Application Engineering

Copeland Discus Compressor with Demand Cooling System

BULLETIN NO: AE4-1287 R10

Contents

COPELAND

Safety

Important Safety Information

Those involved in the design, manufacture, and installation of a system, system purchasers, and service personnel may need to be aware of hazards and precautions discussed in this section and throughout this document. OEMs integrating the compressor into a system should ensure that their own employees follow this bulletin and provide any necessary safety information to those involved in manufacturing, installing, purchasing, and servicing the system.

Responsibilities, Qualifications and Training

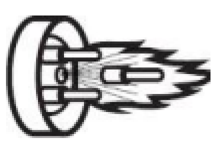
• OEMs are responsible for system design, selection of appropriate components, integration of this component into the system, and testing the system. OEMs must ensure that staff involved in these activities are competent and qualified.

• OEMs are also responsible for ensuring that all product, service, and cautionary labels remain visible or are appropriately added in a conspicuous location on the system to ensure they are clear to any personnel involved in the installation, commissioning, troubleshooting or maintenance of this equipment.

• Only qualified and authorized HVAC or refrigeration personnel are permitted to install, commission, troubleshoot and maintain this equipment. Electrical connections must be made by qualified electrical personnel.

• Observe all applicable standards and codes for installing, servicing, and maintaining electrical and refrigeration equipment.

Terminal Venting and Other Pressurized System Hazards



If a compressor's electrical terminal pin loses its seal, pressurized oil, refrigerant, and debris may spray out. This is called "terminal venting".

The ejected debris, oil, and refrigerant can injure people or damage property. The oil and refrigerant spray can be ignited by electrical arcing at the terminal or any nearby ignition source, producing flames that may project a significant distance from the compressor. The distance depends on the pressure and the amount of refrigerant and oil mixture in the system. The flames can cause serious or fatal burns and ignite nearby materials.

Each compressor has a terminal cover or molded plug that covers electrical connections. The cover or plug helps to protect against electric shock and the risks of terminal venting. If terminal venting occurs, the cover or plug helps contain the spray of refrigerant and oil and reduces the risk of ignition. If ignition occurs, the plug or cover helps contain the flames. However, neither the terminal cover nor the molded plug can completely eliminate the risk of venting, ignition, or electric shock.

See copeland.com/terminal-venting for more details about terminal venting. Additionally, a compressor's refrigerant lines keep refrigerant and oil under pressure. When removing or recharging refrigerant from this component during service, this can pose a pressurized fluid hazard.

Flammable Refrigerant Hazards

If flammable refrigerant is released from a system, an explosive concentration can be present in the air near the system. If there is an ignition source nearby, a release of flammable refrigerant can result in a fire or explosion. While systems using flammable refrigerant are designed to mitigate the risk of ignition if the refrigerant is released, fire and explosion can still occur.

See copeland.com/flammable-refrigerants for more information on flammable refrigerant safety.

Electrical Hazards

Until a system is de-energized, and capacitors have been discharged, the system presents a risk of electric shock.

Hot Surface and Fire Hazards

While the system is energized, and for some time after it is deenergized, the compressor may be hot. Touching the compressor before it has cooled can result in severe burns. When brazing system components during service, the flames can cause severe burns and ignite nearby combustible materials.

Lifting Hazards

Certain system components may be very heavy. Improperly lifting system components or the compressor can result in serious personal injury. Use proper lifting techniques when moving.

POE Oil Hazards

This equipment contains polyol ester (POE) oils. Certain polymers (e.g., PVC/CPVC and polycarbonate) can be harmed if they come into contact with POE oils. If POE oil contacts bare skin, it may cause an allergic skin reaction.

Precautions

• Always wear personal protective equipment (gloves, eye protection, etc.).

• Keep a fire extinguisher at the jobsite at all times.

• Keep clear of the compressor when power is applied.

- IMMEDIATELY GET AWAY **if you hear unusual sounds in the compressor. They can indicate that terminal pin ejection may be imminent. This may sound like electrical arcing (sizzling, sputtering or popping). However, terminal venting may still occur even if you do not hear any unusual sounds.**

• Never reset a breaker or replace a blown fuse without performing appropriate electrical testing

- **A tripped breaker or blown fuse may indicate an electrical fault in the compressor. Energizing a compressor with an electrical fault can cause terminal venting. Perform checks to rule out an electrical fault.**

• Disconnect power and use lock-out/tag-out procedures before servicing.

- Before removing the terminal cover or molded plug, check that ALL electrical power is disconnected from the unit. Make sure that all power legs are open. (Note: The system may have more than one power supply.)

- Discharge capacitors for a minimum of two minutes

- Always use control of hazardous energy (lock-out/tag-out) procedures to ensure that power is not reconnected while the unit is being serviced.

• Allow time for the compressor to cool before servicing.

- Ensure that materials and wiring do not touch high temperature areas of the compressor.

• Keep all non-essential personnel away from the compressor during service.

• For A3 refrigerants (R290) remove refrigerant from both the high and low sides of the compressor. Use a recovery machine and cylinder designed for flammable refrigerants. Do not use standard recovery machines because they contain sources of ignition such as switches, high- and low-pressure controls and relays. Only vent the R290 refrigerant into the atmosphere if the system is in a well-ventilated area.

• Never use a torch to remove the compressor. Only tubing cutters should be used for both A2L and A3 refrigerants.

• Use an appropriate lifting device to install or remove the compressor.

• Never install a system and leave it unattended when it has no charge, a holding charge, or with the service valves closed without electrically locking out the system.

• Always wear appropriate safety glasses and gloves when brazing or unbrazing system components.

• Charge the system with only approved refrigerants and refrigeration oils.

• Keep POE oils away from certain polymers (e.g., PVC/CPVC and polycarbonate) and any other surface or material that might be harmed by POE oils. Proper protective equipment (gloves, eye protection, etc.) must be used when handling POE lubricant. Handle POE oil with care. Refer to the Safety Data Sheet (SDS) for further details.

• Before energizing the system:

1. Securely fasten the protective terminal cover or molded plug to the compressor, and

2. Check that the compressor is properly grounded per the applicable system and compressor requirements.

Signal Word Definitions

The signal word explained below are used throughout the document to indicate safety messages.

⚠ DANGER	**DANGER** indicates a hazardous situation which, if not avoided, will result in death or serious injury.
⚠ WARNING	**WARNING** indicates a hazardous situation which, if not avoided, could result in death or serious injury.
⚠ CAUTION	**CAUTION**, used with the safety alert symbol, indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

Introduction

Copeland Discus Compressors with Demand Cooling System

Energy efficiency regulations drive continuous change in the availability of refrigerants to the marketplace. With the introduction of R-22 as a replacement for R-502, compressors began to experience internal discharge temperatures that exceed the safe operational limits for long term stability of refrigerant oil. In response to this, Demand Cooling was developed as a reliable method to keep discharge temperatures reduced to a safe level without inhibiting the operating limits of the compressor. With the phase out of R-22, the following refrigerants have become viable alternatives for R-22 applications: R-407A/C/F/H, R-448A, R-449A. All the above-mentioned refrigerants require special attention to discharge temperature control.

