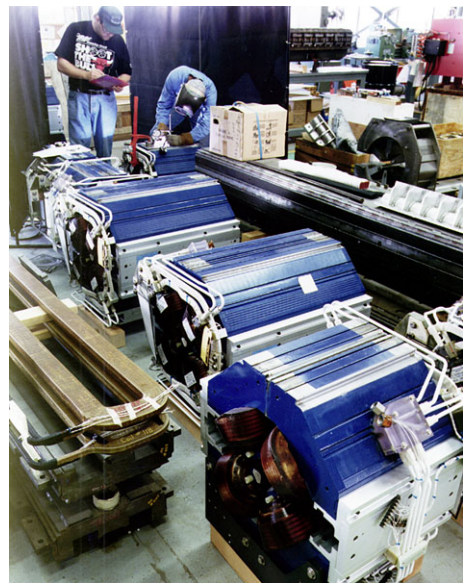
Storage Ring Quadrupole Magnets

There are 400 quadrupole magnets in the storage ring. There are one of each quadrupole magnet in each sector identified as followed: AQ1, AQ2, AQ3, AQ4, AQ5, BQ5, BQ4, BQ3, BQ2, and BQ1. There are three lengths of quadrupole magnets in the storage ring (0.5 m, 0.6 m, and 0.8 m). The AQ1, AQ3, AQ4, BQ4, BQ3, and BQ1 are 0.5 m long magnets. The AQ2 and BQ2 are 0.8 m long magnets. And the AQ5 and BQ5 are 0.6 m long magnets. There are a total of eight different magnet configurations. These configurations are shown in figures 1 through 8.

In addition to these quadrupole magnets there are also nineteen skewed quadrupole magnets in the storage ring. Skewed quadrupole magnets are quadrupole magnets rotated 45°. These magnets are identified as AQS or BQS and are located in the odd sectors from 3 through 39. The AQS skew quadrupole magnet is shown in figure 9.



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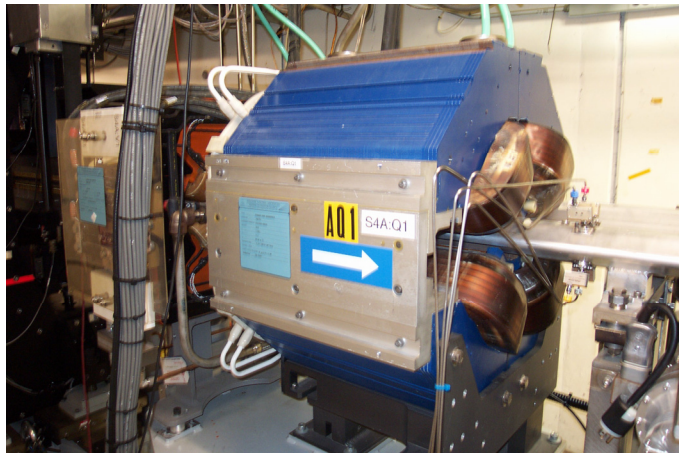
Storage Ring Quadrupole Magnets

Parameters for the Storage Ring Qudrupole Magnets

	Q2	Q5	Q1,Q3,Q4	
Number Required	80	80	240	
Strength at 7.0 GeV	18.9	18.9	18.9	T/m
Effective Length	0.8	0.6	0.5	m
Gap Height or Diameter	80	80	80	mm
Total mass of Magnet	1815	1374	1153	kg
Beam stay clear				
Horizontal	±35.0	±35.0	±35.0	mm
Vertical	±20.0	±20.0	±20.0	mm
Coils per Pole	1	1	1	
Conductor				
Height	11.5	11.5	11.5	mm
Width	11.5	11.5	11.5	mm
Hole Diameter	6.3	6.3	6.3	mm
Number of Turns per Pole	32	32	32	
Total Inductance	27	20	17	mH
Total Resistance	44	35	30	mΩ
Time Constant	614	571	567	ms
Peak Current	412	412	412	A
Current Density in Coil	2.6	2.6	2.6	A/mm^2
Voltage	18.3	14.3	12.3	V
Power	7.5	5.9	5.1	kW
Cooling Water Circuits per Magnet	4	4	4	
Total Water Flow	2.8*	3.2*	3.4*	gpm
Water Pressure Drop	40*	40*	40*	psi
Water Temperature Rise	13*	9*	7*	°C

*Will be redesigned at 80 psi

Storage Ring Quadrupole Magnets



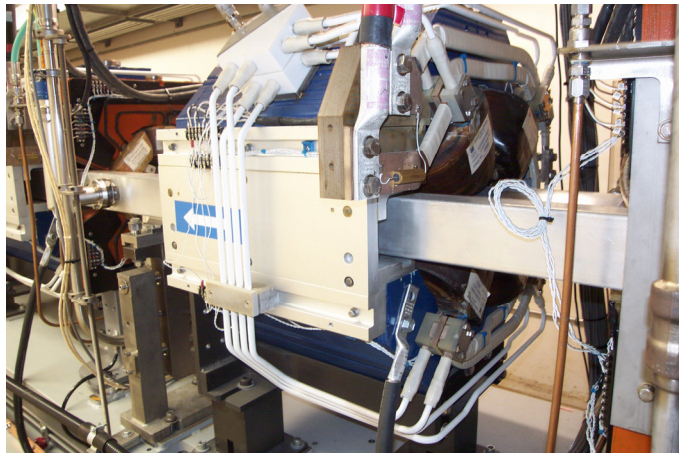
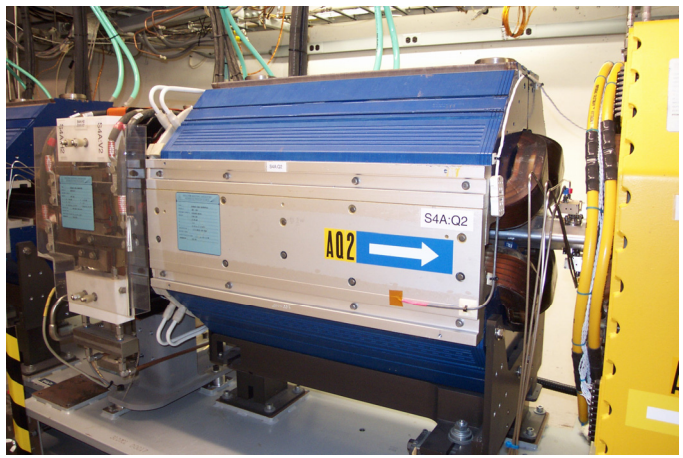


Figure1: AQ1 (31010203-00029) Quadrupole Magnet (0.5 m) is shown. The AQ3 and BQ4 are identical to this magnet.



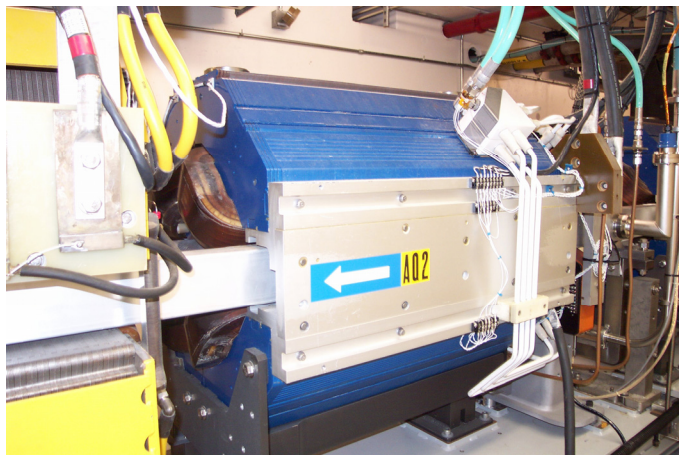


Figure2: AQ2 (31010201-00101) Quadrupole Magnet (0.8 m)

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Storage Ring Quadrupole Magnets

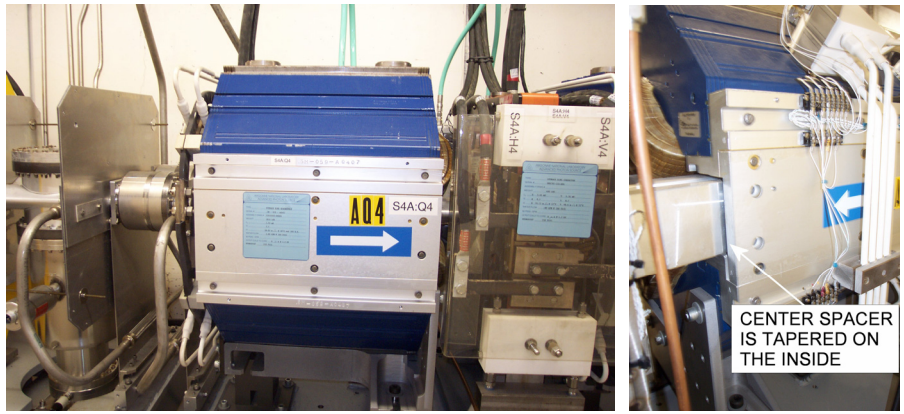


Figure3: AQ4 (31010203-00031) Quadrupole Magnet (0.5 m). Notice the center spacer is tapered on the inside to clear the vacuum chamber.

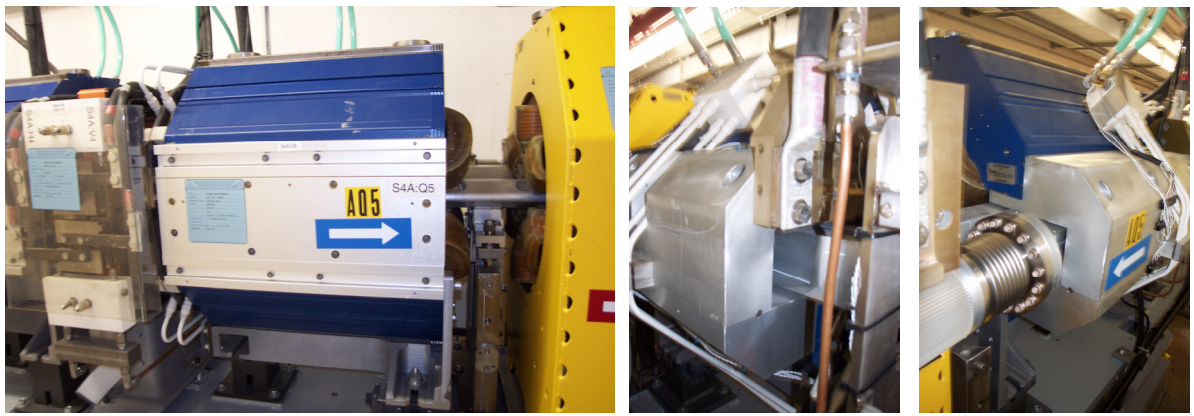


Figure4: AQ5 (31010202-00027) Quadrupole Magnet (0.6 m). Notice the special center spacer that straddles the vacuum chamber. Also notice the special cooling tubes around the center spacer.

