P3010
Los Angeles LRV

HVAC

Section 0500
RUNNING MAINTENANCE & SERVICING MANUAL

LIST OF EFFECTIVE PAGES

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Draft	Final Draft-A	December 2015
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SAFETY SUMMARY

Some of the procedures in this section are preceded by warnings/cautions regarding potential hazards in handling this equipment. These warnings/cautions should be carefully read and understood before proceeding. Failure to observe these precautions may result in serious injury to personnel performing the work and/or bystanders. The key warnings for this equipment are as follows:

Electrical – The electrical equipment described in this section operates at voltages and currents that are extremely dangerous to life. Personnel should closely observe all generally prescribed cautions and warnings before performing any work on the LRV.

Chemicals – Follow safety precautions for handling hazardous chemicals as provided by the manufacturer. The manufacturer's warnings should be closely heeded to avoid personal injury.

Location – Special caution should be taken when accessing or servicing equipment located on the roof and under the car.

Weight – To prevent possible personal injury when attempting to remove or install equipment on the vehicle, adequate support of a lifting device must be used to prevent the equipment from falling. Personnel's failure to heed these warnings could result in severe injury or death and or damage to the equipment.

Contact – Some components in this equipment attain temperatures that can cause severe burns. Closely follow all warnings and recommended procedures for handling these components.

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CHAPTER 1.0

GENERAL DESCRIPTION

1.1 Introduction

This chapter provides a general description and overview of the LACMTA Light Rail Vehicle (LRV) Heating Ventilation and Air Conditioning (HVAC) unit, see Figure 1-1.

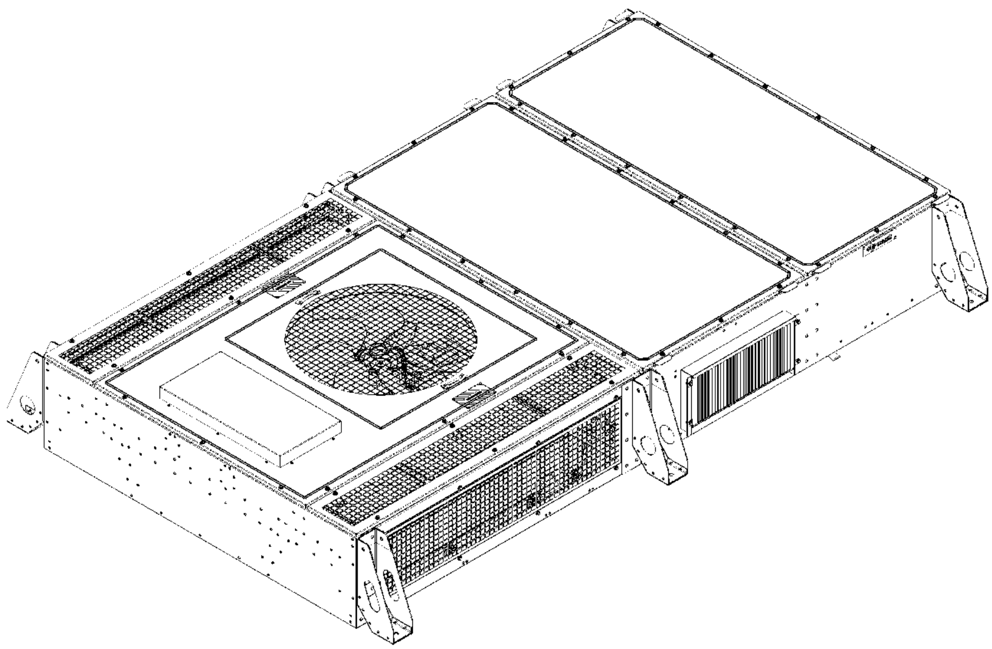

Figure 1-1: HVAC Unit

1.2 System Summary

The LACMTA P3010 LRV Series Cars are provided by Kinkisharyo International for the Los Angeles County Metropolitan Transportation Authority (LACMTA).

The HVAC unit is designed as a single roof mounted package for each light rail car section. Each individual HVAC unit is secured to the car body roof mounts and sealed into place; it requires only connection to the car electrical system for start-up and operation.

The HVAC units discharge air into the primary supply duct through two air supply outlets. The supply air then passes to the secondary duct where it is discharged into the car. Return air is drawn through the return air grill into the HVAC unit.

The HVAC unit consists of an all stainless steel support frame, with stainless steel walkable covers (with the exception of the grills over the condenser coils and condenser fan). The unit is divided into two major halves, the compressor-condenser section and the evaporator section.

The compressor-condenser section contains the condenser coils, the resiliently mounted scroll compressors, and condenser fan and motor.

The evaporator section is a pull through design. Return air is first drawn in through the car's return air grill and through the return air filters. Fresh air is drawn in through the fresh air inlets, then through the fresh air filters and is mixed with the return air in the air mixing plenum. The air mixture is then drawn through the evaporator coil, electric heater, and into the blower fans where it is blown into the cars supply air ducts. The fans are two, double width, double inlet centrifugal wheels mounted onto a double shaft blower motor.

The Control Panel is located in the return air plenum, along with the pressure controls, refrigerant pressure gauge ports, diagnostic test plug, liquid line sight glass/moisture indicator and thermal expansion valves. Access to these components is from inside the car.

The control of the system is based on the return air temperature, the ambient temperature and the supply air temperature, measured by sensors located inside the unit. The microprocessor uses a Proportional Integral (PI) control to determine the required capacity. In addition, the microprocessor will cycle one of the compressors off and/or will operate the solenoid valves on the Hot Gas By-Pass (HGBP) lines to regulate the amount of cooling capacity.

To control the car interior conditions (particularly the relative humidity) when the car temperature continues to fall, an appropriate amount of reheat is brought on to keep the compressor from shutting down.

The cooling system will start and operate without damage at any outside ambient temperature above 40ºF. The ACCU will lock-out the cooling mode below 40ºF degrees ambient temperature.

The unit will deliver modulated cooling at high ambient temperatures up to 125ºF and full cooling capacity up to 115ºF. The unit has a modulation capability due to the Hot Gas By-Pass (HGBP) between the discharge of the compressor and the outlet of the thermal expansion valve, to keep the unit running when the pressures become high due to factors such as dust and dirt accumulation on the condenser side. The controls, in the heating, cooling and reheat stages, are designed to automatically match the particular function of the unit with the prevailing load to keep the interior of the car within the temperatures of the LACMTA P3010 LRV Specification. Dehumidification will be accomplished within the reheat stage in the temperature range that most likely will require dehumidification.

1.2.1 Electrical System

Thermostatic functions are controlled by a microprocessor with inputs from temperature sensors located in the return air stream, supply air stream and fresh air intake of the unit.

The electrical system is integrated into the HVAC unit for the purpose of controlling the car's interior temperature to a desired comfort level. Refer to HVAC Electrical Schematic TA37187/21 (not shown) wiring and component interface connections and Figure 1-2, HVAC Unit Electrical Diagram. The electrical system consists of the following components for each HVAC Unit:

<u>Temperature Sensors:</u>
1 fresh air temperature sensor
1 return air temperature sensor
1 supply air temperature sensor

<u>Refrigerant Pressure Transducers:</u>
2 high pressure transducers
2 low pressure transducers

<u>Control Panel Assembly:</u>
5 circuit breakers
4 motor contactors
4 current transformers (for current monitoring)
2 overhead heat contactors
1 VAC sensing relay
2 valves relays
Terminal blocks
1 Air Conditioning Control Unit (ACCU)
1 switch (off – auto)
1 transformer 208VAC – 24VAC

<u>Operating Power Sources:</u>
24 VDC for electrical and electronics control components.
208 VAC, 3ph, 60Hz for evaporator blower, condenser fan, compressors and overhead heater.
24 VAC for solenoid valves.

<u>Refrigeration and Heating Components</u>
2 Compressors
Condenser Fan and Motor
Blower Motor
Two Stage Overhead Heater
2 Overhead Heater Thermostats
2 Hot Gas By-pass Valves
2 High Pressure Transducers
2 Lower Pressure Transducers
2 Damper Servomotors

Figure 1-2 is the HVAC unit electrical block diagram. Table 1-1 provides a cross reference of system components and abbreviations used through-out this manual and also shown on Figure 1-2 and the HVAC Electrical Schematic (not shown).

Table 1-1. HVAC Unit Electrical Component Identification

Abbreviation	Description
ACCU	Air Conditioning Control Unit
ACD	Alternating Current Detector
AFS	Air Flow Switch
APS	Auxiliary Power Supply
BM	Blower Motor
BMC	Blower Motor Contactor
BMCB	Blower Motor Circuit Breaker
BMCBA	Blower Motor Circuit Breaker Auxiliary
BMCT	Blower Motor Current Transformer
CFM	Condenser Fan Motor
CFMC	Condenser Fan Motor Contactor
CFMCB	Condenser Fan Motor Circuit Breaker
CFMCBA	Condenser Fan Motor Circuit Breaker Auxiliary
CFMCT	Condenser Fan Motor Current Transformer
CM1	Compressor Motor 1
CM2	Compressor Motor 2
CMC1	Compressor Motor Contactor 1
CMC2	Compressor Motor Contactor 2
CMCB1	Compressor Motor Circuit Breaker 1
CMCB2	Compressor Motor Circuit Breaker 2
CMCBA1	Compressor Motor Circuit Breaker Auxiliary 1
CMCBA2	Compressor Motor Circuit Breaker Auxiliary 2
CM1CT	Compressor Motor 1 Current Transformer
CM2CT	Compressor Motor 2 Current Transformer
CN1	Connector 1, Power Supply (208VAC)
CN2	Connector 2, 24VDC, Reset
CN3	Connector 3, MVB, Ethernet, I/O’s
FAT	Fresh Air Temperature Sensor
GND	Ground
HGBPR1 & 2	Hot Gas Bypass Relay 1 & 2
HGBP1 & 2	Hot Gas Bypass Valve 1 & 2

Table 1-1. HVAC Unit Electrical Component Identification (cont'd.)

Abbreviation	Description
HPS1 & 2	High Pressure Switch 1 & 2
HPT1 & 2	High Pressure Transducer 1 & 2
HVAC	Heating Ventilation Air Conditioning
LPS1 & 2	Low Pressure Switch 1 & 2
LPT1 & 2	Low Pressure Transducer 1 & 2
LVPS GND	Low Voltage Power Supply Ground
LVPS+	Low Voltage Power Supply 24VDC +
MVB	Multifunction Vehicle Bus
NC	Normally Closed
NO	Normally Open
OH1	Overhead Heater 1
OH2	Overhead Heater 2
OHC1	Overhead Heater 1 Contactor
OHC2	Overhead Heater 2 Contactor
OHCA1	Overhead Heater Contactor Auxiliary 1
OHCA2	Overhead Heater Contactor Auxiliary 2
OHCB	Overhead Heat Circuit Breaker
OHCBA	Overhead Heat Circuit Breaker Auxiliary
OHPT1	Overhead Heater Protection Thermostat 1
OHPT2	Overhead Heater Protection Thermostat 2
OL	Overload, Motor, Thermal, CFM & BM
Pa	Pascal (unit of pressure)
PTC	Positive Temperature Coefficient, Fuse
PTU	Portable Test Unit
RAT	Return Air Temperature Sensor
RxD	Receive Data
R4	Damper Servomotor
R5	Damper Servomotor
SAT	Supply Air Temperature Sensor
TB	Terminal Block
T1	Transformer 1
TxD	Transmit Data
VAC	Volts, Alternating Current
VDC	Volts, Direct Current
VPS	Valve Power Supply, Transformer, 230 VAC Input / 24 VAC Output
+BAT	24VDC Control Voltage Positive From Train
-BAT	0VDC or Negative From Train

[redacted]

1.2.2 System Operation

The control system is activated when 24 VDC is available from the car's low voltage power supply. The ACCU does self-diagnosis and initialization, and then it reads the status of all control components to detect fault conditions. If the HVAC is in the "on" mode and 208 VAC is detected, the unit will initiate the start sequence. After the start sequence is completed, the ACCU will read the temperature sensor values to determine the required operation mode. If there is a failure of the evaporator blower, the ACCU will not allow heating or cooling functions and the fault will be registered.

Fresh air, return air, and supply air temperature signals are then sent to the ACCU through the analog inputs. The ACCU contains the electronic components and interfacing circuitry necessary to interpret the input signals from the temperature sensors and various HVAC switches and transducers (pressure, air flow, and thermostats) as well as auxiliary switches and motors status. Based on these signals, the ACCU will send digital outputs to switch appropriate AC contactors, solenoid valves, and actuators as required.

1.2.3 Modes of Operation

Five modes of operation are presented in the HVAC Unit.

1. STAND-BY
2. VENTILATION
3. HEATING
4. COOLING
5. REHEAT

Stand-By Mode

The unit is powered and ready for start, but is waiting for the "on "signal through the MVB.

Ventilation Mode

An air flow switch (AFS) is used to detect the presence of air flow in order to allow heating and/or cooling.

Heating Mode

For the overhead heat to function both the air flow switch and the blower motor contactor must be closed. This ensures there is proper air flow prior to energizing the heaters. This also is an automatic reset operation and will allow normal operation if the air flow switch and motor contactor close.

Cooling Mode

Excessive high or low refrigerant pressure will shut down the cooling system through the high pressure switch (HPS) or the low pressure switch (LPS), respectively.

Each motor has an internal protection used to protect the motors from overheating due to an overload condition. Each overload situation for the specific motor will be identified and annunciated on the PTU. Lockout mode is incorporated into the compressor control to prevent continued starts under fault conditions.

Compressors and the condenser fan in each unit are sequentially started to reduce the inrush current and thus less stress on the auxiliary power system. The A and B HVAC units are also sequentially started. This further reduces stress on the auxiliary power system.

Reheat Mode

Reheating will be performed when dehumidification is required, during this mode the overhead heater will be used. Depending on the control temperature setting and high and low pressure limits one compressor and condenser fan will be running in this mode.

1.2.3.1 Temperature Control

The horizontal axis (Figure 1-3) shows the range of exterior temperatures (fresh air or ambient temperature). The vertical axis shows the range of car interior temperatures.

The green line represents the car interior set-point. So, for any given exterior temperature, find the point on the vertical axis that intersects with the green line to get the interior car set-point. For example, at an exterior temperature of 4°C, the interior temperature set-point is 20°C; similarly, at an exterior temperature of 40°C, the interior temperature set-point is 24°C.

The left most blue dotted line (Cooling mode limit) indicates that cooling is not available when the ambient/exterior temperature is below 4°C. The brown dotted line (Only one heater stage allowed) indicates that only one stage of heating is allowed when the ambient temperature is greater than 12°C.

The light blue dotted line (Only one compressor allowed) indicates that only one compressor is allowed to operate (thereby limiting unit capacity to either 25 or 50%) when the ambient temperature is less than 16°C. The red dotted line (Heating mode limit 20°C) indicates that the unit will not operate in Heating Mode when the ambient temperature is greater than 20°C.

The purple dotted line (Reheating mode limit) indicates that the unit may operate in Reheat mode only until an exterior temperature of 26°C. When the temperature is beyond 26°C the unit will operate in Cooling mode and the overhead heaters are completely inhibited.

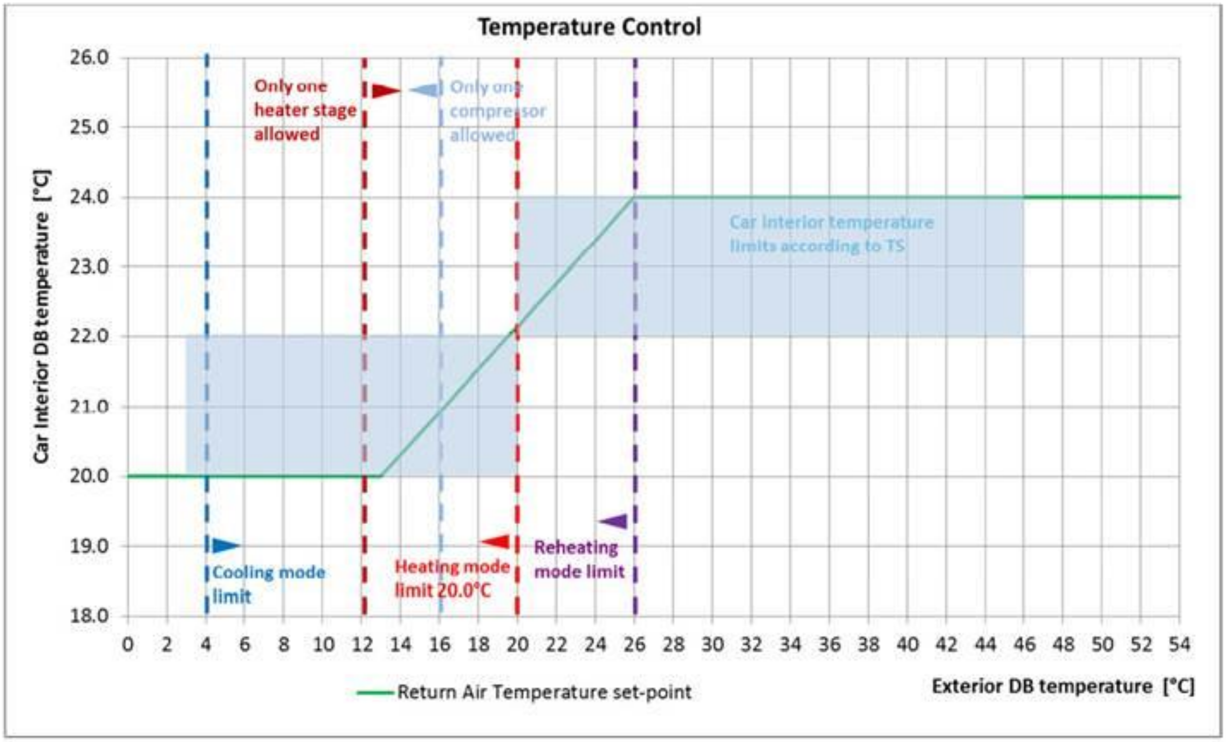

Figure 1-3. Temperature Control

1.2.4 Start Sequence

There are two (2) supply voltages needed for the HVAC System to begin operation:

1. The control voltage should be between 17 VDC to 30 VDC and the nominal voltage is 24 VDC to power the ACCU and Electrical Control Panel.

2. The high voltage should be between 187 to 229 VAC and the nominal voltage is 208 VAC, 3 Phase, 60 Hz to power the fans, compressors and heaters.

When the correct control voltage is received by the ACCU, it will power up and start to initialize. While the ACCU is initializing, it performs a number of self-tests (power on self-tests) to ensure proper functionality. At the same time, the ACD senses the condition of the supply voltage. If the supply voltage is within the acceptable level, the power indicator relay will energize and will be detected by the ACCU.

Each HVAC unit will follow a predefined startup sequence of its components to prevent high inrush currents. First the blower motor is started and will run for 60 seconds to stabilize the conditions inside the car. Then, based on the temperature readings the system will determine the operating mode in which it will start. If cooling is required the system will start the condenser fan then the refrigerant compressor(s). In this way no two components are started at the same time.

The HVAC units on each end (A and B) are also prevented from starting up simultaneously. This is accomplished with an interlock signal between the two units transmitted via MVB. The A-unit (at A-END) is considered the master and the B-unit (at B-END) is considered the slave. Provisions are made through the connector to identify A and B units. This identification is through MVB and car wiring, see Figure 1-2.

The A-unit will start when the unit first is powered up and the AC OK signal is present. The B-unit will not start when first powered; there will be a software delay to account for ACCU startup time between units and the “Other HVAC Compressor Start Permission” MVB command will be monitored.

In case of power interruption, such as catenary wire gap, the unit will re-start sequencing through the normal start up sequence. This function will be handled by the ACCU.

1.2.5 HVAC Unit and Component Specifications

Each HVAC unit is rated 8.0 tons refrigeration at the following conditions:

Cooling System Capacity	28 kW per unit (96,000 BTU/h per unit) 56 kW per car (192,000 BTU/h per car)
Condenser Inlet Temperature	34ºCDB (94ºFDB) at design rating conditions
Fresh Air Intake	34ºCDB - 21ºCWB (94ºFDB - 70ºFWB)
Return Air Intake	24ºCDB - 48% RH (75ºFDB)
Overhead Heating Capacity	15 kW per unit divided in two stages (30 kW per car) 208 VAC / 3ph / 60Hz
Fresh Air Intake	3ºCDB (37ºFDB)
Return Air Intake	20ºCDB (68ºFDB)
Evaporator Air Volumes	
Fresh Air	1080 m3/h (635 acfm) per unit
Total	3600 m3/h (2120 acfm) air per unit at 25 Pa (.01 inWC) car internal positive pressure
Voltage (Design)	208 VAC / 3ph / 60Hz
Control Voltage	24 VDC (17 – 30 VCD)
Refrigerant	R407C

Compressor Motor (CM)

All values are for a power of 208 VAC / 3ph / 60 Hz
Design Speed 3500 rpm (2 poles)
Maximum Operating Current 22 A
In-rush Current 92.1 A, 100 ms

Condenser Fan Motor (CFM)

All values are for a power of 208 VAC / 3ph / 60 Hz
Nominal Speed 1150 rpm (6 poles)
Nominal Shaft power 1.5 kW
Nominal Current 6.7 A
Nominal Power Factor 76%
Duty Point Power Consumption 1.50 kW
Duty Point Current 5.6 A
In-rush Current 30.1 A, 1.3 s

Blower Motor (BM)

All values are for a power of 208 VAC / 3ph / 60 Hz
Nominal Speed 1760 rpm (4 poles)
Nominal Shaft power 1.2 kW
Nominal Current 7.1 A
Nominal Power Factor 54%
Duty Point Power Consumption 1.32 kW
Duty Point Current 6.9 A
In-rush Current 47.6 A, 245 ms

High Pressure Switch (HPS)

Open: 30.0 ± 0.7 bar (435 ± 10 psig)
Close: 24.5 ± 0.7 bar (355 ± 10 psig)

Lower Pressure Switch (LPS)

Open: 0.8 ± 0.3 bar (12 ± 5 psig)
Close: 2.8 ± 0.3 bar (40 ± 5 psig)

Filters

Medium filter efficiency MERV 8, (30 – 35%)
Return Air Filters - 20 x 14 x 2
Fresh Air Filters - 20 x 10 x 2

Overhead Heater Thermostat #1

Open 54.4 ± 2.7°C (130± 5 °F)
Close 35.0 ± 2.7°C (95± 5 °F)

Overhead Heater Thermostat #2

Open 105 ± 3.3°C (221± 6 °F)
Close 125 ± 3.6°C (257± 6 °F)

1.2.6 Basic Refrigeration

The following provides the basic principles of refrigeration and a simplified refrigeration cycle. Refer to Figure 1-4 and Figure 2-3.

- Liquids absorb heat when changed from a liquid to a gas (evaporation).
- Evaporation occurs at a low temperature and low-pressure.
- Gases give off heat when changed from gas to liquid (condensation).
- Condensation occurs at a high temperature and high-pressure.

Starting at the compressor outlet, the refrigeration cycle is as follows, see Figure 1-4.

1. High-pressure, high-temperature refrigerant gas is discharged by the compressor.
2. The high-pressure gas flows from the compressor to the condenser by way of the "discharge line".
3. In the condenser coil, heat is removed from the gas which then condenses and becomes a high-pressure liquid.

[redacted]

4. The high-pressure liquid exits the condenser via the "liquid line" where it flows through the filter drier to the evaporator coil.

5. As the high-pressure liquid refrigerant enters the evaporator coil, it is subjected to a much lower pressure due to the suction of the compressor and the pressure drop across the expansion valve, changing the high-pressure liquid to a low-pressure liquid.

6. This low-pressure liquid expands, absorbs heat, and evaporates, changing to a low-pressure gas at the evaporator coil outlet.

7. The low-pressure gas is then returned to the compressor via the "suction line".

8. The low-pressure gas enters the compressor where it is compressed into a high-pressure gas. The high-pressure, high-temperature gas is then discharged into the discharge line.

9. The cycle then repeats.

The section of the refrigerant circuit that goes from the expansion valve outlet to the compressor inlet is known as the low-pressure side, while the section between the compressor outlet and the expansion valve inlet is called the high-pressure side.

The refrigerant between the condenser outlet and the evaporator coil inlet is in liquid form. The refrigerant between the evaporator coil outlet and the condenser inlet is in gas form.

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CHAPTER 2.0

FUNCTIONAL DESCRIPTION

2.1 Introduction

This chapter provides a functional description of equipment components in the HVAC unit.

2.2 Equipment Component Description

2.2.1 HVAC Frame and Drain Lines

The HVAC unit frame is manufactured from 304L stainless steel alloy to prevent corrosion. The frame is not painted. Frame dimensions are as follows:

- Length: 10 ft.
- Width: 6.26 ft.
- Height: 18.5 in.

The frame interfaces to the car include the return air plenum and evaporator blower. The evaporator blower interfaces to the car's main ducting. The return air plenum interfaces to the car ceiling and is accessible from inside the car by removing the return air grille and return air filter. A number of components are accessible in the return air plenum. Refer to Section 2.2.6 for additional details.

Interface gaskets provide a leak tight seal between the frame and the car interface.

The HVAC frame has two drain ports located on either side of the evaporator coil in the evaporator section and the compressor-condenser section has built in drain ports in the bottom plating, see Figure 2-1. The drain ports drain to the car top and then drain directly to the track bed. Drain traps (kazoos) are attached to two drain ports in the evaporator section (part of evaporator drip tray bracket). The drain traps are inspected, cleaned, and if necessary replaced every 120,000 miles. Refer to Section 5.3.3.

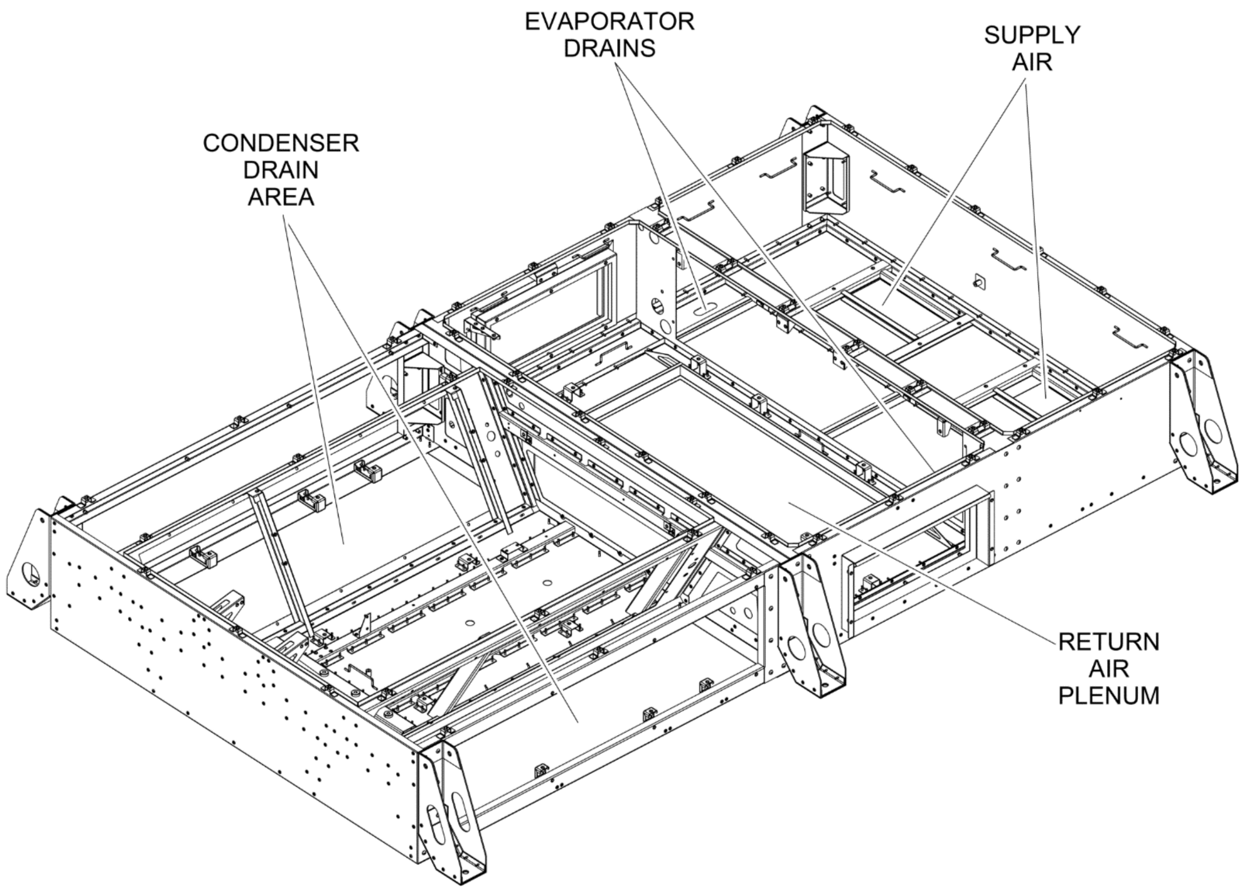


Figure 2-1: HVAC Unit Frame and Drain Lines

2.2.2 Access Covers and Grilles

The HVAC unit covers are stainless steel. The covers and grilles are fastened to the frame by captive screws and hardware. A rubber style gasket is mounted on the frame providing leak tight sealing to the HVAC unit frame. The condenser cover is not insulated. All other covers are insulated. The condenser grille covers are not meant to be walked on or stepped on. All other covers are designed to be walkable. Care should be taken when handling the covers. Any time a cover is removed it must be stored in a safe location to prevent damage. See Figure 2-2.

The evaporator section cover provides access to the evaporator coil, heater assembly, water eliminator, drain port, and evaporator blower assembly.

The return air cover provides rooftop access to all components in the return air space and fresh air inlets.

The condenser cover provides access to all components in the compressor-condenser section. Condenser fans have a protective grille and fan shrouding.

Refer to Section 7.3.8 for covers removal and installation procedures.

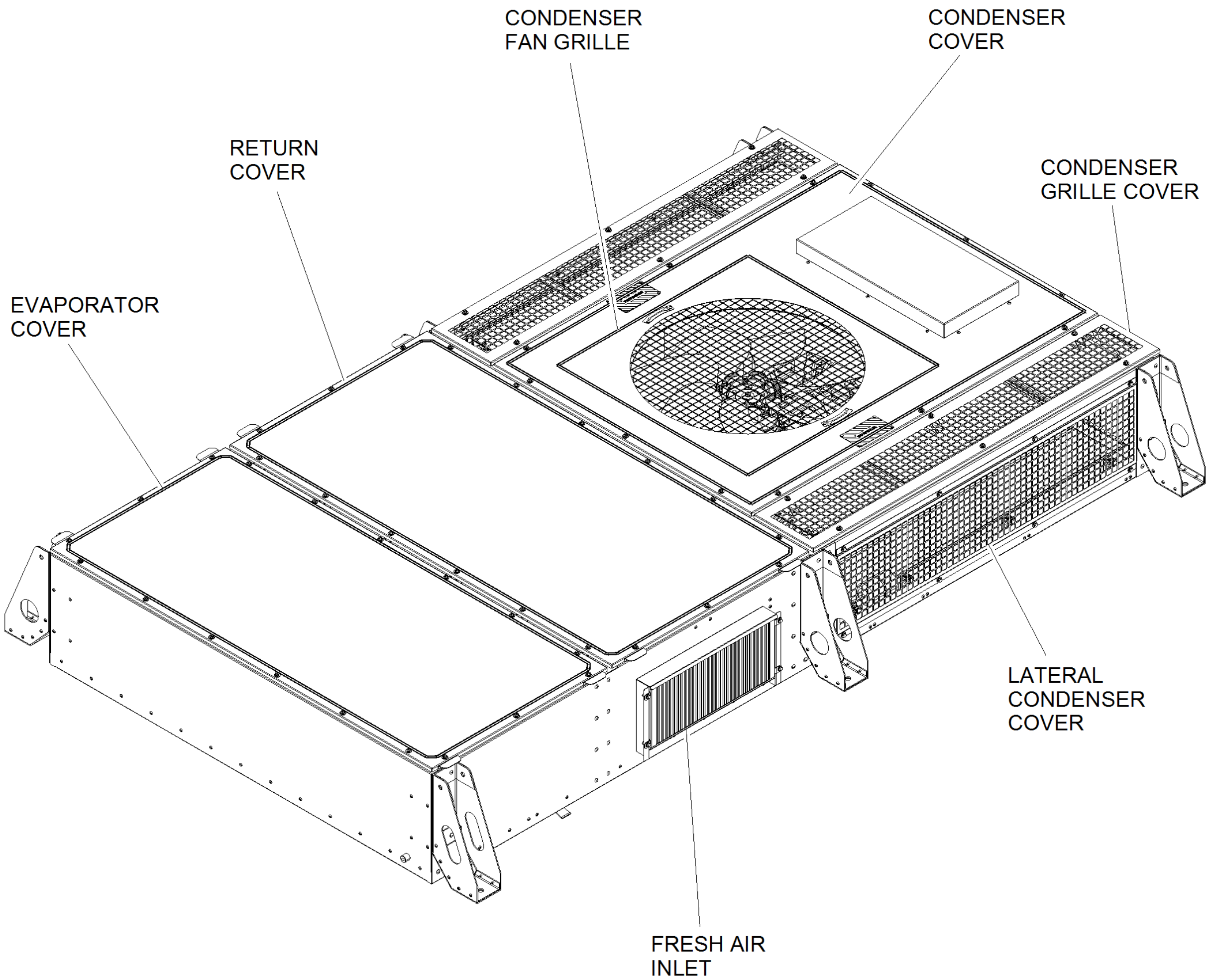


Figure 2-2: Access Covers and Grilles

2.2.3 System Piping and Schematic

The refrigerant copper piping system is fully contained and hermetically sealed to reduce the number of points of potential leakage. The hermetic design requires less maintenance and provides higher reliability by eliminating as many points of potential leakage as possible. The cold refrigerant piping is thermally insulated to prevent sweating due to condensation. The fire-resistant insulation does not interfere with the normal operation of the components or their accessibility.

The piping sizes are as follows:

- Suction: 7/8”
- Liquid: 3/8”
- Discharge: 1/2”

Figure 2-3 depicts the system piping diagram and Table 2-1 provides a cross reference of major system components.

Table 2-1. HVAC System Components

Figure Item No.	Description	Qty.	Item No.	Description	Qty.
1	Compressor	2	14	Low Pressure Transducer	2
2	Condenser Coil	2	15	High Pressure Switch	2
3	Condenser Motor	1	16	Low Pressure Switch	2
4	Condenser Fan	1	17	By-Pass Valve Coil	2
5	Evaporator Coil	1	18	By-Pass Body	2
6	Evaporator Blower Assy.	1	19	Safety Thermostat 1st	1
7	Electrical Heating	1	20	Safety Thermostat 2nd	1
8	Discharge Vibration Absorber	2	21	Air Flow Detector	1
9	Suction Vibration Absorber	2	22	Fusible Plug	2
10	Thermal Expansion Valve	2	23	Low Pressure Port	2
11	Filter Dryer	2	24	High Pressure Port	2
12	Sight Glass	2	25	Check Valve	2
13	High Pressure Transducer	2			

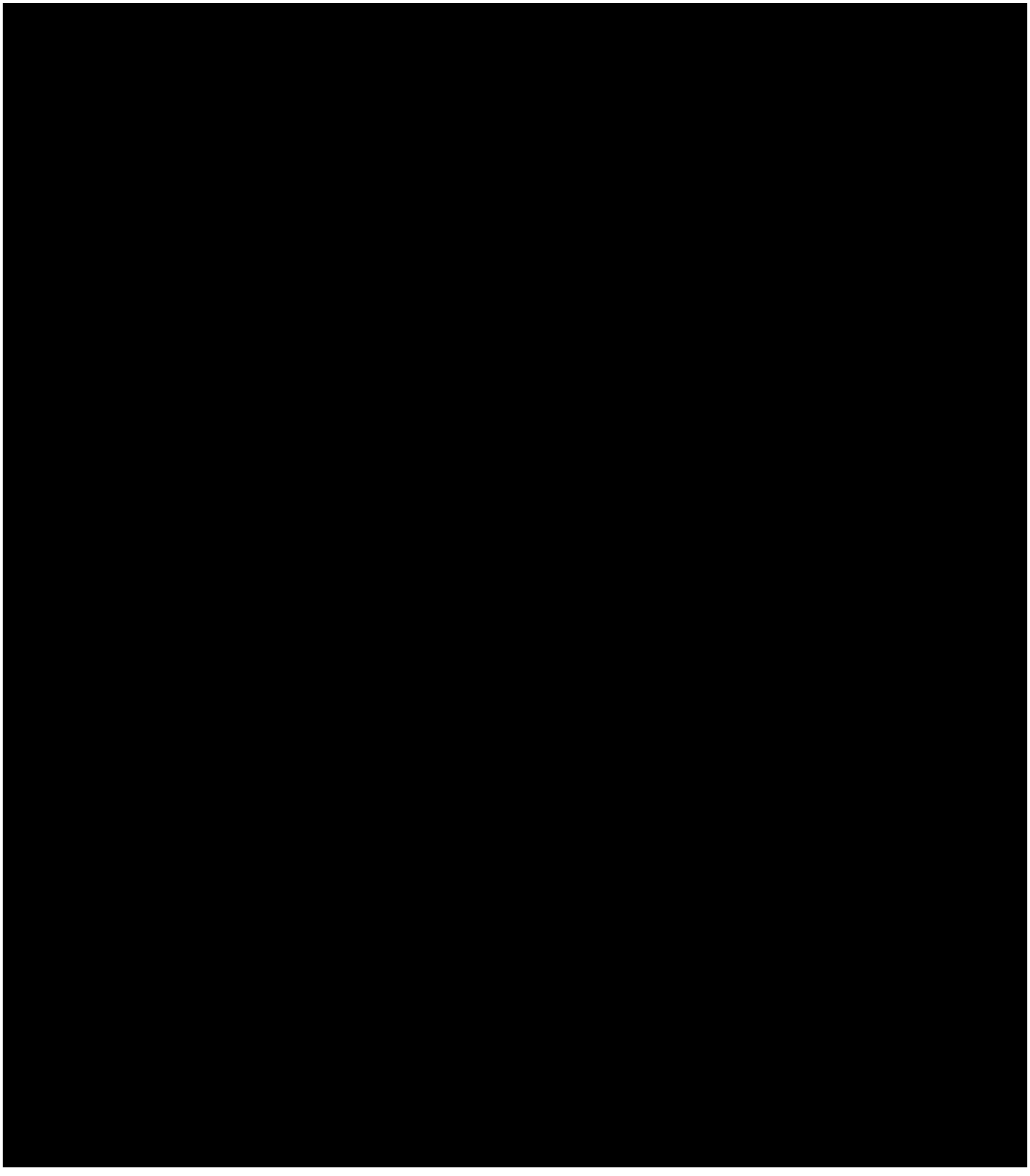


Figure 2-3: System Schematic and Piping Diagram

2.2.4 Car Mating Connectors

There is one set of connectors provided for each HVAC unit to interface with the car. The connection point for each connector is located at the Control Panel on the car side of the HVAC unit. See Table 2-2 and Figure 2-4 for location and part information.

Table 2-2. Car Mating Connectors

Figure Letter	Description	Function
A	CN3 Connector	ACCU Data Interface with PTU and MVB
B	CN2 Connector	24 VDC Main and Aux Power Supply, Master Reset
C	CN1 Connector	208VAC 60HZ 3 Phase Power Supply

2.2.5 Condenser-Compressor Section

The compressor-condenser section contains components for the high-pressure side of the refrigerant system, including condenser coils, resiliently mounted vertical compressors, and condenser fan with motor. Access to the compressor-condenser section is gained by removing a single cover with captive hardware.

The compressor-condenser section contains the following major components; see Figure 2-5:

- Two Compressors
- Four Compressor Vibration Absorbers
- Two Condenser Coils
- Condenser Fan
- Condenser Fan Motor
- Two Dehydrator Filters/Dryer

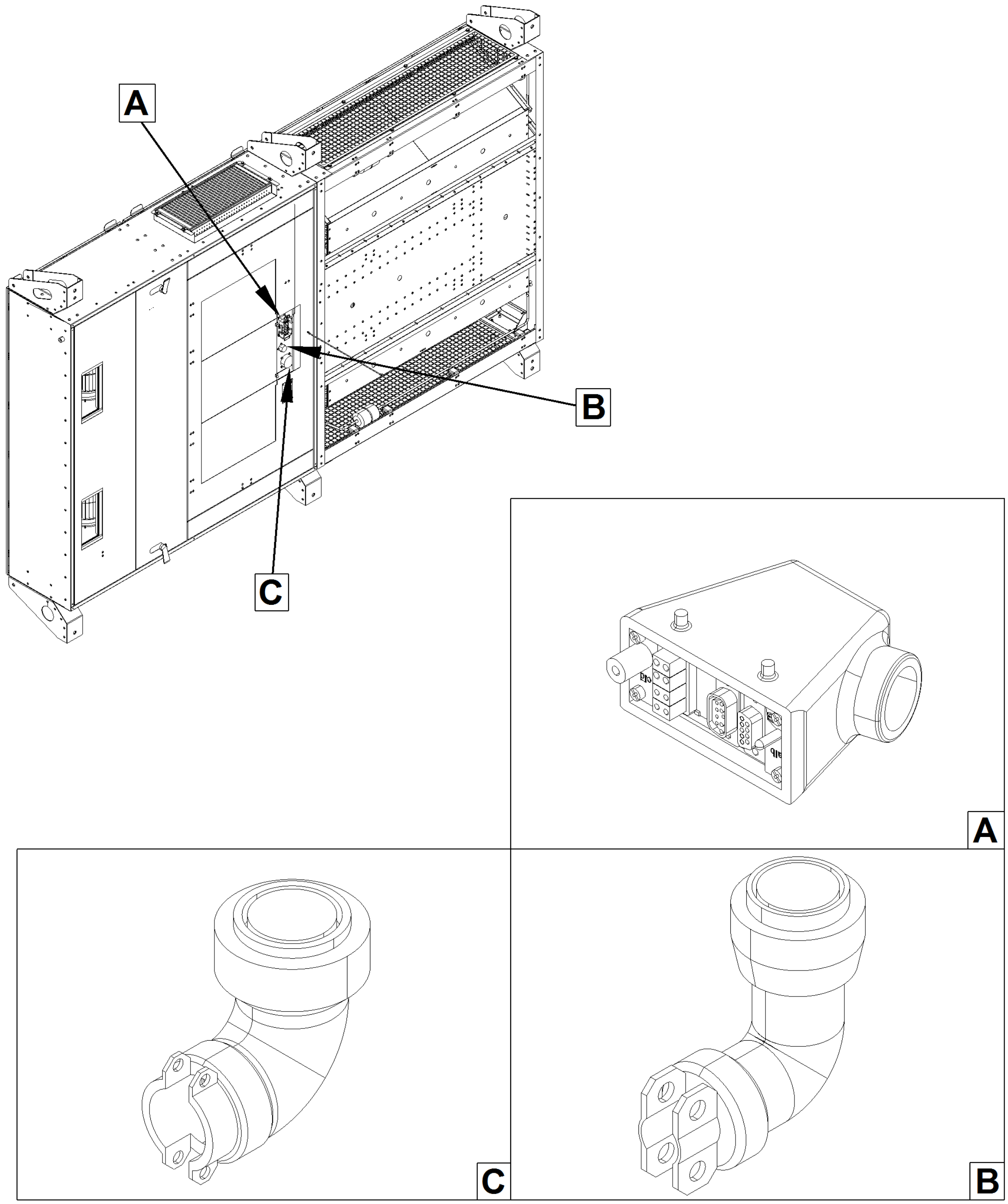


Figure 2-4: HVAC System Mating Connectors

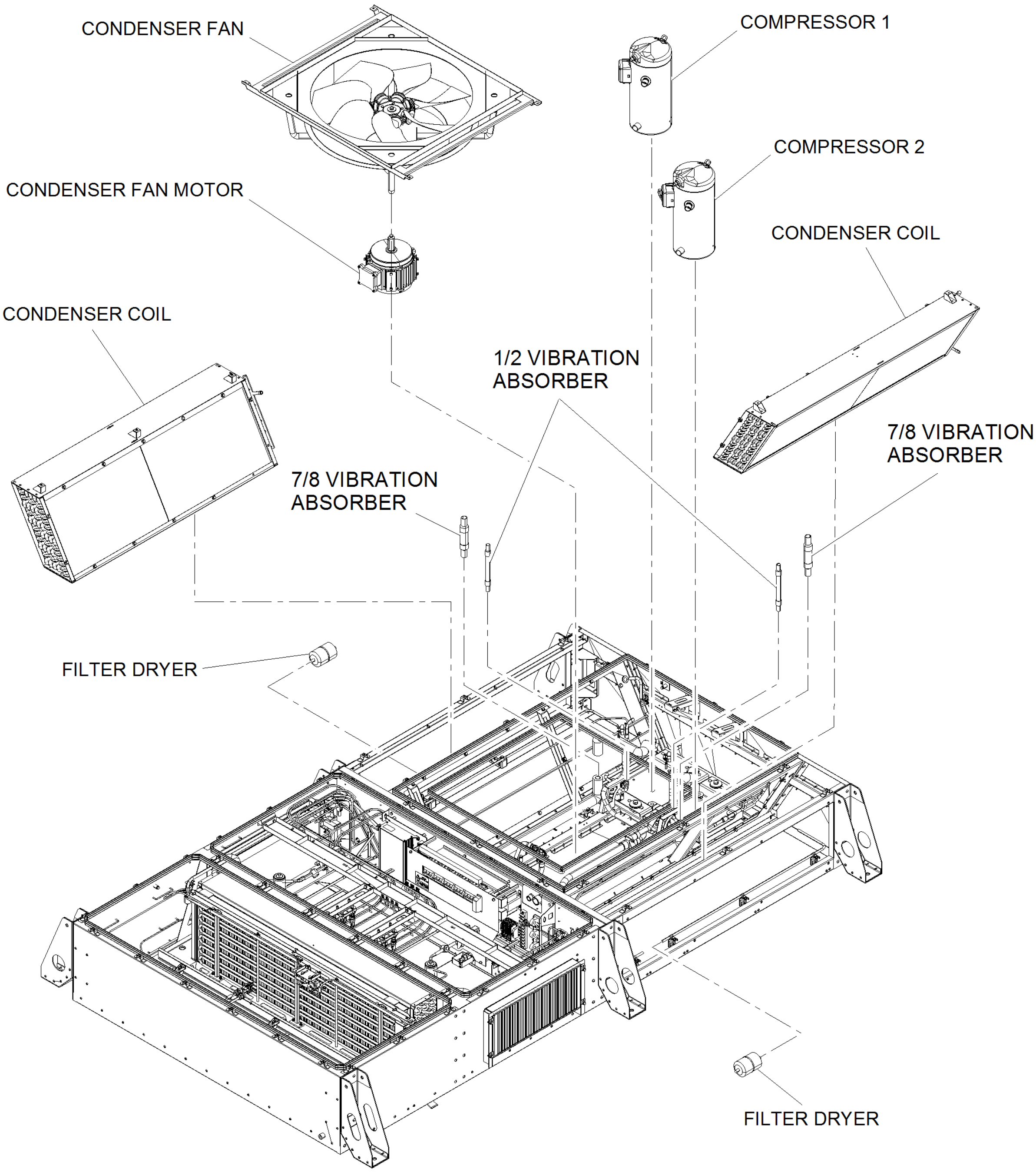


Figure 2-5: Compressor-Condenser Section

2.2.5.1 Compressor

The HVAC unit is equipped with two resiliently mounted vertical compressors, see Figure 2-6. There is one compressor per refrigeration circuit. Each compressor provides half the cooling capacity for each HVAC unit (14 kW).

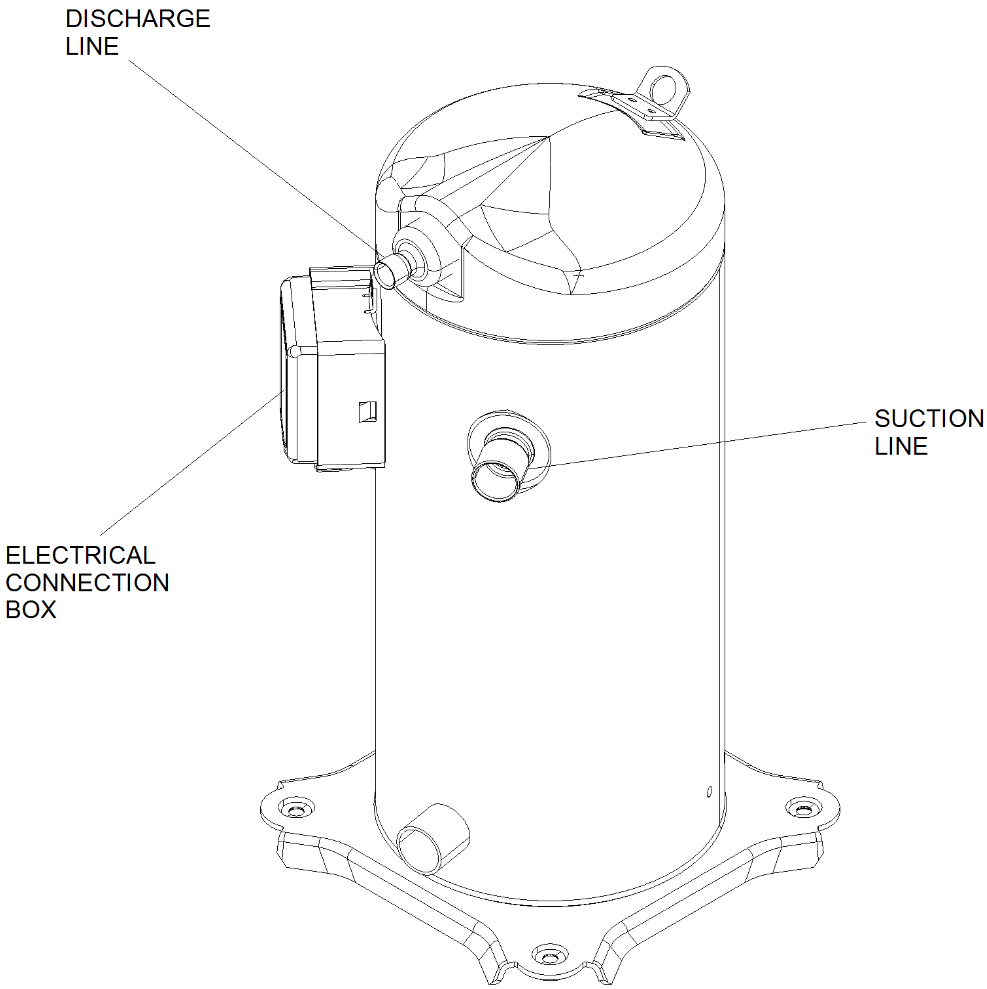


Figure 2-6: Compressor

The scroll compressor is designed around two identical spirals or scrolls which when inserted together, form crescent-shaped pockets. During a compression cycle, one scroll remains stationary while the other orbits around the first. As this motion occurs, gas is drawn into the scrolls and moved in increasingly smaller pockets toward the center. At this point, the gas has been compressed to a high pressure. The high pressure gas is discharged from a port in the center of the fixed scroll. During each orbit, several pockets of gas are compressed simultaneously, creating smooth, nearly continuous compression.