WARNING

POE may cause an allergic skin reaction and must be handled carefully and the proper protective equipment (gloves, eye protection, etc.) must be used when handling POE lubricant. POE must not come into contact with any surface or material that might be harmed by POE, including without limitation, certain polymers (e.g., PVC/ CPVC and polycarbonate). Refer to the Safety Data Sheet (SDS) for further details.

Updated Discharge Temperature Guidelines

Copeland developed and released the Demand Cooling system for Copeland Discus compressors to provide a solution for applications with high discharge temperatures such as the R-22 low temperature refrigeration applications. Without Demand Cooling, these high temperatures typically resulted in overheating of the lubricant leading to compressor failures.

Since additional refrigerant solutions such as R-407A/C/F/H, R-448A, and R-449A became available to the marketplace, there have been numerous requests to operate Discus compressors without Demand Cooling in applications where it is possible to control both condensing temperature and the return gas temperature to low enough levels to avoid overheating related failures. Copeland has re-evaluated operating guidelines for these refrigerants for the following reasons:

1. R-407A/C/F/H, R-448A/R-449A discharge temperatures are higher than R-404A, but lower than R-22.
2. Many new refrigeration systems operate at lower compressor superheat/return gas temperatures than AHRI rating condition at 65°F return gas.
3. Since February 2011, Copeland Discus compressors come standard with more comprehensive compressor protection via CoreSense technology.

Due to these factors, Copeland is pleased to offer updated operating envelopes and guidelines for low temperature R-407A/C/F/H and R-448A/R-449A applications. For details on specific applications with Demand Cooling and without Demand Cooling, refer to page 8 of this bulletin.

Operating Range

Demand Cooling is designed to protect the compressor from high discharge temperatures over the evaporating and condensing temperature ranges shown in **Figures 2, 3,** and **6**. Additionally, in instances where compressor return gas temperature and condensing temperature is closely controlled, the envelope in **Figure 2** is achievable without the addition of Demand Cooling components to the compressor.

Demand Cooling System

Demand Cooling is compatible with single (conventional) units as well as parallel racks.

The Demand Cooling module uses the signal of a discharge head temperature sensor to monitor discharge gas temperature. If a critical temperature is reached, the module energizes a long-life injection valve which meters a controlled amount of saturated refrigerant into the compressor suction cavity to cool the suction gas. This process controls the discharge temperature to a safe level. If, for some reason, the discharge temperature rises above a preset maximum level, the Demand Cooling module will turn the compressor off (requiring a manual reset) and actuate its alarm contact. To minimize the amount of refrigerant which must be injected, the suction gas cooling process is performed after the gas has passed around and through the motor.

Injection valve orifices have been carefully chosen for each body style to be large enough to provide the necessary cooling when required but not so large that dangerous amounts of liquid are injected, or that excessive system pressure fluctuation occurs during injection valve cycling. Normally, pressure fluctuations are no greater than 1 to 2 psi. It is important to use the correct valve for each compressor body style.

Performance data for Demand Cooling compressors includes the effects of injection when it is required. The approximate conditions where injection occurs are shown in **Figures 2, 3,** and **6**. At the conditions where Demand Cooling is operating, the performance values are time averages of the instantaneous values, since small fluctuations in suction and discharge conditions occur as the Demand Cooling injection valve cycles.

Demand Cooling System Design

When Demand Cooling operates, it 'diverts' refrigeration capacity in the form of injected saturated refrigerant from the evaporator to the compressor (See **Figure 7** for a typical single system schematic). The effect of this diversion on evaporator capacity is minimal because the diverted capacity is used to cool the gas entering the compressor. As the gas is cooled, it naturally becomes denser, increasing the mass flow through the compressor, which partly compensates for the capacity diverted from the evaporator.

If there is substantial heat gain along the suction line, injection may result in a substantial loss in evaporator capacity during Demand Cooling operation. To minimize this loss, good practice indicates Demand Cooling operation be kept to a minimum through proper system design and installation practices. There are three areas which can be addressed to minimize the impact of Demand Cooling operation on performance.

1. Compressor Return Gas Temperature: Suction lines should be well insulated to reduce suction line heat gain. Return gas superheat should be as low as possible consistent with safe compressor operation.
2. Condensing Temperatures: It is important when using R22, R-407 A/C/F/H, or R448A/449A as a low temperature refrigerant that condensing temperatures be minimized to reduce compression ratios and compressor discharge temperature.
3. Suction pressure: Evaporator design and system control settings should provide the maximum suction pressure consistent with the application to have as low a compression ratio as possible.

Demand Cooling Compressors

No new compressor models have been introduced for Demand Cooling. Instead, existing low temperature Discus CFC-502 compressors have been modified for use with R-22, R-407 A/C/F/H, or R- 448A/449A and Demand Cooling. The modifications are the addition of an injection port on the compressor body and a temperature sensor port in the head of the compressor. The locations of these ports are critical and were determined through an extensive development program.

The R-22, R-407 A/C/F/H, or R-448A/449A rating data includes the effects of Demand Cooling injection when operating conditions require it based on 65 °F return gas.

Condenser Sizing

Condensers should be sized using conventional methods. Demand Cooling has virtually no effect on system heat of rejection.

Demand Cooling System Components

The Demand Cooling System (see **Figure 1**) consists of: The Demand Cooling Temperature Sensor (TS), the Demand Cooling Module (CM), and the Injection Valve (IV).

The TS uses a precision Negative Temperature Coefficient (NTC) Thermistor (thermistor resistance drops on temperature rise) to provide temperature signals to the CM.

The IV meters refrigerant flow from the liquid line to the compressor. The IV solenoid receives on-off signals from the CM. When compressor cooling is required, the solenoid is energized and opens the IV orifice to deliver saturated refrigerant to the compressor for cooling. The valve orifice is carefully sized to meet the requirements of each body style of Discus compressors.

The CM has three functional groups:

A. The **Input signal** and calculator circuits compare the temperature sensor input signal to an internal set-point and decide whether to energize the IV solenoid or, in the case of a problem, the CM alarm relay.

B. The output signal to the IV is controlled by an electronic switch connected to the IV solenoid so that, when required, refrigerant vapor can be metered to the compressor to prevent compressor overheating. One side of the electronic switch is connected internally to 'L1' and the other side to output terminal 'S' (seeFigure 6).

C. The alarm relay is energized, after a one-minute delay, by a continuous, low, or high TS temperature signal. An alarm signal can indicate the following:

   1. Compressor discharge temperature has risen above the level designed to be controlled by Demand Cooling.
   2. A shorted sensor.
   3. An open sensor.

To avoid nuisance trips, a one-minute time delay is provided before alarm after a continuous high or low resistance reading or over temperature condition.

