Real Time Monitoring and Control of Suction Pressure for NetworkAIR FM

Abstract

Environmental and system conditions that result in low system suction pressures can induce a coil freeze in HVAC systems that cause the system to shut down. The NetworkAIR FM has a unique method of system monitoring and control that prevents freeze up as a result of low suction pressure. This document outlines the causes of low suction pressure and the control strategies for prevention of coil freeze in the NetworkAIR FM.

Introduction

Under certain circumstances, system suction pressures can fall to a level such that coil freeze up can occur. The traditional method of mitigating this situation has been hot gas bypass, or cycling of compressors tied to a low-pressure switch.

Causes

- *Lack of refrigerant*: A system charge that falls below optimal will cause a low suction pressure condition. As the charge level continues to fall, suction pressures also continue to fall.
- *Low return air temperatures*: Under low return air temperature conditions, low evaporator load results in a new lower system balance temperature for the evaporator coil.
- *Evaporator dirty*: As airflow is reduced, total energy transferred to the air stream is also reduced. The result is again a low evaporator load that results in a new lower system balance temperature for the evaporator coil.
- *Clogged filter drier*: A partially clogged liquid line filter drier can cause a low suction pressure condition. As the clog continues to increase, refrigerant flow and hence suction pressure continues to decrease.
- *Malfunctioning expansion valve*: A sticking expansion valve sticking can cause a low suction pressure.
- *Low condensing temperature*: A low condensing temperature will cause a low suction pressure condition. The lower the condensing temperature, the lower the suction pressure.
- *Short-circuited supply air*: Supply air that is short circuiting back to the return air inlet has the same net result as low return air temperatures. The result is again a low evaporator load that results in a new lower system balance temperature for the evaporator coil.

Consequence

- *Lack of refrigerant*: System total capacity will be reduced. System sensible heat ratio will be reduced. Coil freeze up will occur if not addressed
- *Low return air temperatures*: System sensible capacity will be reduced. Coil freeze up will occur if not addressed. Compressor failure due to flood back* could occur if the evaporator coil becomes flooded.
- *Evaporator dirty*: System total capacity will be reduced. System sensible heat ratio will be reduced. Coil freeze up will occur if not addressed. Compressor oil return could be compromised due to reduced refrigerant flow. Compressor flood back* could occur if the evaporator coil becomes flooded.
- *Clogged filter drier*: System total capacity will be reduced. System sensible heat ratio will be reduced. Coil freeze up will occur if not addressed. Trigger of High head pressure switch cutout can occur if the level of closure in the filter becomes severe.
- *Malfunctioning expansion valve*: System total capacity will be reduced. Under certain conditions, coil freeze up will occur if not addressed. Trigger of the high head pressure relief valve or fusible link in the receiver can occur if the level of closure in the expansion valve becomes severe.
- *Low condensing temperature*: System total capacity can be reduced. System sensible heat ratio will be reduced. Coil freeze up can occur if not addressed. Compressor failure due to flood back* could occur if the condensing temperature is dropped to extremely low conditions.
- *Short-circuited supply air*: System sensible capacity will be reduced. Coil freeze up will occur if not addressed. Compressor failure due to flood back* could occur if the evaporator coil becomes flooded.

* A coil becomes flooded when the load on the evaporator coil drops below the lower operating limit of the thermal expansion valve. The surplus of refrigerant allowed through the thermal expansion valve therefore has no load from which to absorb heat and in turn boil. As a result, the percentage of liquid refrigerant present in the evaporator coil rises. When the volume of refrigerant exceeds the volume of the evaporator coil, liquid refrigerant leaves the coil and enters the compressor.

Protection Methods

Hot gas bypass

This approach uses a pressure-equalizing valve that opens when the suction pressure reaches a designed level. Hot gas from the compressor discharge is injected into the distributor just before the evaporator coil. The result is an increase in evaporator pressure and hence temperature.

There are several negative consequences that can occur with this method.

- Energy is wasted as system efficiency is dropped.
- Oil return issues can be magnified if cause is due to lack of refrigerant.
- Capacity reduction due to all of the aforementioned causes can be magnified while masking the cause.
- Accuracy of bypass actuation is low when used alone.

Real time monitoring and control of suction pressure

This approach uses active firmware response to changes in the suction pressure. The actions are triggered based on the system achieving predetermined pressure levels. The severity of the response is based on which pressure level is achieved. Situation one (1) is asserted if suction pressure falls below 52 PSIG but above 20 PSIG. Situation two (2) is asserted if suction pressure falls below 20 PSIG. The attached diagrams one (1) and two (2) show the response flow for situations one (1) and two (2) respectively. Further, firmware reaction is described below.