A motor is built into each compressor. This motor is designed to operate within the refrigerant and oil atmosphere of the piping system and is cooled by the refrigerant flow over the field windings.

The compressor is resiliently mounted on three vibration mounts to isolate the compressor from the HVAC unit frame. Convoluted brass vibration eliminators on each mount isolate the unit piping from the compressor. The compressor suction and discharge pipes are equipped with hose vibration absorbers to provide greater resistance against wearing and reduce vibration and noise.

The suction line has a 7/8 in. diameter, and the discharge line has a 1/2 in. diameter. The compressor refrigerant connections are by direct brazing to provide increased reliability by reducing the number of valves and potential leakage points.

2.2.5.2 Compressor Vibration Absorbers

There are four vibration absorbers, Figure 2-7 per HVAC unit, located on the compressor suction and discharge lines of each refrigeration circuit. The vibration absorbers are braided stainless steel and dampen the transmission of compressor-induced vibration through system piping. The vibration absorbers do not require any maintenance.

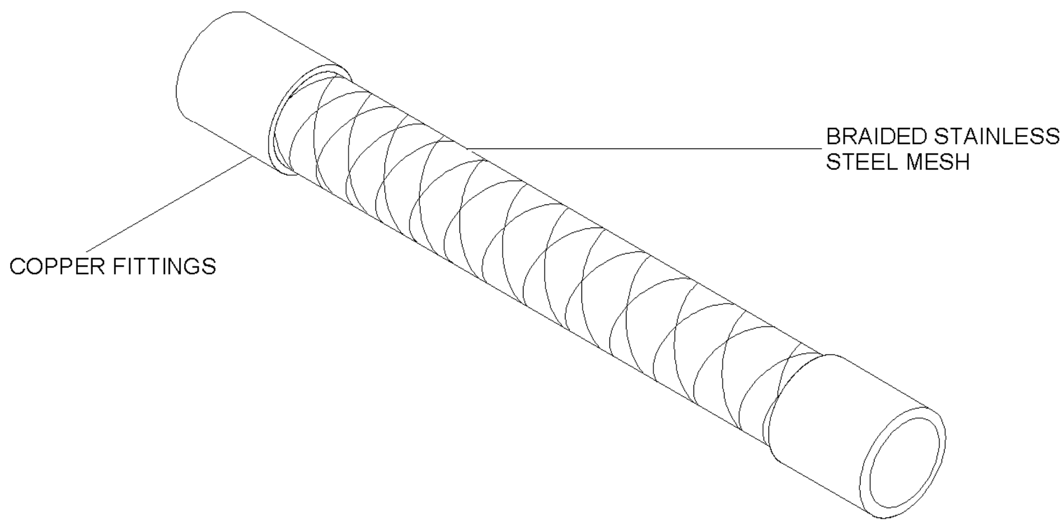


Figure 2-7: Vibration Absorber

2.2.5.3 Condenser Coil

The condenser coil is constructed from copper tubes expanded into aluminum fins. Each condenser is a 6-row coil with 0.008 inch copper plate fins spaced at 8 fins per inch. The 0.375 inch (9.52 mm) outer diameter copper tubes are arranged in series parallel circuits with the tubes mechanically expanded to hold the fins. Air is drawn through the coils by the condenser fans. See Figure 2-8.

The condenser coils are housed in a stainless steel frame and are horizontally mounted on either side of the condenser fans. The coil frame measures 16.41 inches high by 49.21 inches long (5.6 sq ft) and is 6.14 inches wide. The volume of the condenser coil is large enough to hold the entire refrigerant charge.

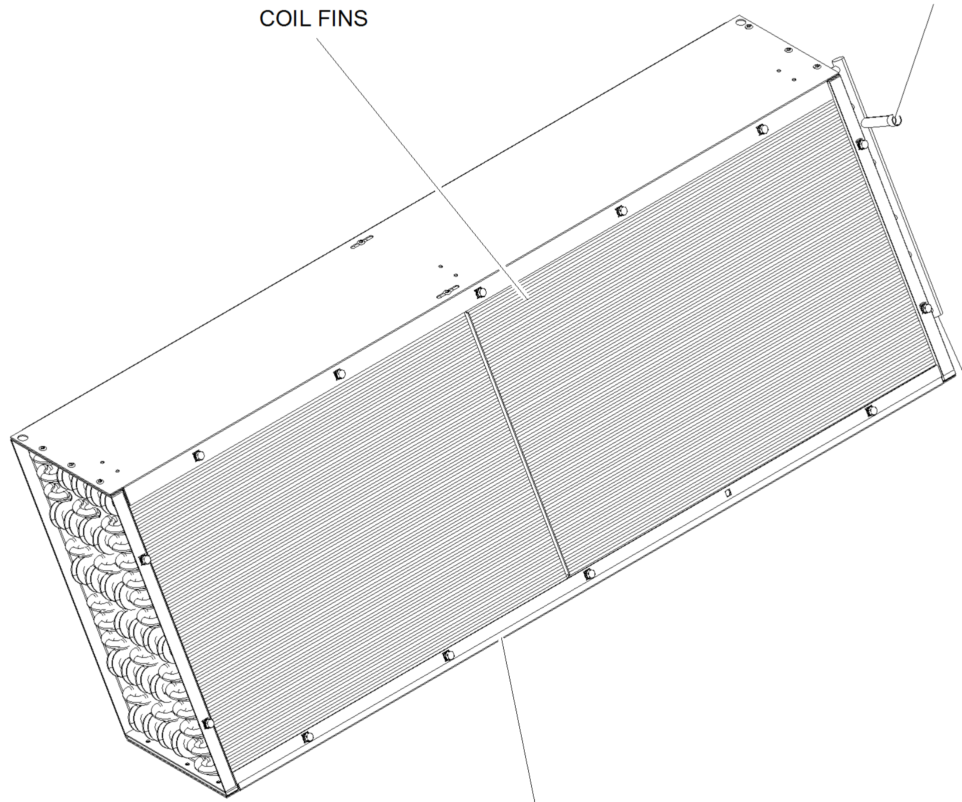


Figure 2-8: Condenser Coil

2.2.5.4 Condenser Fan and Motor

There is one condenser fan and motor assembly per HVAC unit, located between the condenser coils and compressors. The condenser fan pulls air in through the condenser coils and discharges the air vertically upwards. The condenser fan is attached directly to the motor shaft. See Figure 2-9.

Each assembly is composed of a seven blade axial flow fan, with P.A.G. (thermoplastic) blades fitted in a painted aluminum hub. A 3-phase, vertically-mounted single speed motor powers the fan.

The motor is 1.5 kW, 6 pole powered at 208VAC/3-phase/60Hz. The motor speed is 1140 rpm (nominal), airflow 423,776 CF/hr (12,000 m3/hr) and rated at 2 HP. The motor has permanently lubricated ball bearings and Class H insulation.

Each fan and motor assembly has a fan shrouding and protective grille surrounding each fan.

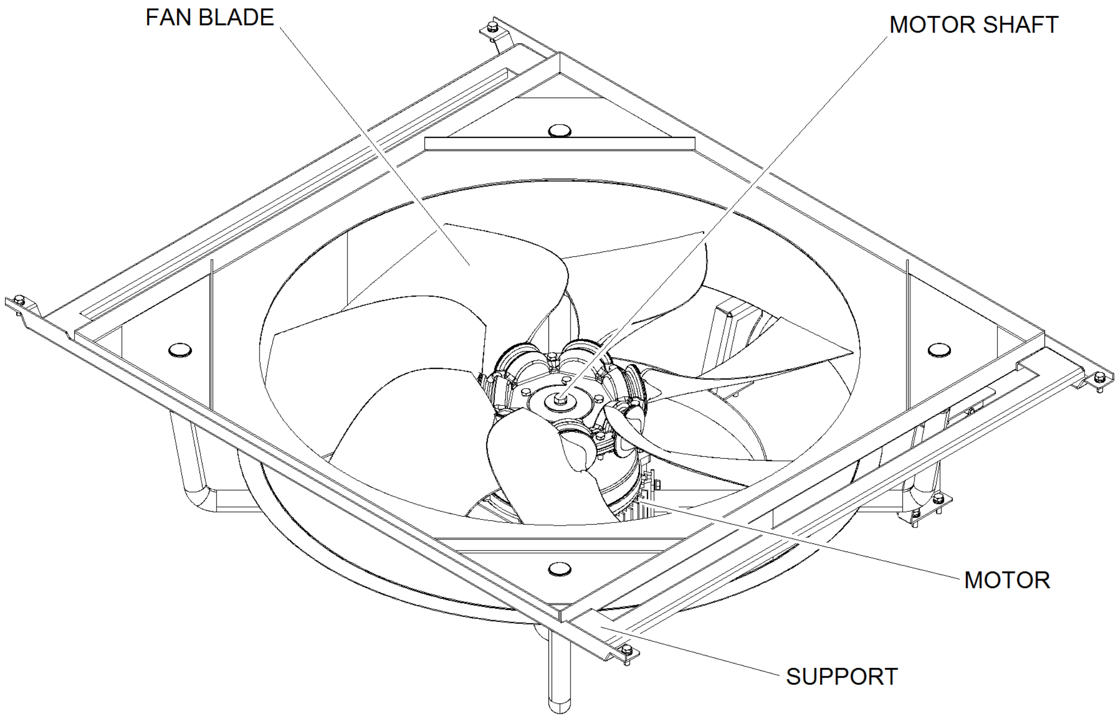


Figure 2-9: Condenser Fan and Motor

2.2.5.5 Filter Drier

There are two filter driers per HVAC unit (one per refrigerant circuit) located on the liquid line between the condenser coil and evaporator coil. The filter drier is hermetically sealed into the system through brazing. See Figure 2-10.

The primary function of the filter drier is filtration and removal of moisture and acid from the system. The desiccant volume is 16 cubic inches, composed of a molecular sieve and alumina in a welded steel shell.

Molecular sieve is a desiccant used for the primary purpose of removing moisture. Water removal is necessary since moisture can play a role in the formation of acids and corrosion within a system. The primary purpose of activated alumina is to remove acid. Acids not removed from a system will react with other materials and could adversely affect system components. A mixture of these desiccants is ideal in the removal of the many types of contaminants which are possible in any system, such as moisture, acids, foreign matter, sludge, and varnish.

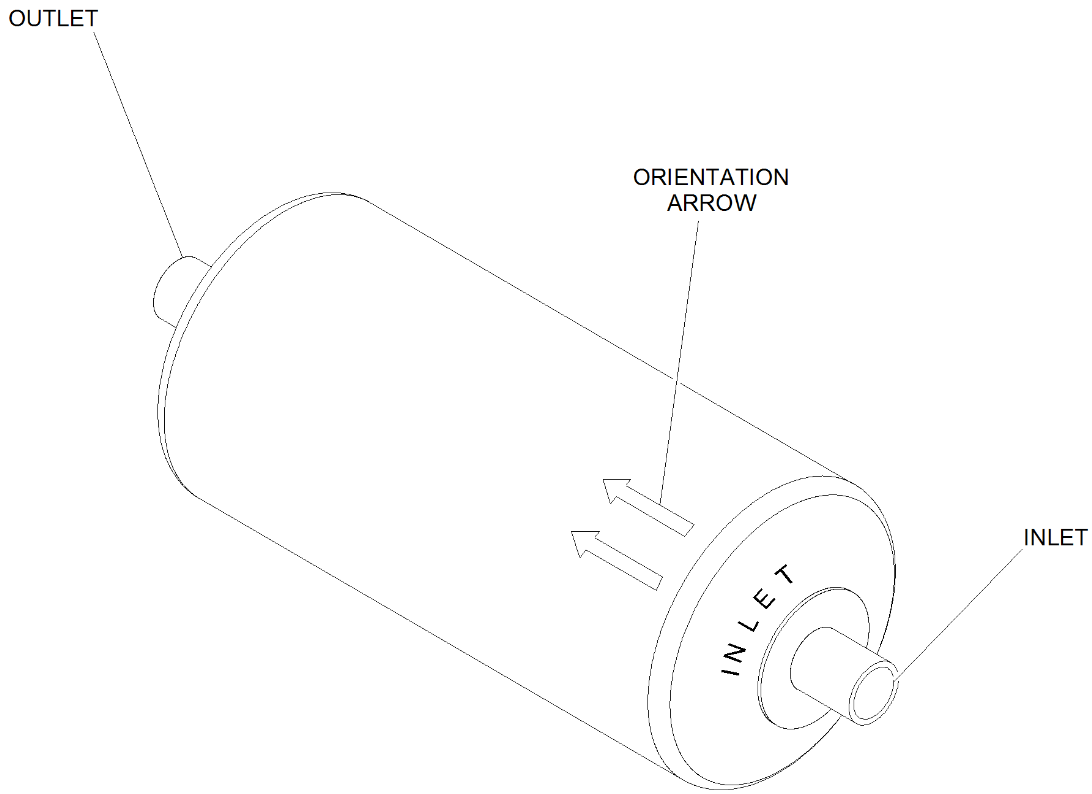


Figure 2-10: Filter Drier

2.2.6 Evaporator Blower and Return Air Section

The evaporator blower section houses components in the low-pressure side of the refrigerant system and includes the heating components. The refrigeration circuit controls are in the return air plenum. See Figure 2-11 for component details.

The evaporator blower section is a pull through design. Return air from the train car is first drawn in through the car's return air grille and through the return air filter. Fresh air is drawn in through the two fresh air inlets, through the water eliminators and is filtered by the fresh air filters. The fresh air is mixed with the return air in the return air plenum. The air mixture is then drawn through the evaporator coil and overhead heater by the suction of the evaporator blower. The cooled or heated air is then blown into the main car duct.

The return air plenum, also known as the return air mix area, is the area in the HVAC unit where the fresh air and return air "mix" before being drawn through the evaporator coil and heater by the suction of the evaporator blower. The mixed air is then blown into the car interior, via the main car duct, by the evaporator blower.

Access to the return air plenum is gained by lowering the return air grille in the car ceiling then removing the return air filter.

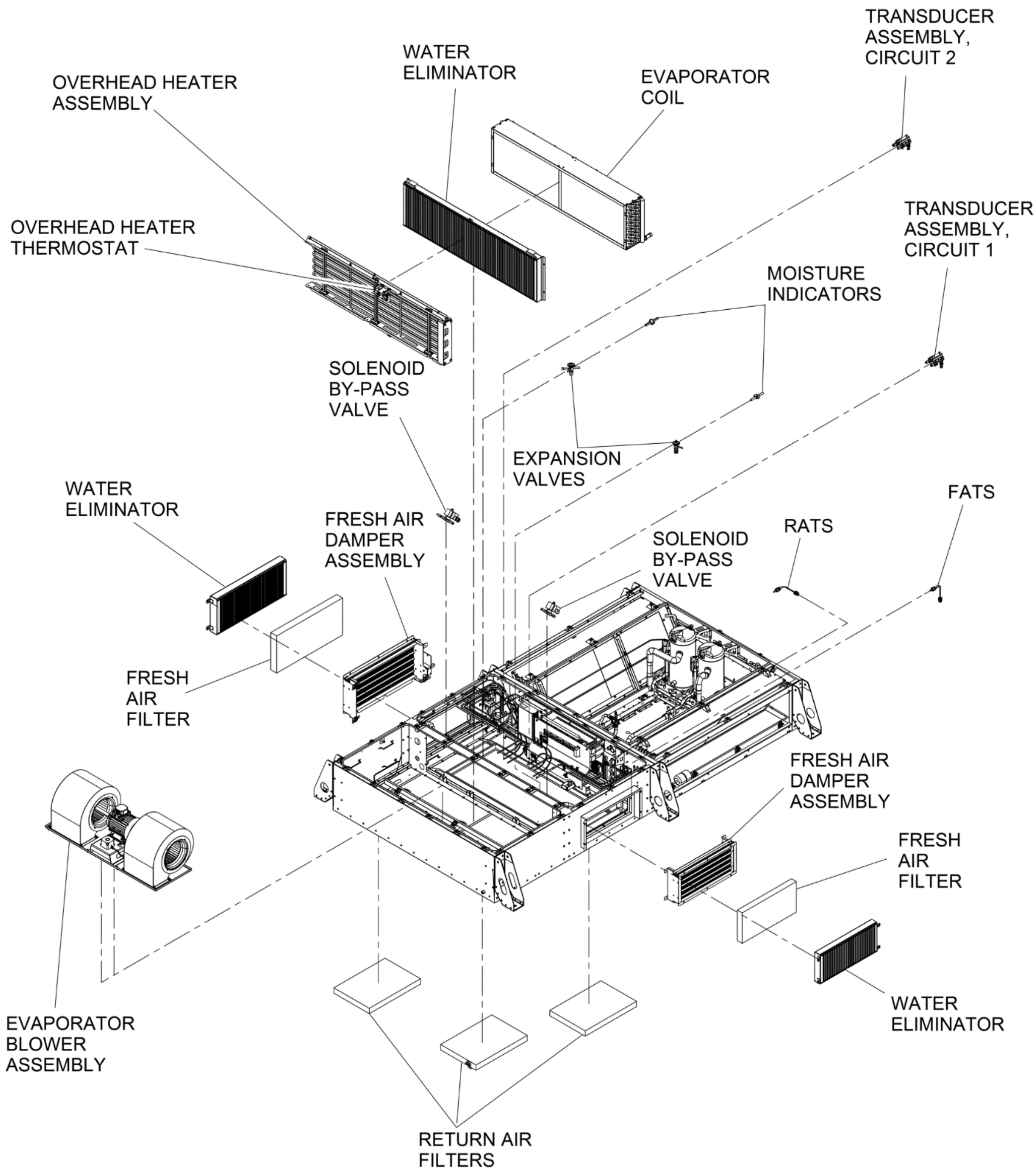


Figure 2-11: Evaporator Blower Return Section

The evaporator section and return air section contains the following main components:

- Two Fresh Air Inlets
    - Water Eliminators at Fresh Air Inlet
    - Fresh Air Dampers
    - Fresh Air Filters
- Return Air Plenum
    - Return Air Filter
    - Two Pressure Transducers Assemblies
    - Two Moisture Indicators with Sight Glass
- Evaporator Coil
- Two Expansion Valves
- Water Eliminator (at evaporator coil)
- Overhead Heater
    - Overhead Heater Thermostat
- Evaporator Blower and Motor Assy.
- Two Hot Gas Bypass Valves
- Two Probe Assemblies
- Two Dampers
- Blower Assembly

2.2.6.1 Return Air Filter

There are three return air filters located in the return air opening at the bottom of the HVAC unit. The return air filter is a disposable 20" x 14" x 2" thick cardboard frame with pleated, non-woven, reinforced cotton/synthetic media blend, bonded to a welded wire support grid. See Figure 2-12.

The filters can be replaced from the interior of the car by lowering the return air grille in the car ceiling. The wire mesh side of the filter faces up, into the return air plenum, while the side without wire mesh faces downward, towards the car interior.

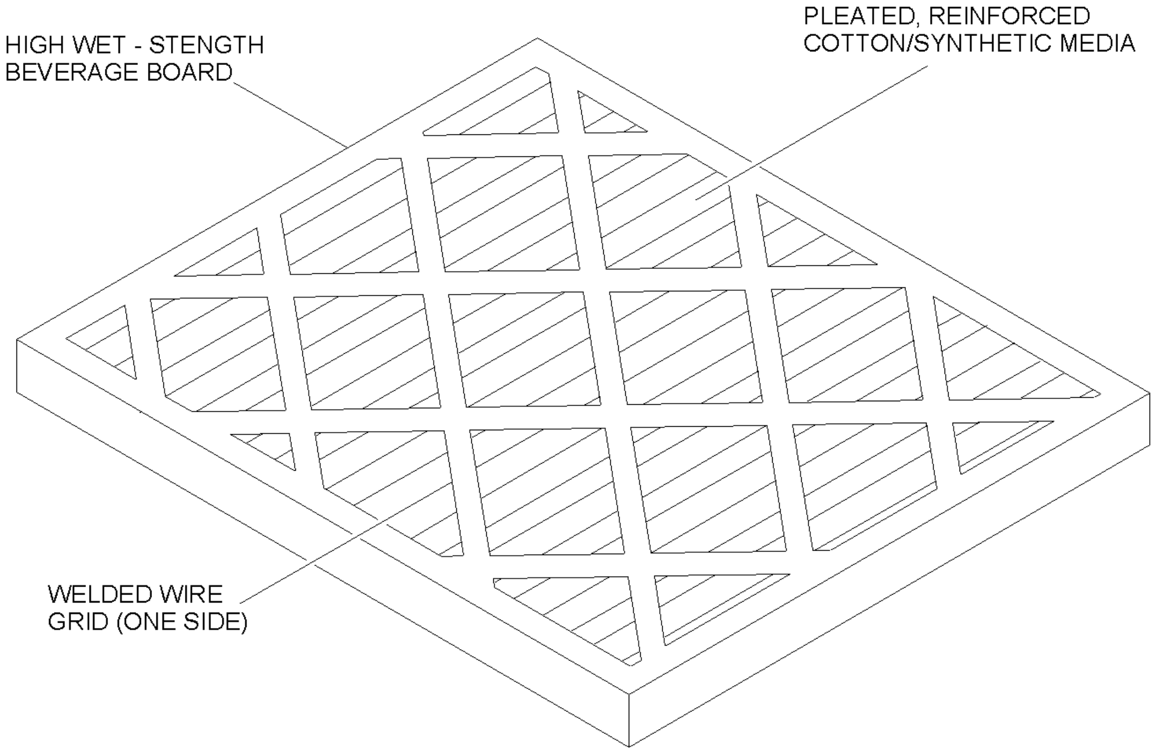


Figure 2-12: Return Air Filter

2.2.6.2 Probe Assembly (Air Temperature Sensor)

There are three probe assembly sensors (Figure 2-13) on the HVAC unit; one on the blower assembly and two in the return plenum area. Each probe assembly is identified as follows:

FATS – Fresh Air Temperature Sensor located on the fresh air inlet vent and measures the fresh air temperature.

RATS – Return Air Temperature Sensor located in the return plenum area at the return air filter and measures the return air temperature.

SATS – Supply Air Temperature Sensor located on the blower assembly and measures the air supplied to the car.

The temperature sensor uses a Negative Temperature Coefficient (NTC) thermistor. The sensing component is encapsulated inside a stainless steel tube. The sensor transmits a signal to the HVAC controller and heating and cooling is performed as necessary.

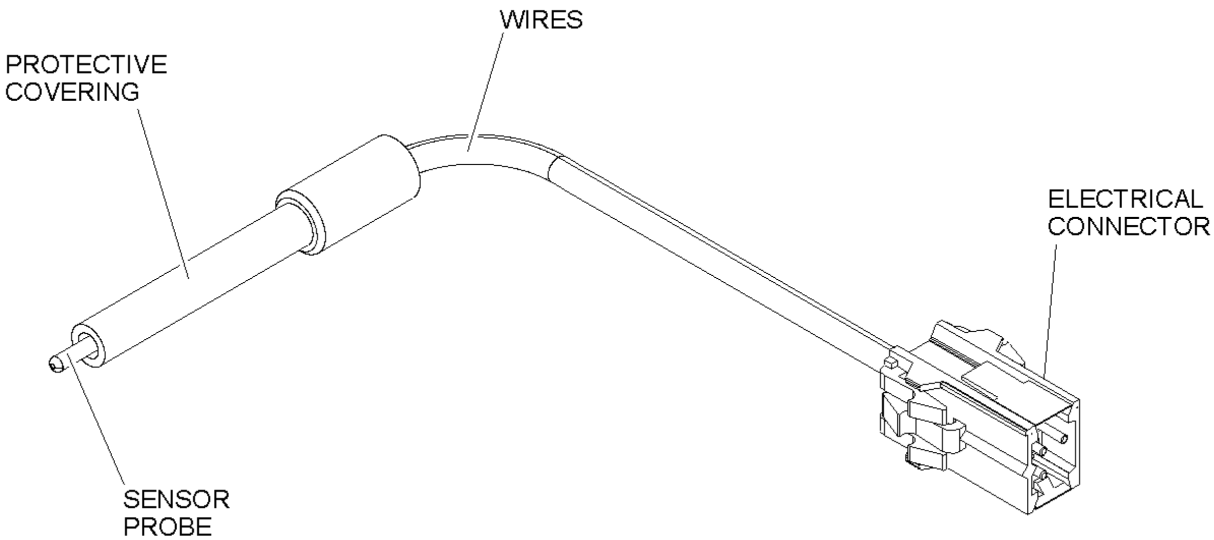


Figure 2-13: Probe Assembly, Air Temperature Sensor

2.2.6.3 Pressure Transducers

There is one high pressure and one low pressure transducer per refrigeration circuit, four transducers per HVAC unit. The transducers are located in the return air plenum and mounted on two transducer assembly brackets. The transducer connections are provided with Schrader valves. The transducers are non-adjustable and are not serviceable. Access to the transducer assembly is through the bottom of the unit by removing the return air grille and filters, see Figure 2-14.

The low pressure transducer (LPT1 and LPT2) monitors the suction pressure of the refrigerant entering the compressor while the high pressure transducer (HPT1 and HPT2) monitors the discharge pressure of the refrigerant output from the compressor.

The transducer develops an analog electric signal between 0 and 5 volts that is proportional to the pressure value. This analog signal is sent to the HVAC controller. The controller converts the analog signal to a pressure value. The controller continuously monitors the suction and discharge pressures, checking for pressures that affect compressor operations.

When the suction pressure drops to 20 psig, the HVAC controller de-energizes the compressor contactor stopping the compressor. The high pressure transducer relays the discharge pressure analog signal value to the HVAC controller to implement modulated cooling, via the hot gas bypass valves, as necessary. The high pressure transducer setting is 420 psig.

Shrader valves are installed in the high and low pressure distributor's ports (refrigeration control assembly) as well as the service ports. The schrader valves allow removal and installation of pressure transducers without refrigerant escaping from the circuit. Refer to IPC, MU-275/2, Section 5.0-11 for schrader valve details.

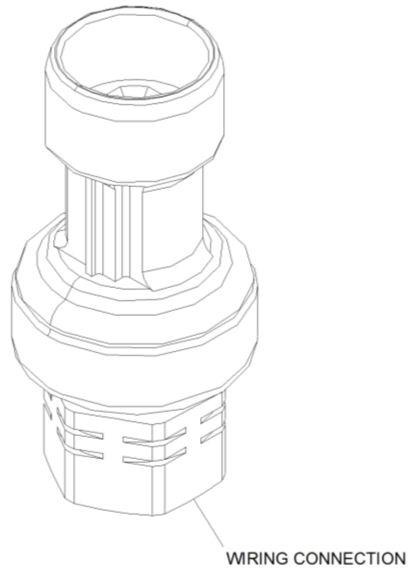


Figure 2-14: Transducer Assembly

2.2.6.4 Pressure Switches

There is one high pressure and one low pressure switch per refrigeration circuit, four switches per HVAC unit. The switches are located in the return air plenum and mounted on the transducer assembly bracket. The switch connections are provided with Schrader valves. The switches are non-adjustable and are not serviceable. Access the transducer assembly through the bottom of the unit by removing the return air grille and filter. See Figure 2-15.

The refrigerant system is modulated and controlled by the pressure transducers. The pressure switches are used as a backup system to stop the compressors in case of failure or malfunctioning of the transducers.

The low pressure switch (LPS1 and LPS2) monitors the suction pressure of the refrigerant input to the compressors. The switch is a safety device and opens when the refrigerant suction pressure reaches a low pressure limit of 12 ± 5 psig. When the switch opens, the compressor stops to prevent system operation below atmospheric pressure. The switch closes when the suction pressure increases to 40 ±5 psig. When the LPS close, the compressor is allowed to restart.

The high pressure switch (HPS1 and HPS2) monitors the discharge pressure of the refrigerant output from the compressor. The switch is a safety device and opens when the refrigerant discharge pressure reaches a high pressure limit of 435 ±10 psig. When the switch opens, the compressor stops. The switch closes when the discharge pressure decreases to 355 ±10 psig. These pressure settings allow unit operation up to 120°F ambient air temperature. When the HPS closes, the compressor is allowed to restart.

Shrader valves are installed in the high and low pressure distributor's ports (refrigeration control assembly) as well as the service ports. The schrader valves allow removal and installation of pressure switches without refrigerant escaping from the circuit. Refer to IPC, MU-275/2, Section 5.0-11 for schrader valve details.

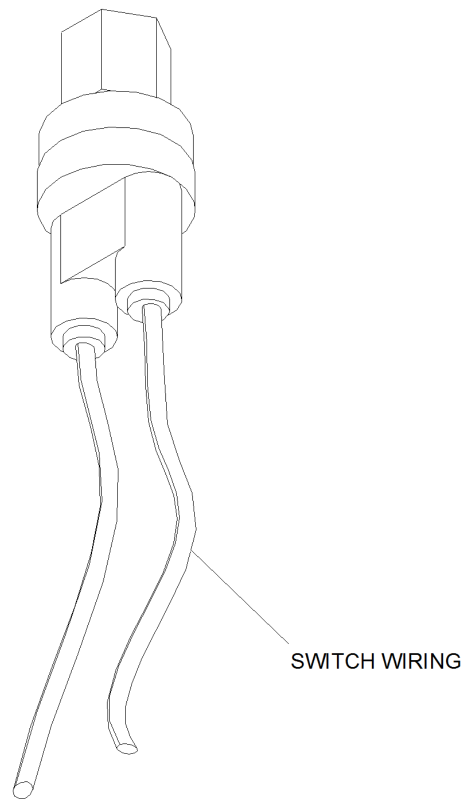


Figure 2-15: Pressure Switch

2.2.6.5 Solenoid By-Pass Valve - Capacity Regulation

There are two by-pass solenoid valves in each HVAC unit, one per refrigeration circuit, located in the return air plenum, see Figure 2-16.

Hot gas by-pass provides an artificial load on the evaporator coil by introducing a portion of high pressure, high temperature refrigerant vapor from the discharge line directly to the low pressure, evaporator/suction side of the system. The refrigerant gas from the by-bass valve enters at the evaporator coil inlet, after the expansion valve. This provides additional modulation capability and keeps the HVAC unit working at low ambient conditions without risk of coil freezing.

The hot gas by-pass solenoid valves provide the following advantages:

- The HVAC unit will continue cooling at low ambient temperatures by cooling modulation.
- More effective cooling modulation versus compressor on/off and condenser fans on/off.
- Increased temperature regulation due to more effective cooling modulation.
- Reduces the number of compressor cycles due to more effective cooling modulation.
- Reduces the power consumption in cooling modulation.

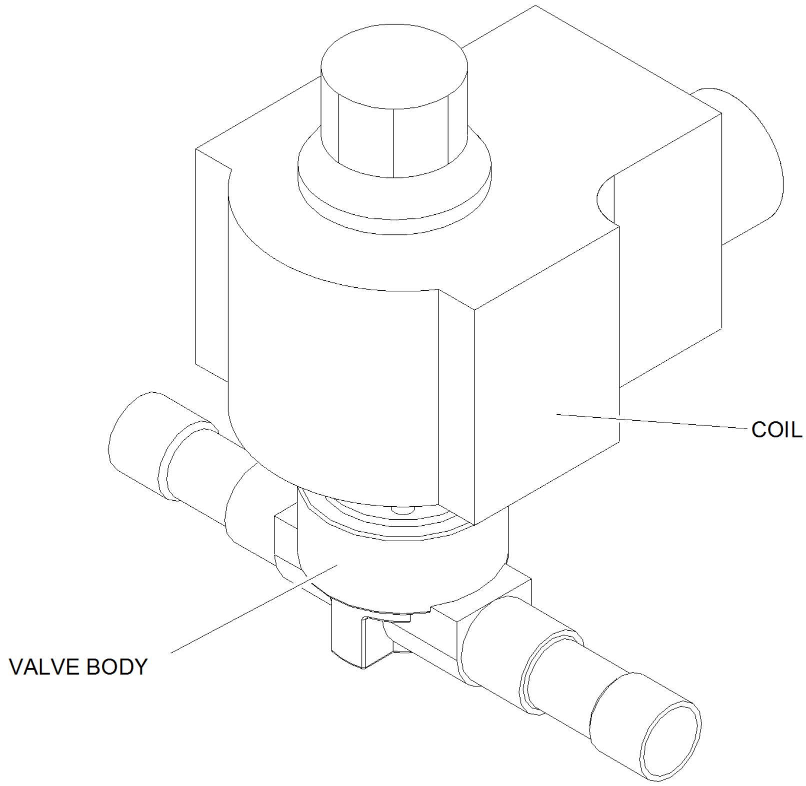


Figure 2-16: Solenoid Capacity Regulator Valve

2.2.6.6 Moisture Indicator

There are two moisture indicators per HVAC unit, one per refrigeration circuit, located on the liquid line between the filter drier and evaporator coil. The moisture indicator has two functions; to show humidity level in the system and to allow viewing the refrigerant flow. See Figure 2-17.

The moisture indicator shows humidity level in the system by means of a porous filter paper impregnated with a chemical salt that is sensitive to moisture. The salt changes color according to the moisture content (relative saturation) in the refrigerant. A dark green color indicates the refrigerant is DRY, chartreuse indicates a CAUTION condition, and yellow indicates a WET condition. The protective cap includes a color reference label.

The indicator is formulated so that it changes color at the moisture levels generally accepted as the safe operating range. The action of the indicator element is completely reversible and will change color as often as the moisture content of the system varies. When the moisture indicator color is in the CAUTION or WET range, the filter drier must be changed.

The moisture indicator allows viewing the refrigerant flow through a clear sight glass. The presence of bubbles may indicate an abnormal situation such as low refrigerant charge, insufficient cooling of the refrigerant liquid, low discharge pressure, or a blocked refrigerant liquid line.

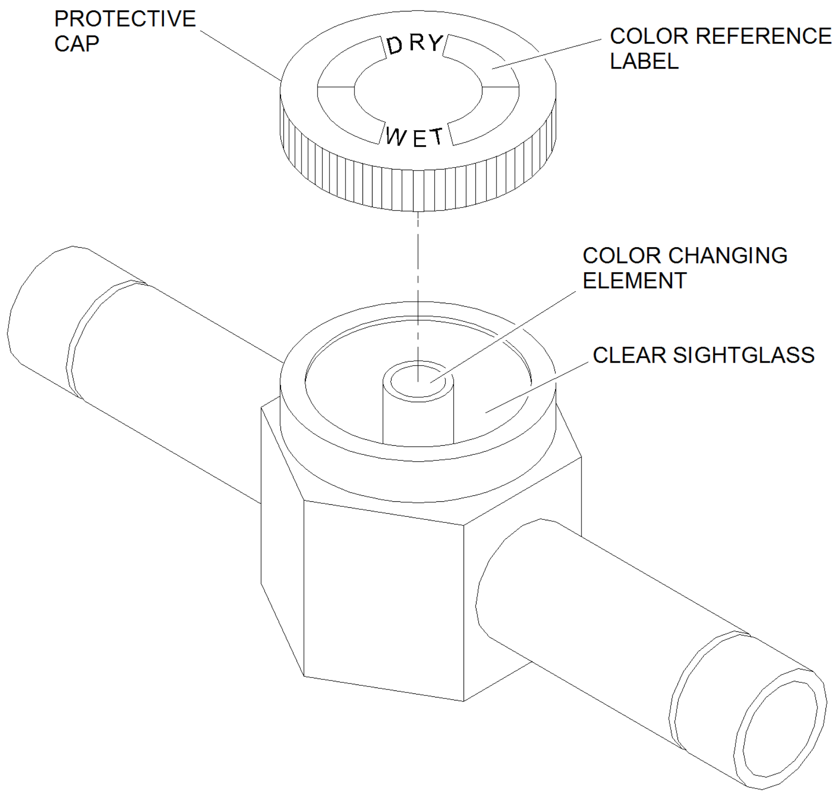


Figure 2-17: Moisture Indicator

The moisture indicator is made of copper plated steel fittings that are copper brazed to the heavily copper plated steel body. The fittings are direct brazed into the ½" liquid line. A glass disc is inserted in the body and heated just to the melting point to fuse the glass to the body in a permanent leak-free joint. The indicator paper (retained in a small brass ferrule) is inserted from the back and held in place with a slotted cylinder. The slotted cylinder and indicator assembly is mounted on a post that screws into the bottom of the body, and seals with a knife-edge joint. This overall construction is highly effective in preventing refrigerant leakage. The unit is painted to protect it from corrosion.

When drying the HVAC system, the system should be dried until the color-changing element stays dark green.

When brazing near the moisture indicator, avoid overheating the body since extreme heat could damage the glass joint. If a wet rag is used it should be wrapped around the fittings and bottom of the body, but not around the top body. This is to avoid moisture inside the indicator condensing on the cool glass surface and washing away the color indicator material.

2.2.6.7 Fresh Air Inlet

There are two fresh air inlets per HVAC unit located on the exterior frame wall in the return air plenum. Each fresh air inlet is equipped with water eliminator, a motorized fresh air damper, and a fresh air filter. Ambient air is drawn in through the two fresh air inlets and through the fresh air filters into the return air plenum by the suction of the evaporator blower.

The fresh air temperature sensor (FATS) is located in one fresh air inlet.

2.2.6.8 Water Eliminator (Fresh Air Inlet)

There are two water eliminators per HVAC unit, located at each fresh air inlet. The purpose of this eliminator is to prevent water from entering the passenger area through the duct work. The water eliminator is made of extruded, anodized aluminum and is located on the outside of the HVAC unit frame. See Figure 2-18.

2.2.6.9 Fresh Air Damper Assembly (Fresh Air Inlet)

There are two fresh air dampers per HVAC unit located in each fresh air inlet on either side of the HVAC unit. The dampers flaps open when powered from the car battery but can be closed by the cab operator when necessary to prevent dangerous airborne particles, smoke, or dust from entering the train. See Figure 2-19.

Opening of the damper flaps is done by an electric servomotor. The servomotor moves the damper flaps to the open position and when power supply to the servomotor is interrupted, moves the damper to the closed position.

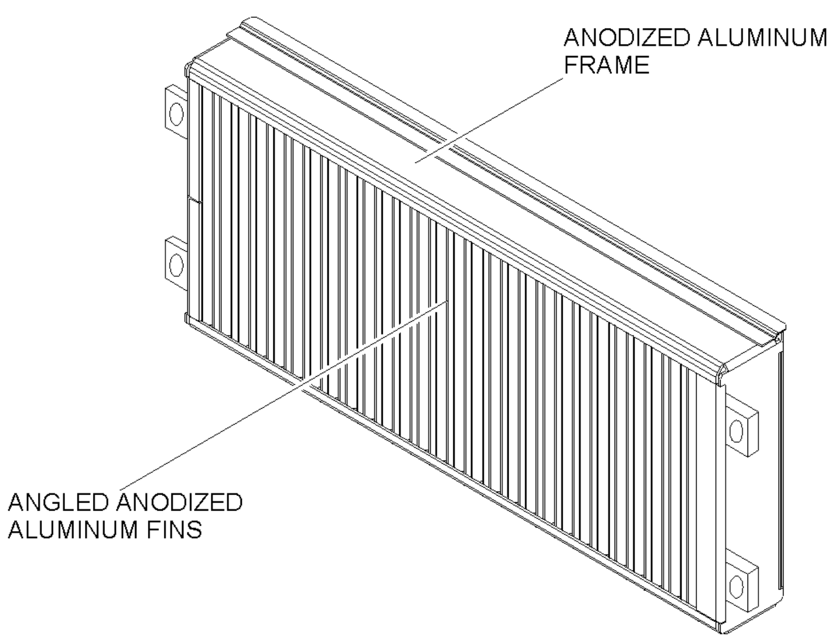


Figure 2-18: Water Eliminator

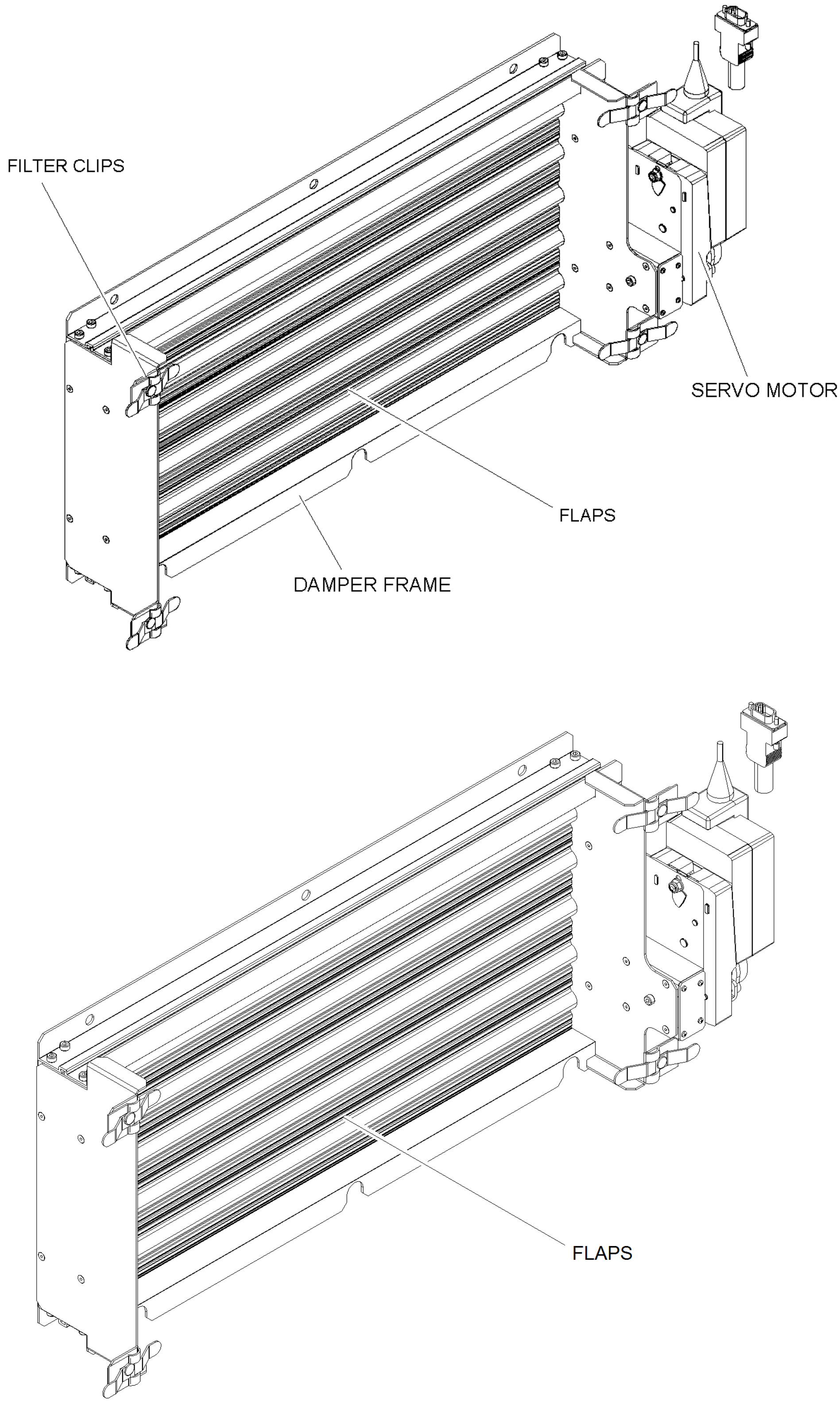


Figure 2-19: Fresh Air Damper

2.2.6.10 Fresh Air Filter (Fresh Air Inlet)

There are two fresh air filters per HVAC unit, located in the fresh air inlets behind the fresh air damper. The fresh air filter is a disposable 24" x 10" x 2" thick cardboard frame with pleated, non-woven, reinforced cotton/synthetic media blend, bonded to a welded wire support grid. See Figure 2-20.

The filters are accessible through the return air plenum. Filter replacement can be performed from the interior of the car by lowering the return air grille in the car ceiling then removing the return air filter to gain access to the return air plenum. The wire mesh side of the filter faces inside the air plenum. Refer to the “Air Flow” arrow printed on the filter.

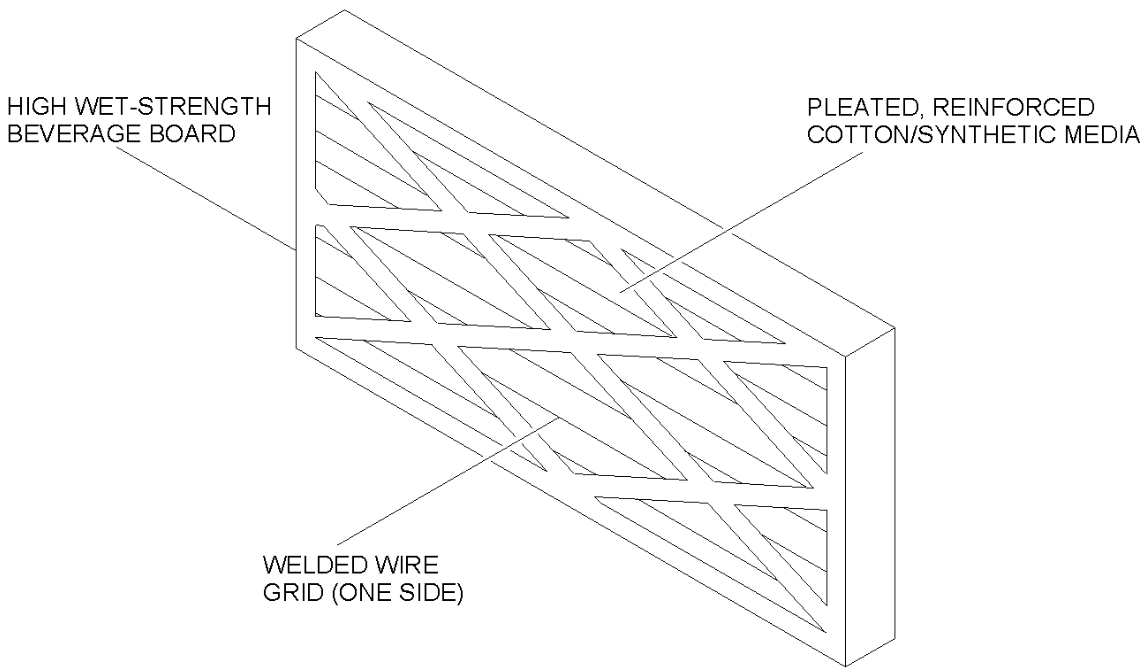


Figure 2-20: Fresh Air Filter

2.2.6.11 Evaporator Coil

There is one dual circuit evaporator coil per HVAC unit, located next to the overhead heater, to cool and dehumidify the fresh and re-circulated air. The evaporator coil is a heat exchanger made of 7-row, 0.375 inch (9.5 mm) copper tubes jointed with 0.008 inch aluminum fins, spaced at 9 fins per inch. The coil frame is stainless steel and measures 14.53 inches high by 50.79 inches long and is 6.06 inches wide. See Figure 2-21.

The evaporator coil is split into two independent circuits. Each circuit is fed by a different compressor and externally equalized expansion valve. The two coil circuit halves are interlaced so the half circuit in-service cools the entire airflow. As the expansion valves regulate the amount of liquid refrigerant entering the evaporator coil, pressure decreases rapidly. The rapid pressure decrease and the heat absorbed from the car interior vaporize the refrigerant and decreases the temperature of air delivered to the car.

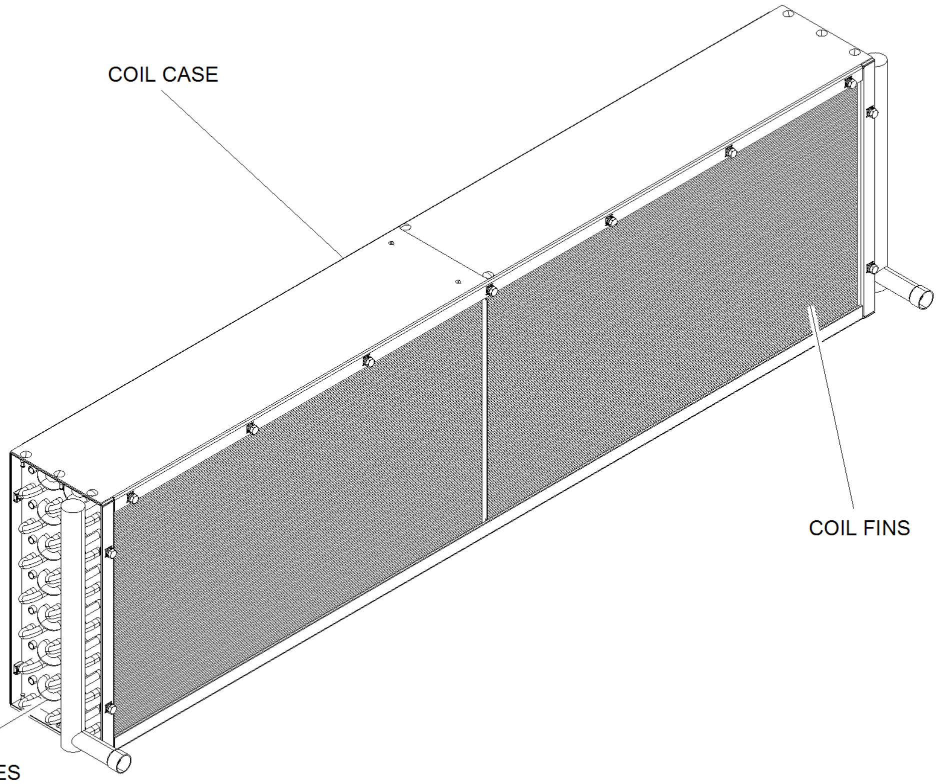


Figure 2-21: Evaporator Coil

2.2.6.12 Thermostatic Expansion Valve

There are two thermostatic expansion valves per evaporator coil, one for each circuit. The expansion valve meters the correct amount of liquid refrigerant into the evaporator coil. This ensures the refrigerant is all vaporized at the evaporator coil outlet while at the same time ensuring there is a sufficient differential pressure between the low pressure and high pressure sides of the refrigerant circuit. See Figure 2-22.

The valve consists of a valve body connected to a bulb by a capillary tube. The body is mounted on the liquid line and the bulb is fixed to the evaporator coil outlet on the suction line.

The bulb holds a small amount of refrigerant. The free space in the bulb, the capillary tube, and the free space above the valve are full of saturated vapor at the pressure corresponding to the bulb temperature. The space below the diaphragm is in contact with the evaporator coil; therefore the pressure here is the evaporation pressure.