The alarm relay uses a single-pole-double-throw contact. The contact terminals are ‘L', 'M', and 'A':

'L' - Common (to 'A' and 'M')

'L - M' - Normally Closed (compressor run. Open on alarm)

'L - A' - Normally Open (alarm signal, close on alarm)

The Normally Closed (NC) contact of the alarm relay ('L' to 'M') should be wired in the compressor contactor control circuit so that opening this contact removes the compressor from the line and removes power to the CM. See **Figures 5A, B, C,** and **D**.

Figures 5 **A** and **B** also show a current sensing relay **(which must be used with compressors employing internal over current protection. The current sensing relay is already included when using CoreSense protection)** and Sentronic oil pressure switch. The control circuit is purposely arranged so that an internal overload protector trip removes power to both the Sentronic and the Demand Cooling module. This precaution prevents the oil pressure switch from timing out and the Demand Cooling solenoid from injecting when the compressor is not operating.

The alarm relay requires a manual reset to call attention to a system problem. Demand Cooling with CoreSense Protection CoreSense Protection is compatible with Copeland Demand Cooling. However, the discharge temperature protection is provided by the Demand Cooling module. Discharge temperature information will not be communicated to the CoreSense Protection module. See **Figure 8E**.

System Information

1. Demand Cooling is designed to work on all Copeland Discus compressors equipped with injection ports. A different kit is required for each compressor body style and control voltage. See **Table 2** for a listing of Demand Cooling Kit part numbers.
2. The system must be clean. A dirty system may have foreign material that can lodge in the solenoid orifice. Always install a liquid line filter dryer in the injection valve inlet line capable of removing particles as small as 25 microns.
3. Do not use any filters containing materials that can leave the filter and possibly clog the IV orifice.
4. The liquid refrigerant supply line must be a minimum of 3/8" and routed so it will not interfere with compressor maintenance. Liquid refrigerant must have sufficient subcooling at the injection valve to prevent flashing upstream of the valve.
5. The liquid refrigerant supply line to the IV must be supported so that it does not place stress on the IV and IV tubing or permit excess vibration.

Failure to make this provision may result in damage to the IV and its tubing and/or refrigerant loss.

6. A head fan must be used to help lower compressor discharge temperatures for compressors using HCFC-22. Return gas temperatures must NOT exceed 65°F.
7. System designers are advised to review their defrost schemes to avoid flood back to the compressor which may occur at defrost termination with R-22, R-407 A/C/F/H, or R-448A/449A.These refrigerants have a significantly higher heat of vaporization than does CFC-502, and if the same design parameters used with CFC-502 are used, flood back may occur.

Demand Cooling with Discus Compressor Unloading

Demand Cooling has been approved with unloading for 4D, 6D and 3D Copeland Discus Digital. Demand Cooling has NOT been approved for 3D Moduload.

Note: For Discus compressors with CoreSense Diagnostics with the build of material (BOM) nomenclature beginning with -ADx (e.g., 4DKNF63KL- TSK-AD0) Demand Cooling capability is built in.

4D and 6D Unloading with Demand Cooling

compressors using conventional blocked suction unloading. Earlier application guidelines required that liquid injection only occur when the compressor is in its fully loaded state. This was to avoid flooding the compressor with saturated liquid. After further evaluation, Copeland engineering has determined that the Copeland Discus compressor will still flash the injected liquid refrigerant when the compressor is unloaded should the discharge temperatures govern the need for added cooling. The Demand Cooling module will only inject liquid when required. When the temperature decreases to an acceptable level, the module will stop injecting.

3D Copeland Discus Digital with Demand Cooling

Demand Cooling can be used with 3D Copeland Discus Digital compressors without adding extra unloader control circuitry. The Demand Cooling temperature sensing probe must be installed to replace the temperature sensing probe that is provided with the Digital Compressor Controller (IDCM). The T1 to T2 connection on the Digital Compressor Controller should be jumped with a 5 kOhm 1 Watt resistor. This allows the Demand Cooling module to protect against high discharge temperatures and inject liquid when needed.

Performance Adjustment Factors

Performance values for R-407 A/C/F/H, R-448A and R-449A are not provided in this bulletin. For actual performance values refer to Product Selection Software (PSS) or the Online Product Information (OPI) at https://webapps.copeland.com/online-product-information/.

Since compressor discharge temperature depends strongly on the return gas temperature, the amount of injection and its effect on evaporator capacity and mass flow will vary somewhat with return gas temperature. The approximate effects of compressor return gas temperature on evaporator capacity and mass flow are calculated in the current version of Copeland Product Selection Software (PSS).

Demand Cooling Specifications

Demand Cooling is designed to operate and protect the compressor within the evaporating and condensing envelope identified in **Figure 2**. Operating setpoints and control actions are listed in **Table 1**.

Attached is the Demand Cooling Diagnostic Troubleshooting Guide (**Form No. 92-91**)

See also:

Demand Cooling Installation Instruction Guides Copeland Publication Nos.

90-130 for 2D/3D Compressors
90-131 for 4D Compressors
90-133 for 6D Compressors

Figure 1 - Demand Cooling System

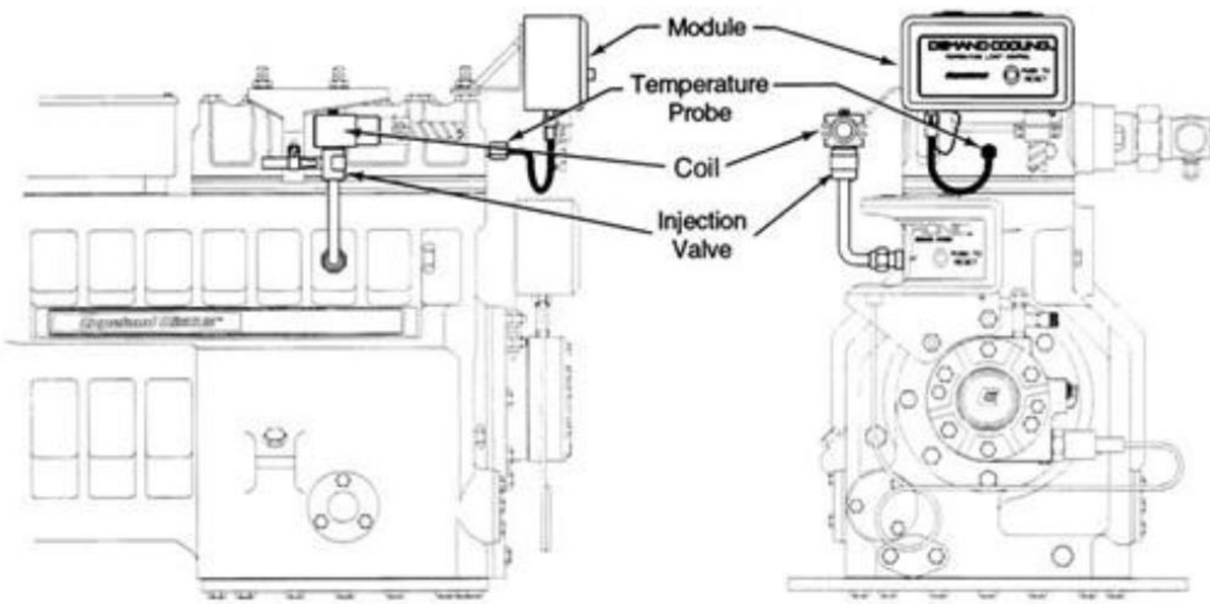
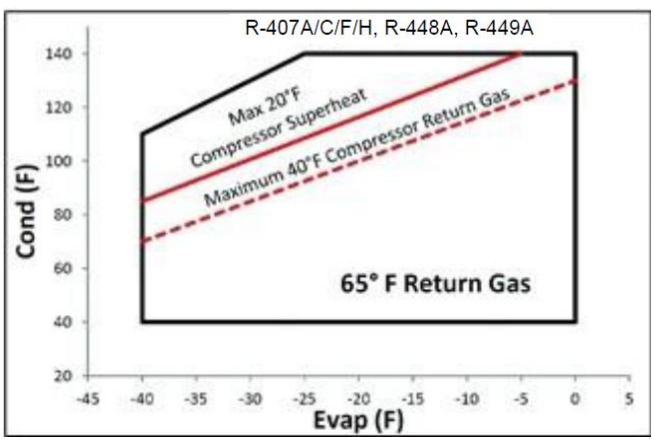


