When you want Quality, specify COLMAC!

Installation, Operation, Maintenance, and Design Guide

ENG00018627 Rev B

Heat Pipe Coils

Contents

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

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

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

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

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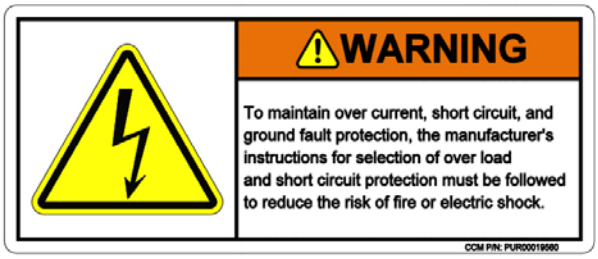

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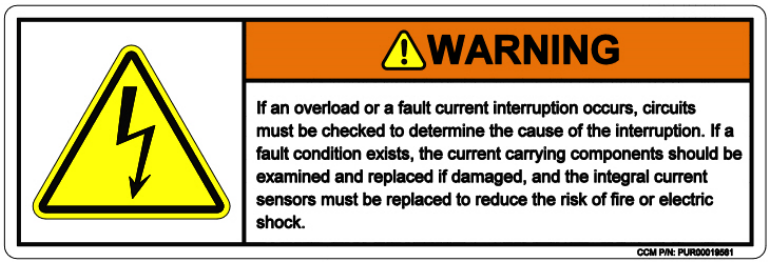

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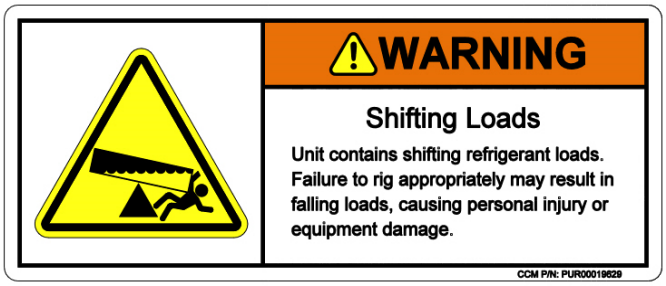

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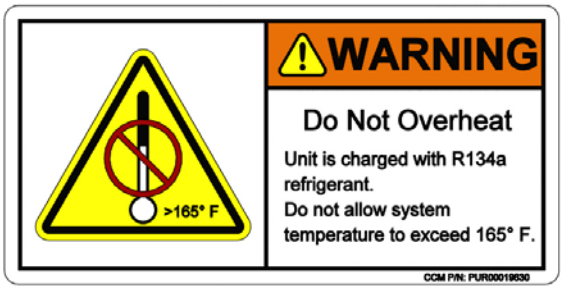

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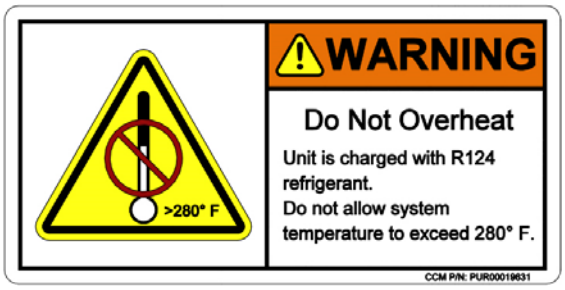

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Notice - Do not operate exhaust air flow over the heat pipe coil without the supply air flow on, unless specifically approved in writing by Colmac. This is referred to as a soak condition.

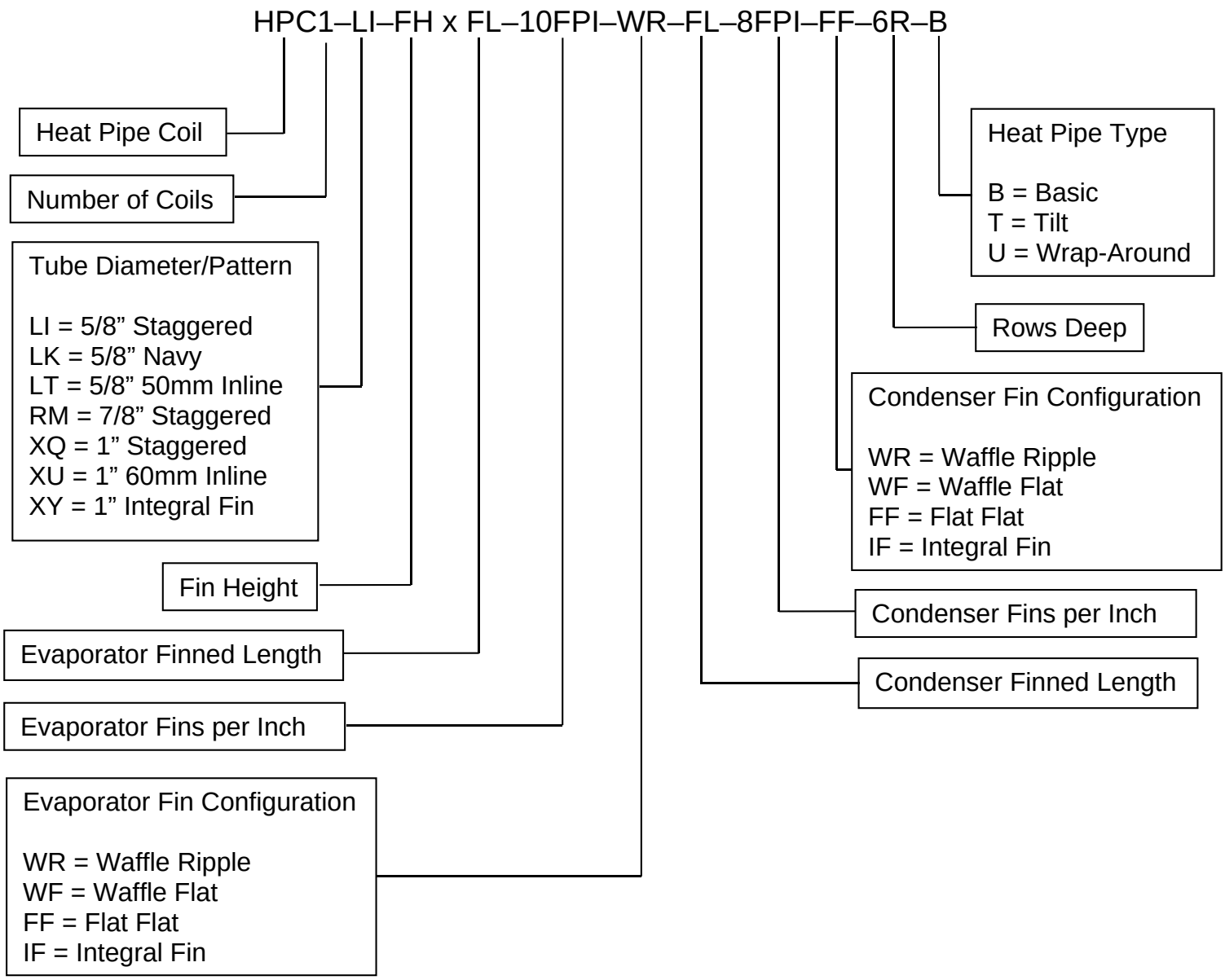
Notice - Do not exceed the maximum soak temperature as indicated on the nameplate.

Notice - Do not operate this heat pipe coil at conditions other than the design criterion for this heat pipe coil. This applies to air flow volume as well as temperature.

Caution - Heat pipes should be lifted with the tubes level.

Caution - The heat pipe tubes have a liquid charge hermetically sealed inside each tube. The center of gravity of the heat pipe will shift appreciably during hoisting.

2. **MODEL NOMECLATURE**



3. GENERAL DESCRIPTION

3.1. Introduction

3.1.1. The Colmac heat pipe coil is on the leading edge of air-to-air heat transfer technology. Colmac heat pipe coils (heat exchangers) are designed to efficiently transfer heat from a warm air stream to a colder one. Heat pipe coils are simple passive devices, with no moving parts, pumps, or external piping.

