TRANSFER LINE BRANCH CONSIDERATIONS FOR SOLENOID & VLPC

D-ZERO ENGINEERING NOTE # 3823.115 - EN- 424

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Approved: ____________________

Transfer Line Branch Issues

The transfer line for the solenoid currently has a dead branch on it. Issues regarding the solenoid transfer line also apply to the VLPC transfer line. Issues that need to be addressed are:

1.) What is the heat load on the branch?

2.) Would it be a good idea to run the LN2 radiation shield on the branch?

3.) What are the thermal acoustic oscillation parameters of a dead headed branch? (A simple remedy, although not analyzed was to install a jumper with a flow restriction at the end of the helium piping to allow a small flow to pass from supply to return. Thus eliminating a stagnant gas volume in which pressure pulses would develop.)

4.) Do we need to have a vapor trap to keep liquid from sloshing back and forth from the cold end to the warm end?

5.) Comment: The tee that passes the 2-phase return into the nested LHe supply/return pipe should be pointed up so that the volume of transfer line acts sort of like a phase separator full of liquid.

There appear to be the following ways we could handle the branch:

A.) **Keep the branch fully cold.** Run enough LHe and LN2 so that the He return and N2 return are close to steady state return values. Could use a u-tube with a manual control valve plus temp sensors placed on the return legs. Could also just incorporate the control valve and temp. sensors into the bayonet box thus eliminating the need and heat leak of u-tubes.

B.) **Keep the branch warm.** No flows of LHe or LN2. Possible variations would include vapor traps or check valves.

C.) **Something in-between.** Allow some flow in the branch to keep stagnant gas from causing thermal acoustic oscillation

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Heat Load
What is the heat load for option A?

When running in the collision hall, the branch in question is the assembly hall branch. There would be approximately 8 feet of transfer line plus a control valve.

Heat load to LHe: 16 feet*1 W/100ft + 0.66 W =0.16W + 0.66 W = **0.8 W**, no u-tube.

Heat load to LHe: 16 feet*1 W/100ft + 1.0 W + 4.3 W = 5.5 W, with valve in u-tube.

Heat load to LN2: 16 feet *0.4 W/ft + 3 W (shield in can) + 0.6 W (valve) = **10 W**, no u-tube. Add 3 W if using a u-tube with the valve in it.

When running in the assembly hall, the bayonet box in the assembly hall is roughly 80 feet from the branch tee. By the same formulas above:

Heat load to LHe = **2.3 W**, no u-tube, add 4.7 W if using u-tube w/ valve.

Heat load to LN2 = **67.6W**, no u-tube, add 3 W if using a u-tube.

What is the heat load for option B or C?

First look at thermal acoustic oscillation which could be up to 1000 times the heat leak of normal conduction. [Reference "Technology of Liquid Helium"] Slenderness ratio:
L/D= 8 feet*12 in/ft / 0.555 inch ID = 173 for ass'y hall branch He supply
L/D=8 feet*12 in/ft / 1.0 inch Hydraulic dia. = 96 for ass'y hall branch He return
L/D= 80 feet*12 in/ft / 0.555 inch ID = 1730 for coll. hall branch He supply
L/D=80 feet*12 in/ft / 1.0 inch Hydraulic dia. = 960 for coll. hall branch He return

From fig. 5.16 Pressure amplitude (atm. * 10^3) is:

Pmax= 18 for ass'y hall branch He supply
Pmax= 5 for ass'y hall branch He return
Pmax= > 70, extrapolate to 200? for coll. hall branch He supply
Pmax= > 70, extrapolate to 150? for coll. hall branch He return

Can't calculate heat loads from this unless I know the frequency of oscillation.

Conclusion

It is very difficult to predict the behavior of the dead ended branch. Therefore the conservative thing to do is to keep the Branch cold as in option A. Use a valve inside the bayonet box for the LHe. Due to space constraints, use a valve and u-tube arrangement for the LN2. The additional heat leak from keeping the section cold is very reasonable. The heat load to LHe is 0.8 W or 2.3 W and to LN2 is 13 W or 71 W when the detector is run in the collision hall or assembly hall respectively. To prevent thermal acoustic oscillation from occurring in the dead ended female bayonets, we can install male bayonet vacuum plugs. The heat load to the system and behavior of such an arrangement will not provide any surprises, unlike a dead ended branch. It also allows flexibility's such as running the helium refrigeration plant without the detector for tests or for precooling the return lines during cooldown, just to name a few. The LHe control valves should have actuators and be able to be remotely controlled. The LN2 valves can be simple manual valves that will probably not be adjusted after their initial setting.