Figure 2 - Low Temp Envelope without Demand Cooling

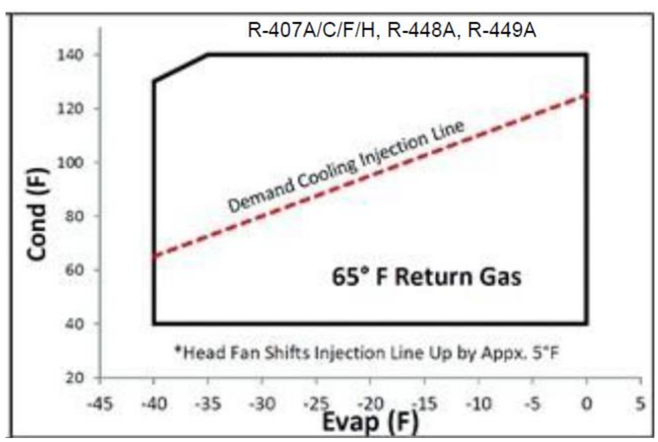


Without Demand Cooling

-Head Fan Required

-CoreSense Discharge temp protection required

Figure 3 - Low Temp Envelope with Demand Cooling



With Demand Cooling

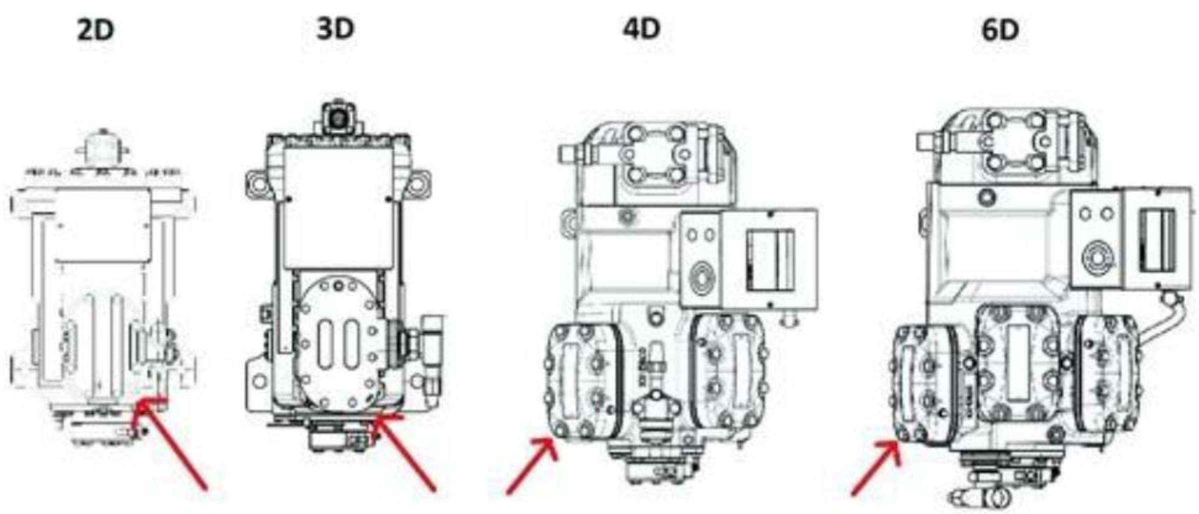
-Head fan optional

Injection lines represent maximum operation point within discharge temperature limits of the compressor. For operating points below the line, Demand Cooling would not be active. For instance, at -25°F evaporating temperature and 80°F condensing and 65°F return gas there would not be injection. However, at the same evaporating temperature and return gas temperature with 120°F condensing temperature there would be injection.

If Demand Cooling is not applied, CoreSense discharge temperature protection is required in addition to a head fan. Refer to **Figure 5** for CoreSense temperature probe installation location. For more information on CoreSense, See AE8-1367. If Demand Cooling is applied, head fan and CoreSense are not needed.

Figure 4 - CoreSense Discharge Temperature Protection
(See AE-1367 for Additional Instruction)

Figure 5 - Standard Location of CoreSense Temperature Probe
(for compressors with CoreSense Diagnostics)



R-22 Low Temp Application

Figure 6 - Low Temperature Operating Envelope for R-22 at 65F Return Gas (with Head Fan)