3.1.2. Colmac manufactures three distinct types of heat pipe coil units: heat recovery, tilt, and wrap around. The individual heat pipes have two types of construction:

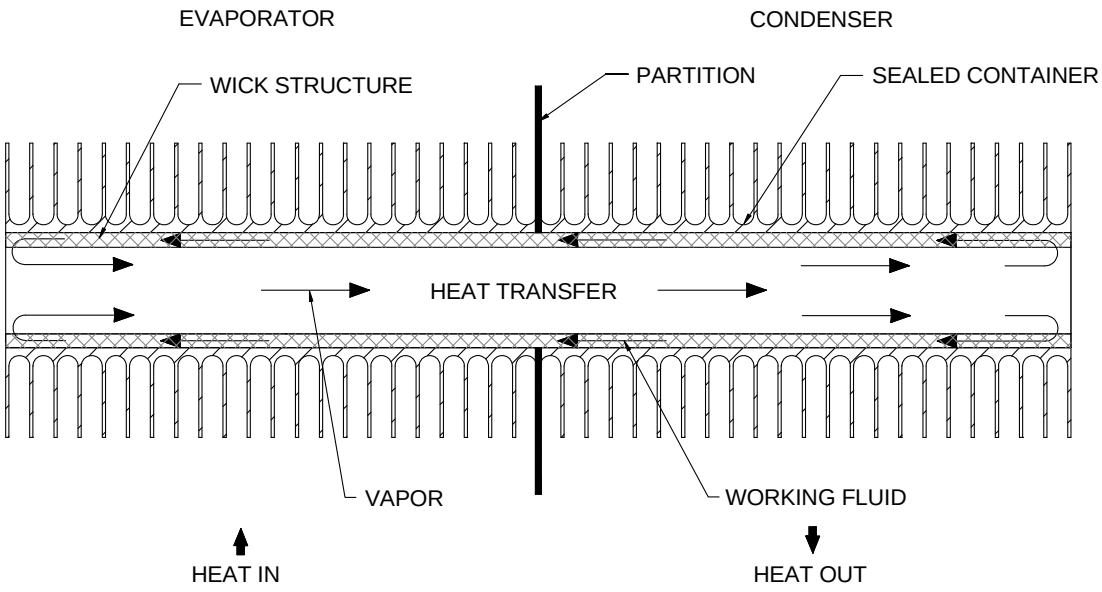
- **Plate Fin Design –** These heat pipes are an assembly of tubes and fins. The fins are tightly fitted to the tubes in order to maximize contact and heat transfer. Plate fins allow variable materials for tube and fin and variable tubing sizes rather than being limited to a 1" internal diameter integral fin design.

- **Integral Fin Design** – Each heat pipe is made from one piece of material, with no discontinuities between fin and tube. This yields the maximum heat transfer possible with minimum pressure drop. It also eliminates the possibility of corrosion at the tube and fin interface.

3.2. How It Works

3.2.1. The individual heat pipes that make up a Colmac heat pipe coil consist of three elements: a sealed pipe, a capillary wick structure, and a refrigerant fluid. Because the pipe is sealed under a vacuum, the working fluid is in equilibrium with its own vapor. The capillary wick distributes the working fluid over the inside of the pipe. Hot air flowing over one end of the pipe evaporates the working fluid. The vapor is then condensed at the cooler end, giving up its heat to the second air stream. The vapor flows back to the evaporator, completing the cycle.

Figure 1
Heat Pipe Section View



3.2.2. The Colmac heat pipe coil is made up of rows of individually finned heat pipes which extend horizontally across the total width of the heat pipe and pass through a sealed center partition. The sealed partition separates the coil into two sections.

3.2.3. The heat pipe coil is typically installed across two side-by-side air ducts containing separate counter-flow airstreams. In operation, exhaust air is discharged across one section of the coil, and supply air is ducted in a counter-flow direction across the other section. Heat is transferred from the hot airstream to the cold airstream by the heat pipes. While Colmac heat pipe coils can recover up to 90% of exhaust energy under ideal conditions, the typical heat recovery performance of installed units is closer to 60% to 70%. This represents tremendous savings of energy while yielding immediate and future dollar savings.

3.3. **Features**

3.3.1. **Individual Heat Pipe** – Each individual heat pipe is independent, ensuring the utmost in reliability and performance. Quality control includes individual testing and assembly of each heat pipe.

3.3.2. **Complete Load Capability** – Colmac heat pipe coils are designed to handle virtually any heating/cooling load without the need for gravity assist. The Colmac heat pipe coil can be installed level for both summer and winter operation. No seasonal change-over is required.

3.3.3. **Integral Capillary Wick** – Colmac heat pipe coils have a capillary wick formed into their inside wall. The integral wick keeps the heat pipe performing under all load conditions, with no dry-out of the evaporator.

3.3.4. **Extended Life** – Each Colmac heat pipe coil is permanently sealed to provide operation indefinitely within the prescribed temperature range.

3.3.5. **No Cross-Contamination** – A sealed partition separates the supply from the exhaust airstreams preventing contamination of one airstream by the other.

3.3.6. **Passive Energy Recovery** – Colmac heat pipe coils require no external power of operation.

3.3.7. **Minimum Maintenance** – Since there are no moving parts in Heat recovery and Wrap-Around Heat Pipes, repairs are not needed. External cleaning only may be required, and with most systems cleaning is infrequent.

3.3.8. **System Size Flexibility** – Many sizes are available to accommodate the capacity of most any system.

3.3.9. **System Performance Flexibility** – A large selection of row depth, face areas and fin densities are available to meet the required energy recovery performance.

3.3.10. **Bidirectional Heat Transfer** – Colmac heat pipe coils can be used for both heating and cooling.

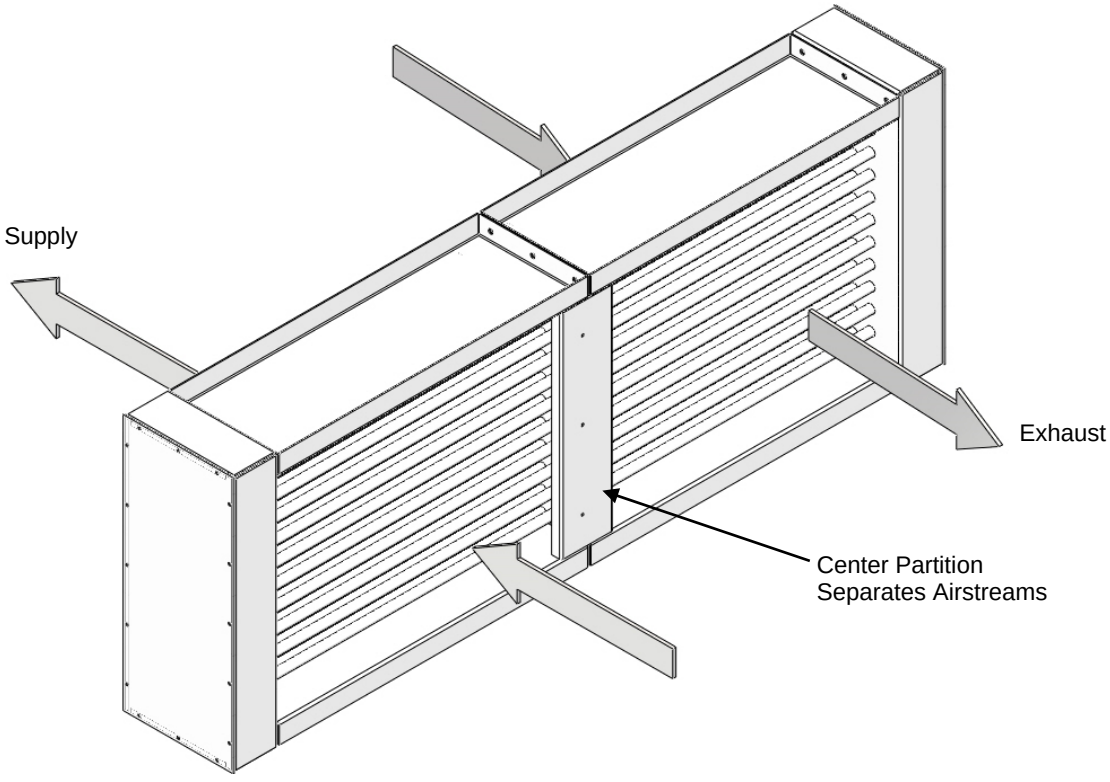
4. **HEAT PIPE TYPES**

4.1. **Heat Recovery Heat Pipe**

4.1.1. The heat recovery heat pipe coil is Colmac's most basic heat transfer unit. Heat recovery heat pipes consist of tubes, fins, and sheet metal. The heat pipe coils are simple passive devices, with no moving parts, pumps, or external piping, which means there is nothing to maintain or replace. The media (refrigerant) never "wears out" or becomes fouled, requiring replacement.

