

When you want Quality, specify COLMAC!



Installation, Operation, and Maintenance
A+P Insulated Penthouse Evaporator
ENG00020125 Rev C

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1. SAFETY INSTRUCTIONS

To avoid serious personal injury, accidental death, or major property damage, read and follow all safety instructions in the manual and on the equipment before attempting to rig or install a Colmac A+P Insulated Penthouse Evaporator. These installation instructions are not intended to replace the knowledge and experience of a licensed installation contractor. It is rather provided to familiarize the installation personnel with the A+P product. Maintain all safety labels in good condition. If necessary, replace labels using the provided part numbers.



This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.



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



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



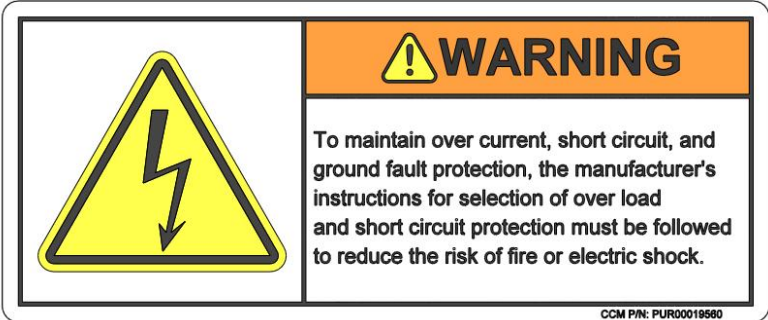
CAUTION indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.




NOTICE indicates instructions that pertain to safe equipment operation. Failure to follow these instructions could result in equipment damage.



PUR00019535



PUR00019560

	! WARNING
	<p>If an overload or a fault current interruption occurs, circuits must be checked to determine the cause of the interruption. If a fault condition exists, the current carrying components should be examined and replaced if damaged, and the integral current sensors must be replaced to reduce the risk of fire or electric shock.</p> <p><small>CCM P/N: PUR00019561</small></p>

PUR00019561

	! DANGER
	<p>Rotating Machinery</p> <p>Equipment may start and stop without warning. Do not operate with guards removed. Lockout prior to servicing.</p> <p><small>CCM P/N: PUR00019536</small></p>

PUR00019536

	! DANGER
	<p>Pressurized Gas/Liquid</p> <p>Contains pressurized gas/liquid. Evacuate system in accordance with applicable regulations and safety standards prior to servicing. Only qualified personnel should service unit.</p> <p><small>CCM P/N: PUR00019634</small></p>

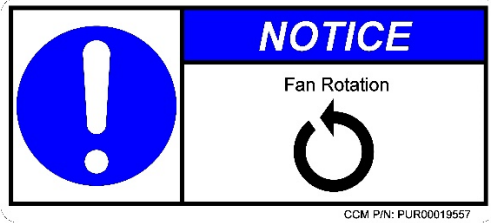
PUR00019634

	! WARNING
	<p>Safety Relief Valve Required</p> <p>This component is intended to be installed in a system protected with an appropriate safety relief valve. Failure to do so may result in personal injury or death.</p> <p><small>CCM P/N: PUR00019628</small></p>

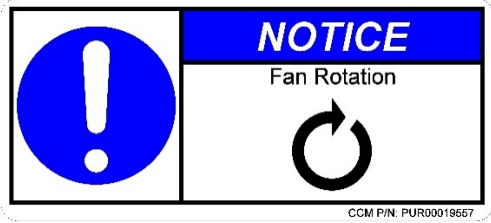
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	! WARNING
	<p>Hot Surfaces</p> <p>Contact may cause burn.</p> <p>Do not touch.</p> <p><small>CCM P/N: PUR00019562</small></p>

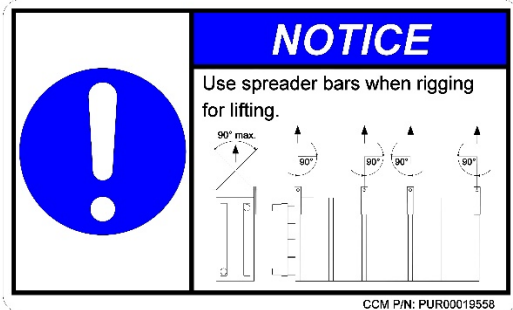
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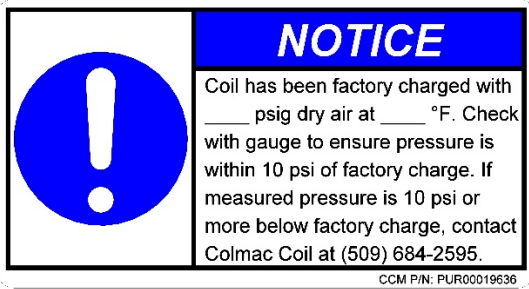
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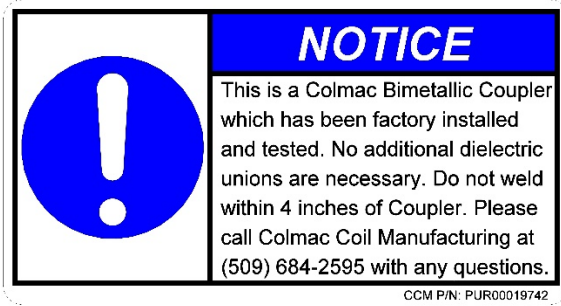
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PUR00019562

1.1. Refrigerant Warning

- 1.1.1. Colmac A+P Insulated Penthouse Evaporators installed in mechanical systems may contain refrigerants such as ammonia, R-22, R-507, etc. For this reason, A+P Evaporators should be installed, operated and serviced by qualified refrigeration technicians only.
- 1.1.2. Improper handling or uncontrolled release of refrigerants could be hazardous to personnel and may result in asphyxiation, frostbite, or burns.
- 1.1.3. Liquid refrigerant that is isolated in a mechanical system without an adequate means of pressure relief can rupture pipes or equipment if it is allowed to warm.
- 1.1.4. Hot refrigerant vapor, when injected into an evaporator containing cold refrigerant, will rapidly condense. This rapid condensation can accelerate liquid slugs to dangerously high energy levels that can rupture pipes, valves and other components.
- 1.1.5. Please refer to various manuals from organizations such as IAR, ASHRAE, and RETA for more information concerning the safe operation of refrigeration equipment.

2. INSTALLATION

2.1. Inspection

- 2.1.1. Damage or Shortage – Upon receipt of equipment, inspect for shortages and damage. Any shortage or damage found during initial inspection should be noted on delivery receipt. This action notifies the carrier that you intend to file a claim. Any damaged equipment is the responsibility of the carrier and should not be returned to Colmac Coil without prior notification. If any shortage or damage is discovered after unpacking the unit, call the deliverer for a concealed damage or shortage inspection. The inspector will need related paperwork, delivery receipt, and any information indicating his liability for the damage. Colmac Coil will gladly assist you in anyway, however, all damage claims must be filed through the transportation company.
- 2.1.2. While Colmac will gladly provide information to assist with the process, the responsibility for filing such a claim is that of the purchaser or the purchaser's consignee.
- 2.1.3. Specified Equipment – Check unit nameplate for:
 - 1) Electrical specifications to ensure compatibility with electrical power supply.
 - 2) Model Nomenclature and other information to match original order.
- 2.1.4. Each Colmac A+P Insulated Penthouse Evaporator coil is shipped with a low-pressure air charge. Evaporator coils are supplied with a pressure gauge indicating the shipping charge pressure. Upon receipt of the coil, compare the gauge pressure to the recorded pressure noted on the accompanying tag. If the gauge pressure is 10psig or more below the factory charge contact Colmac Coil at (509)-684-2595. It is recommended that this charge be maintained until just prior to connecting refrigerant piping to the unit.

