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Accelerator Development Department

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SSC INTERCONNECT PRESSURE DROP

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1. INTRODUCTION

Pressure drops across the SSC interconnect region are computed for the SSC interconnect design using small bellows. There are two such bellows in the interconnect region which are internally pressurized with helium at 4 K. These bellows are internally lined with antisquirm cans since they are unstable as a result of the very low axial stiffnesses required to accommodate the 2 in motion due to thermal extension and contraction of the magnets. The case where the bellows are unlined is also considered in these calculations in order to evaluate the effect of bellows corrugations on the flow. This comparison is of interest if an external squirm can is used instead of an internal one to prevent possible jamming: since the internal can does not fully cover the convolutions when magnets are cold, it might not find its way back into the housing when magnets are warm. The following asymmetries between top and bottom bellows interconnect helium passages are included in the calculations:

. the top passage contains the bus work and a 3 in long splice

. the bottom passage contains instrumentation

Three cases for mass flow were considered: 100, 1000, and 2000 g/sec. In the last two cases corresponding to quenches the helium temperature changes from 4 K to 5 K and pressure increases cause helium density to rise. However the temperature is assumed to remain constant at 4 K for simplicity. Effects of temperature rise during a quench can be estimated by increasing pressure drops by 10 to 15 %.

Pressure drop due to friction only

$$\Delta p_f = \frac{10^{-6}}{2\rho}\left(0.0014 + \frac{0.125}{Re^{0.32}}\right)\frac{fl}{r_h}\left(\frac{M}{a}\right)^2$$

pipe to tank or tank to pipe transition

$$\Delta p_t \simeq \frac{10^{-6}}{2\rho}\left(\frac{M}{a}\right)^2$$

Pressure drop due to pipe to bellows or bellows to pipe transition (a_p : pipe cross-section available to flow, a_s:bellows cross-section).

$$\Delta p_t = \frac{10^{-6}}{2\rho}M^2\left(1/a_p^2 - 1/a_s^2\right)$$

Pressure drop due to bellows corrugations (a_{sm} maximum bellows cross section).

$$\Delta p_c = \frac{10^{-6}}{2\rho}\left(\frac{M}{a_s}\right)^2 2N\left(1 - \frac{a_s^2}{a_{sm}^2}\right)$$

5. RESULTS

For the three cases of mass flow considered table 1 shows the components of the total pressure drop across top and bottom interconnect passages. Bus wo[illegible] instrumentation and splice dimensions are shown in table 2. Total pressure drops for the lined and [illegible]lined cases can be compared to the drop across a magnet including end plates at both ends. It should be noted that the only asymmetry between top and bottom is due to the presence of the splice since bus and instrumentation are of equal areas. This causes a total mass flow (Fig.2) of 100 g/sec to split into 44 and 56 g/sec as indicated in the last line of table 1. For total mass flows of 1000 (Fig.3) and 2000 g/sec (Fig.4), top and bottom mass flows are split in approximately the same ratios.

The pressure drop across the interconnect is about 20% of the pressure drop across the magnet if M=100 g/sec and 25% when M=1000 and 2000 g/sec. A worst case where bus and instrumentation areas are equal to the splice is also shown (Fig.5): the pressure drop across the interconnect amounts to 42 % of the drop across the magnet. These results are based on assumed cross-sections for bus, instrumentation and splice and can be altered to reflect actual dimensions when they become available.

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SSC interconnect pressure drop, mass flow g/sec: 100.0

Table 1: Δp (atm) interconnection

pressure drop	upper interconnect	lower interconnect
tank to pipe	1.952E-05	3.156E-05
friction pipe w/o splice	2.966E-06	4.559E-06
friction pipe with splice	3.087E-06	1.097E-06
bus to splice	2.773E-05	0.000E+00
splice to bus	2.773E-05	0.000E+00
pipe to lined bellows	1.715E-05	2.774E-05
pipe to unlined bellows	1.755E-05	2.869E-05
friction lined bellows	1.470E-07	2.257E-07
unlined bellows	1.258E-05	2.057E-05
lined bellows to pipe	1.715E-05	2.774E-05
unlined bellows to pipe	1.755E-05	2.869E-05
friction pipe	1.977E-06	3.040E-06
pipe to tank	1.952E-05	3.156E-05
mass flow g/s	43.8	56.1

Table 2: Total pressure drops (atm)

bus	splice	instr	interc lined bellows	interc unlined bellows	dipole bypass
4.6× 2.7	4.4× 4.4	4.6× 2.7	1.370E-04	1.502E-04	6.926E-04

Figure 2.

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SSC interconnect pressure drop, mass flow g/sec:2000.0

Table 1: Δp (atm) interconnection

pressure drop	upper interconnect	lower interconnect
tank to pipe	7.732E-03	1.261E-02
friction pipe w/o splice	6.934E-04	1.094E-03
friction pipe with splice	7.359E-04	2.707E-04
bus to splice	1.099E-02	0.000E+00
splice to bus	1.099E-02	0.000E+00
pipe to lined bellows	6.796E-03	1.108E-02
pipe to unlined bellows	7.032E-03	1.146E-02
friction lined bellows	3.378E-05	5.320E-05
unlined bellows	5.041E-03	8.217E-03
lined bellows to pipe	6.796E-03	1.108E-02
unlined bellows to pipe	7.032E-03	1.146E-02
friction pipe	4.622E-04	7.291E-04
pipe to tank	7.732E-03	1.261E-02
mass flow g/s	878.5	1121.5

Table 2: Total pressure drops (atm)

bus	splice	instr	interc lined bellows	interc unlined bellows	dipole bypass
4.6× 2.7	4.4× 4.4	4.6× 2.7	5.296E-02	5.843E-02	2.236E-01

Figure 4.

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