Supplemental Information
For
NASA/TP—2010–216437

Documentation of Stainless Steel Lithium Circuit Test Section Design

Compiled by:
T.J. Godfroy
Maximum Technology Corporation, Huntsville, Alabama

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SECTION A—INSTALLATION DRAWINGS: T.J. GODFROY

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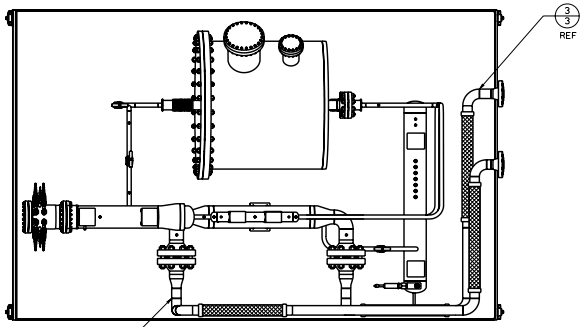


GENERAL NOTES (UNLESS OTHERWISE SPECIFIED)

1. REMOVE ALL BURRS AND BREAK ALL SHARP EDGES.
2. FIELD TO VERIFY ALL TIE-IN CONNECTIONS.
3. ALL PIPE SIZES AND SCHEDULES SHALL CONFORM TO THE DIMENSIONS OF ASME-B36.10 OR ASME-B36.19.
4. ALL FITTINGS SHALL CONFORM TO THE DIMENSIONS OF ASME-B16.9 OR ASME-B16.28. NO BLOCK PATTERN FITTINGS SHALL BE USED. THE CROTCH AREA OF TEES AND CROSSES SHALL BE REINFORCED WITH LONG RADIUS DESIGN TO ELIMINATE SHARP CORNERS.
5. ALL PIPE FLANGES SHALL CONFORM TO THE DIMENSIONS AND PRESSURE - TEMPERATURE RATINGS OF ASME-B16.5
6. ALL NON-METALLIC FLAT GASKETS FOR PIPE FLANGES SHALL CONFORM TO THE DIMENSIONS OF ASME-B16.21.
7. ALL BEVELS FOR BUTTWELDING ENDS OF PIPE FITTINGS, FLANGES, VALVES, AND COMPONENTS SHALL CONFORM TO ASME-B16.25.
8. ALL PIPE FLANGE BOLT HOLES SHALL STRADDLE THE CENTERLINE OF THE PIPE.
9. ALL MACHINED PARTS TO HAVE A 125 MICROINCH ROUGHNESS HEIGHT RATING SURFACE FINISH.
10. ALL PIPING SHALL BE IDENTIFIED AND COLOR CODED PER MIL-STD-1018.
11. ALL PIPING SYSTEMS SHALL BE HYDROSTATED TO 1.5 TIMES THE WORKING PRESSURE OF THE SYSTEM PER ASME-B31.1. THE WATER USED SHALL CONTAIN NO MORE THAN 25 PPM OF CHLORIDE FOR SST PIPE (50 PPM FOR C.S.) AND SHALL HAVE ½% BY WEIGHT SODIUM NITRITE AS AN INHIBITOR.
12. ALL PIPING SYSTEMS AND STRUCTURAL ATTACHMENTS TO PIPING SHALL BE WELDED PER ASME-B31.1. FOR SST PIPE USE 308L WELD WIRE.
13. ALL PIPING SYSTEMS SHALL BE DESIGNED PER ASME-B31.1.
14. ALL STEEL PIPE SUPPORTS SHALL BE WELDED AND 100% VISUALLY INSPECTED PER ASME-B31.1.
15. BOLTS SHALL BE TORQUED PER MSFC-STD-486B, EXCEPT FOR VENDOR SUPPLIED COMPONENTS, WHICH SHALL BE TORQUED PER VENDOR SPECIFICATIONS. FLANGE JOINT STUDS FOR FLANGES CONTAINING NON-METALLIC FLAT GASKETS OR METALLIC RING SEALS SHALL BE TORQUED AS NECESSARY TO PREVENT LEAKAGE. THERE SHALL BE NO GASKET EXTRUSION OR COLD FLOW.

16. STEEL PLATE ALLOWABLE STRESS SHALL BE PER ASME SECTION VIII, DIVISION 1.
17. STEEL STAMP .25 HIGH CHARACTERS AS SHOWN.
18. 316 STAINLESS STEEL MAY BE USED IN PLACE OF 316H IF THE CARBON CONTENT IS VERIFIED TO BE .04% OR HIGHER ON HEAT ANALYSIS. NO OTHER SUBSTITUTIONS SHALL BE PERMITTED FOR 316H SST.

PRELIMINARY
HAS NOT COMPLETED REVIEW CYCLE
AND IS SUBJECT TO CHANGE
1-31-05

SPECIFIC NOTES

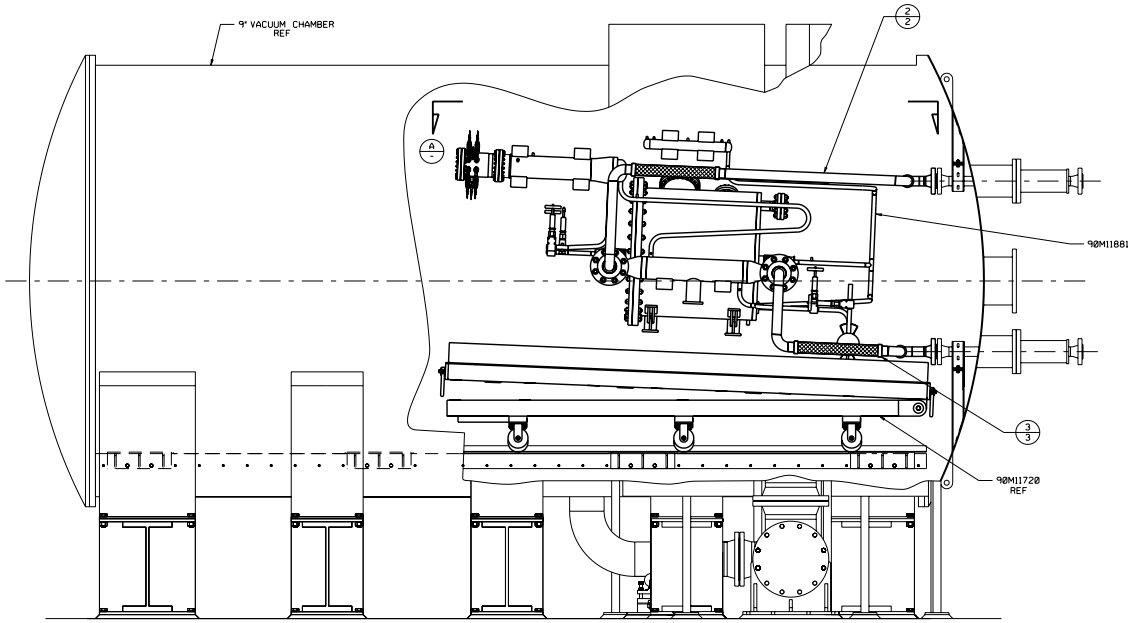
18 19. MATERIAL SPECIFICATIONS FOR STAINLESS STEEL SYSTEMS

PIPE:	ASTM-A312-TP316H SST. - SEAMED OR SEAMLESS
PIPE FITTINGS:	ASTM-A403-WP-S 316H SST.
TUBE:	ASTM-A213 TYPE 316H SST. - SEAMLESS
BAR STOCK:	AISI-316H SST PER ASTM A479.
16 PLATE:	AISI-316 SST PER ASTM A240.
PIPE FLANGES:	ASTM-A182-F316H SST.
STUD BOLTS:	ASTM-A193-B8 CLASS 1 SST.
HEX HEAD BOLTS:	ASTM-A193-B8 CLASS 1 SST.
HEXAGON NUTS:	ASTM-A194-GR.8 SST.
FORGINGS:	ASTM-A182-F316H SST.

SPECIFIC NOTES

HELIUM SYSTEMS

20. ALL PIPING SYSTEM GIRTH WELD JOINTS SHALL BE 100% VISUALLY AND 100% RADIOGRAPHICALLY EXAMINED PER ASME-B31.1.
21. THE PIPING SYSTEM SHALL BE HELIUM LEAK CHECKED USING A HELIUM MASS SPECTROMETER LEAK DETECTOR. ALLOWABLE LEAK RATE = 1 X 10^{-7} CC PER SECOND.
22. THE PIPING SYSTEM SHALL BE CLEANED FOR PNEUMATIC SERVICE PER MSFC-SPEC-164B.
23. FLAT GASKET MATERIAL: SPIRAL WOUND, FLEXIBLE GRAPHITE WITH 100% MICA OD & ID. SPIRAL WINDING MATERIAL: 316 SST (HEAT SHIELD EDGE GASKET).



ELEVATION

FIND NO. (1)

SCALE: 1:12

SUGGESTED VENDORS:

1. GARLOCK SEALING TECHNOLOGIES
METALLIC GASKET DIVISION
1977 KINDRED ST.
HOUSTON, TX 77049
PH. (281) 459-7200

2. ANVIL INTERNATIONAL INC.
110 CORPORATE DRIVE
PORTSMOUTH, NH 03802
PH. (603) 422-8000

3. McMASTER CARR SUPPLY CO.
P.O. BOX 4355
CHICAGO, ILLINOIS 60680
PH. (630) 833-0300

4. MICROFLEX INC.
P.O. BOX 730068
ORMOND BEACH, FL 32173
PH. (386) 677-8100

FIND NO.	SHEET NO.	TOT. REQ'D	PART NO.	DESCRIPTION	VEND. NO.	REMARKS
36	4	1	90M11880-36	⅜ STUD BOLT		316 SST PER ASTM A479
35	4	1	90M11880-35	CLIP ANGLE		316 SST PER ASTM A479
34	4	4	90M11880-34	⅜ STUD BOLT		316 SST PER ASTM A479
33	4	8	90M11880-33	CLIP ANGLE		316 SST PER ASTM A479
32	4	A/R	90M11880-32	.88 DIA ROD		316 SST PER ASTM A479
31	4	2	90M11880-31	BASE PLATE		SST SEE NOTE 19
30	4	A/R	90M11880-30	.50 DIA ROD		316 SST PER ASTM A479
29	4	20	90M11880-29	⅜ FLAT WASHER	3	SST CAT. NO. 90107A031
28	4	20	90M11880-28	⅜-16 UNC 2B HEX NUT		SST SEE NOTE 19
27	4	A/R	90M11880-27	L 2X2X.25		316 SST PER ASTM A479
26	4	10	90M11880-26	⅞-9 UNC 2B HEX NUT		SST SEE NOTE 19
25	4	5	90M11880-25	8-10 PIPE ROLL	2	FIG. 277 PIPE ROLL ONLY 316 SST PER ASTM A479
24	4	5	90M11880-24	PIPE PROTECTION SADDLE FOR 2" PIPE	2	FIG. 162A ASTM-A240 316H SST
23	2,3	2	90M11880-23	2" FLEX HOSE, LIVE LENGTH=20, SCH 80S WELD ENDS	4	MICROFLEX TYPE MSS-301, 321 SST
22	2,3	2	90M11880-22	2" FLEX HOSE, LIVE LENGTH=25.5, SCH 80S WELD ENDS	4	MICROFLEX TYPE MSS-301, 321 SST
21	2,3	2	90M11880-21	FLAT GASKET FOR 2" 600# RF FLANGE	1	SEE NOTE 23
20	2,3	32	90M11880-20	⅝ HEX NUT		SST SEE NOTE 19
19	2,3	16	90M11880-19	⅝ X 4.25 LG STUD		SST SEE NOTE 19
18	2,3	2	90M11880-18	2" 600# RF WELD NECK FLANGE W/ SCH 80S BORE		SST SEE NOTE 19
17	2,3	2	90M11880-17	FLAT GASKET FOR 3" 900# RF FLANGE	1	SEE NOTE 23
16	2,3	32	90M11880-16	⅞ HEX NUT		SST SEE NOTE 19
15	2,3	16	90M11880-15	⅞ X 5.75 LG STUD		SST SEE NOTE 19
14	2,3	2	90M11880-14	3" 900# RF WELD NECK FLANGE W/ SCH 80S BORE		SST SEE NOTE 19
13	2,3	2	90M11880-13	3" X 2" SCH 80S CONCENTRIC PIPE REDUCER		SST SEE NOTE 19
12	4	A/R	90M11880-12	2" SCH 40S PIPE		ASTM-A312-TP316 SST SEAMED OR SEAMLESS
11	2,3	8	90M11880-11	2" SCH 80S 90° LONG RADIUS ELBOW		SST SEE NOTE 19
10	2,3	A/R	90M11880-10	2" SCH 80S SEAMLESS PIPE		SST SEE NOTE 19
9	4	2	90M11880-9	ROLLER SUPPORT		SST SEE NOTE 19
8	4	2	90M11880-8	BASE PLATE		SST SEE NOTE 19
7	4	1	90M11880-7	BASE PLATE		SST SEE NOTE 19
6	2,4	2	90M11880-6	PIPE SUPPORT		SST SEE NOTE 19
5	3,4	1	90M11880-5	PIPE SUPPORT		SST SEE NOTE 19
4	2,3,4	2	90M11880-4	PIPE SUPPORT		SST SEE NOTE 19
3	1,3	1	90M11880-3	HELIUM OUTLET FEEDLINE ASSEMBLY		SST SEE NOTE 19
2	1,2	1	90M11880-2	HELIUM INLET FEEDLINE ASSEMBLY		SST SEE NOTE 19
1	1	-	90M11880-1	MAIN ASSEMBLY		