The opening degree of the valve is determined by the pressure caused by the bulb charge temperature exerted on the upper side of the diaphragm; and by the pressure below the diaphragm, which is the addition of the evaporation pressure plus the pressure of the spring acting on the lower side of the diaphragm.

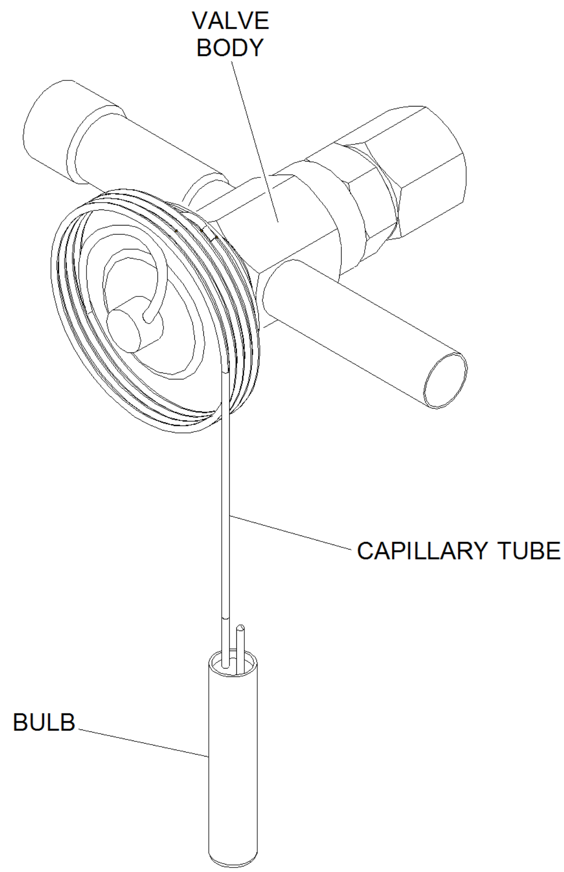


Figure 2-22: Expansion Valve

Therefore, the thermostatic expansion valve works because of the pressure differential between the vapor pressure in the evaporator coil and the charge pressure in the bulb. Since the thermal bulb is in touch with the suction line, the pressure on this bulb depends on the temperature of the suction line, which makes it possible to control it.

The thermostatic expansion valve is provided with a pressure equalizing line connected to the evaporator coil outlet, by the thermal bulb, to compensate the pressure drops caused by the distributor and the evaporator coil surface. The role of the liquid distributor is to achieve a uniform feeding of the coil.

2.2.6.13 Water Eliminator at Evaporator Coil

There is one water eliminator per HVAC unit, located between the evaporator coil and electric heater. The water eliminator is made of extruded, anodized aluminum and ensures water droplets do not enter the supply air. See Figure 2-23.

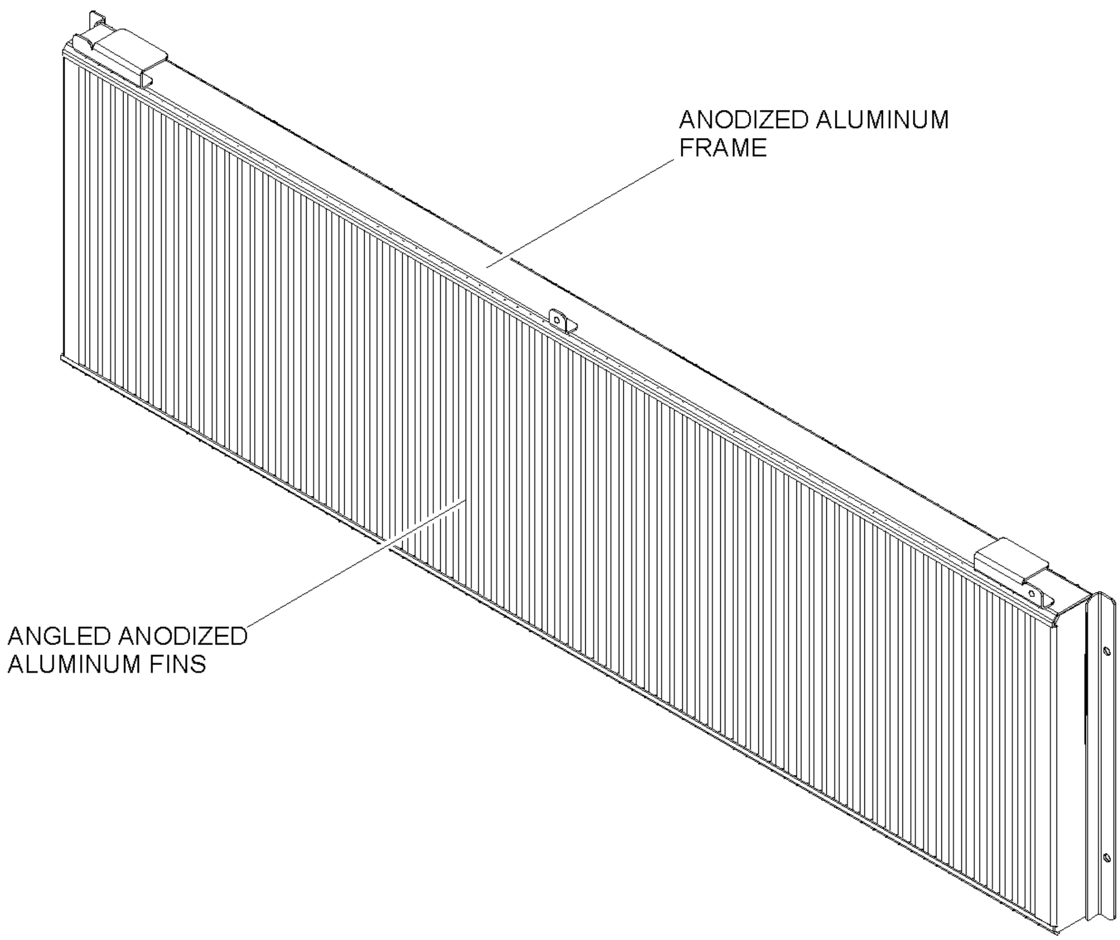


Figure 2-23: Water Eliminator at Evaporator Coil

2.2.6.14 Heater Assembly

There is one heater assembly per HVAC unit, located between the water eliminator the evaporator blower. See Figure 2-24.

The heater assembly is a complete electrical circuit fed by the 208 VAC auxiliary car power. The coil and other electrical wiring are insulated from the rest of the HVAC system and car body so that current must flow through the heater coil to complete the circuit. The element of the heater coil is composed of a high resistance metal alloy. The heater frame is stainless steel and measures 14.81 inches high by 52.45 inches long and is 4.82 inches wide.

As electrical current is pushed through the heater coil by the high voltage electrical supply, the friction between the electrons and atoms creates heat, called resistance heat. The resistance heat causes the coil to become very hot. Air is drawn over the heater coil by suction of the evaporator blower. As the air passes over the coils, the heat is transferred to the air. The warmed air is then blown into the main car duct and discharged into the passenger compartment and operator's cab.

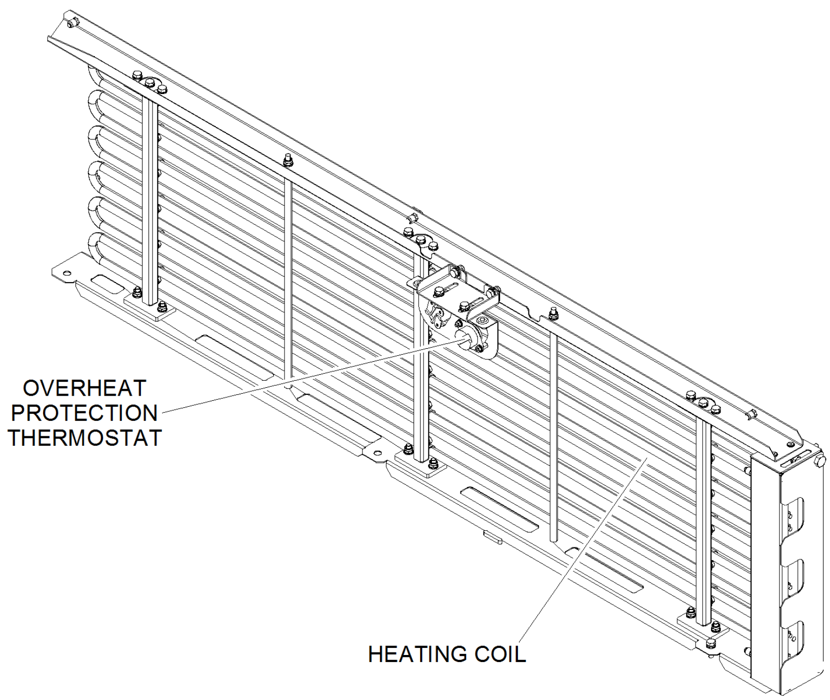


Figure 2-24: Overhead Heater

The overhead heater assembly is arranged in two stages. Stage 1 is 7.5 kW and stage 2 is 7.5 kW. Therefore, the total overhead heat per car with two units is 30 kW.

To ensure the heater coil does not overheat, the coil electric circuit is interlocked to the air flow detector. Therefore, the coil cannot heat-up unless the evaporator blower is running and there is air flow through the heater. The heater assembly also uses a protective thermostat that causes the heater's circuit breaker to open and stop the heater if the temperature reaches 194°F.

2.2.6.15 Overhead Heater Thermostat

Two automatic high limit thermostats (OHPT1 and OHPT2) are installed adjacent to the overhead heater assembly to detect excessive temperature. Upon detection of excessive temperature, the thermostat will shut down the heater assembly. See Figure 2-25 and Figure 2-26.

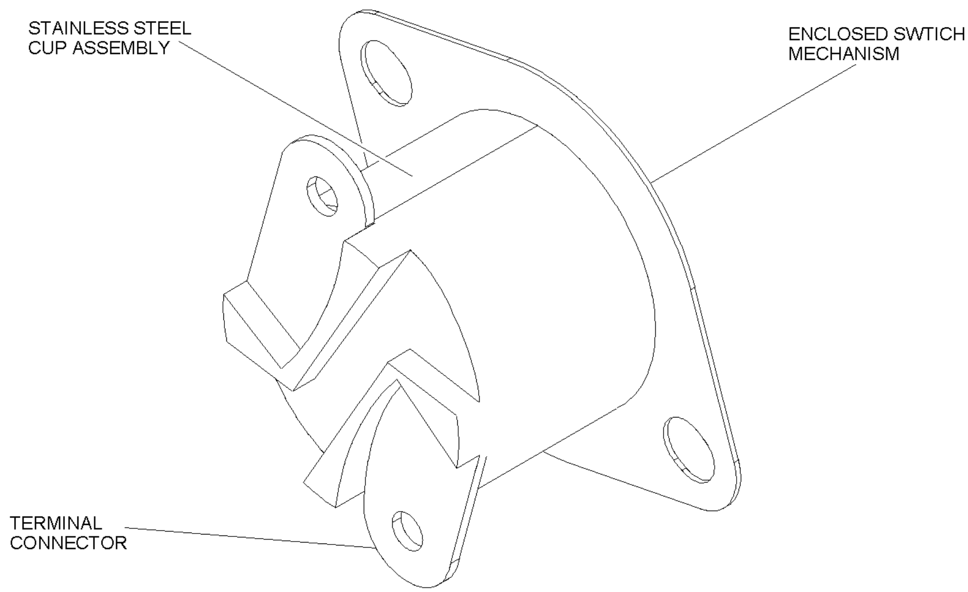


Figure 2-25: Overhead Heater Thermostat (OHPT1)

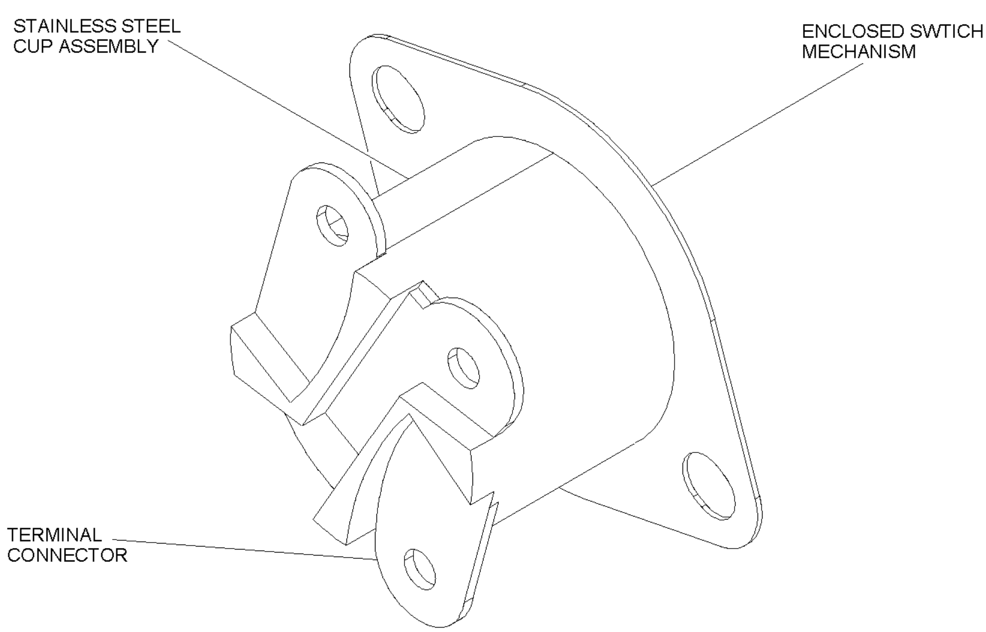


Figure 2-26: Overhead Heater Thermostat (OHPT2)

The OHPT2 thermostat activates (closes) when its temperature reaches 257±6°F. The thermostat is wired into the shunt trip (OHCBA) connect of the circuit breaker (OHCB). When OHPT2 activates (closes), the heater contactors (OHC1 and OHC2) open, the shunt trips the circuit breaker to disconnect the heater. The thermostatic switch automatically resets at 221±6°F, but a manual reset of the heater circuit breaker is required to restore power back to the heaters. The thermostat (OHPT2) is the last protective device that will trip if the other devices should fail to turn off the heaters.

The OHPT1 thermostat acts as the second level of overheating protection by monitoring the temperature level of the overhead heater and sending digital inputs to the system control unit (ACCU). The thermostat is normally closed and only opens when the temperature reaches 130±5°F. When OHPT1 opens a signal is sent to the ACCU. The ACCU detects this signal (OHPT1 turns from on to off) and will forbid either heater from powering on (set heating demand to 0). OHPT1 will reset (close) when the temperature reaches 95±5°F. The ACCU will detect the signal (OHPT1 turns from off to on) and allows power to either heater (returning to normal operations).

Users can monitor (and manipulate) system temperature using the PTU. Refer to MU-275-7A, Section 2.3, PTU Monitor Area and Section 2.6 - Analog I/O.

2.2.6.16 Evaporator Blower and Motor

There is one 208VAC/3-phase/60Hz, 1725 RPM evaporator blower and motor per HVAC unit, see Figure 2-27. The blower and double-shafted motor assembly consist of two centrifugal forward curved fan wheels mounted in galvanized steel fan casings. The fans are directly mounted on the motor shafts. The blower and motor assembly is rated at 3600 m3/h (2120 cfm), at 120 Pa (0.48 in WC) of static pressure external to the unit (372 Pa, 1.49 in WC of total static pressure at blower).

The return air and fresh air mixture in the return air plenum is forced through the evaporator coil and overhead heater by the suction of the evaporator blower. The evaporator blower then blows the heated or cooled air into the main car duct. This supply air is then discharged into the passenger compartment and operator's cab.

The ventilation system runs continuously anytime the evaporator blowers are powered with 208 VAC and the environmental control is on. The evaporator blowers are not dependent on HVAC controllers for control and operate even if the HVAC unit is shut down or the controller fails. If the evaporator blowers were to fail, the failure is displayed on the Train Control Display in the operator's cab.

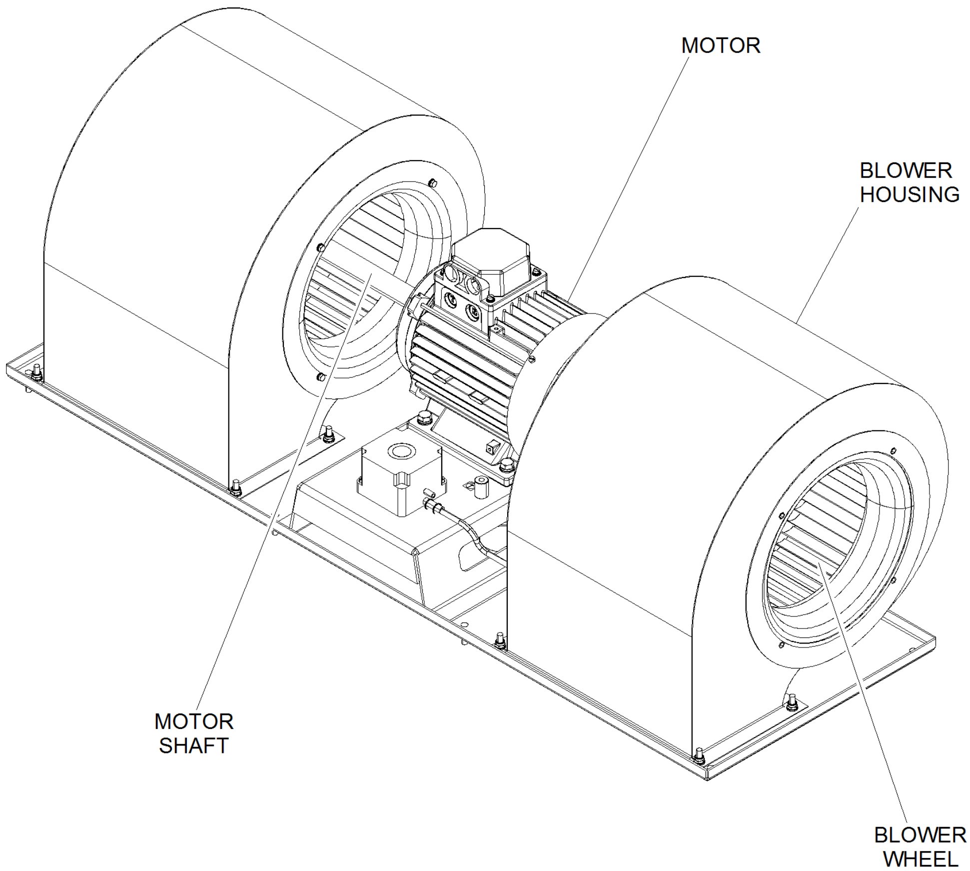


Figure 2-27: Evaporator Blower and Motor

2.2.6.17 Differential Pressure Switch (Air Flow Switch)

There is one differential type air flow detector switch per HVAC unit mounted on a bracket next to evaporator blower assembly. The switch is used to detect the presence of air flow from the evaporator blower in order to allow heating and cooling. See Figure 2-28.

A tube connects the switch to an air flow sensor located in the evaporator blower wheel housing, allowing the switch to sense the loss, or severe reduction, in the evaporator air volume. This switch is wired to the control panel to restrict heating if a "no airflow signal" is detected. The air flow switch is set to 225 ± 15 Pa.

2.2.6.18 Check Valve

There are two vertical lift type check valves per HVAC unit, one per refrigerant circuit, installed on the discharge line between the compressor and condenser coil. The check valve has a floating piston with positive closing action to ensure the liquid refrigerant in the condenser circuit cannot return to the compressor once pump-down is achieved.

The check valves are hard-piped into the refrigerant circuit and require no maintenance. The valve must be un-brazed if being replaced. See Figure 2-29.

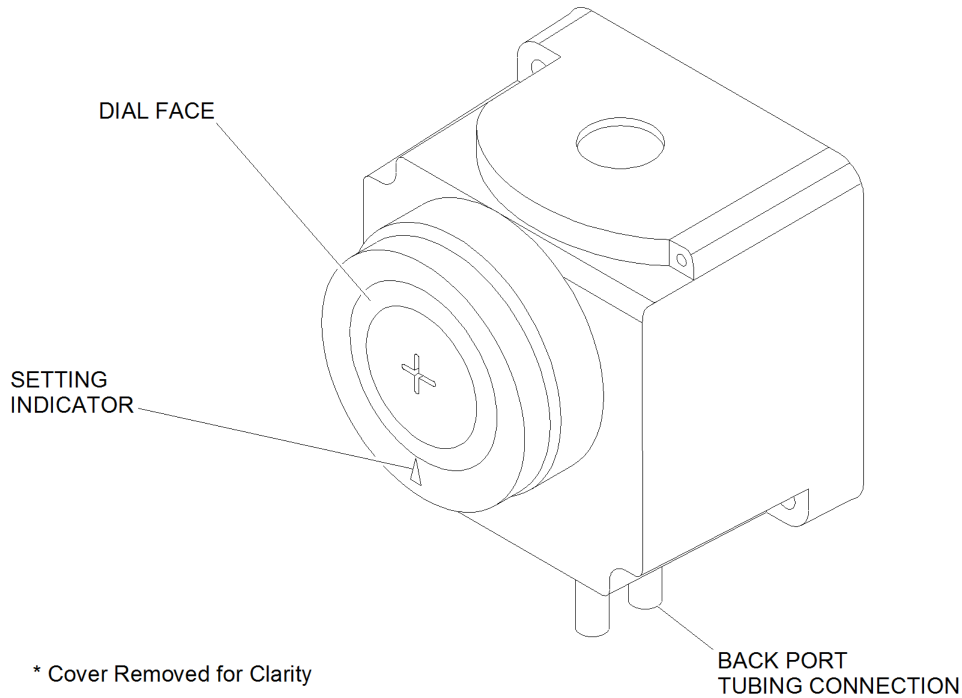


Figure 2-28: Air Flow Switch

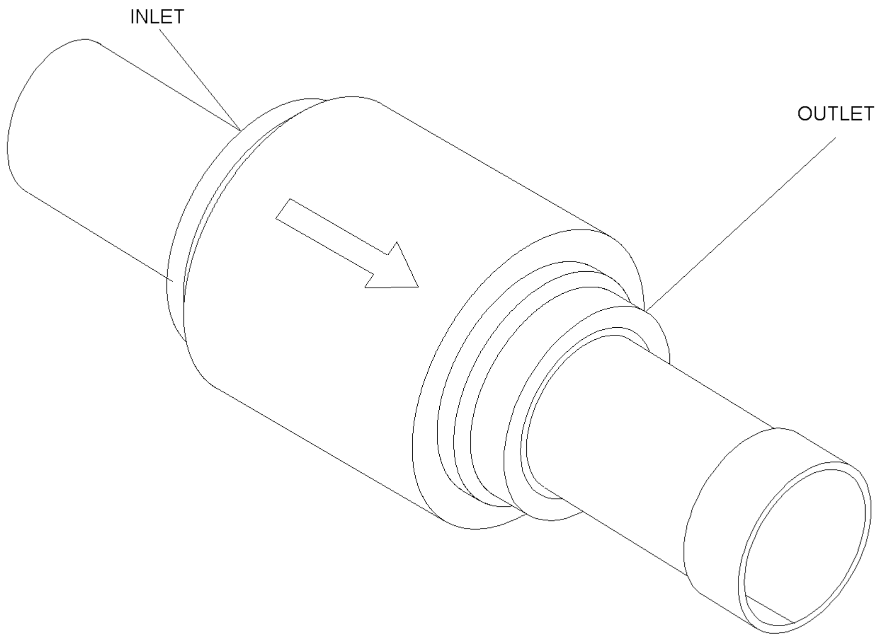


Figure 2-29: Check Valve

2.2.6.19 Fusible Plug

There are two fusible plugs located in the high pressure discharge lines of each compressor. Each plug acts as a safety valve releasing gas from the discharge line when the temperature in the line reaches 283°F. Since the fusible plug is filled with soft metal that melts away when the temperature reaches 283°, the fusible plug must be replaced after the temperature stabilizes. See Figure 2-30.

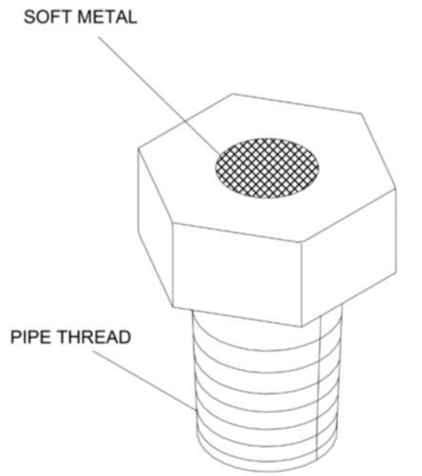


Figure 2-30: Fusible Plug

2.2.7 Control Panel

The control panel is mounted in the return air plenum of every HVAC unit. Access for service is through the return air opening. The control panel circuit breakers, contactors and terminal strips can be accessed for by removing the control panel cover. The Air Conditioner Control Unit (ACCU) with microprocessor is mounted on one side of the control panel.

The control panel includes the following components. The control panel access cover is not shown in Figure 2-31.

- Contactors to control motors, compressor, overhead heaters, and floor heaters
- Circuit breakers for motors and compressors
- Two hot gas bypass relays
- Current transformers/sensors for blower motor, fan motor, compressor motors
- Circuit breakers for blower motor, fan motor, compressor motors, overhead heater
- One AC detector/voltage monitor
- OFF-AUTO switch
- ACCU microprocessor
- Terminal Blocks

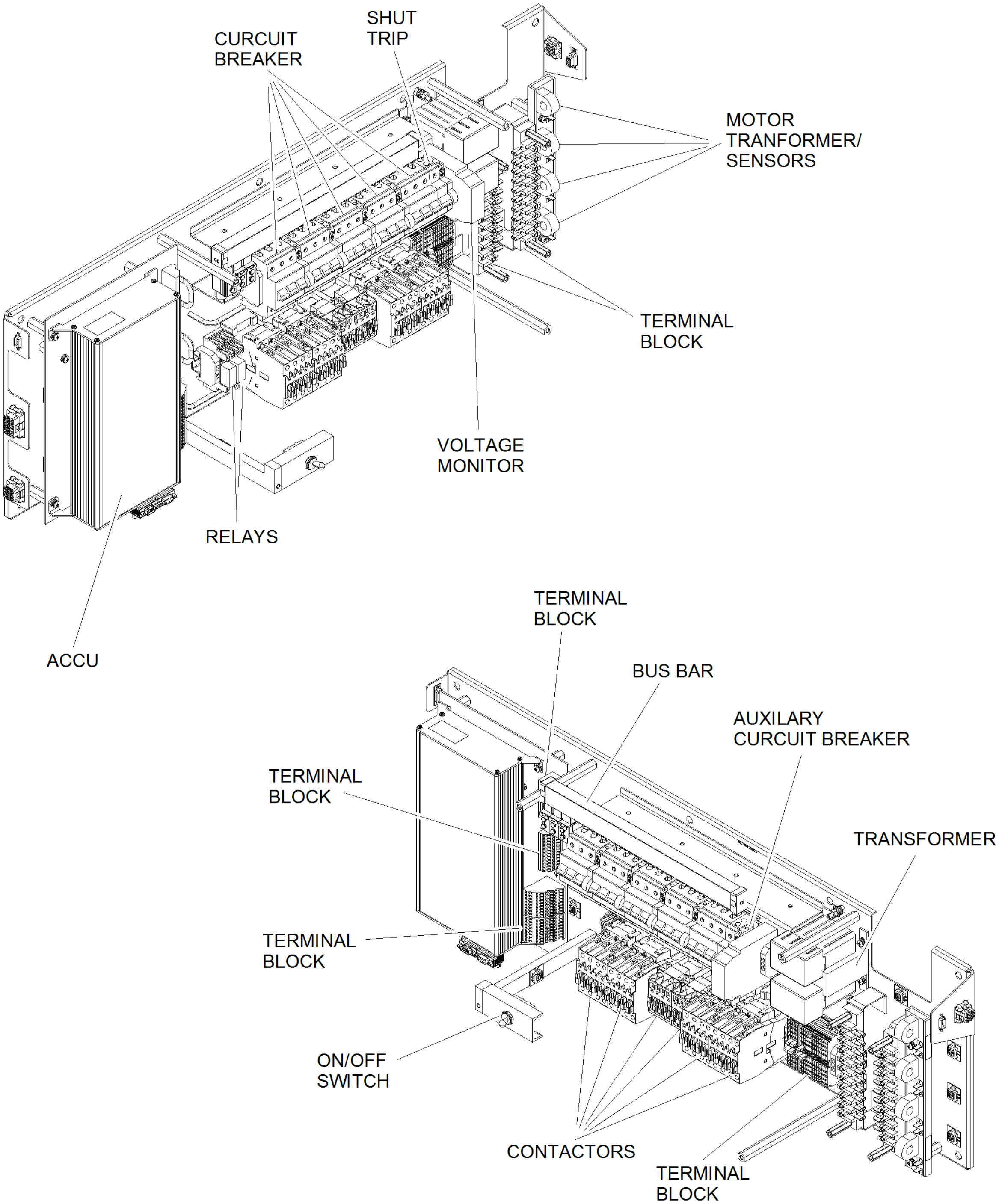


Figure 2-31: Control Panel

2.2.7.1 Contactors

All 3-phase motors are driven by contactors, see Figure 2-32. The control panel contains the electro-mechanical contactors for the compressor motors, condenser fan motor, evaporator blower motor and the overhead heater. All contactors are mounted on the contactor DIN rail on the control panel and are accessible by removing the control panel cover.

Each contactor has three main poles and one built in auxiliary pole that is not used. The three main poles are normally open (NO). When the On signal is received from the trainline, the three normally open main contactor poles close allowing the motor in the circuit to start operating.

Table 2-4 lists the details of each contactor and provides a cross reference between the contactor labels in the control panel and the contactor functional description.

Table 2-3. Control Panel Contactors

Contactor Description	Contactor Label	Main Poles (NO)	Aux Poles	Coil Voltage	Rated Voltage	Operating Current	Terminal Type
Compressor Motor Contactor 1	CMC1	3	1	17-32 VDC	690 VAC	50 Amp	Ring-Tongue
Compressor Motor Contactor 2	CMC2	3	1	17-32 VDC	690 VAC	50 Amp	Ring-Tongue
Overhead Heater Contactor 1	OHC1	3	1	17-32 VDC	690 VAC	50 Amp	Ring-Tongue
Overhead Heater Contactor 2	OHC2	3	1	17-32 VDC	690 VAC	50 Amp	Ring-Tongue
Blower Motor Contactor	BMC	3	1	17-32 VDC	690 VAC	25 Amp	Ring-Tongue
Condenser Fan Motor Contactor	CFMC	3	1	17-32 VDC	690 VAC	25Amp	Ring-Tongue

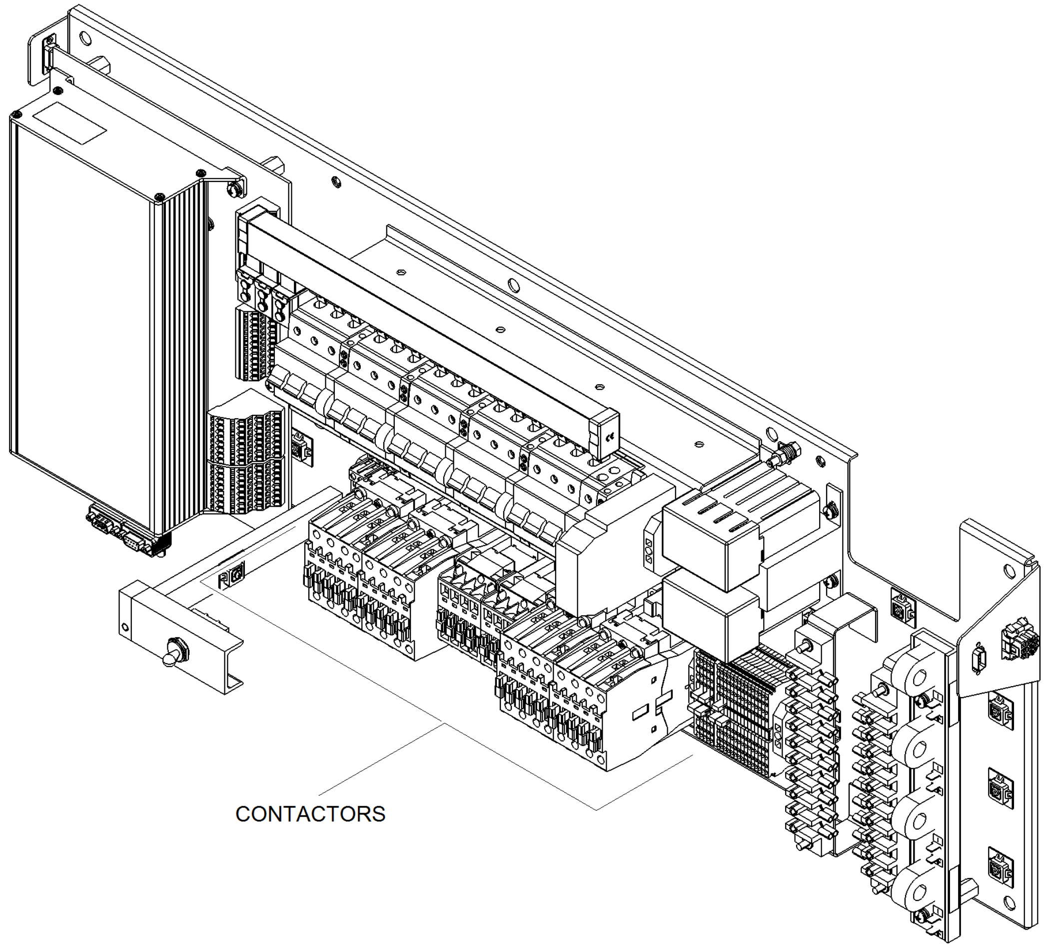


Figure 2-32: Contactors

2.2.7.2 Circuit Breakers

Each 208VAC/3-phase/60Hz motor and the overhead heater have a corresponding 3 pole circuit breaker, see Figure 2-33. All breakers are mounted on the circuit breaker rail in the control panel and are accessible by removing the control panel cover.

The circuit breakers have auxiliary contacts for feedback to the ACCU controller. Each feedback signal from each circuit breaker is a digital input to the controller. This enables the HVAC controller to know the on/off state of the circuit breaker.

The circuit breaker handle is marked “0” (green) for off and “1” (red) for on.

Table 2-4 lists the details of each breaker and provides a cross reference between the circuit breaker labels in the control panel and the circuit breaker functional description.

Table 2-4. Control Panel Circuit Breakers

Circuit Breaker Description	Circuit Breaker Label	Rated Current	Rated Voltage	Poles
Compressor Motor Circuit Breaker 1	CMCB1	32 Amp	415 VAC 440 VDC	3
Compressor Motor Circuit Breaker 2	CMCB2	32 Amp	415 VAC 440 VDC	3
Condenser Fan Motor Circuit Breaker	CFMCB	15 Amp	415 VAC 440 VDC	3
Blower Motor Circuit Breaker	BMCB	15 Amp	415 VAC 440 VDC	3
Overhead Heater Circuit Breaker	OHCBA	50 Amp	415 VAC 440 VDC	3
Auxiliary Contact, Circuit Breaker	N/A	2 Amp 1.5 Amp	277 VAC 125 VDC	1

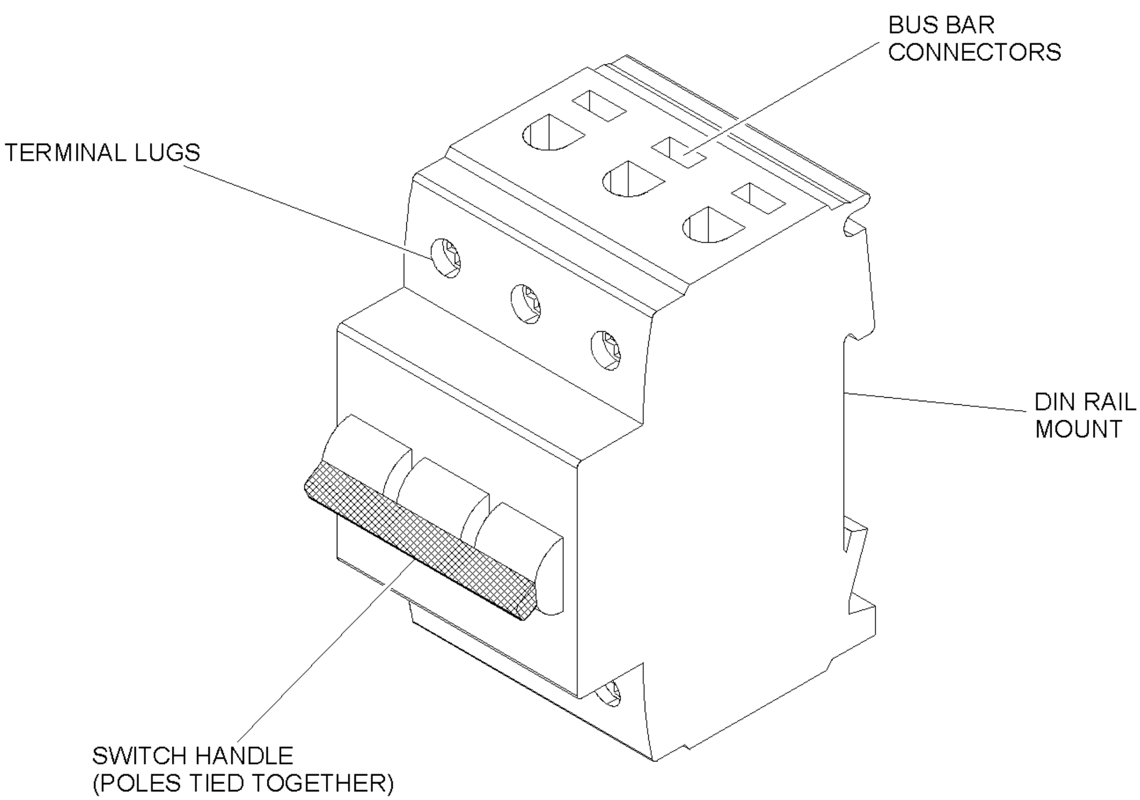


Figure 2-33: Circuit Breakers

2.2.7.3 Relays

There are two hot gas bypass relays in the control panel, used to switch on and off the hot gas bypass valves and also used to provide indication to the ACCU. The relays are mounted on a DIN rail on the control panel and held in place with a retaining clip. Each relay has a red LED to indicate the relay is closed. See Figure 2-34.

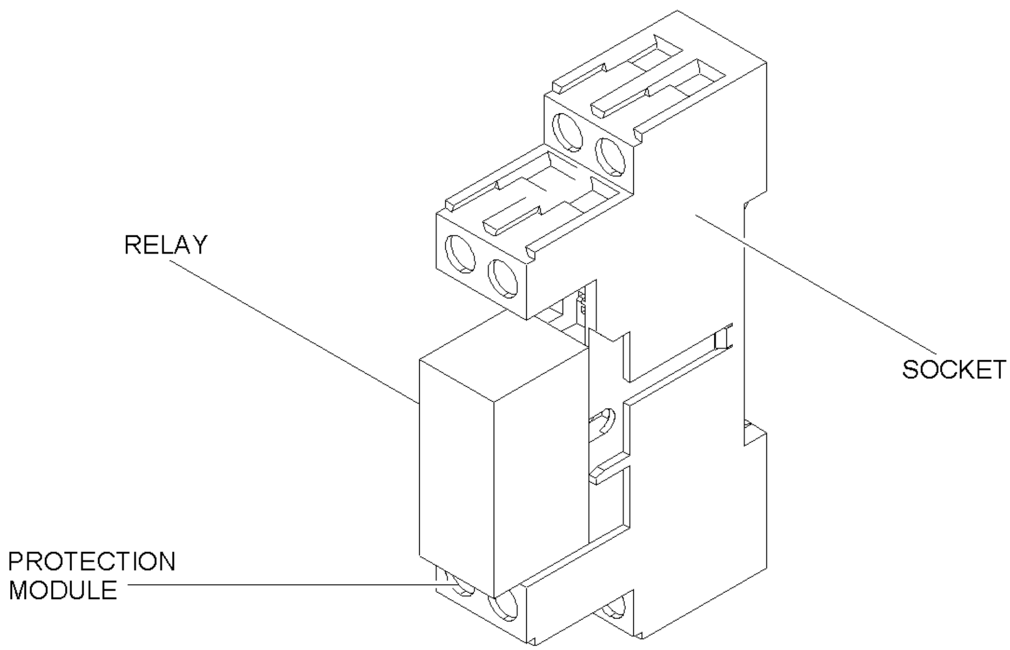


Figure 2-34: Relays

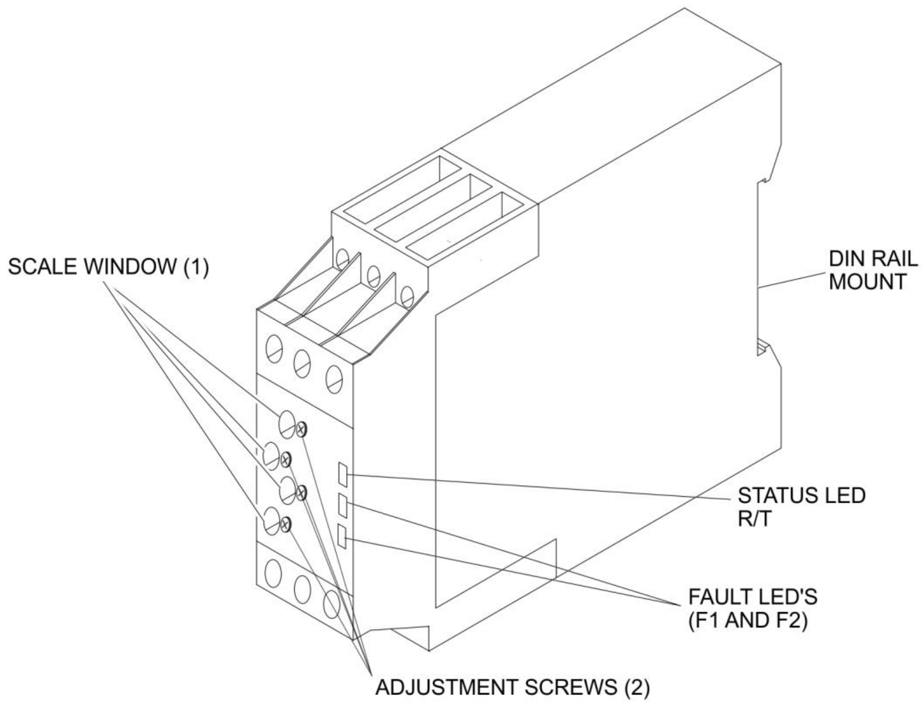
2.2.7.4 Alternating Current Detector (Voltage Monitor)

There is one AC detector located in the control panel on the top rail next to the row of circuit breakers, see Figure 2-35. The AC detector is a multifunctional monitoring relay for the three-phase electrical circuit. It monitors the phase parameters - phase sequence, phase failure, over- and under-voltage and phase unbalance. The threshold values for over- and under-voltage and phase unbalance are adjustable. Configuring the AC detector is done by setting the elements using the adjusting screw (2) on the front of the unit. Turning the adjustment screw (2) will change the setting shown in the scale window (1).

SETTINGS:

- Overvoltage – 240VAC
- Undervoltage – 180VAC,
- Phase Unbalance – 10%,
- Tripping Delay – 4 Sec.

LEDs R/T, F1 and F2 signal fault messages, see Table 2-4 for explanation of signals.



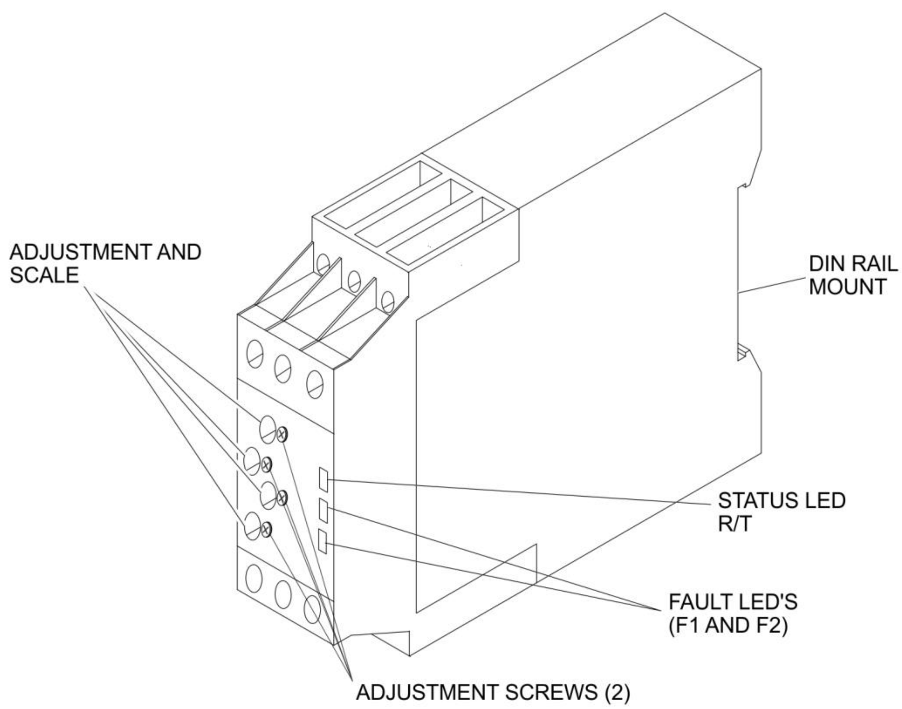


Figure 2-35: AC Current Detector (Voltage Monitor)

Table 2-5. AC Detector LED Signals

Function	R/T: Yellow LED	F1: Red LED	F2: Red LED
Control supply voltage applied, output relay energized	Steady	-	-
Tripping delay t_v active	Blinking	-	-
Phase failure	-	Steady	Blinking
Phase sequence	-	Blinking, alternating between F1 and F2	
Overvoltage	-	Steady	-
Under voltage	-	-	Steady
Phase unbalance	-	Steady	Steady
Interruption of neutral	-	Steady	Blinking
Adjustment error	Blinking	Blinking	Blinking

2.2.7.5 Motor Current Sensor

Each motor in the HVAC unit has a current sensor monitoring one phase of the motor to diagnose potential failures, see Figure 2-36. The evaporator blower motor, condenser fan motor, and compressors use a 25 Amp current sensor. The sensors produce an analog signal (input) to the ACCU. The current sensors are located on different legs (phase) for each motor as follows:

- Compressor Motor 1 – T3
- Compressor Motor 2 – T2
- Condenser Fan Motor – T1
- Evaporator Blower Motor – R

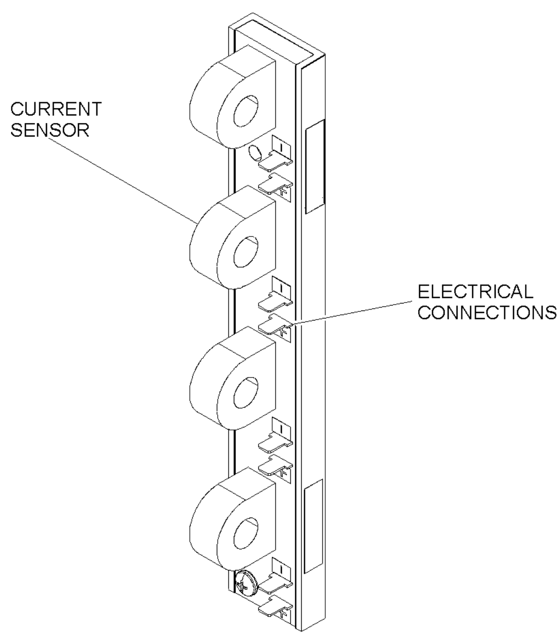


Figure 2-36: Motor Current Sensors

2.2.7.6 OFF – AUTO Switch

The OFF-AUTO switch is located on the front of the control panel. By placing this switch in the “AUTO” position the HVAC unit will automatically control the temperature (automatic mode). When the switch is placed in the “OFF” position the unit will initiate a shut-down sequence.

2.2.7.7 Air Conditioning Control Unit (ACCU)

This system utilizes microprocessor and associated control circuits for the advantages of performance and reliability. The Air Conditioning Control Unit (ACCU), see Figure 2-37, consist of both hardware and software elements in order to control, command and supervise all the elements of the HVAC unit. The ACCU is mounted to the HVAC unit control panel with four screws and four retainers. Access for service is through the return air opening.

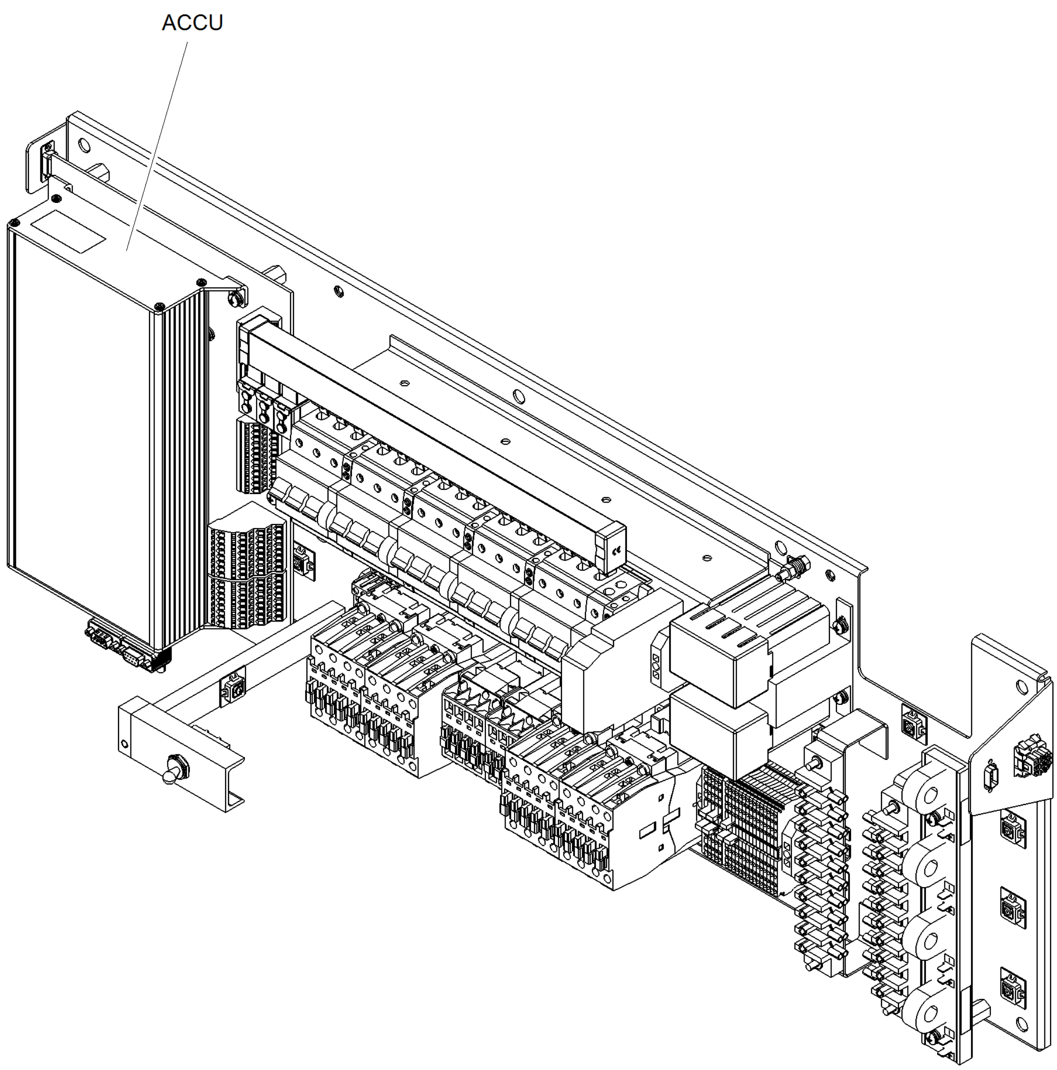


Figure 2-37: Air Conditioning Control Unit (ACCU)

The ACCU and supporting hardware is divided in three different parts:

- ACCU contains the microprocessor, and all the related I/O’s,
- Backplane provides support and electrical interface between the ACCU and the unit components,
- Control Panel houses the ACCU and other interface components.

