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SSC DETECTOR SOLENOID DESIGN NOTE #122

TITLE: Helium System Configuration

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ABSTRACT: Two types of helium cooling systems for the detector solenoid are described. Each system can be configured in several ways.

DISCUSSION:

In the single loop system, helium flows from the refrigerator, through the solenoid's cooling coil and then returns to the refrigerator. The helium supply is single phase liquid. Both liquid and vapor phases are present in the return helium flow. The two phases can be returned together in a single line or the phases can be separated at the detector and returned in separate lines. Pressure to circulate the helium through the loop during normal operation can be provided by the refrigeration compressors, pumps or thermosiphon action.

If supply pressure is generated by the refrigeration compressors, either with or without a supply dewar, the two phase mixture returns directly to the low pressure side of the refrigerator. A back-up supply of helium gas can be used to pressurize the supply dewar to keep the solenoid operating when the compressors shutdown.

If supply pressure is generated by pumps, the two phase mixture returns to the pump dewar instead of to the low pressure side of the refrigerator. Refrigerator output is throttled to match the load. Vapor from the pump dewar returns to the refrigerator.

The system that circulates helium with thermosiphon action operates like the pump system. A supply dewar replaces the pump dewar.

The supply flow passes through a subcooler just before it enters the chimney. Either a small stream taken from the supply flow or the two phase return flow can provide the cooling in the subcooler. When subcooling with the return flow, the entire stream flows into the subcooler. Helium flow for the power leads is taken from the subcooler. The two phases can be separated in the subcooler. If this is done then the liquid phase is pumped back to the supply dewar and recirculated through the system. Refrigerator output is throttled to match the load. Vapor from the subcooler returns to the refrigerator. A cold compressor can be used to provide the lowest operating pressure for the subcooling pool. The solenoid's cooling coil will operate at a lower pressure when the liquid phase is separated and pumped back to the dewar because the back pressure

created by the two phase return line is eliminated. The quality of the return flow can be determined if the two phases are separated.

Desuperheating of helium vapor returning to the refrigerator can be accomplished with a cooling coil in the supply dewar or by using a temperature control loop to inject liquid helium into the returning flow.

A sketch for a single loop system with supply dewar and subcooling with the return flow is shown in figure 1.

In the dual loop system, helium flows from a dewar installed on top of the detector, through the solenoid's cooling coil and then returns to the same dewar. The helium supply to the coil is single phase liquid and the return helium flow is a two phase mixture. Pressure to circulate the helium through this local loop can be provided by pumps or thermosiphon action. Boiloff gas from the local dewar returns to the refrigerator and is made-up with single phase liquid helium from the refrigerator. Pressure to supply helium to the local dewar during normal operation can be provided by the refrigeration compressors or pumps. As discussed for the single loop system, a supply dewar can be used to back-up the refrigeration compressors, a cold compressor can be used to provide the lowest operating pressure in the local dewar and helium vapor returning to the refrigerator can be desuperheated.

A sketch for a dual loop system with supply dewar and solenoid thermosiphon loop is shown in figure 1.

CONCLUSION: The performance of each attractive system must be determined and compared to the SDC solenoid's operating requirements to establish the appropriate configuration for the helium system.

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FIGURE 1: SINGLE LOOP SYSTEM WITH SUPPLY DEWAR AND SUBCOOLING WITH THE RETURN FLOW

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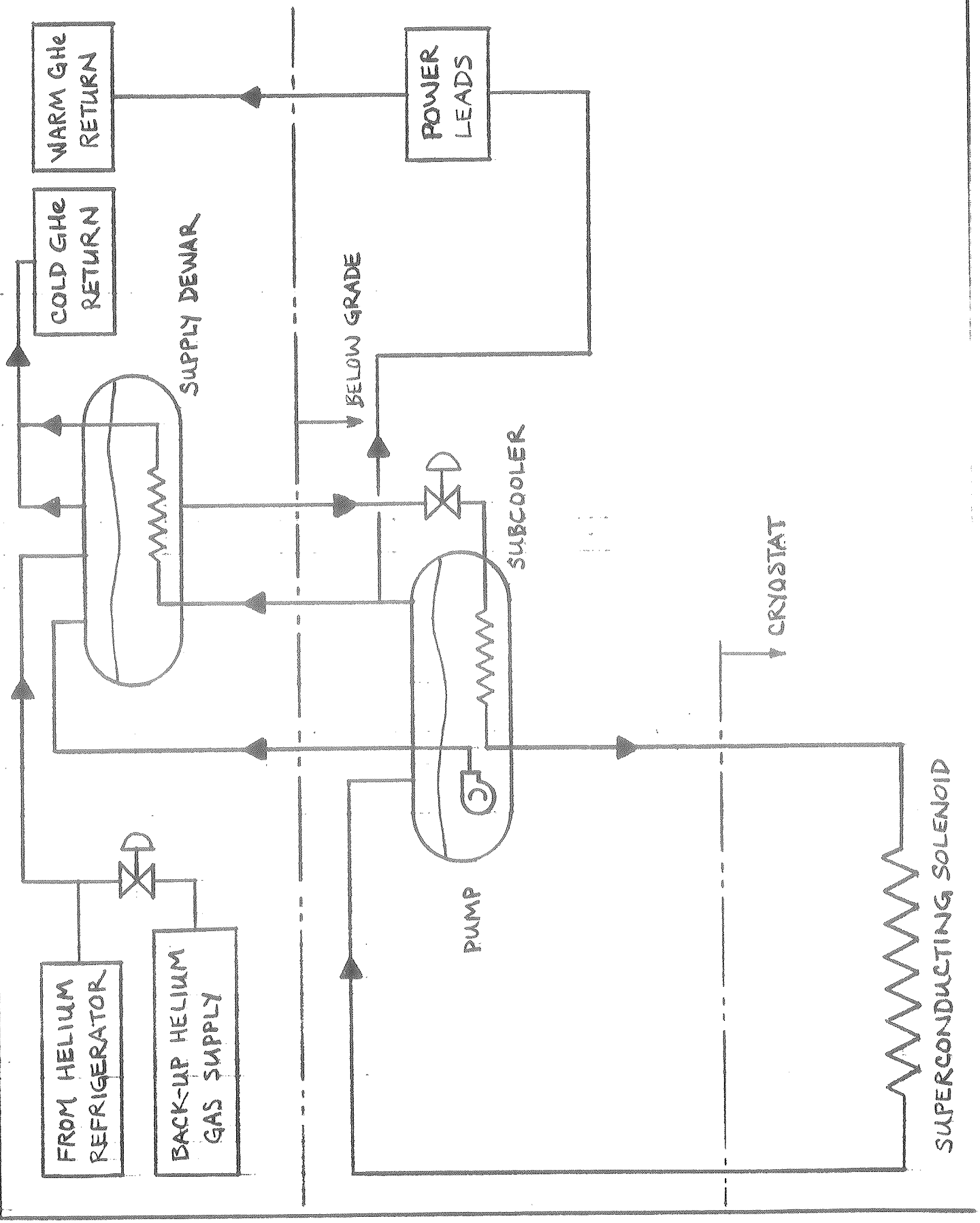