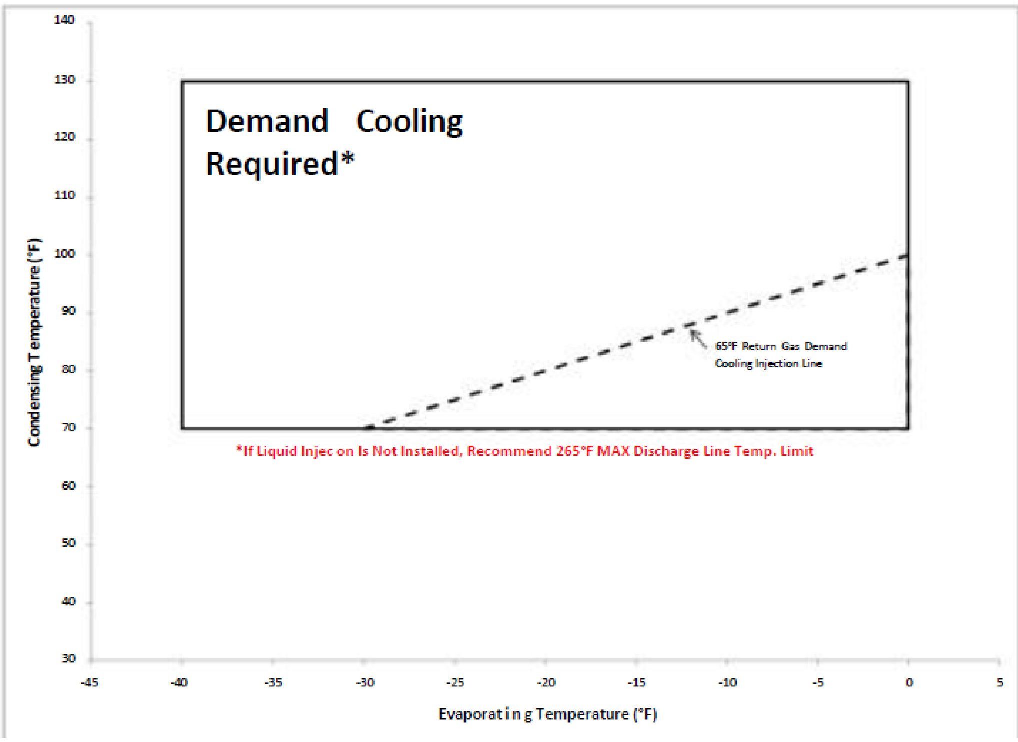


Figure 7 - Demand Cooling System Diagram

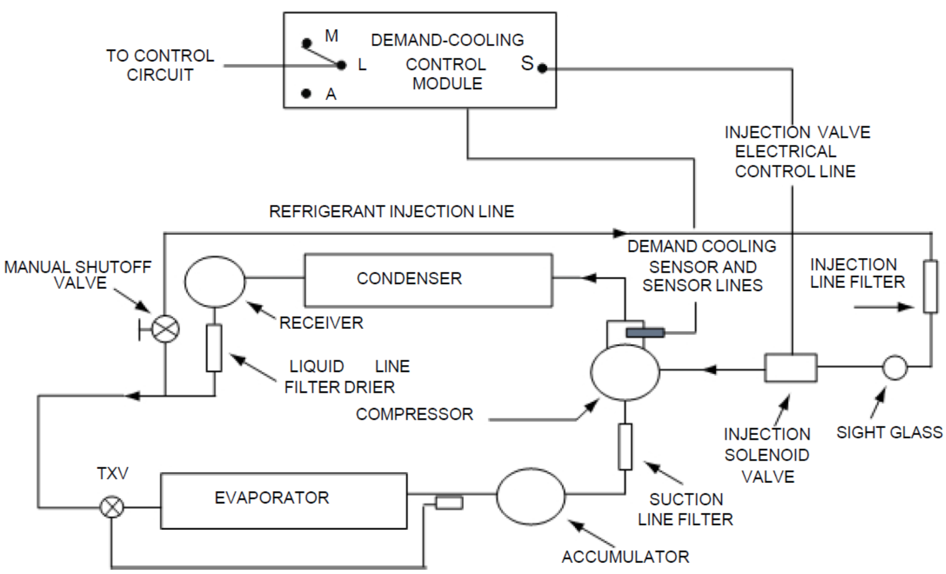


Figure 8 - Demand Cooling Wiring Schematic with Sentronic Oil Pressure Control and Current Sensing Relay

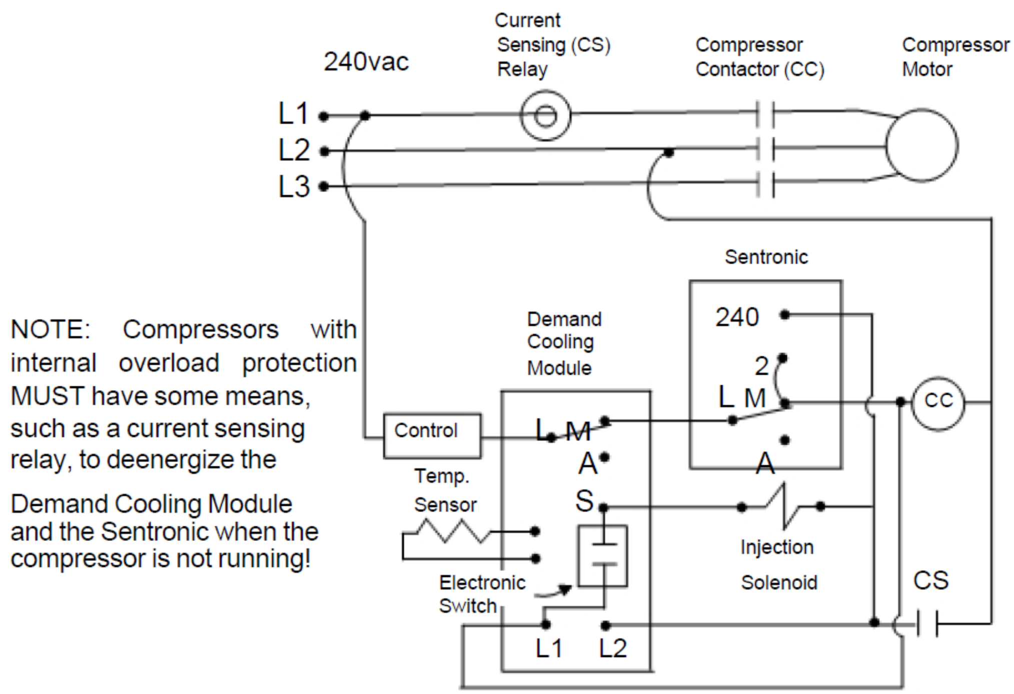


Figure 9 - Demand Cooling WIring Schematic less Sentronic Oil Pressure Control

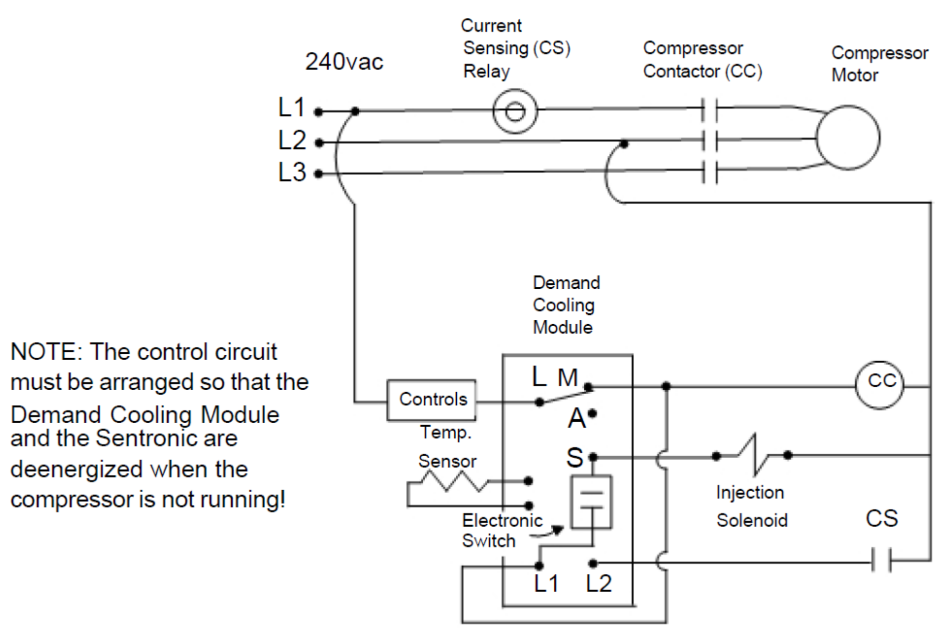


Figure 10 - Demand Cooling Wiring Schematic with Sentonic Oil Pressure Control Less Current Sensing Relay