2.2. Handling and Storing

- 2.2.1. Safe rigging and handling are the responsibility of the installing contractor.
- 2.2.2. Colmac A+P Insulated Penthouse Evaporators are designed to be lifted only by means of an overhead crane using spreader bars connected to the provided lifting lugs. Use caution when handling to prevent damage to the insulated panels, roofing membrane, and exposed components. The unit should never be pulled or pushed since this could damage the structure and integrity of the unit.
- 2.2.3. Colmac A+P Evaporators utilize bolt-on lifting lugs to facilitate removal of the lifting lugs after the unit has been set into place. After removal, the lifting lugs should be kept and stored to facilitate lifting or relocating the A+P unit in the future.
- 2.2.4. Rigging points for the A+P Insulated Penthouse Evaporators are shown on the rigging diagram included with each submittal. Each unit will be fitted with 4, 6, or 8 lifting lugs depending on the unit dimensions and weight.
- 2.2.5. All provided lifting lugs shall be utilized when lifting the unit from the truck and while flying the unit to the intended installation location.
- 2.2.6. Spreader bars shall be used when rigging the penthouse unit to prevent rigging components from contacting any portion of the penthouse enclosure or externally mounted components. Failure to use spreader bars may result in damage to the penthouse enclosure.
- 2.2.7. When using spreader bars for lifting Colmac A+P Evaporators, ensure that the side lifting angle does not exceed 10 degrees from vertical. See Figure 1. below.

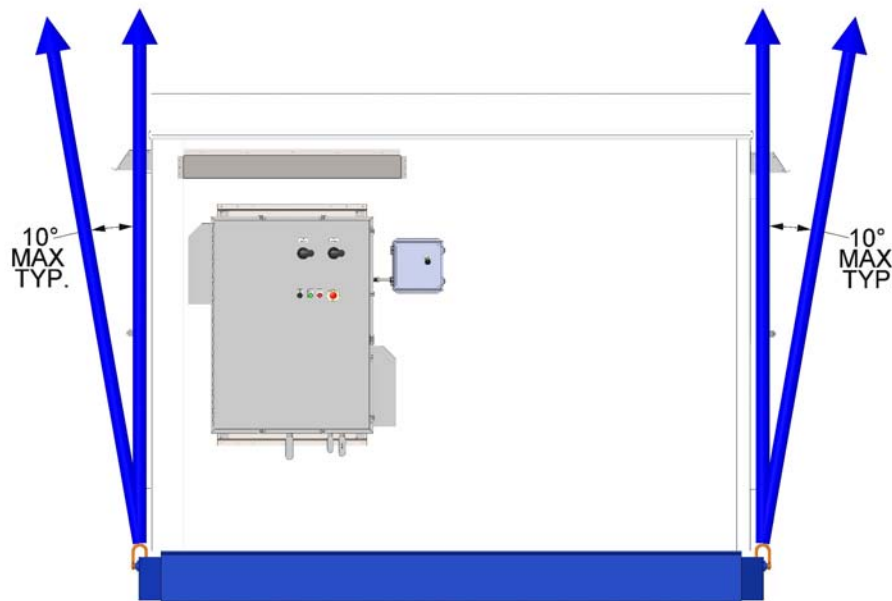


Figure 1.

2.2.8. Triangulated rigging systems can be utilized on pairs of lifting lugs on the same side of the unit but must be limited to a maximum of 30 degrees from vertical. See Figure 2. below.

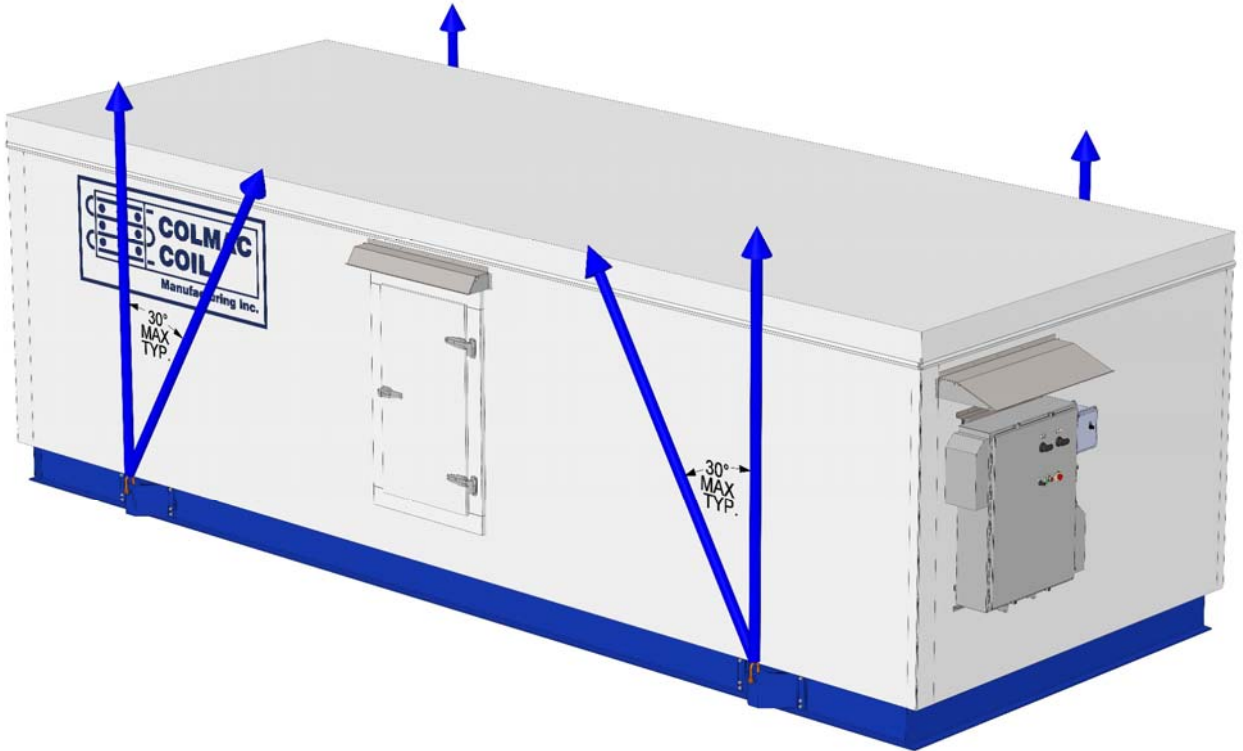


Figure 2.

2.2.9. Colmac A+P Evaporators may utilize mechanical bracing to support the coil refrigerant connections during shipping. The shipping braces can be removed after the unit has been set into place. See Figure 3. below.



Figure 3. Shipping braces removed.

2.2.10. Store unit in a clean, dry area protected from adverse ambient conditions, and away from traffic and congestion that could cause damage.

2.2.11. Units stored for long periods of time should have the fan motor shaft(s) turned several revolutions on a monthly basis to prevent the motor bearings from seizing.

2.3. Location

2.3.1. Defrost condensate drain lines should be pitched away from the drain connections on the unit. Minimize length of drain line runs.

2.3.2. Insulated man-doors are provided on both sides of the unit allowing access to either side of the cooling coil. Accessibility to the doors should be reviewed prior to final installation.

2.3.3. The electrical control panels and pipe connections are located on one end of the penthouse enclosure and will require sufficient clearance for installation and maintenance access.

2.3.4. If the unit is located near the edge of the roof, consult local codes and OSHA requirements, which may dictate railings or other safety devices along the building edge to facilitate safe access to the penthouse.