A=ASSEMBLY/SUB-ASSEMBLY/INSTALLATION E=EXISTING ITEM/FACILITY F=FABRICATED ITEM M=MODIFIED ITEM P=PURCHASED ITEM

SERVICE: HELIUM
TEMPERATURE: 50°F TO 860 °F
INTERNAL PRESSURE: 200 PSI
EXTERNAL PRESSURE: 0 PSI

90M11880 ~ REVISION

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS ± 1/16 | DECIMAL X ± .06 | XX ± .03 | XXX ± .010 | ANGLES ± 1/2°
DO NOT SCALE DRAWING

DESIGN ENGINEER	- -	DATE
TEST ENGINEER/REQUESTER	- -	DATE
STRESS	- -	DATE
MATERIALS	- -	DATE
INDUSTRIAL SAFETY	- -	DATE
PROJ APPROVAL	- -	DATE

LITHIUM SYSTEM FEEDLINES

SPECIAL TEST EQUIPMENT DESIGN BRANCH
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA

LOCATION	9" VC, BLDG. 4655	DETAILED	DATE 10-15-04 ET22
NEXT ASSEMBLY	NONE	LAST DETAIL, SECTION OR VIEW LETTER USED A	DESIGN NOTED

SIZE E | DRAWING NO. 90M11880 | SHEET 1 OF 4

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVED
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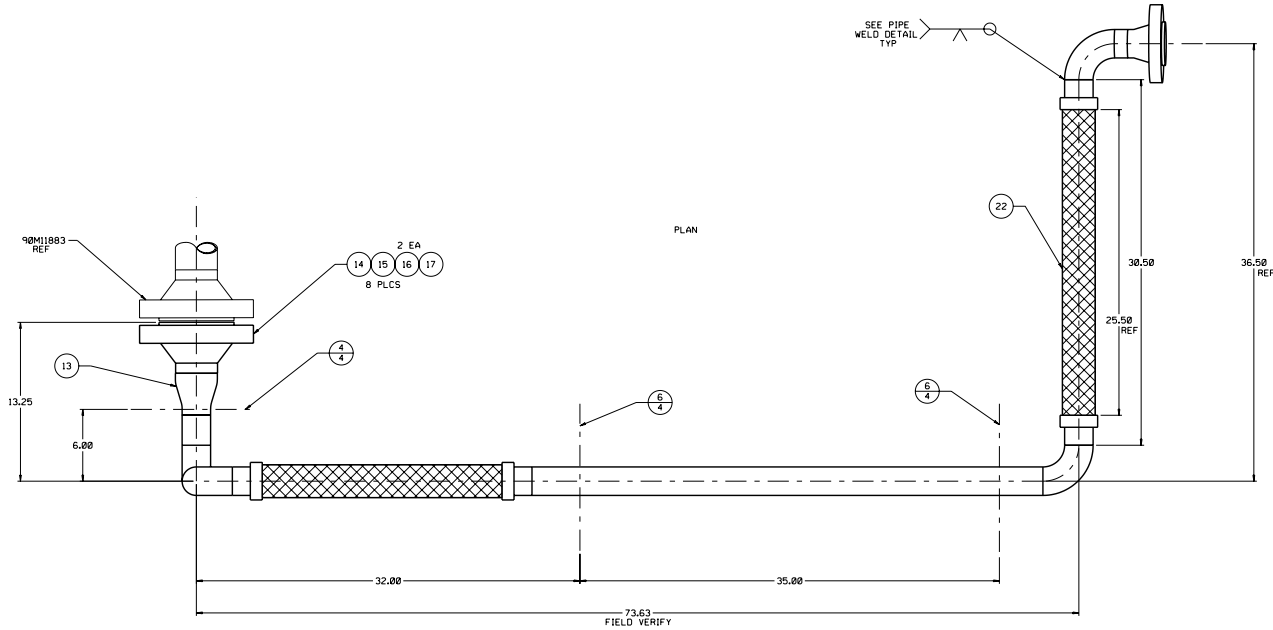

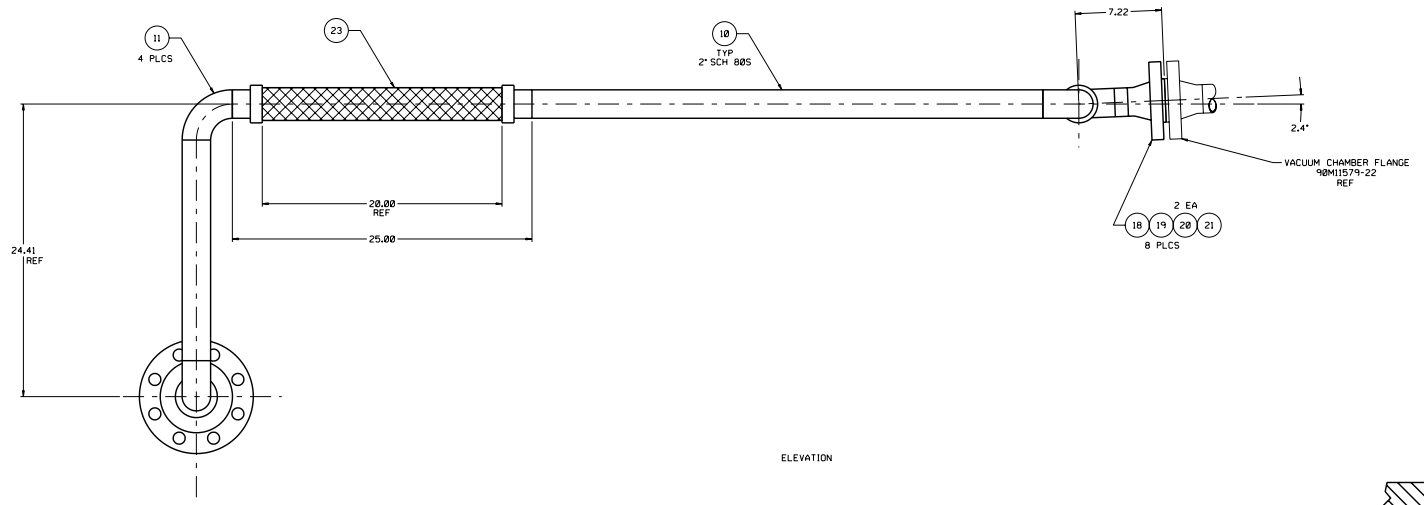

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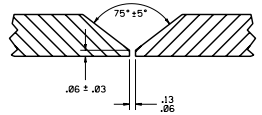

TYPICAL PIPE WELD DETAIL

SCALE: NONE

90M11880
SEE SHT1
REVISION

LITHIUM SYSTEM FEEDLINES	SPECIAL TEST EQUIPMENT DESIGN BRANCH GEORGE C. MARSHALL SPACE FLIGHT CENTER NATIONAL AERONAUTICS AND SPACE ADMINISTRATION HUNTSVILLE, ALABAMA	
DATE - -	SPEC CODE ET22	SIZE E
DETAILER	SCALE NOTED	DWG NO 90M11880
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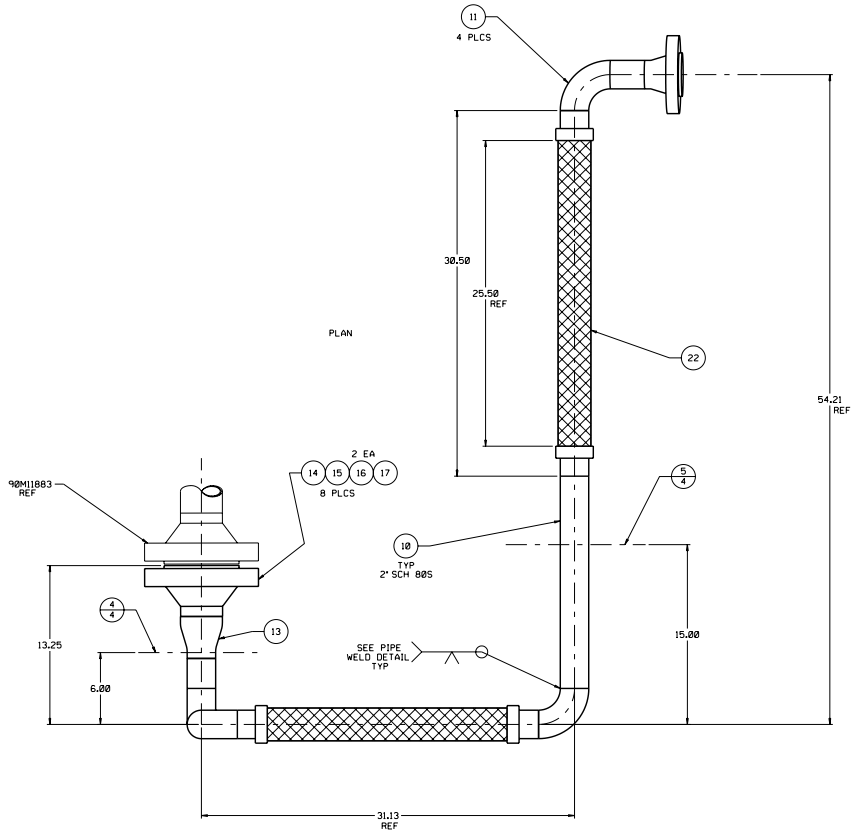
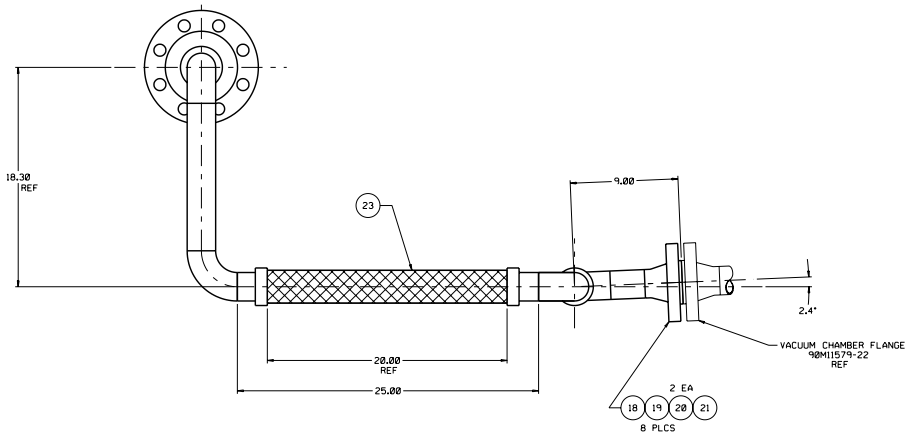
		- -	