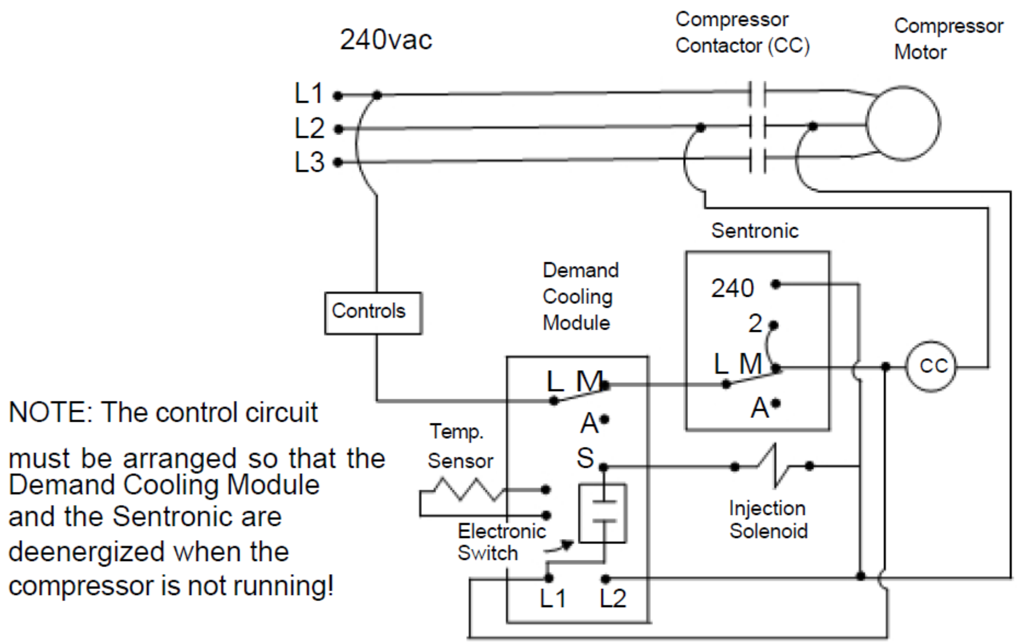


Figure 11 Demand Cooling Wiring Schematic with Isolated Control Contacts

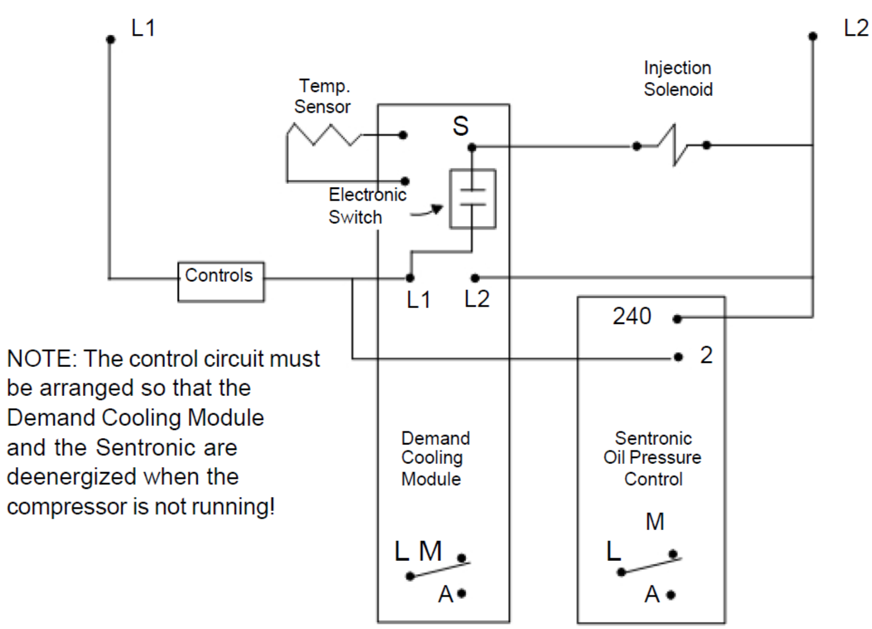


Figure 12 Coresense Protection with Copeland Demand Cooling

NOTE: The CoreSense module is dual rated for 120v / 240v.
The Demand Cooling module must be matched to the line voltage.