2.4. Mounting

2.4.1. Penthouse units are designed to be installed on the rooftop of a building and rely on the building structure to support the entire operating weight of the unit(s). Care must be taken to ensure that the building roof structure is adequately strong to support the operating weight of the unit(s).

2.4.2. The unit must be mounted with the cooling coil level to facilitate complete condensate drainage. The unit must be supported around the entire perimeter of the base frame and secured adequately by welding the base frame to the building structure.

2.4.3. **CAUTION:** Use extreme care when welding the base frame to prevent damage to the insulated panel walls. Once welding is complete, clean weld affected areas and repaint to prevent corrosion and deterioration of the base frame.

2.4.4. Cross bracing on the base frame is included to provide additional strength. These braces do not require support or connection to the building structure.

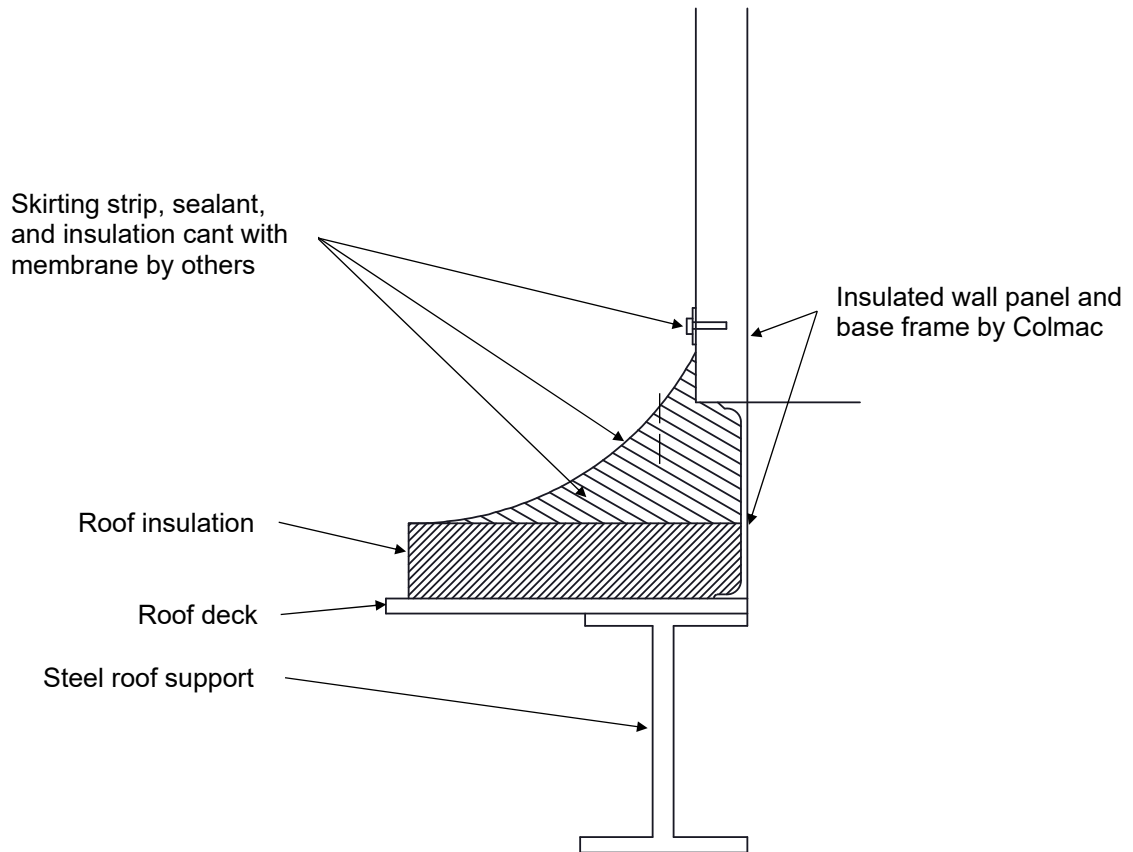


Figure 3

2.4.5. The facility roof insulation system must be installed up to the penthouse unit base frame, around the entire perimeter. An insulation cant must be installed between the facility roof insulation and the insulated wall panels of the penthouse to maintain continuity of the vapor barrier and insulation system.

2.4.6. When specified, optional duct extensions and discharge louver systems shall be independently supported from building steel. The provided fan tube flanges provide a connection location for duct extensions but are not designed to support the weight of the duct extensions.

3. PIPING

3.1. Refrigerant Piping

3.1.1. For ammonia applications, all refrigeration and piping components must be installed by qualified personnel in accordance with the IIAR Ammonia Refrigeration Piping Handbook and other applicable local and national codes. Piping practices for ammonia are also described in the "System Practices for Ammonia Refrigerant" chapter in the ASHRAE Refrigeration Handbook.

3.1.2. For halocarbon applications, all refrigeration and piping components must be installed by qualified personnel in accordance with the "System Practices for Halocarbon Refrigerants" chapter in the ASHRAE Refrigeration Handbook and other applicable local and national codes.

- 3.1.3. Piping is to be designed and supported independent of the evaporator to minimize the transmission of vibration, to permit expansion and contraction, and to impose no load on the evaporator connections.
- 3.1.4. Do not stand on or apply any unnecessary weight to piping.
- 3.1.5. Pipe sizes are to be established according to good engineering design practices, taking into account all applicable facets of the system: the connection size provided by Colmac should not be used to determine the system piping.
- 3.1.6. The air holding charge in the coil should be permitted to remain intact as long as possible. When ready to connect the refrigerant piping, slowly vent the charge to the atmosphere, and then remove the temporary connection caps. Note that these temporary capping provisions are not intended for refrigeration service and must be removed prior to placing the coil in service.
- 3.1.7. Standard coil connections for units having all aluminum coil construction utilize bimetallic couplings with carbon steel stubs which can be welded directly to system piping after removal of the factory welded cap. Remove cap so that at least 4" of the connection stub remains. Do not weld within 4" of the bimetallic coupler.

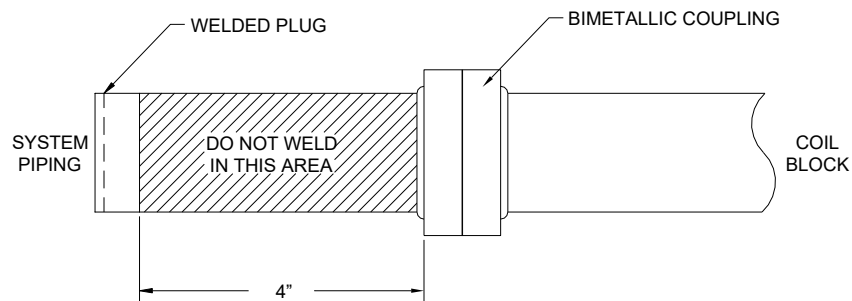


Figure 4: Bimetallic coupler

- 3.1.8. Carbon steel connections will be Schedule 80 pipe for connections less than or equal to 1-1/2" in diameter or Schedule 40 for connections 2" in diameter and greater.
- 3.1.9. Standard coil connections for halocarbon systems are copper "sweat" connections.
- 3.1.10. Prior to charging the system with refrigerant, the entire system must be pressure tested to ensure there are no leaks and then evacuated to remove moisture.
- 3.2. Expansion Valves for Direct Expansion (DX) Evaporators
- 3.2.1. Follow expansion valve manufacturer's instructions carefully when installing expansion valves and associated sensors.
- 3.2.2. **CAUTION:** It is recommended that a suction trap, or suction accumulator, be used on all direct expansion systems for compressor protection.

