v. Pressure Drop of Magnets and Distribution System

As mentioned in the introduction, the flow in the loop through the magnets will be driven by a circulating compressors in each loop. Because the work which these compressors perform on the helium is part of the load seen by the refrigerator, it is important that the work input be minimized. The work is a direct function of the pressure drop in the loop which is the output head required from the compressor. In order to maximize the efficiency of the compressors it is necessary to specify the range of operating conditions that will be encountered in RHIC operations. For this reason a pressure drop budget has been established and must be adhered to when designing components in the flow loop.

Table 3-9 shows the calculated pressure drops for flow through a model of one RHIC ring. Each component which is known to contribute to the pressure drop has been shown with its budgeted allowance for pressure drop. No safety margins are included in these figures, and they represent expected baseline performance with the minimum flow in any magnet at 100 g/s. It can be seen that the pressure drop for these six sextants is estimated to be about 0.5 bar. A similar table has been developed for the same section of the collider ring but for the high heat model conditions, i.e., minimum flow rate is 150 g/s. Under these conditions the estimated pressure drop is about 1.0 bar.

Table 3-9. RHIC Circulating Compressor Loop Through 1 Ring - 6 Sextants in Series

MAG IC:2.5"+3" TUBE WITH LEADS AND SPLICE, 2" CVI ISOLATION VALVES,3 1/2"SCH5-I
NOM FLOW = 100 g/s MAGNET LENGTH = 2X TO ADJUST FOR 2X FRICTION FACTOR

	INPUT DATA							CALCULATED DATA			DESCRIPTION
SEC NO.	P_{IN} bar	F_{IN} g/s	T_{IN} K	T_{OUT} K	LEN m	DIA cm	# VEL HEADS	FRIC DROP bar	VEL DROP bar	P_{OUT} bar	
1	5.00	118.0	4.50	4.50	5.0	5.70	10.0	.000	.001	5.00	FEED FROM CIRC COMPR
2	5.00	118.0	4.50	4.50	.0	5.08	4.1	.000	.001	5.00	CVI 2" VALVE
3	5.00	118.0	4.50	4.50	2.0	10.00	2.0	.000	.000	5.00	LEAD POT
4	5.00	9.6	4.50	4.30	9.5	1.60	10.0	.001	.001	5.00	225W RECOOL(.63"X12)
5	5.00	57.5	4.30	4.30	14.0	3.81	12.0	.000	.001	5.00	Q1,Q2,Q3 (2@1.5"SQ)
6	5.00	115.0	4.30	4.30	98.4	4.97	10.0	.000	.000	5.00	Q3-Q4 W LEADS
7	5.00	28.8	4.30	4.40	845.2	3.00	296.0	.025	.017	4.95	636 M RING (68 MAGS)
8	4.95	57.5	4.40	4.40	14.0	3.81	12.0	.000	.001	4.95	Q1,Q2,Q3 (2@1.5"SQ)
9	4.95	73.7	4.50	4.50	75.9	4.26	70.0	.000	.001	4.95	3" W.LEAD(A=35.25)
10	4.95	73.7	4.50	4.50	8.5	3.55	1.4	.000	.000	4.95	3" W.SPLICE(A=31.62)
11	4.95	11.5	4.50	4.30	2.5	1.10	10.0	.002	.005	4.94	50W RECOOL(.43"X10)
12	4.94	11.5	4.50	4.30	2.5	1.10	10.0	.002	.005	4.94	50W RECOOL(.43"X10)
13	4.94	11.5	4.50	4.30	2.5	1.10	10.0	.002	.005	4.93	50W RECOOL(.43"X10)
14	4.93	11.5	4.50	4.30	2.5	1.10	10.0	.002	.005	4.92	50W RECOOL(.43"X10)
15	4.92	11.5	4.50	4.30	2.5	1.10	10.0	.002	.005	4.92	50W RECOOL(.43"X10)
16	4.92	115.0	4.30	4.30	78.0	4.97	30.0	.000	.000	4.91	SEXT CONN
17	4.91	115.0	4.50	4.50	.0	5.08	4.1	.000	.000	4.91	CVI 2" VALVE
18	4.91	115.0	4.50	4.50	2.0	10.00	2.0	.000	.000	4.91	LEAD POT
19	4.91	9.3	4.50	4.30	9.5	1.60	10.0	.001	.001	4.91	225W RECOOL(.63"X12)
20	4.91	55.0	4.30	4.30	14.0	3.81	12.0	.000	.001	4.91	Q1,Q2,Q3 (2@1.5"SQ)
21	4.91	112.0	4.50	4.50	98.4	4.97	10.0	.000	.000	4.91	Q3-Q4 W LEADS
22	4.91	28.0	4.30	4.40	845.0	3.00	296.0	.024	.017	4.87	636 M RING (68 MAGS)
23	4.87	56.0	4.40	4.40	14.0	3.81	12.0	.000	.001	4.87	Q1,Q2,Q3 (2@1.5"SQ)
24	4.87	71.8	4.50	4.50	75.9	4.26	70.0	.000	.001	4.87	3" W.LEAD(A=35.25)
25	4.87	71.8	4.50	4.50	8.5	3.55	1.4	.000	.000	4.87	3" W.SPLICE(A=31.62)
26	4.87	11.2	4.50	4.30	2.5	1.10	10.0	.002	.005	4.86	50W RECOOL(.43"X10)