ELEVATION

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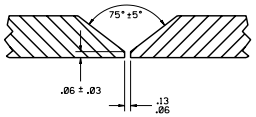

TYPICAL PIPE WELD DETAIL

SCALE: NONE

90M11880

SEE SHT1

REVISION

LITHIUM SYSTEM FEEDLINES	SPECIAL TEST EQUIPMENT DESIGN BRANCH GEORGE C. MARSHALL SPACE FLIGHT CENTER NATIONAL AERONAUTICS AND SPACE ADMINISTRATION HUNTSVILLE, ALABAMA	
DATE - -	SPACE CODE ET22	SIZE E
DETAILER	SCALE NOTED	90M11880
		SHEET 3 OF 4

REVISIONS			
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		- -	
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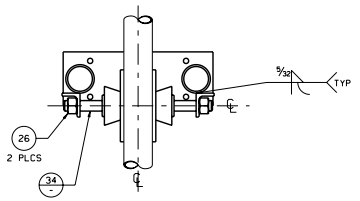

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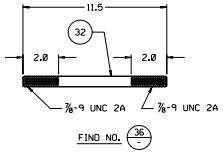
SEE ANCHOR DETAIL 4 PLCS



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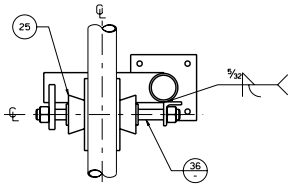

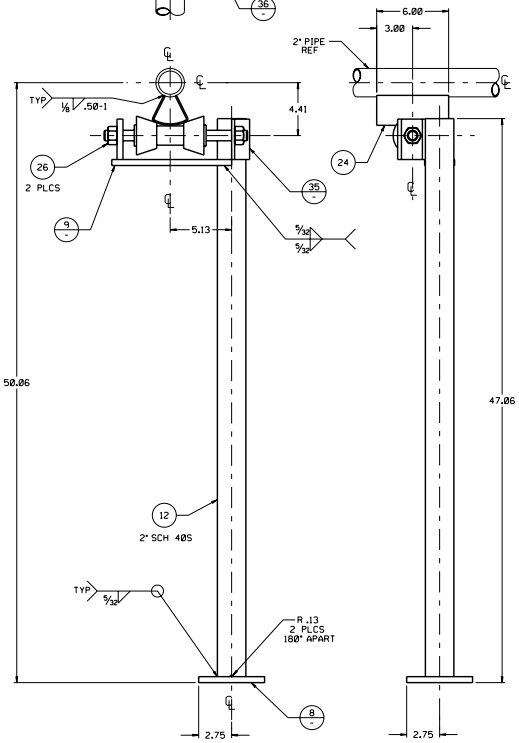

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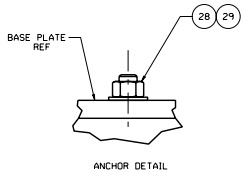

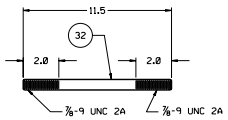

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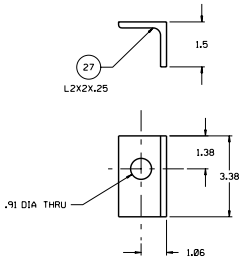

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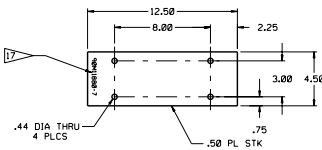

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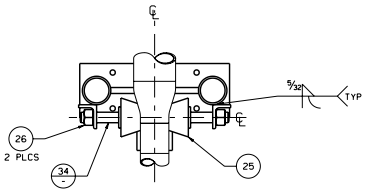

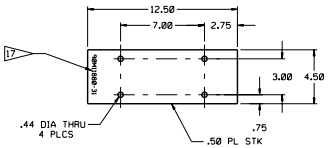

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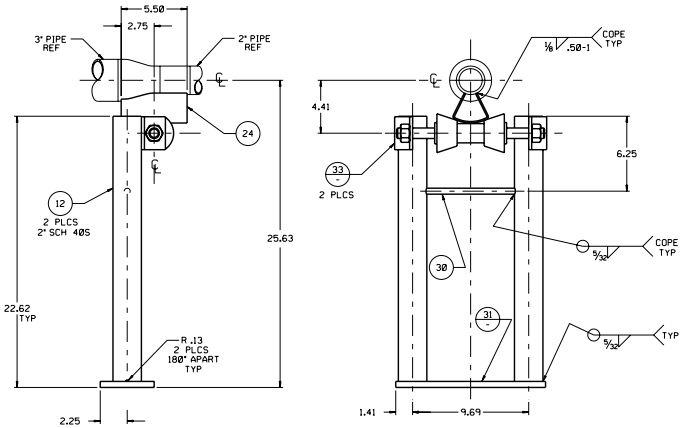

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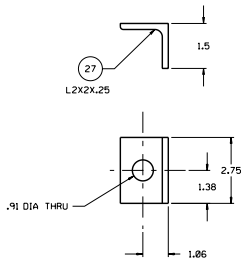
SEE ANCHOR DETAIL 4 PLCS



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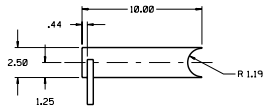

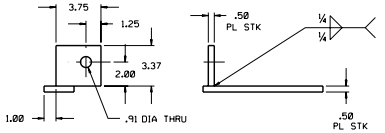

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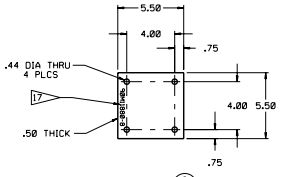

FIND NO. 8/-

SCALE: 1:4

90M11880

SEE SHT1 REVISION

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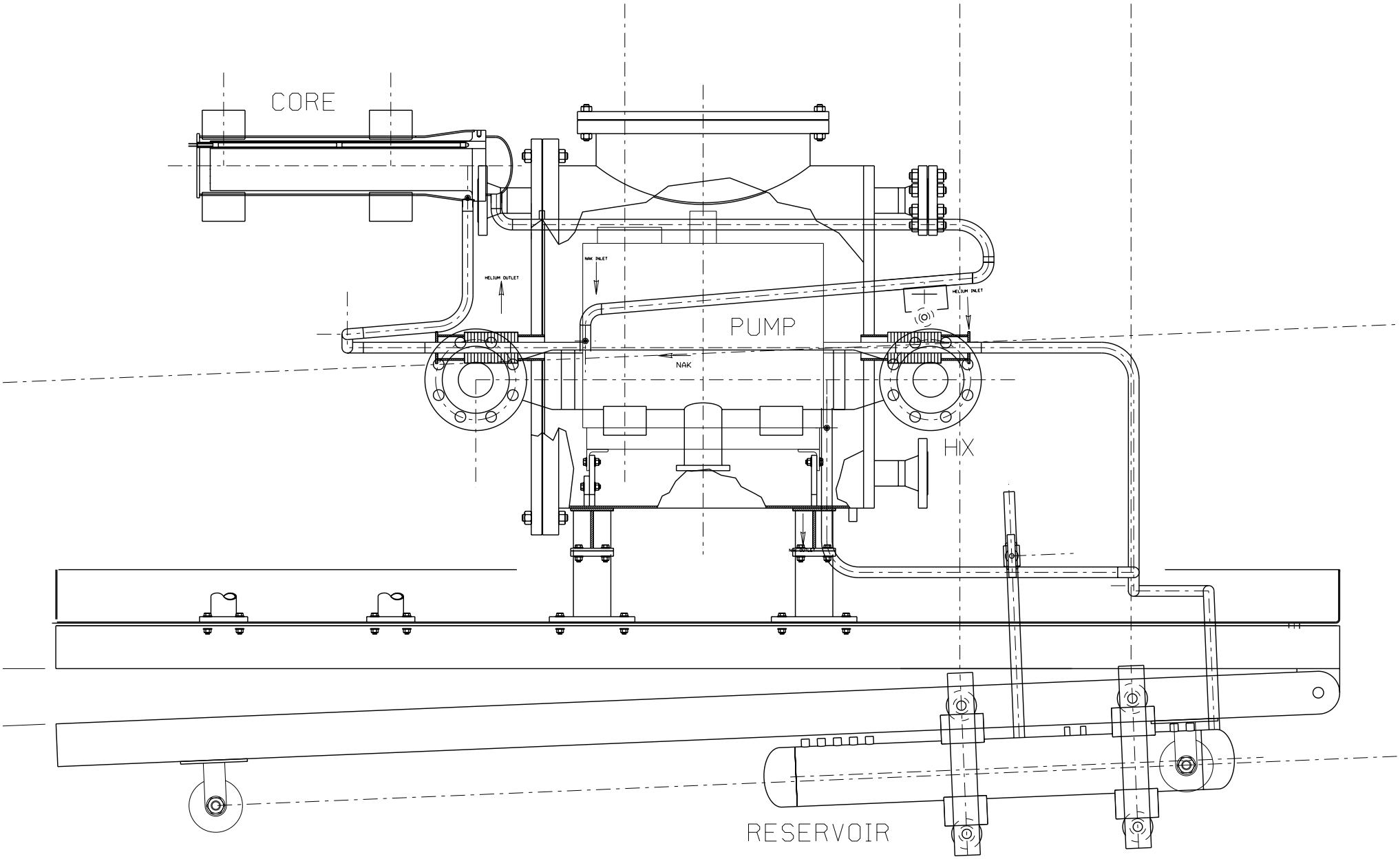
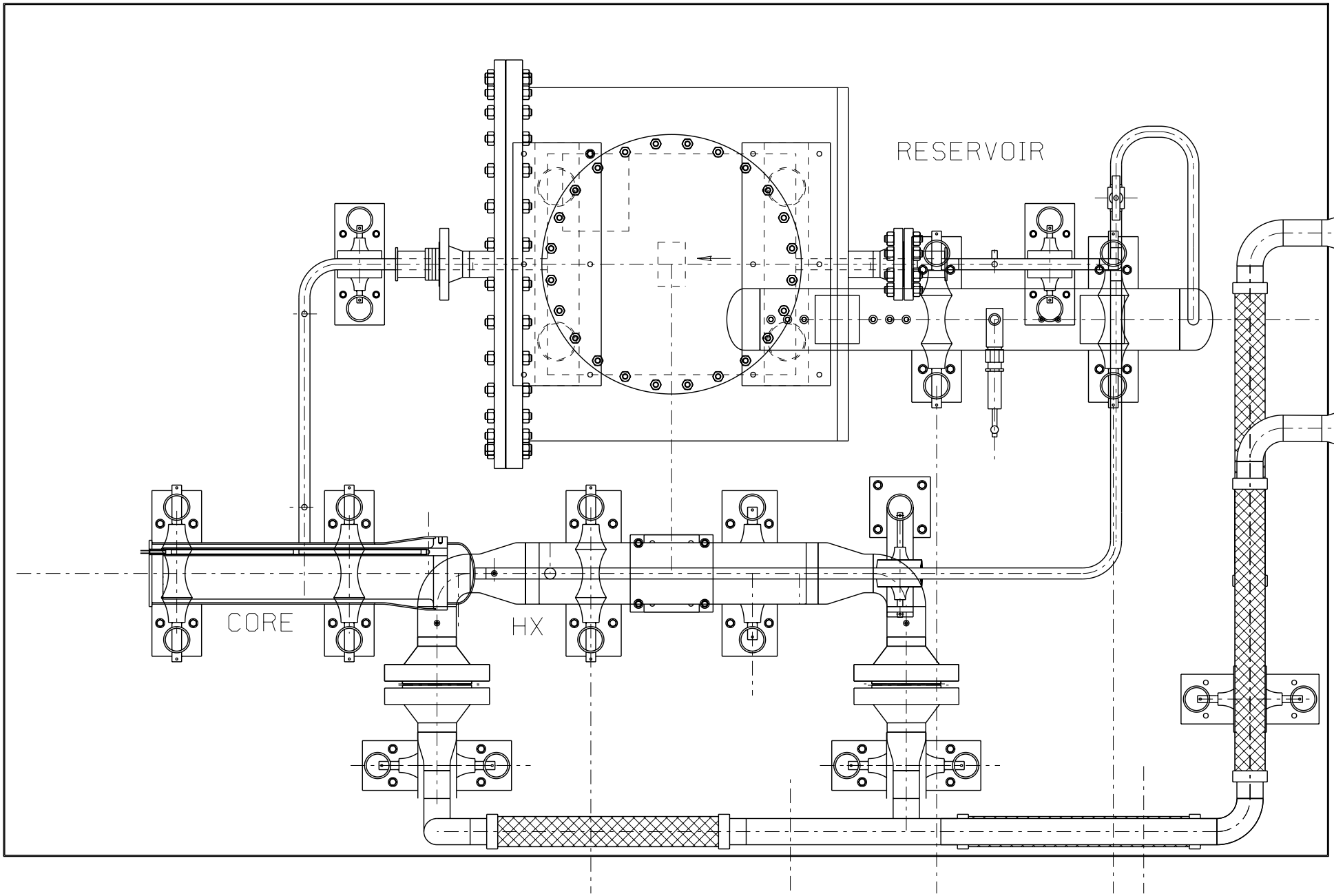
DATE - -	SPACE CODE ET22	DRAWING SIZE E
DETAILER	SCALE NOTED	90M11880
		SHEET 4 OF 4