3.3. Hot Gas Defrost Piping

- 3.3.1. With this method of defrost, some of the hot discharge gas from the compressor is routed into the evaporator instead of the condenser. During hot gas defrost, the coil temperature should be high enough to melt frost and ice on the coil, but low enough so that heat and steam loss to the refrigerated space are minimized.
- 3.3.2. Only 1/3 of the evaporators in a system should be defrosted at one time. Example: if total evaporator capacity is 100 tons (352 kW), then evaporators with no more than 33 tons (116 kW) of capacity should be defrosted at once. Consult factory if your system does not permit this.
- 3.3.3. Suggested methods of piping can be found in Colmac's technical bulletin ENG000019934, as well as at www.colmaccoil.com.
- 3.3.4. For evaporators with cooling capacity 15 tons and greater, a soft start solenoid valve is recommended. Soft Start uses a secondary, smaller solenoid capable of letting a reduced amount of hot gas into the defrost system at the beginning of defrost, while the main hot gas solenoid remains closed. Once the system is up to a pre-designated pressure (~40 psig), the main hot gas solenoid is opened, allowing the system to approach its normal operating pressure. The Soft Start system eases the unit cooler into the defrost cycle, limiting unwanted problems like check valve chatter, pipe movements, and most of all, liquid hammer. This control method is particularly useful on larger systems.
- 3.3.5. All hot gas piping located in cold spaces should be insulated, as well as all hot gas piping located outdoors in cold climates.
- 3.3.6. The amount of hot gas supplied will depend on the inlet pressure of the hot gas, and the capacity of the air unit.
- 3.3.7. Ammonia - Hot gas is typically supplied to evaporators by one of two methods:
- 1) Install a pressure regulator in the compressor room at the hot gas takeoff. Set the regulator to approximately 100 psig (689.5 kPa), then size the piping to achieve 75 to 85 psig (517 to 586 kPa) hot gas pressure at the evaporators, accordingly.
 - 2) In branches leading to each evaporator from the main hot gas line, install a pressure regulator set at approximately 75 to 85 psig (517 to 586 kPa), then size the branches accordingly.
- 3.3.8. Halocarbon – Hot gas piping is typically sized to accommodate twice the normal refrigerant mass flow to the evaporator. Pressure drop is not as critical for the Halocarbon defrost cycle, so refrigerant velocity can be used as the criterion for line size. It is suggested that hot gas lines are sized for the refrigerant velocity between 1000 to 2000 ft/min (5 to 10.2 m/s).

3.4. Defrost Drain Piping

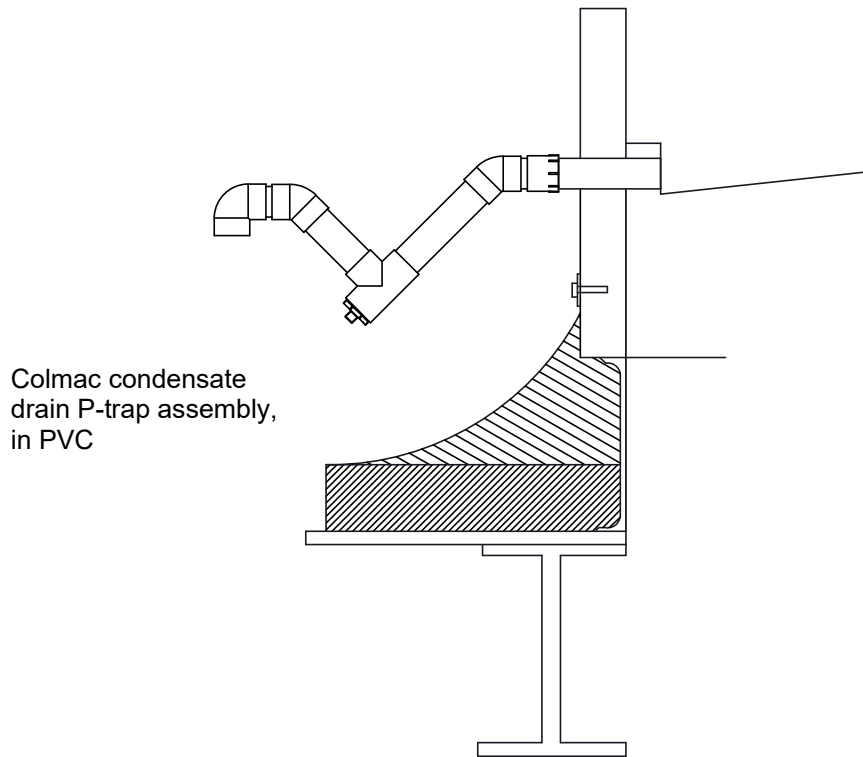


Figure 5

- 3.4.1. Drain connections from the evaporator drain pan should be individually trapped. Individual trapping prevents warm air from being drawn back through the drain piping of non-defrosting units. Drain line size should be at least equivalent to the unit cooler drain connection size.
- 3.4.2. Within the refrigerated space, the drain line should be pitched sharply down, at least 1/2 in/ft (4 cm/m) and be as short as possible. It should also be heat traced and insulated along its entire length. Traps should be located in a warm area outside the refrigerated space. Any traps or extensive lengths of pipe located outdoors must be heated and insulated to prevent freeze up. Any such heater should be connected for continuous operation. Standard industry practice is for 20 Watts / linear foot of pipe @ 0°F (-17.8°C) and 30 Watts / linear foot of pipe @ -20°F (-28.9°C).
- 3.4.3. The trap requires static head to overcome the resistance to flow. For this reason, it should be located at least 4" below the outlet of the drain connection from the enclosure. The trap should not be heated if it is located in a space in which the temperature is continuously above freezing. This avoids the possibility of boiling the trap dry. The piping should include a cross or tee to facilitate cleanout.
- 3.4.4. All piping should be adequately supported independent of the unit so no load is imposed on the pan connection. In some cases, consideration should be given to using a union at/near the pan connection to enable disconnecting the drain line for maintenance.
- 3.4.5. **CAUTION:** Do not apply torque to the drain pan connection; use two wrenches to secure the pipe union.

- 3.4.6. **CAUTION:** Do not reduce the diameter of the drain piping.
- 3.4.7. Drain pan and drain lines should be inspected routinely for evidence of ice buildup. Periodic manual maintenance of icing drain pans and drain lines may be required if less than ideal frosting/defrosting conditions have existed. See the Troubleshooting chart for information regarding the diagnosis of freezing drain pans and drain lines.
- 3.4.8. The coil must be installed in a level position so the drain pan will drain completely.
- 3.4.9. Electrical service for drain trap heat trace, with GFCI protection is included in electrical panel.
- 3.4.10. PVC or galvanized steel condensate drain P-trap assemblies and factory provided drain line heat trace kits are available from CCM. Refer to Colmac engineering document ENG00020489.

3.5. Connection Sizes

- 3.5.1. Refrigerant, defrost supply, and defrost drain connection sizes are pre-determined by the factory and the customer. Connection sizes are automatically selected through the use of our proprietary selection software. More information on connection sizing can be found in the ASHRAE Refrigeration Handbook.

4. ELECTRICAL

4.1. General

- 4.1.1. All wiring must be performed by qualified personnel, in compliance with national and local codes and standards. Ensure that all sources of power have been deenergized and locked out prior to servicing.
- 4.1.2. Complete, factory wired and tested, electrical control panels with a UL 508 Enclosed Industrial Control Panel listing can be provided at the customer's request at the time of the order.
- 4.1.3. In the case of user supplied electrical controls, select feeder circuit protection, branch circuit protection, motor contactors, overload relays, and wire sizes in accordance with applicable local and national codes. Nominal horsepower motors utilized in A+P air coolers do not include thermal overload protection.
- 4.1.4. Refer to the unit nameplate and the project specific wiring diagrams for details on penthouse control wiring and operation.
- 4.1.5. Units equipped with special electrical components will be provided with project specific wiring diagrams and operational instructions.
- 4.1.6. Field wiring connections are made at a common electrical enclosure. The electrical enclosure and internal components may differ depending on unit type and customer specification.
- 4.1.7. In units supplied with Hand-Off-Auto switch, the Hand mode is meant for local operation of the fan motors in the penthouse. The Auto mode allows the facility BMS (Building Management System) to control fan motor operation in the penthouse.
- 4.1.8. Units can be designed with staggered motor starting to reduce the overall starting current, and/or to allow for the operation of a reduced number of fans.

