BULLETIN OEM 94T-2

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COMPOUND COOLING APPLICATION GUIDE ADDENDUM

The Compound Cooling Compressors have been successfully applied, both domestically and internationally, in low temperature systems since their introduction in 1991. The applications have been greatly varied in both application and system design. Many new systems are currently using evaporator pressure regulators (EPR's) at the subcooler outlet to maintain steady or minimum liquid temperatures. During prolonged cold temperatures in winter, the subcooling load requirements are minimized, a situation which is exacerbated with the use of an EPR. Under these conditions, the subcooling load may be virtually eliminated as the EPR closes off. Each compressor will then operate at its individual mid-stage pressure (mid-stage pressure with no economizer). This may result in reverse flow from the mid-stage port of the compressor with the highest mid-stage pressure. Also, many compressors have been applied with suction and/or interstage (or mid-stage) piping outside of Carlyle's normal application guidelines that allow free draining into an off compressor or slugs of oil to return to the compressor. The recommendations and requirements in this bulletin will clearly address these issues for both new system design and existing systems.

Suction and Mid-Stage Piping Recommendations

Carlyle has conducted extensive field evaluations of compressors with reported suction or discharge valve problems. In almost all cases, the problems have been related to refrigerant and/or oil control problems. Carlyle has required avoiding suction and mid-stage header designs that may allow free draining into an off compressor. This avoids liquid refrigerant and oil accumulation in off compressors or suction line traps (see **figure #1A** for piping recommendations). For that reason, suction and mid-stage manifolds are recommended to be located below their respective compressor inlet locations. However, this lower location does not eliminate the need to avoid refrigerant and especially oil from accumulating in large quantities in these manifolds. Unless this is avoided, large slugs of liquid refrigerant and especially oil can be drawn into running compressors. This has been found to be a primary cause of valve failures. To avoid this, the piping must be configured as shown in **figure #1B**.

To prevent liquid refrigerant floodback and oil slugging into the suction inlet of the C3 compressors, a suction accumulator can be used in conjunction with a properly designed suction manifold, although use of a well designed and sufficiently oversized suction manifold will also suffice. In multiple compressor applications, one large accumulator manifolded to the individual compressors is recommended rather than smaller individual accumulators on each compressor. In single compressor applications, suction accumulators which utilize a U tube with a weep hole for oil return should be avoided. If the system is over charged with oil, this weep hole can allow oil to accumulate in the suction tube during a compressor off cycle, resulting in an oil slug reaching the compressor on start-up. (Carlyle is, at this time, working on an alternate design for individual suction accumulators to eliminate this problem.) No matter what design is used at the compressor suction, poor piping practices can result in filling the accumulator or header with liquid and oil faster than it can be removed, thereby allowing liquid or oil to reach the compressor. To avoid this, the piping recommendations addressed in this bulletin along with proper system piping practices must be followed!

Oil Management System

Carlyle has recommended the use of motor barrel equalization on single stage 06E compressors to avoid oil accumulation in suction headers from draining into the motor barrel. Due to the more stringent mid-stage and suction piping requirements of the C3 compressors, motor barrel equalization is no longer recommended or required on the 06CC550, 665, 675, and 899 models.

The use of crankcase equalization through the sight glass or oil floats must be avoided on all C3 models. The compressors may operate at slightly different crankcase pressures and crankcase equalization lines may cause erratic oil control.

The reservoir check valve or reservoir pressure control system must have a minimum of 15-20 psi differential between mid-stage and reservoir oil pressure. This is required to positively feed all compressor crankcases under varying mid-stage pressure conditions.

Interstage (or Mid-Stage) Pressure Control

As noted above, the use of EPR valves at the subcooler vapor outlet may virtually eliminate the subcooling load under low head pressure operating conditions. On parallel applications, each compressor will then run at its individual mid-stage pressure. This may result in reverse flow from the economizer port of the compressor with the highest mid-stage pressure. EPR valves have typically been used to keep stable liquid refrigerant temperatures and to help keep the liquid refrigerant temperature from falling below a minimum level. One option on existing systems, during periods of very low subcooling loads, is to adjust the EPR valve to allow the liquid temperature to float to lower levels. This will result in increased mass flow through the compressor mid-stage and result in stable mid-stage pressures in all compressors.

On existing systems experiencing reverse flow (from a compressor economizer port), and where adjusting the EPR valve is not a viable option, one of the following methods may be used. Options are listed in order of most to least preferable, although all three options are viable.

(1) Set system head pressure control to maintain a minimum of 80 degrees saturated condensing temperature. This will insure sufficient load for the subcooler will always be available.

(2) Installation of a check valve in each compressor mid-stage line upstream of the desuperheating valve will prevent potential reverse flow (see **figure #2** for details).

(3) Installation of a hot gas bypass valve to maintain a minimum interstage pressure (see **figure #3**). This valve can be used to supercharge the mid-stage with flow during low ambient periods while the mid-stage desuperheating will still be able to maintain acceptable discharge temperatures. During higher ambient periods, the HGBP valve will shut down as subcooler load and mass flow increases. The HGBP should be no larger than the expansion valve used with the subcooler. The setting of this HGBP valve should be slightly higher than the highest compressor mid-state pressure as measured without subcooler flow, suggested settings will be in the 50-60 psig range. The actual setting will vary depending on the application. The valve should feed as close to the center of the system mid-stage as possible for best refrigerant mixture. Care should also be taken to avoid heat transfer from the HGBP to the subcooler TXV sensing bulb.

The 06CC016, 018 and 550 compressors operate at higher individual (without the subcooler) mid-stage pressures (4-8 psi greater) than other models. For this reason, multiple compressor systems which utilize any of these models will require the use of one of the above options.

On new systems, Carlyle recommends installing a check valve in each compressor's mid-stage piping on multiple compressor systems. The check valve must be located upstream of the desuperheating valve as shown in **figure #2**. This will prevent any compressor reverse flow from occurring regardless of the subcooler loading.