CORE
HELIUM OUTLET
NAK INLET
PUMP
NAK
HELIUM INLET
HIX
RESERVOIR


RESERVOIR
CORE
HX

SECTION B — ASSEMBLY DRAWINGS: T.J. GODFROY

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SYM	DESCRIPTION	DATE	APPROVAL
		- -	
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15. 316 STAINLESS STEEL MAY BE USED IN PLACE OF 316H IF THE CARBON CONTENT IS VERIFIED TO BE .04% OR HIGHER ON HEAT ANALYSIS. NO OTHER SUBSTITUTIONS SHALL BE PERMITTED FOR 316H SST.

SPECIFIC NOTES

15 ▷ 16. MATERIAL SPECIFICATIONS FOR STAINLESS STEEL SYSTEMS

PIPE:	ASTM-A312-TP316 SST. - SEAMED OR SEAMLESS
PIPE FITTINGS:	ASTM-A403-WP-S 316H SST.
TUBE AND TUBE FITTINGS:	ASTM-A213 TYPE 316H SST. - SEAMLESS
BAR STOCK:	AISI-316H SST PER ASTM A479.
14 ▷ PLATE AND SHEET:	AISI-316 SST PER ASTM A240.
PIPE FLANGES:	ASTM-A182-F316H SST.
STUD BOLTS:	ASTM-A193-B8 CLASS 1 SST.
HEX HEAD BOLTS:	ASTM-A193-B8 CLASS 1 SST.
HEXAGON NUTS:	ASTM-A194-GR.8 SST.
FORGINGS:	ASTM-A182-F316H SST.

SPECIFIC NOTES

LITHIUM SYSTEMS

17. ALL PIPING SYSTEM GIRTH WELD JOINTS SHALL BE 100% VISUALLY AND 100% RADIOGRAPHICALLY EXAMINED PER ASME-B31.1.
18. THE PIPING SYSTEM SHALL BE HELIUM LEAK CHECKED USING A HELIUM MASS SPECTROMETER LEAK DETECTOR. ALLOWABLE LEAK RATE = 1×10^{-7} CC PER SECOND.
19. THE PIPING SYSTEM SHALL BE CLEANED FOR LIQUID OXYGEN SERVICE PER MSFC-SPEC-164B.
20. ALL MATERIAL IN CONTACT WITH LITHIUM SHALL BE CERTIFIED AND APPROVED BY MATERIALS, PROCESSES AND MANUFACTURING DEPARTMENT.
21. ALL VALVE MATERIAL IN CONTACT WITH LITHIUM SHALL BE CERTIFIED AND APPROVED BY MATERIALS, PROCESSES AND MANUFACTURING DEPARTMENT.

SUGGESTED VENDORS:

1. ANVIL INTERNATIONAL INC.
110 CORPORATE DRIVE
PORTSMOUTH, NH 03802
PH. (603) 422-8000

2. McMASTER CARR SUPPLY CO.
P.O. BOX 4355
CHICAGO, ILLINOIS 60680
PH. (630) 833-0300

3. ALABAMA FLUID SYSTEM TECHNOLOGIES INC.
237 CAHABA VALLEY PARKWAY
PELHAM, AL 35124
PH. (205) 988-4812

PRELIMINARY
HAS NOT COMPLETED REVIEW CYCLE
AND IS SUBJECT TO CHANGE
1-27-05

FIND NO.	SHEET NO.	TOT. REQ'D		PART NO.	DESCRIPTION	VEND. NO.	REMARKS
70							
69							
68							
67							
66	2,9	1		90M11881-66	CORE SUPPORT ASSEMBLY		SST SEE NOTE 16
65	9	4		90M11881-65	7/8 STUD BOLT		316 SST PER ASTM A479
64	9	8		90M11881-64	CLIP ANGLE		316 SST PER ASTM A479
63	8	3		90M11881-63	7/8 STUD BOLT		316 SST PER ASTM A479
62	8	6		90M11881-62	CLIP ANGLE		316 SST PER ASTM A479
61	7	1		90M11881-61	CLIP ANGLE		316 SST PER ASTM A479
60	7	1		90M11881-60	5/8 STUD BOLT		316 SST PER ASTM A479
59	7	2		90M11881-59	7/8 STUD BOLT		316 SST PER ASTM A479
58	7	4		90M11881-58	CLIP ANGLE		316 SST PER ASTM A479
57	6,7	6		90M11881-57	5/8-11 UNC 2B HEX NUT		SST SEE NOTE 16
56	6	2		90M11881-56	5/8 STUD BOLT		316 SST PER ASTM A479
55	6	4		90M11881-55	CLIP ANGLE		316 SST PER ASTM A479
54	6	1		90M11881-54	7/8 STUD BOLT		316 SST PER ASTM A479
53	6	2		90M11881-53	CLIP ANGLE		316 SST PER ASTM A479
52	6,7	3		90M11881-52	4-6 PIPE ROLL	1	FIG. 277 PIPE ROLL ONLY 316 SST PER ASTM A479
51	3,6-9	28		90M11881-51	7/8-9 UNC 2B HEX NUT		SST SEE NOTE 16
50	8	8		90M11881-50	3/8-16 UNC 2A X 1.5 LG HEX HD BOLT		SST SEE NOTE 16
49	6	4		90M11881-49	3/8-16 UNC 2A X 3.0 LG HEX HD BOLT		SST SEE NOTE 16
48	3,5-9	176		90M11881-48	3/8 FLAT WASHER	2	SST CAT. NO. 90107A031
47	3,5-9	164		90M11881-47	3/8-16 UNC 2B HEX NUT		SST SEE NOTE 16
46	5	76		90M11881-46	3/8-16 UNC 2A X 3.0 LG DOUBLE END THREADED STUD		SST SEE NOTE 16
45	6,7,8,9	A/R		90M11881-45	.50 DIA ROD		316 SST PER ASTM A479
44	7	1		90M11881-44	ROLLER SUPPORT		SST SEE NOTE 16
43	3,6-9	A/R		90M11881-43	.88 DIA ROD		316 SST PER ASTM A479
42	3,6-9	14		90M11881-42	8-10 PIPE ROLL	1	FIG. 277 PIPE ROLL ONLY 316 SST PER ASTM A479
41	8	2		90M11881-41	TOP PLATE		SST SEE NOTE 16
40	3,6-9	A/R		90M11881-40	L 2X2X.25		316 SST PER ASTM A479
39	3	8		90M11881-39	CLIP ANGLE		316 SST PER ASTM A479
38	5	A/R		90M11881-38	12 GAUGE (.1054") THICK SHEET		SST SEE NOTE 16
37	6,7	3		90M11881-37	PIPE PROTECTION SADDLE FOR 3/4" PIPE	1	FIG. 162A ASTM-A240 316H SST
36	6,8	A/R		90M11881-36	3" SCH 40S PIPE		SST SEE NOTE 16
35	3,6-9	A/R		90M11881-35	2" SCH 40S PIPE		SST SEE NOTE 16
34	3,4	5		90M11881-34	1" VALVE	3	SWAGELOK PART NO. SS-12UW-TW-HT
33	3,4	4		90M11881-33	1" O.D. X .095" WALL TUBE TEE		SST SEE NOTE 16
32	3	4		90M11881-32	7/8 STUD BOLT		316 SST PER ASTM A479
31	6,7	A/R		90M11881-31	.63 DIA ROD		316 SST PER ASTM A479
30	3,4	A/R		90M11881-30	1" O.D. X .095" WALL SEAMLESS TUBE		SST SEE NOTE 16
29	8	2		90M11881-29	BASE PLATE		SST SEE NOTE 16
28	4	A/R		90M11881-28	3/4" O.D. X .095" WALL SEAMLESS TUBE		SST SEE NOTE 16
27	3	2		90M11881-27	BASE PLATE		SST SEE NOTE 16
26	7	1		90M11881-26	BASE PLATE		SST SEE NOTE 16
25	9	1		90M11881-25	BASE PLATE		SST SEE NOTE 16
24	7,9	2		90M11881-24	BASE PLATE		SST SEE NOTE 16
23	6	4		90M11881-23	INSULATOR	2	ALUMINA SILICATE, CAT. NO. 8479K49
22	6	1		90M11881-22	TOP PLATE		SST SEE NOTE 16
21	6	1		90M11881-21	BASE PLATE		SST SEE NOTE 16
20	6	2		90M11881-20	BASE PLATE		SST SEE NOTE 16
19	8	2		90M11881-19	TOP PLATE		SST SEE NOTE 16
18	6,8	2		90M11881-18	BASE PLATE		SST SEE NOTE 16
17	2,8	1		90M11881-17	PUMP ENCLOSURE SLIDE ASSEMBLY		SST SEE NOTE 16
16	2,8	1		90M11881-16	PUMP ENCLOSURE ANCHOR ASSEMBLY		SST SEE NOTE 16
15	4	1		90M11881-15	1" X 3/4" TUBE REDUCER		SST SEE NOTE 16
14	2,8	1		90M11881-14	HEAT EXCHANGER AND RESERVOIR SUPPORT ASSEMBLY		SST SEE NOTE 16
13	4,7	1		90M11881-13	LOOP SUPPORT ASSEMBLY		SST SEE NOTE 16
12	2,9	1		90M11881-12	RESERVOIR SUPPORT ASSEMBLY		SST SEE NOTE 16
11	2,7	1		90M11881-11	CORE SUPPORT ASSEMBLY		SST SEE NOTE 16
10	2,6	1		90M11881-10	HEAT EXCHANGER ANCHOR ASSEMBLY		SST SEE NOTE 16
9	3,4,6	2		90M11881-9	1" TUBE SUPPORT ASSEMBLY		SST SEE NOTE 16
8	2,3	2		90M11881-8	RESERVOIR SUPPORT		SST SEE NOTE 16
7	2,6	1		90M11881-7	HEAT EXCHANGER SUPPORT		SST SEE NOTE 16
6	2,5	1		90M11881-6	CATCH TRAY		SST SEE NOTE 16
5	2,4	1		90M11881-5	RESERVOIR FILL		SST SEE NOTE 16
4	2,4	1		90M11881-4	TUBE LOOP		SST SEE NOTE 16
3	2,4	1		90M11881-3	DRAIN TUBING ASSEMBLY		SST SEE NOTE 16
2	2,3	1		90M11881-2	TUBING ASSEMBLY		SST SEE NOTE 16
1	2	-		90M11881-1	MAIN ASSEMBLY		