4.1.2. Warm and cold airstreams never mix (become "cross contaminated"). Any building or industrial process that exhausts air must bring in an equal amount of replacement ambient air. Heat pipes offer building and process designers a passive technology which effectively recovers a significant amount (typically 60 to 70%) of the heat energy in the exhaust air stream. Heat pipe coils can be designed to pre-cool supply air in summer months and equally as effectively pre-heat supply air in winter months in a single unit. Heat pipe coils can be effectively applied to recover heat from laboratory building exhaust where cross contamination to the supply air is unacceptable.

Figure 2
Heat Recovery Heat Pipe



4.2. **Tilt Heat Pipe (Frost and Temperature Control)**

4.2.1. It is sometimes desirable to control the performance of a heat pipe coil in order to prevent frost build-up on the exhaust side of the heat pipe in the winter, or to prevent inadvertent heating of the supply air when cool make-up air is desired in the spring or fall. Colmac heat pipe coils have a very effective method of temperature control:

4.2.2. Because Colmac heat pipe coils depend on an internal evaporation/condensate cycle, their performance can be altered by using gravity to limit the effectiveness of the cycle. If the heat pipe is tilted such that the cool air is lowered below the warm air end, the effectiveness of the heat pipe is diminished. The tilt can be adjusted to accomplish just the right amount of temperature control. The heat pipe coil is mounted on a central pivot; its tilt from level is controlled by a mechanical actuator responding to the input from two proportional temperature controllers. The heat pipe coil is connected to ducts by short flexible duct connectors.

4.2.3. There is a common misconception that tilting a heat pipe coil increases its efficiency. It does not. Gravity can assist a small diameter heat pipe that “chokes” due to insufficient flow area; but because of their larger internal diameter, Colmac heat pipe coils have no such problem, and can handle any thermal load, summer or winter, without resorting to tilt. For temperature and frost control, tilt is actually used to de-rate the performance of the heat pipe coil to achieve its desired effect.

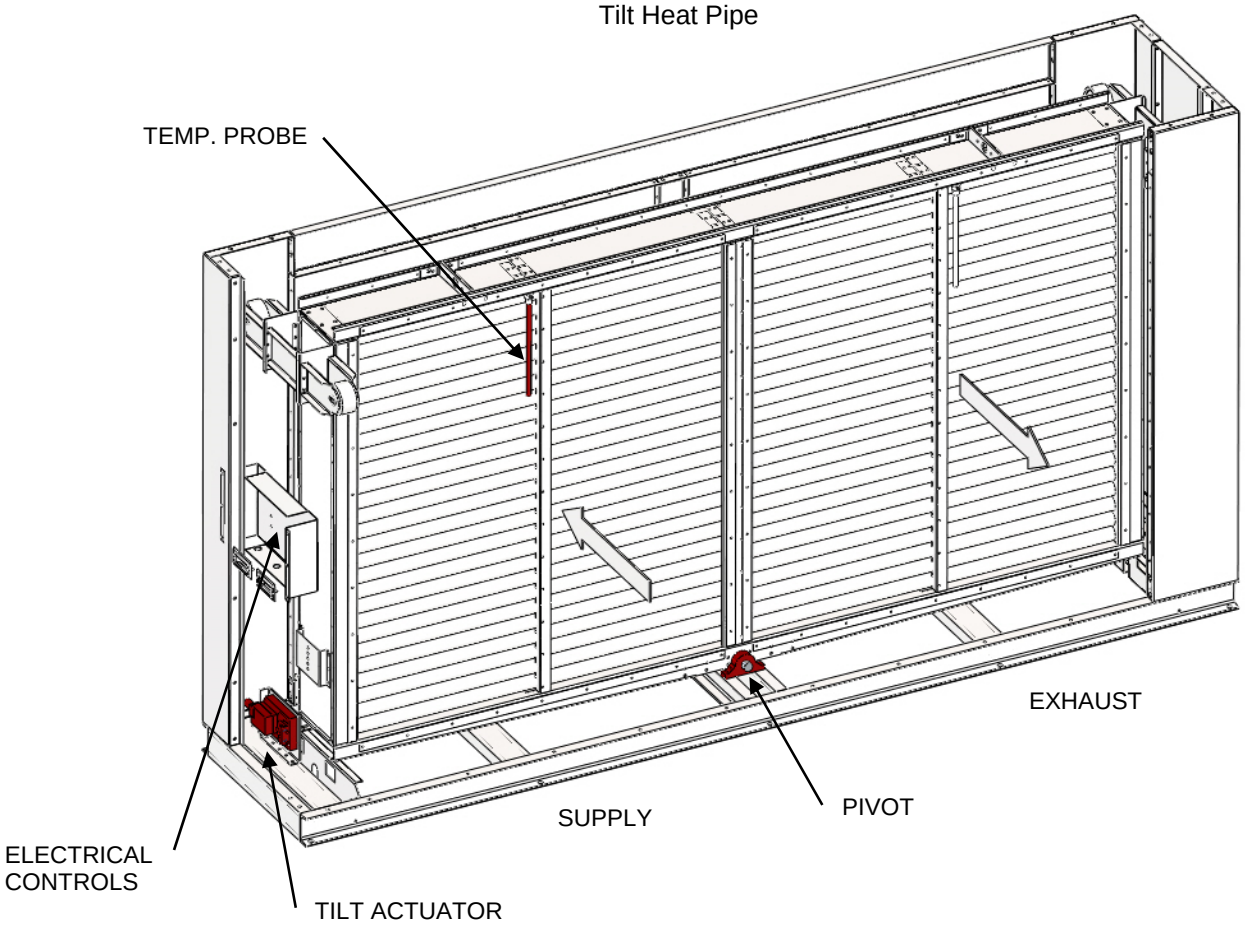
4.2.4. **Sequence of Operation**

- **Heat Recovery Mode:** When supply side air temperature is less than the inside air temperature, the supply side acts as a condenser and the exhaust side acts as an evaporator. As long as the exhaust air temperature is greater than the exhaust setpoint, the heat pipe will operate in a level condition allowing incoming air to be preheated. If the incoming supply air temperature decreases to the point where exhaust air approaches the exhaust side setpoint, then the heat pipe will begin to tilt. This will reduce the effectiveness of the heat pipe, which will increase the exhaust temperature, stopping the frosting condition.

- **Economizer Mode:** When the supply side air temperature is greater than the supply setpoint and less than the inside air temperature, the heat pipe will be fully tilted with the supply side down. In this position the heat pipe is effectively “Off” and so no heat transfer takes places. This allows the cool outside air to assist with the building air conditioning load.

- **Cooling Mode:** When supply side air temperature is greater than the supply setpoint and greater than the inside air temperature, the heat pipe will be fully tilted, but the internal cycle will be reversed. The supply side will act as an evaporator and the exhaust side will act as a condenser in this condition. Exhaust air will pre-cool incoming supply air to reduce the building A/C load.

Figure 3
Tilt Heat Pipe



4.3. **Wrap-Around Heat Pipe Coil (Enhanced Dehumidification)**

4.3.1. An example of how the Colmac heat pipe coils can be used to solve air-to-air heat pipe recovery problems is its use in conjunction with dehumidification coils.

4.3.2. Dehumidification coils cool air below its dew point, extracting water in the process. The air leaving the coil has less absolute humidity, but it is saturated with water vapor and has no capacity to absorb more water. It is common practice to reheat this cold, clammy air to avoid condensation in duct work and to make the air more comfortable.