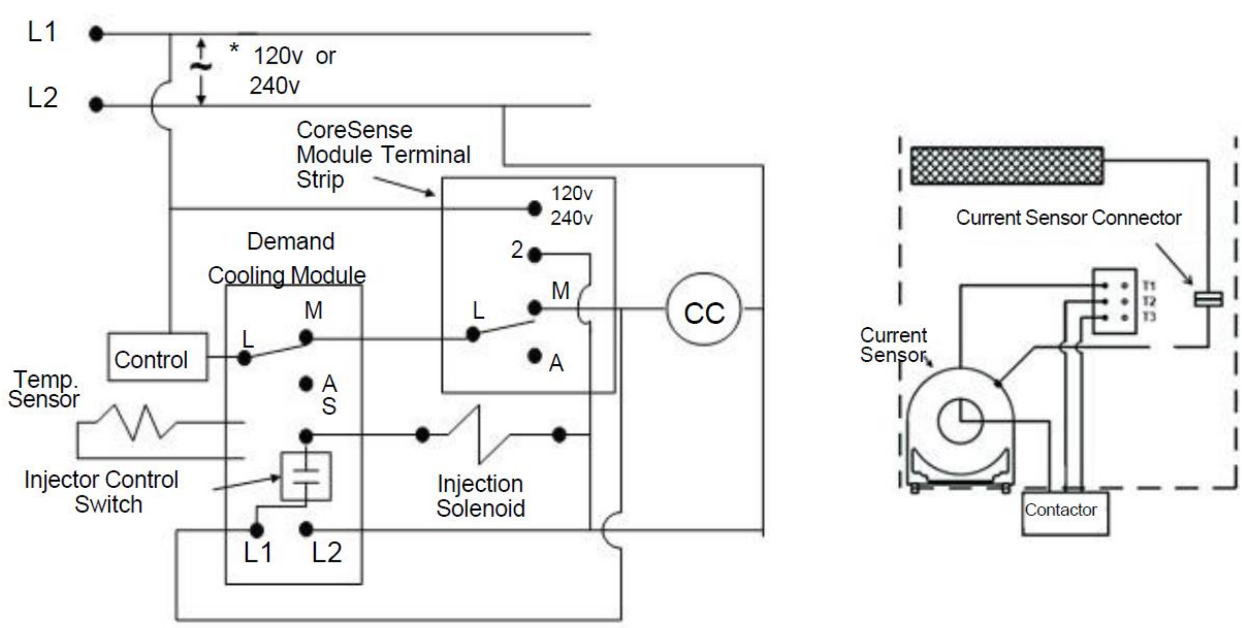


Table 1 - Demand Cooling Operating Setpoints and Control Actions

Internal Head Temperature	CM Operation	Approximate Sensor Resistance
Rising through 292°F	Demand Cooling Solenoid On	2100 Ohms
Falling through 282°F	Demand Cooling Solenoid Off	2400 Ohms
Rising through 310°F	Alarm Contact Energized	1700 Ohms
At Room Temp. (77°F)	Demand Cooling Solenoid Off	90,000 Ohms

Maximum Contact Ratings: 720VA, 120/240VAC, 60HZ Maximum Solenoid Output ("S" Terminal) Rating: 16W (The IV solenoid must be the only load on this output.)

Time Delay For Demand Cooling Alarm Actuation (after a continuous low or high resistance TS signal input): 1 minute

Table 2 - Demand Cooling Kit Part Numbers

Frequency	Voltage	2D	3D	4D	6D	4D*X, 4D*N[1]	6D*X, 6D*N[1]
50 HZ	120V	998-1000-12	998-1001-13	998-1001-14	998-1001-16	998-2001-14	998-2001-16
	240V	998-1000-22	998-1001-23	998-1001-24	998-1001-26	998-2001-24	998-2001-26
60 HZ	120V	998-1000-12	998-1000-13	998-1000-14	998-1000-16	998-2000-14	998-2000-16
	240V	998-1000-22	998-1000-23	998-1000-24	998-1000-26	998-2000-24	998-2000-26

Demand Cooling Kits Include: Demand Cooling Module with 2 Mounting Screws

Temperature Sensor with 3ft. Shielded cable

Injection Valve and Solenoid (without mounting hardware)

Installation/Troubleshooting Guide

Optional Demand Cooling Module Mounting Brackets

2D and 3D Models	998-0700-09
4D and 6D Models	998-0700-10

Temperature Sensors

3ft. Shielded Cable (Standard)	085-0109-00
10ft. Shielded Cable (Optional)	085-0109-01

[1]4D*X, 4D*N, 6D*X, 6D*N Indicate Discus III Models

Appendix

Copeland Demand Cooling Diagnostics

Demand Cooling Operating Characteristics

The Copeland Demand Cooling control uses a Negative Temperature Coefficient thermistor (NTC). Incorporated in the Demand Cooling temperature sensor (hereafter called 'sensor'), is a compressor discharge temperature monitor. When the temperature sensed by the NTC Thermistor rises, its resistance falls, and when temperature sensed by the thermistor drops, its resistance increases.

The sensor resistance signal is coupled to the Demand Cooling module (hereafter called 'module'). The module uses the signal to determine when the compressor discharge temperature has risen to a point where Demand Cooling is required. When Demand Cooling is required, the module energizes the Demand Cooling Injection Valve (hereafter called 'injection valve') and the injection valve injects saturated refrigerant into the compressor suction cavity until the discharge temperature drops to an acceptable level.

Whenever the compressor starts and the module first receives power, there is a one-minute delay during which the Demand Cooling system injects saturated refrigerant if it is required but waits for compressor discharge temperature to stabilize before checking for alarm conditions. After one minute, if the resistance of the probe is too low (the resistance equivalent of 310°F), or too high (the resistance equivalent of 4°F) the module will trip and deenergize the compressor.

Bench Testing Demand Cooling Components

Bench Check of the Sensor

Required Equipment:

- A digital thermometer of +/- 1 % full scale accuracy. The thermometer probe should be checked for calibration in an ice water bath or compared with another accurately known temperature source.
- A digital ohmmeter capable of +/- 1 % accuracy. The ohmmeter should be checked for accuracy with a known resistance value such as a +1 % resistor.

Room temperature should be stable and between 60°F and 110°F.

1. Wrap the end of the digital thermometer probe and the metal end of the Demand Cooling sensor probe together with electrical tape or hook and loop fasteners (Velcro). The end of the probe and the end of the thermometer must touch.
2. Place the wrapped probe-sensor inside an insulation shield to protect it from air currents. Use a material such as Permagum or piping insulation such as ArmafleX. The insulating material should be tightly wrapped around the taped-sensor and the wrap should be secured with wire or tie wraps if necessary. There should be no free air movement over the metal part of the taped sensor.
3. Connect the digital ohmmeter to the two pins on the plug of the sensor. Make sure there is a good connection. Do not take a sensor resistance measurement until there is no change in the ohmmeter display.
4. Measure the temperature of the thermometer sensor and find the corresponding calculated sensor resistance value from Table 1. Since the values of Table 1 are not continuous, you may have to interpolate.
5. The sensor resistance reading should be within +/- 5% of the calculated resistance value of Step 4.

End of Test

Table 3 Appendix Table 1

Thermometer Temp (°F)	Calculated Sensor Resistance (Ohms)	Thermometer Temp (°F)	Calculated Sensor Resistance (Ohms)
59	141426	86	72504
60.8	135000	87.8	69480
62.6	128907	89.6	66609
64.4	123129	91.4	63864
66.2	117639	93.2	61254
68	112437	95	58770
69.8	107478	96.8	56394
71.6	102762	98.6	54126
73.4	98289	100.4	51966
75.2	94041	102.2	49914
77	90000	104	47943
78.8	86139	105.8	46053
80.6	82476	107.6	44262
82.4	78984	109.4	42543
84.2	75663		

Bench Check of the Module and Injection Valve Required equipment:

- A controlled voltage source the same as the rating of the module and the injection valve.
- A multimeter.
- If the jumper supplied on the sensor plug of the module is not available, you may use a small paper clip for the test.

Before starting the test, make sure you have the correct module and injection valve.