Storage Ring Quadrupole Magnets

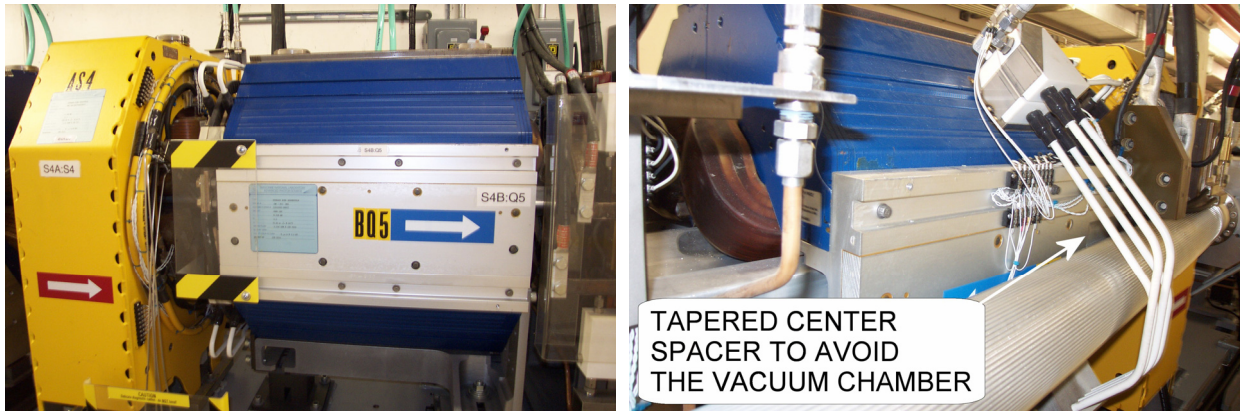


Figure5: BQ5 (31010202-00028) Quadrupole Magnet (0.6 m). Notice the tapered center spacer that clears the vacuum chamber. Also notice the special cooling tubes around the vacuum chamber.

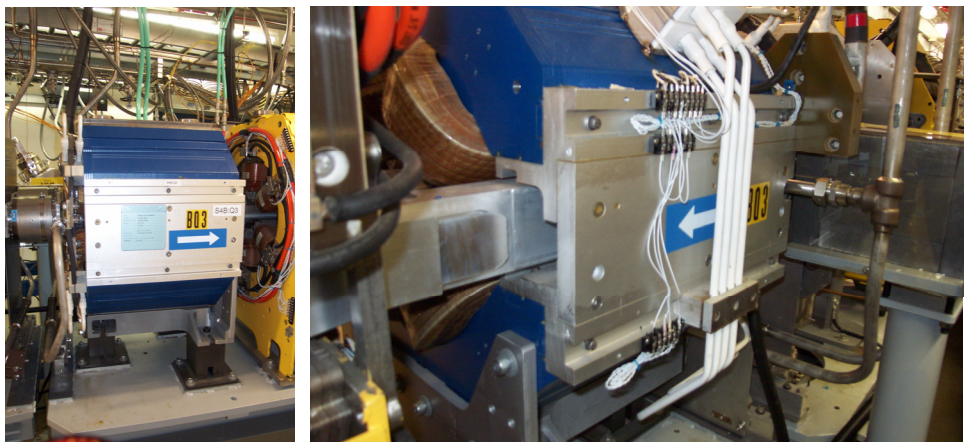


Figure6: BQ3 (31010203-500000) Quadrupole Magnet (0.5 m). Notice the slot in the center spacer to clear the cooling pipe.

Storage Ring Quadrupole Magnets

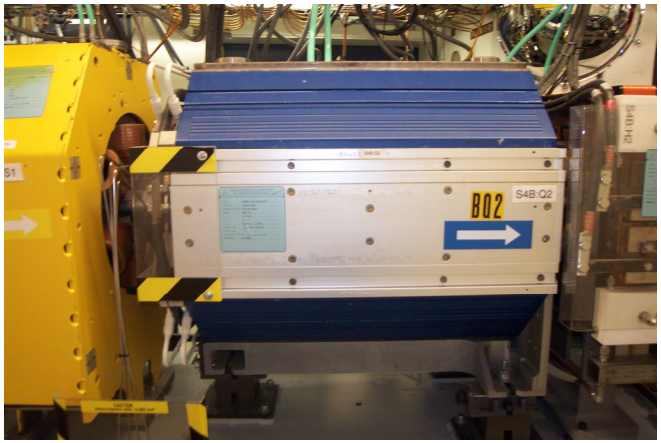
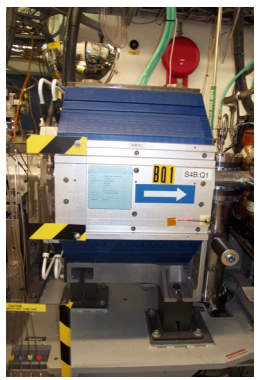


Figure7: BQ2 (31010201-00102) Quadrupole Magnet (0.8 m). Also notice the special cooling tubes around the center spacer.



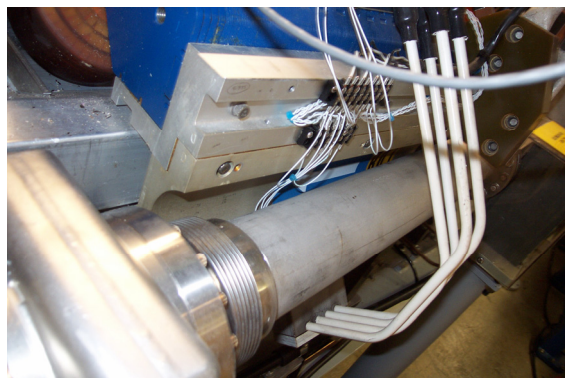
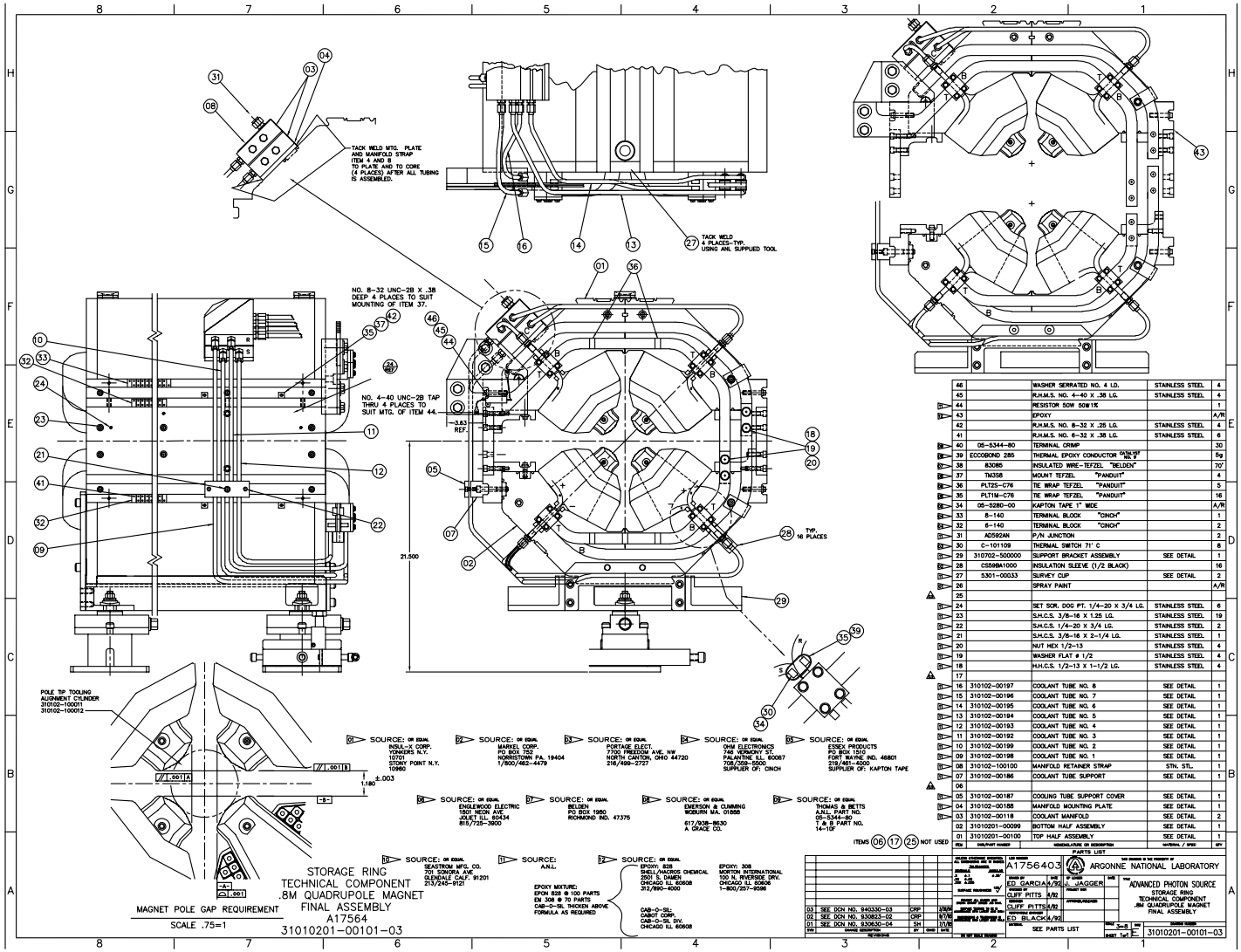


Figure8: BQ1 (31010203-00030) Quadrupole Magnet (0.5 m). Notice the radial cut out of the center spacer to clear the vacuum chamber. Also notice the special cooling tubes around the vacuum chamber.