4.3.3. This additional expenditure of energy can be avoided by the use of Colmac heat pipe coils. In its in-line (wrap-around) configuration, the heat pipe actually wraps around the DX or chilled water dehumidification coil, with one section of the heat pipe coil upstream and one section downstream. Typically, a two row heat pipe coil is used.

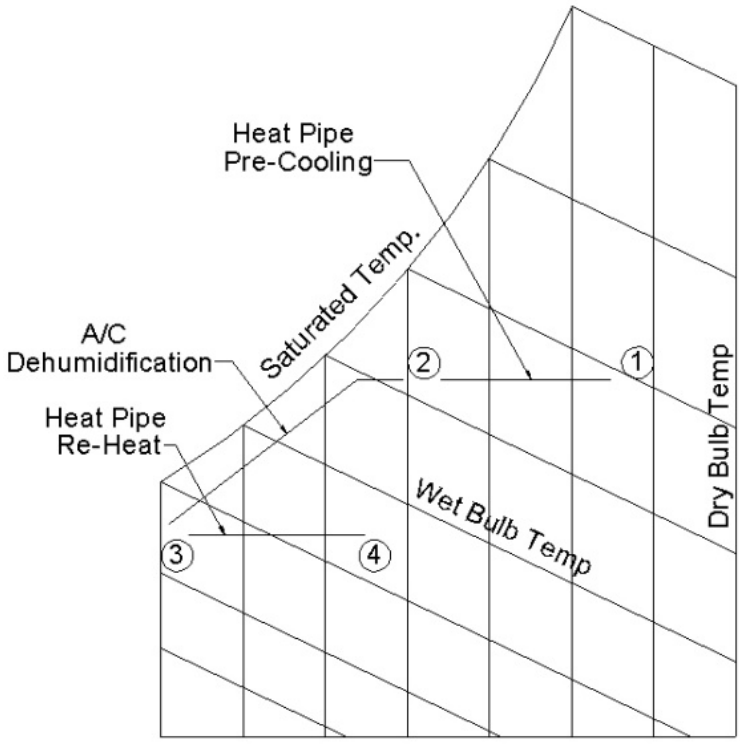
4.3.4. Hot, humid air enters through the first heat pipe coil section. The heat pipe pre-cools this air prior to entering the dehumidification coil. This allows the coil to have a higher chilled water temperature for a given amount of cooling, or in the case of a DX coil, a lower compressor load. This cooling savings is in addition to the saving from the free reheat.

4.3.5. As the cool, dehumidified air emerges from the cooling coil, it passes through the second section of the heat pipe coil, where it is reheated to a temperature with a more comfortable relative humidity.

4.3.6. All of this is done without any expenditure of energy. The Colmac heat pipe coil simply exchanges pre-cooling energy in the first section for reheat energy in the second section. The heat pipe coil modifies the “sensible heat ratio” or the air, transforming cool, muggy air into slightly warmer air with a much lower relative humidity.

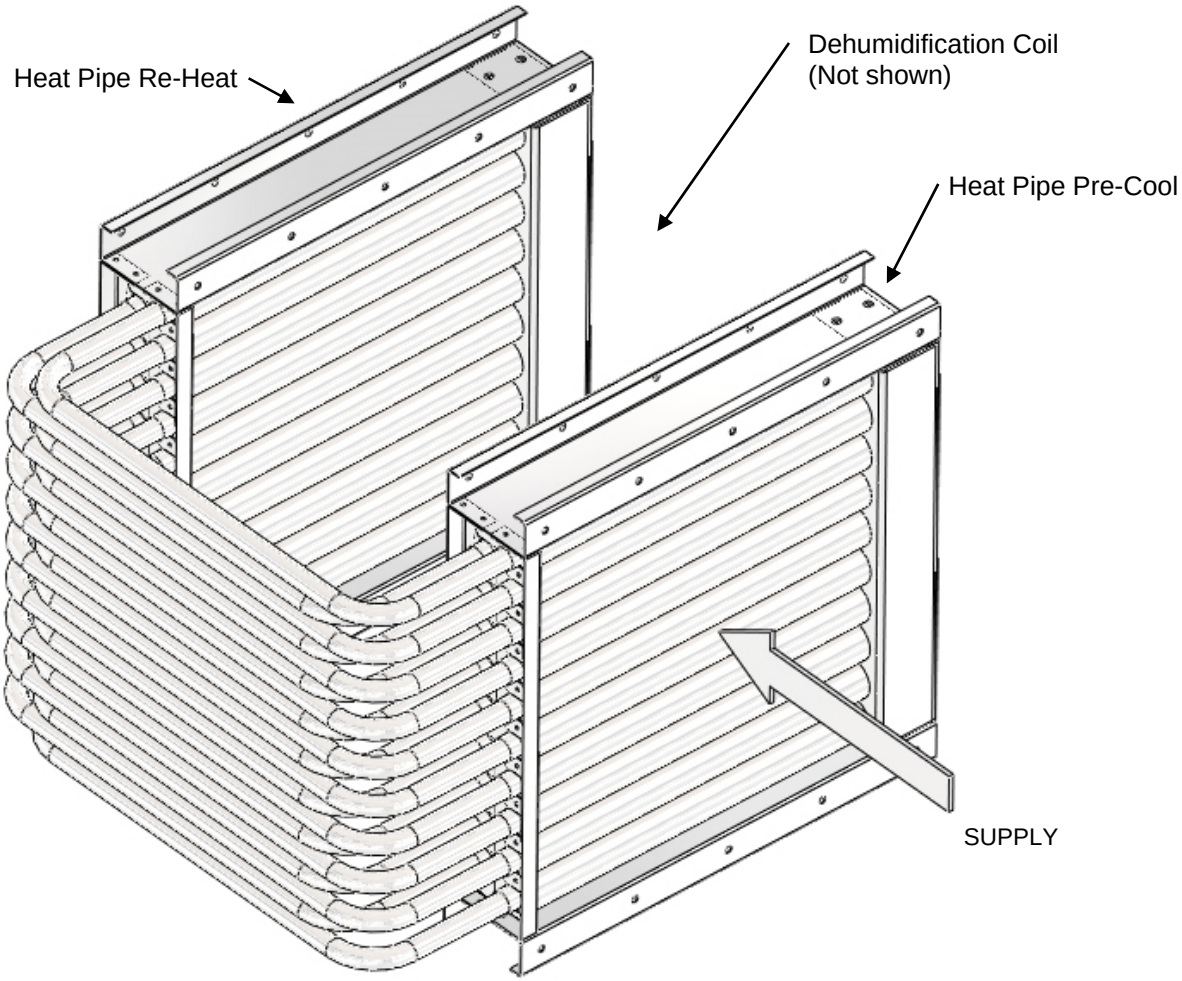
4.3.7. The psychrometric chart below shows the effect of the Colmac heat pipe coil. Air entering at “1” is pre-cooled by the heat pipe coil to the condition at “2.” From here, the dehumidification coil brings the air to saturation and cools the air further, extracting water. The air leaves the dehumidification coil at “3.” The muggy air at “3” then passes through the second section of the heat pipe coil, where it is reheated to a more comfortable condition at “4.”

Figure 4
Psychrometric Chart



4.3.8. The Colmac “Enhanced Dehumidification” heat pipe coil is designed to be a sturdy, reliable unit. Individual “U” tubes are welded to each section of the heat pipe coil to ensure sound construction. Moreover, the individual tubes ensure that there is even distribution of working fluid in all heat pipes. Connections between the heat pipe sections are compact and are located opposite to the dehumidification coil connections. The heat pipe coil can be sized either to closely wrap around the coil or to allow space between it and the cooling coil.