- 4.1.9. When staggered motor starting has been specified, care must be taken to minimize the time delay between the staggered start of fans, so that no reverse rotation occurs in the fans that have a delayed start. This delay is factory programmed for 1-2 seconds for operation in the "Hand" mode. The time delay setting should be confirmed on site by the customer and also duplicated for the staggered start initiated from the BMS. Attempting to start fan motors that are reverse rotating may result in tripping the motor overloads.
- 4.1.10. When operating only a portion of the fan motors in a penthouse unit for air circulation, the operating fan motors must be deenergized and allowed to stop completely prior to restarting all fan motors in the penthouse. Attempting to start fan motors that are reverse rotating may result in tripping the motor overloads.
- 4.1.11. Penthouse units specified with door safety interlocks will initiate a shutdown of the unit fan motors when the man doors are opened during operation. The door interlock utilizes a magnetic switch to provide a run permissive for the fan motor control circuit. The door safety interlock should be tested periodically to ensure proper operation.
- 4.1.12. Penthouse units operating at freezer temperatures will be fitted with man-doors having perimeter heaters to prevent freezing of the door gasket to the metal door frame. Colmac provides a safety GFCI (Ground Fault Circuit Interrupter) device for each door heater. GFCI devices should be checked frequently to ensure that they are in good working order and that they are not tripped, which may result in the door freezing in the closed position.
- 4.1.13. Penthouse units specified with ammonia detection sensors will have the associated wiring terminated in the main control panel. Ammonia detector wiring will need to be incorporated into the facility ammonia detection system. Ammonia sensors shall be calibrated and maintained in accordance with the requirements of standard ANSI/IIAR-2.
- 4.1.14. Penthouse units specified with refrigeration control valves and controllers will be equipped with a stand-alone control panel for the valve controller. The valve controller panel will be limited to voltages that are less than 50 volts to facilitate programming the controller without the need for PPE. Power supplies for the valve and controller will be located in the main control panel.
- 4.1.15. Penthouse units specified with VFDs (Variable Frequency Drives) will be factory wired and tested. Bypass contactors will be supplied as standard in this configuration, to allow for across the line starting of the fan motors in case of VFD failure.
- 4.1.16. Penthouse units specified with the Colmac Demand Defrost sensor should refer to Colmac engineering document ENG00020301 for installation, operation and maintenance instructions.

5. GENERAL OPERATION

- 5.1. Before Startup - Following is a representative checklist of items to be checked prior to startup. It is not, nor is it intended to be, a comprehensive checklist for the many varying types of industrial refrigeration systems. Consult with a qualified system startup expert for assistance.
- 5.1.1. Make sure unit is mounted securely and coil is level.
- 5.1.2. Make sure unit voltage agrees with supply voltage.

- 5.1.3. Make sure system is wired correctly and in accordance with the guidelines laid out in this IOM, as well as local and national standards that may apply.
 - 5.1.4. Check torque on all electrical connections.
 - 5.1.5. Confirm the supply voltage is within 10% of design and the phase-to-phase imbalance is within 2%.
 - 5.1.6. Make sure that all fan set screws are tight.
 - 5.1.7. Check fan direction and amperage.
 - 5.1.8. Make sure all piping is done completely and in accordance with the guidelines laid out in this IOM, as well as in accordance with standard good practice.
 - 5.1.9. Make sure that liquid supply, suction, and hot gas supply (as applicable) service valves are open.
 - 5.1.10. Check drainage of drain pan and drain piping by pouring water into drainpan.
 - 5.1.11. Check water defrost distribution – see “Regulating Water Flow Rate”. (Water Defrost units only)
- 5.2. After Startup
- 5.2.1. Check fan rotation of all fans to make sure rotation is correct.
 - 5.2.2. Confirm the room thermostat and/or control system are functioning properly.
 - 5.2.3. Look and listen for any excessive vibration, severe valve chatter, water hammer, or moving pipes, and correct as necessary.
 - 5.2.4. Heavy moisture loads are usually encountered when starting a system for the first time. This will cause rapid frost buildup on the unit. During the initial pull-down we suggest that the frost buildup be watched, and that the unit be defrosted manually as required.
 - 5.2.5. Evaporators with liquid feed orifices for liquid overfeed must have liquid refrigerant supplied to the coil inlet at a pressure 5 psig (35 kPa) above saturated suction pressure, and at a temperature not exceeding 30°F (16.7°C) above saturated suction temperature. Please consult factory if conditions exceed these recommendations.
- 5.3. Field Adjustments - Perform the following functions when commissioning A+P Penthouse evaporators, based on the refrigerant feed system and defrost technique being employed on the particular unit. These instructions are not, nor are they intended to be, a comprehensive list of tasks required to successfully commission all A+P Penthouse evaporators. Consult with a qualified system startup expert for assistance.
- 5.3.1. Recirculated & Controlled Pressure Receiver Feed:
- 1) Open hand expansion valves (HEVs) slowly and observe frost/condensate formation on all return bends, top and bottom alike.
 - 2) The proper setting may be achieved by observing the frost or condensate on all return bends and opening the HEV until all return bends are evenly wetted or frosted.

- 3) Alternatively, if the defrost relief regulator is connected to the liquid line and is equipped with a gauge, set the HEV to achieve a 5 psi rise in pressure when the liquid solenoid valve is energized.

5.3.2. Flooded Feed:

- 1) Verify that the liquid level is at the design level in the surge drum.
- 2) Open and adjust the liquid feed HEV to allow for the solenoid to be energized approximately 70% of the time at design temperature difference (TD).

5.3.3. Direct Expansion Feed:

- 1) After room temperature has been achieved, check the superheat, and adjust the expansion valve or expansion valve controller.
- 2) If the coil is being starved, resulting in too much superheat at the desired room temperature, reduce the superheat setting of the valve or controller.
- 3) If there is not enough superheat, increase the setting of the valve or controller.
- 4) After waiting approximately 30 minutes, re-check the superheat and re-adjust as necessary.
- 5) Repeat until the unit operation is stable.
- 6) Note that 10°F is the minimum superheat required to fully stroke a typical expansion valve and that 10°F superheat requires an 11 or 12°F split between the room return air temperature and the evaporating temperature.

5.3.4. Manual Hot Gas Defrost:

- 1) Allow the unit to frost, then initiate the defrost cycle.
- 2) Monitor the leaving air temperature. It should show a rise if the pump-out time is sufficient.
- 3) Monitor the condensate flow. It should diminish to a trickle prior to hot gas termination.
- 4) Check the bottom of the coil for residual ice or frost.
- 5) Do not allow long hot gas times that cause coil steaming.
- 6) If more than 15 minutes of hot gas is required, there may be system design problems.
- 7) Monitor the bleed time. The pressure of the coil should be within 25 psig of suction pressure by the end of the bleed cycle.
- 8) Monitor the fan delay. The free water on the coil should be frozen prior to the fans starting.
- 9) Make adjustments to the various function times as necessary

5.3.5. Hot Gas Defrost with Defrost Sensor:

- 1) Set defrost sensor to activate when frost thickness reaches between 1 and 1.5 mm.
- 2) Monitor defrost sensor activity, and watch for red or yellow warning lights, as this is an indication that the defrost sensor is not working properly.
- 3) Check coil and drain pan for proper defrosting until consistent evaporator defrosting operation is achieved.