The ACCU is packaged in a single rugged, aluminum control panel which is arranged for ease of installation and removal. The ACCU is attached to the control panel backplane which has two Harting connectors that plug into the back of the ACCU. It is secured to the backplane using four (4) screws and washers. The ACCU can be removed from the backplane after removing the four screws.

The ACCU is the brains of the HVAC system containing all electronic components. The ACCU microprocessor runs customized software to monitor and control the HVAC unit according to the PI control logic. The self-diagnostic capabilities of the control system, along with the Portable Test Unit (PTU) facilitates troubleshooting, on-board diagnostic testing, and simulations. Additionally, the system operating status and fault information can be stored for fault analysis. With the use of the PTU, the status of all inputs and outputs of the ACCU can be viewed. Refer to paragraph 3.6 for PTU operating procedures.

The ACCU consist of three different electronic boards:

1. <u>Main board</u> – With the isolated power supply, analog inputs, digital inputs, digital outputs.
2. <u>Microcontroller board</u> – With the Ethernet and MVB ports, and a third-party microprocessor board System On Module (SOM). Also the DUAGON MVB interface is connected to this board.
3. <u>Display board</u> - Located in the front part of the ACCU, it contains the state LED and the TEST pushbutton

<u>Analog Inputs</u>

Analog inputs are connected to different sensors located on the HVAC Unit. The analog input circuitry is designed to provide interface between the sensor and the microcontroller, at the same time isolating the microcontroller from EMI and over-voltages.

Types of analog inputs (one per each type of signal to be measured)

- Analog inputs for temperature sensors measures the resistance changes on the NTC (Negative Temperature Coefficient) resistors,
- Analog inputs for pressure transducer measures from 0 to 5 VDC,
- Analog inputs for current transducers measures current values from the current transformers installed in the motors lines.

The analog inputs convert the signals using different hardware and software filtration values. The conversion resolution of the Analog Digital Converter (ADC) is 24 bits. The analog inputs are linked to the 24 VDC that powers the sensors and the sensors are linked to each other.

Digital Outputs

The ACCU has solid state outputs limited in current and protected against short-circuit. Each output has its own current limit, short-circuit protection, freewheeling diode and surge protection. The output circuits are “high side”, which means the outputs apply voltage to the loads when they are activated. All ACCU outputs use the same power source.

Every output has voltage feedback: the microcontroller knows if voltage is applied at the output. This feature offers auto diagnostics and self-test options and can detect if an output is short-circuited.

The ACCU uses the digital outputs to control and command the relays and contactors in order to activate or deactivate the motors, compressors, heaters, etc.

Digital Inputs

The digital inputs are simple bi-directional optocouplers. The load on the optocouplers can be adjusted to ensure a minimum current goes in the inputs. The resistors can also be adjusted to accept different voltages. The digital inputs are protected against surges and transients. All digital inputs are connected and reference to the 24VDC from the battery power. The digital inputs are connected by means of the backplane to the switches and feedbacks of the different components of the control panel and the HVAC.

Microcontroller

The microcontroller is a Linux-based System On Module (SOM) Phytec Core AM335XX family. The Phytec SOM includes the microprocessor, flash and RAM memory, and all hardware needed by the microprocessor. In the ACCU design, the Phytec SOM is mounted on an interface board, itself mounted on the ACCU main board.

The interface board includes:

- Connector to interface to the Phytec SOM.
- Watch Dog to remove power from the Phytec SOM in case of a problem.
- Ethernet interface, with voltage protection, isolation transformer and PCB-mount M12 connector
- USB interface, with some voltage protection and connector.
- Connector and interface for a Duagon MVB board.
- Connector to interface with the ACCU main board.

The Phytec SOM communicates with and controls the ACCU through an SPI communication link. It is possible to reprogram the application through the Ethernet network. The flash memory is able to store two temperature control applications. Therefore, should a new version download fail, the microprocessor could run the previous version.

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CHAPTER 3.0

SPECIAL TOOLS AND MATERIALS

3.1 Introduction

This chapter provides a general description and overview of the LACMTA Light Rail Vehicle (LRV) HVAC unit special tool requirements.

3.2 PTU Software

The PTU maintenance software is installed on a laptop computer and allows the diagnosis and troubleshooting of the HVAC system. The PTU connects to the ACCU and enables bi-directional Ethernet communications. When the maintenance program main screen is opened all digital input/output signals, temperatures, set point temperatures, and system status and parameters can be accessed. A Fault screen can also be accessed from the main screen by selecting the Fault button. The Fault screen displays the fault conditions (red LEDs detected by the Air Conditioning Control Unit (ACCU). The PTU is also used to upload software revisions by selecting the Software Update button. Refer to Section 0500, HVAC of the Tools and Test Equipment Manual for additional PTU details.

3.3 Coil Maintenance Tools

Coil maintenance tool consists of a multi-sided fin straightener for the condenser and evaporator coils.

Maintenance of the coils should follow these steps:

a. Remove dust, dirt, and debris from the coil using compressed air.

b. Wash the condenser coil with hot pressure water using a pressure washer. Clean the evaporator coil with compressed air.

c. Use the multi-sided fin straightener to clean and straighten the fins of the coil.

3.4 Lifting Jig

The lifting jig (Figure 3-1) is a steel structure used for lifting the entire HVAC unit on and off of the car. The lifting fixture frame provides a stable platform for movement of the HVAC unit between the storage rack and the car roof. The lifting fixture frame is designed to connect to the lifting points (Figure 3-2) on all four corners of the HVAC unit frame using the supplied connecting slings with pin shackles. The lifting jig provides one central connection (master link, Figure 3-1) for an overhead crane to lift and move the HVAC unit. Refer to Section 0500, HVAC of the Heavy Repair Maintenance Manual, Chapter 3, Special Tools and Materials for additional information on the lifting fixture.

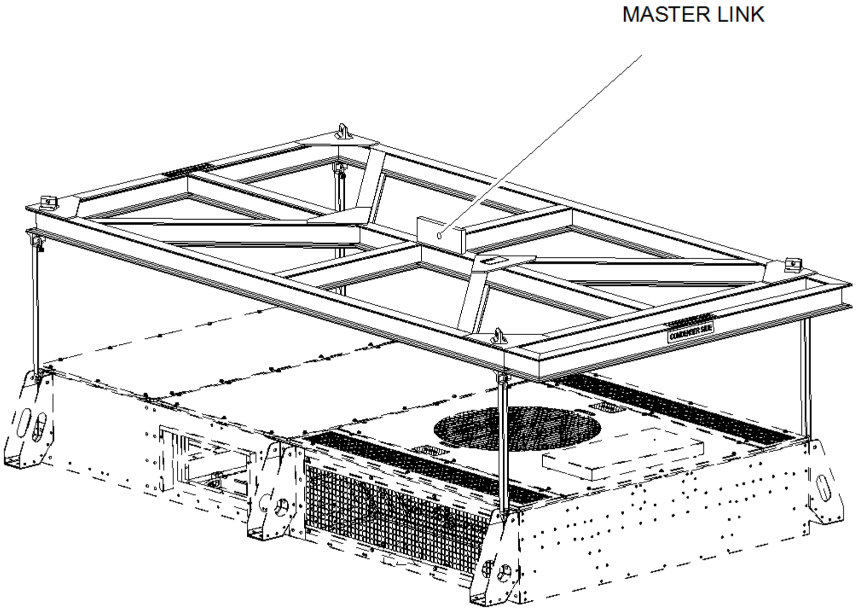

Figure 3-1: Lifting Jig

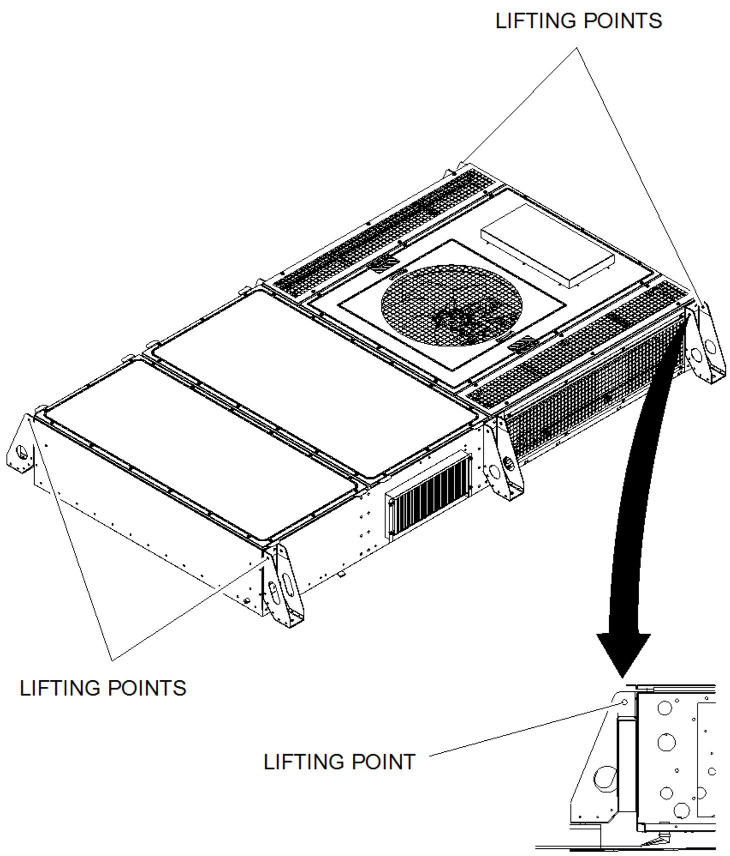

Figure 3-2: Lifting Points

3.5 Rack Assembly

The rack assembly (Figure 3-3) storage rack is a steel structure that provides a safe and convenient way for storing HVAC units not installed on a car. The rack assembly provides stable support for the HVAC unit at the car body mounting points and protects the drain ports and other peripheral components from damage.

The rack assembly is designed to support the HVAC unit during routine maintenance and troubleshooting conducted off-car. The rack is optimized to allow technicians to access the HVAC unit easily from all sides and through the supply air and return air openings.

The rack is equipped with casters to facilitate movement. The caster assemblies include swivels, bearings, brakes, and robust wheels.

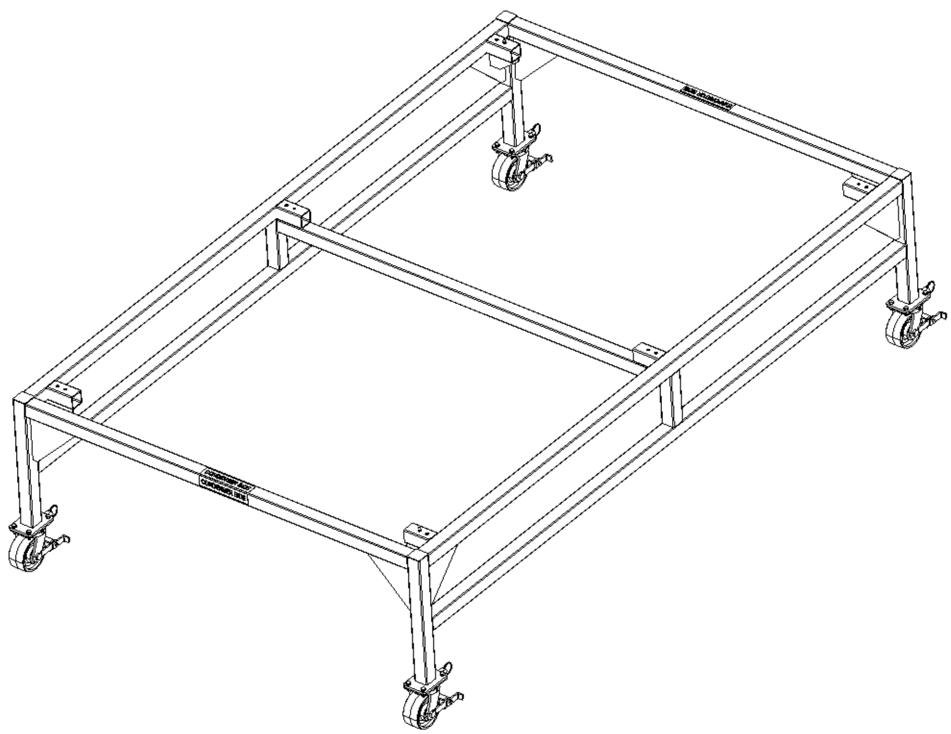

Figure 3-3: Rack Assembly

3.6 PTU Operations

For detailed information on PTU Operations refer to Section 0500, PTU Users Manual.

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CHAPTER 4.0

SCHEDULED MAINTENANCE TASKS

4.1 Introduction

This chapter provides the inspection and servicing procedures and schedules required to maintain the HVAC unit components. Inspection and service procedures range from 10,000 miles to 1,200,000 miles and are performed at scheduled intervals from monthly to every 10 years.

Table 4-1 identifies the maintenance task to be performed and the related LRU, the recommended frequency interval and where the maintenance procedure can be found in this document.

Functionality testing of the HVAC unit components and system is performed by the ACCU continuously during each refrigeration cycle. The ACCU has the ability to read all temperature sensors, digital input/output signals, system status and parameters as well as identify and report troubleshooting faults when they occur during normal operation of the HVAC unit. When a component or system fails the functional test and the ACCU is not able to correct the failure a signal is sent to the Faults Monitor Screen identifying the fault.

Because the ACCU is continuously checking the HVAC unit component and system functionality; some functional testing is not included in the scheduled maintenance intervals in Table 4-1. However the ACCU cannot functionally test all components so those tests must be performed separately on an annual basis.

Table 4-1. Scheduled Maintenance Tasks

Maintenance Interval	Part Description	Scheduled Maintenance Task	Section 0500, HVAC Running Maintenance Manual Section Reference
10,000	HVAC Unit	Check HVAC system for faults	3.6
10,000	HVAC Unit	Clean and Inspect drain traps (outside HVAC unit)	5.3.1.1
*10,000	Air Filter	Change return air filter	5.3.1.3
*10,000	Air Filter	Change fresh air filter	5.3.1.3
30,000	HVAC Unit	Clean and Inspect drain traps (Inside HVAC Unit)	5.3.2.1
30,000	HVAC Unit	Inspect HVAC Unit	5.3.2
60,000	Condenser Coil	Clean condenser coil using pressure washer	5.3.5
60,000	Condenser Coil	Inspect condenser coil after cleaning	5.3.5
120,000	HVAC Unit	Clean and Inspect HVAC Unit	5.3.3
120,000	HVAC Unit	Perform leak test of HVAC unit	5.3.4
120,000	Evaporator Coil	Clean and Inspect evaporator coil	5.3.6
120,000	Moisture Indicator	Clean and Inspect Moisture Indicator	5.3.7
120,000	Temperature Sensor	Test Fresh Air Temperature Sensor	5.3.8
120,000	Temperature Sensor	Test Return Air Temperature Sensor	5.3.9
120,000	Temperature Sensor	Test Supply Air Temperature Sensor	5.3.10
120,000	HVAC Unit	Perform HVAC System Functional Test (ACCU Self-Test)	5.3.13
120,000	Pressure Transducer	Test High and Low Pressure Transducers	5.3.14
120,000	Pressure Switch	Test High and Low Pressure Switches	5.3.15 and .16
120,000	Thermostat	Test Overhead Heater Protective Thermostat 1	5.3.11
120,000	Thermostat	Test Overhead Heater Protective Thermostat 2	5.3.12
600,000	HVAC Unit	Remove HVAC unit from car	HRMM
600,000	HVAC Unit	Clean HVAC unit at overhaul	HRMM
600,000	HVAC Unit	Recover Refrigerant from HVAC unit	HRMM
600,000	HVAC Unit	Refrigeration Circuit Pressure Tightness Test	HRMM
600,000	HVAC Unit	Vacuum & Dehydrate Refrigeration Circuit	HRMM
600,000	HVAC Unit	Charge HVAC System with Refrigerant	HRMM
600,000	ACCU	Clean PCBs	HRMM
600,000	ACCU	Test PCBs using BTE	HRMM
600,000	Air Flow Switch	Replace AFS	HRMM
600,000	Air Filter Switch	Replace Clogged Filter Detector Switch	HRMM
600,000	Compressor	Replace Compressors	HRMM
600,000	Compressor	Replace Compressor Discharge Gas Thermostat	HRMM
600,000	Temperature Sensor	Replace FATS	HRMM
600,000	Temperature Sensor	Replace RATS	HRMM
600,000	Temperature Sensor	Replace SATS	HRMM
600,000	Pressure Switch	Replace HPS1 and HPS2	HRMM

Maintenance Interval	Part Description	Scheduled Maintenance Task	Section 0500, HVAC Running Maintenance Manual Section Reference
600,000	Pressure Transducer	Replace HPT1 and HPT2	HRMM
600,000	Pressure Switch	Replace LPS1 and LPS2	HRMM
600,000	Pressure Transducer	Replace LPT1 and LPT2	HRMM
600,000	Thermostat	Replace OHPT1 and OHPT2	HRMM
600,000	Thermostat	Replace Layover Thermostat	HRMM
600,000	Thermostat	Replace Floor Heater Thermostats	HRMM
600,000	Solenoid Vale	Replace By-Pass Solenoid Valve Coil	HRMM
600,000	Check Valve	Replace Check Valve	HRMM
600,000	Relief Valve	Replace Safety Pressure Relief Valve	HRMM
600,000	Filter Drier	Replace Filter Drier	HRMM
600,000	Circuit Breaker	Replace Circuit Breakers	7.3.2
600,000	Voltage Detector	Replace AC Voltage Detector	7.3.4
600,000	Transformer	Replace Transformer	7.3.5
600,000	Current Sensor	Replace Current Sensor	7.3.6
600,000	Expansion Valve	Replace Thermostatic Expansion Valve	HRMM
600,000	Motor	Replace Condenser Fan Motor	HRMM
600,000	Motor	Replace Evaporator Blower Motor	HRMM
1,200,000	Relay	Replace Relays	7.3.3
1,200,000	Contactor	Replace Contactors	7.3.1
1,200,000	HVAC Unit	Replace car / HVAC unit interface gasket	HRMM
1,200,000	HVAC Unit	Replace car interface gasket in roof	HRMM
1,200,000	HVAC Unit	Replace return air plenum gasket	HRMM

* Air filters must be changed at 10,000 miles or 30-days, whichever comes first.

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CHAPTER 5.0

CORRECTIVE MAINTENANCE

5.1 Introduction

This chapter provides inspection and adjustment procedures identified in section 4.0, scheduled maintenance tasks.

5.2 Safety Information

Some of the procedures in this section are preceded by warnings, cautions and notes regarding potential hazards in handling this equipment. All of these warnings should be carefully read and understood before proceeding, and then be followed closely while performing related tasks. The prominent warnings for this equipment are:

WARNING

BECAUSE THIS EQUIPMENT OPERATES AT LETHAL POWER LEVELS, WARNINGS AND REMINDERS ABOUT REMOVAL OF POWER, IN ACCORDANCE WITH LACMTA REGULATIONS SHOULD BE COMPLETELY UNDERSTOOD BEFORE ANY WORK IS BEGUN.

WARNING

SOME COMPONENTS MAY CONTAIN HAZARDOUS CHEMICALS, OR THEIR USE MAY BE REQUIRED IN CLEANING OR SERVICING SUCH COMPONENTS. IN THESE CASES, THE MANUFACTURER'S WARNINGS SHOULD BE CLOSELY HEEDED, AND ONLY THOSE ITEMS SPECIFICALLY AND CURRENTLY APPROVED FOR USE BY LACMTA SHOULD BE EMPLOYED, REGARDLESS OF ANY RECOMMENDED USE IN THE PROCEDURE.

WARNING

MUCH OF THE EQUIPMENT ON THIS VEHICLE IS LOCATED UNDER THE FLOOR. SPECIAL CAUTION SHOULD BE TAKEN WHEN ACCESSING OR SERVICING ITEMS IN THIS LOCATION.

WARNING

SOME COMPONENTS IN THIS EQUIPMENT ATTAIN TEMPERATURES THAT CAN CAUSE SEVERE BURNS, AND OTHERS, IF MISHANDLED, MAY CAUSE SERIOUS CUTS OR PRODUCE TOXIC FUMES OR RESIDUES. CLOSELY FOLLOWS MANUFACTURER'S WARNINGS AND RECOMMENDED PROCEDURES FOR HANDLING THESE COMPONENTS.

WARNING

SOME OF THE EQUIPMENT CONTAINS COMPONENTS UNDER SPRING TENSION THAT CAN BE HAZARDOUS IN AN UNCONTROLLED RELEASE. OTHER COMPONENTS CONTAIN FLUIDS OR GASSES UNDER PRESSURE THAT CAN READILY CAUSE PERSONAL INJURY IF IMPROPERLY RELEASED. WARNINGS AND SPECIFIC INSTRUCTIONS FOR HANDLING SUCH COMPONENTS SHOULD BE CLOSELY ADHERED TO.

WARNING

MANY EQUIPMENT ITEMS AND COMPONENTS ARE QUITE HEAVY AND MAY REQUIRE LIFTING DEVICES OR ASSISTANCE FOR THEIR SAFE HANDLING, AND ARE GENERALLY NOTED. HOWEVER, ALL EQUIPMENT THAT LOOKS HEAVY, PROBABLY IS, AND SHOULD BE TREATED ACCORDINGLY.

NOTE: The use of WARNING statements is necessarily limited to significant cases, so that effectiveness will not be reduced by too frequent usage. The absence of such statements does not, in any way, imply the absence of hazards which may be present anytime electrical or refrigeration equipment is activated, or when working on items with inherent hazards, such as those cited above.

5.3 Inspection and Procedures

5.3.1 HVAC Maintenance

5.3.1.1 Clean and Inspect Drain Traps

Equipment Conditions

- HVAC unit switched off
- Environmental control circuit breaker off

Materials Required

- Drain Trap P/N 659D387
- General Purpose Soap: La's Totally Awesome All Purpose Cleaner; MPN: FBA_22429640222 or equivalent,
- Soft Bristle Brush; Long Straw Brush, Nylon Pipe Tube Cleaner 8.2-inch Set of 10 Different Diameters, MPN: 9344186720 or equivalent,
- Flashlight: Maglite Mini LED, P/N SP2201HL or equivalent,
- Telescoping Inspection Mirror: Ullman, Pocket Size Telescoping Inspection Mirror, P/N HTC-2 or equivalent.

See Figure 5-1.

NOTE: Based on LACMTA's vehicle operation, Merak recommends inspecting and cleaning the evaporator drain traps from outside of the HVAC unit every 10,000 miles; in addition to, our normal manufacturer's recommendation of cleaning them from inside of the HVAC unit every 30,000 miles (or 90 days whichever is first). Refer to Section 5.3.2.

NOTE: The manufacturer's field engineering team confirms this maintenance can be accomplished.

1. From outside the HVAC unit, clean drain traps (8) by hand using general purpose soap and soft bristle brush or pipe brush. Ensure to clean up inside the drain trap (duck bill) as much as possible.

NOTE: Use of a flashlight and telescoping mirror is required to inspect all aspects of the drain trap.

2. After cleaning, inspect drain traps (8) for damage, cracks, and deterioration. If either drain trap (8) is damaged, replace drain trap (8); refer to Section 5.3.1.2.

5.3.1.2 Drain Trap Replacement

1. Using 7mm socket, extension, and rachet, loosen hose clamp (7, Figure 5-1) and remove drain trap (8) and hose clamp (7) from drain pipe (6). Retain hose clamp unless damaged.

NOTE: Drain trap beak must be positioned 41 (+0/-3) mm from bottom of HVAC frame and a minimum of 3mm from top of train car roof.

2. Install retained or new hose clamp (7) on new drain trap (8).

3. Install new drain trap (8) with hose clamp (7) attached on HVAC unit drain pipe (6) and ensure drain trap (8) beak is facing outward (perpendicular to HVAC unit). Refer to Figure 5-1, Detail A, for drain trap (8) positioning before tightening hose clamp (7).

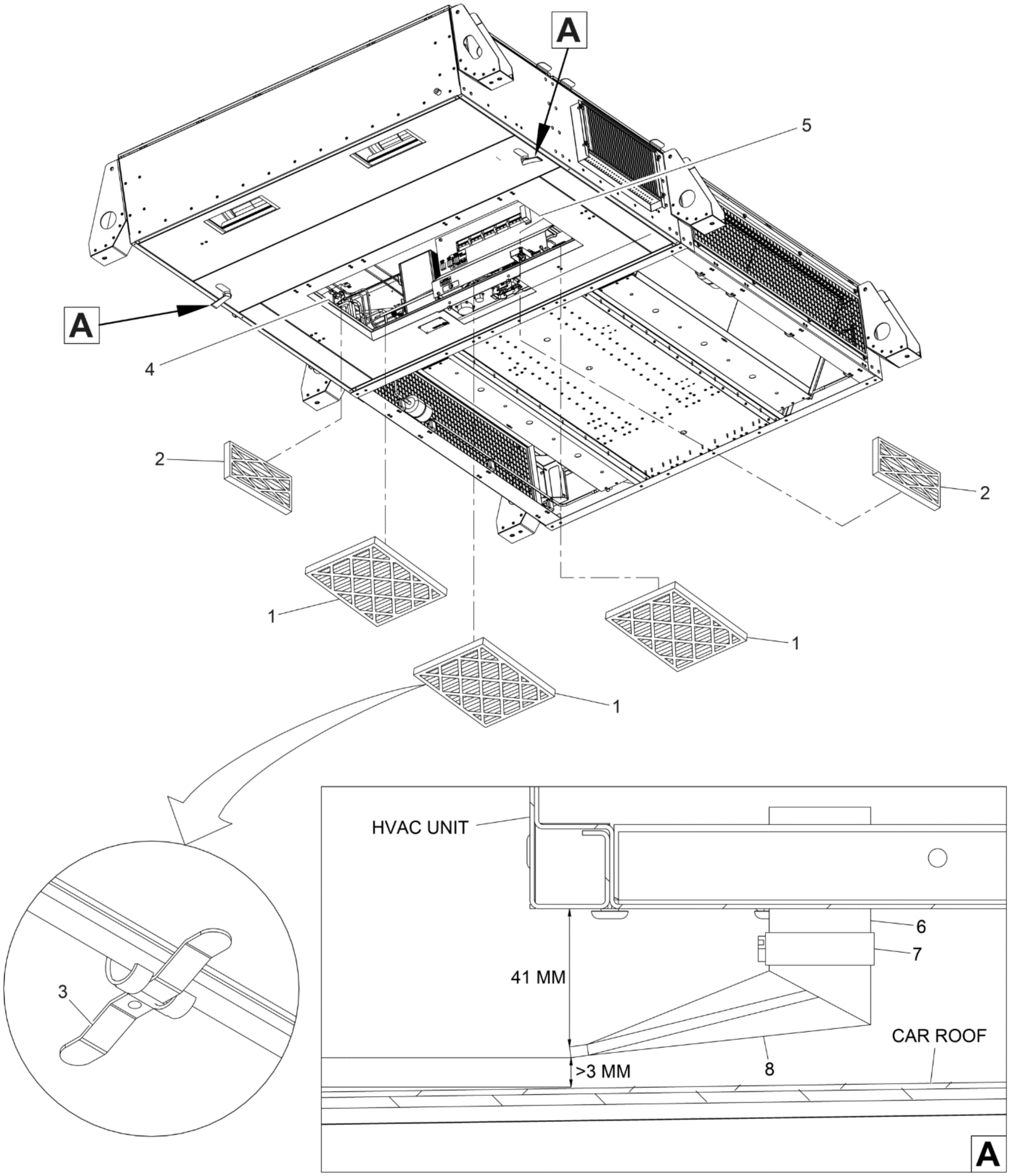

Figure 5-1: Monthly HVAC Maintenance

5.3.1.3 Replace Return Air Filter & Fresh Air Filter

NOTE: The air filters should be replaced every 10,000 miles or every 30 days, whichever comes first.

Equipment Conditions

- HVAC unit switched off
- Circuit breaker off
- Remove appropriate HVAC Unit Cover according to Section 7.3.8.

Materials Required

- Return Air Filter – 658E20015, Qty 3
- Fresh Air Filter – 658E10085, Qty 2

See Figure 5-1.

5.3.1.3.1 Return Air Filter Replacement

1. Access return air filters (1) through return air grille in low ceiling of passenger car.
2. Unclip two air filter clips (3) then remove filters (1) and discard.
3. Wipe dirt from return air filter installation seat (4).
4. If fresh air filters (2) are being replaced, replace filters per the following instructions before installing new return air filter (1).

NOTE: When installing the return air filter, the wire mesh side of the filter must face up into the return air plenum. The side without wire mesh must face downward, towards the car interior. Refer to the “Air Flow” arrow printed on the filter.

5. Position new return air filter (1) in HVAC unit and lock in place with air filter clips (3).

5.3.1.3.2 Fresh Air Filter Replacement

1. Access fresh air filter (2) through return air plenum (5).
2. Unclip four air filter clips (3) on filter frame then remove filter (2) and discard.
3. Wipe dirt from fresh air filter in fresh air inlet.
4. Check fresh air damper for dirt and debris. Clean as necessary.

NOTE: When installing the fresh air filter, the wire mesh side of the filter must face inside the HVAC unit. The side without wire mesh must face the fresh air damper. Refer to the “Air Flow” arrow printed on the filter.

5. Position new fresh air filter (2) in filter frame and lock in place with air filter clips (3).

5.3.2 Inspect HVAC Unit (30,000 Miles)

Equipment Conditions

- HVAC unit switched off
- Environmental control circuit breaker off
- Remove HVAC Unit Covers according to Section 7.3.8.

Materials Required

- Anti-Seize Compound (Loctite 8150 or equivalent)

See Figure 5-2.

WARNING

DANGER OF ELECTRIC SHOCK AND COMPONENT DAMAGE. WHEN WORKING WITH UNIT OR REMOVING ELECTRICAL COMPONENTS, BE SURE CIRCUIT IS DEAD. WORKING WITH LETHAL VOLTAGE COULD RESULT IN PERSONAL INJURY OR DEATH. TAG CIRCUIT BREAKER WITH LOCK OUT DEVICE.

1. Ensure HVAC unit is powered off.
2. Remove two condenser coil grilles (4, Figure 5-3) by loosening twelve M6 x 20mm screws, lock washers, and flat washers. Discard lock washers.
3. Remove two condenser lateral grilles (5) by loosening sixteen M6 x 20mm screws, lock washers, and flat washers. Discard lock washers.
4. Place grilles in a safe location to avoid damage to grilles (4,5).
5. Check all major components (6 thru 21) for leakage, looseness, missing hardware, damage, or deterioration. Repair or replace components as necessary.
6. Inspect fresh air inlet for debris, blockage, or damage. Clean fresh air inlet to remove dirt and debris such as leaves and feathers.

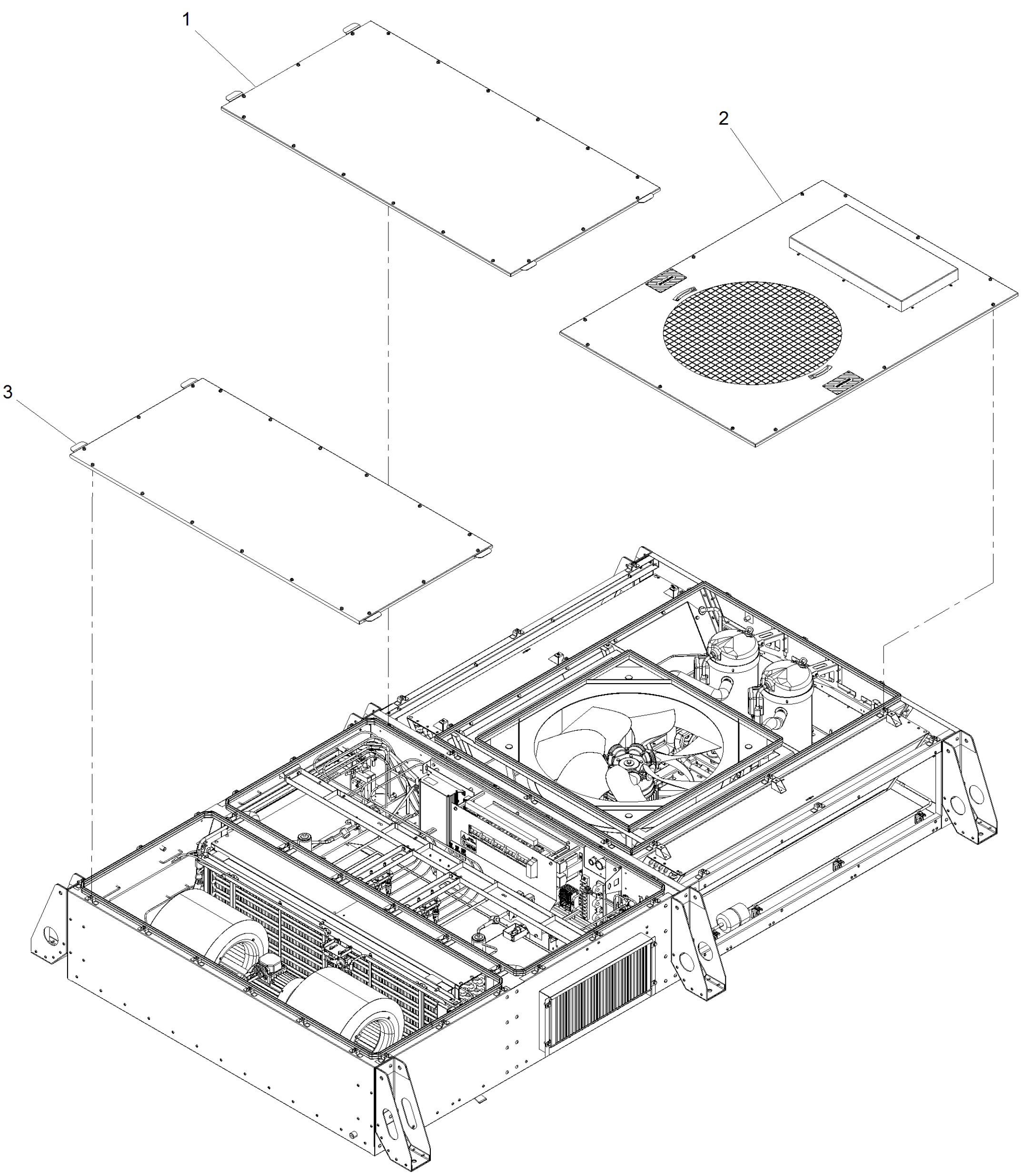

Figure 5-2: Clean and Inspect HVAC Equipment 30,000 Miles
(Sheet 1 of 4)

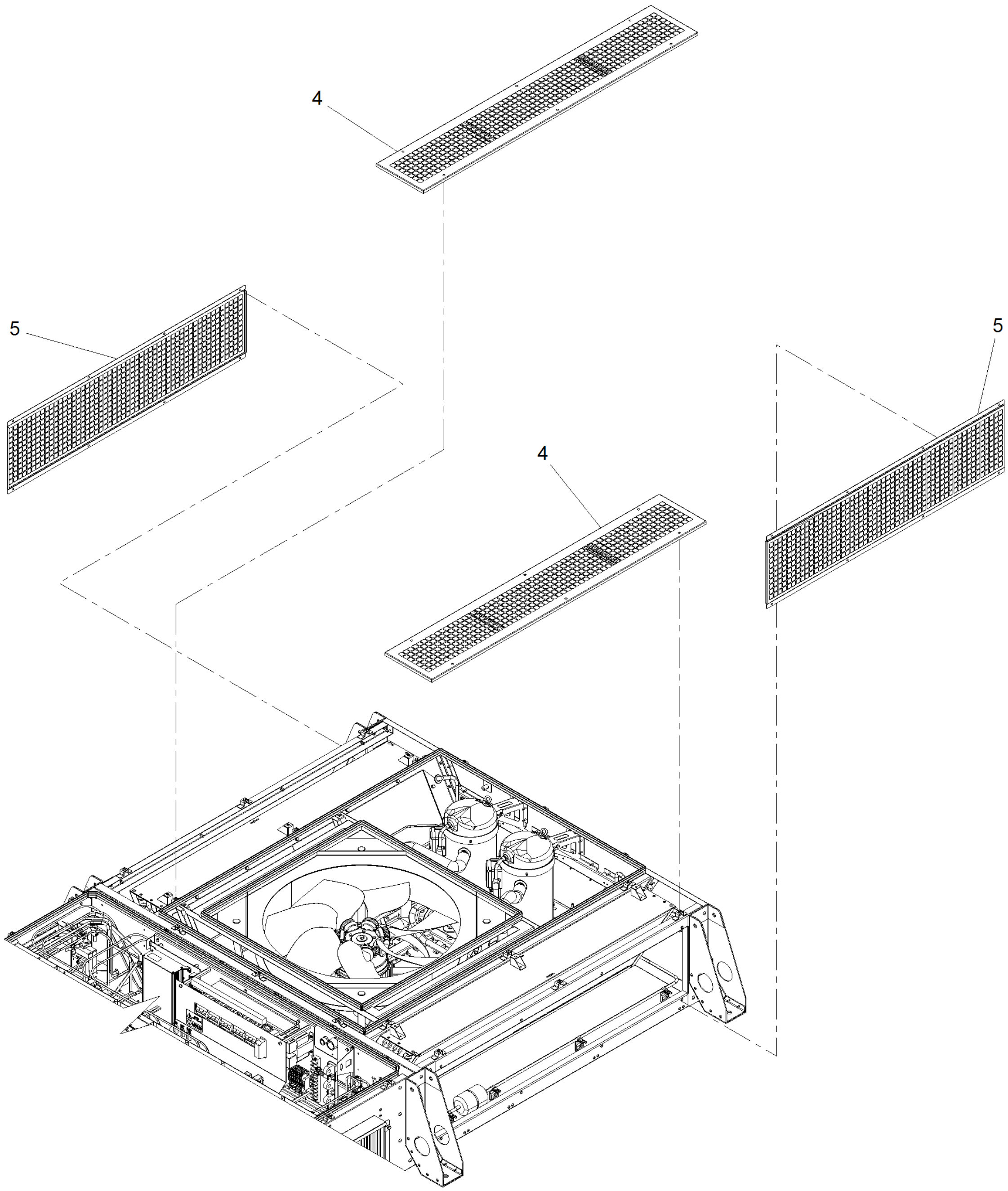

Figure 5-2: Clean and Inspect HVAC Equipment 30,000 Miles
(Sheet 2 of 4)

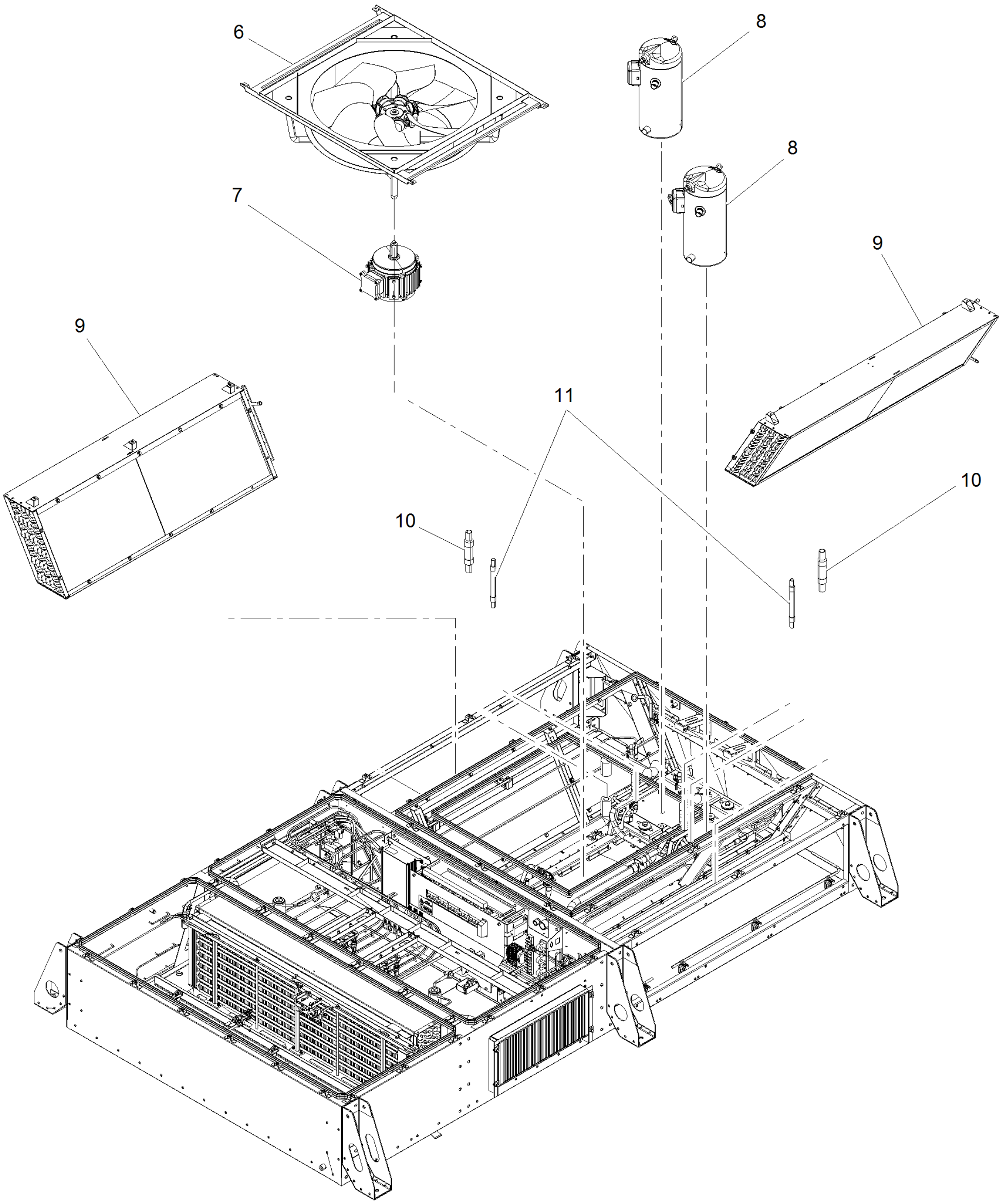

Figure 5-2: Clean and Inspect HVAC Equipment 30,000 Miles
(Sheet 3 of 4)

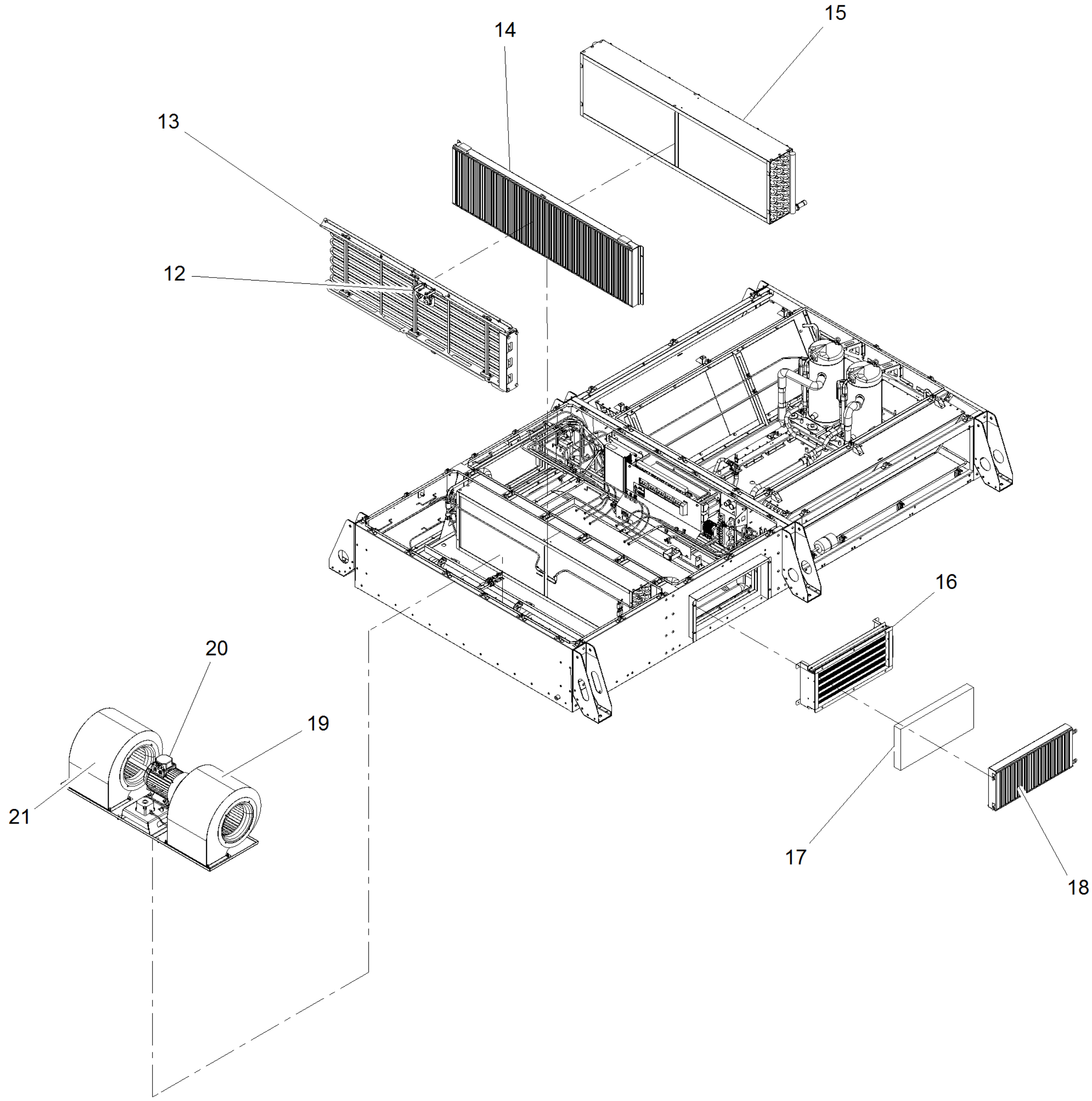

Figure 5-2: Clean and Inspect HVAC Equipment 30,000 Miles
(Sheet 4 of 4)

7. Inspect water eliminator (18) at fresh air inlet for debris, blockage, or damage. Clean water eliminator as necessary.

8. Inspect water eliminator (14) at evaporator coil (15) for debris, blockage, or damage. Clean water eliminator as necessary.

9. Inspect moisture indicator per Section 5.3.7.

10. Check for oil leaks.

11. Check refrigerant lines for damage and leakage. Presence of oil on joints can indicate refrigerant leak. If refrigerant leak is suspected perform leak test per Section 5.3.4.

12. Inspect overhead heater (13) for dirt or damage. Clean heater as necessary and straighten any bent fins.

13. Check all motors (7, 19) for dirt, debris, and loose or damaged parts.

14. Inspect control panel electrical components and connections as follows.

    a. Check electrical components and connections for damage.

    b. Verify all connections are not damaged and are correctly tightened.

NOTE: Inspect threads of all grille (4 and 5) mounting screws and hexsert rivnuts and replace any damaged mounting hardware.

15. Apply anti-seize to threads of all M6 x 20mm grille (4 and 5) mounting screws.

16. Position condenser lateral grille (5) on side of HVAC unit and align mounting holes.

17. Install eight M6 x 20mm screws, new lock washers, and flat washers and secure lateral grille (5) to HVAC unit. Repeat steps 17 and 18 for second lateral grille (5).

18. Position grille (4) on top of HVAC unit and align mounting holes.

19. Install six M6 x 20mm screws, new lock washers, and flat washers to secure grille (4) to HVAC unit. Repeat steps 19 and 20 for second grille (4).

20. Replace HVAC unit covers (1, 2, and 3). Refer to Section 7.3.8, HVAC Covers Removal and Installation.

5.3.2.1 Clean and Inspect Evaporator Coil Drains

Equipment Conditions

- HVAC unit switched off
- Environmental control circuit breaker off
- Evaporator Section Cover removed, refer to Section 7.3.8

Materials Required

- Drain Trap P/N 659D387
- Clamp P/N 664025
- General Purpose Soap: La's Totally Awesome All Purpose Cleaner; MPN:FBA_22429640222 or equivalent
- Soft Bristle Brush: Long Straw Brush, Nylon Pipe Tube Cleaner 8.2-inch, Set of 10 Different Diameters, MPN: 9344186720 or equivalent

Refer to Figure 5-1.

NOTE: In addition to cleaning at 10,000 miles, the two evaporator coil drain traps should be cleaned every 30,000 miles or 90 days, whichever comes first. Use shop water hose (or compressed air) to remove dirt and debris from inside evaporator section and clear clogged drain traps (8).

1. Vacuum and clean evaporator coil drain pan.

a. Use vacuum cleaner to remove dust, dirt, and debris from return air plenum and evaporator blower section.

b. Use shop hose, general purpose soap, shop rags, scrub brush or scraper to clean evaporator drain pan surface. Allow water, dirt and debris to drain through drain traps.

2. On bottom of HVAC unit, visually check drain traps are clear of debris.

3. If drain trap is not clear, position shop water hose or compressed air hose in top of evaporator drain port and clear drain trap of dirt and debris.

4. Repeat Step 1 through 3 for second drain trap.

5. If drain trap (8) clog does not clear, use a 7mm socket, extension, and rachet, and loosen hose clamp (7) and remove drain trap (8) from drain pipe (6). Retain hose clamps.

NOTE: Use of a flashlight and telescoping mirror is required to inspect all aspects of the drain trap.