Storage Ring Quadrupole Magnets



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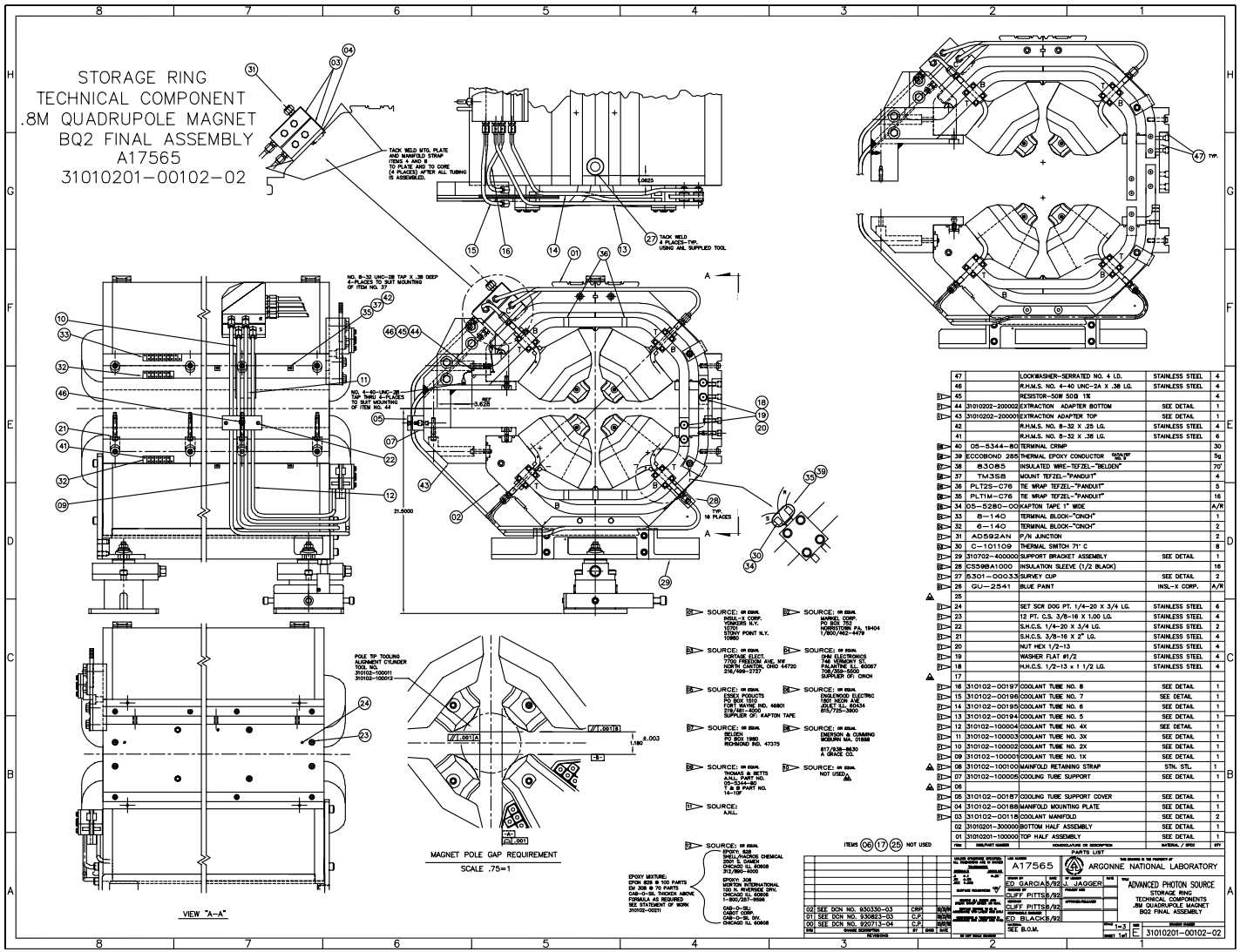

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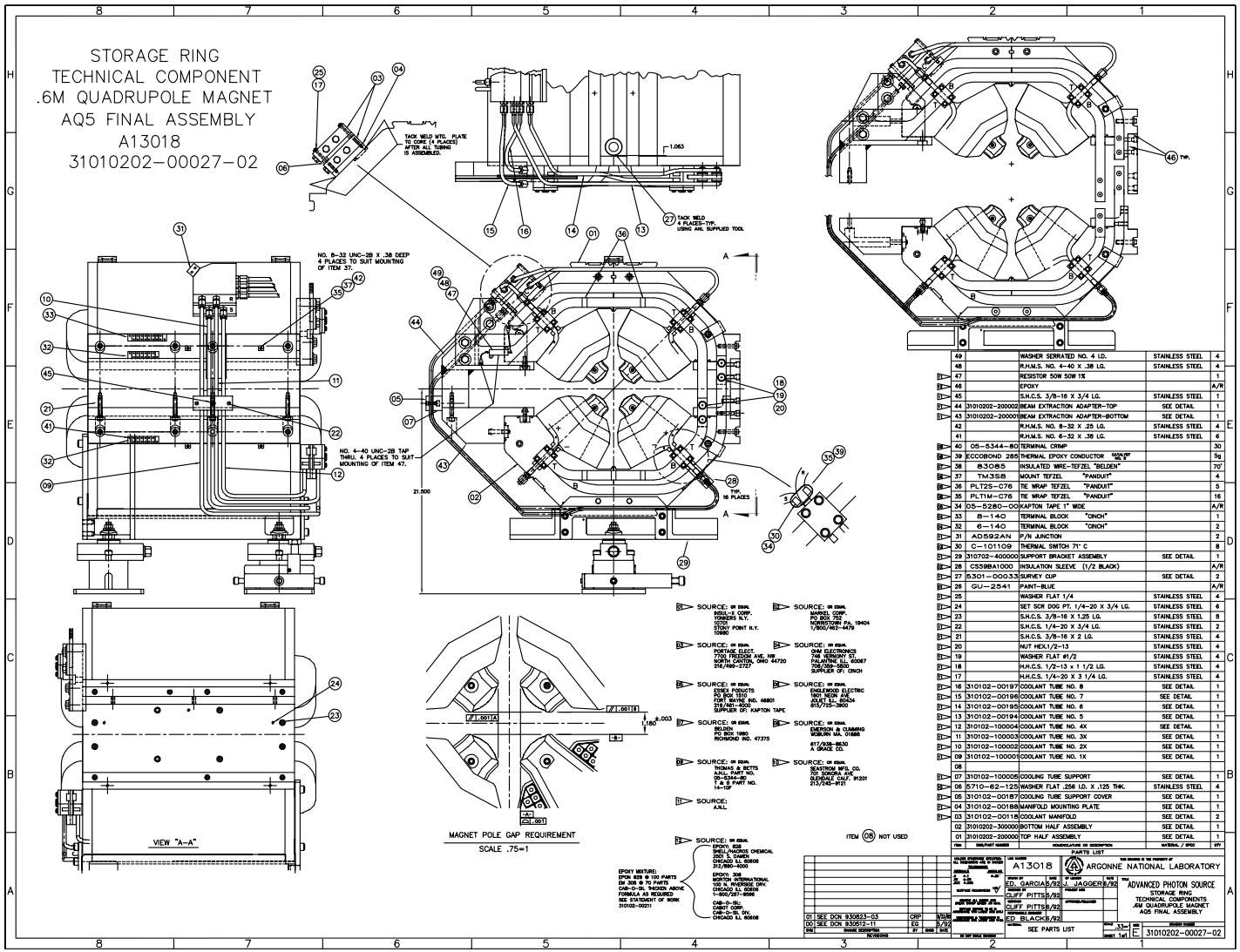

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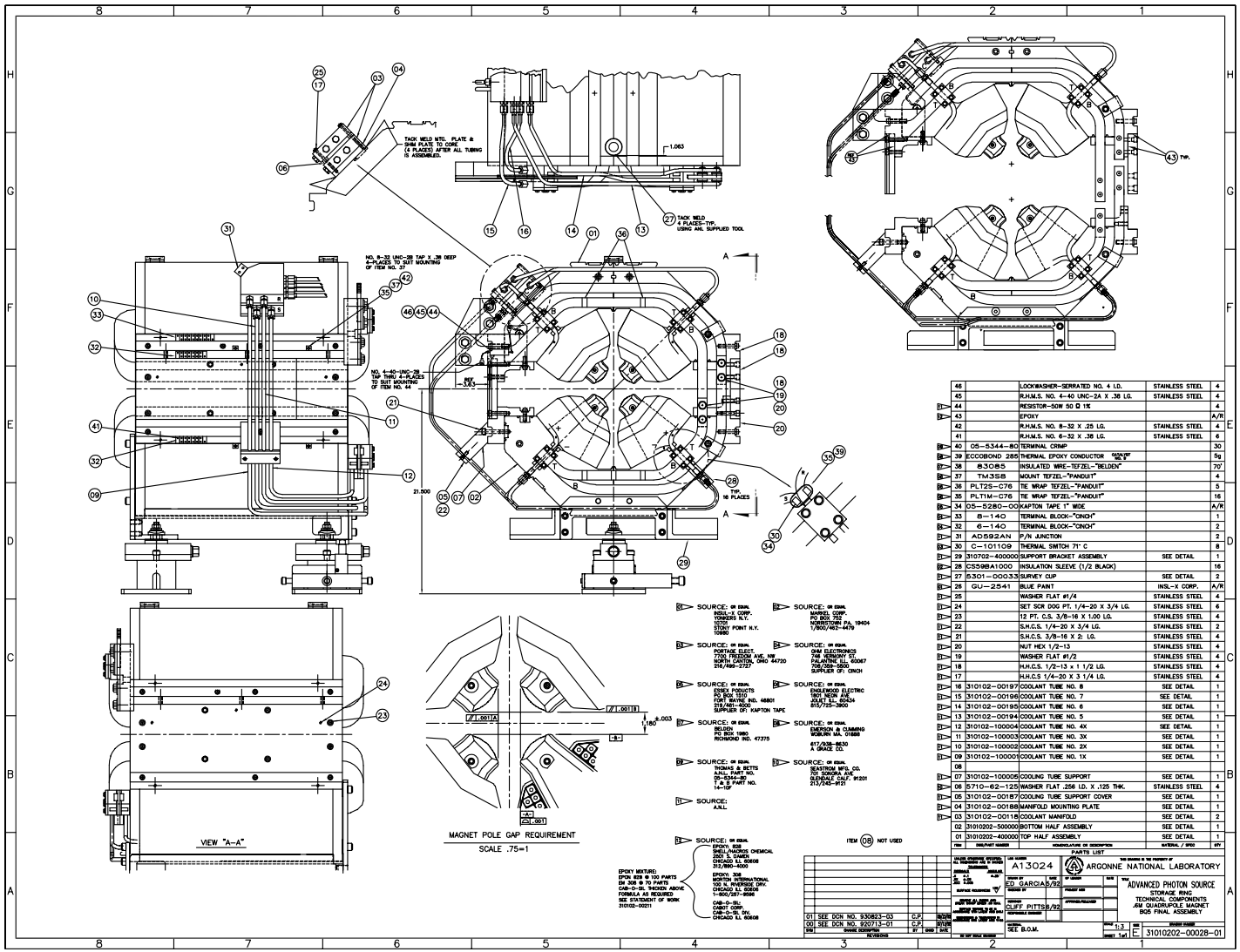

