjusted for the proper setting, after the system has been put into operation.

Hot gas piping must never be designed to trap liquid. If the hot gas line traps liquid during off periods, it will send a large slug of liquid into the DX coil when the hot gas is activated. This slug of liquid will not be fully evaporated in the DX coil and a liquid slug will be fed to the compressor, potentially causing damage. A hot gas line should be sloped so that it drains into the DX coil distributor from above the distributor, which also promotes oil return.

Local, state and federal energy standards such as ASHRAE 90.1 may limit the use of hot gas bypass in some applications. Be sure to consult local code requirements before installing the system.

Check Valves – All multiple HGBP auxiliary connections on a single circuit MUST include check valves as shown in Fig. 4. The use of these valves prevents one coil circuit from short circuiting to the other and influencing its operating pressure. This short circuiting produces unwanted TXV hunting and refrigerant over and under feed.

Check valves shall be refrigeration grade selected for suitable pressures involved. Valve bodies shall be constructed of copper with an integral check ball permitting flow only to the distributor (not reversed). Valves installed in the near horizontal must include a spring-loaded design. Valves must not exceed a 1 psi pressure drop at the design flow-tons for hot gas applications.

Maintaining Adequate Airflow

An electrical interlock between the air handler and the condenser must be included for permissive run of the condenser. In addition, a differential pressure switch mounted across the supply fan must always be included to ensure airflow across the coil before the condensing unit is energized. The condenser must never be operated unless the air handler fan is operating and air is flowing across the active coil. Insufficient airflow will result in liquid refrigerant returning to the condensing unit, which could damage the compressors by liquid slugging or washing oil from the bearing surfaces.

In variable volume systems, the minimum acceptable airflow for fixed speed or VAV systems is 350 FPM face velocity across each DX coil, as applied to split DX systems. This is critical to assure that the TXV does not overfeed, causing compressor failure.

The air velocity flowing through chilled water and direct expansion coils must not exceed specific recommended values, to prevent water carryover.

SECTION 2 - OPERATION AND MAINTENANCE

COIL SEGMENT

Coil Cleaning Procedure

Suggested Tools, Equipment & Materials List

- Pressure washer that does not exceed 2000 PSI.
- Sprayer (utility garden, etc.) applicator.
- Plastic sheeting.
- Duct tape.
- Screening.
- Coil cleaner (safe, commercial grade, disinfecting).
- Garden hose.
- Garden hose spray nozzle.
- Rags.
- Pail.
- Trash bags.
- Power cords.
- Four inch paintbrush.

Cleaning Procedure

Perform cleaning of dehumidification coils at least once a year or when air pressure drop exceeds 125% of design.

1. Cover electrical components such as fan motors, damper motors, compressors, thermostats, etc. with plastic. Care should be taken on interior coil cleaning. Remove filters; cover fan bearings and any insulation to keep these items free of water damage. Condensate drain piping should be screened to allow coil-cleaning water to flow freely. Screening keeps traps and drain lines from clogging with debris washed from the coils.
2. Prior to any application of wet cleaning materials, use a wide soft bristle paint brush to dust off any heavy dust, leaves, bugs or other foreign matter that may be on the coil fin surface.

Safety glasses should be worn when cleaning coils.

3. When possible, remove dirt lodged in the depth of the coil by using clean oil-free air under pressure. Caution should be taken not to use extreme high-pressure air as this may cause fin surface damage. Direct the air straight at the openings between the fins and never at an angle, which may bend the fins against one another. Always apply the air from the air leaving side of the coil.
4. On heavily soiled coils, use a safe commercial grade coil cleaner.

Follow the safety and mixing instructions as noted on or with the cleaning agent.