Figure 5
Wrap-Around Heat Pipe



5. **DIMENSIONS**

Figure 6
Basic Heat Pipe

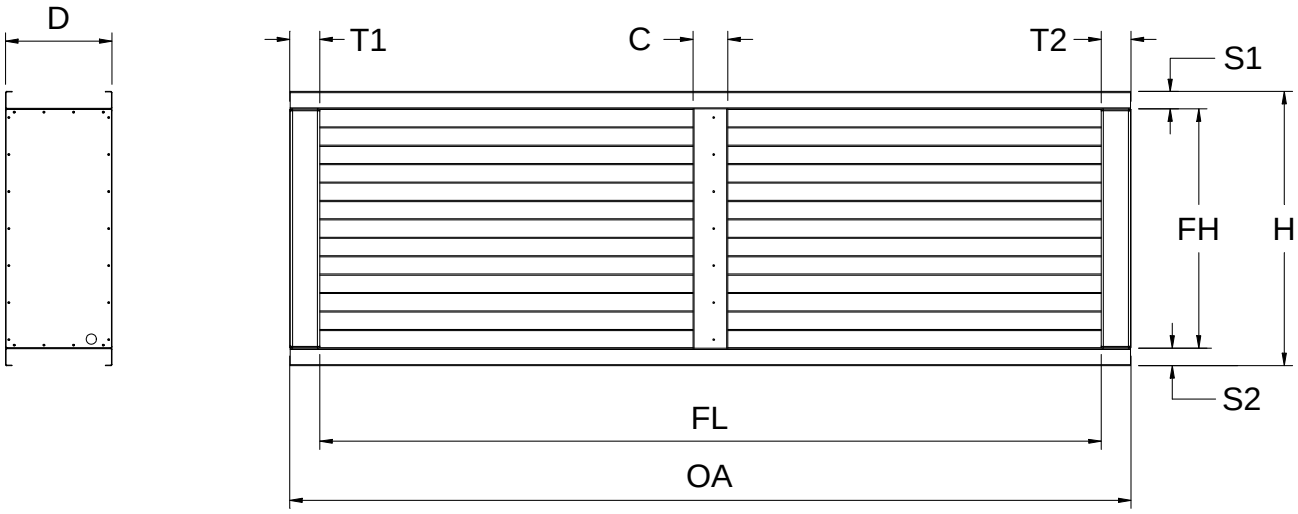
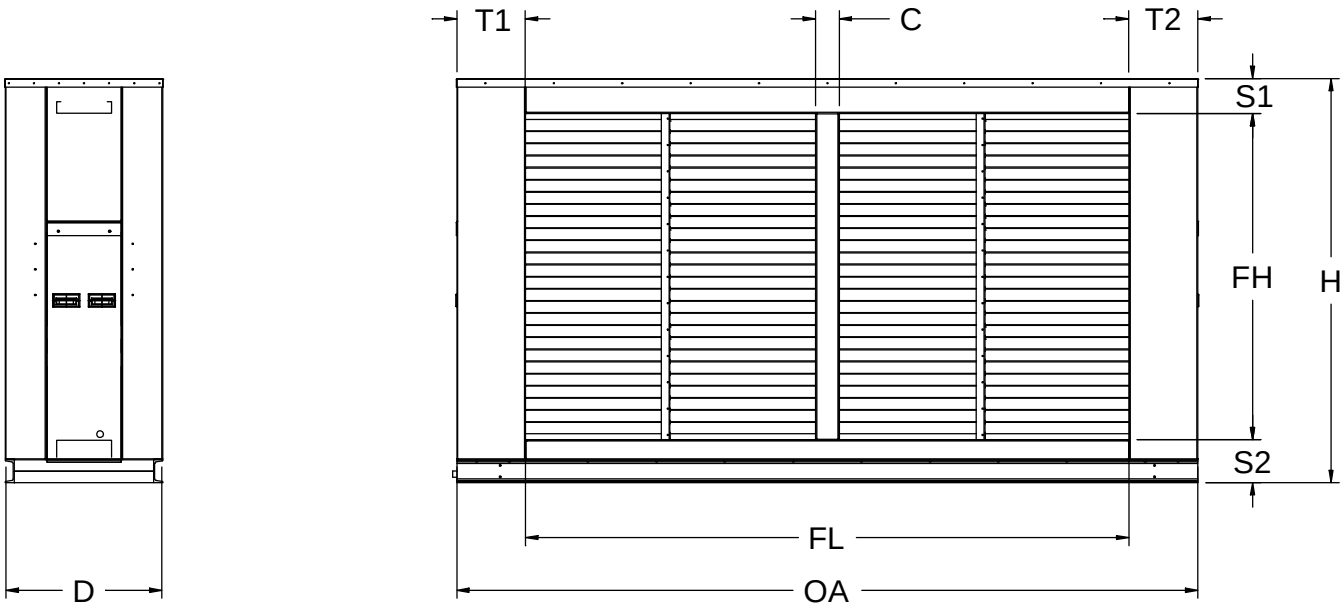
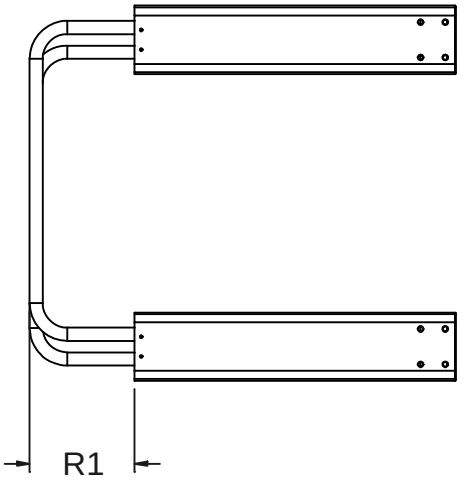


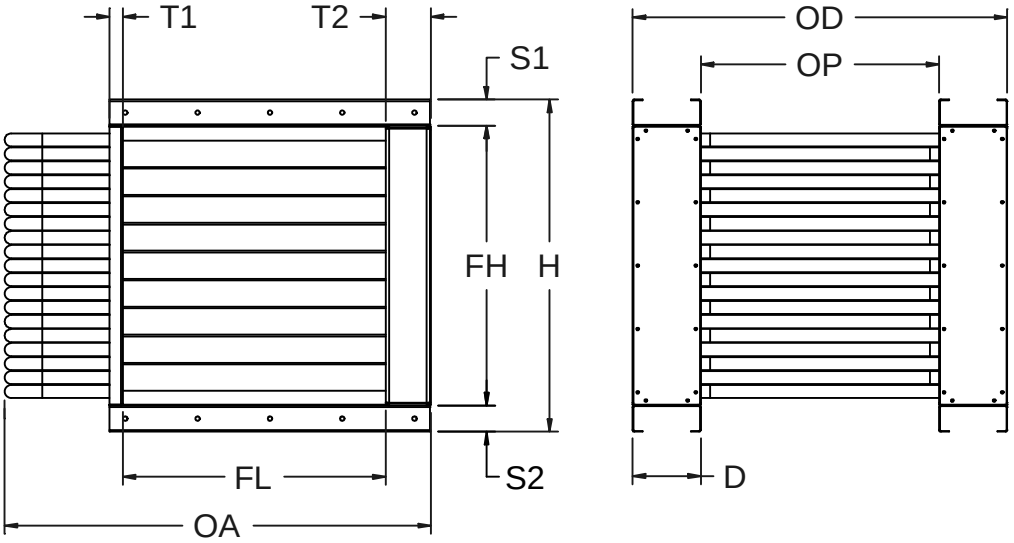
Figure 7
Tilt Heat Pipe



D – Coil Depth
OA – Overall Length
H – Coil Height
FH – Fin Height
FL – Finned Length
S – Horizontal Flange Height
T – Vertical Flange Width
C – Center Flange Width

Figure 8
Wrap Around Heat Pipe





D – Coil Depth
OA – Overall Length
OD – Overall Depth
OP – Coil Opening
H – Coil Height
FH – Fin Height
FL – Finned Length
S – Horizontal Flange Height
T – Vertical Flange Width
R1 – Return Bend Depth

6. SELECTION

6.1. Colmac heat pipe coils are normally sized in a manner similar to other heating/cooling coils, using a face velocity of 500 feet per minute. At this velocity, pressure drops across the heat pipe coil are modest when compared with other types of heat exchangers. If higher pressure drops can be tolerated, face velocities higher than 500 feet per minute can be used under proper conditions. For precise details of sizing and selection, Colmac software, “Coil Pro,” is provided online.