6. Clean drain trap (8) by hand using general purpose soap and pipe brush or similar tool. Inspect drain traps (8) for damage, cracks, and deterioration. If drain trap (8) is damaged, replace drain trap (8); refer to Section 5.3.1.2. Otherwise, continue with Step 7.

7. Install cleaned (or new) drain trap (8) with retained hose clamp (7) and ensure drain trap (8) beak is facing outward (perpendicular to HVAC unit). Refer to Figure 5-1, Detail A, for drain trap (8) positioning before tightening hose clamps (7).

8. Repeat Steps 5 through 7 for second drain trap (8).

5.3.3 Clean and Inspect HVAC Equipment (120,000 Miles)

Equipment Conditions

- HVAC unit switched off
- Control circuit breaker off
- HVAC unit at ambient temperature
- Remove HVAC Unit Covers according to Section 7.3.8.

Materials Required

- Anti-Seize compound
- Household detergent
- Soft cloth
- Non-abrasive sponge

WARNING

DANGER OF ELECTRIC SHOCK AND COMPONENT DAMAGE. WHEN WORKING WITH UNIT OR REMOVING ELECTRICAL COMPONENTS, BE SURE CIRCUIT IS DEAD. WORKING WITH LETHAL VOLTAGE COULD RESULT IN PERSONAL INJURY OR DEATH. TAG CIRCUIT BREAKER WITH LOCK OUT LABEL "DO NOT MANEUVER".

See Figure 5-3, Sheets 1 through 4.

1. Ensure HVAC unit is switched off and power disconnected.

2. Perform quarterly cleaning and inspection procedure per Section 5.3.2, step 1 through step 17.

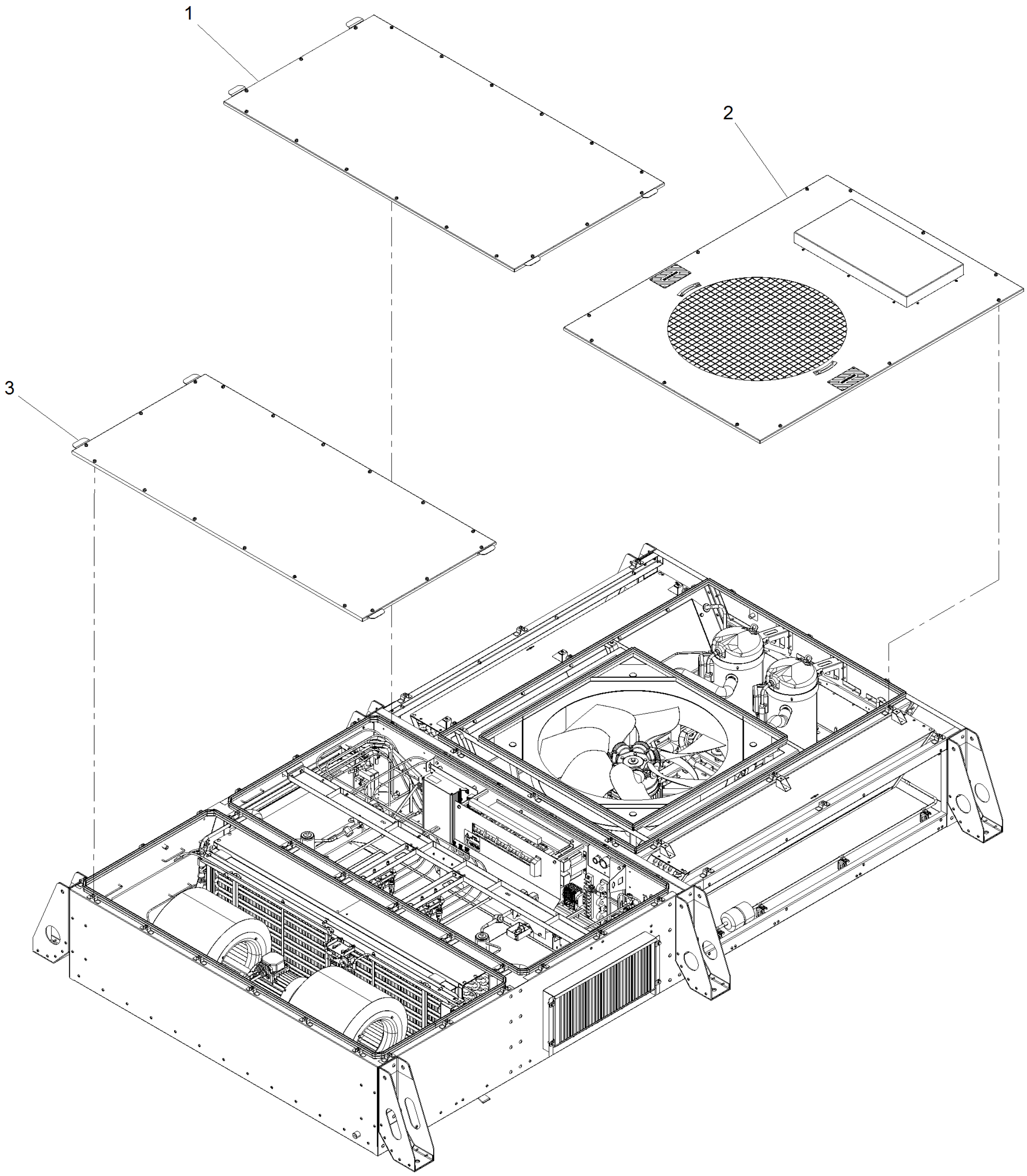

Figure 5-3: Annual Clean and Inspect HVAC Equipment
(Sheet 1 of 4)

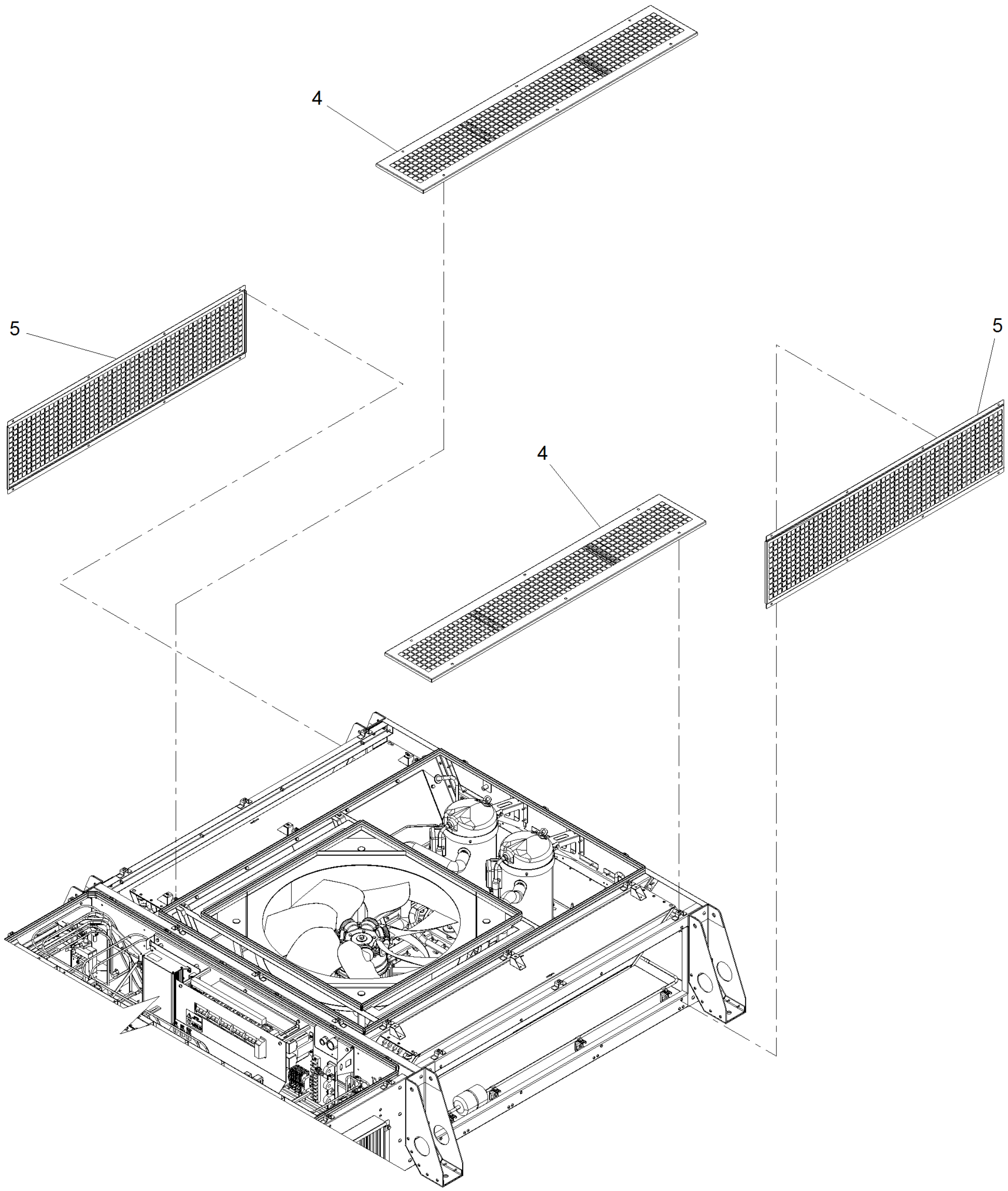

Figure 5-3: Annual Clean and Inspect HVAC Equipment
(Sheet 2 of 4)

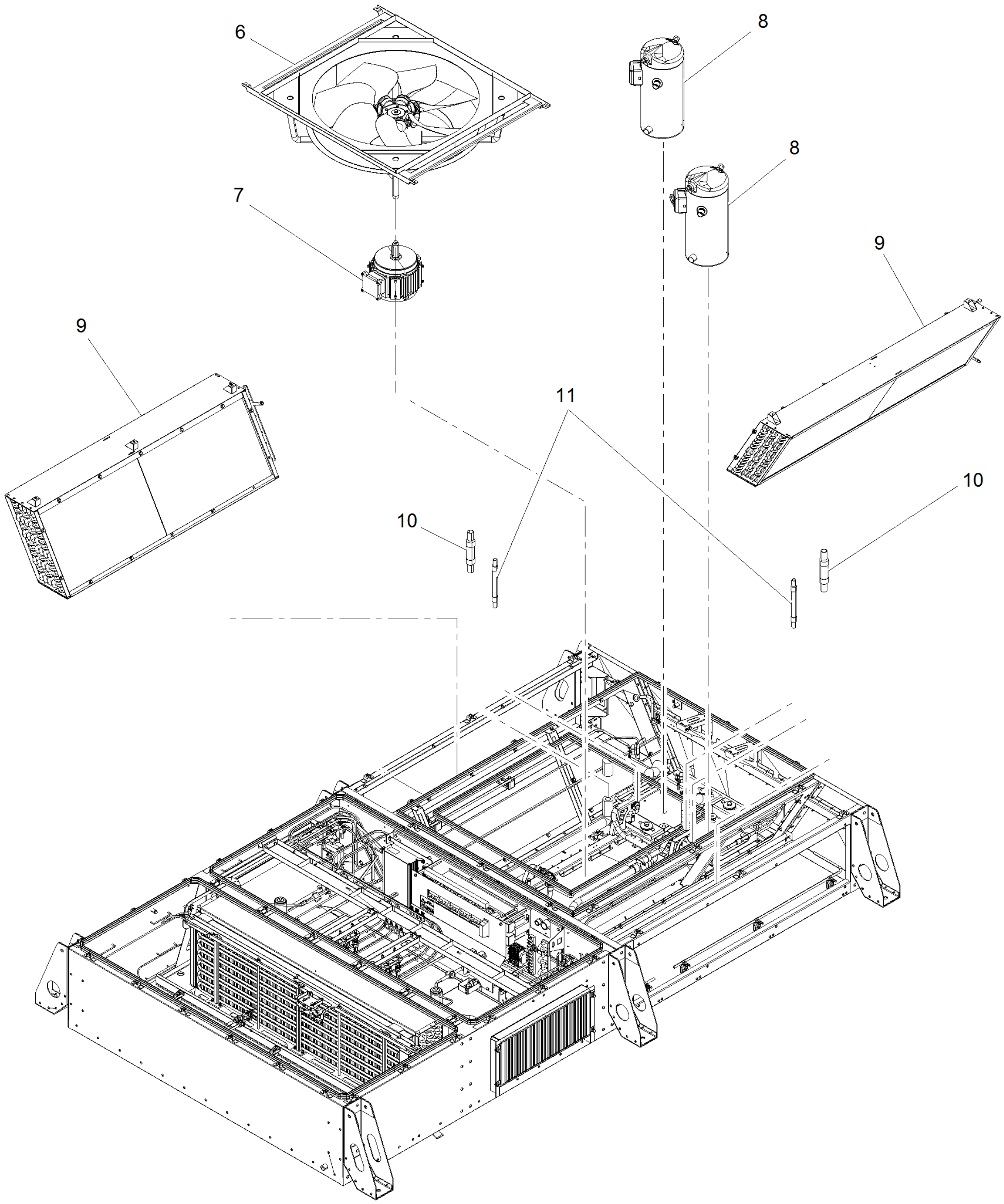

Figure 5-3: Annual Clean and Inspect HVAC Equipment
(Sheet 3 of 4)

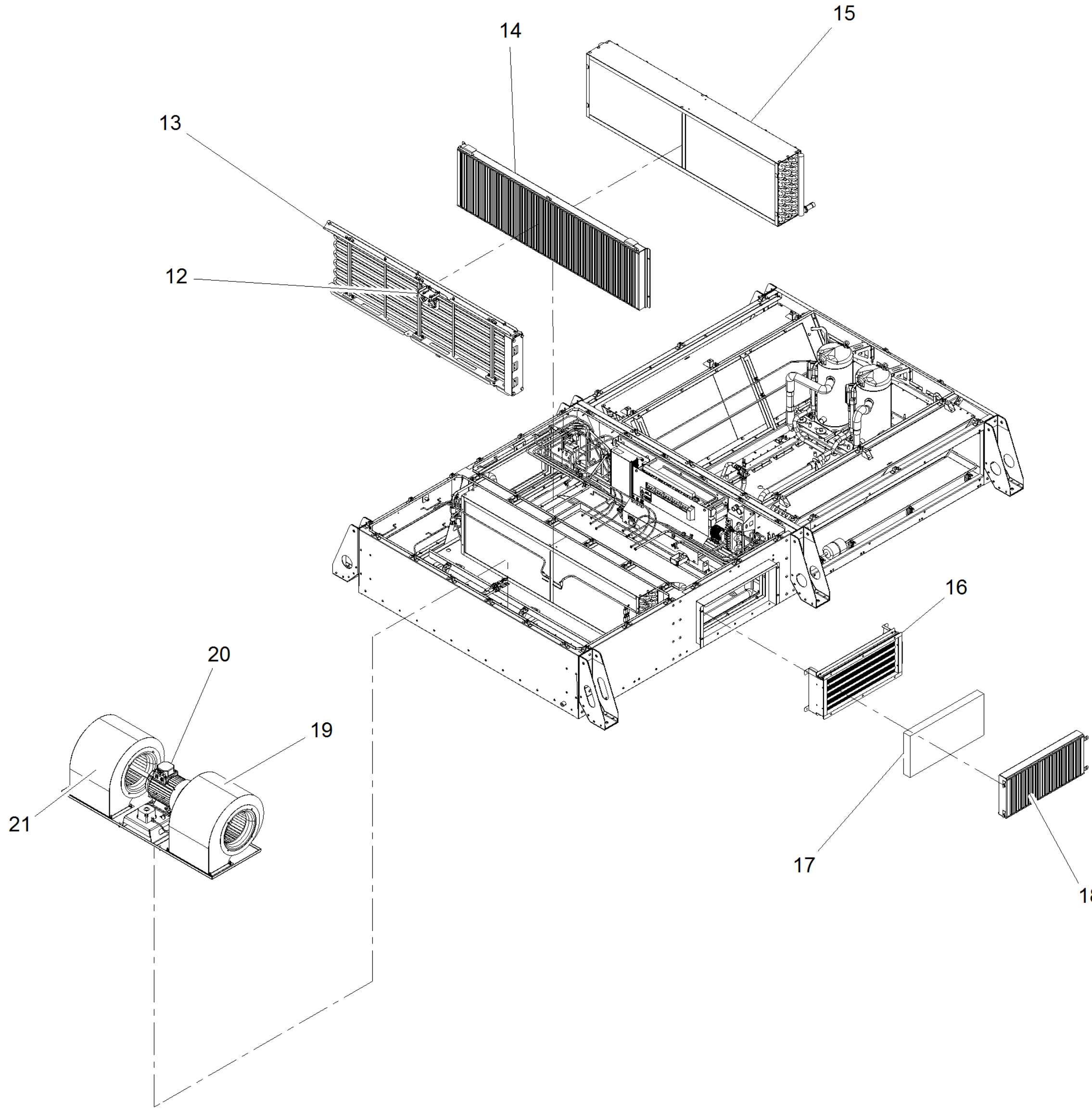

Figure 5-3: Annual Clean and Inspect HVAC Equipment
(Sheet 4 of 4)

3. Perform the following for all covers (1, 2, 3) and grills (4, 5):

a. Remove covers and grills; refer to Section 7.3.8, HVAC Covers Removal and Installation for additional remove and install procedures.

b. Inspect all covers and grilles for damage such as dents, cracks, warping, etc. Replace any cover or grille that is damaged to the point of affecting proper operation.

c. Inspect all gaskets on covers and grilles for wear and damage such as cracking, tearing, missing sections, and so forth. Replace worn or damaged gaskets per HRMM.

d. Inspect insulation on covers. Check insulation is attached securely and is not damaged. If insulation is damaged, repair insulation or replace cover.

e. Inspect all cover mounting hardware and hexserts rivnuts for thread damage. Replace any hardware with signs of thread damage.

CAUTION

DO NOT USE PRESSURE WASHER TO CLEAN GRILLES. DAMAGE TO GRILLE COATING MAY OCCUR.

4. Carefully clean fresh air inlet dampers (16), water eliminators (18) and condenser coil grilles (5) to remove any dirt, debris, or blockage using house hold detergent and non-abrasive sponge.

5. Clean and flush drain lines of the condensate drain system as follows:

a. Clean bottom of unit in compressor-condenser section.

b. At each two drain locations in HVAC unit, place hose in drain and check water evacuates at other end.

6. Check overhead heater (18) connections and terminals for tightness. Retighten as necessary.

7. Inspect condenser fan (6) and evaporator blower fan wheels (19, 21) as follows:

a. Check for excessive buildup of dirt or oil. Clean as necessary.

b. Check for warped, bent, or otherwise damaged blades.

c. Check for smooth rotation.

d. Check for loose driving shaft or connection.

8. Inspect condenser fan motor (7) and evaporator blower motor (20) as follows:

a. Check motors for excessive dirt.

b. Check for damage and deterioration.

c. Check motor tightness and friction.

d. Check motor electrical connections. Retighten as necessary.

e. Check tightness of condenser fan motor mounting bolts. Re-torque as necessary.

f. Check tightness of evaporator blower motor mounting bolts. Re-torque as necessary.

g. If there is any evidence of motor deterioration replace motor per HRMM.

h. Check all electrical components, cable conditions, and installation (connectors, temperature sensors, and so on.).

9. Inspect control panel electrical components and connections as follows.

a. Check electrical components and connections for damage.

b. Verify all electrical connections are not damaged and are correctly tightened.

c. Inspect control panel contactors and circuit breakers.

10. Clean and inspect condenser coils (9) per Section 5.3.5.

11. Clean and inspect evaporator coil (20) per Section 5.3.6.

12. Clean return air plenum and evaporator blower section as follows:

a. Use vacuum cleaner to remove dust, dirt, and debris from return air plenum and evaporator blower section.

b. Use shop hose, general purpose soap, shop rags, scrub brush or scraper to clean evaporator drain pan surface. Allow water, dirt, and debris to drain through drain traps.

c. Clean, inspect or replace evaporator coil drain traps. Refer to Section 5.3.1.1 and 5.3.1.2.

13. Perform leak test of HVAC unit per Section 5.3.4.

14. Apply anti-seize to threads of grille (5) bolts.

15. Replace HVAC unit covers and grilles. Refer to Section 7.3.8, HVAC Covers Replacement for additional remove and install procedures.

5.3.4 Leak Test HVAC Unit

Equipment Conditions

- HVAC unit run in full cool mode for 30 minutes prior to test
- Remove HVAC Unit Covers according to Section 7.3.8.

Materials Required

- Snoop or soap solution
- Refrigerant leak detector wand

NOTE: The smallest leak can completely empty refrigeration system over short time. Refrigerant system is always pressurized and most leaks continue even when system is not operating. Therefore, all leaks must be found and repaired as soon as possible. Air bubbles in sight glass indicate a possible leak. An insufficient amount of refrigerant causes reduction of cooled air and/or lowers the normal suction and discharge pressure values.

1. Before performing leak test, run unit for 30 minutes in full cool mode using PTU. Refer to paragraph 3.6 for PTU operating procedures.

2. After unit has run for 30 minutes in full cool mode, shut down HVAC unit and remove power.

3. Using refrigerant leak detector wand, check if leaks exist:

a. Check for presence of oil on joints which can indicate refrigerant leak.

b. Check for leaks in brazed tubes, pipe fittings, valves, spanners, sight glass, and gaskets.

4. Once leaks have been detected, apply a solution of soap and water to pinpoint exact location.

5. If leak is confirmed with leak detector wand, repair leak per HRMM.

5.3.5 Clean and Inspect Condenser Coil

Equipment Conditions

- HVAC unit switched off
- HVAC unit at ambient temperature
- Remove HVAC Unit Covers according to Section 7.3.8.

Materials Required

- Soft Bristle Brush
- High Pressure Power Washer
- Detergent Solution (Nutek Green Grime Off Extreme or similar)
- Compressed Air
- Shop Vacuum
- Fin Comb

Refer to Figure 5-4.

1. Use vacuum to remove all loose dirt and debris such as leaves and feathers from condenser coil surface (1) and frame (2).

CAUTION

DO NOT USE WIRE BRUSH OR SIMILAR, AS THIS WILL DAMAGE THE COIL FINS. EXERCISE CARE TO ENSURE COIL FINS ARE NOT DAMAGED.

2. Using soft bristle brush, carefully brush and rub off loose dirt on coil surface (1).

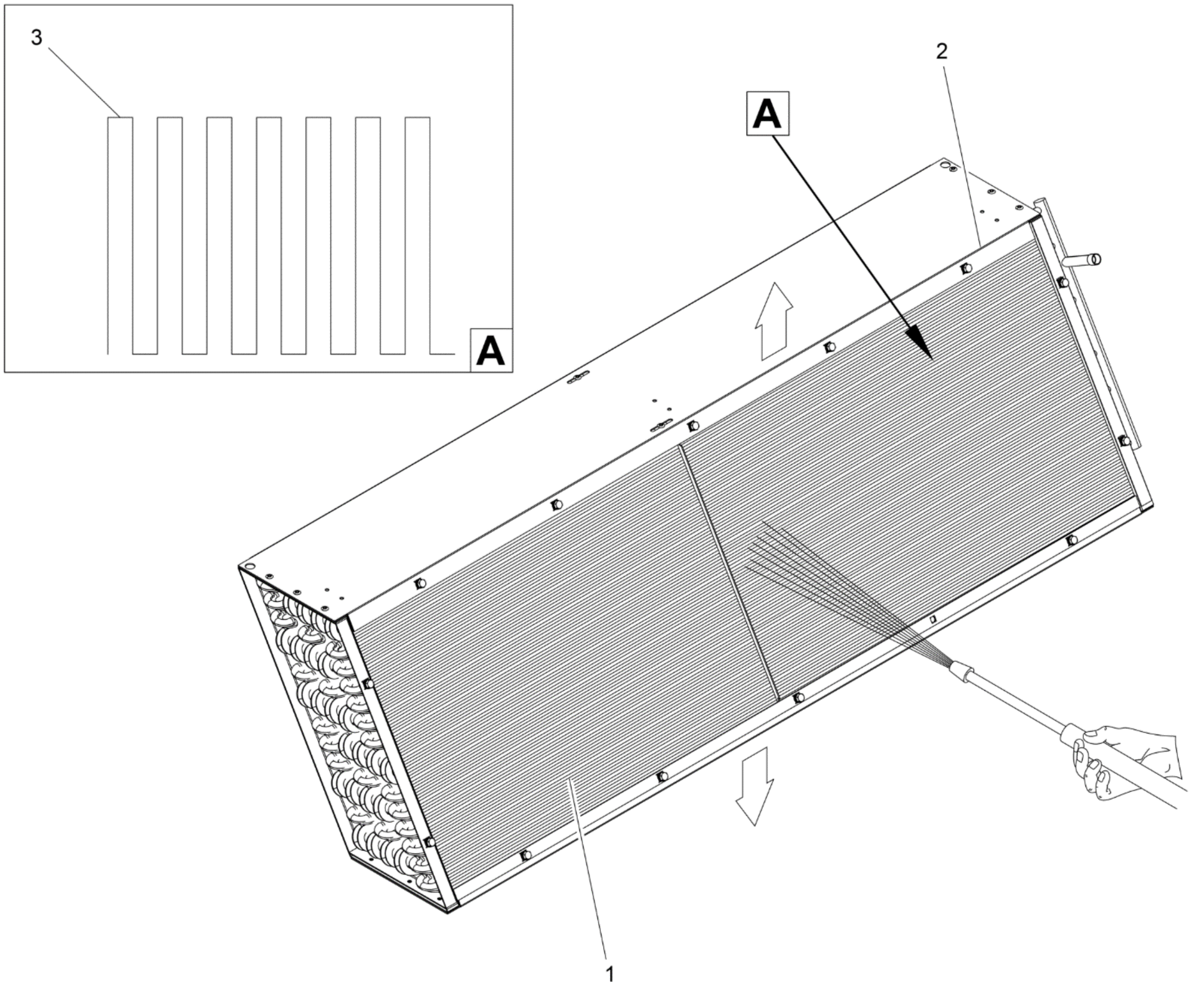

Figure 5-4: Annual Clean and Inspect Condenser Coil

WARNING

USING COMPRESSED AIR CAN CAUSE DEBRIS BETWEEN COILS TO BECOME AIRBORNE. WEAR EYE PROTECTION AND GLOVES WHILE USING COMPRESSED AIR TO AVOID INJURY.

3. Use compressed air to remove any additional loose debris from coil fins (1). Using serpentine motion (3) as shown in Figure 5-4 force compressed air through condenser coil (2) to loosen debris trapped within fin block (1).

4. Use vacuum cleaner to remove all loosened debris from condenser coil (2) and HVAC unit.

CAUTION

COIL FINS CAN EASILY BE DAMAGED WHEN WASHING WITH A HIGH PRESSURE SPRAYER. EXERCISE CARE TO ENSURE COIL FINS ARE NOT DAMAGED.

WARNING

USING HIGH PRESSURE SPRAYER CAN CAUSE DEBRIS BETWEEN COILS TO BECOME AIRBORNE WEAR EYE PROTECTION AND GLOVES WHILE USING HIGH PRESSURE SPRAYER TO AVOID INJURY.

COIL CLEANING FLUIDS CAN BE CORROSIVE, ALWAYS FOLLOW SAFETY PRECAUTIONS RELATED TO THESE PRODUCTS

5. Using high pressure power washer, set hot water temperature to 160°F and detergent strength to 2.0 – 3.0%.

CAUTION

DO NOT MOVE SPRAY NOZZLE SIDE TO SIDE AS EXTENSIVE FIN DAMAGE MAY RESULT.

6. Wash entire coil surface (1) with power washer, moving water jet in downward stroke, at a right angle (90) to coil surface, following a serpentine motion (3) as shown in Figure 5-4.
7. Turn off power washer and allow 5 to 15 minutes for detergent to work.
8. Set power washer to hot clean water setting (0% detergent) and rinse entire condenser coil (2) until completely free of detergent.
9. Clean all dirt from inside HVAC frame.
10. Dry coils (1) with compressed air.
11. Use fin comb to straighten any bent fins.
12. Resume HVAC inspection per Section 5.3.3.

5.3.6 Clean and Inspect Evaporator Coil

Equipment Conditions

- HVAC unit switched off
- Environmental control circuit breaker off
- HVAC unit at ambient temperature
- Remove HVAC Unit Covers; refer to Section 7.3.8.

Materials Required

- Soft Bristle Brush
- Compressed Air
- Shop Vacuum
- Fin Comb

Refe to Figure 5-5.

1. Remove water eliminator between evaporator coil and heater by removing seven M6 x 20 hex head screws, M6 washers, and M6 lock washers. Discard lock washers.

2. Use vacuum to remove all loose dirt and debris from evaporator coil surface (1) and frame (2).

CAUTION

DO NOT USE WIRE BRUSH OR SIMILAR, AS THIS WILL DAMAGE THE COIL FINS. USE EXERCISE CARE TO ENSURE COIL FINS ARE NOT DAMAGED.

3. Using soft bristle brush, carefully brush and rub off all dirt on coil surface (1).

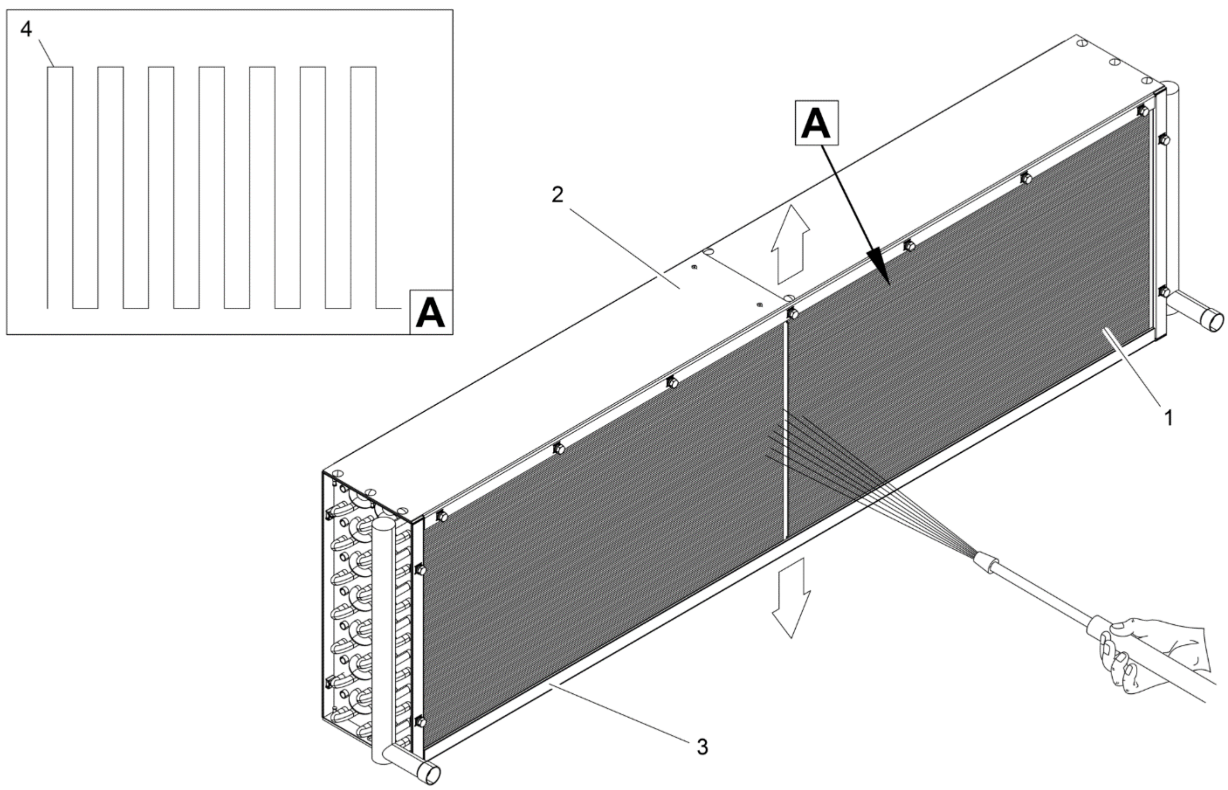

Figure 5-5: Annual Inspect and Clean Evaporator Coil

WARNING

USING COMPRESSED AIR CAN CAUSE DEBRIS BETWEEN COILS TO BECOME AIRBORNE. WEAR EYE PROTECTION AND GLOVES WHILE USING COMPRESSED AIR TO AVOID INJURY.

4. Clean coil fin block (1) using compressed air. Using serpentine motion (4) as shown in Figure 5-5 force compressed air through intake side (3) of evaporator coil in return air plenum to loosen debris trapped within fin block.

5. Use vacuum cleaner to remove all loosened debris from unit, including in between evaporator coil and overhead heater and around evaporator blower.

6. Using soft cloth, wipe off all dirt on HVAC frame surrounding evaporator coil.

7. Use fin comb on coil fin block (1) to straighten any bent fins while checking evaporator coil fin block for damage. If damage to fin block will affect evaporator coil operation, replace evaporator coil per HRMM.

8. Resume HVAC inspection per Section 5.3.3.

5.3.7 Inspect Moisture Indicator

Equipment Conditions

- Compressor on associated refrigeration circuit running
- Return air plenum open and return air filter removed

Materials Required

- None

NOTE: Moisture indicator is located in return air plenum.

Refer to Figure 5-6.

1. Remove protective cap (1) from moisture indicator (2).

2. While compressor is running, visually check color changing element (4) in center of sight glass (3).

3. Compare color changing element (4) to color reference label (5) on cap (1).

4. If color changing element (4) matches dark green DRY color no additional action is necessary.

5. If color changing element (4) matches light green/chartreuse CAUTION color or yellow WET color perform the following before replacing filter drier:

a. Run associated compressor for 30 to 60 minutes then recheck color changing element (4).

b. If color changing element (4) matches green DRY color, the associated refrigerant circuit is normal and no additional action is necessary.

c. If color changing element (4) still matches light green/chartreuse CAUTION color or yellow WET color, perform leak test per Section 5.3.4.

d. If a leak is found, repair leak per HRMM.

e. If no leaks are found, replace filter drier per HRMM.

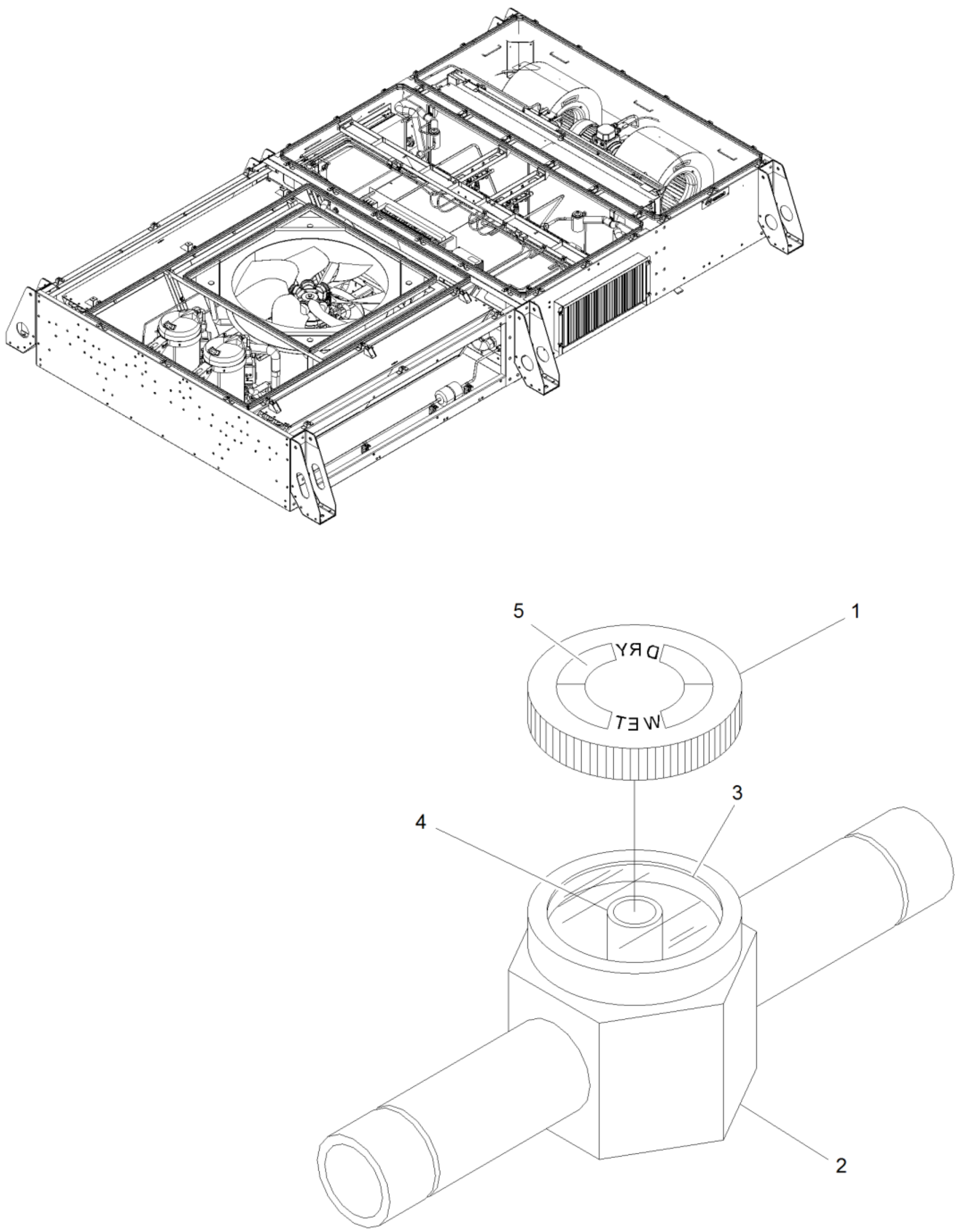

Figure 5-6: Inspect Moisture Indicator

5.3.8 Test Fresh Air Temperature Sensor

1. Using a digital thermometer, measure air temperature at fresh air intake, near fresh air temperature sensor.

2. Compare the digital thermometer value with the Fresh Air Sensor value on the PTU Temperatures and Pressures screen (Figure 5-7). The two temperature values should be within ±1.8°F of each other. Refer to paragraph 3.6 for PTU operating procedures.

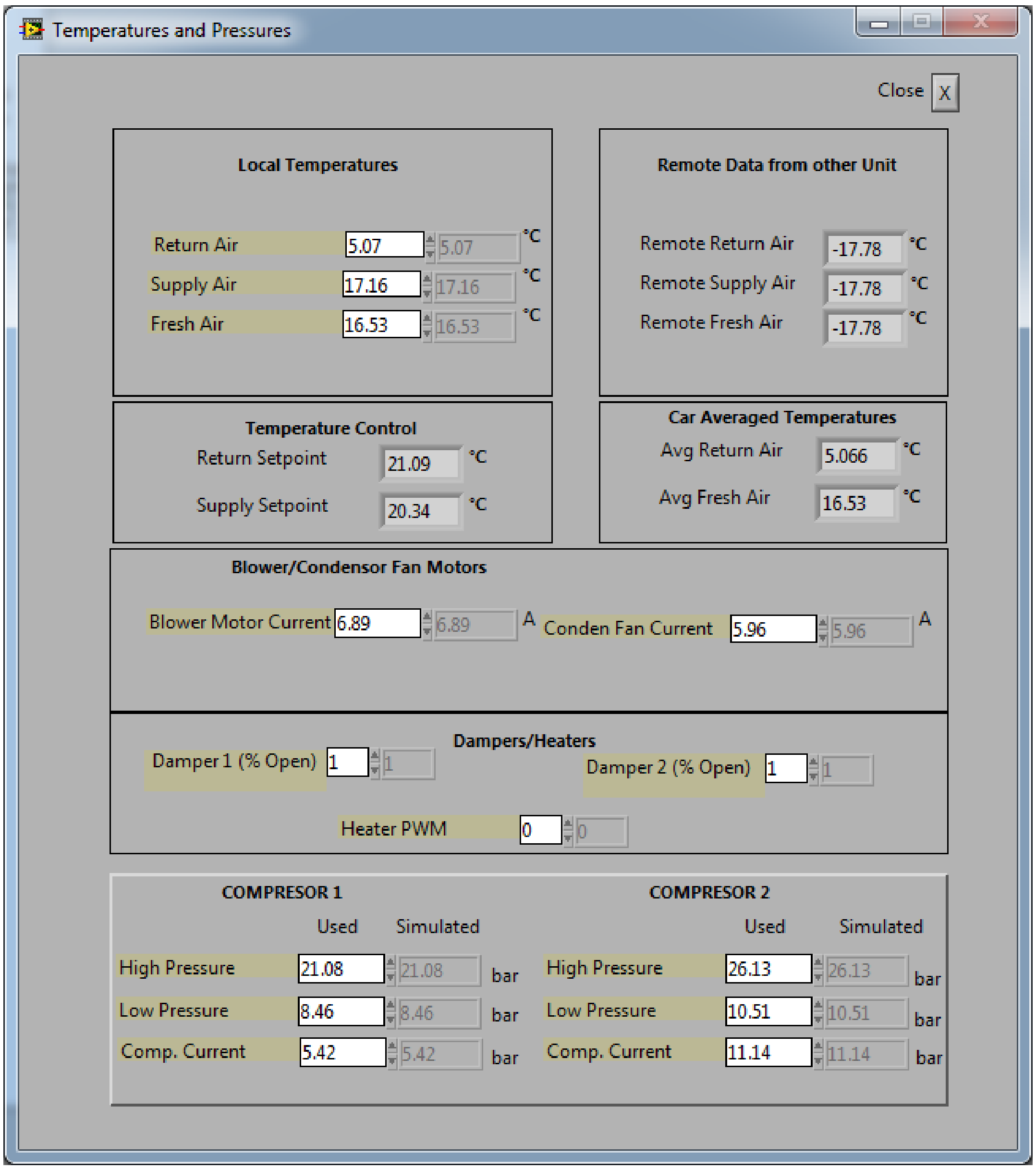

Figure 5-7: PTU, Temperatures and Pressures Window

3. If temperatures differ by more than 1.8°F, repeat test. If temperatures differ by more than 1.8°F after second test, replace fresh air temperature sensor per HRMM.

5.3.9 Test Return Air Temperature Sensor

1. Using a digital thermometer, measure air temperature at return air intake, near return air temperature sensor.

2. Compare the digital thermometer value with the Return Air Sensor value on the PTU Temperatures and Pressures window (Figure 5-7). The two temperature values should be within ±1.8°F of each other. Refer to paragraph 3.6 for PTU operating procedures.

3. If temperatures differ by more than 1.8°F, repeat test. If temperatures differ by more than 1.8°F after second test, replace return air temperature sensor per HRMM.

5.3.10 Test Supply Air Temperature Sensor

1. Using a digital thermometer, measure air temperature at the supply air ductwork inside the car.

2. Compare the digital thermometer value with the Supply Air Sensor value on the PTU Temperatures and Pressures window (Figure 5-7). The two temperature values should be within ±1.8°F of each other. Refer to paragraph 3.6 for PTU operating procedures.

3. If temperatures differ by more than 1.8°F, repeat test. If temperatures differ by more than 1.8°F after second test, replace supply air temperature sensor per HRMM.

5.3.11 Test of Overhead Heater Protective Thermostat 1

Equipment Conditions

- Environmental control circuit breaker ON
- Overhead heater circuit breaker ON

Material Required

- Non-contact infrared thermometer
- Hot air gun
- Portable Test Unit (PTU)

Refer to Figure 5-8 and Figure 5-9.

NOTE: This procedure uses the Portable Test Unit (PTU). Refer to the PTU User's Manual for detailed instructions on operating the PTU.

CAUTION

THE HVAC SYSTEM IS MANUALLY CONTROLLED FROM THE PORTABLE TEST UNIT (PTU) AND THE SYSTEM RESPONDS TO COMMANDS GIVEN BY THE USER. AN IMPROPER COMMAND FROM THE PTU USER CAN CAUSE THE HVAC SYSTEM TO MALFUNCTION. DAMAGE TO EQUIPMENT CAN OCCUR IF THE PTU IS NOT OPERATED PROPERLY. ONLY EXPERIENCED, TRAINED PERSONNEL SHOULD USE THE PTU.

1. Remove evaporator section cover to gain access to overhead heater (1) protective thermostat 1 (OHPT1) (2).

2. Using PTU, click “Digital I/O” button to open Digital Inputs and Outputs screen. Refer to Figure 5-8.

3. Using PTU, check LED for digital input OHPT1 is illuminated.

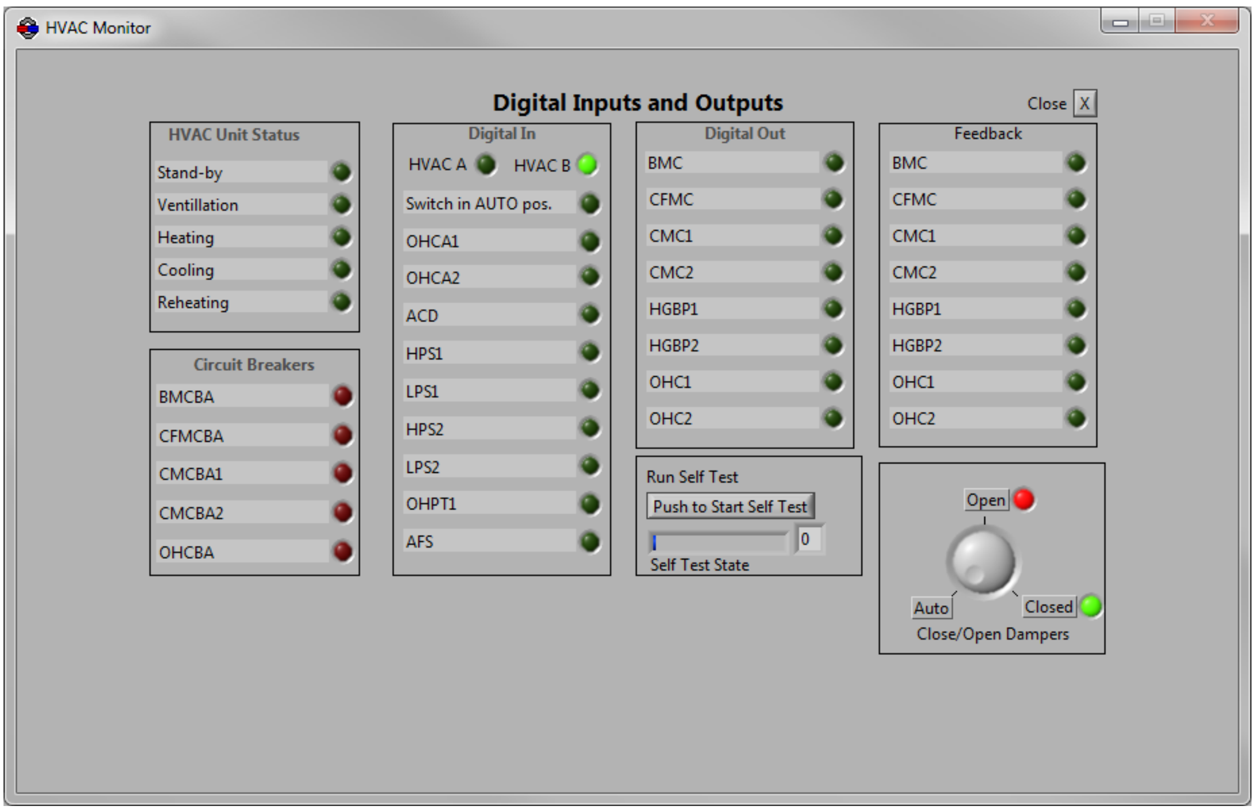

Figure 5-8: PTU Digital Inputs and Outputs Screen

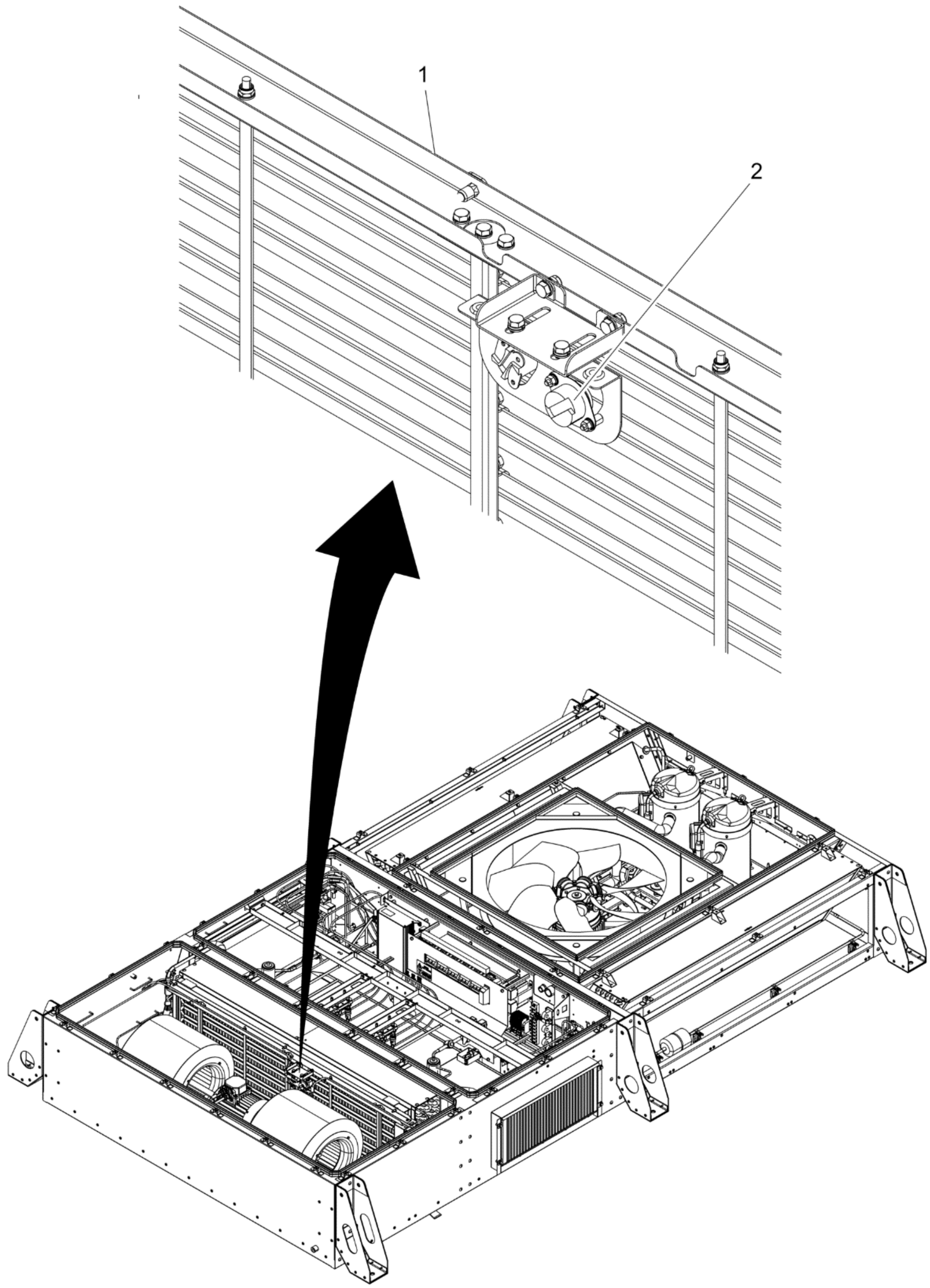

Figure 5-9: OHPT1 Functional Test

WARNING

DANGER OF BURN INJURY. USE CAUTION WHEN WORKING WITH HOT AIR GUN AND OVERHEAD HEATER.

