Application Engineering Bulletin

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LOW LIMIT PRESSURE CONTROLS FOR LOW TEMPERATURE TRUCK APPLICATIONS

By far the great majority of compressor failures on low temperature truck applications, particularly when using eutectic plates, are due to a loss of proper lubrication in the compressor. Field experience has proven that the most common source of this type of failure is the setting of the low pressure control at a cut-out point below the system's operating limits.

In reciprocating compressors, oil and refrigerant mix continuously. Since oil must pass through the compressor cylinders to provide lubrication, a small amount of oil is always circulating with the refrigerant. Oil and refrigerant vapor do not mix readily, and the oil can be properly circulated through the evaporator only if gas velocities are high enough to sweep the oil along. If velocities are not sufficiently high, oil will tend to lie on the bottom of the evaporator tubing, resulting in a shortage of oil in the compressor. As evaporating temperatures are lowered, this problem becomes more critical since the viscosity of the oil increases with a decrease in temperature.

A properly designed system will have adequate refrigerant velocities in the evaporator and suction line to insure oil return as long as the system is operated within its design limitations. But the user must realize that a system designed for operation with evaporating temperatures of -35°F. may not have sufficient vapor density and velocity to return oil if operated with an evaporating temperature of -55°F. Conversely, a system designed to properly return oil when operated with an evaporating temperature of -55°F. might have an excessively high pressure drop if operated with an evaporating temperature of -35°. Therefore every refrigeration system design must be based on a compromise between pressure drop and velocity in relation to the desired evaporating temperature.

Eutectic plate installations may vary to some extent, but in general the tubing size and plate configuration do not normally insure oil return at evaporating temperatures below -40°F. If the low pressure control is set to allow the system to operate below this level, **lubrication problems are not only possible but probable.** This typically can occur overnight or over a weekend in mild or low ambient temperature conditions when the eutectic solution in the plates is frozen and the body temperature is low. As the compressor suction pressure falls, the refrigerant velocity and density decrease, an increasing amount of oil is trapped in the evaporator, and eventually the compressor crankcase is emptied of oil. If the compressor is equipped with an oil pressure safety control, it will trip. If the compressor has no oil pump and therefore no oil pressure safety control, the usual result is scoring of the rods and crankshaft, with eventual seizure and rod breakage.

Many servicemen assume that the lower the cut-out point is set on the low pressure control on low temperature applications, the colder the load temperature will automatically become. **Probably no single factor on truck applications is more misunderstood, or has caused more compressor failures than this belief.**

It is true that by lowering the low pressure control cut-out setting, the control can in effect be bypassed, and the compressor will run continuously. But compressor operation is but one factor in the refrigeration process. In the majority of cases where the load temperatures are not satisfactory, other factors are the actual culprit, for example: high temperature of the product when loaded, excessive frost on the evaporator surface, shortage of refrigerant, air or moisture in the system, or inadequate evaporator surface for the load. In a properly balanced system, the compressor will take the body temperature as low as is safely possible within the operating limits of the system while cycling on a reasonable low pressure control setting.

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In a typical low temperature truck equipped with eutectic plates, a user can realistically expect to reduce the body temperature during night time operation to 3 or 4 degrees below the eutectic temperature without endangering the compressor, but very little more. Body temperature can only be obtained by freezing the eutectic solid, and lowering the plate and frozen eutectic temperature below the freezing point of the eutectic solution. But the frozen eutectic acts as a heat transfer barrier—making the plate an inefficient heat transfer device. The resulting increasing temperature difference between the evaporating refrigerant and the load temperature places a practical limitation on the load temperatures that can be obtained while operating within the allowable operating limits of the compressor.

Operation of Copeland compressors at suction pressures below their published operating range without the specific approval of the Copeland Application Engineering Department is considered misuse and abuse of the compressor, and will adversely affect any warranty consideration.

Because of the difficulty of assuring that operating or service personnel do not set the low pressure control at excessively low cut-out points, special pressure controls with fixed low limit settings have been developed and are now available. Basically the control operates in the same fashion as a conventional dual pressure control, with the exception that a lock nut on the adjusting stem makes it impossible to set the low pressure cut-out below its preset limit.

The low limit control is strongly recommended as a replacement control for any field application having compressors that cannot be equipped with oil pressure safety controls, and is recommended as an added safety factor on any low temperature truck application. Low limit controls are being made standard on all Copeland truck condensing units 1½ H.P. and larger, and will be mandatory on low temperature units.

On the original fixed limits controls developed for truck applications, the operating differential in some cases could not be regulated within close enough limits. To remedy this problem, new controls have been developed with a total scale of 50 psi, and an operating differential which can be set as low as 6.2 psi.

	Copeland Part No.	**Penn Part No.**
R-12 (Minimum Cut-out 12")		
Low Pressure Control, Single Pole, Light Duty	085-0098-14	P70AN-3
Dual Pressure Control Single Pole, Light Duty	085-0098-16	P70MN-2
R-502 (Minimum Cut-out 2#)		
Dual Pressure Control, Single Pole, Light Duty	085-0098-17	P70MN-3