Vent Stack
Liquid N2 RTD
Temperature Sensor

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This engineering note documents the installation of two temperature sensing RTD's in the EC's. Previously, the temperature sensing device used in all three cryostats consisted of a FNAL designed liquid sensing probe (see EN-168, and drawing ME-273505). This device was necessary because of the concern that overfilling LN2 into the main vent line during cooldown could create an undesirable back pressure on the relief valves or rupture disks. This could possibly hinder the relieving of argon gas at the required flow rate in a safety situation. The probe was installed on the CC, and has been operating perfectly, therefore, this probe will not be changed. Figure 1 shows the location of TS232E, the CC liquid sensing probe. Note that the probe is located downstream of the condenser outlet valve (PV210N), therefore, it effectively operates under atmospheric pressure.

On the EC's, however, the probe was originally installed at a different location, upstream of the condenser outlet valve (PV110N or PV310N). This resulted in the probe effectively sensing the condenser pressure, which varied from approximately 30 psia to 60 psia during cooldown. The changing pressure meant that the corresponding temperature at which liquid appeared also changed. The probe then became inaccurate, especially at higher condenser pressures, when the probe would fail to trip at the higher liquid temperature.

The solution was to replace the original probe with an RTD. This involved using the PLC to compare the temperature sensed by the RTD to the liquid saturation temperature, calculated using the measured condenser pressure. A formula was created to calculate the saturation temperature from the condenser pressure. This formula was derived by

curve fitting points taken from the NBS Technical Note 129 for nitrogen. A 2nd order equation was used to fit the points, since the accuracy was not very important for temperature comparison. The entire equation was then shifted so that the curve was above all of the actual points. This was done to insure that the formula would provide higher temperatures, so the comparison to the RTD would be conservative, switching before the temperature reached saturation. Figure 2 shows the curve used to fit the data points. The lower curve is the actual data, and the higher curve is the formula to be used.

Using the formula derived, the PLC calculates a conservative saturation temperature from the condenser pressure. The condenser pressure is measured by PT110N or PT310N, on the ECN and ECS, respectively. The transmitters are Rosemount 0-75 psia pressure transmitters. The PLC then compares the calculated temperature to the measured temperature from the RTD's, EI132E and EI332E, which are Omega platinum RTD probes, model #PR-14-2-100-1/4-12-E. If the measured temperature drops below the calculated saturation temperature, an alarm signals on the view page, and the PLC automatically closes the two inlet condenser valves (PV101N and PV102N, or PV301N and PV302N).

As a final note, there are various advantages and disadvantages to using the RTD's instead of the original probe. The advantages are that the RTD's provide constant monitoring of the temperature, whereas the probe was basically designed as a switch. The RTD's are more accurate in that they can respond over the range of the condenser pressure. The probe

was designed to operate under atmospheric pressure. The only disadvantage of the RTD's is that they sense temperature, therefore, they cannot distinguish saturated GN2 from liquid, while the probe was designed specifically to do so. Overall, however, the RTD's provide an acceptable solution to the problem of liquid sensing in the vent line. Figure 3 shows the final location of the RTD on the ECN. The ECS location is the same.

VENT OVERFILL SENSOR

TS 232E

- Vapor Bulb with a Pressure Switch connected to PLC
- SET TO TRSP when Temperature is below 78°F

Fig 1. Location of CC Probe

Fig 2. LN2 Saturation Curve Fit

VENT OVERFILL SENSOR

EI232E

- PLATINUM RESISTOR CONNECTED TO PLC
- SET TO TRIP WHEN PRESSURE & TEMPERATURE INDICATE LN_2 PRESENT.

Fig 3. Location of ECN RTD