Situation 1: If system suction pressure falls below 52 PSIG for more than three minutes, and the unit is running both compressors, the compressor currently deemed the 2^{nd} stage is shut down. At the time of shut down, the control temperature reading is logged. If at any time after shutdown the control temperature rises two (2) degrees above the logged control temperature, the compressor currently deemed the 2^{nd} stage is re-started. Short cycle start up delays apply.

Situation 2: If system suction pressure falls below 20 PSIG, both compressors are shut down. The only exception to this is if the system is an air-cooled unit. If the system is an air-cooled unit, compressor shutdown occurs if the below 20 PSIG condition persists in excess of 90 seconds. Shutdown is maintained for all systems for three (3) minutes. After the three (3) minute waiting period has expired. Both compressors are restarted following the standard startup staging sequence. Should shut down occur three (3) times within a 30 minute period, a low pressure alarm is asserted and startup is halted until a manual review of the log and reset is completed by the user.

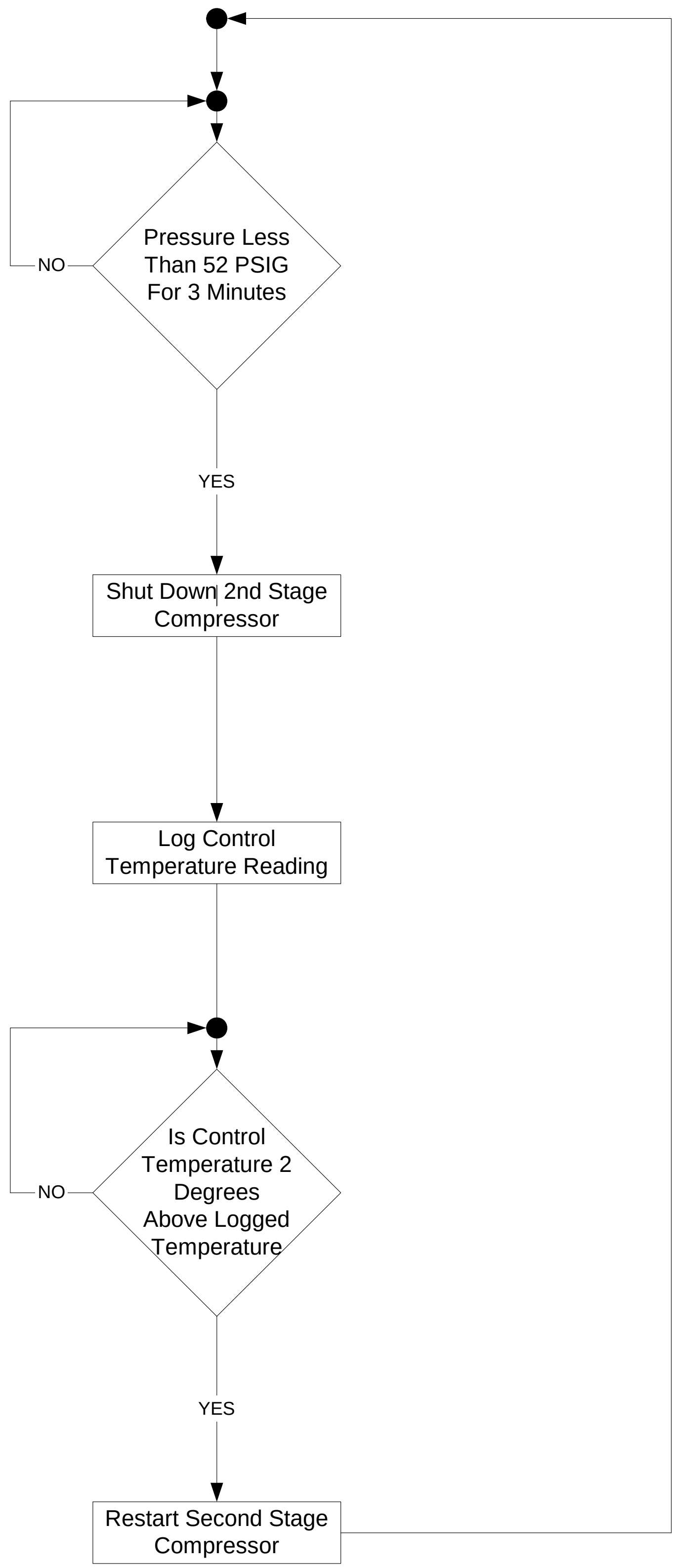
Pressure Less Than 52 PSIG For 3 Minutes
NO
YES
Shut Down 2nd Stage Compressor
Log Control Temperature Reading
Is Control Temperature 2 Degrees Above Logged Temperature
NO
YES
Restart Second Stage Compressor