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45		R.H.M.S. NO. 4–40 UNC–2A X .38 LG.	STAINLESS STEEL	4
B	44		RESISTOR–50W 50 Ω 1%	4
B	43		EPOXY	A/R
	42		R.H.M.S. NO. 8–32 X .25 LG.	STAINLESS STEEL	4
	41		R.H.M.S. NO. 6–32 X .38 LG.	STAINLESS STEEL	6
B	40	05–5344–80	TERMINAL CRIMP		30
B	39	ECCOBOND 285	THERMAL EPOXY CONDUCTOR		5g
B	38	83085	INSULATED WIRE–TEFZEL–"BELDEN"		70'
B	37	TM3SB	MOUNT TEFZEL–"PANDUIT"		4
B	36	PLT2S–C76	TIE WRAP TEFZEL–"PANDUIT"		5
B	35	PLT1M–C76	TIE WRAP TEFZEL–"PANDUIT"		16
B	34	05–5280–00	KAPTON TAPE 1" WIDE		A/R
B	33	8–140	TERMINAL BLOCK–"CINCH"		1
B	32	6–140	TERMINAL BLOCK–"CINCH"		2
B	31	AD592AN	P/N JUNCTION		2
B	30	C–101109	THERMAL SWITCH 71° C		8
B	29	310702–400000	SUPPORT BRACKET ASSEMBLY	SEE DETAIL	1
B	28	C5598A1000	INSULATION SLEEVE (1/2 BLACK)		16
B	27	5301–00033	SURVEY CUP	SEE DETAIL	2
B	26	GU–2541	BLUE PAINT	INSL–X CORP.	A/R
B	25		WASHER FLAT #1/4	STAINLESS STEEL	4
B	24		SET SCR DOG PT, 1/4–20 X 3/4 LG.	STAINLESS STEEL	6
B	23		12 PT. C.S. 3/8–16 X 1.00 LG.	STAINLESS STEEL	4
B	22		S.H.C.S. 1/4–20 X 3/4 LG.	STAINLESS STEEL	2
B	21		S.H.C.S. 3/8–16 X 2: LG.	STAINLESS STEEL	4
B	20		NUT HEX 1/2–13	STAINLESS STEEL	4
B	19		WASHER FLAT #1/2	STAINLESS STEEL	4
B	18		H.H.C.S. 1/2–13 x 1 1/2 LG.	STAINLESS STEEL	4
B	17		H.H.C.S 1/4–20 X 3 1/4 LG.	STAINLESS STEEL	4
B	16	310102–00197	COOLANT TUBE NO. 8	SEE DETAIL	1
B	15	310102–00196	COOLANT TUBE NO. 7	SEE DETAIL	1
B	14	310102–00195	COOLANT TUBE NO. 6	SEE DETAIL	1
B	13	310102–00194	COOLANT TUBE NO. 5	SEE DETAIL	1
B	12	310102–100004	COOLANT TUBE NO. 4X	SEE DETAIL	1
B	11	310102–100003	COOLANT TUBE NO. 3X	SEE DETAIL	1
B	10	310102–100002	COOLANT TUBE NO. 2X	SEE DETAIL	1
B	09	310102–100001	COOLANT TUBE NO. 1X	SEE DETAIL	1
	08				
B	07	310102–100005	COOLING TUBE SUPPORT	SEE DETAIL	1
B	06	5710–62–125	WASHER FLAT .256 I.D. X .125 THK.	STAINLESS STEEL	4
B	05	310102–00187	COOLING TUBE SUPPORT COVER	SEE DETAIL	1
B	04	310102–00188	MANIFOLD MOUNTING PLATE	SEE DETAIL	1
B	03	310102–00118	COOLANT MANIFOLD	SEE DETAIL	2
	02	31010202–500000	BOTTOM HALF ASSEMBLY	SEE DETAIL	1
	01	31010202–400000	TOP HALF ASSEMBLY	SEE DETAIL	1

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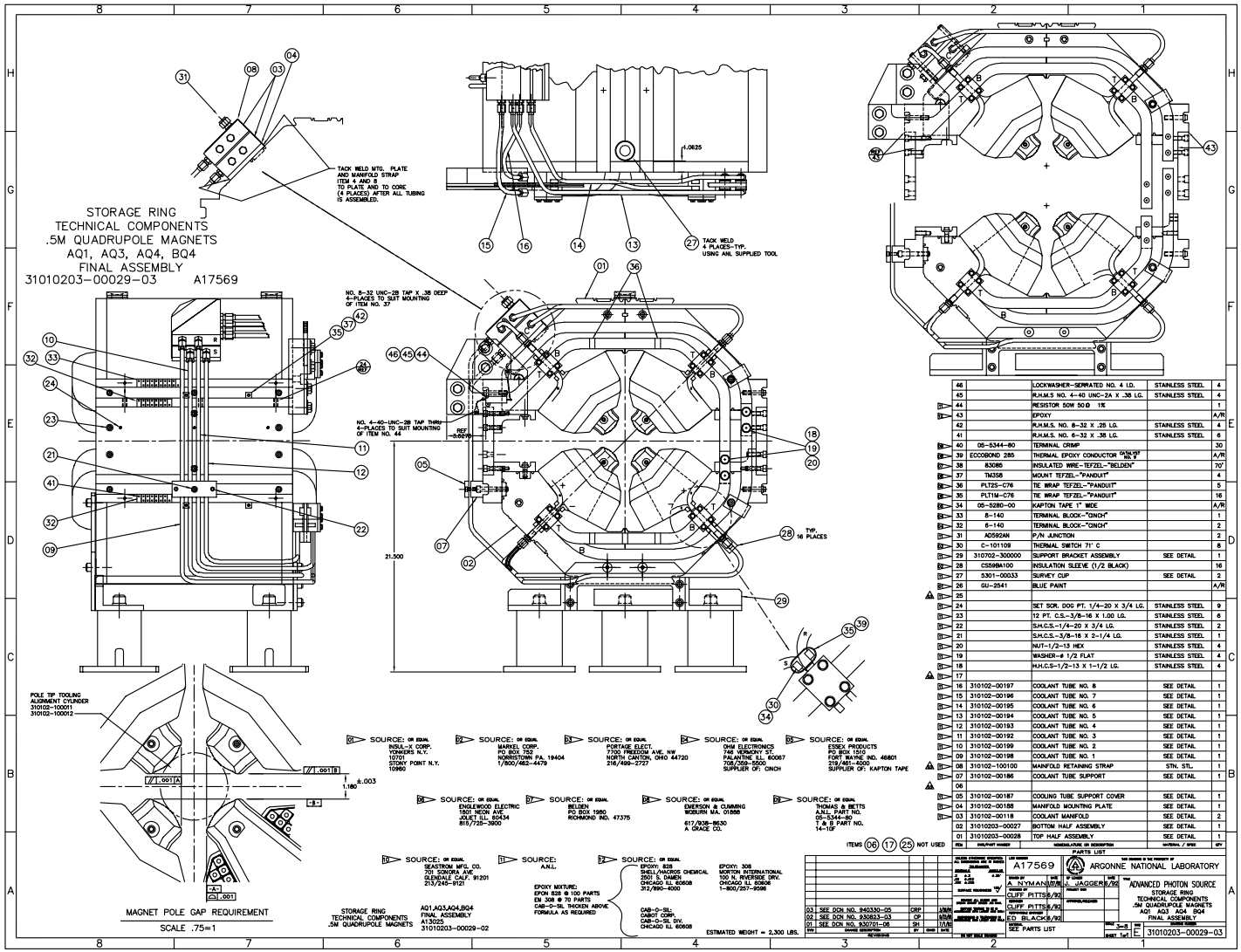

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45		R.H.M.S NO. 4-40 UNC-2A X .38 LG.	STAINLESS STEEL	4
44		RESISTOR 50W 50 Ω 1%		1
43		EPOXY		A/R
42		R.H.M.S. NO. 8-32 X .25 LG.	STAINLESS STEEL	4
41		R.H.M.S. NO. 6-32 X .38 LG.	STAINLESS STEEL	6
40	05-5344-80	TERMINAL CRIMP		30
39	ECCOBOND 285	THERMAL EPOXY CONDUCTOR CATALYST NO. 9		A/R
38	83085	INSULATED WIRE-TEFZEL-"BELDEN"		70'
37	TM358	MOUNT TEFZEL-"PANDUIT"		4
36	PLT2S-C76	TIE WRAP TEFZEL-"PANDUIT"		5
35	PLT1M-C76	TIE WRAP TEFZEL-"PANDUIT"		16
34	05-5280-00	KAPTON TAPE 1" WIDE		A/R
33	8-140	TERMINAL BLOCK-"CINCH"		1
32	6-140	TERMINAL BLOCK-"CINCH"		2
31	AD592AN	P/N JUNCTION		2
30	C-101109	THERMAL SWITCH 71° C		8
29	310702-300000	SUPPORT BRACKET ASSEMBLY	SEE DETAIL	1
28	CS598A100	INSULATION SLEEVE (1/2 BLACK)		16
27	5301-00033	SURVEY CUP	SEE DETAIL	2
26	GU-2541	BLUE PAINT		A/R
25				
24		SET SCR. DOG PT. 1/4-20 X 3/4 LG.	STAINLESS STEEL	9
23		12 PT. C.S.-3/8-16 X 1.00 LG.	STAINLESS STEEL	6
22		S.H.C.S.-1/4-20 X 3/4 LG.	STAINLESS STEEL	2
21		S.H.C.S.-3/8-16 X 2-1/4 LG.	STAINLESS STEEL	1
20		NUT-1/2-13 HEX	STAINLESS STEEL	4
19		WASHER-ø 1/2 FLAT	STAINLESS STEEL	4
18		H.H.C.S-1/2-13 X 1-1/2 LG.	STAINLESS STEEL	4
17				
16	310102-00197	COOLANT TUBE NO. 8	SEE DETAIL	1
15	310102-00196	COOLANT TUBE NO. 7	SEE DETAIL	1
14	310102-00195	COOLANT TUBE NO. 6	SEE DETAIL	1
13	310102-00194	COOLANT TUBE NO. 5	SEE DETAIL	1
12	310102-00193	COOLANT TUBE NO. 4	SEE DETAIL	1
11	310102-00192	COOLANT TUBE NO. 3	SEE DETAIL	1
10	310102-00199	COOLANT TUBE NO. 2	SEE DETAIL	1
09	310102-00198	COOLANT TUBE NO. 1	SEE DETAIL	1
08	310102-100100	MANIFOLD RETAINING STRAP	STN. STL.	1
07	310102-00186	COOLANT TUBE SUPPORT	SEE DETAIL	1
06				
05	310102-00187	COOLING TUBE SUPPORT COVER	SEE DETAIL	1
04	310102-00188	MANIFOLD MOUNTING PLATE	SEE DETAIL	1
03	310102-00118	COOLANT MANIFOLD	SEE DETAIL	2
02	31010203-00027	BOTTOM HALF ASSEMBLY	SEE DETAIL	1
01	31010203-00028	TOP HALF ASSEMBLY	SEE DETAIL	1