Table 3-9. RHIC Circulating Compressor Loop Through 1 Ring - 6 Sextants in Series (continued)

	INPUT DATA							CALCULATED DATA			DESCRIPTION
SEC NO.	P_{IN} bar	F_{IN} g/s	T_{IN} K	T_{OUT} K	LEN m	DIA cm	# VEL HEADS	FRIC DROP bar	VEL DROP bar	P_{OUT} bar	
27	4.86	11.2	4.50	4.30	2.5	1.10	10.0	.002	.005	4.86	50W RECOOL(.43"X10)

Table 3-9. RHIC Circulating Compressor Loop Through 1 Ring - 6 Sextants in Series (continued)

	INPUT DATA							CALCULATED DATA			DESCRIPTION
SEC NO.	P_{IN} bar	F_{IN} g/s	T_{IN} K	T_{OUT} K	LEN m	DIA cm	# VEL HEADS	FRIC DROP bar	VEL DROP bar	P_{OUT} bar	
28	4.86	11.2	4.50	4.30	2.5	1.10	10.0	.002	.005	4.85	50W RECOOL(.43"X10)
29	4.85	11.2	4.50	4.30	2.5	1.10	10.0	.002	.005	4.84	50W RECOOL(.43"X10)
30	4.84	11.2	4.50	4.30	2.5	1.10	10.0	.002	.005	4.84	50W RECOOL(.43"X10)
31	4.84	112.0	4.30	4.30	78.0	4.97	30.0	.000	.000	4.83	SEXT CONN
32	4.83	112.0	4.50	4.50	.0	5.08	4.1	.000	.000	4.83	CVI 2" VALVE
33	4.83	112.0	4.50	4.50	2.0	10.00	2.0	.000	.000	4.83	LEAD POT
34	4.83	9.1	4.50	4.30	9.5	1.60	10.0	.001	.001	4.83	225W RECOOL(.63"X12)
35	4.83	54.5	4.30	4.30	14.0	3.81	12.0	.000	.001	4.83	Q1,Q2,Q3 (2@1.5"SQ)
36	4.83	109.0	4.50	4.50	98.4	4.97	10.0	.000	.000	4.83	Q3-Q4 W LEADS
37	4.83	27.3	4.30	4.40	845.0	3.00	296.0	.022	.016	4.79	636 M RING (68 MAGS)
38	4.79	54.5	4.40	4.40	14.0	3.81	12.0	.000	.001	4.79	Q1,Q2,Q3 (2@1.5"SQ)
39	4.79	66.9	4.50	4.50	75.9	4.26	70.0	.000	.001	4.79	3" W.LEAD(A=35.25)
40	4.79	66.9	4.50	4.50	8.5	3.55	1.4	.000	.000	4.79	3" W.SPLICE(A=31.62)
41	4.79	10.9	4.50	4.30	2.5	1.10	10.0	.002	.005	4.78	50W RECOOL(.43"X10)
42	4.78	10.9	4.50	4.30	2.5	1.10	10.0	.002	.005	4.78	50W RECOOL(.43"X10)
43	4.78	10.9	4.50	4.30	2.5	1.10	10.0	.002	.005	4.77	50W RECOOL(.43"X10)
44	4.77	10.9	4.50	4.30	2.5	1.10	10.0	.002	.005	4.77	50W RECOOL(.43"X10)
45	4.77	10.9	4.50	4.30	2.5	1.10	10.0	.002	.005	4.76	50W RECOOL(.43"X10)
46	4.76	109.0	4.30	4.30	78.0	4.97	30.0	.000	.000	4.76	SEXT CONN
47	4.76	109.0	4.50	4.50	.0	5.08	4.1	.000	.000	4.76	CVI 2" VALVE
48	4.76	109.0	4.50	4.50	2.0	10.00	2.0	.000	.000	4.76	LEAD POT
49	4.76	8.8	4.50	4.30	9.5	1.60	10.0	.001	.001	4.76	225W RECOOL(.63"X12)
50	4.76	53.0	4.30	4.30	14.0	3.81	12.0	.000	.001	4.76	Q1,Q2,Q3 (2@1.5"SQ)
51	4.76	106.0	4.30	4.30	98.4	4.97	10.0	.000	.000	4.76	Q3-Q4 W LEADS
52	4.76	26.5	4.30	4.40	845.0	3.00	296.0	.021	.015	4.72	636 M RING (68 MAGS)
53	4.72	53.0	4.40	4.40	14.0	3.81	12.0	.000	.001	4.72	Q1,Q2,Q3 (2@1.5"SQ)
54	4.72	65.2	4.50	4.50	75.9	4.26	70.0	.000	.001	4.72	3" W.LEAD(A=35.25)
55	4.72	65.2	4.50	4.50	8.5	3.55	1.4	.000	.000	4.72	3" W.SPLICE(A=31.62)