5.3.6. Electric Defrost:

- 1) Allow the unit to frost, then initiate the defrost cycle.
- 2) Monitor the leaving air temperature. It should show a rise if the pump-out time is sufficient.
- 3) Monitor the condensate flow. It should diminish to a trickle prior to heater termination.
- 4) Check the bottom of the coil for residual ice or frost.
- 5) Do not allow long heater on times that cause coil steaming.
- 6) Verify the operation of the defrost termination thermostat and remove the start-up jumper, if used.
- 7) Verify that all of the heaters are working by checking the amp draw.
- 8) Monitor the fan delay. The free water on the coil should be frozen prior to the fans starting.
- 9) Make adjustments to the various function times as necessary.

5.4. Hot Gas Defrost Operation

5.4.1. Condition of Operation - Hot Gas Defrost can be used for any design criteria, including Low-Temp and Medium-Temp.

5.4.2. Proper hot gas defrost operation is entirely dependent on refrigerant latent condensation during the defrost operation. This requires hot gas to be delivered to the evaporator at a saturation pressure necessary for condensation to occur during defrost. Typical design hot gas saturation temperatures run between 50°F (10°C) to 60°F (15.6°C). Table 1 shows the equivalent saturation pressures, for a variety of refrigerants, required at the evaporator to accommodate this temperature range.

**Table 1
Hot Gas Pressures for Various Refrigerants**

Refrigerant	R22	Ammonia (R717)	R507a	R404a
Hot Gas Pressure @ Evaporator	~85 to 100 psig (~688 to 791 kPa)	~75 to 90 psig (~619 to 722 kPa)	~105 to 125 psig (~826 to 964 kPa)	~105 to 125 psig (~826 to 964 kPa)

5.4.3. Hot Gas Supply line pressure should be maintained at less than the system condensing pressure. This serves two purposes; the first being decreased energy losses due to excessive heat gain, and the second being that condensing pressure has a tendency to fluctuate with ambient conditions and with the load. Maintaining the Hot Gas Supply pressure at less than the system condensing pressure helps ensure a constant Hot Gas pressure at the evaporator.

5.4.4. Sequence of Manual Hot Gas Defrost Operation

1) Recirculated Bottom Feed Evaporators

- a) Close Liquid Solenoid and continue operating fan motors.
- b) Pump down liquid refrigerant from coil for a period of approximately 15 minutes (or as long as required). Any cold liquid refrigerant remaining in the coil at the beginning of defrost will greatly reduce the effectiveness of the hot gas defrost operation and can extend the time required for defrost. Evidence of residual liquid refrigerant can be seen in the form of uneven melting or the absence of melting on the lower tubes of the evaporator coil.
- c) Stop fan motors.
- d) Open Hot Gas Pilot Solenoid to close Gas-Powered Suction Stop Valve.
- e) On Coils of 15 tons cooling capacity and larger, open Soft Start Hot Gas Solenoid to gradually bring coil up to near defrost pressure.
- f) Open Hot Gas Solenoid to start defrost. Duration of defrost should be long enough to clear coil and pan. Extending the defrost period longer than this is not necessarily better.
- g) Close Hot Gas Solenoid (and Soft Start Hot Gas Solenoid if applicable) to end defrost.
- h) Open Equalizing Bleed Valve to gradually bring evaporator back down to suction pressure.
- i) Close Hot Gas Pilot Solenoid to open the Gas-Powered Suction Stop Valve. At the same time, open the Liquid Solenoid to start cooling the coil.
- j) After a delay to refreeze remaining water droplets on the coil, restart the fans.

2) Recirculated Top Feed and Direct Expansion Evaporators

- a) Close Liquid Solenoid and continue operating fan motors.
- b) Pump down liquid refrigerant from coil for a period of approximately 15 minutes (or as long as required). Any cold liquid refrigerant remaining in the coil at the beginning of defrost will greatly reduce the effectiveness of the hot gas defrost operation. Evidence of residual liquid refrigerant can be seen in the form of uneven melting or the absence of melting on the lower tubes of the evaporator coil.
- c) Stop fan motors.
- d) Open Hot Gas Pilot Solenoid to close Gas-Powered Suction Stop Valve.

- e) On Coils of 15 tons cooling capacity and larger, open Soft Start Hot Gas Solenoid to gradually bring coil up to near defrost pressure.
 - f) Open Hot Gas Solenoid to start defrost. Duration of defrost should be long enough to clear coil and pan. Extending the defrost period longer than this is not necessarily better.
 - g) Close Hot Gas Solenoid (and Soft Start Hot Gas Solenoid if applicable) to end defrost.
 - h) Energize the Defrost Relief Regulator to the wide open position to gradually bring the evaporator back down to suction pressure (equalize).
 - i) Close Hot Gas Pilot Solenoid to open the Gas-Powered Suction Stop Valve. At the same time, de-energize the Defrost Regulator Valve.
 - j) Open the Liquid Solenoid to start cooling the coil.
 - k) After a delay to refreeze remaining water droplets on the coil, restart the fans.
- 3) Gravity Flooded Evaporators
- a) Close Liquid Solenoid and stop fan motors.
 - b) Open Hot Gas Pilot Solenoid to close the two Gas-Powered Stop Valves in the coil liquid and suction lines.
 - c) On Coils of 15 tons cooling capacity and larger, open Soft Start Hot Gas Solenoid to gradually bring coil up to near defrost pressure.
 - d) Open Hot Gas Solenoid to start defrost. Duration of defrost should be long enough to clear coil and pan. Extending the defrost period longer than this is not necessarily better.
 - e) Close Hot Gas Solenoid (and Soft Start Hot Gas Solenoid if applicable) to end defrost.
 - f) Energize the Defrost Relief Regulator to the wide open position to gradually bring the evaporator back down to suction pressure (equalize).
 - g) Close Hot Gas Pilot Solenoid to open the Gas-Powered Suction Stop Valves. At the same time, de-energize the Defrost Regulator Valve.
 - h) Open the Liquid Solenoid.
 - i) After a delay to refreeze remaining water droplets on the coil, restart the fans.
- 4) Setting Hot Gas Defrost Timer. Time periods should be set as follows:
- a) Length of defrost should be set to the minimum time necessary to melt all frost. Defrost operation beyond this point will convert liquid water to steam, leading to secondary condensation and freezing on non-heated areas of the unit cooler and introduced unwanted heat gain into the controlled space.

- b) Depending on frost loading conditions, defrost duration can typically last anywhere from 12 to 20 minutes, and in most cases, should never exceed 30 minutes.
- c) Actual defrost times must be determined from careful observation of defrost operation and adherence to the previously mentioned guidelines. Frost is usually heaviest on the air-entering side of the coil, and inspection of fins on this side can usually be used to determine if complete defrost has occurred. Periodic observation of the defrost cycle throughout the year is necessary to maintain a properly operating defrost system.

NOTICE: Once frost turns to ice, the amount of time required to melt increases. Incomplete defrosting may allow excessive ice to build up which could damage the machinery. Allowing ice to build up on the fan blades will result in excessive vibration which could lead to catastrophic failure. It is imperative that the end user inspect the unit coolers regularly for proper defrosting. Manual defrosting may be required to remove ice buildup.

5.5. Electric Defrost Operation

5.5.1. Condition of Operation - Electric Defrost can be used for any design criteria, including Low-Temp, Medium-Temp, and High-Temp Applications.