5. Spray the cleaning agent on both sides of the coil to be cleaned. Allow the cleaning agent to remain in contact with the dirty surface for about 5 minutes or as recommended by the agent instructions. Then flush the coil with clean water from a hose (with spray nozzle or from pressure washer). Flush from the air leaving side of the coil. Caution should be taken, as extreme water pressure may result in fin surface damage. Direct the water straight at the openings between the fins and never at an angle, which may bend the fins against one another. This process will wash away surface dirt on the air entering side of the coil, and prevent it form loading within the depth of the coil.
6. Most cleaners are concentrated detergents and can be diluted with up to 10 parts of water. Dilute as per cleaning agent instructions and coil condition. Re-spray both sides of the coil with cleaner. Allow to stand 5 minutes and flush as described previously. Finish flushing from both sides of the coil.

Follow cleaning agent instructions. Agent should meet environmental and OSHA standards.

7 Some extreme oil and dirt conditions may require steam cleaning. Most steam equipment can be adjusted to provide a mixture of water and steam at a moderate pressure. Steam alone without the presence of water does not work well with most cleaning agents. Cleaning the coils with steam should be done as described previously.

8. Comb out any bent or flattened areas of fin surface.
9. Restore equipment to operational state.

Condensate Drain Pan, Trap and Drain Line Cleaning Procedure

Tools and Materials

- Toilet bowl brush or similar utility cleaning brush.
- Cleaning agent (safe, commercial grade, disinfecting).
- Rags.
- Trash bags.
- Garden hose with spray nozzle or power washer.
- Scraper.
- Screening.
- Wet vacuum.

Cleaning Procedure

Clean condensate drain pan, trap, drain line and adjacent wetted surfaces at least once per year or as often as required to retard growth of microbial substances.

Testing of Drain Pans - ***To minimize conditions of water stagnation that may result in microbial growth, drain pans shall be field-tested under normal operating conditions to ensure proper drainage.***

Exception: ***Field testing of drain pans is not required if units with factory-installed drain pans have been certified (attested in writing) by the manufacturer for proper drainage when installed as recommended.***

1. Cover any nearby components such as motors, control devices or wiring.
2. Sweep, gather and remove debris from drain pan, auxiliary pans and splash guards.
3. Scrape loose and remove any clinging substances.
4. Cover drain pan outlet with screening to prevent drain clogging.
5. Prepare cleaning agent per manufacturer's instructions.
6. Apply cleaning agent with spray applicator or brush.
7. Apply cleaner to ***ALL*** surfaces including: under side of coil, header and return bends if in air stream, coil supports, coil wall or bulkhead, auxiliary drain pans, splash guards, any other surfaces subject to wetting by condensation dripping or carried by normal air flow, drain pan and outlet.
8. Add ample amount of cleaning agent to drain line and trap.
9. Allow cleaner to stand for time required by manufacturer's instructions.
10. Flush with clean water from pressure washer or garden hose with spray nozzle.
11. Apply as much water under pressure as possible to drain outlet to clean trap and drain line.
12. Remove water from any puddle areas with wet vacuum.
13. Wipe down if necessary to remove any stubborn material.
14. Restore equipment to operational state.

Winterizing Drain Traps

During the winter months when the cooling system is turned off and the unit is exposed to freezing conditions, an antifreeze solution, which is environmentally friendly and safe for the roof can be poured in the condensate drain trap to prevent freezing and possible damage. The condensate drain trap may also be removed as well as heat traced and insulated.

MONTHLY MAINTENANCE CHECK

Refrigerant Coils - Check holding charge pressure monthly to be sure that the pressure has not dropped. If pressure has dropped, the unit should be inspected for signs of visible damage which may have caused loss of pressure. If pressure drops more than 2 psi, the unit should be pressure tested to locate the leak; the leak should be repaired and the unit recharged with nitrogen to 5 psig pressure.

WARRANTY

The standard warranty policy is described by Form 50.05-NM2.

COIL LEAKS

Reporting coil leaks that occur during the standard warranty period must be done in accordance with the procedure outlined in Service Bulletin SB0033. This form is required for warranty claim processing.

REPLACEMENT COILS

To order coils, refer to the Loose Coil Quick Shipment Guide for product offering and ordering instructions.

NOTES:

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