A=ASSEMBLY/SUB-ASSEMBLY/INSTALLATION E=EXISTING ITEM/FACILITY F=FABRICATED ITEM M=MODIFIED ITEM P=PURCHASED ITEM

SERVICE: LITHIUM
TEMPERATURE: 50°F TO 860 °F
INTERNAL PRESSURE: 20 PSI
EXTERNAL PRESSURE: 0 PSI

90M11881
~ REVISION

UNLESS OTHERWISE SPECIFIED
(DIMENSIONS ARE IN INCHES)
TOLERANCES ARE:
FRACTIONS $\pm \frac{1}{16}$ DECIMALS .X- ±.06 .XX- ±.03 .XXX- ±.010 ANGLES $\pm \frac{1}{2}°$
DO NOT SCALE DRAWING

LOCATION: 9' VC, BLDG. 4655
NEXT ASSEMBLY 90M11880 LAST DETAIL, SECTION, OR VIEW LETTER USED B

ET22 DESIGN ENGINEER DATE - -
TEST ENGINEER/REQUESTER DATE - -
STRESS DATE - -
MATERIALS DATE - -
INDUSTRIAL SAFETY DATE - -
ET22 APPROVAL DATE - -

LITHIUM SYSTEM LAYOUT

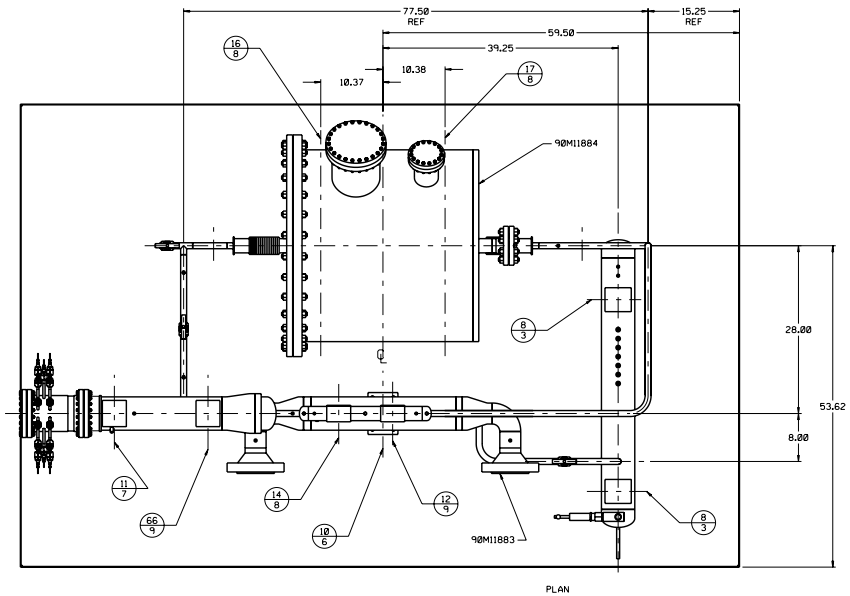
DETAILER | DATE 10-15-04 | OFFICE CODE ET22
CHECKER | SCALE

SPECIAL TEST EQUIPMENT DESIGN BRANCH
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA

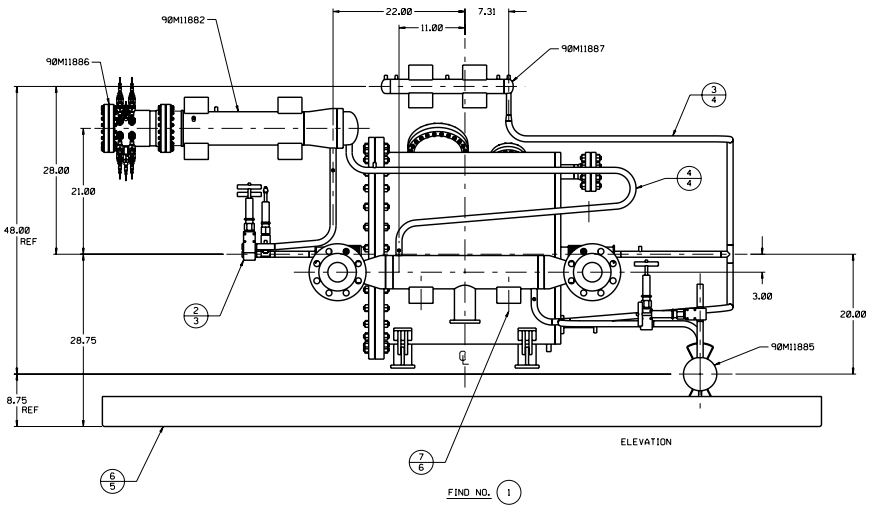
DRAWING SIZE E 90M11881
SHEET 1 OF 9

REVISIONS

SYM	DESCRIPTION	DATE	APPROVED
		- -	
		- -	
		- -	



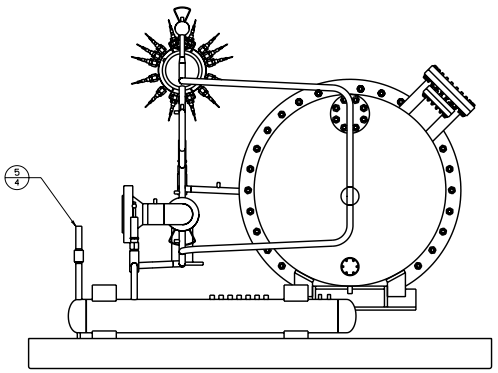
PLAN



ELEVATION

FIND NO. (1)

SCALE: 1:8



90M11881
SEE SHT1
REVISION

LITHIUM SYSTEM LAYOUT		SPECIAL TEST EQUIPMENT DESIGN BRANCH GEORGE C. MARSHALL SPACE FLIGHT CENTER NATIONAL AERONAUTICS AND SPACE ADMINISTRATION HUNTSVILLE, ALABAMA
DATE - -	SPACE CODE ET22	SIZE E 90M11881
DETAILER	SCALE NOTED	SHEET 2 OF 9

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVED
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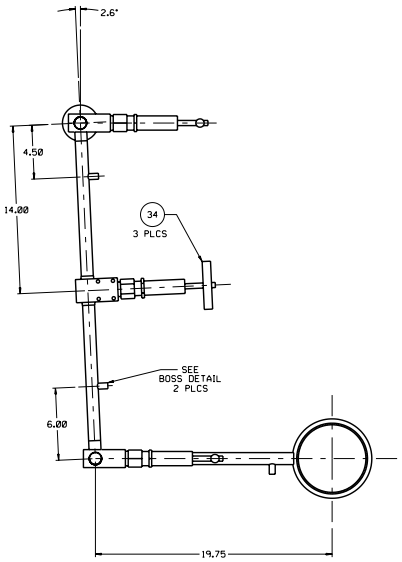
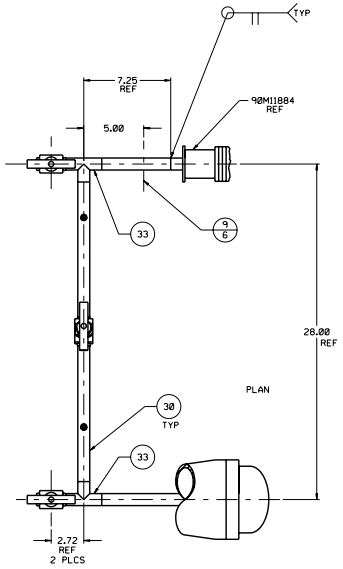
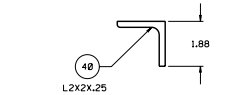
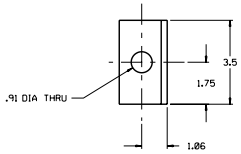
		- -	
		- -	









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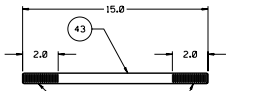

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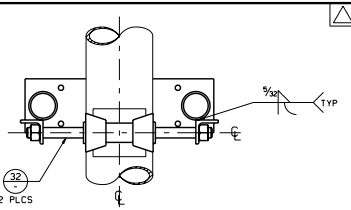

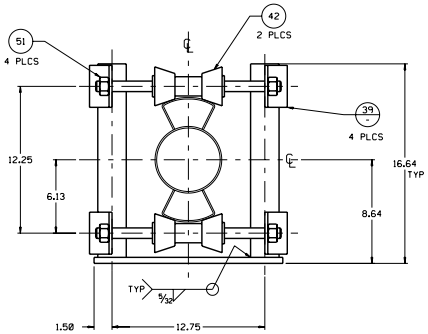

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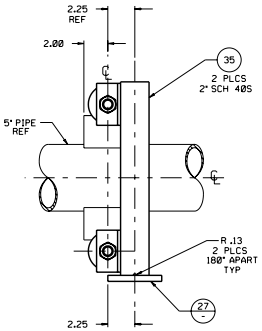
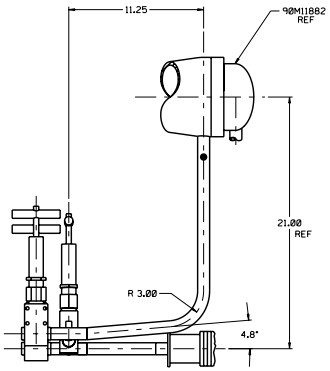
SEE ANCHOR DETAIL 4 PLCS

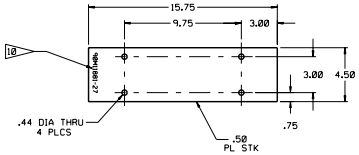




ELEVATION

FIND NO. 2 2

SCALE: 1:4



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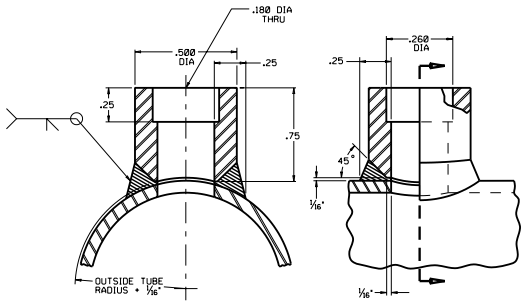
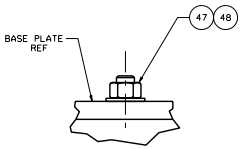