Table 3-9. RHIC Circulating Compressor Loop Through 1 Ring - 6 Sextants in Series (continued)

	INPUT DATA							CALCULATED DATA			DESCRIPTION
SEC NO.	P_{IN} bar	F_{IN} g/s	T_{IN} K	T_{OUT} K	LEN m	DIA cm	# VEL HEADS	FRIC DROP bar	VEL DROP bar	P_{OUT} bar	
56	4.72	10.6	4.50	4.30	2.5	1.10	10.0	.002	.004	4.71	50W RECOOL(.43"X10)
57	4.71	10.6	4.50	4.30	2.5	1.10	10.0	.002	.004	4.71	50W RECOOL(.43"X10)
58	4.71	10.6	4.50	4.30	2.5	1.10	10.0	.002	.004	4.70	50W RECOOL(.43"X10)
59	4.70	10.6	4.50	4.30	2.5	1.10	10.0	.002	.004	4.69	50W RECOOL(.43"X10)
60	4.69	10.6	4.50	4.30	2.5	1.10	10.0	.002	.004	4.69	50W RECOOL(.43"X10)
61	4.69	106.0	4.30	4.30	78.0	4.97	30.0	.000	.000	4.69	SEXT CONN
62	4.69	106.0	4.50	4.50	.0	5.08	4.1	.000	.000	4.69	CVI 2" VALVE
63	4.69	106.0	4.50	4.50	2.0	10.00	2.0	.000	.000	4.69	LEAD POT
64	4.69	8.6	4.50	4.30	9.5	1.60	10.0	.001	.001	4.69	225W RECOOL(.63"X12)
65	4.69	51.5	4.30	4.30	14.0	3.81	12.0	.000	.001	4.68	Q1,Q2,Q3 (2@1.5"SQ)
66	4.68	103.0	4.50	4.50	98.4	4.97	10.0	.000	.000	4.68	Q3-Q4 W LEADS
67	4.68	25.8	4.30	4.40	790.0	3.00	284.0	.019	.014	4.65	636 M RING (68 MAGS)
68	4.65	51.5	4.40	4.40	14.0	3.81	12.0	.000	.001	4.65	Q1,Q2,Q3 (2@1.5"SQ)
69	4.65	62.7	4.50	4.50	75.9	4.26	70.0	.000	.001	4.65	3" W.LEAD(A=35.25)
70	4.65	62.7	4.50	4.50	8.5	3.55	1.4	.000	.000	4.65	3" W.SPLICE(A=31.62)
71	4.65	10.3	4.50	4.30	2.5	1.10	10.0	.001	.004	4.64	50W RECOOL(.43"X10)
72	4.64	10.3	4.50	4.30	2.5	1.10	10.0	.001	.004	4.64	50W RECOOL(.43"X10)
73	4.64	10.3	4.50	4.30	2.5	1.10	10.0	.001	.004	4.63	50W RECOOL(.43"X10)
74	4.63	10.3	4.50	4.30	2.5	1.10	10.0	.001	.004	4.63	50W RECOOL(.43"X10)
75	4.63	10.3	4.50	4.30	2.5	1.10	10.0	.001	.004	4.62	50W RECOOL(.43"X10)