6.2. Software

6.2.1. Coil Pro will select an appropriate Colmac heat pipe coil model, given flow and temperature input; or will give the exact performance of a heat pipe for a selected model. It performs precise psychrometric calculations and determines exactly how much control is required to prevent frost build up. It also calculates dehumidification application as well. Heat pipe drawings, specifications, and pricing for the model selected are also included in the software. The software is accessible on Colmac’s online site. The heat pipe selected and manufactured is designed from the results of Coil Pro.

6.2.2. **Software Capabilities**

Coil Pro will calculate design specifics for a desired coil:

- Efficiency
- Heat Recovery Rate
- Temperature Change
- Humidity Change
- Pressure Change
- Weight and Dimensions

6.2.3. The Software bases its results from desired: function, material, coil type, airflow dimensions and properties, and environmental specifications.

7. SPECIFICATIONS

7.1. General Specifications

7.1.1. Heat pipe coils shall transfer heat between air streams flowing in a counter-flow arrangement unless specified for parallel flow.

7.1.2. Heat pipe coils shall be installed level within 1/8-inch difference end to end when used for heating, ventilating and cooling applications.

7.2. Construction

7.2.1. Integral fins will be fabricated from 1050 Aluminum Alloy.

7.2.2. Plate Fins will be made from Aluminum Alloy, Aluminum Polycoat, Heresite, or Copper. Tubes will be made from Aluminum Alloy or Copper.

7.2.3. Heat pipes will have a capillary wick structure integral to the heat pipe container wall.

7.2.4. Heat pipe working fluids will be R-134a, R-124, or be selected on the basis of heat pipe operating temperatures and compatibility with heat pipe container material.

7.2.5. Heat pipes will be individually processed, charged, hermetically sealed and factory tested.

7.2.6. The sheet metal thickness will be driven by unit's weight.

7.2.7. Heat pipe coil structural casing will be fabricated from a minimum of C90 Galvanized Steel, Aluminum Alloy 5052, or 304 Stainless. The heat pipe coil will be supplied with 4 flanges on the top and bottom along the front and back edges. Intermediate supports shall be furnished as required.

7.2.8. Heat pipe coils shall be provided with a partition to isolate the airstreams and prevent cross contamination. The partition will be at the center unless otherwise specified. The partition will be fabricated from either galvanized or stainless steel and will extend beyond the finned surface with 4-inch flanges. Both front and back are to be flush with the frame. There are two methods of sealing the center sheet to divide the flow directions.

- For integral fins, an Epoxy is used to seal all joints between the tube and sheet.
- For plate fins, the tubes are expanded into the tube sheet making a tight seal.

7.2.9. End covers will be provided to protect the heat pipe ends.

7.2.10. Additional specifications for other configurations available upon request.

8. **INSTALLATION**

8.1. **Code Requirements**

8.1.1. The installation of Colmac heat pipe coils and all other Colmac supplied equipment must conform to all local, state, and federal laws and regulations applying at the site.

8.2. **Removal from Crate** – Due care must be exercised when unpacking and mobilizing. Carrier should be instructed in proper transferring methods. If damage occurs refer to "8.4.2."

8.3. **Lifting & Rigging**

8.3.1. CAUTION: The heat pipe should be lifted with the tubes level.

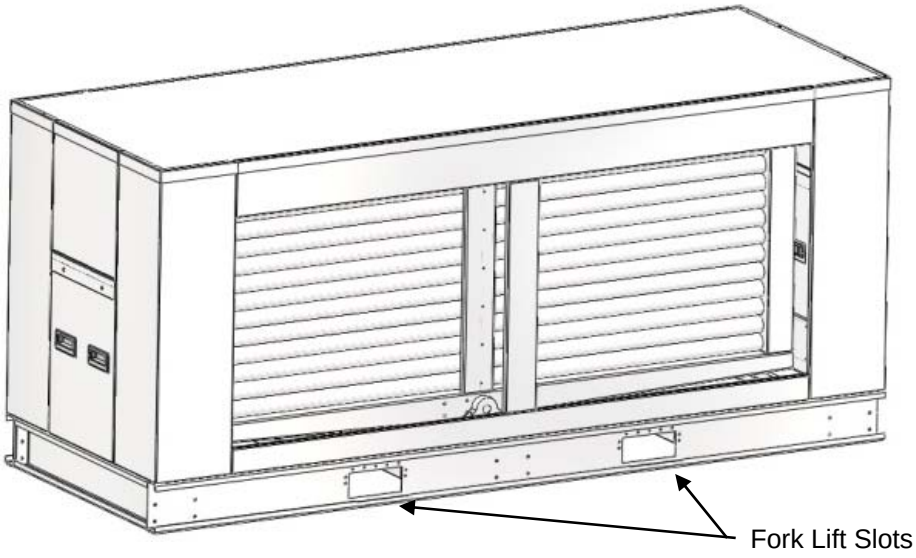
8.3.2. Use shipping container to transport unit until it is necessary to remove unit from container.

8.3.3. CAUTION: The heat pipe tubes are partially filled with a liquid refrigerant. Movement of the refrigerant is unrestricted through the length of the tubing and may shift to one end or the other during handling. Extreme care should be taken to ensure that the load is secured during handling.

8.3.4. CAUTION: Where the finned surface of the coil is exposed, extreme care should be taken to avoid contact with the sharp edges of the fins to minimize the chance of injury.

8.3.5. Use forklift to move Heat Pipe. Slots are provided for fork locations.

Figure 9
Rigging with Fork Lift

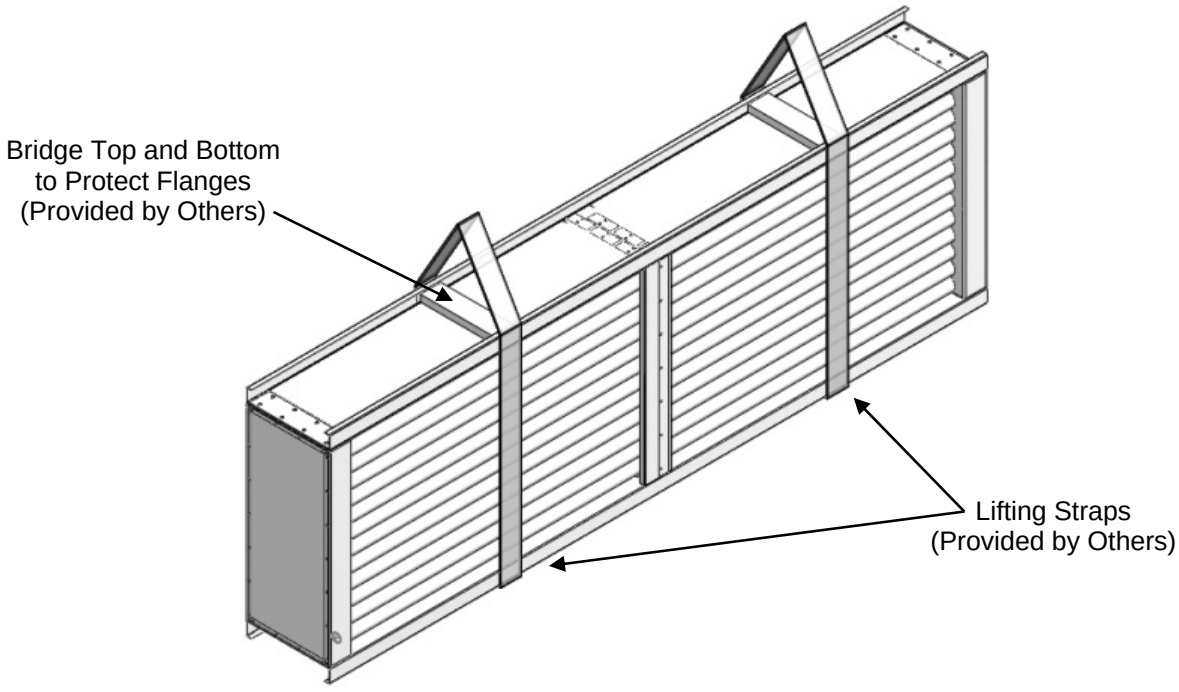


NOTICE: Never lift unit by placing forklift in direct contact with the drainpan.