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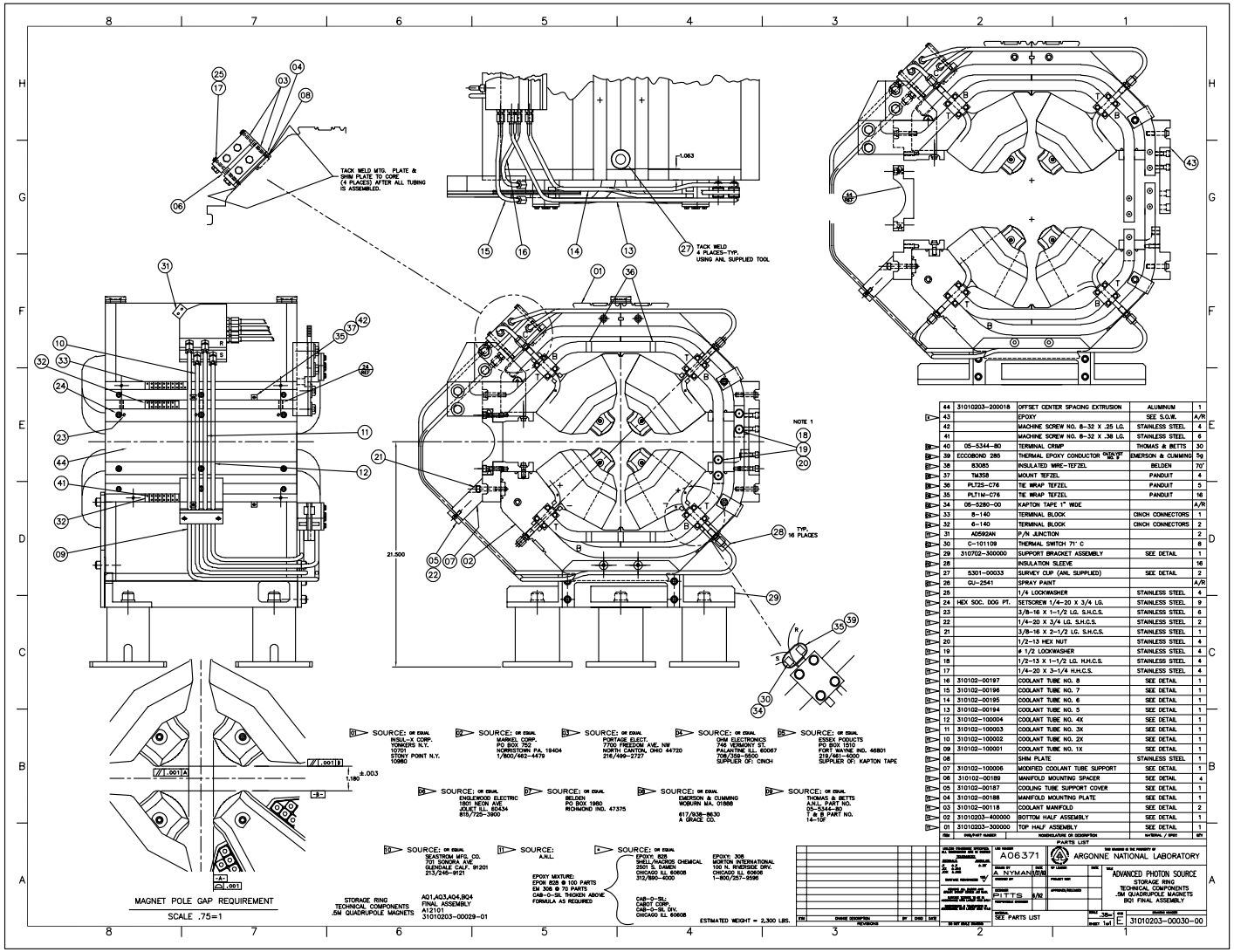

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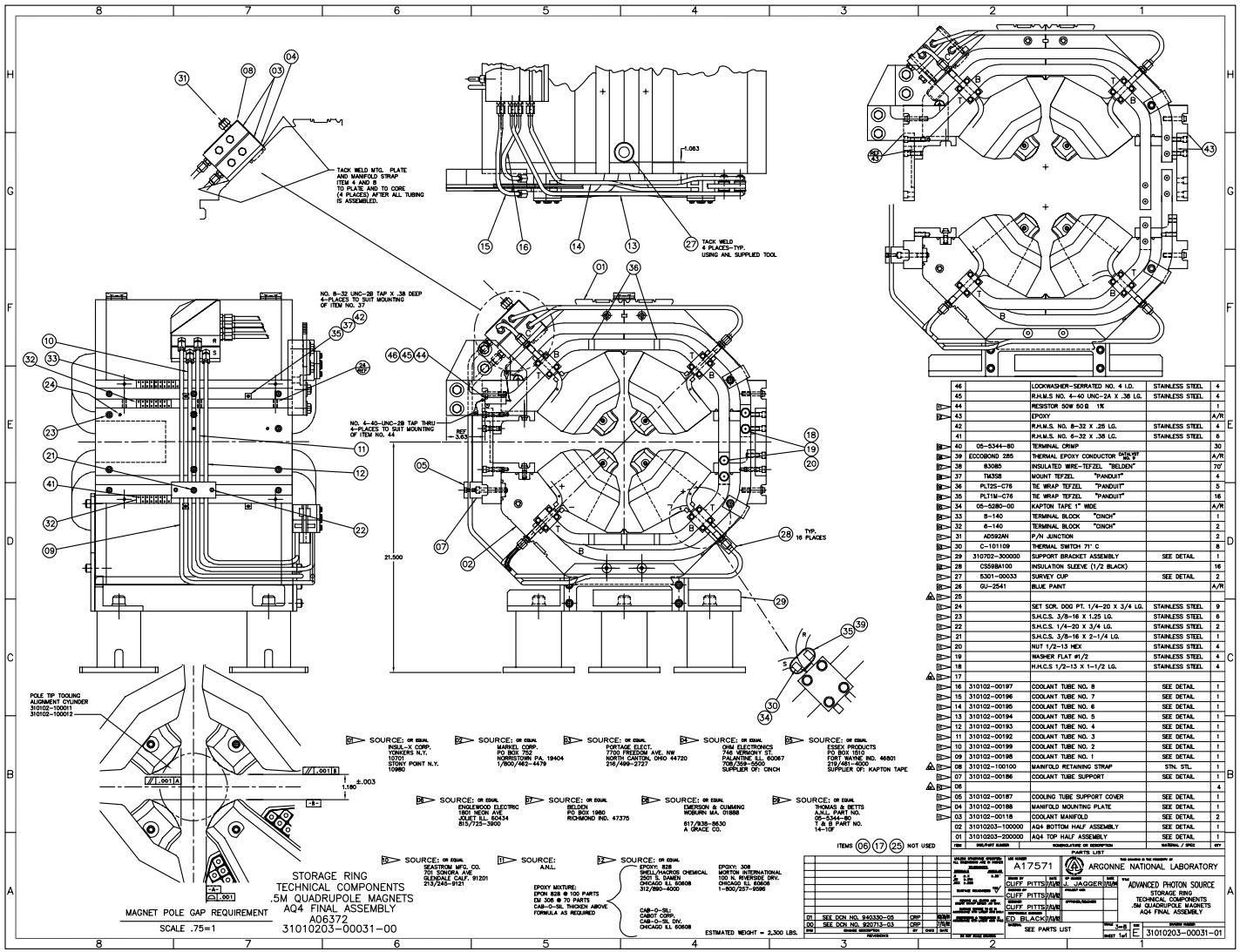

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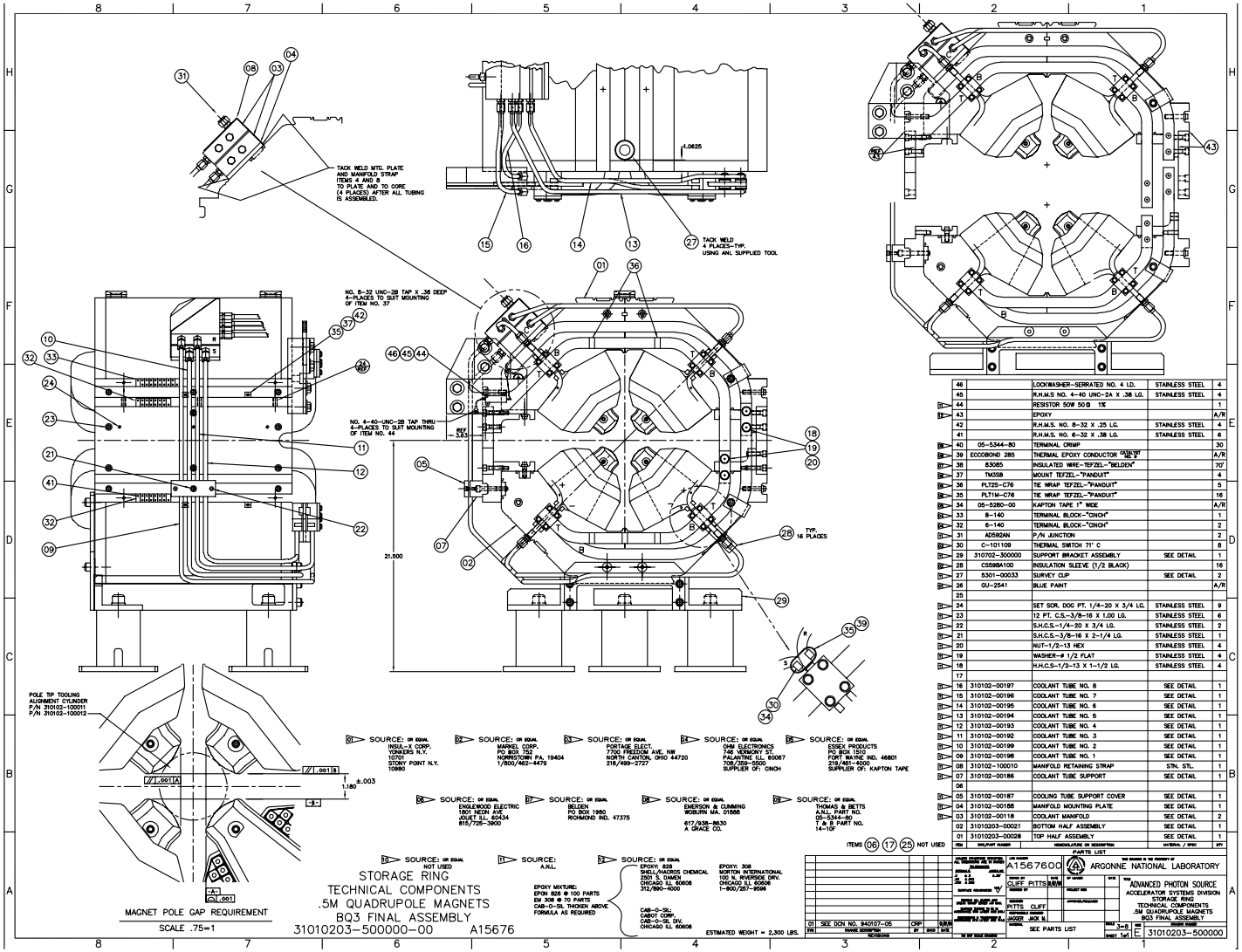