1. With the module control voltage disconnected, short the module sensor plugs female terminals with the jumper or the paperclip. Press the module reset button.
2. Attach the injection valve leads to terminals 'L2' and 'S' of the module. The injection valve should be propped in an upright position.
3. You should read zero ohms between the 'L' and 'M' terminals of the module. This is the Normally Closed (NC) contact of the Single Pole Double Throw (SPDT) module alarm relay. You should read an open circuit between 'L' and 'A'. This is Normally Open (NO) contact of the alarm relay.
4. Energize the module by bringing module rated voltage to terminals 'Ll' and 'L2'. *When the sensor connection at the module is shorted, a very low resistance is seen by the module as a very high temperature, and an injection signal is sent to the injection valve.
5. The injection valve will be energized by the closing of an electronic switch in the module. The control voltage to energize the injection valve may be measured across module terminals 'S' and 'L2'. *Because this measurement is made across an electronic switch some 'leakage' voltage may be measured when the switch is deenergized. This voltage is much less than the control voltage which is measured when the electronic switch is closed. The injection valve operation may also be checked by listening to the 'click' heard each time the coil of the injection valve is energized and the injection valve solenoid plunger seats itself.
   If background noise prevents an audible check of the injection valve coil and magnet operation, grip the injection valve magnet housing, and loosen its housing cover screw until magnet vibration is felt. This proves solenoid operation. Retighten the magnet housing cover screw after this check.
6. After one minute, the module should trip. The run contact 'L' to 'M' should open, and the alarm contact 'L' to 'A' should close. Deenergize the module and disconnect the injection valve. The resistance should be zero ohms between 'L' and 'A', and between 'L' and 'M' there should be an open circuit.
7. Reset the module. Remove the jumper from the module probe plug so there is an open circuit at the plug input.
8. Energize the module.

When the sensor connection to the Demand Cooling Module is opened the very high resistance is interpreted by the module as a very low temperature. Consequently, no injection signal is sent to the injection valve.

9. The injection valve should be energized. A recheck of Step 5 will confirm this.
10. Refer to the test of Step 6 to check the alarm circuit. Reset the module after the test. If the module or injection valve fails any of the checks it should be replaced.

End of Test

Installed System Checks of Demand Cooling Components

When the Demand Cooling control injects saturated refrigerant into the suction cavity of the compressor, the outlet tube of the injection valve frosts. If the module sensor connection is opened or shorted while the module is energized, the module will trip after one minute of operation and must be reset to continue.

Before starting the test, make sure you have the correct module and injection valve.

If the Injection Valve is Not Injecting

1. With the system deenergized, disconnect the sensor from the module and jumper the terminals of the module connector. Energize the system so the compressor is running, and the module is activated. The injection valve should begin injecting, and frost should form on the outlet tube of the injection valve. If frost forms, go to Step 4 otherwise continue to Step 2.
2. If frost does not form in Step 1, check to see if there is control voltage on the coil of the injection valve (terminals 'L2' and 'S' of the module).

   *Because this measurement is made across an electronic switch in the module some 'leakage' voltage may be measured when the switch is deenergized. This voltage is much less than the control voltage which is measured when the switch is closed. If correct control voltage is not present, replace the module.
3. If correct control voltage is present, make sure there is a full sight glass of liquid from the receiver at the injection valve. If there is not a full sight glass of liquid, the piping from the receiver should be checked before proceeding. Piping connections and sizes must be chosen to assure a full sight glass of liquid for the injection valve during any phase of the refrigeration system operation. Piping that is too small, or connections taken from the tops of manifolds rather from the bottom may result in a lack of refrigerant available for the injection valve just when it needs it most, such as after a defrost.

   If a full sight glass is present and frost still does not form, replace the injection valve.
4. With the module sensor connector shorted or open and the module and compressor running, the module should trip in one minute and stop the compressor.

   If the compressor does not stop, check the control circuit wiring to be sure the module is wired to stop the compressor when the module trips. If the wiring is correct, replace the module.
5. Check the discharge temperature by performing Steps 1-6 of the Injection Valve is Cycling on and Off test.

   If the discharge temperature is higher than the allowable Table 2 selection, remove the sensor from the compressor and use the Bench Check of the Sensor Test to check the probe. Replace the sensor if necessary.

End of Test

If the Injection Valve is Continually Injecting

When the saturated refrigerant is injected into the compressor suction cavity it lowers the temperature sensed by the sensor. The lower temperature in turn causes the injection valve to shutoff. After shutoff the temperature in the suction cavity rises again until it is high enough for injection to start. The result of this cycling is that frost on the injection valve outlet tubing alternately appears during injection, and then disappears after injection stops.

Table 4 - Appendix Table 2

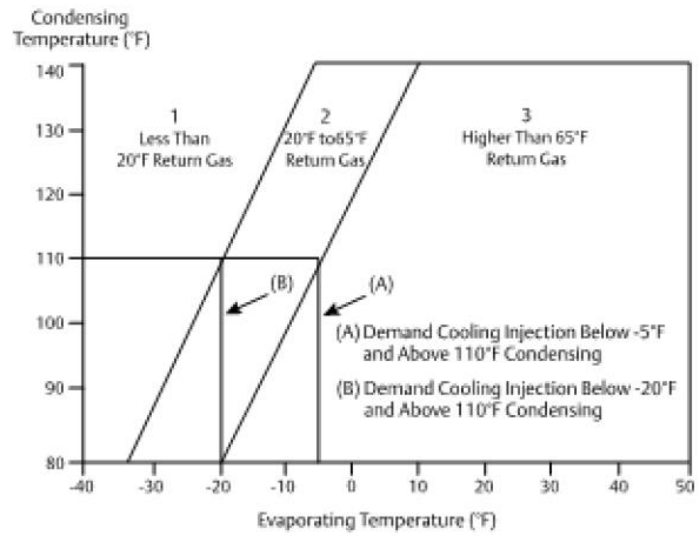
Compressor Model	Room Temp. (°F)	Condensing Temp. (°F)	Discharge Temp. (°F)
2D	80	80	250-270
	110	110	270-280
3D	80	80	240-256
	110	110	265-280
4D	80	80	230-260
	110	110	260-280
6D	80	80	250-270
	110	110	250-270

1. Measure the room temperature.
2. Connect the temperature sensor probe to the compressor discharge line 6” from the discharge valve. The probe must be tightly secured to the discharge line and must be well insulated so that moving air will not produce a false reading (a poorly insulated probe may cause errors of more than 30°F!).
3. Using Table 2, check the conditions that are closest to your system. (The evaporator temperature used for Table 2 was -25°F). There may be deviation from the table due to system variation, however, within 5-10% of the published discharge pressures is acceptable. Note: Table 2 is for R-22. Copeland recommends assuming that R-407 A/C/F/H, R-448A, and R-449A run about 10°F to 15°F cooler per the approved operating ranges.
4. When operating under published conditions, the discharge temperature should never be more than 280°F or less than 200°F. If successful, the test is ended. Otherwise continue to the next step.
5. If the measured discharge temperature is lower by more than 10% of the discharge temperature of Table 2, perform Steps 5-8 of the 'If the Injection Valve Is Continually Injecting' test.

If the measured discharge temperature is more than 280°F, replace the sensor.

End of Test

Figure 13 Appendix Figure 1
Demand Cooling Areas of Expected Injection



Revision Tracking R10

The document format has been updated to the new Copeland format

All occurrences of "Emerson" have been removed

A note regarding A3 and R290 venting has been updated