4. Using hot air gun, slowly heat thermostat (2) to 125°F. Use thermometer (such as non-contact infrared thermometer) to monitor temperature of thermostat.

5. Using PTU, check OHPT1 LED status. When temperature reaches 130° ±5°F, thermostat should open causing OHPT1 LED to de-illuminate.

6. Stop heating thermostat.

7. Monitor temperature of overhead heater thermostat (2) while thermostat cools.

8. Using PTU, check OHPT1 LED status. When temperature drops to 95° ±5°F thermostat should reset causing OHPT1 LED to illuminate.

9. OHPT1 is non-adjustable. Cut-in and cut-out temperatures have a tolerance of ±5°F. If thermostat is out of tolerance repeat test. If thermostat fails second test replace OHPT1 per HRMM then repeat full test.

10. Replace evaporator section cover: refer to Section 7.3.8 for detailed procedures.

5.3.12 Test of Overhead Heater Protective Thermostat 2

Equipment Conditions

- Environmental control circuit breaker ON
- Overhead heater circuit breaker ON

Material Required

- Non-contact infrared thermometer
- Hot air gun

Refer to Figure 5-10.

WARNING

DANGER OF BURN INJURY. USE CAUTION WHEN WORKING WITH HOT AIR GUN AND OVERHEAD HEATER.

1. Remove evaporator section cover to gain access to overhead heater (1) protective thermostat 2 (OHPT2) (2).

2. Verify circuit breaker on control panel for overhead heater (OHCB) is not tripped.

3. Using hot air gun, slowly heat thermostat (2) to 251°F. Use non-contact infrared thermometer to monitor temperature of thermostat.

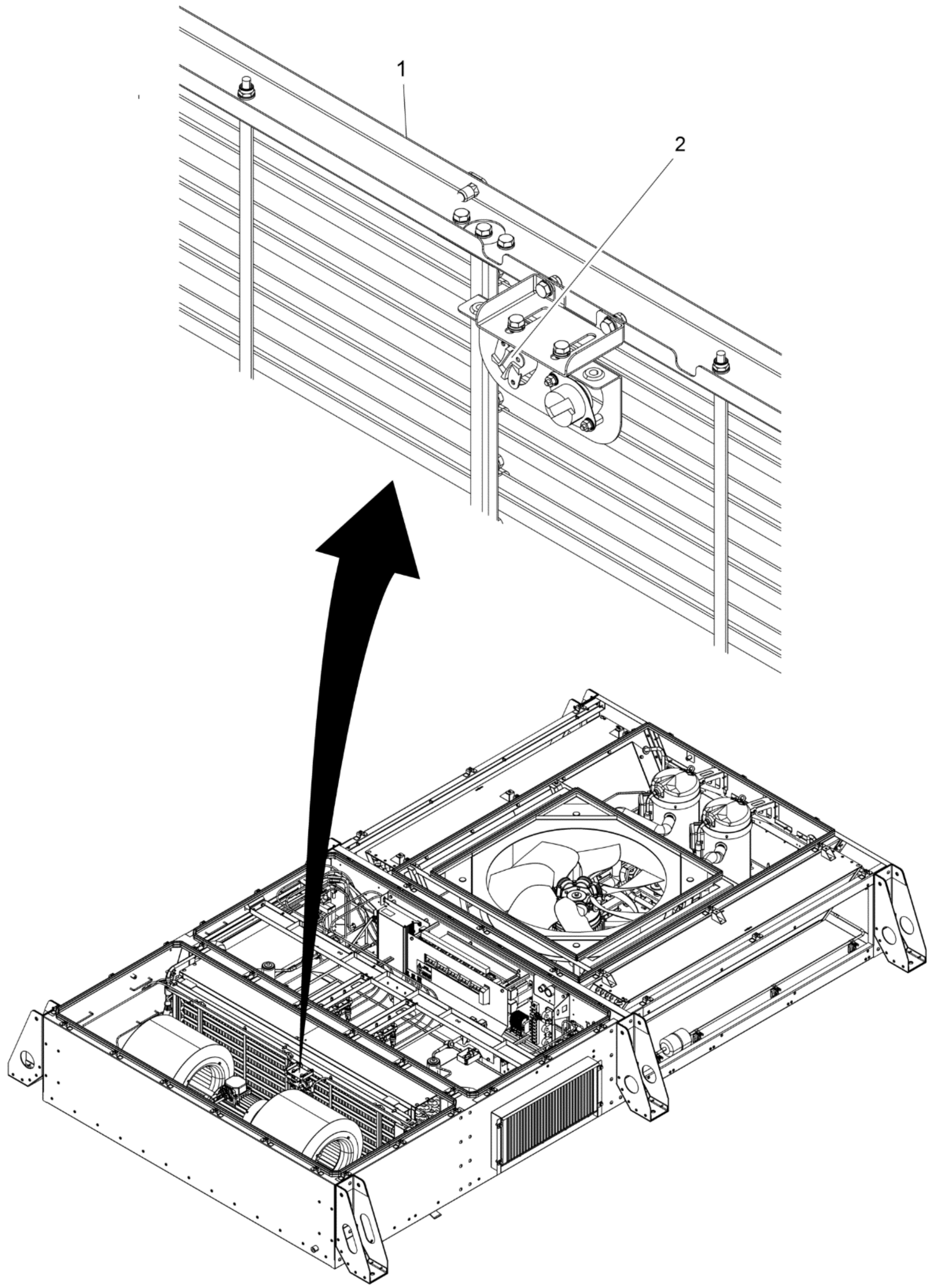

Figure 5-10: OHPT2 Functional Test

4. When temperature reaches 257±6°F, thermostat (12) should open causing overhead heater circuit breaker to trip. Stop heating thermostat.

5. Check circuit breaker on control panel for overhead heater (OHCB) tripped.

6. Monitor temperature of overhead heater thermostat (2) while thermostat cools.

7. Thermostat should reset when temperature drops to 221±6°F.

8. Reset overhead heater control panel circuit breaker.

9. OHPT2 is non-adjustable. Cut-in and cut-out temperatures have a tolerance of ±6°F. If thermostat is out of tolerance repeat test. If thermostat fails second test replace OHPT2 per HRMM then repeat full test.

10. Replace evaporator section cover; refer to Section 7.3.8 for detailed procedures.

5.3.13 HVAC System Functional Test

Equipment Conditions

- Environmental control circuit breaker ON

Material Required

- Portable Test Unit (PTU)

Refer to Figure 5-11.

NOTE: The HVAC system function test is run using the PTU self-test feature. The self-test tests the following components:

- Fresh Air Dampers
- Evaporator Blower Motor
- Overhead Heater
- Condenser Fan Motor
- Compressors
- Hot Gas By-Pass Valves

NOTE: This procedure uses the Portable Test Unit (PTU). Refer to the PTU User's Manual for detailed instructions on operating the PTU.

CAUTION

THE HVAC SYSTEM IS MANUALLY CONTROLLED FROM THE PORTABLE TEST UNIT (PTU) AND THE SYSTEM RESPONDS TO COMMANDS GIVEN BY THE USER. AN IMPROPER COMMAND FROM THE PTU USER CAN CAUSE THE HVAC SYSTEM TO MALFUNCTION. DAMAGE TO EQUIPMENT CAN OCCUR IF THE PTU IS NOT OPERATED PROPERLY. ONLY EXPERIENCED, TRAINED PERSONNEL SHOULD USE THE PTU.

1. Using PTU, click “Digital I/O” button to open Digital Inputs and Outputs screen. Refer to Figure 5-11.

2. Click “Push to Start Self Test” button to start the self-test. The self-test contains 12 steps and runs for approximately 5 minutes.

3. When the self-test is complete the ACCU returns to its standard routine.

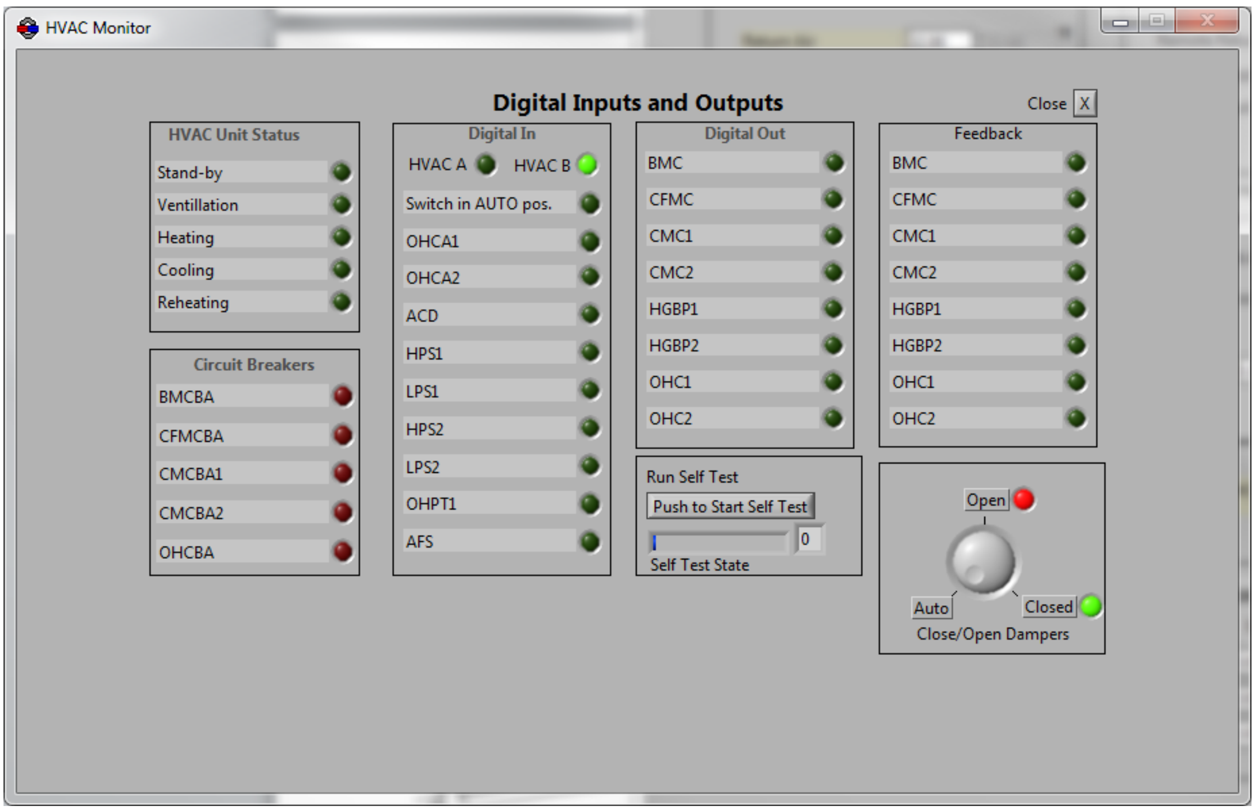

Figure 5-11: HVAC System Self-Test

5.3.14 Test High and Low Pressure Transducers

Equipment Conditions

- Ambient temperature at test location above 45°F
- Environmental control circuit breaker ON
- HVAC unit running in full cool mode (both compressors running)

Material Required

- Portable Test Unit (PTU)
- Refrigerant manifold gauge set
- Service couplers, high and low side

NOTE: This procedure uses the Portable Test Unit (PTU). Refer to the PTU User's Manual for detailed instructions on operating the PTU.

This test is written for the pressure transducers in a single refrigerant circuit. Each refrigerant circuit must be independently tested.

1. Ensure HVAC unit is running in full cool mode. If necessary simulate full cool mode using PTU.

CAUTION

DO NOT USE EQUIPMENT THAT HAS BEEN USED WITH ANOTHER REFRIGERANT.

THIS TEST PLACES THE HVAC UNIT IN COOLING MODE. TEST MUST NOT BE PERFORMED WHEN AMBIENT TEMPERATURE AT TEST LOCATION IS BELOW 45°F AS DAMAGE TO HVAC UNIT CAN OCCUR.

2. Verify hoses (4, 6, Figure 5-12) on manifold gauge set (1) are in good condition.
3. Ensure center hose port (5) on manifold gauge set is capped.
4. Ensure both high-pressure and low-pressure control valves (3, 7) on manifold gauge (1) are closed.

NOTE: The service ports are located in the return air plenum (15), above the return air filter. There are two sets of ports, one set for each refrigerant circuit. Each set consists of one high-pressure service port (12) and one low pressure service port (11). The service port for refrigeration circuit 1 is on the left side when facing the refrigeration controls inside the return air plenum.

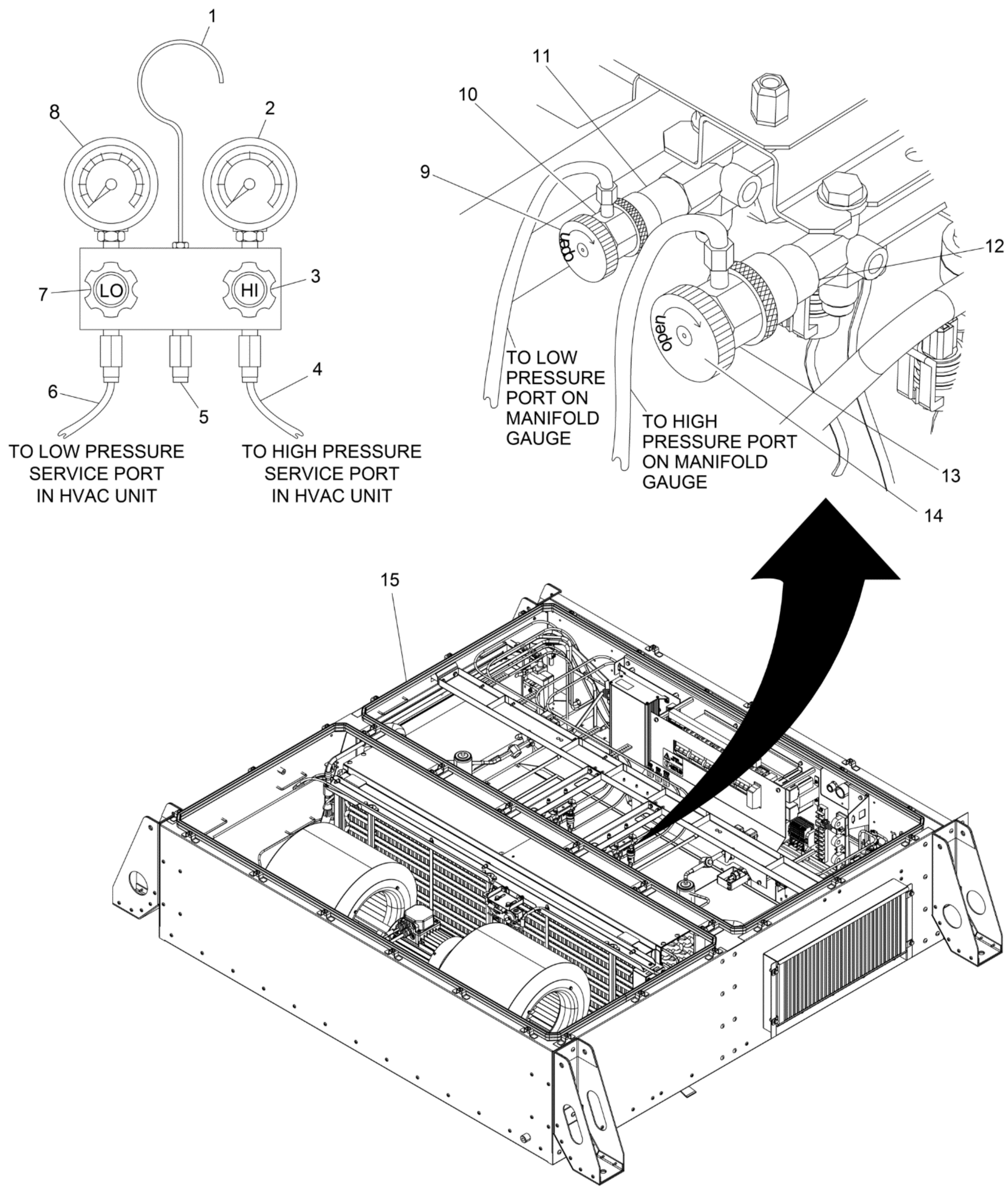

Figure 5-12: Pressure Transducer Functional Test

CAUTION

A SMALL AMOUNT OF REFRIGERANT ESCAPES FROM SCHRADER VALVE IN SERVICE PORT WHEN SERVICE COUPLER IS CONNECTED. COUPLER SHOULD BE ATTACHED QUICKLY AND SECURELY TO MINIMIZE REFRIGERANT LEAKS.

5. Close service couplers (10, 13) by turning knobs (9, 14) fully counter-clockwise.

6. Install service couplers on service ports in return air plenum (15) as follows (refer to Figure 5-12):

a. Ensure red service coupler (13) is closed by turning knob (14) fully counter-clockwise.

b. At high-pressure service port (12), remove black cap from port and install red service coupler (13).

c. Ensure service coupler is tight and is not leaking.

d. Ensure blue service coupler (10) is closed by turning knob (9) fully counter-clockwise.

e. At low-pressure service port (11), remove black cap from port and install blue service coupler (10).

f. Ensure service coupler is tight and is not leaking.

7. Connect manifold gauge high-pressure hose (4) to red service coupler (13) on high-pressure service port (12).

8. Connect manifold gauge low-pressure hose (6) to blue service coupler (10) on low-pressure service port (11).

9. Turn knobs (9, 14) on service couplers (10, 13) fully clockwise to open to circuit.

CAUTION

HVAC SYSTEM IS MANUALLY CONTROLLED FROM PTU. AS THE SYSTEM STRICTLY RECOGNIZES FORCED CONNECTION OR DISCONNECT ORDERS, A WRONG ACTUATION FROM PTU CAN CAUSE HVAC SYSTEM TO MALFUNCTION. ONLY EXPERIENCED, TRAINED PERSONNEL SHOULD USE THE PORTABLE TEST UNIT (PTU). DAMAGE TO EQUIPMENT CAN OCCUR IF PTU IS NOT OPERATED PROPERLY.

THIS TEST PLACES THE HVAC UNIT IN COOLING MODE. TEST MUST NOT BE PERFORMED WHEN AMBIENT TEMPERATURE AT TEST LOCATION IS BELOW 45°F AS DAMAGE TO HVAC UNIT CAN OCCUR.

10. Using PTU, click “Analog I/O” button to open the Temperatures and Pressures screen (Figure 5-13). The high and low pressure for compressors 1 and 2 are located at the bottom of the screen.

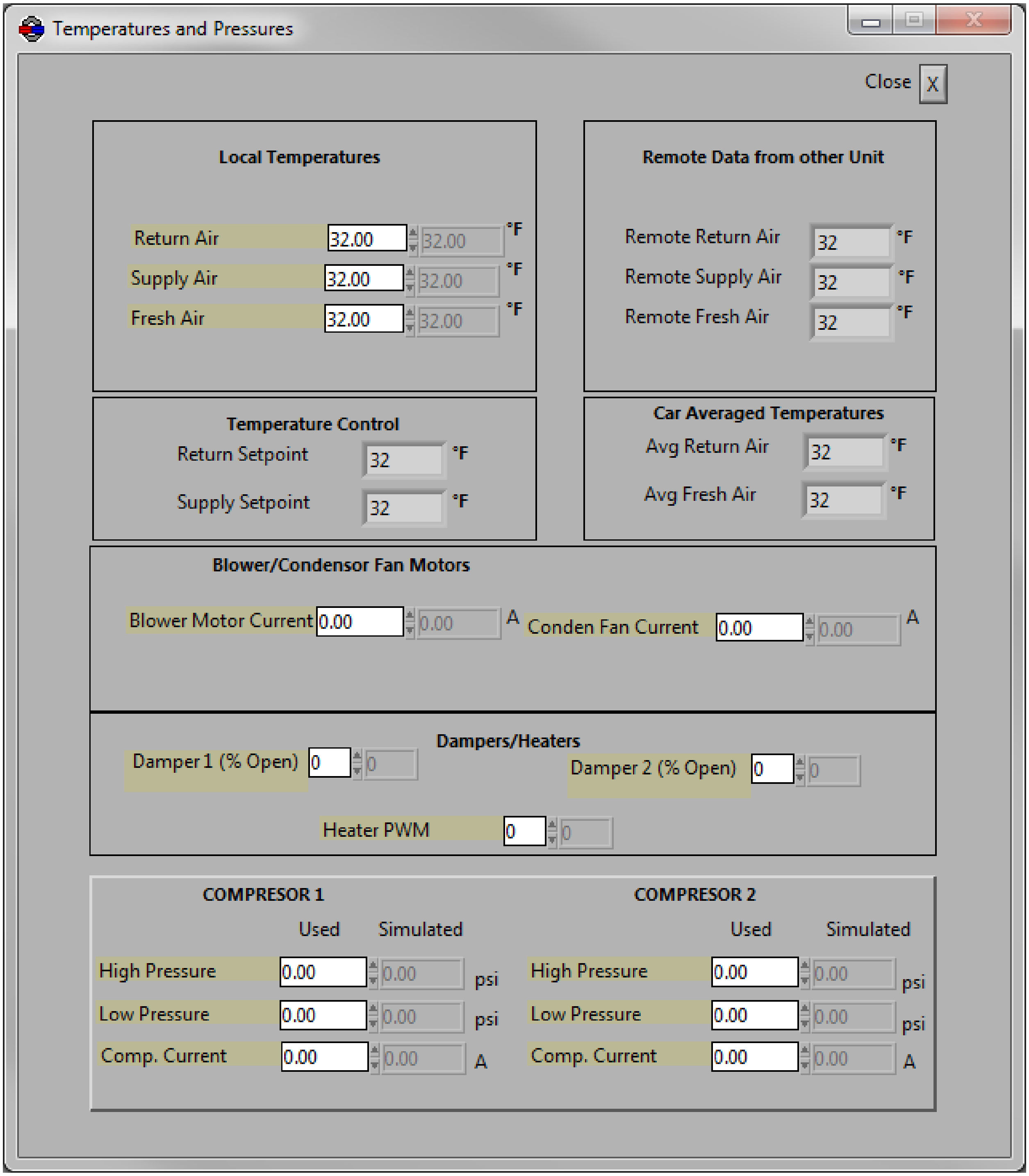

Figure 5-13: PTU Temperatures and Pressures Screen

11. On Temperatures and Pressures screen compare compressor 1 "Low Pressure" value to low pressure gauge (8) reading on manifold gauge set (1). The low pressure transducer readings should be within ±5 psig of each other.

a. If low pressure transducer readings are not within ±5 psig of each other, complete remainder of this test, then repeat the low pressure transducer portion of this test.

b. If low pressure transducer is out of tolerance after second test, replace transducer per heavy repair maintenance manual.

12. On Temperatures and Pressures screen compare compressor 1 "High Pressure" value to high pressure gauge (2) reading on manifold gauge set (1). The high pressure transducer readings should be within ±10 psig of each other.

a. If high pressure transducer readings are not within ±10 psig of each other, complete remainder of this test, then repeat the high pressure transducer portion of this test.

b. If high pressure transducer is out of tolerance after second test, replace transducer per heavy repair maintenance manual.

13. Turn knobs (9, 14) on service couplers (10, 13) fully counterclockwise to close to circuit.

14. Disconnect manifold gauge hoses (4, 6) from service couplers (10, 13) in return air plenum (15).

15. Remove service couplers (10, 13) from high and low-pressure service ports (11, 12), then install black caps over ports.

16. Repeat test for refrigerant circuit 2 (compressor 2).

5.3.15 Test Low Pressure Switch

Refer to Section 8.1.2, Troubleshooting Procedures for verification of the low pressure switch.

5.3.16 Test High Pressure Switch

Refer to Section 8.1.2, Troubleshooting Procedures for verification of the high pressure switch.

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CHAPTER 6.0

LUBRICATION

6.1 Introduction

There are no lubrication procedures for the HVAC Unit at this maintenance level.

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CHAPTER 7.0

COMPONENT REMOVAL AND INSTALLATION

7.1 Introduction

This chapter contains removal and installations procedures that are used when troubleshooting or inspecting any component part that may not be included in Chapter 5.

7.2 Safety Information

Some of the procedures in this section are preceded by warnings, cautions and notes regarding potential hazards in handling this equipment. All of these warnings should be carefully read and understood before proceeding, and then be followed closely while performing related tasks. The prominent warnings for this equipment are:

WARNING

BECAUSE THIS EQUIPMENT OPERATES AT LETHAL POWER LEVELS, WARNINGS AND REMINDERS ABOUT REMOVAL OF POWER, IN ACCORDANCE WITH LACMTA REGULATIONS SHOULD BE COMPLETELY UNDERSTOOD BEFORE ANY WORK IS BEGUN.

WARNING

SOME COMPONENTS MAY CONTAIN HAZARDOUS CHEMICALS, OR THEIR USE MAY BE REQUIRED IN CLEANING OR SERVICING SUCH COMPONENTS. IN THESE CASES, THE MANUFACTURER'S WARNINGS SHOULD BE CLOSELY HEEDED, AND ONLY THOSE ITEMS SPECIFICALLY AND CURRENTLY APPROVED FOR USE BY LACMTA SHOULD BE EMPLOYED, REGARDLESS OF ANY RECOMMENDED USE IN THE PROCEDURE.

WARNING

MUCH OF THE EQUIPMENT ON THIS VEHICLE IS LOCATED UNDER THE FLOOR. SPECIAL CAUTION SHOULD BE TAKEN WHEN ACCESSING OR SERVICING ITEMS IN THIS LOCATION.

WARNING

SOME COMPONENTS IN THIS EQUIPMENT ATTAIN TEMPERATURES THAT CAN CAUSE SEVERE BURNS, AND OTHERS, IF MISHANDLED, MAY CAUSE SERIOUS CUTS OR PRODUCE TOXIC FUMES OR RESIDUES. CLOSELY FOLLOWS MANUFACTURER'S WARNINGS AND RECOMMENDED PROCEDURES FOR HANDLING THESE COMPONENTS.

WARNING

SOME OF THE EQUIPMENT CONTAINS COMPONENTS UNDER SPRING TENSION THAT CAN BE HAZARDOUS IN AN UNCONTROLLED RELEASE. OTHER COMPONENTS CONTAIN FLUIDS OR GASSES UNDER PRESSURE THAT CAN READILY CAUSE PERSONAL INJURY IF IMPROPERLY RELEASED. WARNINGS AND SPECIFIC INSTRUCTIONS FOR HANDLING SUCH COMPONENTS SHOULD BE CLOSELY ADHERED TO.

WARNING

MANY EQUIPMENT ITEMS AND COMPONENTS ARE QUITE HEAVY AND MAY REQUIRE LIFTING DEVICES OR ASSISTANCE FOR THEIR SAFE HANDLING, AND ARE GENERALLY NOTED. HOWEVER, ALL EQUIPMENT THAT LOOKS HEAVY, PROBABLY IS, AND SHOULD BE TREATED ACCORDINGLY.

NOTE**:** The use of WARNING statements is necessarily limited to significant cases, so that effectiveness will not be reduced by too frequent usage. The absence of such statements does not, in any way, imply the absence of hazards which may be present anytime electrical or refrigeration equipment is activated, or when working on items with inherent hazards, such as those cited above.

7.3 Remove and Installation Procedures

7.3.1 Replace Contactor

Equipment Conditions

- HVAC unit powered off
- Environmental control circuit breaker off
- Control panel switch off

Material Required

- None

NOTE: This procedure is applicable to all contactors located on the control panel contactor rail. The contactor rail on the control panel is accessible by removing the control panel cover. All HVAC Unit contactors are mounted on the control panel contactor rail:

- Blow Motor Contactor (BMC)
- Condenser Fan Motor Contactor (CFMC)
- Compressor Motor Contactor 1 (CMC1)
- Compressor Motor Contactor 2 (CMC2)
- Overhead Heater 1 Contactor (OHC1)
- Overhead Heater 2 Contactor (OHC2)
- Overhead Heater Contactor Auxiliary 1 (OHCA1)
- Overhead Heater 2 Contactor Auxiliary 1 (OHCA2

See Figure 7-1.

7.3.1.1 Removal

1. Remove control panel cover (3) from control panel (1) by loosening four captive screws (4).
2. Tag and remove all wires from contactor (2) terminals.
3. Remove contactor (2) from mounting rail.

7.3.1.2 Installation

1. Install new contactor (2) into position and snap into place.
2. Connect tagged wires to contactor (2) terminals.
3. Replace control panel cover (3) and secure with four captive screws (4).

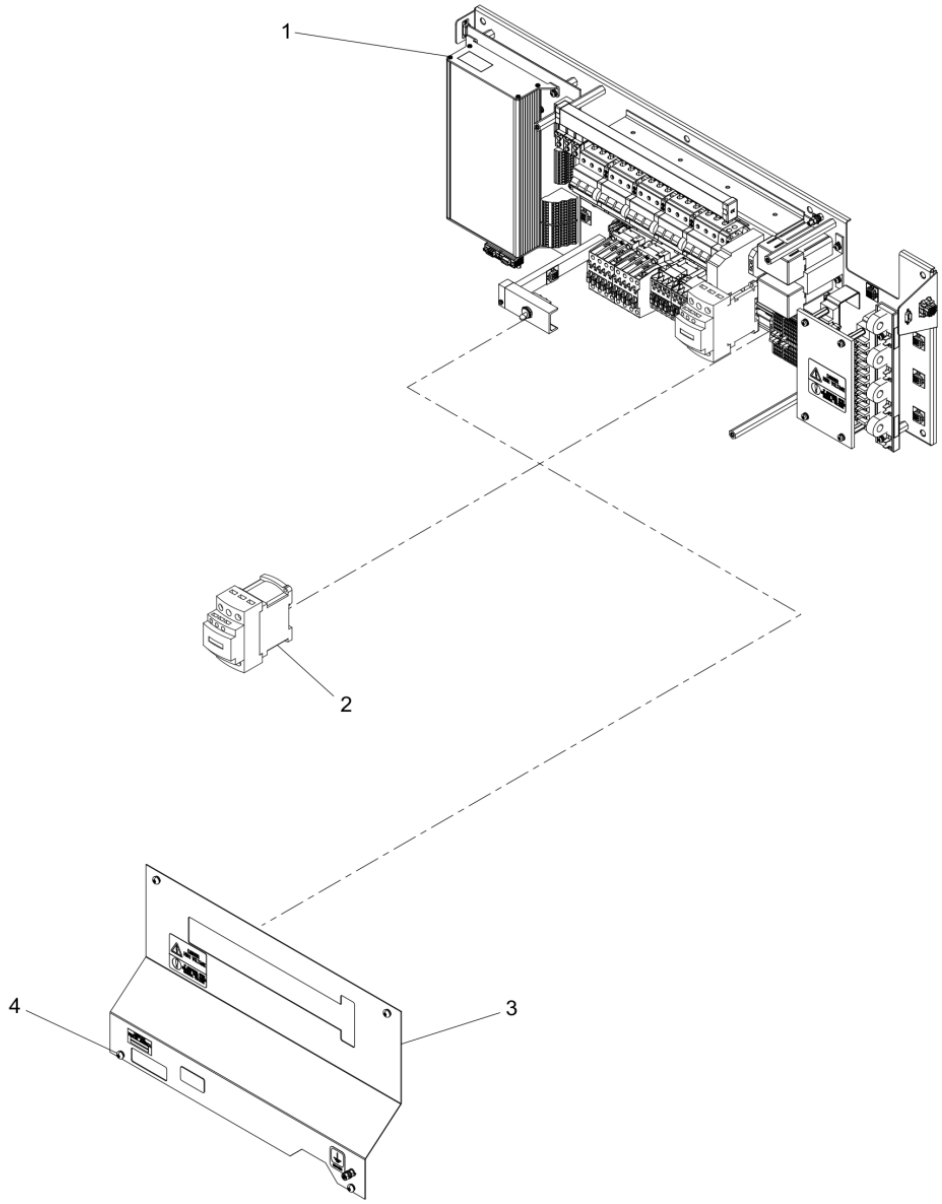


Figure 7-1: Replace Contactor

7.3.2 Replace Circuit Breaker and Auxiliary Circuit Breaker

Equipment Conditions

- HVAC unit control panel switched off
- Control circuit breaker off
- Control panel switch off

Materials Required

- None

NOTE: This procedure is applicable to all circuit breakers and auxiliary circuit breakers located on the control panel circuit breaker rail. The circuit breaker rail on the control panel is accessible by removing the control panel cover. All HVAC Unit circuit breakers and auxiliary circuit breakers are mounted on the control panel circuit breaker rail:

- Blow Motor Circuit Breaker (BMCB)
- Blow Motor Circuit Breaker Auxiliary (BMCBA)
- Condenser Fan Motor Circuit Breaker (CFMCB)
- Condenser Fan Motor Circuit Breaker Auxiliary (CFMCBA)
- Compressor Motor Circuit Breaker 1 (CMCB1)
- Compressor Motor Circuit Breaker 2 (CMCB2)
- Compressor Motor Circuit Breaker Auxiliary 1 (CMCBA1)
- Compressor Motor Circuit Breaker Auxiliary 2 (CMCBA2)
- Overhead Heater Circuit Breaker (OHCA)

NOTE: This procedure replaces circuit breaker (4) and auxiliary circuit breaker (5) at the same time. This procedure can also be used to replace the auxiliary and main circuit breakers individually.

See Figure 7-2.

7.3.2.1 Removal

1. Remove cover (3) from control panel (7) by removing four screws (1) and four retainers (2).

2. Place cover in safe location to avoid damage to cover.

3. Tag and remove wires from circuit breaker (4) and auxiliary circuit breaker (5).

4. Loosen screws connecting circuit breaker (4) and auxiliary circuit breaker (5) to bus bar (6).

5. Remove circuit breaker (4) and circuit breaker (5) from control panel (7) mounting rail.

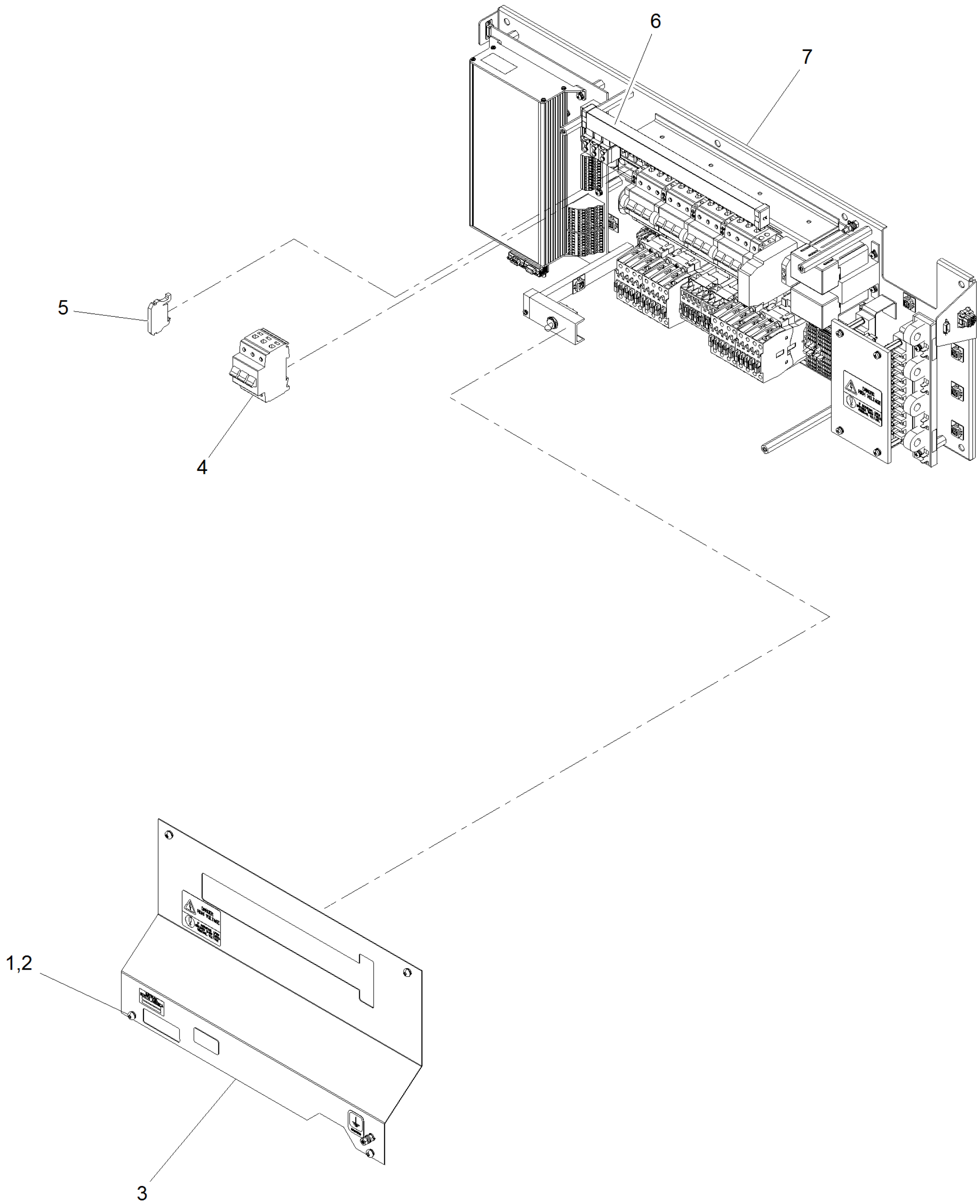


Figure 7-2: Replace Circuit Breaker

7.3.2.2 Installation

1. Position bus bar (6) terminal into circuit breaker (4) and auxiliary circuit breaker (5).
2. Connect new circuit breaker (4) and auxiliary circuit breaker (5) to control panel (7) mounting rail.
3. Reconnect all wires to circuit breaker (4) and auxiliary circuit breaker (5).
4. Tighten screws connecting circuit breaker to bus bar (6).
5. Replace cover (3) and secure with four screws (1) and four retainers (2).

7.3.3 Replace Hot Gas By-Pass Relay (HGBPR1 and HGBPR2)

<u>Equipment Conditions</u>

- HVAC unit switched off
- Control circuit breaker off
- Control panel switch off

<u>Material Required</u>

- None

NOTE: This procedure is applicable to the two relays in the control panel. The relay assembly is mounted on the control panel on the contactor rail and is accessible by removing the control panel cover (3).

See Figure 7-3.

7.3.3.1 Removal

1. Remove cover (3) from control panel (8) by removing four screws (1) and four retainers (2).
2. Press down on clip (5) to unplug and remove relay (6) from relay support bracket (4) on control panel (8).
3. Unplug module (7) from relay support bracket (4).

7.3.3.2 Installation

1. Snap relay (6) into support bracket (4).
2. Snap module (7) into support bracket (4).
3. Replace cover (3) and secure with four screws (1) and four retainers (2).

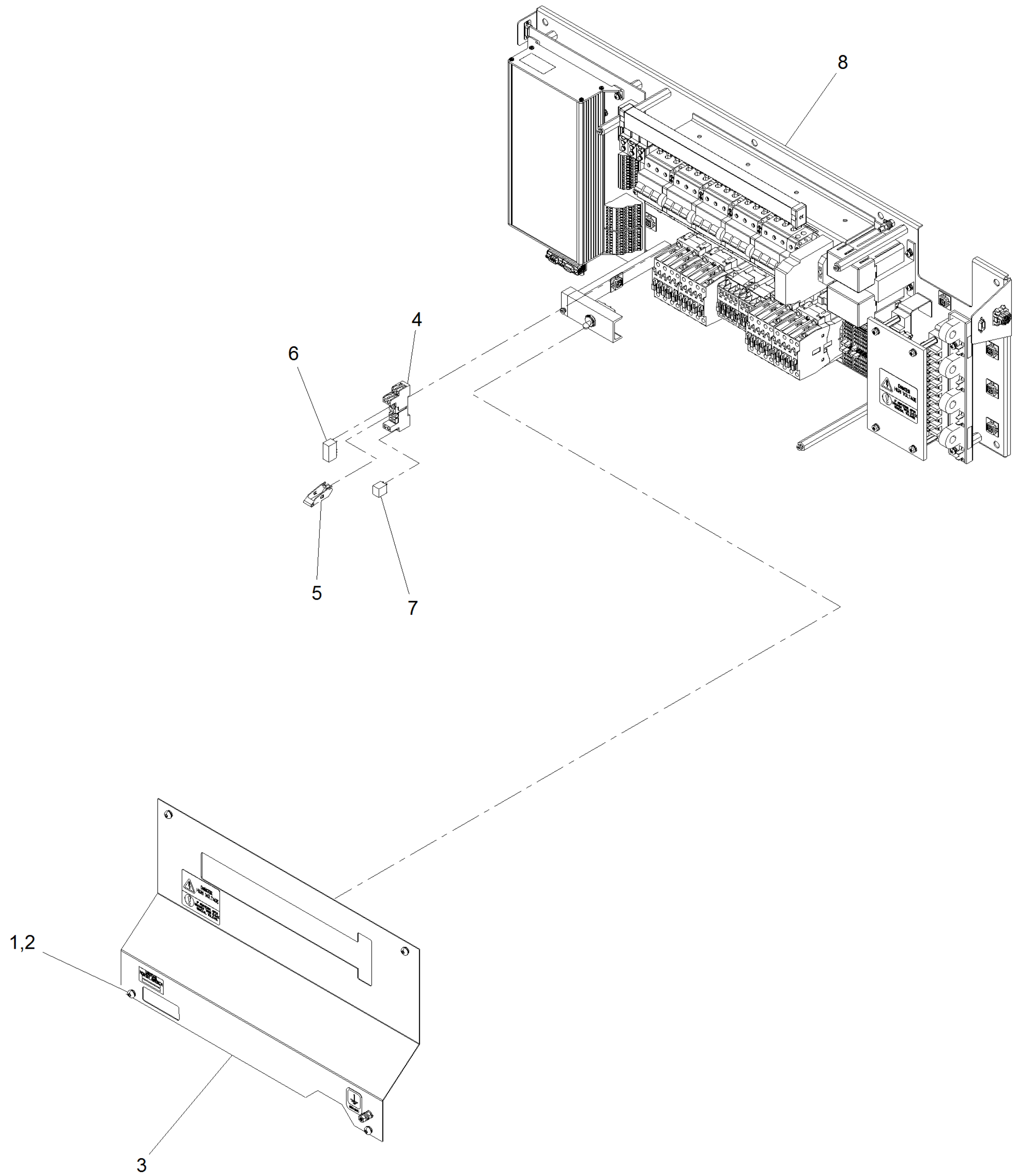


Figure 7-3: Replace Relay

7.3.4 Replace AC Detector, Voltage Monitor (ACD)

Equipment Conditions

- HVAC unit switched off
- Control circuit breaker off
- Control panel switch off

Material Required

- None

NOTE: The AC voltage detector is located on the circuit breaker rail mounted on the control panel, on the right side wall, and is accessible by removing the control panel cover.

See Figure 7-4.

7.3.4.1 Removal

1. Remove access cover (3) from control panel (4) by removing four captive screws (1).
2. Tag and remove all wires from AC voltage detector (5).
3. Unclip AC voltage detector (5) from control panel (4) mounting rail.

7.3.4.2 Installation

1. Clip new AC voltage detector (5) to control panel (4) mounting rail.
2. Reconnect all wires to AC voltage detector (5).
3. Install access cover (3) onto control panel (4) and secure using four captive screws (1).

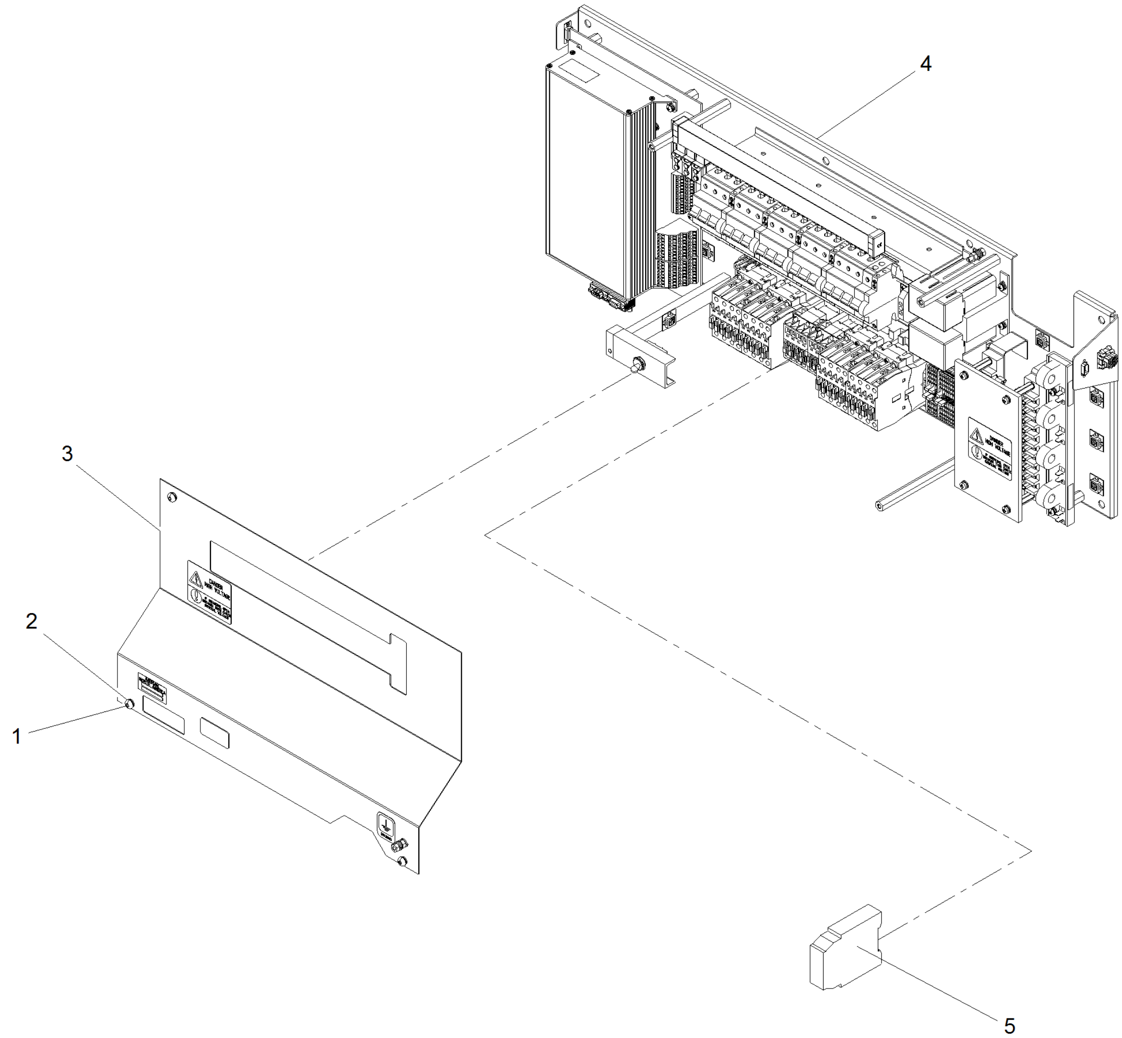


Figure 7-4: Replace AC Voltage Detector

7.3.5 Replace Transformer Control (T1)

Equipment Conditions

- HVAC unit switched off
- Control circuit breaker off
- Control panel switch off

Material Required

- None

NOTE: The AC voltage transformer control is located on the control panel, top right, and is accessible by removing the control panel cover.

See Figure 7-5.

7.3.5.1 Removal

1. Remove access cover (2) from control panel (3) by removing four captive screws (1).

2. Tag and remove all wires from transformer control (4). If needed, remove plastic terminal covers (8) to remove wiring.

3. Remove four screws (7), lock washers (6) and flat washers (5) securing transformer control (4) to control panel (3). Discard lock washers (6).

7.3.5.2 Installation

1. Install new transformer control (4) onto control panel (3) using four screws (7), new lock washers (6) and flat washers (5).

2. Reconnect all tagged wires to transformer control (4). If removed, install plastic terminal covers (8).

3. Install access cover (2) onto control panel (3) using four captive screws (1).

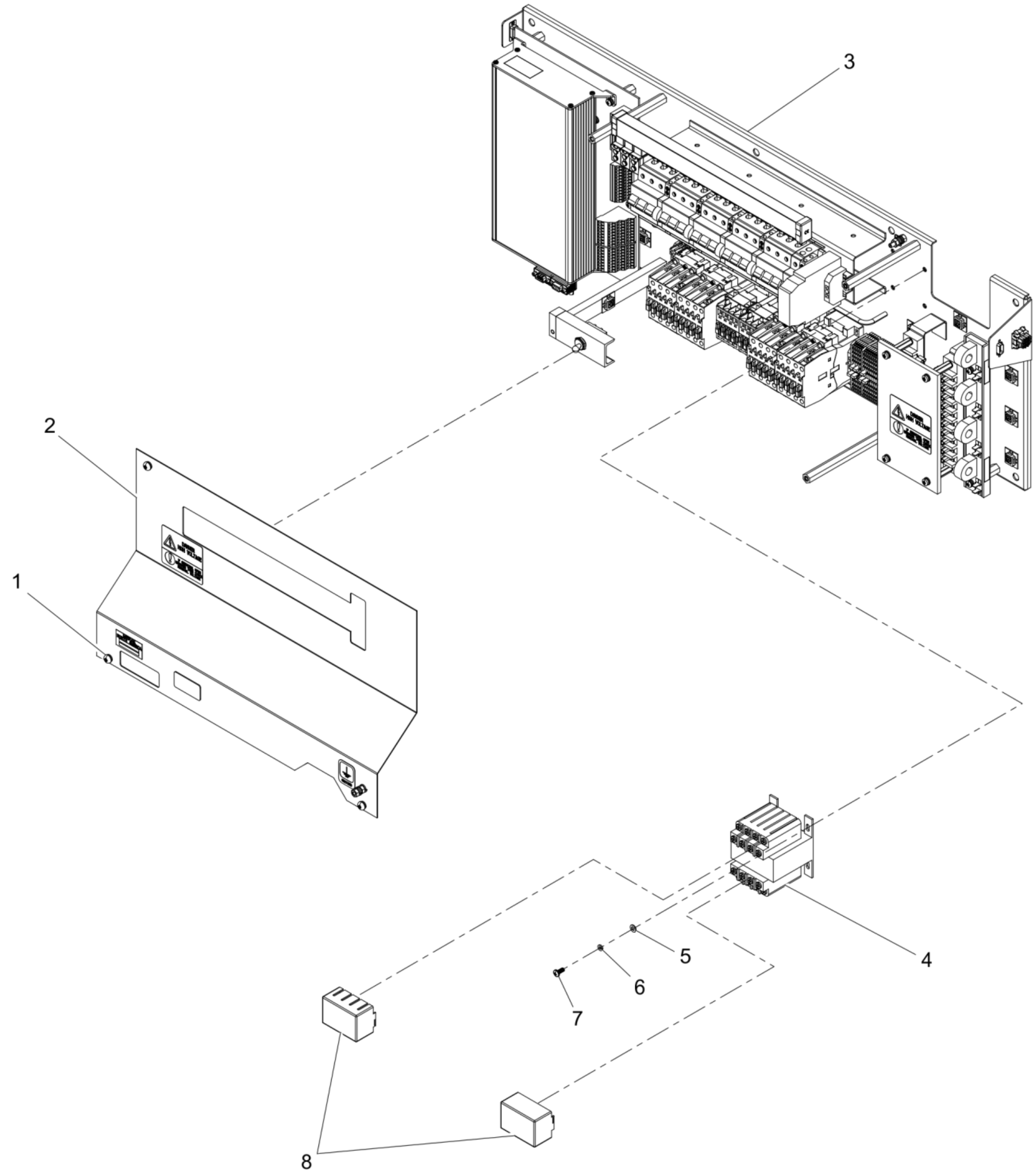


Figure 7-5: Replace Transformer Control

7.3.6 Replace Current Sensor

Equipment Conditions

- HVAC unit switched off
- Control circuit breaker off
- Control panel switch off

Material Required

- None

NOTE: The current sensor bar is located on the right side of the control panel and does not require panel cover removal for access. However, panel cover may need to be removed in order to tag and remove power wiring from current sensor. Panel cover shown removed for clarity.