76	4.62	103.0	4.30	4.30	78.0	4.97	30.0	.000	.000	4.62	SEXT CONN
77	4.62	103.0	4.50	4.50	.0	5.08	4.1	.000	.000	4.62	CVI 2" VALVE
78	4.62	103.0	4.50	4.50	2.0	10.00	2.0	.000	.000	4.62	LEAD POT
79	4.62	8.3	4.50	4.30	9.5	1.60	10.0	.001	.001	4.62	225W RECOOL(.63"X12)
80	4.62	50.0	4.30	4.30	14.0	3.81	12.0	.000	.001	4.62	Q1,Q2,Q3 (2@1.5"SQ)
81	4.62	100.0	4.50	4.50	98.4	4.97	10.0	.000	.000	4.62	Q3-Q4 W LEADS
82	4.62	100.0	4.50	4.50	26.2	4.97	10.0	.000	.000	4.62	Q7-D8 W LEADS
83	4.62	25.0	4.30	4.40	835.0	3.00	292.0	.019	.013	4.59	636 M RING (67 MAGS)

Table 3-9. RHIC Circulating Compressor Loop Through 1 Ring - 6 Sextants in Series (continued)

	INPUT DATA							CALCULATED DATA			DESCRIPTION
SEC NO.	P_{IN} bar	F_{IN} g/s	T_{IN} K	T_{OUT} K	LEN m	DIA cm	# VEL HEADS	FRIC DROP bar	VEL DROP bar	P_{OUT} bar	
84	4.59	50.0	4.40	4.40	14.0	3.81	12.0	.000	.001	4.58	Q1,Q2,Q3 (2@1.5"SQ)
85	4.58	60.0	4.50	4.50	55.9	4.26	68.2	.000	.001	4.58	3" W.LEAD(A=35.25)
86	4.58	60.0	4.50	4.50	8.5	3.55	1.4	.000	.000	4.58	3" W.SPLICE(A=31.62)
87	4.58	10.0	4.50	4.30	2.5	1.10	10.0	.001	.004	4.58	50W RECOOL(.43"X10)
88	4.58	10.0	4.50	4.30	2.5	1.10	10.0	.001	.004	4.57	50W RECOOL(.43"X10)
89	4.57	10.0	4.50	4.30	2.5	1.10	10.0	.001	.004	4.57	50W RECOOL(.43"X10)
90	4.57	10.0	4.50	4.30	2.5	1.10	10.0	.001	.004	4.56	50W RECOOL(.43"X10)
91	4.56	10.0	4.50	4.30	2.5	1.10	10.0	.001	.004	4.56	50W RECOOL(.43"X10)
92	4.56	100.0	4.30	4.30	78.0	4.97	30.0	.000	.000	4.56	SEXT CONN
93	4.56	100.0	4.50	4.50	.0	5.08	4.1	.000	.000	4.56	CVI 2" VALVE
94	4.56	100.0	4.50	4.50	5.0	5.70	10.0	.000	.001	4.56	FEED TO CIRC COMPR

TOTAL PRESSURE DROP OVER ALL SECTIONS = .445 ATM