5.5.2. Sequence of Electric Defrost Operation

- 1) Stop refrigeration by closing liquid solenoid.
- 2) Pump down liquid refrigerant from coil for a period at least equal to 15 minutes. Any liquid refrigerant that may remain in the coil during defrost will greatly reduce the effectiveness of the electric defrost operation. Evidence of residual liquid refrigerant during defrost can be seen in the form of uneven melting or the absence of melting on the lower tubes of the evaporator coil.
- 3) Stop fan motors.
- 4) Energize power to electric defrost heating elements for the necessary time of defrost.
- 5) De-energize power to heating elements when defrost is complete.
- 6) Start refrigeration to cool the evaporator.
- 7) Restart fan motors.

5.5.3. Setting Electric Defrost Timer - Time periods should be set as follows:

- 1) Length of defrost should be set to the minimum time necessary to melt all frost. Defrost operation beyond this point will convert liquid water to steam, leading to secondary condensation and freezing on non-heated areas of the unit cooler and introduced unwanted heat gain into the controlled space.
- 2) Average defrost times can vary anywhere from fifteen to twenty minutes, and in most cases, should never exceed thirty minutes.
- 3) Actual defrost times must be determined from careful observation of defrost operation and adherence to the previously mentioned guidelines. Frost is usually

heaviest on the air-entering side of the coil, and inspection of fins on this side can usually be used to determine if complete defrost has occurred. Periodic observation of the defrost cycle throughout the year is necessary to maintain a properly operating defrost system.

NOTICE: Once frost turns to ice, the amount of time required to melt increases. Incomplete defrosting may allow excessive ice to build up which could damage the machinery. Allowing ice to build up on the fan blades will result in excessive vibration which could lead to catastrophic failure. It is imperative that the end user inspect the unit coolers regularly for proper defrosting. Manual defrosting may be required to remove ice buildup.

5.6. Air Defrost Operation

5.6.1. Condition of Operation - Air Defrost can be used for High-Temp installations only.

5.6.2. Sequence of Air Defrost Operation

- 1) Pump down liquid refrigerant from coil for a period at least equal to 15 minutes. Any liquid refrigerant that may remain in the coil during defrost will greatly reduce the effectiveness of the air defrost operation. Evidence of residual liquid refrigerant during defrost can be seen in the form of uneven melting or the absence of melting on the lower tubes of the evaporator coil.
- 2) Allow fans to continue operating for the necessary time of defrost.
- 3) Re-introduce refrigerant into evaporator and re-start refrigeration to cool the evaporator.

5.6.3. Setting Air Defrost Timer

- 1) Time periods should be set as follows:
 - a) Time to defrost should be just long enough to melt all frost.

6. EMERGENCY SITUATIONS

6.1. During normal operation, the units described in this IOM contain either ammonia, CO₂, or one of several possible halocarbon refrigerants. There are hazards and risks associated with all refrigerants. Refrigerant leaks can cause an emergency situation. Refer to the facility "Emergency Planning Policy" and "Hazardous Chemical Communication Policy" for the proper methods of dealing with any potential emergency situation resulting from a refrigerant leak.

7. MAINTENANCE

- 7.1. **WARNING:** Prior to any maintenance being performed, unit must be locked out and tagged out per the Lockout/Tag Out policy of the facility where installed.
- 7.2. Note that equipment may be damaged by incompatible cleaning agents or water condensate from defrost that is contaminated by airborne impurities. It is the responsibility of the owner/operator to be familiar with these chemicals and the room environment and to select compatible agents and materials of construction.
- 7.3. Refer to the certified submittals for a listing of the materials used in the specific evaporator in question.

7.4. Consult with a qualified chemical/corrosion expert to ensure compatibility and to develop a plan to address any special circumstances, such as airborne impurities.

7.5. System Maintenance Schedule (recommended maximum time periods)

7.5.1. Every month

- 1) The system should be periodically checked for proper defrosting and defrost timing due to variations in the quantity and pattern of frost.
- 2) Frost accumulation is dependent on the following: temperature of the space, type of product stored, product loading rate, traffic, moisture content of air entering conditioned space, etc.
- 3) It may be necessary to periodically adjust number of defrost cycles or duration of each defrost cycle to accommodate these varying conditions.
- 4) Check that all sensors are properly operating.

7.5.2. Every 6 months

- 1) Check refrigeration system for charge level, oil level, and any evidence of leaks.
- 2) Tighten all electrical connections.
- 3) Check operation of control system and proper functioning of defrost solenoids, drain line heaters, thermostats, etc.
- 4) Check that all safety controls are operating appropriately.

7.6. Evaporator Maintenance Schedule (recommended maximum time periods)

7.6.1. Every 6 months

- 1) Clean the coil surface.
- 2) Inspect defrost drain pan. Clean if necessary. Check for proper drainage.
- 3) Inspect all insulated supply and drain lines.
- 4) Check all wiring.
- 5) Check all motors and fans, tightening when necessary all motor mounting bolts and fan set screws.

NOTICE: Do not use alkaline detergents on Aluminum coil surfaces, as corrosion may result and cause refrigerant containment failure.

7.7. Man-Door Maintenance Schedule

7.7.1. Every week

- 1) Check for smooth operation of the door.
- 2) Inspect the door for loose, damaged, or missing parts.

- 3) Ensure that the gasket system is not damaged or worn and that it provides positive sealing to maintain a good vapor barrier.

7.7.2. Every month

- 1) Check all door fasteners, tighten as needed.

7.7.3. Every 3 months

- 1) Clean gaskets with soap and water to allow for smooth contact between the door and gaskets.
- 2) Inspect the factory door seams for loose or missing sealants. Reapply as necessary to maintain a tight vapor barrier.

7.7.4. Every 6 months

- 1) It is recommended that a few drops of light oil be used on all moving parts.

7.8. Roofing Membrane Maintenance Schedule

7.8.1. The 50 mil PVC roofing membrane used on Colmac A+P Insulated Penthouses should exhibit superior performance for a minimum of 15 years if properly maintained.

7.8.2. Keep roof clean and free of debris that could puncture or damage the roofing membrane.

7.8.3. Every 6 months and after experiencing severe weather.

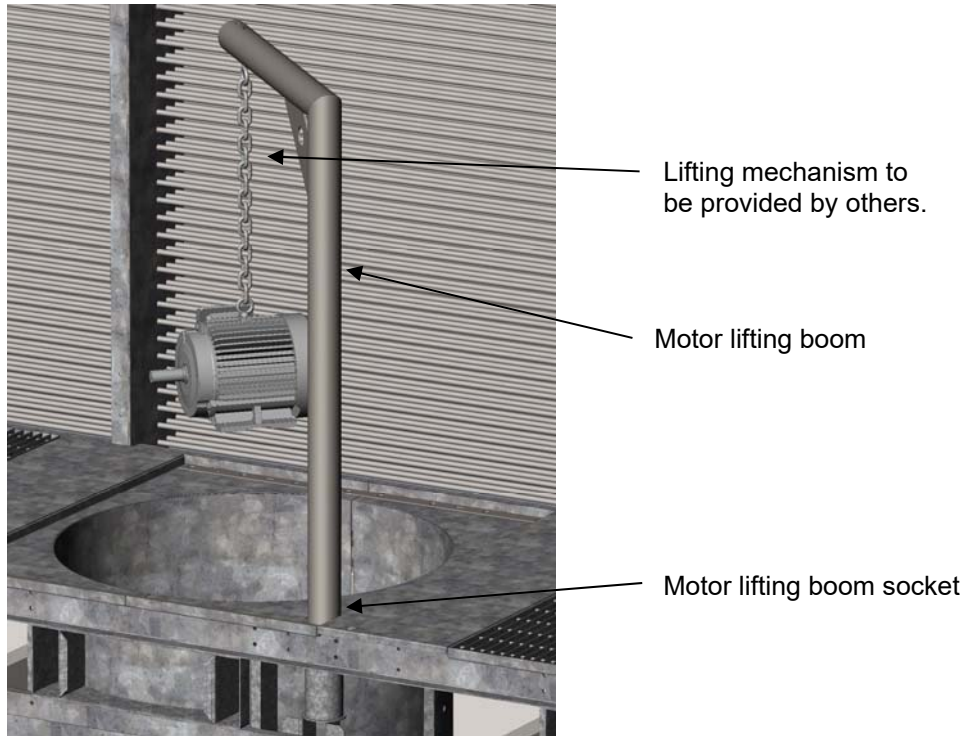
- 1) Inspect the roofing membrane system in the spring and fall for evidence of damage or deterioration. Any defects should be noted and repaired as soon as possible to maintain the integrity of the vapor barrier.
- 2) Contact Colmac Coil for details on repairing damaged roofing membrane.