See Figure 7-6.

7.3.6.1 Removal

1. Tag and remove wires from each sensor on the current sensor bar (4).
2. Remove two screws (1), lock washers (2) and flat washers (3) securing current sensor bar (4) to stand off (5) and control panel (6). Discard lock washers.

7.3.6.2 Installation

1. Position current sensor bar (4) onto two stand-offs (5) and secure to control panel (6) with two screws (1), new lock washers (2) and flat washers (3).
2. Reconnect all current sensor wires.

7.3.7 Replace HVAC Controller (ACCU)

Equipment Conditions

- HVAC unit switched off
- Control circuit breaker off
- Control panel switch off

Material Required

- None

NOTE: Special care should be taken to avoid flexing or bending the control panel backplane (5).

See Figure 7-7.

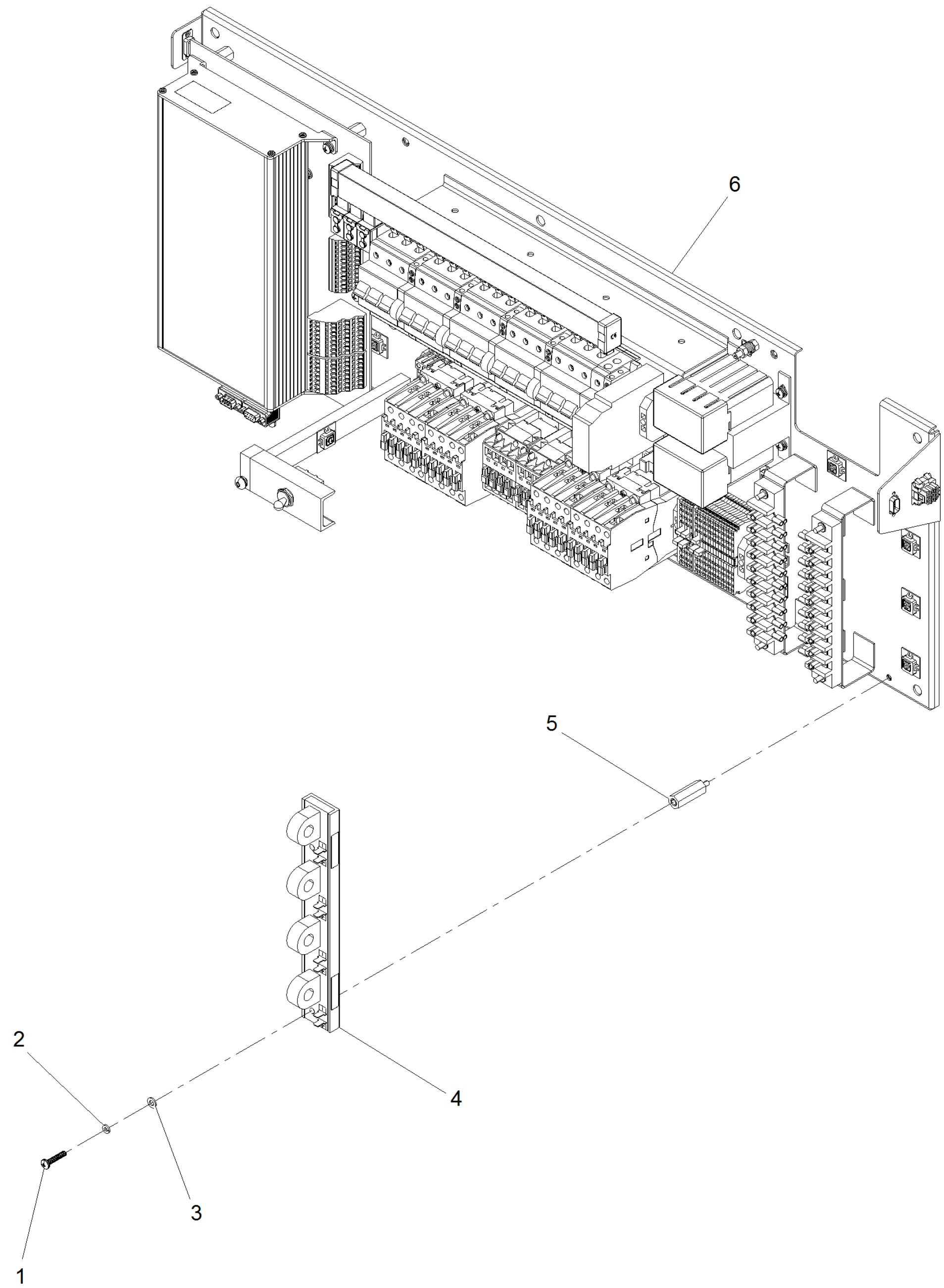


Figure 7-6: Replace AC Current Sensor

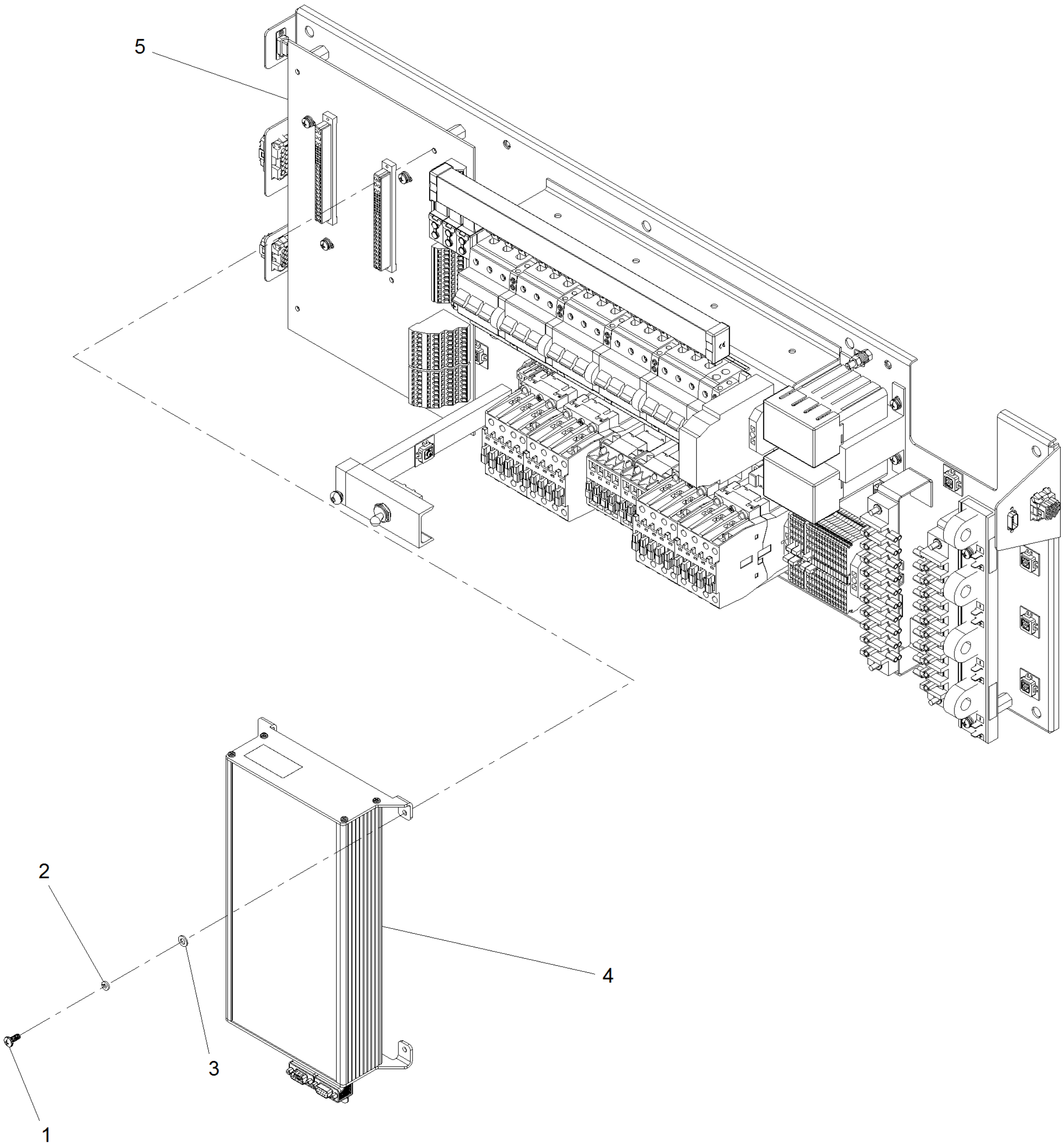


Figure 7-7: Replace HVAC Controller

7.3.7.1 Removal

1. Tag and remove connectors from bottom of the HVAC controller (ACCU) (4).
2. Remove four screws (1), lock washers (2), and flat washers (3) securing ACCU (4) to backplane (5). Carefully pull ACCU (4) from backplane (5) connectors. Discard lock washers.

7.3.7.2 Installation

1. Carefully insert HVAC controller (4) onto backplane (5) connectors.
2. Carefully install ACCU (4) onto connectors on backplane (5) and align mounting holes.
3. Install four screws (1), new lock washers (2), and flat washers (3) and secure ACCU (4) to backplane (5).
4. Carefully install tagged connectors to bottom of ACCU (4).

7.3.8 HVAC Covers Removal and Installation

Equipment Conditions

- Power removed from HVAC unit

Materials Required

- Anti-seize 8150 (or equivalent)
- Water
- Hexsert rivnut, M6 – P/N 661190
- Screw M6x20 – P/N 660l168
- Washer, helical, – P/N 663028
- Flat washer – P/N 662E050
- Retainer – P/N 664F160

Tools Required

- Rivnut setter (w/M6 arbor)
- Torque wrench (0-100 in-lb).

NOTE:

- Prior to installation, inspect captive screws (5, Figure 7-8) and hexsert rivnuts for signs of thread damage.
- Anti-seize should be applied to captive screws (5) on all covers (1, 2 or 3) prior to installation.
- A small amount of water may be sprayed on the EMKA gasket to allow easier alignment of covers (1, 2 or 3). Do not allow water in dry areas, such as return air plenum and evaporator sections.
- During cover installation (1, 2 or 3), it is highly recommended two people place the cover on the HVAC unit gasket and align the cover captive screws with the hexsert rivnut in the HVAC unit (4) frame. Misalignment will result in damaging shear stresses to the hardware, cross threading, and potential failure of the captive screws or hexsert rivnuts.

See Figure 7-8.

7.3.8.1 Removal

NOTE: Assistance will be required to remove and install HVAC unit (4) covers.

1. Carefully remove evaporator section cover (1) by loosening eighteen M6 x 20mm captive screws. Do not remove captive screws from cover.
2. Carefully remove return air cover (2) by loosening eighteen M6 x 20mm captive screws. Do not remove captive screws from cover.
3. Carefully remove condenser cover (3) by loosening twelve M6 x 20 mm captive screws. Do not remove captive screws from cover.
4. With assistance, slightly lift cover (1, 2 or 3) and verify all captive screws are separated from threads of hexsert rivnuts.

NOTE: Use blocking to hold up cover while removing grounding strap.

5. Lift and block cover (1, 2 or 3) on side closest to ground strap.

NOTE: Ground strap should remain with HVAC unit covers (1, 2 or 3).

6. Disconnect ground strap from HVAC unit (4) and retain mounting hardware.
7. With assistance, lift cover (1, 2 or 3) from HVAC unit (4) and place in a suitable area to avoid damage to cover.
8. Ensure mounting hardware remains with the covers (1, 2 or 3).

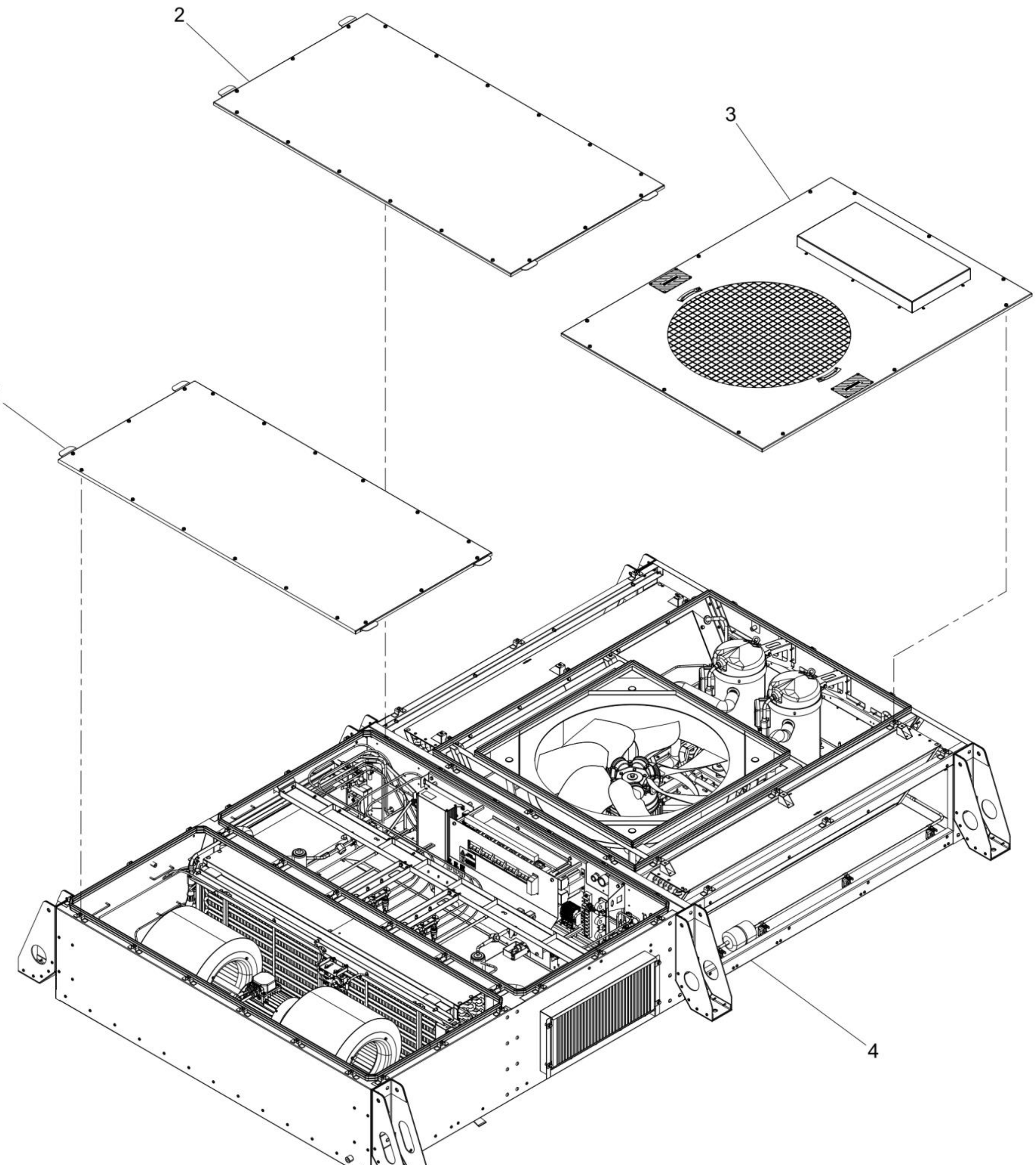
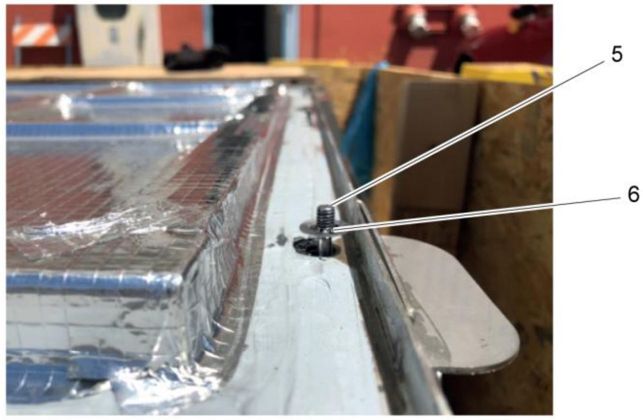


Figure 7-8: HVAC Covers Removal and Installation (Sheet 1 of 2)



NOT FULLY EXTENDED

FULLY EXTENDED

Figure 7-8: HVAC Covers Removal and Installation (Sheet 2 of 2)

7.3.8.2 Installation

WARNING

DO NOT USE POWER TOOLS TO INSTALL COVER MOUNTING HARDWARE TO HVAC UNIT (4, Figure 7-8) FRAME.

NOTE: Due to the nature of this fastening solution, special care must be taken to ensure proper alignment of the covers (1, 2 or 3) prior to tightening captive screws (5). Otherwise, damage to hexsert rivnuts or captive screws (5) may occur.

1. Inspect threads of captive screws (5) and hexsert rivnuts for damage. Replace if damaged.

NOTE: In order to inspect each captive screw (5) and retainer (6), it will be necessary to turn the cover (1, 2 or 3) over. Assistance will be required.

2. Verify all captive screws (5) are fully extended through each retainer (6). This will ensure each captive screw (5) reaches the hexsert rivnut threads. Refer to Figure 7-8, Sheet 2.
3. Apply a small amount of Anti-Seize 8150 or an approved equivalent to threads of each captive screw (5).

NOTE: Repositioning the cover (1, 2 or 3) may be very difficult once it has been placed on the HVAC unit (4) gasket, and there is risk causing a fold in the gasket which will compromise a water-tight seal.

4. Apply a small amount of water to the interfacing gasket to allow some movement of the cover (1, 2 or 3) during alignment.
5. With assistance, lower the cover (1, 2 or 3) onto the HVAC unit (4) frame .
6. With assistance or blocking, lift the cover (1, 2 or 3) nearest the grounding strap and attach grounding strap to HVAC unit (4) frame using retained mounting hardware. Torque bolt to 70 in-lb (7.9 Nm).
7. Once the cover (1, 2 or 3) has been properly aligned, start thread engagement of one captive screw (5) at each corner of the cover (1, 2 or 3) by turning them approximately three rotations. Ensure captive screws (5) are not cross threading.
8. Inspect each captive screw (5) to ensure they are still perpendicular to the cover. If any captive screw (5) is angled from perpendicular, reposition the cover (1, 2 or 3) for proper alignment.

NOTE: While hand starting each captive screw (5), if there is unusual resistance while attempting to install, do NOT force captive screw (5). Forcing captive screw (5) will run the risk of damaging the threads. If you encounter unusual resistance stop, remedy the issue and then continue the installation.

9. Start thread engagement of all captive screws (5) with a flat head screwdriver to help prevent cross threading.

10. Once all captive screws (5) are installed (hand tight), torque each captive screw to 70 in-lb (7.9 Nm).

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CHAPTER 8.0

TROUBLESHOOTING

8.1 Introduction

The HVAC unit may develop operational problems due to mechanical or electrical condition. This chapter gives a guide for system troubleshooting based on observed Fault Codes on the PTU Fault.vi screen. Refer to HVAC Schematic TA37187/21 and Figure 2-4 for wiring and component interface connections.

The data in Sections 8.1.1 through 8.1.3 must be used together to troubleshoot a particular fault condition. Each section provides supporting information to enable the technician to understand, locate, and correct fault conditions.

The troubleshooting chart is divided into four columns as follows:

Column 1, Step – assigns the step and sub step numbers to each procedure.

Column 2, Symptom – lists the fault code from the ACCU and the symptoms (indications) of the problem. For non-fault coded symptoms just the indication of the problem will be listed.

Column 3, Cause – indicates the probable faults which may cause the problem.

Column 4, Remedy – indicate the remedy (corrective section) to repair the cause of the problem.

NOTE: The following steps are considered standard practice when troubleshooting electrical and electronic components.

Therefore these steps will not be repeated in Table 8-1 for each applicable component and cable assembly; but should be performed as standard troubleshooting practice when applicable.

- Inspect cables or wiring for damaged or broken wires
  Replace damaged cables or wiring
- Check to be sure cables or wiring are properly connected per wiring diagram
  Reconnect cables or wiring per wiring diagram
- Check cables or wiring for loose connections
  Tighten loose cable or wiring connections
- Check component for damage
  Replace damaged component

8.1.1 Troubleshooting Chart

Table 8-1 guides the technician during system troubleshooting based on observed Fault Codes on the PTU Fault.vi screen (MU-275/7A). Table 8-1 provides a reference column to relevant data in Table 8-2, Event Data Description. A "PTU Only" reference indicates the error message appears only on the PTU and is not identified in Table 8-2. Table 8-1, Section 8.1.2, and Table 8-2 contain accociated data required to fault isolate the HVAC UUT and should be used in concert during troubleshooting.

Table 8-1. HVAC Unit Troubleshooting Chart

Step	Symptom/Fault Code	Cause	Remedy	Table 8-2 Reference
	HVAC Unit nonresponsive or ACCU locked up		Refer to ACCU Lock-out, Section 8.1.2	----
1	HVAC Fault	Any internal failure in the HVAC controller	Check correct ACCU mode LED is illuminated Check ACCU Fault LED is not illuminated, if so check fault log Reboot HVAC controller, if fault persists, test ACC using ACCU BTE If Fault persists replace ACCU	32
2	Cold Car Fault It is not possible to reach the temperature set point of the car (heating performance)	Return Air temperature is more than 10°F below set point temperature	Check temperature sensor: Check wiring is connected properly and not damaged Check sensor operation –use digital thermometer Verify there are no blower failures (circuit breaker or contactor) and the airflow switch is operational Troubleshoot overhead heater related faults; Step 7 through 10. Test overhead heater for proper operation, replace overhead heater.	34
2.1	Cold Car Fault It is not possible to reach the temperature set point of the car (heating performance)	Return Air Temperature increases less than 4°F within 30 minutes	Check temperature sensor: Check wiring is connected properly and not damaged Check sensor operation –use digital thermometer Verify there are no blower failures (circuit breaker or contactor) and the airflow switch is operational Troubleshoot overhead heater related faults; Step 7 through 10. Test overhead heater for proper operation, replace overhead heater	34

Table 8-1. HVAC Unit Troubleshooting Chart (cont'd.)

Step	Symptom/Fault Code	Cause	Remedy	Table 8-2 Reference
3	Hot Car Fault It is not possible to reach the temperature set point of the car (cooling performance)	Return Air temperature is more than 10°F above Set point temperature	Check temperature sensor: Check wiring is connected properly and not damaged Check sensor operation –use digital thermometer Verify there are no blower failures (circuit breaker or contactor) and the airflow switch is operational Verify that the condenser fan is operational - troubleshoot any CFM related faults. Verify that the compressors are operational – troubleshoot any compressor related faults.	33
3.1	Hot Car Fault It is not possible to reach the temperature set point of the car (cooling performance)	Return Air Temperature decreases less than 4°F within 30 minutes	Check temperature sensor: Check wiring is connected properly and not damaged Check sensor operation –use digital thermometer Verify that there are no blower failures (circuit breaker or contactor) and the airflow switch is operational Verify that the condenser fan is operational - troubleshoot any CFM related faults. Verify that the compressors are operational – troubleshoot any compressor related faults.	33
4	ACD Fault No 208VAC – AC voltage detector does not detect 208 VAC power supply.	AC voltage detector failure	Verify presence of 208 VAC at the ACD Verify ACD is set properly; see schematic (Sheet A-2). Verify that the quality of the power supply is within correct parameters. If the power supply appears to be within the defined parameters, replace the ACD.	1
5	CFMCT Fault Condenser fan motor – CFMC contactor does not *clos*e when demanded	CFM contactor failure	Check contactor for visible signs of damage. Verify contactor is physically functioning properly Verify wiring is correct and not damaged. Perform electrical troubleshooting refer to Sect. 8.1.2 and 8.1.3 Test ACCU using ACCU Tester. If fault persists in either case, replace the component.	3

Table 8-1. HVAC Unit Troubleshooting Chart (cont'd.)

Step	Symptom/Fault Code	Cause	Remedy	Table 8-2 Reference
6	CFMCT Fault Condenser fan motor – CFM contactor does not *open* when demanded	Use Step 5 Cause	Check contactor for visible signs of damage. Verify contactor is physically functioning properly Verify wiring is correct and not damaged. Perform electrical troubleshooting refer to Sect. 8.1.2 and 8.1.3 Test ACCU using ACCU Tester. If fault persists in either case, replace the component.	3
7.	OHCA1 Fault Overhead Heater – OH1 contactor does not open when demanded	Contactor failure	Check contactor for visible signs of damage. Verify contactor is physically functioning properly Verify wiring is correct and not damaged. Perform electrical troubleshooting refer to Sect. 8.1.2 and 8.1.3 Test ACCU using ACCU Tester. If fault persists in either case, replace the component.	5
8	OHCA1 Fault Overhead Heater – OH1 contactor does not *close* when demanded	Contactor failure	Check contactor for visible signs of damage. Verify contactor is physically functioning properly Verify wiring is correct and not damaged. Perform electrical troubleshooting refer to Sect. 8.1.2 and 8.1.3 Test ACCU using ACCU Tester. If fault persists in either case, replace the component.	5
9	OHCA2 Fault Overhead Heater – OH2 circuit breaker does not *close* when demanded	Contactor failure	Use Step 8 remedy	5.1
10	OHCA2 Fault Overhead Heater – OH2 circuit breaker does not *open* when demanded	Contactor failure	Use Step 7 remedy	5.1
10.1	OHC1DO	ACCU Internal fault.	Verify contactor is physically functioning properly Perform electrical troubleshooting refer to Sect. 8.1.2and 8.1.3 Reboot ACCU (Section 8.1.2) Test ACCU using ACCU BTE If fault persists on PTU, replace ACCU	30

Table 8-1. HVAC Unit Troubleshooting Chart (cont'd.)

Step	Symptom/Fault Code	Cause	Remedy	Table 8-2 Reference
10.2	OHC2DO	ACCU Internal fault.	Verify contactor is physically functioning properly Perform electrical troubleshooting refer to Sect. 8.1.2 and 8.1.3 Reboot ACCU (Section 8.1.2) Test ACCU using ACCU BTE If fault persists on PTU, replace ACCU	31
11	BMCT Fault Blower motor – contactor does not open when demanded	Blower motor contactor failure	Check contactor for visible signs of damage. Verify contactor is physically functioning properly Verify wiring is correct and not damaged. Perform electrical troubleshooting refer to Sect. 8.1.2 and 8.1.3 Test ACCU using ACCU Tester. If fault persists in either case, replace the component.	4
11.1	BMCT Fault Blower motor – contactor does not close when demanded	Blower motor failure	Use Step 11 Remedy	4
11.2	BMCT Fault Blower motor – contactor does not close when demanded	Blower motor failure	Use Step 11 Remedy	4
12	CFMCB Fault Condenser fan motor - CFM circuit breaker is tripped or off	Circuit breaker is tripped or off	Set circuit breaker position to on	7
12.1	CFMCB Fault Condenser fan motor - CFM circuit breaker is tripped or off	CFM circuit breaker failure	Check CFM circuit breaker for visible signs of damage Verify breaker is physically functioning properly Set CB On, if CB trips perform electrical troubleshooting, refer to Sect. 8.1.2 and 8.1.3 Replace CB	7
12.2	CFMCB Fault Condenser fan motor - CFM circuit breaker is tripped or off	CFM failure	Check wiring is connected properly and not damaged check motor windings continuity Perform electrical troubleshooting refer to Sect. 8.1.2 and 8.1.3 Replace CFM	7

Table 8-1. HVAC Unit Troubleshooting Chart (cont'd.)

Step	Symptom/Fault Code	Cause	Remedy	Table 8-2 Reference
13	CMCB1 Fault Compressor motor 1 - CM1 circuit breaker is tripped or off	Circuit breaker is tripped or off	Check wiring is connected properly and not damaged Verify breaker is physically functioning properly Set CB On, if CB trips perform electrical troubleshooting, refer to Sect. 8.1.2 and 8.1.3 Replace CB	6
13.1	CMCB1 Fault Compressor motor 1 - CM1 circuit breaker is tripped or off	CM circuit breaker failure	Check CM circuit breaker for visible signs of damage, Verify breaker is physically functioning properly Set CB On, if CB trips perform electrical troubleshooting, refer to Sect. 8.1.2 and 8.1.3 Replace CB	6
13.2	CMCB1 Fault Compressor motor 1 - CM1 circuit breaker is tripped or off	CM failure	Check wiring is connected properly and not damaged check motor windings continuity Perform electrical troubleshooting refer to Sect. 8.1.2 and 8.1.3 Replace CM	6
14	CMCB2 Fault Compressor motor 2 – CM2 circuit breaker is tripped or off	Use troubleshooting Causes for Step 13	Perform troubleshooting Remedy for Step 13	6
15	BMCB Fault Evaporator blower motor – circuit breaker is tripped or off	Circuit breaker is tripped or off	Check wiring is connected properly and not damaged Verify breaker is physically functioning properly Set CB On, if CB trips perform electrical troubleshooting, refer to Sect. 8.1.2 and 8.1.3 Replace CB	8
15.1	BMCB Fault Evaporator blower motor – circuit breaker is tripped or off	EBM circuit breaker failure	Check wiring is connected properly and not damaged Verify breaker is physically functioning properly Set CB On, if CB trips perform electrical troubleshooting, refer to Sect. 8.1.2 and 8.1.3 Replace CB	8

Table 8-1. HVAC Unit Troubleshooting Chart (cont'd.)

Step	Symptom/Fault Code	Cause	Remedy	Table 8-2 Reference
15.2	BMCB Fault Evaporator blower motor – circuit breaker is tripped or off	EBM failure	Check wiring is connected properly and not damaged Check motor windings continuity Set CB On, if CB trips perform electrical troubleshooting, refer to Sect. 8.1.2 and 8.1.3 Replace CB	8
16	BMCT Fault No air flow from evaporator blower	EBM failure	Check wiring is connected properly and not damaged check motor windings continuity Perform electrical troubleshooting refer to Sect. 8.1.2 and 8.1.3 Replace EBM	4
16.1	BMCT Fault No air flow from the evaporator blower	Fan wheels on evaporator blower are loose on shaft	Tighten fan wheels on shaft per HRMM.	4
16.2	BMCT Fault No air flow from the evaporator blower	Sensor (tube) in blower housing damaged or missing	Check to be sure sensor (tube) in blower housing is properly installed per HRMM	4
17	AFS Fault No air flow from the evaporator blower	Faulty AFS	Replace AFS per HRMM	10
17.1	AFS Fault No air flow from the evaporator blower	Improper setting of AFS	Check AFS setting is 225 +/- 15 Pa. Check all tubing is properly and securely connected to AFS and copper sensor	10
17.2	AFS Fault Fresh Air Filter Clogged Detector Switch is monitored as filter clogged	The fresh air filters are clogged	Replace fresh air filters.	10
17.3	AFS Fault Fresh Air Filter Clogged - Detector Switch is monitored as filter clogged	The switch setting is incorrect.	Correct switch setting per HRMM	10
17.4	AFS Fault Fresh Air Filter Clogged - Detector Switch is monitored as filter clogged	The switch is faulty.	Verify switch using Differential Pressure Swithc Tester Replace switch per HRMM.	10

Table 8-1. HVAC Unit Troubleshooting Chart (cont'd.)

Step	Symptom/Fault Code	Cause	Remedy	Table 8-2 Reference
18	RAT Fault Return Air Temperature sensor fault - reading of the return air temperature sensor is out of limits	Faulty sensor	Verify temperature sensor using digital thermometer Replace Return Air Temperature sensor	12
19	SAT Fault Supply Air Temperature sensor fault - reading of the supply air temperature sensor is out of limits	Faulty sensor	Verify temperature sensor using digital thermometer Replace Supply Air Temperature sensor	13
20	FAT Fault Fresh Air Temperature sensor fault - reading of the fresh air temperature sensor is out of limits	Faulty sensor	Verify temperature sensor using digital thermometer Replace Fresh Air Temperature sensor	11
21	LPT1 Fault Low Pressure Transducer 1 Fault - reading of the LPT1 for compressor 1 is out of limits	Faulty transducer	Perform troubleshooting procedures, refer to Sect. 8.1.2 and 8.1.3 Replace transducer	14
21.1	LPT1 Fault Low Pressure Transducer 1 Fault - reading of the LPT1 for compressor 1 is out of limits	Insufficient refrigerant charge	Charge system with refrigerant per HRMM	14
22	HPT1 Fault High Pressure Transducer 1 Fault - reading of the HPT1 for compressor 1 is out of limits	Faulty transducer	Perform troubleshooting procedures, refer to Sect. 8.1.2 and 8.1.3 Replace transducer	15
22.1	HPT1 Fault High Pressure Transducer 1 Fault - reading of the HPT1 for compressor 1 is out of limits	Clogged condenser coil	Check and clean condenser coil for dirt restricting air flow	15
22.2	HPT1 Fault High Pressure Transducer 1 Fault - reading of the HPT1 for compressor 1 is out of limits	Malfunctioning CFM	Check and replace fan impellor if damaged.	15

Table 8-1. HVAC Unit Troubleshooting Chart (cont'd.)

Step	Symptom/Fault Code	Cause	Remedy	Table 8-2 Reference
22.3	HPT1 Fault High Pressure Transducer 1 Fault - reading of the HPT1 for compressor 1 is out of limits	Check CFM windings for continuity	Replace CFM if motor windings are open	15
22.4	HPT1 Fault High Pressure Transducer 1 Fault - reading of the HPT1 for compressor 1 is out of limits	Overcharge in refrigerant system	Check refrigerant charge Remove excess refrigerant from system	15
22.5	HPT1 Fault High Pressure Transducer 1 Fault - reading of the HPT1 for compressor 1 is out of limits	Excessive liquid flow through expansion valve	Check expansion valve thermal bulb attachment to suction line Ensure bulb is properly attached to suction line	15
22.6	HPT1 Fault High Pressure Transducer 1 Fault - reading of the HPT1 for compressor 1 is out of limits	Restricted discharge line	Localize and remove restriction: contact KBC field service.	15
23	LPT2 Fault Low Pressure Transducer 2 Fault - reading of the LPT2 for compressor 1 is out of limits	Use troubleshooting Causes for Step 21	Use troubleshooting Remedies for Step 21	16
24	HPT2 Fault High Pressure Transducer 2 Fault - reading of the HPT2 for compressor 1 is out of limits	Use troubleshooting Cause for Step 22	Use troubleshooting Remedies for Step 22	17
25	HPS1 Fault Compressor 1 locked due to pressure -- pressure switches of compressor 1 have been actuated the maximum number of times allowed (HPS1 opened more than 3 times in 1 hour)	Clogged condenser coil	Check condenser coil for dirt restricting air flow Perform troubleshooting procedures, refer to Sect. 8.1.2 and 8.1.3 Clean condenser coil.	21

Table 8-1. HVAC Unit Troubleshooting Chart (cont'd.)

Step	Symptom/Fault Code	Cause	Remedy	Table 8-2 Reference
25.1	HPS1 Fault Compressor 1 locked due to pressure -- pressure switches of compressor 1 have been actuated the maximum number of times allowed (HPS1 opened more than 3 times in 1 hour	Malfunctioning CFM	Check and replace fan impellor if damaged.	21
25.2	HPS1 Fault Compressor 1 locked due to pressure -- pressure switches of compressor 1 have been actuated the maximum number of times allowed (HPS1 opened more than 3 times in 1 hour	Overcharge in refrigerant system	Check refrigerant charge Remove excess refrigerant from system	21
25.3	HPS1 Fault Compressor 1 locked due to pressure -- pressure switches of compressor 1 have been actuated the maximum number of times allowed (HPS1 opened more than 3 times in 1 hour	Excessive liquid flow through expansion valve	Check expansion valve thermal bulb attachment to suction line Ensure bulb is properly attached to suction line	21
25.4	HPS1 Fault Compressor 1 locked due to pressure -- pressure switches of compressor 1 have been actuated the maximum number of times allowed (HPS1 opened more than 3 times in 1 hour	Restricted discharge line	Localize and remove restriction: contact KBC field service.	21

Table 8-1. HVAC Unit Troubleshooting Chart (cont'd.)

Step	Symptom/Fault Code	Cause	Remedy	Table 8-2 Reference
26	LPS1 Fault Compressor 1 locked due to pressure -- pressure switches of compressor 1 have been actuated the maximum number of times allowed (LPS1 opened more than 3 times in 1 hour)	Dirty or clogged air filters	Check air filters for dirt and debris Replace air filters	20
26.2	LPS1 Fault Compressor 1 locked due to pressure -- pressure switches of compressor 1 have been actuated the maximum number of times allowed (LPS1 opened more than 3 times in 1 hour)	Overcharge in refrigerant system	Check refrigerant charge Remove excess refrigerant from system	20
26.3	LPS1 Fault Compressor 1 locked due to pressure -- pressure switches of compressor 1 have been actuated the maximum number of times allowed (LPS1 opened more than 3 times in 1 hour)	Liquid refrigerant flooding back from evaporator coil	Check expansion valve thermal bulb attachment to suction line Ensure bulb is properly attached to suction line	20
26.3	LPS1 Fault Compressor 1 locked due to pressure -- pressure switches of compressor 1 have been actuated the maximum number of times allowed (LPS1 opened more than 3 times in 1 hour)	Restriction in liquid refrigerant circuit	Localize and remove restriction.	20

Table 8-1. HVAC Unit Troubleshooting Chart (cont'd.)

Step	Symptom/Fault Code	Cause	Remedy	Table 8-2 Reference
27	HPS2 Fault Compressor 2 locked due to pressure - pressure switches of compressor 2 have been actuated the maximum number of times allowed (HPS2 opened more than 3 times in 1 hour)	For HPS2 troubleshoot per Step 25	For HPS2 troubleshoot per Step 25	23
28	LPS2 Fault Compressor 2 locked due to pressure - pressure switches of compressor 2 have been actuated the maximum number of times allowed (LPS2 opened more than 3 times in 1 hour)	For LPS2 troubleshoot per Step 26 Causes	For LPS2 troubleshoot per Step 26 Remedies	22
29	Damper 1 Fault Fresh Air Damper closed position – will not close	Bad damper motor	Check damper motor per HRMM Perform troubleshooting procedures, refer to Sect. 8.1.2 and 8.1.3 Replace if defective	19
30	Damper 2 Fault Fresh Air Damper closed position – will not close	Bad damper motor	Check damper motor per HRMM Replace if defective	19
31	BMCTOC Fault Evaporator Blower Motor Current - current through the evaporator motor is higher than the limit	Motor is rotating backwards	Connect PTU and check motor current, replace motor as needed. Refer to paragraph 3.6 for PTU operating procedures.	4
31.1	BMCTOC Fault Evaporator Blower Motor Current - current through the evaporator motor is higher than the limit	Blower wheel obstruction	Clear obstruction.	4
31.2	BMCTOC Fault Evaporator Blower Motor Current - current through the evaporator motor is higher than the limit	Bearings are failing	Perform troubleshooting procedures, refer to Sect. 8.1.2 and 8.1.3 Replace motor per HRMM.	4

Table 8-1. HVAC Unit Troubleshooting Chart (cont'd.)

Step	Symptom/Fault Code	Cause	Remedy	Table 8-2 Reference
31.3	BMCTOC Fault Evaporator Blower Motor Current - current through the evaporator motor is higher than the limit	Motor is failing	Perform troubleshooting procedures, refer to Sect. 8.1.2 and 8.1.3 Replace motor per HRMM.	4
32	CFMCT Fault Condenser Fan Motor - current through condenser fan motor 1 is higher than the limit	Motor is rotating backwards	Perform Step 16 Connect PTU and check motor current, replace motor as needed. Refer to paragraph 3.6 for PTU operating procedures.	3
33	BMCDO	ACCU Internal fault.	Reboot ACCU (Section 8.1.2) Test ACCU using ACCU BTE (MU-275/7C) If fault persists on PTU, replace ACCU	29
34	CFMCT Fault Condenser Fan Motor - current through condenser fan motor 1 is higher than the limit	Fan obstruction	Clear obstruction	3
34.1	CFMCT Fault Condenser Fan Motor - current through condenser fan motor is higher than the limit	Bearings are failing	Check wiring is connected properly and not damaged check motor windings continuity Perform electrical troubleshooting refer to Sect. 8.1.2 and 8.1.3 Replace motor per HRMM.	3
34.2	CFMCT Fault Condenser Fan Motor - current through condenser fan motor is higher than the limit	Motor is failing	Check wiring is connected properly and not damaged check motor windings continuity Perform electrical troubleshooting refer to Sect. 8.1.2 and 8.1.3 Replace motor per HRMM.	3
34.3	CFMCDO	Internal system (ACCU) fault.	Reboot ACCU (Section 8.1.2) Test ACCU using ACCU BTE (MU-275/7C) If fault persists on PTU, replace ACCU	28
35	CMCT1 Fault Compressor Motor 1 Current - current through compressor motor 1 is higher than the limit	Motor is rotating backwards	Connect PTU and check motor current, replace motor as needed. Refer to paragraph 3.6 for PTU operating procedures.	2
35.1	CMCT1 Fault Compressor Motor 1 Current - current through compressor motor 1 is higher than the limit	Bearings are failing	Check wiring is connected properly and not damaged check motor windings continuity Perform electrical troubleshooting refer to Sect. 8.1.2 and 8.1.3 Replace CM per HRMM.	2

Table 8-1. HVAC Unit Troubleshooting Chart (cont'd.)

Step	Symptom/Fault Code	Cause	Remedy	Table 8-2 Reference
35.2	CMCT1 Fault Compressor Motor 1 Current - current through compressor motor 1 is higher than the limit	Motor is failing	Check wiring is connected properly and not damaged check motor windings continuity Perform electrical troubleshooting refer to Sect. 8.1.2 and 8.1.3 Replace CM1 per HRMM.	2
36	CMCT2 Fault Compressor Motor 2 Current - current through compressor motor 2 is higher than the limit	Motor is rotating backwards	Check wiring is connected properly and not damaged check motor windings continuity Perform electrical troubleshooting refer to Sect. 8.1.2 and 8.1.3 Connect PTU and check motor current, refer to paragraph 3.6 for PTU operating procedures. Replace CM1 per HRMM.	2.3
36.1	CMCT2 Fault Compressor Motor 2 Current - current through compressor motor 2 is higher than the limit	Bearings are failing	Check wiring is connected properly and not damaged check motor windings continuity Perform electrical troubleshooting refer to Sect. 8.1.2 and 8.1.3 Replace CM2 per HRMM.	2.3
36.2	CMCT2 Fault Compressor Motor 2 Current - current through compressor motor 2 is higher than the limit	Motor is failing	Check wiring is connected properly and not damaged check motor windings continuity Perform electrical troubleshooting refer to Sect. 8.1.2 and 8.1.3 Replace CM2 per HRMM.	2.3
37	CMC1DO	ACCU Internal fault.	Reboot ACCU (Section 8.1.2) Test ACCU using ACCU BTE (MU-275/7C) If fault persists on PTU, replace ACCU	24
38	CMC2DO	ACCU Internal fault.	Reboot ACCU (Section 8.1.2) Test ACCU using ACCU BTE (MU-275/7C) If fault persists on PTU, replace ACCU	25
39	HGBP1DO	ACCU Internal fault.	Reboot ACCU (Section 8.1.2) Test ACCU using ACCU BTE (MU-275/7C) If fault persists on PTU, replace ACCU	26
40	HGBP2DO	ACCU Internal fault.	Reboot ACCU (Section 8.1.2) Test ACCU using ACCU BTE (MU-275/7C) If fault persists on PTU, replace ACCU	27

8.1.2 Troubleshooting Procedures

This section provides troubleshooting procedures to functionally check individual HVAC Unit components based on Fault Codes identified in the Portable Test Unit's (PTU) Faults.vi Screen.

NOTE: Merak recommends that all personnel maintaining and operating HVAC equipment be certified to EPA 608 in line with the requirements of the Clean Air Act.

Completing the respective procedures will help the technician determine functionality of a specific component. These procedures also recommend remedies to clear specific faults or direct the technician to replace a defective component.

NOTE: Troubleshooting procedures assume the HVAC UUT has been removed from the train car and the HVAC Unit Tester (BTE) (MU-275/7B) and PTU (MU-275/7A) are connected. References to toggle switches and LED's are on the HVAC Tester unless specified otherwise.

Reboot UUT Air Conditioning Control Unit (ACCU):

1. On HVAC Tester, set Main Power Switch to OFF.
2. On HVAC Tester, engage E-Stop Switch.
3. On HVAC Tester, set CAR I.D. toggle switch to OFF.
4. On HVAC Tester, set APS OK toggle switch to OFF.
5. On HVAC Tester, set MASTER RESET toggle switch to OFF.
6. On HVAC Tester, release E-Stop switch (rotate clockwise).
7. On HVAC Tester, set Main Power Switch to ON.
8. On HVAC Tester, set CAR I.D. toggle switch to ON.
9. On HVAC Tester, set APS OK toggle switch to ON, ensure LED illuminates.
10. ON HVAC Tester, set MASTER RESET toggle switch to ON, ensure LED illuminates.
11. Ensure LVPS LED is illuminated.
12. Visually check UUT's ACCU LEDs:

a) Correct Mode LED is illuminated.

b) Fault LED is not illuminated.

13. Using the PTU, select PTU Monitor Screen and select “Push to Start Self-test” button.
14. Once Self-test is complete, check for any reported faults on PTU Faults.vi. Screen. If faults are indicated, refer to respective fault code in Section 8.1.1.

ACD Fault:

1. On UUT control panel, ensure AC Detector (ACD) (5, Figure 7-4) R/T LED is illuminated yellow.

a. If illuminated yellow, continue to step 2.

b. If not illuminated, check facility power to BTE is on.

2. Using a phase meter, check for proper phase sequencing.

a. If phase sequence is correct, continue with step 3.

b. If phase sequence is not correct, correct wire connections.

3. On UUT control panel, check ACD's F1 and F2 LEDs are off.

a. If either LED illuminated, check BTE power source is correct.

b. If LEDs are off, continue to next step.

4. On UUT control panel, verify ACD is set properly; refer to schematic (Sheet A-8).

5. If fault continues, replace ACD per Section 7.3.4.

Cold Car Fault:

1. Check temperature sensor wiring is connected properly and not damaged.

2. Ensure OHPT2 circuit breaker OHCB is set to on.

3. Check temperature sensor operation using digital thermometer and PTU Temperature and Pressures Screen, Figure 8-2.

a. If sensor not functioning properly, replace sensor.

b. If sensor functioning properly, continue with step 3.

4. If fault continues, check AFS for proper functionality; goto AFS Faults to clear faults.

5. If fault continues, verify there are no blower motor faults.

a. Blower motor fault, go to BMCB and BMCT to clear faults.

b. No blower motor fault, continue with step 5.

6. If fault continues, check for heater faults.

a. Heater faults go to OHCA to clear faults.

b. No heater faults, Continue with step 6.

7. If fault continues, replace ACCU per Section 7.3.7 .

Hot Car Fault:

1. Check temperature sensor wiring is connected properly.
2. Check temperature sensor operation using digital thermometer and PTU, Temperature and Pressures Screen.

a. If sensor is not functioning properly, replace sensor.

b. If sensor is functioning properly, continue with step 3.

3. Verify blower motor faults.

a. If there are blower motor faults, go to BMCB and BMCT to clear faults.

b. If no blower motor faults, continue with step 4.

4. Verify condenser fan motor faults.

a. If there are condenser fan motor faults, go to CFMCB, CFMCT, and CFMCT-OC/UC to clear faults.

b. If no condenser fan motor faults, continue with step 5.

5. Verify compressor faults.

a. If there are compressor faults, go to CMCT, CMCB, and CMCT1/2 to clear faults.

b. If Fault continues, contact higher maintenance authority.

CFMCT Fault:

1. Verify Condenser Fan Contactor wiring is not damaged and installed correctly per schematic in Appendix A.
2. Verify proper supply voltage at contactor (or check TB6 and TB7 on terminal block)

a. Voltage is OK, continue with step 3.

b. Voltage is insufficient, correct or change facility power.

3. Use PTU to power on CF Motor and verify feedback LED for CFMC is illuminated.

a. Feedback LED illuminated, continue with step 5.

b. Feedback LED not illuminated, continue with step 4.

4. Check CFM current using clamp meter.

a. Incorrect or no current, replace CFM Contactor.

b. Correct current, continue with step 5.

5. Verify ACCU is working properly.
a. Check Mode LED is illuminated.
b. Check Fault LED is not illuminated.
6. ACCU working properly, replace CF Motor per HRMM.
7. ACCU not working properly, replace ACCU per Section 7.3.7.

CFMCB Fault:

1. Verify CFM Circuit Breaker wiring is not damaged and is installed correctly per schematic. Also ensure CB handle switches from off to on with positive detent.
2. Verify proper supply voltage at CFM Circuit Breaker.
a. Voltage is OK, continue with step 3.
b. Voltage is insufficient; correct or change facility power.
3. Verify correct voltage at auxiliary circuit breaker.
a. Correct auxiliary voltage is present, continue with step 4.
b. Incorrect auxiliary voltage or voltage not present, replace ACCU.
4. Verify Condenser Fan Motor wiring is correct per schematic.
a. Wiring correct, continue to step 5.
b. Wiring incorrect, repair wiring and return to operations.
5. If fault continues, replace CF Motor per HRMM.