8.3.6. Lifting lugs are not provided. Appropriate straps must be used to hoist the heat pipe coil in place, if forklift mounts are not built in.

8.3.7. Bridging between the flanges of the top and bottom plates is necessary to prevent bending of the flanges during hoisting. Due care must be exercised.

Figure 10
Rigging with Overhead Straps



8.4. **Inspection**

8.4.1. The installation of the heat pipe coil should conform to all codes, laws and regulations applying at jobsite.

8.4.2. 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.

8.4.3. Specified Equipment – Check unit nameplate for: Electrical specifications to ensure compatibility with electrical power supply. Check model nomenclature and other information to ensure that the equipment matches the original order.

8.4.4. The heat pipe coil must be installed in a counter-flow arrangement unless otherwise called for by the design. The supply and exhaust air streams must flow through each respective side of the coil as marked on its end covers. Air stream position in the coil and stream directions cannot be interchanged unless approved by Colmac.

8.4.5. Make sure all warning labels on unit are recognized and understood.

8.4.6. All field wiring must comply with National Electrical Code and all other state and local regulations. This includes providing proper and safe motor protection, fusing, disconnects, and other basic equipment.

8.4.7. Make sure unit voltage agrees with supply voltage for **Tilt Heat Pipes.**

8.4.8. Always re-check flanges for tightness prior to system startup.

8.5. **Placement and Connections**

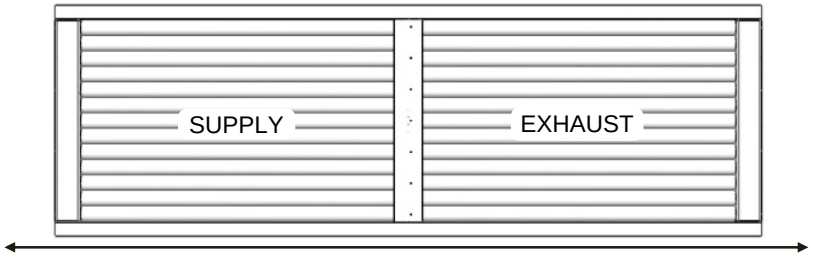
8.5.1. The heat pipe must be installed level and be securely anchored to the building structure or concrete pad.

8.5.2. Make sure unit is mounted securely using all available flanges

8.5.3. Heat Pipe coils must be mounted rigidly. No more than 1/8” total bow end to end is allowable.

8.5.4. When using the heat pipe coil for heating, ventilating, and air conditioning (summer/winter recovery) it must be installed level within 1/8-inch end to end.

Figure 11
Basic Heat Pipe



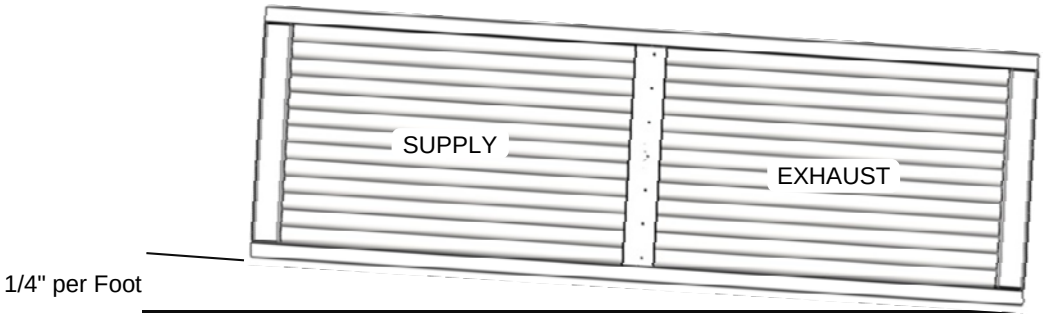
Level within 1/8” End to End

8.5.5. The heat pipe coil is manufactured with a dividing partition and frame such that standard duct flanges can be screwed to the frame. Use 3/16” diameter by 3/8” long self tapping sheet metal screws. Space as required. Do not allow drill bit to penetrate over 1/2" into the coil end boxes. Use of gaskets or sealants on the flange faces is recommended.

8.5.6. The duct system supplying the coil should be in accordance with good engineering practice in establishing a uniform air flow across the entire coil face surface.

8.5.7. Heat Recovery only Installation: When using the heat pipe coil for heat recovery only, it must be installed with the exhaust end tilted down. Colmac defines the tilt angle in its approved submittals. For Standard recovery units the tilt should be ¼ inch per foot span.

Figure 12
Heat Recovery Heat Pipe



8.6. **Multiple Heat Pipe Coils**

8.6.1. Systems requiring two or more heat pipe coils to be mounted in parallel may utilize several methods for installation as shown below. Heat pipe coils can be stacked or mounted so that air flows are at any angle between horizontal to vertical, such as in the V-Bank. Installation must be in accordance with the approved Colmac submittals.

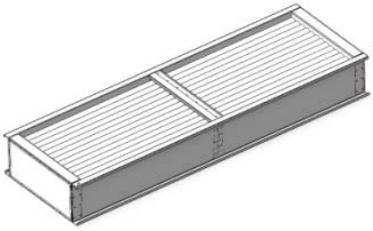
8.6.2. Heat pipe coils mounted atop one another must be well sealed at their common flange junction to prevent air or water (condensate) leakage between the coil flanges.

8.6.3. Heat pipe coils mounted in series should have access doors available between the coils for inspection and cleaning.

8.6.4. Colmac heat pipe coils may be installed in a variety of configurations and positions.

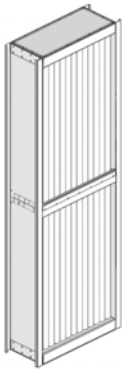
Figure 13
Heat Pipe Arrangements

Horizontal Air
Horizontal Tubes

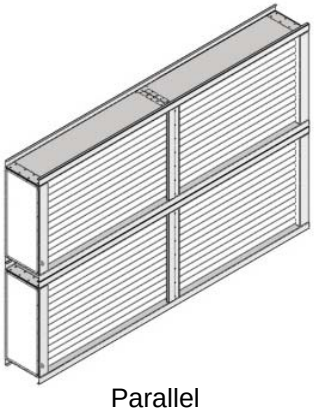


Vertical Air
Horizontal Tubes

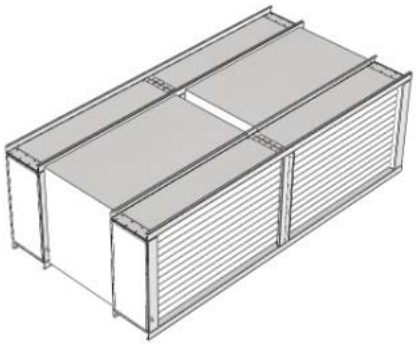
V-Bank



Horizontal Air
Vertical Tubes



Parallel



Series

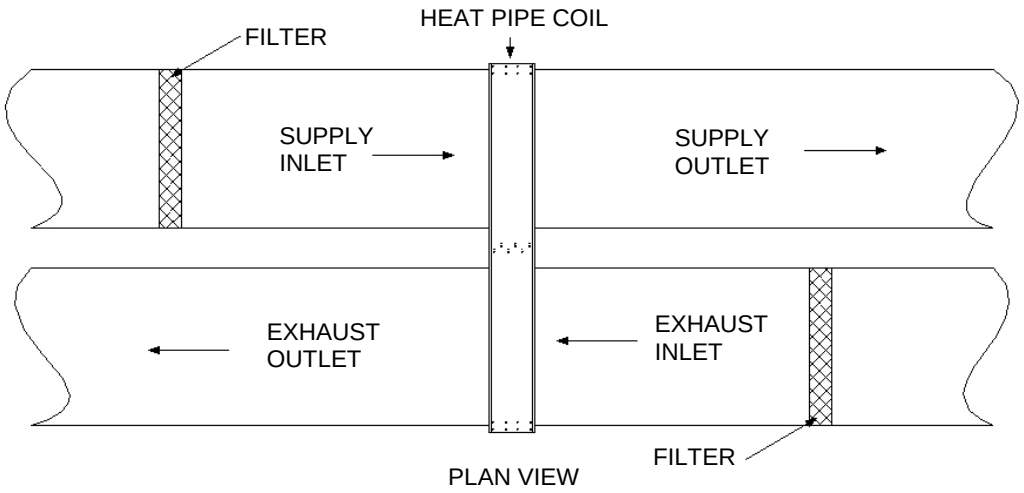
8.7. **Drain Pan**

8.7.1. Drain pans are recommended under the ENTIRE coil, both as a condensate collection and for cleaning. Many other designs are suitable.

