By Jerry Bisbee – ATC Tech Trainer
techtalk@atcfreightliner.com

# Blend-Air AC Freezing Up?

## Air Flow in a Blend-Air Unit

Current production Century Class, Columbia, and Coronado vehicles are equipped with BEHR Blend-Air HVAC units. All of the air flow in these units passes through the AC evaporator. After the air passes through the evaporator it passes through a "blend-air" doorway that controls whether the air passes through the heater core or passes around the heater core. Duct outlet temperature is controlled by how much air passes through the heater core. When the blend-air door is in the coldest position none of the air passes through the heater core. As the temperature control knob on the control panel is turned toward the warmer side of the scale, more of the air is allowed to pass through the heater core. The air that passes through the heater core and the air that only passes through the evaporator are "blended" back together before the air is sent out through the ducts.

## Evaporator Temperature Control

The AC compressor clutch is controlled by the Front HVAC Control Unit, a.k.a FCU. The FCU monitors J1587 datalink information such as air system pressure status and engine RPM, along with the temperature of the air coming off the evaporator to control the compressor clutch. The FCU receives evaporator "air off" temperature information from a temperature sensor that is mounted a short distance away from the evaporator on the downstream side. This sensor is a Negative Temperature Coefficient (NTC) sensor. That is, the electrical resistance of the sensor increases as the temperature of the air decreases (see Table 1). Once all the clutch engagement rules are met, the FCU will engage the clutch when the temperature of the air coming off the evaporator is above 44ºF and will disengage the clutch when the "air off" temperature is at or below 37ºF.

**Table 1 - Evaporator Temperature Sensor- Temperature Versus Resistance**

| Temperature ºF | Resistance Ω | Temperature ºF | Resistance Ω |
|---|---|---|---|
| 20 | 12,814 | 55 | 4792 |
| 25 | 11,036 | 60 | 4209 |
| 30 | 9535 | 65 | 3706 |
| **32** | **9000** | 70 | 3271 |
| 35 | 8265 | 75 | 2894 |
| 40 | 7183 | 80 | 2566 |
| 45 | 6259 | 85 | 2281 |
| 50 | 5468 | 90 | 1996 |

## Compressor Clutch Control Circuitry

When the FCU determines that the clutch engagement rules are met (see Table 2) it sends a 12V signal to the AC Clutch Relay coil through wire 97T (refer to the schematic in Figure 1). The other end of the relay coil is grounded. This causes the relay to close the normally open contacts. Battery voltage from the 20amp Maxi-Fuse in position 55 of the Main Cab Power Distribution Module is sent through the relay contacts, through circuit 97T*, through the contacts in the Binary switch, to the AC clutch. Once the temperature of the air coming off the evaporator drops to 37ºF the FCU shuts off power to the AC clutch relay coil, the relay opens the normally open contacts, and power is turned off to the clutch.

**Table 2 - A/C Request Rules***

| Input | Input Type | State All Inputs Must Be for the FCU to Send A/C Request Signal |
|---|---|---|
| Accessory Power | +12V | On |
| Engine Speed | J1587 Data from Engine | Above 450 rpm for at least 5 seconds |
| Low Air | J1587 Data from ICU | Not Low |
| Evaporator Temperature | Evaporator Temp Sensor | Above 44ºF |
| A/C Switch/Light | Control Panel | On |
| Air Selection Switch | Control Panel | Any A/C or defrost position except when rear override is active |
| Temp Control Switch | Control Panel | Any |
| Fan Switch | Control Panel | Any setting other than off except when rear override is active; fan will be at least minimum speed |
| Compressor Cycling Timer | Internal FCU Logic | 15 seconds elapsed since A/C request last active |

* If any input does not meet the conditions listed in this table, A/C request will not be sent.
The only exception is when the sleeper unit requests A/C support by going into "Rear Override Mode."