OHCA1 Fault:

1. Verify OH Contactor wiring is not damaged and is installed correctly per schematic.
2. Verify proper supply voltage at OH contactor.
a. Voltage is OK, continue with step 3.
b. Voltage is insufficient; correct or change facility power.
3. Verify 24 Vdc at terminals A1 and A2 when commanded by PTU.
a. Correct voltage is present, replace contactor.
b. Incorrect voltage or voltage not present, replace ACCU.
4. If fault continues, replace Overhead Heater per HRMM.

OHCA2 Fault:

1. Verify OH Circuit Breaker wiring is not damaged and is installed correctly per schematic.

2. Verify proper supply voltage at OH Circuit Breaker.

a. Voltage is OK, continue with step 3.

b. Voltage is insufficient; correct or change facility power.

3. Verify voltage at auxiliary circuit breaker.

a. Correct auxiliary voltage is present, replace circuit breaker.

b. Incorrect auxiliary voltage or voltage not present, replace ACCU.

4. If fault continues, replace Overhead Heater per HRMM.

OHCB Fault:

1. Verify OH Circuit Breaker wiring is not damaged and is installed correctly per schematic. Also ensure CB handle switches from off to on with positive detent.

2. Verify proper supply voltage at OH Circuit Breaker.

a. Voltage is OK, continue with step 3.

b. Voltage is insufficient; correct or change facility power.

3. Verify voltage at auxiliary circuit breaker.

a. Proper auxiliary voltage is present, replace circuit breaker.

b. Proper auxiliary voltage is not present, replace ACCU.

4. If fault continues, replace Overhead Heater per HRMM.

OHPT1 Fault:

1. Slowly apply heat source to front portion of thermostat (OHPT1).
2. Using a digital thermometer, monitor the temperature at thermostat.
3. On PTU, Temperatures and Pressures Screen, check OHPT1 LED status. When temperature reaches 130° ±5°F, the thermostat should open causing OHPT1 LED to de-illuminate.

a. OHPT1 LED de-illuminated, thermostat functioning properly, continue to step 4.

b. OHPT1 LED did not de-illuminate, replace thermostat per HRMM.

4. Observe thermostat temperature drop to 95° ±5°F, OHPT1 thermostat should reset causing OHPT1 LED to illuminate.

a. OHPT1 LED illuminated, thermostat reset and functioning properly.

b. OHPT1 LED did not illuminate, replace thermostat per HRMM.

BMCT Fault:

1. Verify Blower Motor Contactor wiring is not damaged and is installed correctly per schematic.
2. Verify proper supply voltage at BM contactor.

a. Voltage is OK, continue with step 3.

b. Voltage is insufficient or no voltage; check Fault BMCB to clear fault.

3. Verify 24 Vdc at terminals A1 and A2 when commanded by PTU.

a. Correct voltage is present, replace contactor.

b. Incorrect voltage or voltage not present, replace ACCU.

BMCB Faults:

1. Verify BM Circuit Breaker wiring is not damaged and is installed correctly per schematic. Also ensure CB handle switches from off to on with positive detent.
2. Verify proper supply voltage at BM Circuit Breaker.

a. Voltage is OK, continue with step 3.

b. Voltage is insufficient; correct or change BTE power source.

3. Verify voltage at auxiliary circuit breaker.

a. Correct auxiliary voltage is present, replace circuit breaker per Section 7.3.2.

b. Incorrect auxiliary voltage or no voltage present; replace ACCU per Section 7.3.7.

4. If fault continues, replace Blower Motor per HRMM.

CMCT Fault:

1. Verify Compressor contactor wiring is not damaged and is installed correctly per schematic.

2. Verify 24 Vdc at terminals A1 and A2 when commanded by PTU.

a. Correct voltage is present, replace contactor.

b. Incorrect voltage, continue with Fault CMCB to clear fault.

3. If fault continues, replace Compressor per HRMM.

CMCB Fault:

1. Verify Compressor circuit breaker (CMCB1 or CMCB 2) wiring is not damaged and is installed correctly per schematic; refer to Appendix A. Also, ensure circuit breaker handles switch on/off and off/on with positive detent.

2. Verify correct supply voltage at Compressor circuit breaker.

a. Voltage is OK, continue with step 3.

b. Voltage is insufficient; correct or change BTE power source.

3. Verify voltage at auxiliary circuit breaker.

a. Correct auxiliary voltage is present, replace circuit breaker per Section 7.3.2.

b. Incorrect auxiliary voltage or voltage not present, replace ACCU per Section 7.3.7.

4. If fault continues, replace Compressor per HRM.

AFS Fault:

1. Ensure blower motor is rotating correctly (according to rotational labels).

2. Ensure all AFS tubing is clear and properly connected.

3. Ensure 24 VAC at AFS terminals.

a. Correct Voltage, continue with step 4.

b. Incorrect voltage, replace ACCU per Section 7.3.7.

4. Ensure dial is set to 225 Pa ± 15 Pa. adjust if necessary.

5. On PTU Monitor Screen, power on Blower Motor (BMC) and verify AFS LED is on.

a. AFS LED on, continue to step 6.

b. AFS LED not illuminated, replace AFS per HRM.

6. If fault continues, replace ACCU per Section 7.3.7.

FAT, RAT, SAT Faults:

1. Verify each temperature sensor wiring is correct and not damaged. Refer to schematic in Appendix A.
2. Slowly apply heat source to respective temperature sensor (RAT, FAT, or SAT).
3. Using a digital thermometer, measure temperature at respective sensor.
4. On PTU, Temperatures and Pressures Screen, compare digital thermometer reading to respective sensor temperature display.
5. The difference between the two temperatures should be no more than 1.8°F.

a. Difference is greater than 1.8°F, replace respective sensor.

b. Difference is within the 1.8°F, replace ACCU per Section 7.3.7.

Verify Refrigerant Charge:

NOTE: Significant oil residue around service manifold ports is an indicator of refrigerant leaks.

1. If significant oil residue is noted, use schrader valve replacement tool to replace schrader valve core.
2. Install a thermocouple on each suction line as close to existing Thermostatic Expansion Valve (TXV) bulb as possible. Install thermocoupler on suction line, at the 4 ‘o’ clock or 8 ‘o’ clock position. Refer to Figure 8-1.
3. Make sure thermocouples are covered by insulation to prevent temperature measurement being affected by ambient temperature.
4. Ensure return air grille is closed.
5. Open two instances of the PTU software on the laptop (side-by-side screens) and connect to F-end and R-end HVAC units respectively.
6. Close dampers and verify no damper faults are displayed.
7. Ensure doors of car are closed. On PTU, power on overhead heaters to create a heat load in car.

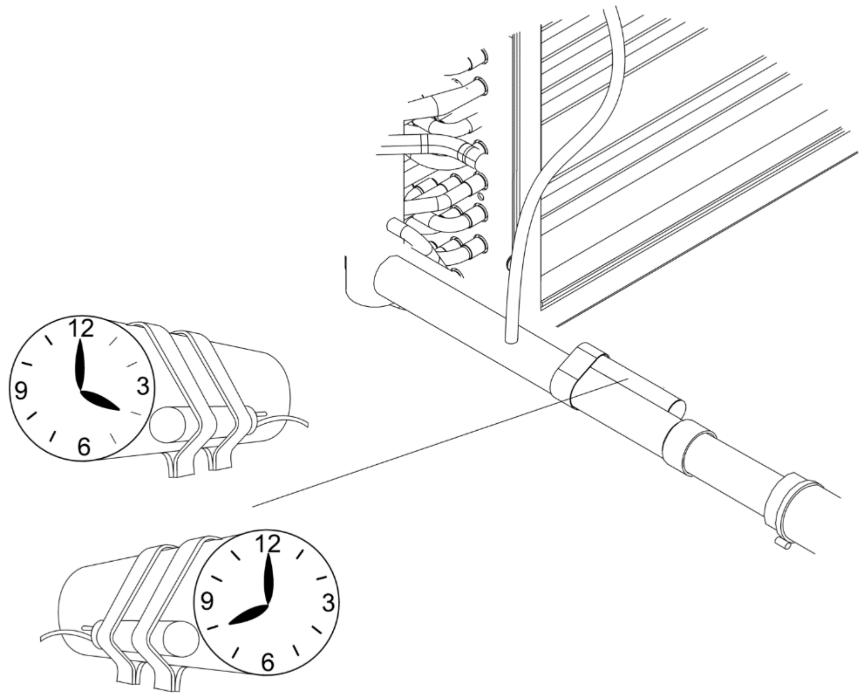


Figure 8-1: Thermocouple Positioning

NOTE: Try to maintain 80°F degree temperature throughout the test.

8. Allow overhead heaters to run for a minimum of 20 minutes or until the return temperature in the car reaches 80°F, whichever is longer.

9. Once car temperature is at least 80°F, operate cooling circuits in full cool mode (do not allow bypass) for approximately 20 minutes and allow refrigerant pressures to stabilize.

10. At the end of the 20 minutes, note suction pressure, discharge pressure, and suction line temperature.

11. The difference between the Saturated Suction Temperature (dew point) and the suction line temperature is the <u>superheat</u> in the refrigerant circuit. This value should be between 7°F and 20°F.

12. If the superheat is greater than 20°F, there is insufficient refrigerant in the circuit. Refer to HRM for refrigerant circuit charging procedures.

LPT and HPT Faults:

NOTE: To ensure latent issues are identified, Merak recommends checking both the LPT and HPT for proper functioning before the HVAC UUT is returned to service.

CAUTION

READ ALL INSTRUCTIONS PRIOR TO PERFORMING TESTS. FAILURE TO DO SO COULD RESULT IN DAMAGE TO EQUIPMENT.

Verify Low Pressure Transducer (LPT) functionality:

1. Connect PTU to HVAC ACCU.
2. Connect calibrated manifold gauge set hoses to service manifold couplers.
3. On PTU Temperatures and Pressures screen (Figure 8-3), set the following Local Temperatures (yellow box) values to 100°F.

a. Return Air Temperature

b. Supply Air Temperature

c. Fresh Air Temperature

4. Verify both compressors are operating by checking “Feedback” (green box) signals on PTU HVAC Monitor screen, Figure 8-2.
5. On PTU HVAC Monitor screen, force hot gas bypass valves HGBP1 and HGBP2 (blue box) closed.
6. On the HVAC unit control panel (located in the return air section of the unit) set Blower Motor Circuit Breaker (BMCB) to Off.

WARNING

TECHNICIANS MUST BE PREPARED TO QUICKLY SHUT DOWN THE HVAC UNIT IF THE REFRIGERANT PRESSURE DROPS BELOW 7 PSI.

7. Monitor both low pressure gauges carefully and verify COMPRESSOR 1 and COMPRESSOR 2 power Off when 20 ±5 psi is reached. Refer to PTU Monitor screen (Figure 8-2) and verify CMC1 and CMC2 “Feedback” signals (green box) are Off.
8. If refrigerant pressure falls below 7 psi, immediately remove power from HVAC unit.
9. If Low Pressure Transducer (LPT) disables the compressor as intended, reset blower motor circuit breaker (BMCB) and restore HVAC unit to normal operating modes.
10. If refrigerant pressure fell below 20±5 psi in either circuit, prior to the corresponding compressor shutting down, replace the LPT for that circuit.

Verify High Pressure Transducer (HPT) functionality:

WARNING

EXTREMELY HIGH REFRIGERANT PRESSURE IS REQUIRED TO TEST THE HIGH PRESSURE SAFETY SWITCHES. ONLY QUALIFIED TECHNICIANS SHOULD BE USING THE PTU TO TEST HVAC UNIT COMPONENTS.

1. Connect PTU to HVAC ACCU.

2. Connect calibrated manifold gauge set hoses to service manifold couplers.

3. On PTU Temperatures and Pressures screen (Figure 8-3), set the following Local Temperatures (yellow box) values to 100°F.

a. Return Air Temperature

b. Supply Air Temperature

c. Fresh Air Temperature

4. Verify both compressors are operating by checking “Feedback” (green box) signals on PTU HVAC Monitor screen, Figure 8-2.

5. On PTU HVAC Monitor screen, force Hot Gas Bypass Valve HGBP1 and HGBP2 (blue box) closed.

6. On the HVAC unit control panel (located in the return air section of the unit) turn off the Condenser Fan Circuit Breaker CFMCB to power Off condenser fan.

WARNING

TECHNICIANS MUST BE PREPARED TO QUICKLY SHUT DOWN THE HVAC UNIT IF THE REFRIGERANT PRESSURE RISES ABOVE 445 PSI.

7. Monitor both high pressure gauges carefully and verify COMPRESSOR 1 and COMPRESSOR 2 power Off when 415 ±10 psi is reached. Refer to PTU Monitor screen (Figure 8-2) and verify CMC1 and CMC2 “Feedback” signals (green box) are Off.

8. If refrigerant pressure exceeds 445 psi, immediately remove power from HVAC unit.

9. If High Pressure Transducer (HPT) disables the compressor as intended, reset condenser fan circuit breaker (CFMCB) and restore HVAC unit to normal operating modes.

10. If refrigerant pressure exceeded 415 ±10 psi in either circuit, prior to the corresponding compressor shutting down, replace the HPT for that circuit.

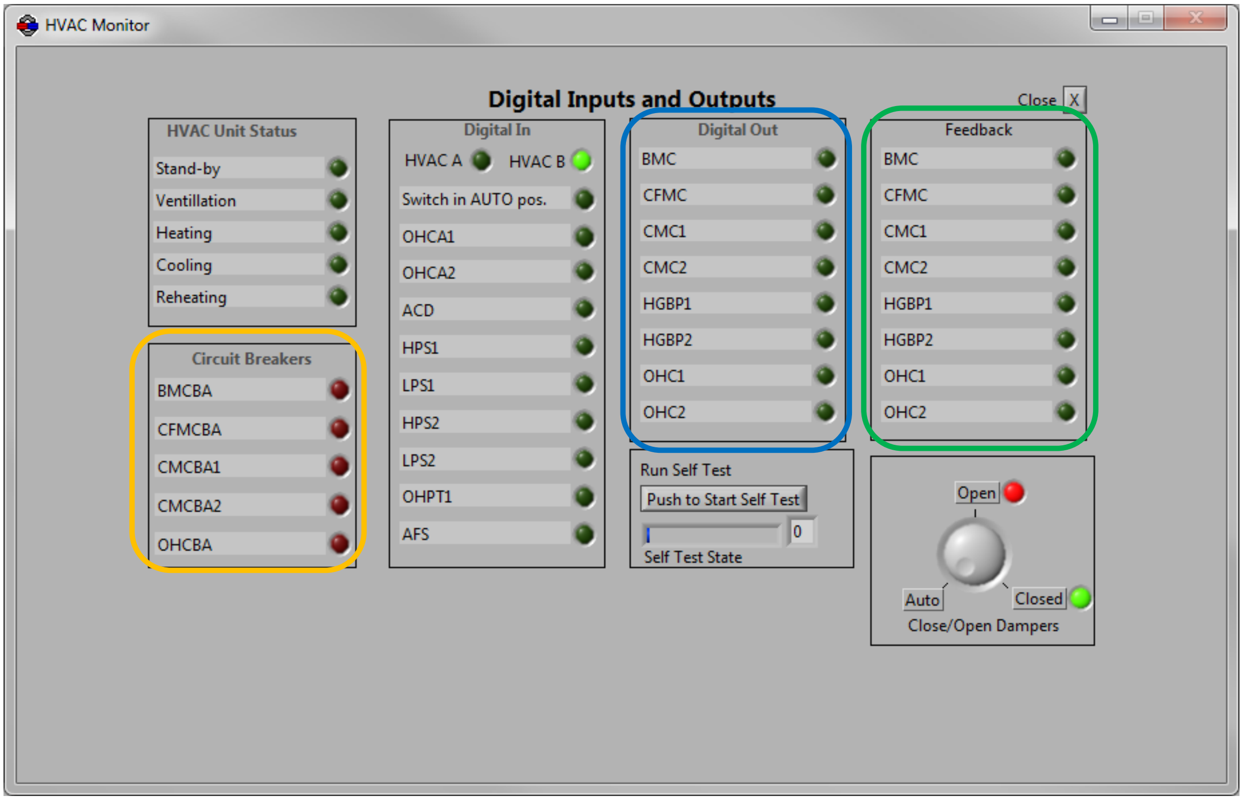


Figure 8-2. HVAC Monitor Screen

HPS and LPS Faults:

Verify High Pressure Switch (HPS) functionality:

CAUTION

READ ALL INSTRUCTIONS PRIOR TO PERFORMING TESTS. FAILURE TO DO SO COULD RESULT IN DAMAGE TO EQUIPMENT.

WARNING

EXTREMELY HIGH REFRIGERANT PRESSURE IS REQUIRED TO TEST THE HIGH PRESSURE SAFETY SWITCHES. ONLY QUALIFIED TECHNICIANS SHOULD BE USING THE PTU TO TEST HVAC UNIT COMPONENTS.

1. Connect PTU to HVAC ACCU.
2. Connect calibrated manifold gauge set hoses to service manifold couplers.

3. On PTU Temperatures and Pressures screen (Figure 8-3), set the following Local Temperatures (yellow box) values to 100°F.

a. Return Air Temperature

b. Supply Air Temperature

c. Fresh Air Temperature

4. Set high pressure value for COMPRESSOR 1 and COMPRESSOR 2 to 200psi (red box).

5. Verify both compressors are operating by checking “Feedback” (green box) signals on PTU HVAC Monitor screen, Figure 8-2.

6. On PTU HVAC Monitor screen, ensure Hot Gas Bypass Valve HGBP1 and HGBP2 (blue box) are closed.

7. On the HVAC unit control panel (located in the return air section of the unit) turn off the Condenser Fan Circuit Breaker CFMCB to power Off condenser fan.

WARNING

TECHNICIANS MUST BE PREPARED TO QUICKLY SHUT DOWN THE HVAC UNIT IF THE REFRIGERANT PRESSURE RISES ABOVE 445 PSI.

8. Monitor both high pressure gauges carefully and verify COMPRESSOR 1 and COMPRESSOR 2 power Off when 435 ±10 psi is reached. Refer to PTU Monitor screen (Figure 8-2) and verify CMC1 and CMC2 “Feedback” signals (green box) are Off.

9. If refrigerant pressure exceeds 445 psi, immediately remove power from HVAC unit.

10. If High Pressure Switch (HPS) disables the compressor as intended, reset condenser fan circuit breaker (CFMCB) and restore HVAC unit to normal operating modes.

11. If refrigerant pressure exceeded 435 ±10 psi in either circuit, prior to the corresponding compressor shutting down, replace the HPS for that circuit.

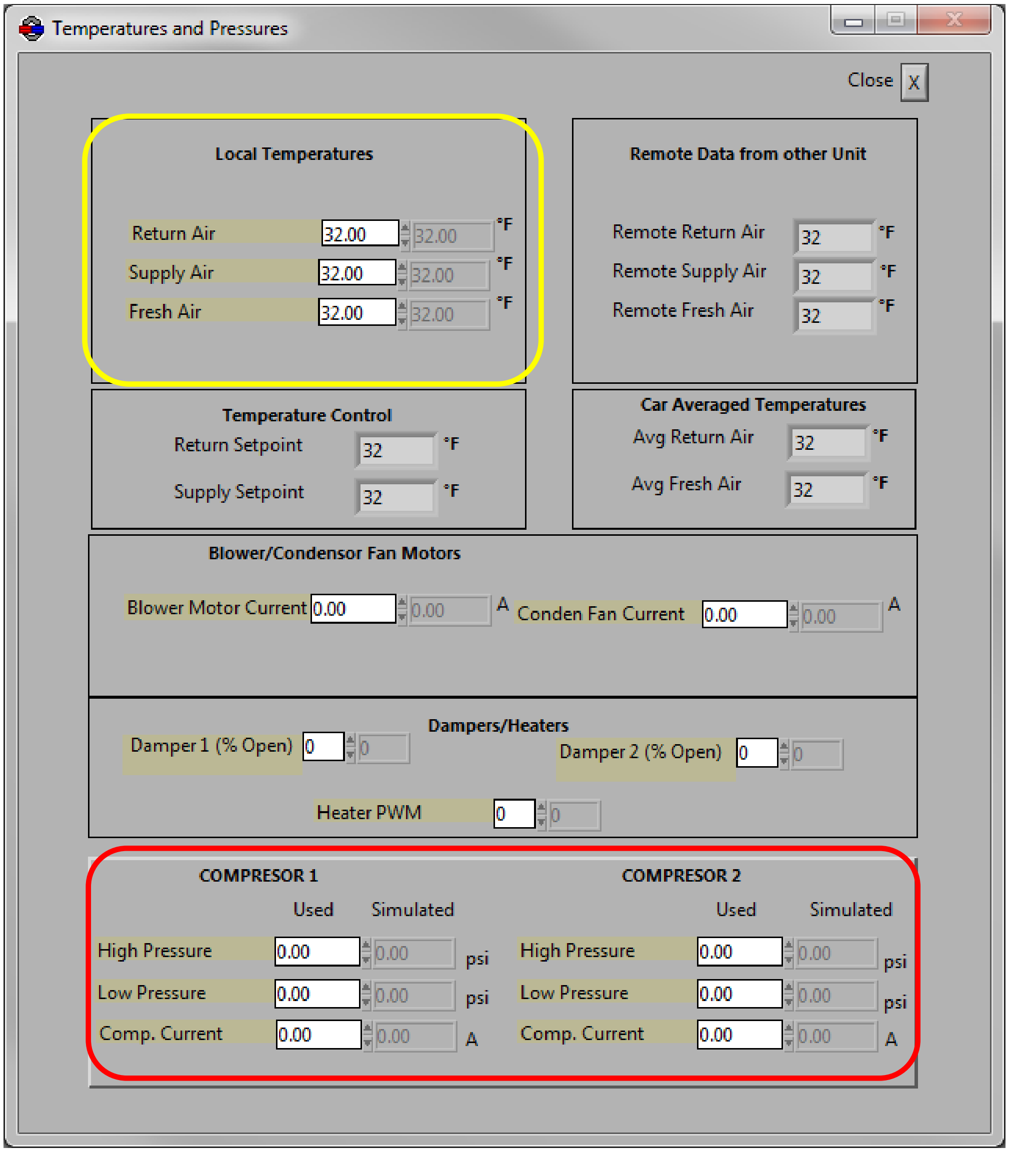


Figure 8-3. Temperatures and Pressures Screen

Verify Low Pressure Switch (LPS) functionality:

CAUTION

READ ALL INSTRUCTIONS PRIOR TO PERFORMING TESTS. FAILURE TO DO SO COULD RESULT IN DAMAGE TO EQUIPMENT.

1. Connect PTU to HVAC ACCU.
2. Connect calibrated manifold gauge set hoses to service manifold couplers.
3. On PTU Temperatures and Pressures screen (Figure 8-3), set the following Local Temperatures (yellow box) values to 100°F.

a. Return Air Temperature

b. Supply Air Temperature

c. Fresh Air Temperature

4. Set high pressure value for COMPRESSOR 1 and COMPRESSOR 2 to 60psi (red box).
5. Verify both compressors are operating by checking "Feedback" (green box) signals on PTU HVAC Monitor screen, Figure 8-2.
6. On PTU HVAC Monitor screen, ensure hot gas bypass valves HGBP1 and HGBP2 (blue box) are closed.
7. On the HVAC unit control panel (located in the return air section of the unit) turn off Blower Motor Circuit Breaker BMCB to power Off blower motor fan.

WARNING

TECHNICIANS MUST BE PREPARED TO QUICKLY SHUT DOWN THE HVAC UNIT IF THE REFRIGERANT PRESSURE DROPS BELOW 7 PSI.

8. Monitor both low pressure gauges carefully and verify COMPRESSOR 1 and COMPRESSOR 2 power Off when 12 ±5 psi is reached. Refer to PTU Monitor screen (Figure 8-2) and verify CMC1 and CMC2 "Feedback" signals (green box) are Off.
9. If refrigerant pressure falls below 7 psi, immediately remove power from HVAC unit.
10. If Low Pressure Switch (LPS) disables the compressor as intended, reset blower motor circuit breaker (BMCB) and restore HVAC unit to normal operating modes.
11. If refrigerant pressure fell below 12±5 psi in either circuit, prior to the corresponding compressor shutting down, replace the LPS for that circuit.

Damper 1 and 2 Fault:

1. Ensure 24Vdc at damper 1 and 2 motor connectors (refer to schematic).

a. Correct voltage, continue with step 2.

b. Incorrect or no voltage; replace ACCU per Section 7.3.7.

2. On PTU Monitor Screen, manually open and close dampers and verify they operate properly.

a. Dampers operate properly, continue operations.

b. One or both dampers do not operate properly, replace damper motor per HRMM.

CMCT1 and 2 - OC and UC Fault:

1. Check compressor motor is powered on.

a. Compressor motor is powered on, continue with step 2.

b. Compressor motor is not powered on, continue to Fault CMCT to clear fault.

2. Check compressor motor is functioning properly.

a. On PTU Temperatures and Pressures Screen, system pressures are correct, continue with step 3.

b. On PTU Temperatures and Pressures Screen, system pressures are incorrect, continue with next step.

1) Check compressor wiring.

a) Wiring correct, continue with step 3.

b) Wiring incorrect, repair wiring and continue operations.

3. Replace current sensor per Section 7.3.6.

4. If Fault continues, replace compressor per HRM.

CFMCT - OC and UC Fault:

1. Check condenser fan motor is powered on.

a. Condenser fan is powered on, continue with step 2.

b. Condenser fan is not powered on, continue to Fault CMCT.

2. Check Condenser fan motor is functioning properly.

a. On PTU Temperatures and Pressures Screen, condenser fan current displayed is correct, continue with step 3.

b. On PTU Temperatures and Pressures Screen, condenser fan current displayed is incorrect, continue with next step.

1) Check condenser fan motor wiring.

a) Wiring correct, continue with step 3.

b) Wiring incorrect, repair wiring and continue operations.

3. Replace current sensor per Section 7.3.6.

4. If Fault continues, replace condenser fan motor per HRM.

BMCT - OC and UC Fault:

1. Check blower motor is powered on.

a. Blower motor is powered on, continue with step 2.

b. Blower motor is not powered on, continue to Fault CMCT.

2. Check blower motor is functioning properly.

a. On PTU Temperatures and Pressures Screen, blower motor current displayed is correct, continue with step 3.

b. On PTU Temperatures and Pressures Screen, blower motor current displayed is incorrect, continue with next step.

1) Check condenser fan motor wiring.

a) Wiring correct, continue with step 3

b) Wiring incorrect, repair wiring and continue operations.

3. Replace current sensor per Section 7.3.6.

4. If Fault continues, replace blower motor per HRM.

ACCU Lock-out:

NOTE: Do not cycle ACCU power prior to performing the following troubleshooting steps. The information gathered in this guide will be used to diagnose the issue related to the ACCU randomly losing functionality.

ACCU Power Check:

1. Using a multimeter, set to DC voltage. Refer to Figure 8-4 and Figure 8-5 for location of control panel terminal blocks and terminals.
2. On ACCU backplane:

a. Affix multimeter black probe to TB5-6.

b. Touch Red probe to TB3A-11.

c. Mulltimeter must indicate between 17-34 VDC (24-28 VDC nominal).

d. If voltage is not within 17-34 VDC range, return ACCU to manufacturer for repair.

3. On ACCU backplane:

a. Affix multimeter black probe to TB3A-9.

b. Touch Red probe to TB3A-11.

c. Mulltimeter must indicate between 17-34 VDC (24-28 VDC nominal).

d. If voltage is not within 17-34 VDC range, return ACCU to manufacturer for repair.

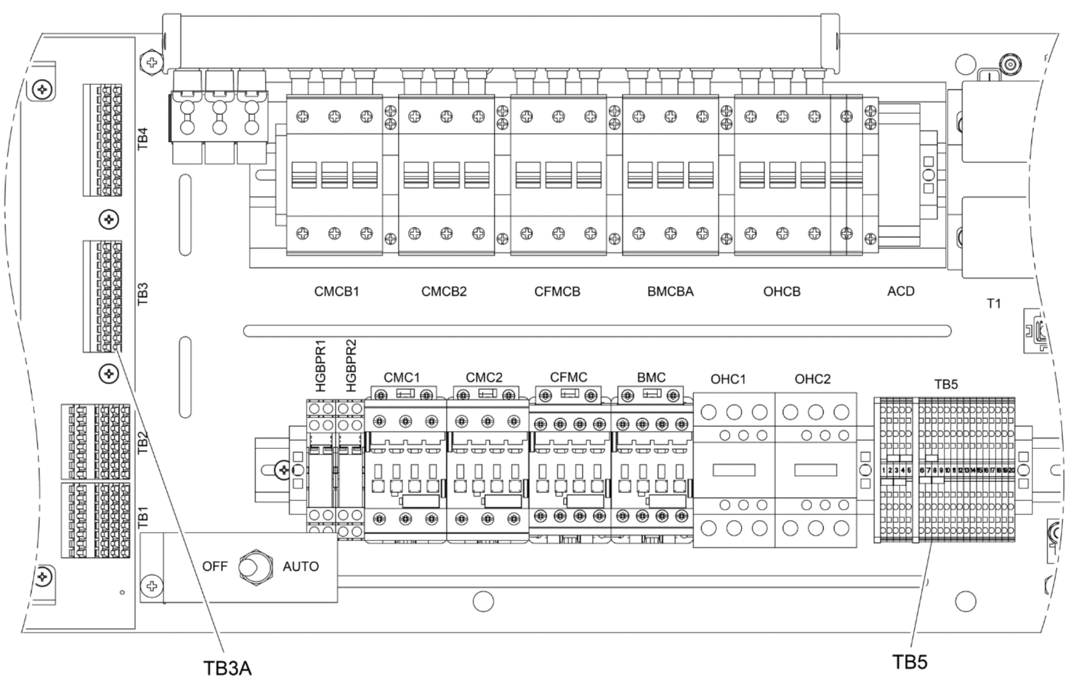


Figure 8-4: Terminal Block – TB3 and TB5

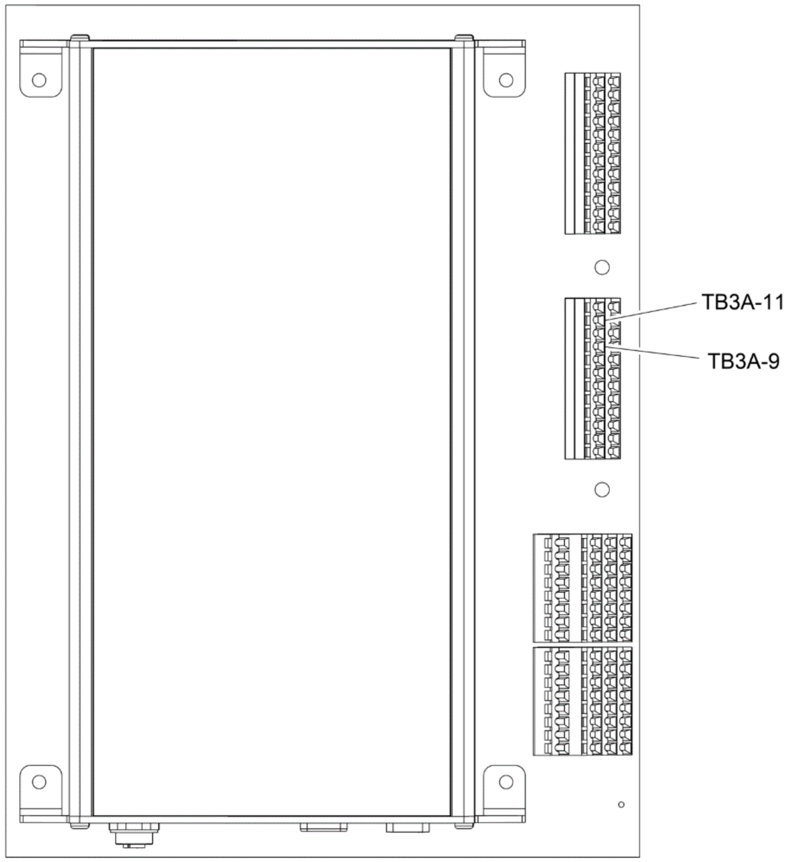


Figure 8-5: ACCU Backplane, TB3

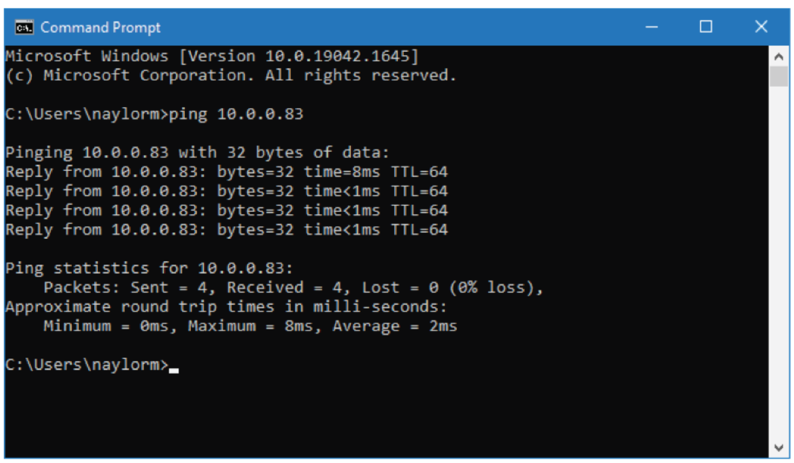
ACCU Communications Test:

1. Ensure HVAC system is in AUTO mode.
2. If available, check Comms Status on Cab Display or PTU. Refer to Figure 8-7.
3. Check LEDs on ACCU:

a. Mode:
   1) Stand-by
   2) Ventilation
   3) Heating
   4) Cooling
   5) Reheating
   6) Fault

4. Connect PTU and verify connection (connection icon is green).
a. If connection is successful, extract Log Files.
b. If not successful, make note and continue with the following steps to “PING” the ACCU:
1) Open a windows command prompt by typing cmd in the search bar.
2) Enter “ping <IP Address>” where the IP address is either 10.0.0.83 (A unit) or 10.0.0.84 (B unit).
3) Note the output (for example, does the ping get a reply or does it timeout): Refer to Figure 8-6.
a) If ACCU times out, verify network switch is ON. If network switch is on, cycle power to ACCU and repeat the test. If there is no response (Figure 8-6), ACCU should be returned to manufacturer for repair.
b) If the system (ACCU) responds, continue with Step 4.
4) Select Test Button on front of ACCU and check LED Status: Self-Test initiated: ACCU LEDs will flash approximately once per second.

SUCCESSFUL RESPONSE



UNSUCCESSFUL RESPONSE

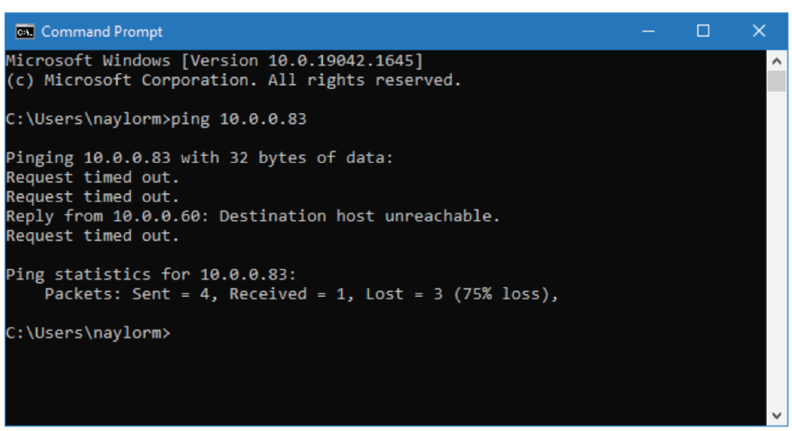


Figure 8-6: Ping Response

5) Cycle ACCU Power (circuit breaker in cab) and monitor ACCU LEDs.

a. Verify LEDs blink (flash) about 10 seconds after power up.

b. If LEDs do not flash, then there is a boot-up issue and the unit should be returned to the manufacturer.

1) Check PTU and verify communications icon is green after power cycle. Refer to Figure 8-7.

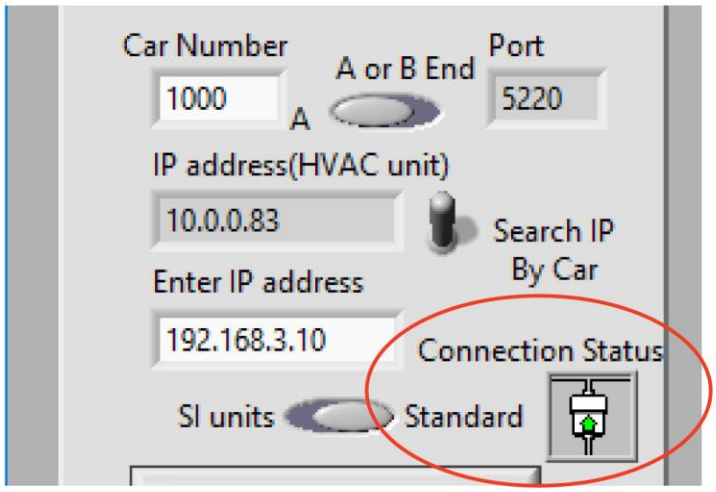


Figure 8-7: Communications Status

8.1.3 Event Data Description

The Event Data Description table provides explanatory data for each fault code displayed on the PTU. This table should be used in conjunction with Table 8-1 and troubleshooting procedures in Section 8.1.2.

Table 8-2. Event Description

No.	Fault	Detailed Description	Cause/Trigger Condition	Reset/Clear condition	Remark/ Attributes
1	**AC Power Fault**	No detection of 208Vac power supply (ACD detector is low) This Fault will not be detected for 30 seconds after ACD detector goes low.	ACD digital input LOW	ACD digital input HIGH	ACD = Alternating Current Detector (Digital Input)
2	**CMCT 1 Fault**	Compressor 1 is running and the current of CMCT1 is out of limits.	CMCT1 OC Fault or CMCT1 UC Fault	Current reading is between 5 A and 26 A or compressor motor 1 off (LOW)	CMCT = Compressor Motor Current Transformer
2.1	**CMCT 1 OC Fault**	The reading of CMCT1 is over maximum current	Current reading is above 26A for 5 seconds	Current reading is below 26A or compressor motor 1 is off (LOW)	OC = over current
2.2	**CMCT1 UC Fault**	Compressor 1 is running and the reading of CMCT1 is under minimum current	Current reading is below 5A for 5 seconds and ACD is On	Current reading is above 5A or compressor motor 1 off (LOW)	UC = under current
2.3	**CMCT 2 Fault**	Compressor 2 is running and the current of CMCT2 is out of limits.	CMCT2 OC Fault or CMCT2 UC Fault	CMCT2 is between 5 A and 26 A	CMCT = Compressor Motor Current Transformer
2.4	**CMCT 2 OC Fault**	The reading of CMCT2 is over maximum current	Current reading is above 26A for 5 seconds	Current reading is below 26A or compressor motor 2 off (LOW)	OC = over current
2.5	**CMCT2 UC Fault**	Compressor 2 is running and the reading of CMCT2 is under minimum current	Current reading is below 5A for 5 seconds time and ACD is On	Current reading is above 5A or compressor motor 2 off (LOW)	UC = under current
3	**CFMCT Fault**	The reading of CFMCT is out of limits	CFMCT OC Fault or CFMCT UC Fault	CFMCT is between 4.5A and 8A or condenser fan motor off (LOW)	CFMCT = Condenser Fan Motor Current Transformer

Table 8-2. Event Description (cont'd.)

No.	Fault	Detailed Description	Cause/Trigger Condition	Reset/Clear condition	Remark/ Attributes
3.1	**CFMCT OC Fault**	The reading of CFMCT is over maximum current	CFMC digital input is On and Current reading is above 8A for 5 seconds	Current reading is below 8A or condenser fan motor off (LOW)	OC = over current
3.2	**CFMCT UC Fault**	The reading of CFMCT is under minimum current	Current reading is below 4.5A for 5 seconds and ACD is On	Current reading is above 4.5A or condenser fan motor off (LOW)	UC = under current
4	**BMCT Fault**	The reading of BMCT is out of limits	BMCT OC Fault or BMCT UC Fault	BMCT is between 5.5A and 8.5A or Blower motor off (LOW)	BMCT = Blower Motor current transformer
4.1	**BMCT OC Fault**	The reading of BMCT is over maximum current	BMC is On (High) and current reading above 8.5A for 5 seconds	Current reading is below 8.5A or Blower motor off (LOW)	OC = over current
4.2	**BMCT UC Fault**	The reading of BMCT is under minimum current	BMC is On (High) and ACD is ON and current reading is below 5.5A for 5 seconds	Current reading is above 5 or Blower motor off (LOW)	UC = under current
5	**OHCA 1 Fault**	OHCA 1 status doesn't match OHC1 (- Absence of feedback when the contactor is demanded to be closed. - Presence of feedback when the contactor is demanded to be opened.)	OHCA1 ≠ OHC1	OHCA1 = OHC1	OHCA1 = Overhead heater 1 circuit auxiliary contactor OHC1 = Overhead heater 1 contactor feedback
5.1	**OHCA 2 Fault**	OHCA 2 status doesn't match OHC2 (- Absence of feedback when the contactor is demanded to be closed. - Presence of feedback when the contactor is demanded to be opened.)	OHCA2 ≠ OHC2	OHCA2 = OHC2	OHCA2 = Overhead heater 2 circuit auxiliary contactor OHC2 = Overhead heater 2 contactor feedback
6	**CMCB1 Fault**	Compressor Motor 1 circuit breaker feedback is monitored as tripped or OFF position	CMCBA1 is On (High)	CMCBA1 is Off (Low)	CMCB(A) = Compressor Motor Circuit Breaker (Auxiliary contactor)

Table 8-2. Event Description (cont'd.)

No.	Fault	Detailed Description	Cause/Trigger Condition	Reset/Clear condition	Remark/ Attributes
6.1	**CMCB2 Fault**	Compressor Motor 2 circuit breaker feedback is monitored as tripped or OFF position	CMCBA2 is On (High)	CMCBA2 is Off (Low)	CMCB(A) = Compressor Motor Circuit Breaker (Auxiliary contactor)
7	**CFMCB Fault**	Condenser Fan Motor circuit breaker feedback is monitored as tripped or OFF position	CFMCBA is On (High)	CFMCBA is Off (Low)	CFMCB(A) = Condenser Fan Motor Circuit Breaker (Auxiliary contactor)
8	**BMCB Fault**	Blower Motor circuit breaker feedback is monitored as tripped or OFF position	BMCBA is On (High)	BMCBA is Off (Low)	BMCB(A) = Blower Motor Circuit Breaker (Auxiliary contactor)
9	**OHCB Fault**	Overhead heater circuit breaker feedback is monitored as tripped or OFF position	OHCBA is On (High)	OHCBA is Off (Low)	OHCB(A) = Overhead Heater Circuit Breaker (Auxiliary contactor)
10	**AFS Fault**	In absence of air flow from the blower motor, detected by the Air Flow Switch.	Blower motor is started for more than 10 seconds and AFS is Off (low) and ACD is On	AFS is On or Blower Motor is off or ACD is Off	AFS = Air Flow Switch
11	**FAT Fault**	The reading of the fresh air temperature sensor is out of limits	Fresh air temperature is above 70 C or below -50 C	Fresh air temperature reading is between -50 C and 70 C.	FAT = Fresh Air Temperature Sensor
12	**RAT Fault**	The reading of the return air temperature sensor is out of limits	Return air temperature reading is above 70 C (158 F) or below -50 C (-58 F)	Return air temperature reading is between -50 C and 70 C.	RAT = Return Air Temperature Sensor
13	**SAT Fault**	The reading of the supply air temperature sensor is out of limits	Supply air temperature reading is above 70 C (158 F) or below -50 C (-58 F)	Supply air temperature reading is between -50 C and 70 C.	SAT = Supply Air Temperature Sensor
14	**LPT 1 Fault**	The reading of Low pressure transducer of compressor 1 is out of limits	Voltage reading is below 0.3V or above 4.7 V	Voltage reading is between 0.3V and 4.7 V	LPT = Low Pressure Switch
15	**HPT 1 Fault**	The reading of High pressure transducer of compressor 1 is out of limits	Voltage reading is below 0.3V or above 4.7 V	Voltage reading is between 0.3V and 4.7 V	HPT = High Pressure Switch

Table 8-2. Event Description (cont'd.)

No.	Fault	Detailed Description	Cause/Trigger Condition	Reset/Clear condition	Remark/ Attributes
16	**LPT 2 Fault**	The reading of Low pressure transducer of compressor 2 is out of limits	Voltage reading is below 0.3V or above 4.7 V	Voltage reading is between 0.3V and 4.7 V	LPT = Low Pressure Switch
17	**HPT 2 Fault**	The reading of High pressure transducer of compressor 2 is out of limits	Voltage reading is below 0.3V or above 4.7 V	Voltage reading is between 0.3V and 4.7 V	HPT = High Pressure Switch
18	**OHPT1 Fault**	The OHPT1 fail to open for 30 seconds	OHC1 or OHC2 is ON and OHPT1is Off and ACD is On	Not in heating mode or OHPT1 is On	OHPT1 = Overhead heat protective thermostat
19	**Damper Fault**	One or Both fresh air damper s doesn't work during normal operation	Damper 1 Fault or Damper 2 Fault	No fault on both damper 1 and damper 2	Damper = Fresh air plenum venting
19.1	**Damper 1 Fault**	Fresh air damper 1 doesn't work in correct position during normal operation	The absolute value between Damper1 real position and setpoint 1 is above 100 for at least 40 seconds.	Damper1 in correct position	Damper = Fresh air plenum venting
19.2	**Damper 2 Fault**	Fresh air damper 2 doesn't work in correct position during normal operation	The absolute value between Damper 2 real position and setpoint 2 is above 100 for at least 40 seconds.	Damper2 in correct position	Damper = Fresh air plenum venting
20	**LPS1 Fault**	Failure in LPS1 to close when Compressor 1 is running	Compressor 1 is running and LPS 1 is Off(open)	Compressor 1 is running and LPS is On or Restart of the Controller	LPS = Low Pressure Switch
21	**HPS1 Fault**	Failure in HPS1 to close when Compressor 1 is running	Compressor 1 is running and HPS 1 is Off(open)	Compressor 1 is running and HPS is On or Restart of the Controller	HSP = High Pressure Switch
22	**LPS2 Fault**	Failure in LPS2 to close when Compressor 2 is running	Compressor 1 is running and LPS 2 is Off(open)	Compressor 2 is running and LPS is On or Restart of the Controller	LPS = Low Pressure Switch
23	**HPS2 Fault**	Failure in HPS2 to close when Compressor 2 is running	Compressor 1 is running and HPS 2 is Off(open)	Compressor 2 is running and HPS is On or Restart of the Controller	HSP = High Pressure Switch
24	**CMC1 DO Fault**	CMC 1 DO status doesn't match CMC1 feedback DI status Internal system (ACCU) fault	CMC1 DO High CMC1 feedback DI Low or CMC1 DO Low CMC1 feedback DI High	CMC1 DO status matches CMC1 feedback DI status	CMC = Compressor Motor Contactor DO = Digital Output, DI = Digital Input

Table 8-2. Event Description (cont'd.)

No.	Fault	Detailed Description	Cause/Trigger Condition	Reset/Clear condition	Remark/ Attributes
25	**CMC2 DO Fault**	CMC 2 DO status doesn't match CMC1 feedback DI status Internal system (ACCU) fault	CMC2 DO High CMC2 feedback DI Low or CMC2 DO Low CMC2 feedback DI High	CMC2 DO status matches CMC2 feedback DI status	CMC = Compressor Motor Contactor DO = Digital Output, DI = Digital Input
26	**HGBP 1 DO Fault**	HGBP 1 DO status doesn't match HGBP1 feedback DI status	HGBP1 DO High HGBP1 feedback DI Low or HGBP1 DO Low HGBP1 feedback DI High	HGBP1 DO status matches HGBP1 feedback DI status	HGBP = Hot Gas By-Pass DO = Digital Output, DI = Digital Input
27	**HGBP 2 DO Fault**	HGBP 2 DO status doesn't match HGBP2 feedback DI status Internal system (ACCU) fault	HGBP2 DO High HGBP2 feedback DI Low or HGBP2 DO Low HGBP2 feedback DI High	HGBP2 DO status matches HGBP2 feedback DI status	HGBP = Hot Gas By-Pass DO = Digital Output, DI = Digital Input
28	**CFMC DO Fault**	CFMC DO status doesn't match CFMC feedback DI status Internal system (ACCU) fault	CFMC DO High CFMC feedback DI Low or CFMC DO Low CFMC feedback DI High	CFMC DO status matches CFMC feedback DI status	CFMC = Condenser Fan Motor Contactor DO = Digital Output, DI = Digital Input
29	**BMC DO Fault**	BMC DO status doesn't match BMC feedback DI status Internal system (ACCU) fault	BMC DO High BMC feedback DI Low or BMC DO Low BMC feedback DI High	BMC DO status matches BMC feedback DI status	BMC = Blower Motor Contactor DO = Digital Output, DI = Digital Input
30	**OHC1 DO Fault**	OHC1 DO status doesn't match OHC1 feedback DI status Internal system (ACCU) fault	OHC1 DO High OHC1 feedback DI Low or OHC1 DO Low OHC1 feedback DI High	OHC1 DO status matches OHC1 feedback DI status	OHC = Overhead Heater Contactor DO = Digital Output, DI = Digital Input
31	**OHC2 DO Fault**	OHC2 DO status doesn't match OHC2 feedback DI status Internal system (ACCU) fault	OHC2 DO High OHC2 feedback DI Low or OHC2 DO Low OHC2 feedback DI High	OHC2 DO status matches OHC2 feedback DI status	OHC = Overhead Heater Contactor DO = Digital Output, DI = Digital Input
32	**HVAC Fault**	At least one error is detected in HVAC unit	One or more application faults	No fault condition	Heating, Ventilation, and Air Conditioning Unit

Table 8-2. Event Description (cont'd.)

No.	Fault	Detailed Description	Cause/Trigger Condition	Reset/Clear condition	Remark/ Attributes
33	**Hot Car**	Return Air temperature is had been more the 10F higher than expected for 30 minutes and is not dropping	The return air temperature is more than 10 degrees Fahrenheit above the return air setpoint for more than 30 minutes and the return air has not decreased by more than 4F.	Return Air temperature is within 10 degrees Fahrenheit of Return Air Set point OR Return Air Temperature has decreased by more than 4 F.	None
34	**Cold Car**	Return Air temperature is had been more the 10F lower than expected for 30 minutes and is not increasing	The return air temperature is more than 10 degrees Fahrenheit below the return air setpoint for more than 30 minutes and the return air has not increased by more than 4F.	Return Air temperature is within 10 degrees Fahrenheit of Return Air Set point OR Return Air Temperature has increased by more than 4 F.	None

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