8.8. **Filters**

8.8.1. Heat pipe coil performance specifications are based on clean air and a clean surface. It is required that adequate filtration be utilized in both air streams to insure optimum performance and minimum coil maintenance.

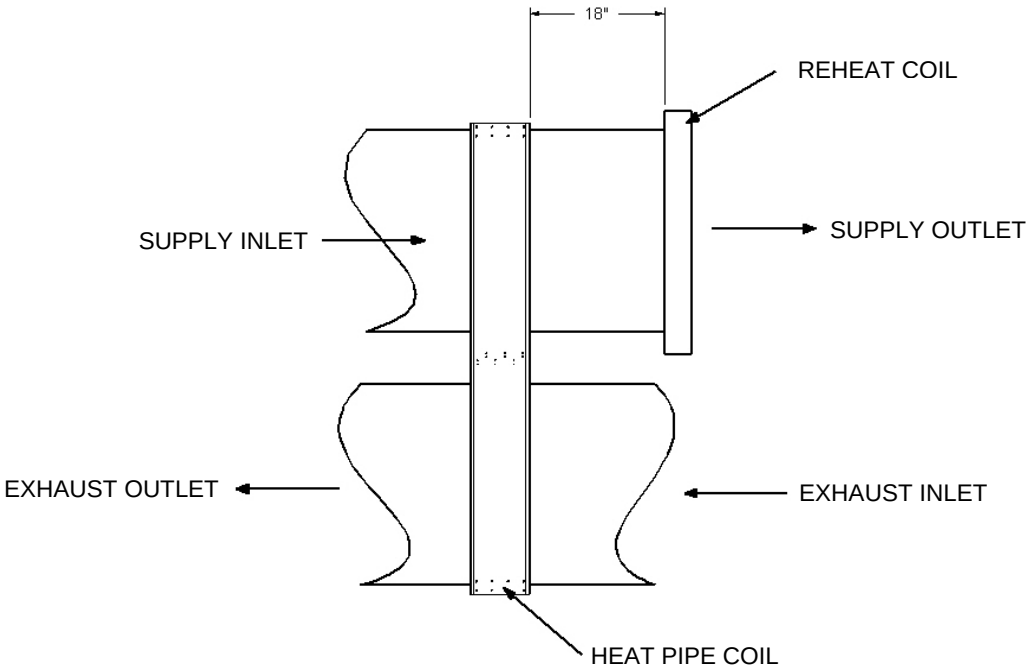
Figure 14
Filter Arrangement



8.9. **Reheat Coils**

8.9.1. Reheat coils when used must be a minimum of 18 inches downstream from the heat pipe coil face on the supply side outlet.

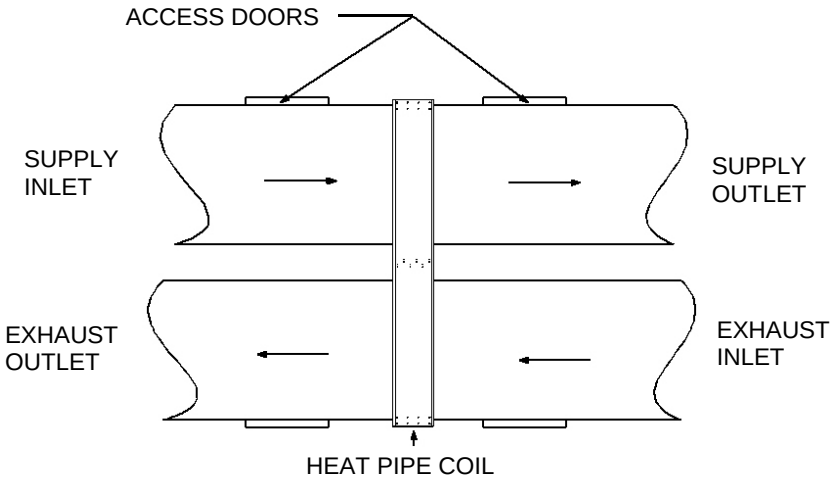
Figure 14
Re-Heat Coil Arrangement



8.10. **Access Doors**

8.10.1. Access doors should be provided to allow periodic inspection of the coil faces and to facilitate cleaning when necessary. This is particularly important when dirty or non-filtered airstreams are used on either side. There must be access to all faces of every heat pipe.

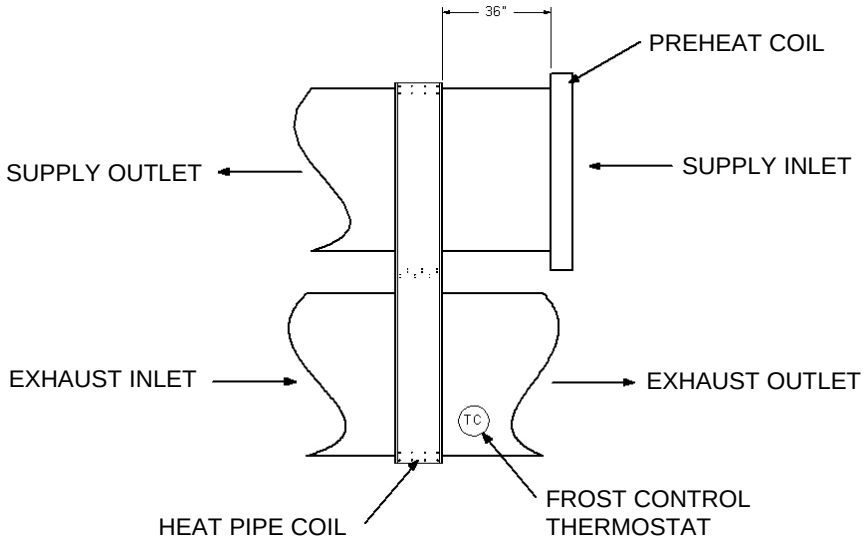
Figure 15
Access Door Arrangements



8.11. **Frost Control-Optional Preheat Coil**

8.11.1. The preheat coil must be installed on the inlet supply side of the heat pipe coil. A frost control thermostat senses the leaving exhaust air flow temperature. If the leaving exhaust air temperature goes below a preset temperature (normally 36° F), the controller energizes the supply to the heating coil to maintain the preset temperature. Any heating coil must be installed a minimum of 3 feet from the supply face inlet of the heat pipe coil.

Figure 16
Pre-Heat Coil Arrangements



9. **OPERATION**

9.1. There must be an airstream present through each side of the coil for desired results.

9.2. Heat Recovery and Wrap Around Heat Pipe Coils – have no moving parts and no external power to keep them running, so once installed only periodic inspection is required.

9.3. Tilt Heat Pipe Coils – contain thermostats, tilt actuators, and temperature controls that automatically adjust the heat pipe's efficiency to prevent frost build-up or inadvertent heating, of which all are contained within the unit. A power supply must be connected at all times during operation.

10. **MAINTENANCE**

10.1. Inspect Heat recovery and Wrap Around Heat Pipe Coils at least every 6 months.

10.2. Leakage from heat pipes or a malfunction of the tilt control system are failures in the unit and will interfere with the unit's efficiency if not taken care of.

10.3. Remove any debris that collects on the air inlet side of the finned tubes as this will reduce the airflow. The debris can often be removed by blowing air or a water spray in the reverse direction. A soft bristled brush with a water-detergent solution may be required to remove oily deposits followed by rinsing with clean water. Straighten any fins that may have bent during cleaning.

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

10.4. Check drain pan for debris that would prevent proper drainage.

10.5. For **Tilt Heat Pipe Coils** check operation of control system and proper functioning of tilt actuator, thermostats, and etc. quarterly.

10.6. Check that all safety controls are operating appropriately.

10.7. **Replacement Parts**

10.7.1. 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.

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