BOSS DETAIL

SCALE: NONE



ANCHOR DETAIL

90M11881
SEE SHT1
REVISION

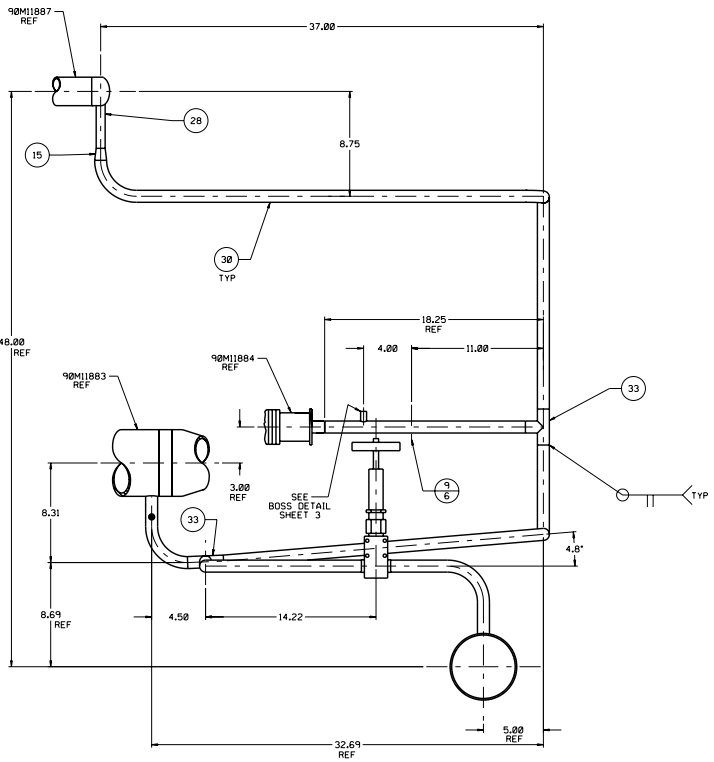
BOSS DETAIL NOTES: (UNLESS OTHERWISE SPECIFIED)

1. REMOVE ALL BURRS AND BREAK ALL SHARP EDGES.
2. ALL BOSS WELDS SHALL BE 100% VISUALLY AND 100% DYE PENETRANT EXAMINED PER ASME B31.1.

LITHIUM SYSTEM LAYOUT		SPECIAL TEST EQUIPMENT DESIGN BRANCH GEORGE C. MARSHALL SPACE FLIGHT CENTER NATIONAL AERONAUTICS AND SPACE ADMINISTRATION HUNTSVILLE, ALABAMA
DATE - -	SPACE CODE ET22	SIZE E 90M11881
DETAILER	SCALE NOTED	SHEET 3 OF 9

REVISIONS

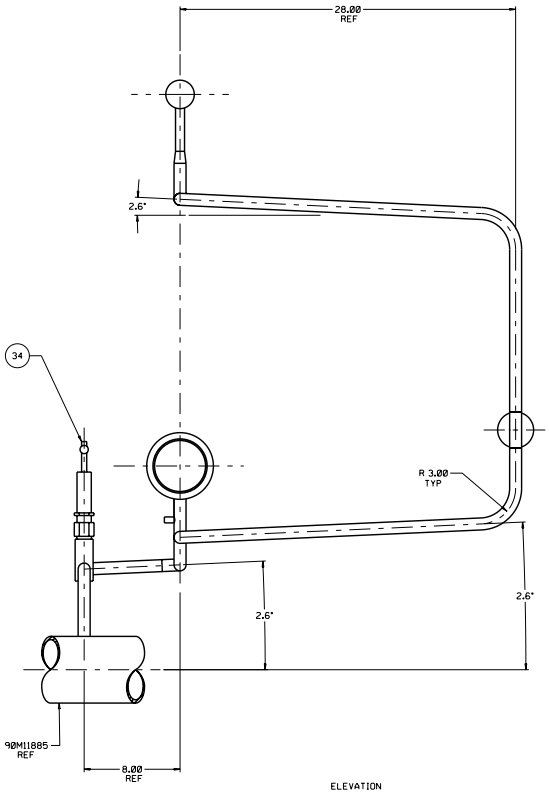
SYM	DESCRIPTION	DATE	APPROVED
		- -	
		- -	
		- -	



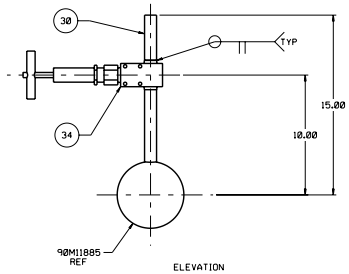
ELEVATION

FIND NO. 3/2

SCALE: 1:4



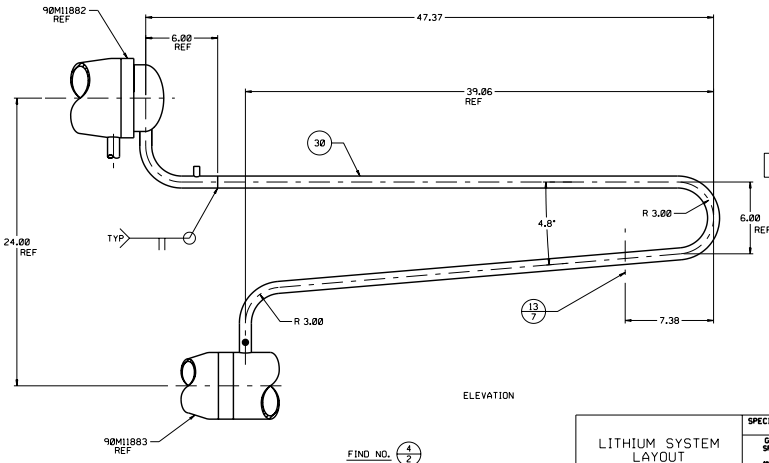
ELEVATION



ELEVATION

FIND NO. 5/2

SCALE: 1:4



ELEVATION

FIND NO. 4/2

SCALE: 1:4

90M11881
SEE SHT1
REVISION

LITHIUM SYSTEM LAYOUT	SPECIAL TEST EQUIPMENT DESIGN BRANCH GEORGE C. MARSHALL SPACE FLIGHT CENTER NATIONAL AERONAUTICS AND SPACE ADMINISTRATION HUNTSVILLE, ALABAMA
DATE - -	SPACE CODE ET22
DETAILER	SCALE NOTED
	DRAWING SIZE E 90M11881
	SHEET 4 OF 9

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVED
		- -	
		- -	
		- -	

HINGED END

PLAN

FIND NO. 6/2
SCALE: 1:4

VIEW B
SCALE: 1:2

SECTION A
SCALE: 1:2

.40 DIA THRU
76 PLCS

1.00 DIA IN BOTTOM SIDE
OF SQUARE TUBE
22 PLCS

R .25
TYP

5.0
TYP

1.5
TYP

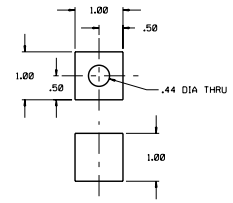
90M11720

46 47 48
76 PLCS

90M11881
SEE SHT1
REVISION

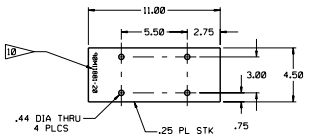
LITHIUM SYSTEM LAYOUT	SPECIAL TEST EQUIPMENT DESIGN BRANCH GEORGE C. MARSHALL SPACE FLIGHT CENTER NATIONAL AERONAUTICS AND SPACE ADMINISTRATION HUNTSVILLE, ALABAMA	
DATE - -	SPEC CODE ET22	SIZE E
DETAILER	SCALE NOTED	DRAWING NO. 90M11881
		SHEET 5 OF 9

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVED
		- -	
		- -	
		- -	



FIND NO. 23

SCALE: FULL



FIND NO. 20

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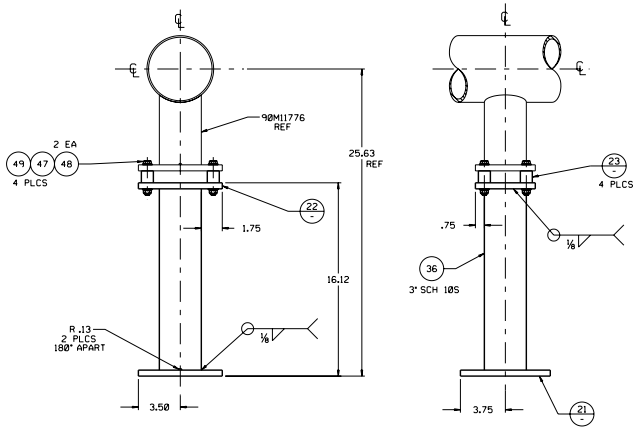
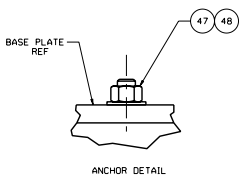


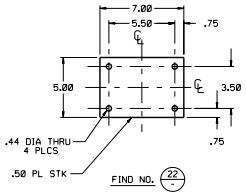
FIND NO. 10
2

SCALE: 1:4

SEE ANCHOR DETAIL 4 PLCS

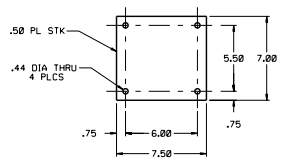


ANCHOR DETAIL



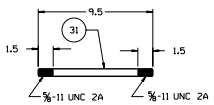
FIND NO. 22

SCALE: 1:4



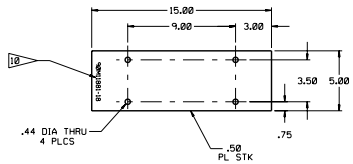
FIND NO. 21

SCALE: 1:4



FIND NO. 56

SCALE: 1:4



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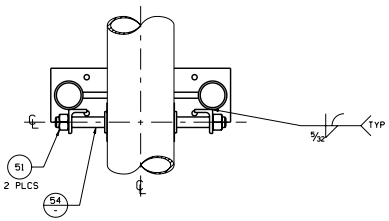

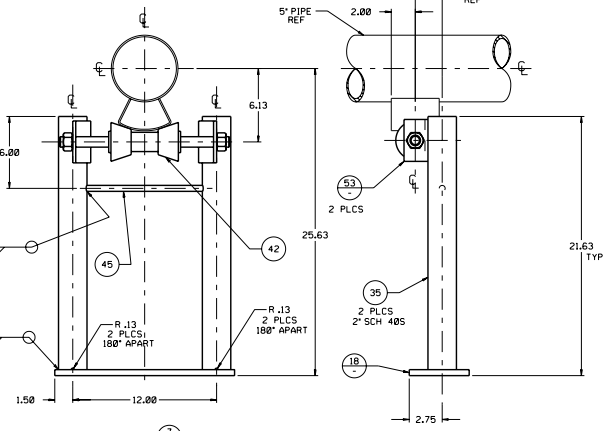

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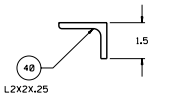
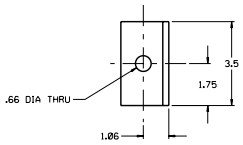
SCALE: 1:4

SEE ANCHOR DETAIL 4 PLCS





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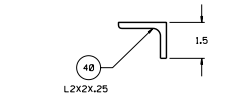

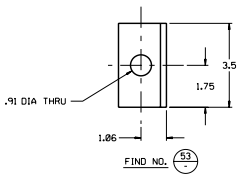

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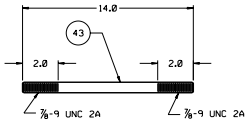