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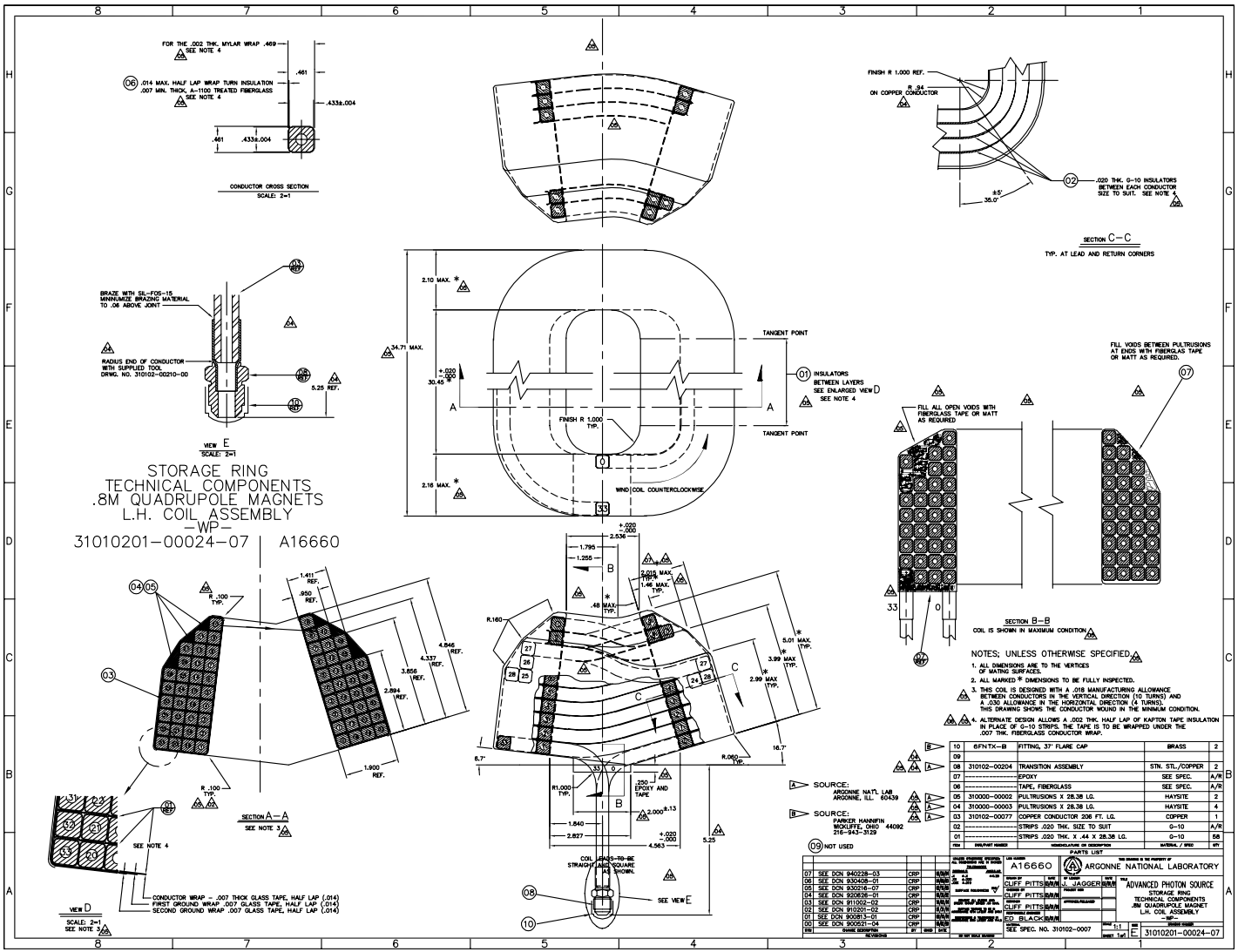

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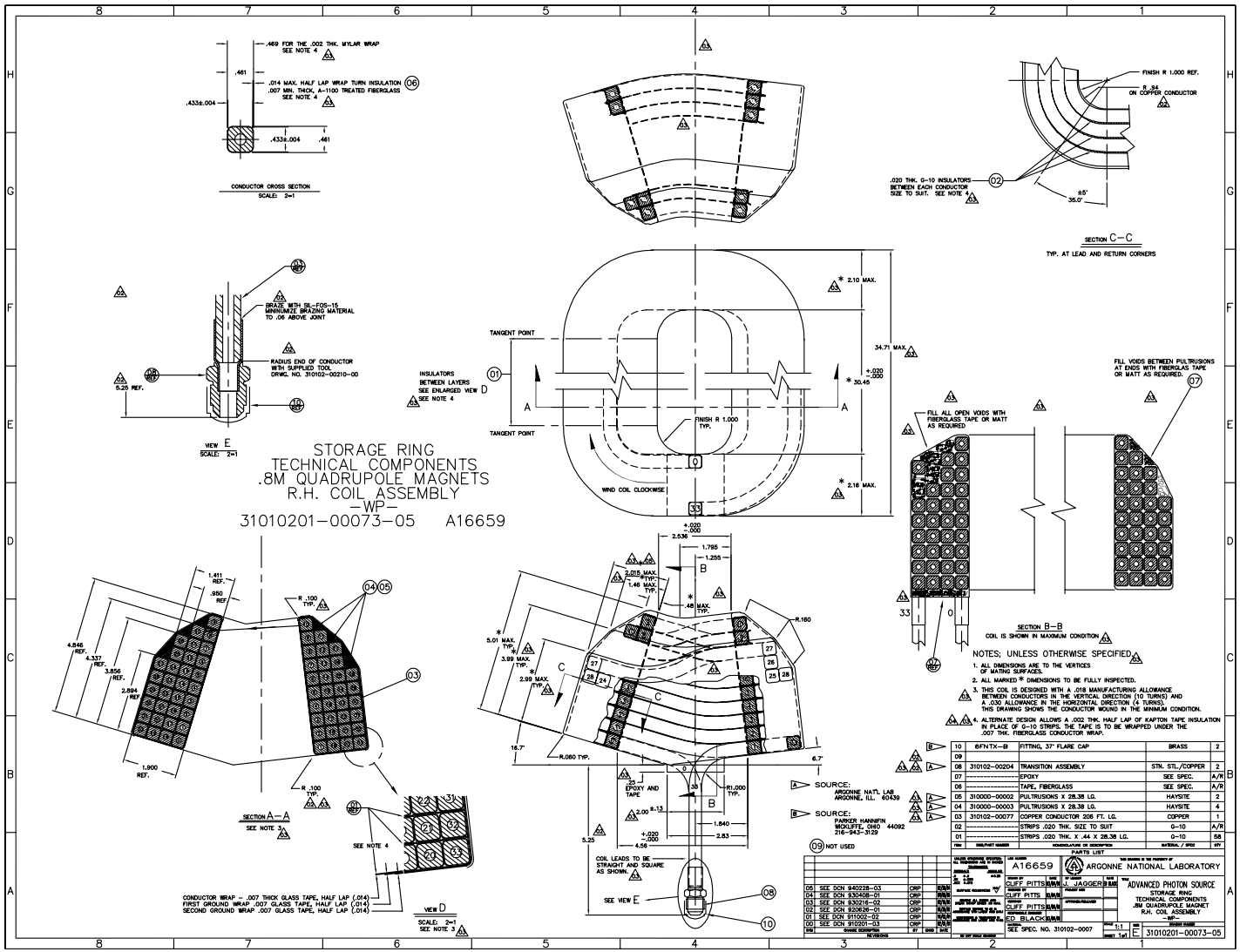

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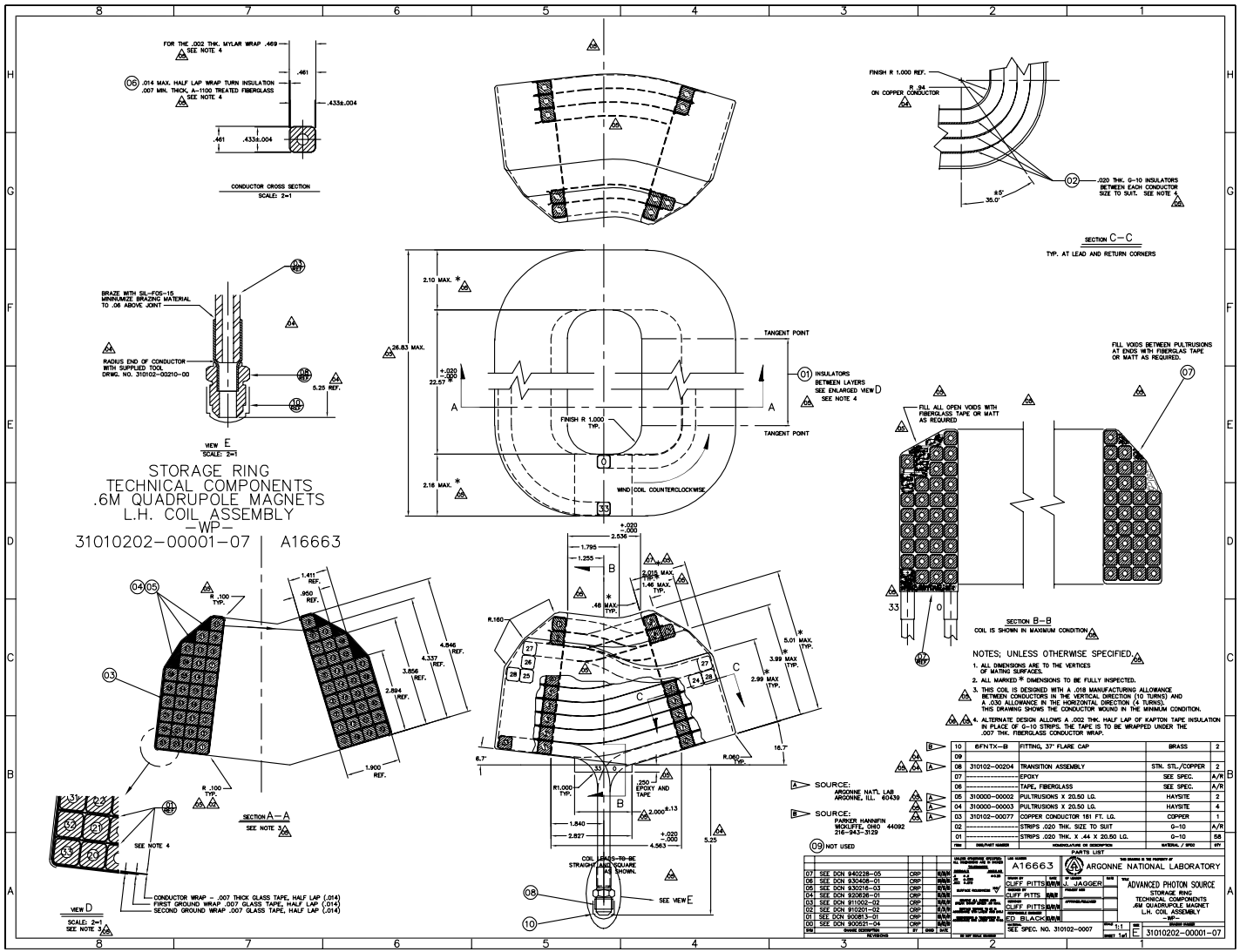