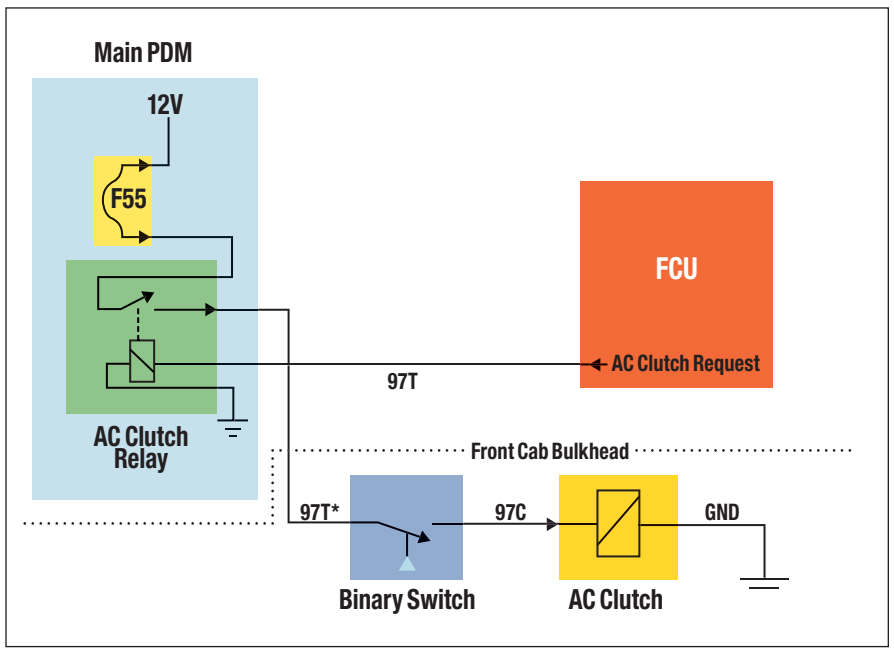


**Figure 1 - AC Clutch Control Circuitry**

## Evaporator "Freeze Up" Conditions

Several conditions may cause the evaporator in these Blend-Air units to freeze up.

1. Low air flow across the evaporator

   The Evaporator Temperature Sensor is measuring "air off" temperature. Since the sensor is not mounted in the evaporator core it doesn't sense evaporator temperature unless there is air flowing across it. Low blower speed, restricted return and fresh air filters and debris on the evaporator may cause the evaporator to freeze up without the FCU knowing that it is.

2. Incorrect refrigerant charge

   To operate at maximum efficiency, air conditioning units, that use thermostatic expansion valves to control refrigerant flow through the evaporator, must have liquid refrigerant all the way to the expansion valve(s). The coldest part of an evaporator changes based on how much refrigerant is coming into the evaporator and how much heat load is in the air passing through the evaporator. The evaporator temperature sensor is positioned to measure air coming off the coldest part of the evaporator when conditions are correct. If conditions such as refrigerant charge, condenser performance, and air flow across the evaporator are not correct, parts of the evaporator may start to freeze-up without the FCU sensing it. As the evaporator freezes, air flow is restricted and the evaporator temperature sensor cannot accurately measure evaporator temperature.

3. Clutch control circuit electrical problems

   Shorted or stuck clutch relay contacts or the 97T wire, 97T* wire or 97C shorted to power in the engine harness or dash harness may cause the clutch to stay engaged when the FCU is trying to turn it off.

## Troubleshooting Evaporator "Freeze Up"

The easiest way to determine of the FCU and clutch control circuitry are working correctly is to start the engine, turn the AC controls to the positions that should cause the clutch to engage and make sure that it is engaged. Then, leaving the harness connected to the evaporator temperature sensor, remove the sensor from the HVAC unit and insert it into a container of ice and water (see Figure 2). An ice and water bath will be approximately 32ºF. This should cause the AC clutch to disengage. If it will not, disconnect the harness from the sensor and measure the resistance across


**Figure 2 - Testing the Evap Temp Sensor in an Ice Bath**

the terminals of the sensor. According to Table 1, the resistance at 32ºF should be approximately 9000Ω. If it is not, replace the sensor. If it is, test the wiring between the sensor and the FCU. When you disconnect the harness from the FCU the clutch relay should open and turn off the clutch. If it does not, check the relay to see if it is stuck and check the harness to see if the 97T wire between the FCU and the AC clutch relay, or the 97T* wire between the AC clutch relay and the AC clutch is shorted to power.

If submerging the sensor in an ice bath causes the clutch to disengage, the "freeze up" condition is most likely caused by an incorrect refrigerant charge or restricted air flow across the evaporator. Make sure the system has the correct refrigerant charge, according to the label on the truck. If the vehicle was equipped from the factory with a BEHR condenser and has had the condenser replaced, the replacement condenser may be a Modine condenser. If so, the refrigerant charge label may be incorrect. If you think this may be the case, refer to Freightliner Service Bulletin 83-113. It has an illustration that shows how to tell the difference between a BEHR condenser and a Modine condenser. It also lists the correct refrigerant charge levels for both.

## Conclusion

When one of these blend-air systems is freezing up, the condition may be caused by either an electrical problem or a problem in the refrigeration system itself. Eliminate the electrical system first by dipping the evaporator temperature sensor in an ice bath as this article describes. That is a quick easy step to take and it may keep you from having to spend unnecessary time testing the refrigeration system.

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