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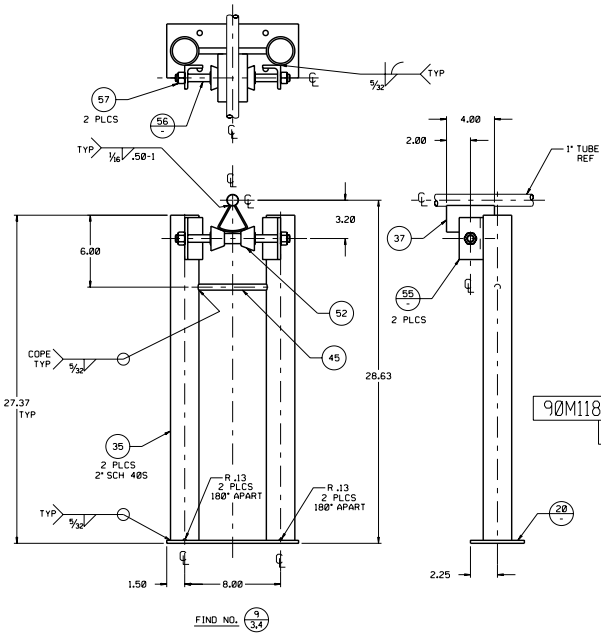

FIND NO. 9
3,4

SCALE: 1:4

SEE ANCHOR DETAIL 4 PLCS

90M11881
SEE SHT1
REVISION

LITHIUM SYSTEM LAYOUT	SPECIAL TEST EQUIPMENT DESIGN BRANCH GEORGE C. MARSHALL SPACE FLIGHT CENTER NATIONAL AERONAUTICS AND SPACE ADMINISTRATION HUNTSVILLE, ALABAMA	
DATE - -	SPACE CODE ET22	SIZE E
DETAILER	SCALE NOTED	DRAWING NO. 90M11881
		SHEET 6 OF 9

REVISIONS

SYM	DESCRIPTION	DATE	APPROVED
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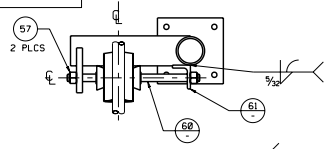
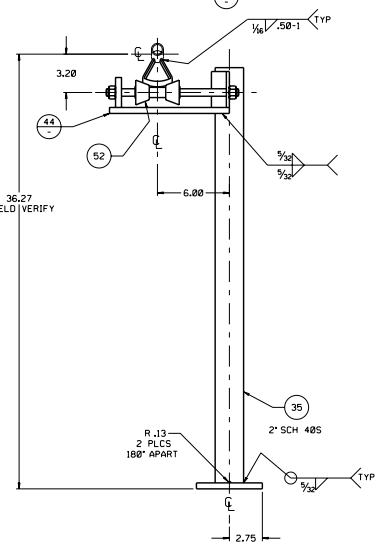
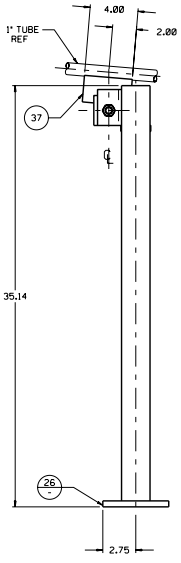


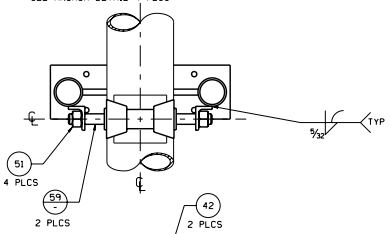


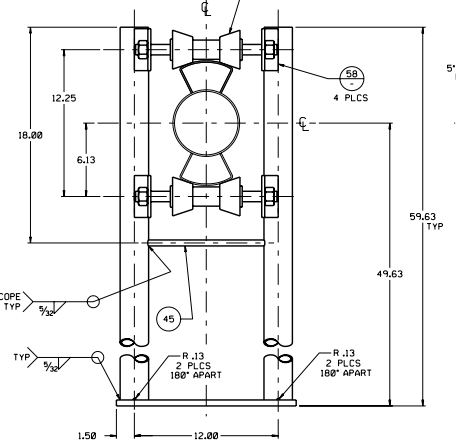


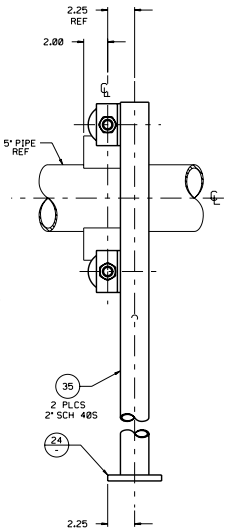
FIND NO. 13/4

SCALE: 1:4

SEE ANCHOR DETAIL 4 PLCS



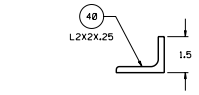


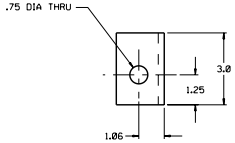


FIND NO. 11/2

SCALE: 1:4

SEE ANCHOR DETAIL 4 PLCS





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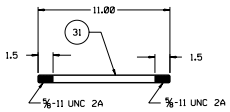

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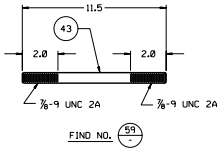

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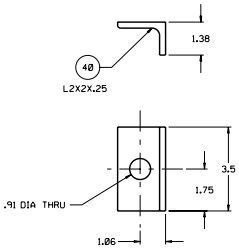

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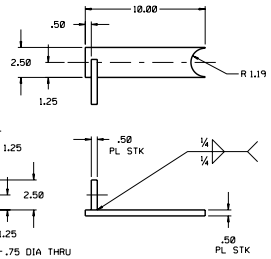

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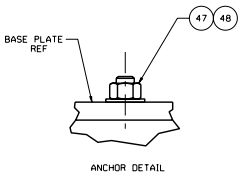
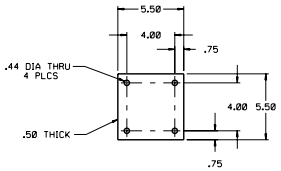


ANCHOR DETAIL



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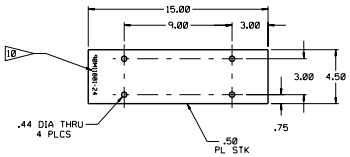

FIND NO. 24

SCALE: 1:4

90M11881

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REVISION

LITHIUM SYSTEM LAYOUT	SPECIAL TEST EQUIPMENT DESIGN BRANCH GEORGE C. MARSHALL SPACE FLIGHT CENTER NATIONAL AERONAUTICS AND SPACE ADMINISTRATION HUNTSVILLE, ALABAMA	
DATE - -	OFFICE CODE ET22	SIZE E
DETAILER	SCALE NOTED	DRAWING NO. 90M11881
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REVISIONS

SYM	DESCRIPTION	DATE	APPROVED
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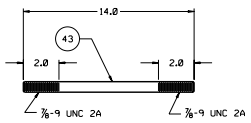
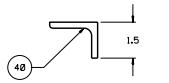
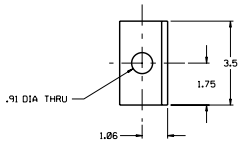


FIND NO. 63 -

SCALE: 1:4





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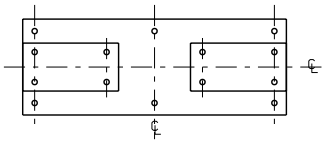

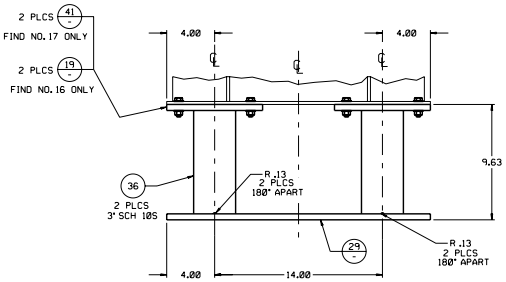

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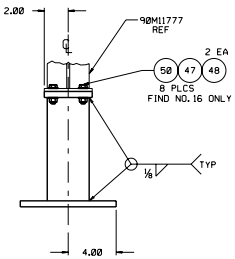
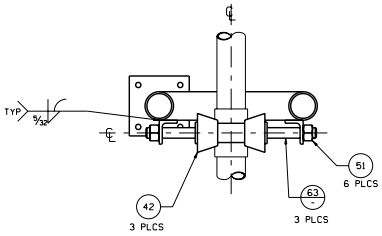
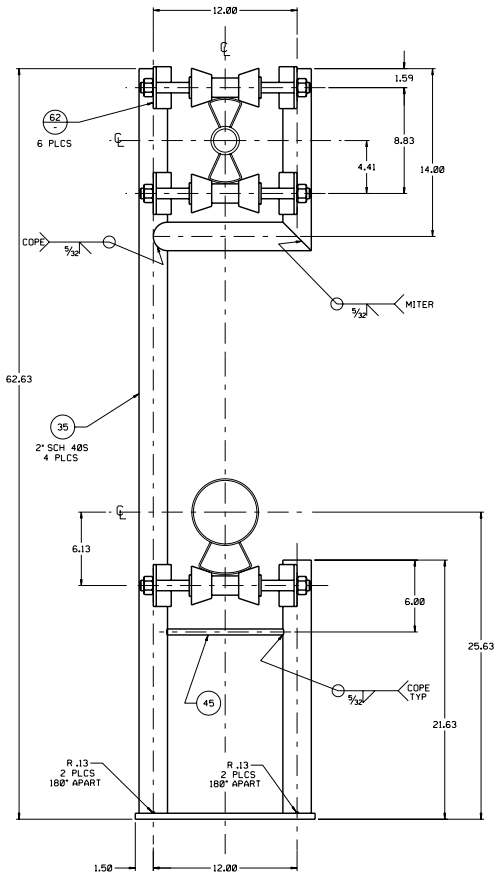
SCALE: 1:4

SEE ANCHOR DETAIL 6 PLCS







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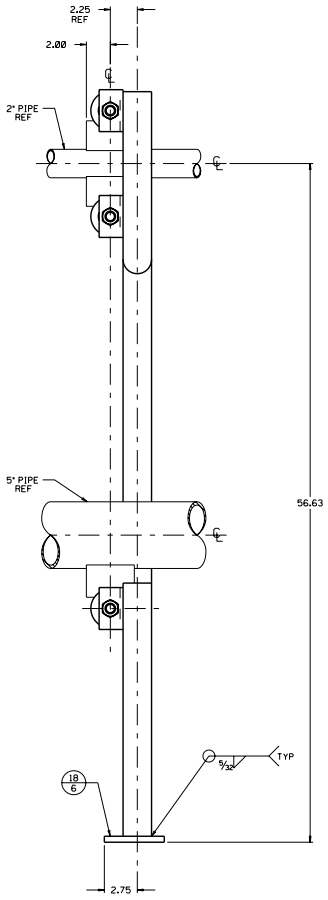
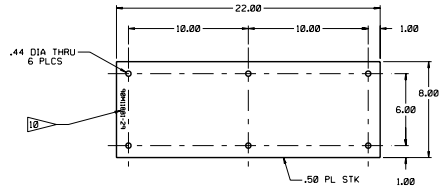
SCALE: 1:4

SEE ANCHOR DETAIL 4 PLCS





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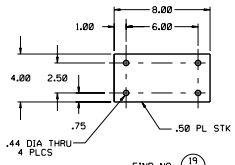