7.9. Motor/Fan Replacement

7.9.1. Prior to servicing A+P penthouse motors and fans, ensure that all sources of power have been deenergized and locked out.

7.9.2. A lifting boom is provided in each Colmac A+P penthouse to facilitate rigging during replacement of motors and fans. Motor boom sockets and removable floor gratings are provided for each fan bay.

7.9.3. Ensure that the motor boom is fully inserted into the motor boom socket prior to attempting to lift the motor.



7.9.4. During motor and fan replacement, ensure that the coil fins and tubes are not damaged. Use of plywood barriers to protect the coil face is recommended.

7.9.5. Ensure that steps are taken to mitigate the possibility of personnel being injured from falling tools or equipment into the space below.

7.9.6. Ensure that the motor rotation direction is correct prior to returning the unit back into service.

7.10. Replacement Parts

7.10.1. Replacement parts which are covered under the conditions of Colmac Coil's warranty (see Limited Warranty) will be reimbursed at the part cost only. For replacement parts, warranted or otherwise, contact Colmac Coil directly. When contacting Colmac Coil with the explanation of failure, have the complete model number, serial number, date of installation, and date of failure at hand.

8. COIL CLEANING

8.1. Many cleaning products found in a typical food preparation and packing environment are safe to use on A+P coils, depending on coil materials.

8.2. Coils should be cleaned in the same manner as any other piece of equipment in a food safe environment.

8.3. Cleaning Solutions

8.3.1. Cleaning solutions suitable for stainless steel tube/stainless steel fin coils, stainless steel tube/aluminum fin coils, aluminum tube/aluminum fin coils, and copper tube/aluminum fin coils.

Name	Manufacturer
CL-122	NALCO
CL-127	NALCO
LMC-44	LW Chemical
SoilSolv	DuChem
FS Process Cleaner	Zep
Formula 940	Zep

8.3.2. Cleaning solutions suitable for hot dipped galvanized coils

Name	Manufacturer
CL-127	NALCO
E+	Refrigeration Technologies
FS Process Cleaner	Zep
Formula 940	Zep

8.4. Sanitizers

8.4.1. Sanitizers suitable for stainless steel tube/stainless steel fin coils, stainless steel tube/aluminum fin coils, aluminum tube/aluminum fin coils, and copper tube/aluminum fin coils.

Name	Manufacturer
CoilClear	NALCO
DQS	DuChem
Amine A	Zep
Amine Z	Zep

8.4.2. Sanitizers suitable for hot dipped galvanized coils

Name	Manufacturer
DQS	DuChem
Amine A	Zep
Amine Z	Zep

8.5. To minimize corrosion, chemical exposure should be less than 30 minutes and temperatures should not exceed 70° F.

9. TROUBLESHOOTING

SYMPTOM	POSSIBLE CAUSE	POSSIBLE SOLUTION
1. Coil not clearing of frost during defrost cycle.	Insufficient number of defrost cycles.	Adjust timer for more defrost cycles.
	Insufficient time for each defrost cycle.	Adjust for increased defrost duration.
	Hot Gas refrigerant pressure too low.	Adjust pressure regulator/back pressure regulator for increased pressure. Check condenser fans/pumps for proper operation.
	Defective timer or pressure regulator.	Replace timer/regulator.
	Excessive air/moisture infiltration resulting in unreasonably high frost load.	Consider some form of air/moisture infiltration mitigation, i.e. dock conditioning, air curtains, improved doors.
	Fan still operating during defrost.	Cycle fans off during defrost. Check defrost timer or other fan control device for proper operation.
2. Ice building in drainpan.	Drain line plugged.	Clean drain line.
	Drain line not sloped as required.	Adjust as necessary.
	Unit Cooler not level.	Adjust as necessary.
	Drain line heater not operating adequately.	Repair or replace as necessary.
	Defective defrosting timer/thermostat/pressure regulator.	Repair or replace as necessary.
	Hot Gas Piping not adequately supported, forcing hot gas loop away from drainpan.	Add additional hot gas piping support.
	Improper piping and/or inadequate flow of hot gas to pan.	Increase hot gas flow to drain pan.
	Steam created during defrost is condensing above unit and dripping/freezing onto unheated areas of evaporator.	See Symptom #4 below.
3. Uneven coil frosting.	Unit Cooler located too close to door or other room opening.	Relocate as necessary.

	Unit Cooler not level, causing uneven loading.	Adjust as necessary.
	Defrost cycle time too short.	Increase duration of each defrost cycle.
	Fans not operating correctly.	Check fans and fan motors for proper operation. Replace or repair as needed.
	Liquid supply not sufficient to properly feed unit.	Increase refrigerant supply to unit cooler. Check strainers, expansion valves, etc.
	Liquid control device not open or large enough.	Correct or replace as necessary.
4. Ice accumulating on ceiling above evaporator or in air section or around motors, fans, and fan venturis.	Defrost cycle time too long, "overcooking" the unit.	Decrease duration of each defrost cycle.
	Too many defrosts cycles during a 24-hour period.	Decrease number of defrost cycles.
	Defective defrosting timer/thermostat/pressure regulator.	Repair or replace as necessary.
5. Elevated Room Temperature	Room thermostat set incorrectly.	Check thermostat and adjust appropriately.
	Low refrigerant charge.	Add refrigerant.
	Airflow restricted to evaporator.	Check evaporator for airflow blockage, including ice buildup, foreign matter, etc. Clean as necessary.
	Undersized evaporators for required heat load.	If heat load exceeds design conditions, evaporator operating conditions may have to be changed, or evaporators will need to be added to the conditioned space.
	Fan motors not operating.	Check fans and fan motors for proper operation. Replace or repair as needed.
	Insufficient refrigerant flow.	Check strainers, hand expansion valves, etc.
6. Frequent Fan and/or Motor Failure	Unit cycling too frequently, causing excessive fatigue related wear and tear.	Limit number of cycles, whether it is for capacity control or defrost operation.
	Check quality of power supply.	Install power conditioning equipment, phase failure relays, etc.

7. Insufficient Airflow	Unit too close to wall, product, etc. for proper return air supply to fan.	Relocate unit to allow for unobstructed airflow.
	Unit obstructed with ice blockage.	See Symptoms 1-4 above.
	No air throw straightener specified with unit purchase.	Purchase optional airflow straighteners from evaporator manufacturer.
	Fan and/or fan motors not operating correctly.	Check fans and fan motors for proper operation. Replace or repair as needed.
	VFD fan speed too low.	Increase fan speed.



Colmac reserves the right to change product design and specifications without notice.

For more information on Colmac products call us at 1-800-845-6778 or visit us online at:

WWW.COLMACCOIL.COM