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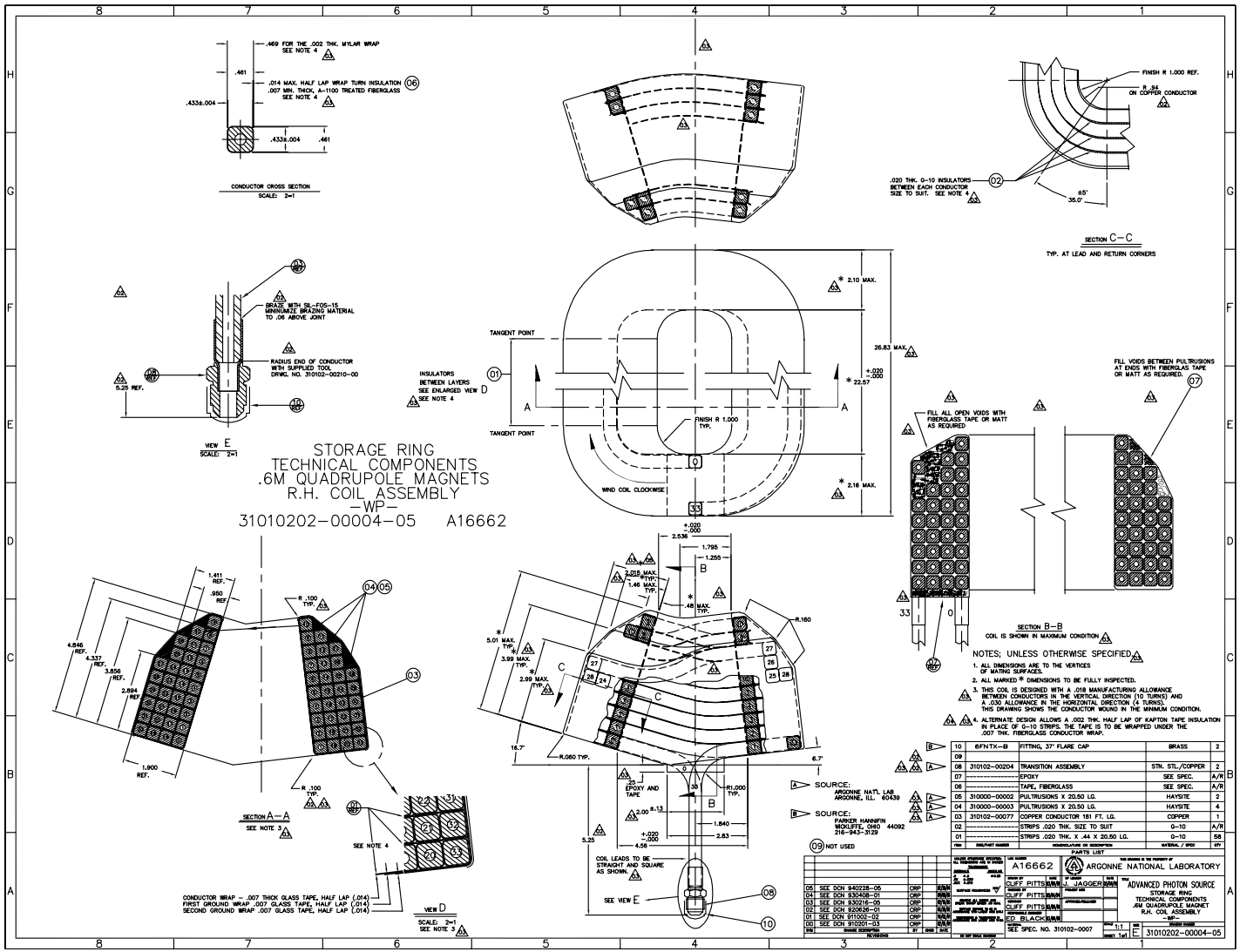

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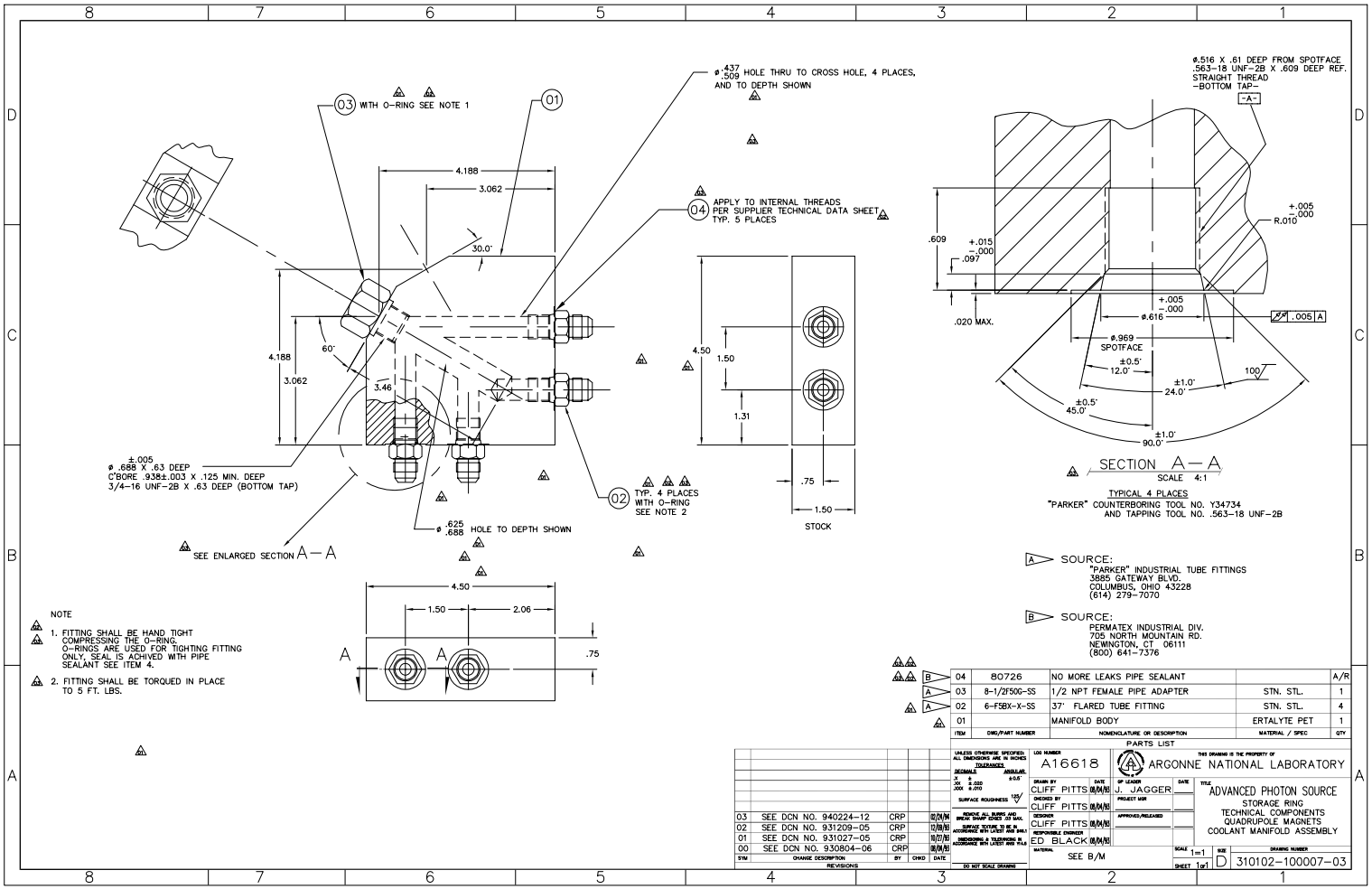

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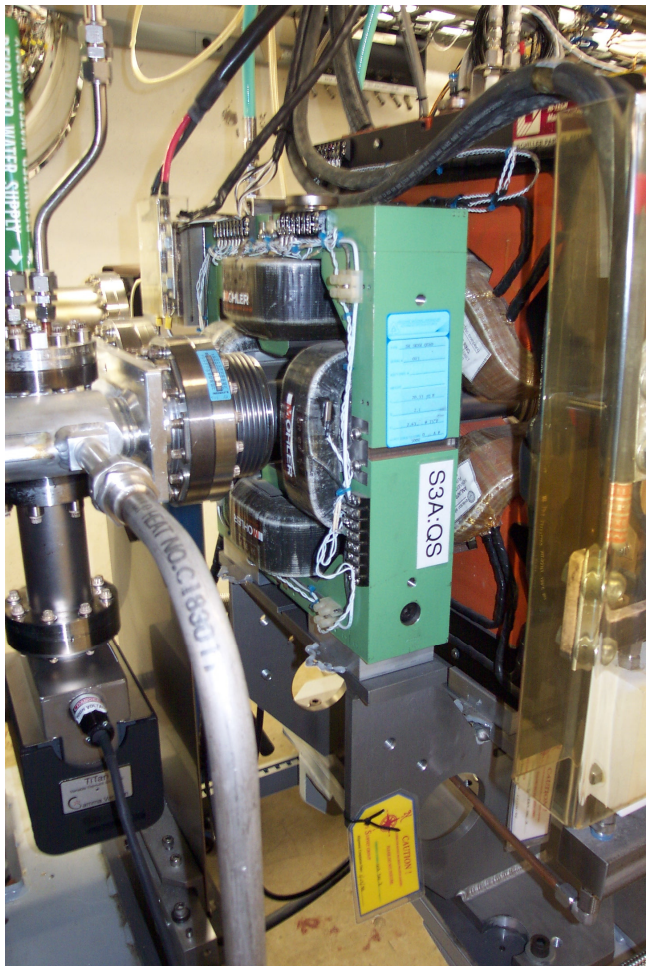