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FIGURE 2: DUAL LOOP SYSTEM WITH SUPPLY DEWAR AND SOLENOID THERMOSIPHON LOOP

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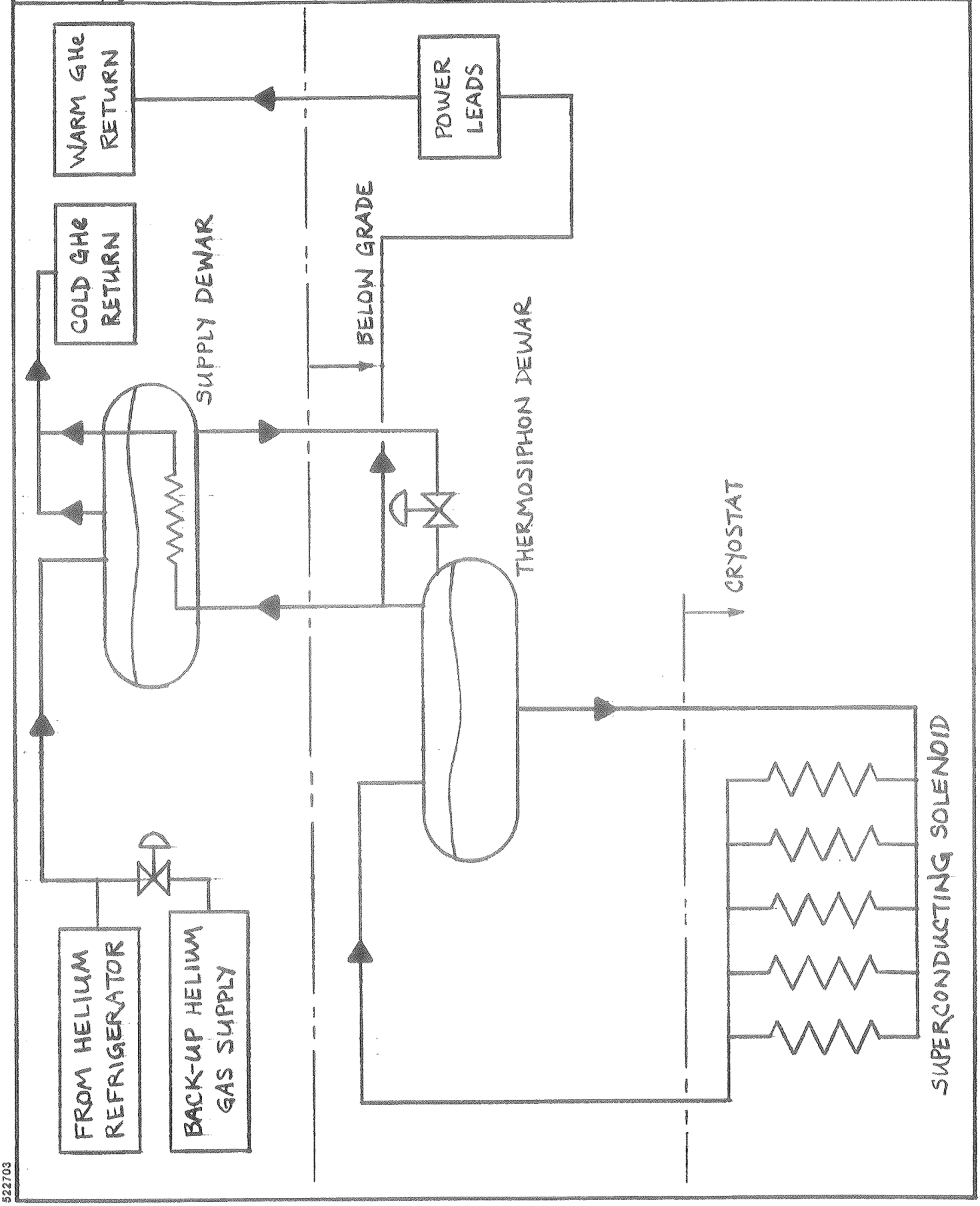

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