Diagram 1

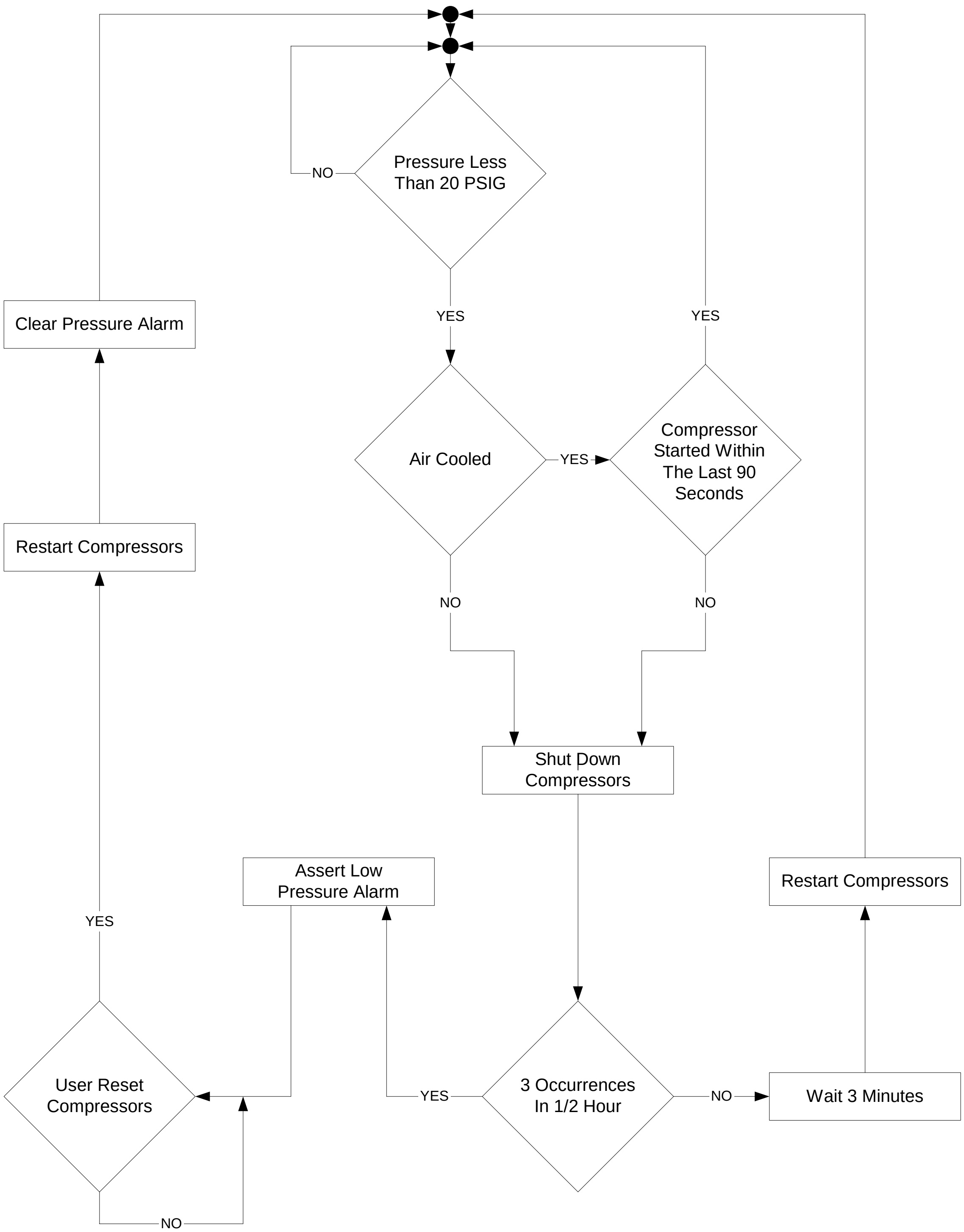
Pressure Less Than 20 PSIG
NO
YES
Clear Pressure Alarm
Air Cooled
YES
Compressor Started Within The Last 90 Seconds
YES
NO
NO
Restart Compressors
Shut Down Compressors
Assert Low Pressure Alarm
Restart Compressors
YES
User Reset Compressors
YES
3 Occurrences In 1/2 Hour
NO
Wait 3 Minutes
NO

Diagram 2