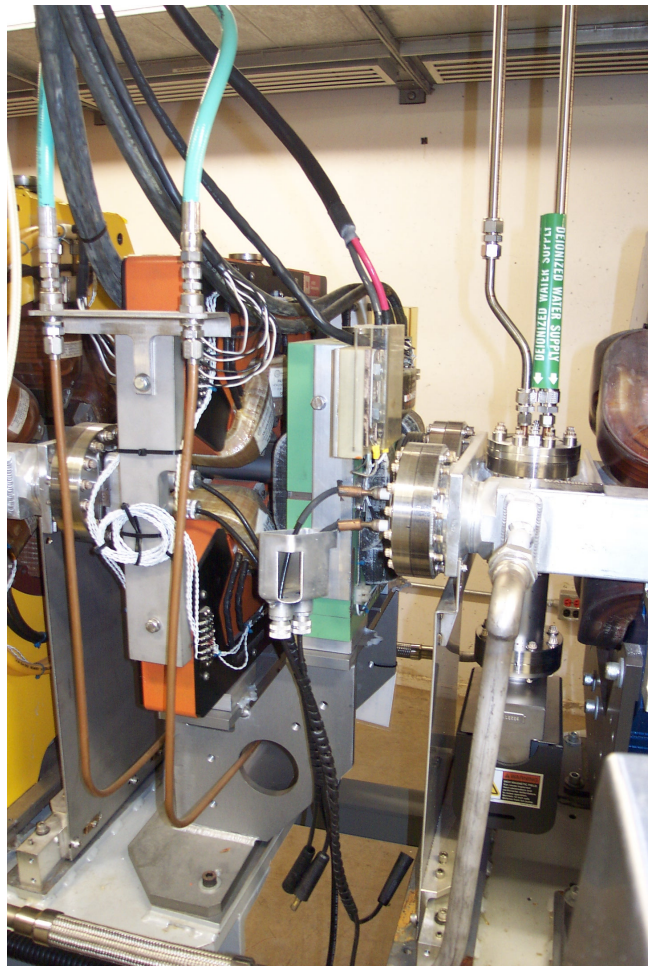
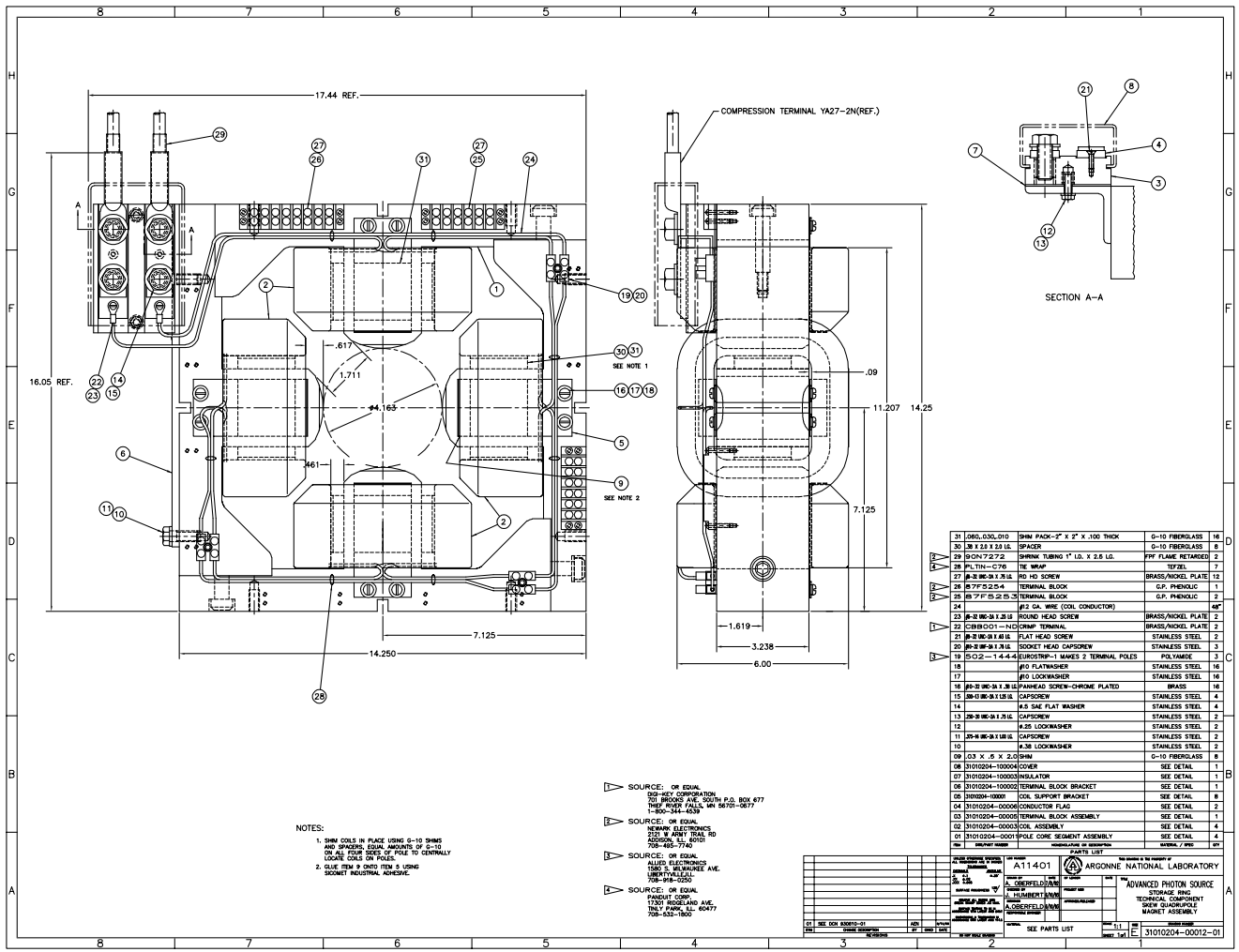


Figure 9: AQS (31010204-00012) Skew Quadrupole Magnet.

Storage Ring Quadrupole Magnets



31	.080,.030,.010	SHIM PACK-2" X 2" X .100 THICK	G-10 FIBERGLASS	16
30	.38 X 2.5 X 2.5 LG.	SPACER	G-10 FIBERGLASS	8
29	9ON7272	SHRINK TUBING 1" I.D. X 2.5 LG.	FPF FLAME RETARDED	2
28	PLTIN-C76	TIE WRAP	TEFZEL	7
27	Ø.38 UNC-3A X .75 LG.	RD HD SCREW	BRASS/NICKEL PLATE	12
26	67F5254	TERMINAL BLOCK	G.P. PHENOLIC	1
25	67F5253	TERMINAL BLOCK	G.P. PHENOLIC	2
24		#12 GA. WIRE (COIL CONDUCTOR)		AR"
23	Ø.38 UNC-3A X .25 LG	ROUND HEAD SCREW	BRASS/NICKEL PLATE	2
22	CBB01-ND	CRIMP TERMINAL	BRASS/NICKEL PLATE	2
21	Ø.38 UNC-3A X .60 LG.	FLAT HEAD SCREW	STAINLESS STEEL	2
20	Ø.38 UNC-3A X .75 LG.	SOCKET HEAD CAPSCREW	STAINLESS STEEL	3
19	502-1444	EURO/STRIP-1 MAKES 2 TERMINAL POLES	POLYAMIDE	3
18		#10 FLATWASHER	STAINLESS STEEL	16
17		#10 LOCKWASHER	STAINLESS STEEL	16
16	Ø0.38 UNC-3A X .38 LG.	PANHEAD SCREW-CHROME PLATED	BRASS	16
15	.38-16 UNC-3A X 1.25 LG.	CAPSCREW	STAINLESS STEEL	4
14		#.5 SAE FLAT WASHER	STAINLESS STEEL	4
13	.25-28 UNC-3A X .75 LG.	CAPSCREW	STAINLESS STEEL	2
12		#.25 LOCKWASHER	STAINLESS STEEL	2
11	.25-16 UNC-3A X 1.00 LG.	CAPSCREW	STAINLESS STEEL	2
10		#.38 LOCKWASHER	STAINLESS STEEL	2
09	.03 X .5 X 2.0	SHIM	G-10 FIBERGLASS	8
08	31010204-100004	COVER	SEE DETAIL	1
07	31010204-100003	INSULATOR	SEE DETAIL	1
06	31010204-100002	TERMINAL BLOCK BRACKET	SEE DETAIL	1
05	31010204-100001	COIL SUPPORT BRACKET	SEE DETAIL	8
04	31010204-00006	CONDUCTOR FLAG	SEE DETAIL	2
03	31010204-00005	TERMINAL BLOCK ASSEMBLY	SEE DETAIL	1
02	31010204-00003	COIL ASSEMBLY	SEE DETAIL	4
01	31010204-00001	POLE CORE SEGMENT ASSEMBLY	SEE DETAIL	4
ITEM	DRAWING NUMBER	NOMENCLATURE OR DESCRIPTION	MATERIAL / SPEC	QTY

Mark Jaski
Last edited on
November 23, 2004

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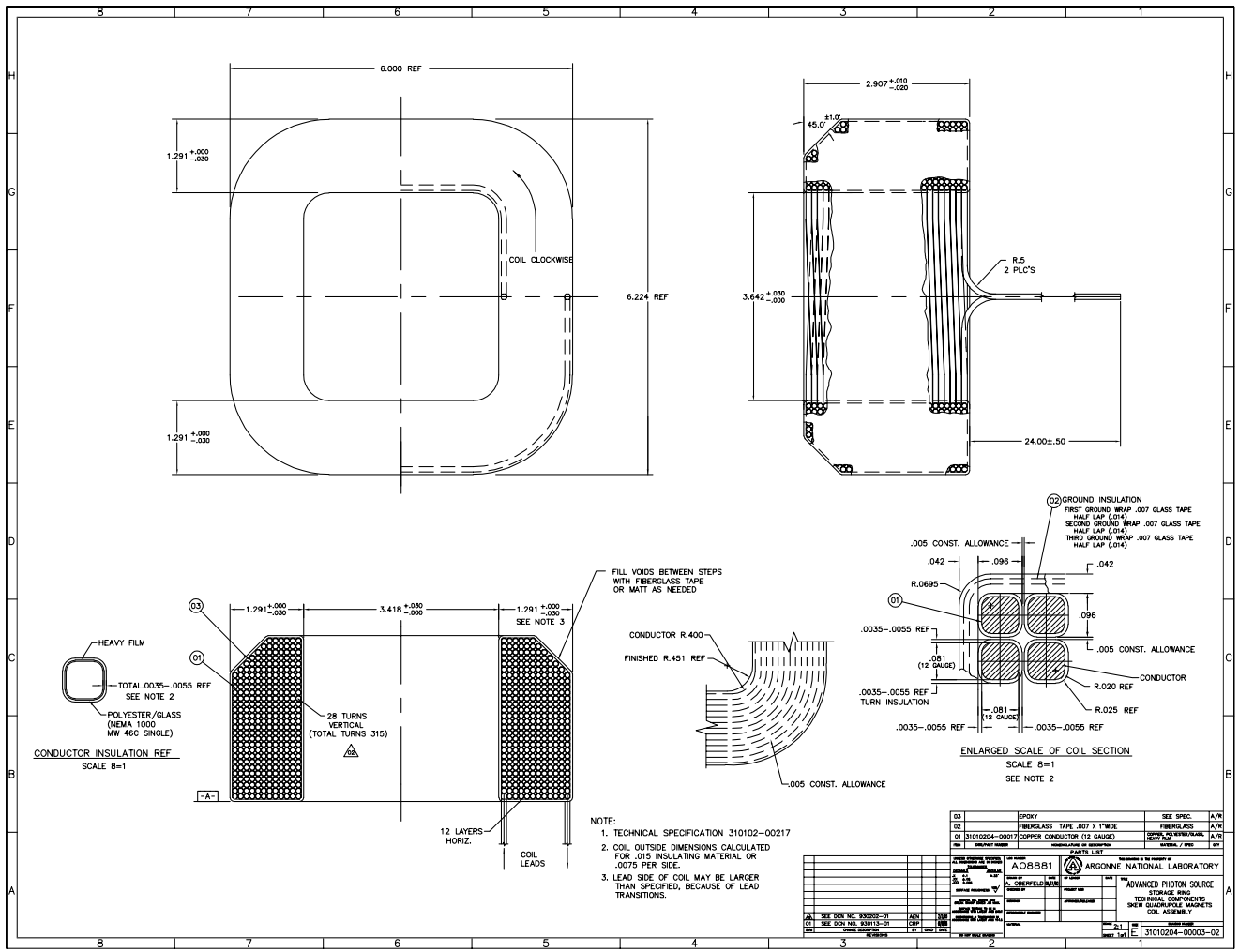
Advanced Photon Source
Argonne National Laboratory

Storage Ring Quadrupole Magnets



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