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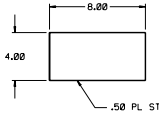

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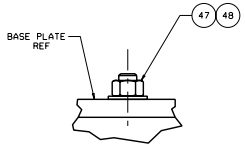

ANCHOR DETAIL

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LITHIUM SYSTEM LAYOUT	SPECIAL TEST EQUIPMENT DESIGN BRANCH -	
	GEORGE C. MARSHALL SPACE FLIGHT CENTER NATIONAL AERONAUTICS AND SPACE ADMINISTRATION HUNTSVILLE, ALABAMA	
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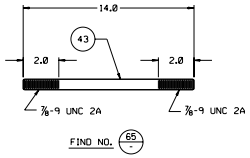

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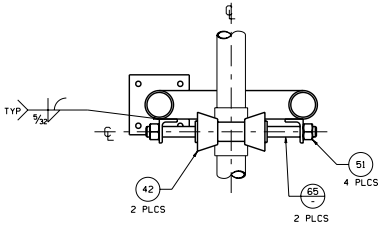

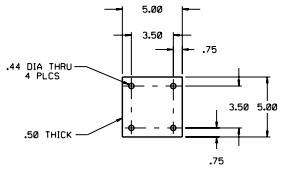

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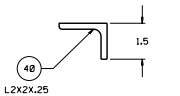
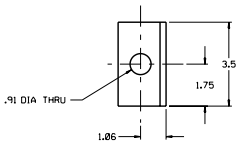
SCALE: 1:4





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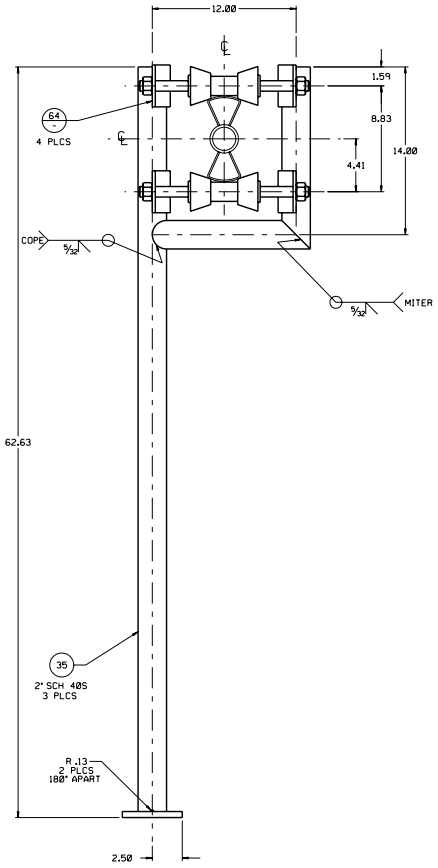

FIND NO. 12 2

SCALE: 1:4

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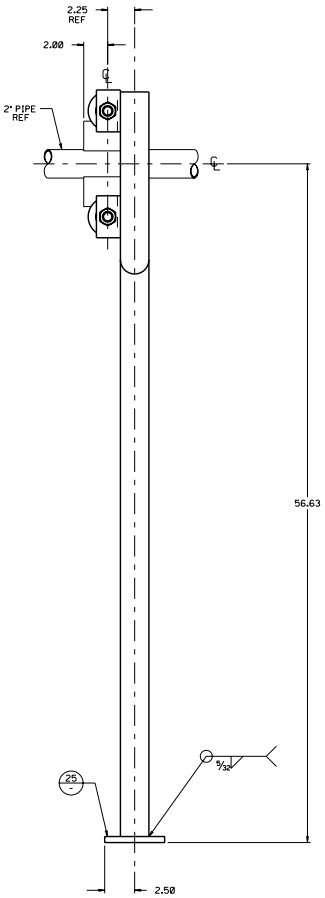

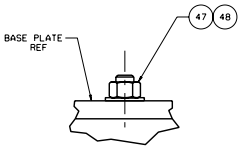

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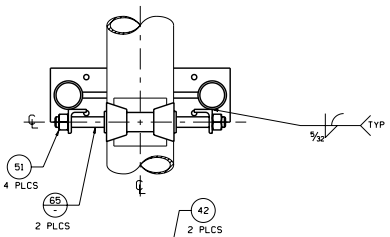

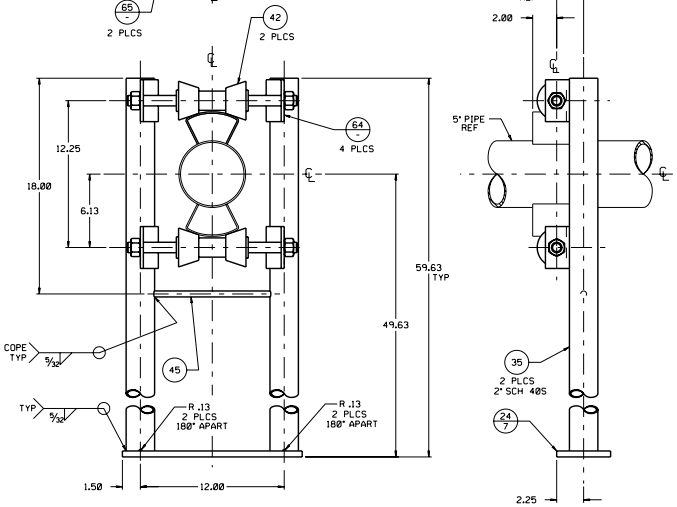

FIND NO. 66 2

SCALE: 1:4

SEE ANCHOR DETAIL 4 PLCS

90M1881

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REVISION

LITHIUM SYSTEM LAYOUT	SPECIAL TEST EQUIPMENT DESIGN BRANCH GEORGE C. MARSHALL SPACE FLIGHT CENTER NATIONAL AERONAUTICS AND SPACE ADMINISTRATION HUNTSVILLE, ALABAMA	
DATE - -	SPACE CODE ET22	SIZE E
DETAILER	SCALE NOTED	DRAWING NO. 90M1881
		SHEET 9 OF 9

SECTION C—CORE DRAWINGS: T.J. GODFROY

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVED
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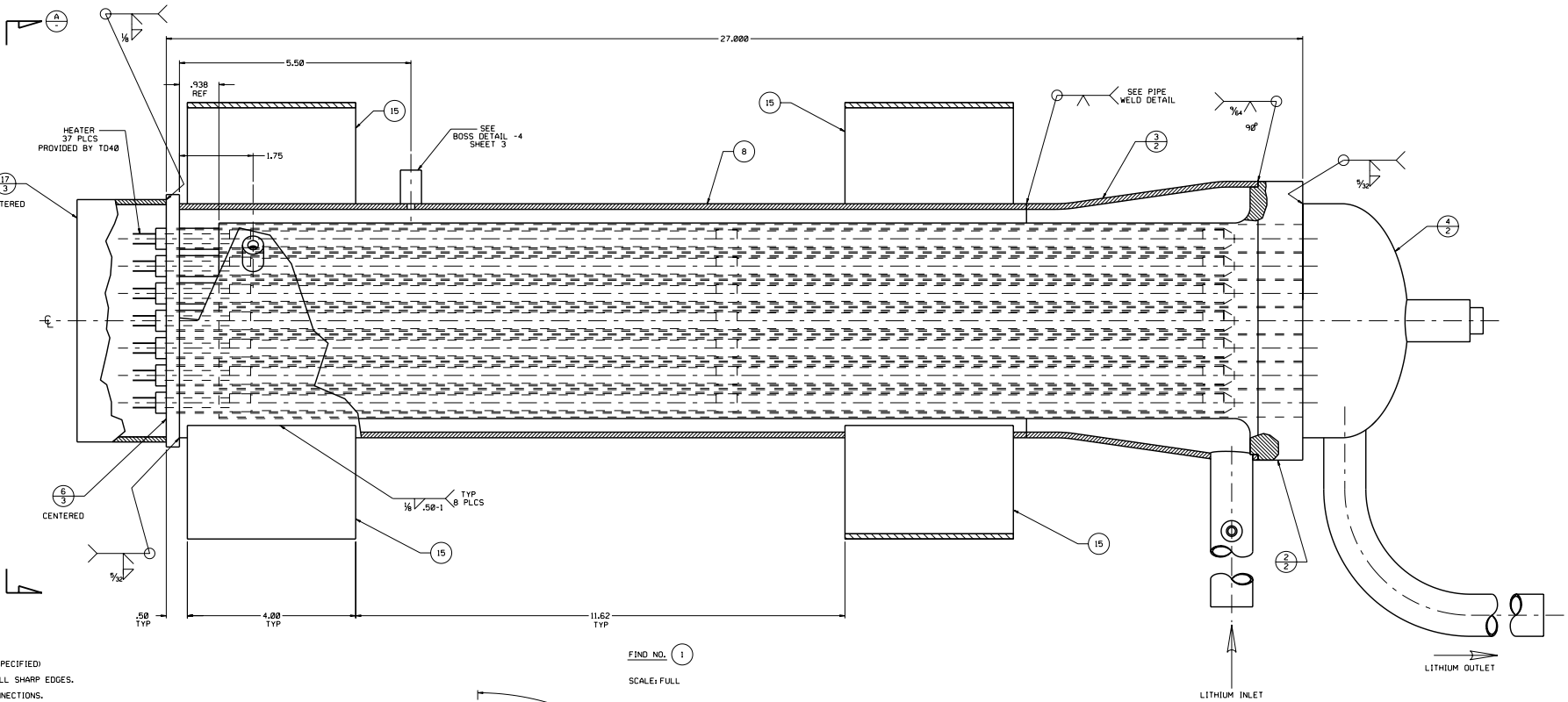


GENERAL NOTES (UNLESS OTHERWISE SPECIFIED)

1. REMOVE ALL BURRS AND BREAK ALL SHARP EDGES.
2. FIELD TO VERIFY ALL TIE-IN CONNECTIONS.
3. ALL PIPE SIZES AND SCHEDULES SHALL CONFORM TO THE DIMENSIONS OF ASME-B36.10 OR ASME-B36.19.
4. ALL FITTINGS SHALL CONFORM TO THE DIMENSIONS OF ASME-B16.9 OR ASME-B16.28. NO BLOCK PATTERN FITTINGS SHALL BE USED. THE CROTCH AREA OF TEES AND CROSSES SHALL BE REINFORCED WITH LONG RADIUS DESIGN TO ELIMINATE SHARP CORNERS.
5. ALL BEVELS FOR BUTTWELDING ENDS OF PIPE FITTINGS, FLANGES, VALVES, AND COMPONENTS SHALL CONFORM TO ASME-B16.25.
6. ALL MACHINED PARTS TO HAVE A 125 MICROINCH ROUGHNESS HEIGHT RATING SURFACE FINISH.
7. THE SYSTEM SHALL BE HYDROSTATED TO 2.24 TIMES THE WORKING PRESSURE OF THE SYSTEM PER ASME SECTION VIII, DIV 1. THE WATER USED SHALL CONTAIN NO MORE THAN 25 PPM OF CHLORIDE FOR SST PIPE (50 PPM FOR C.S.) AND SHALL HAVE ½% BY WEIGHT SODIUM NITRITE AS AN INHIBITOR.
8. ALL SYSTEM WELDS AND STRUCTURAL ATTACHMENTS TO PIPING SHALL BE WELDED PER ASME SECTION VIII, DIVISION 1.
9. THE SYSTEM SHALL BE DESIGNED PER ASME SECTION VIII, DIVISION 1.
10. STEEL STAMP .25 HIGH CHARACTERS AS SHOWN.
11. ALL STEEL SUPPORTS SHALL BE WELDED AND 100% VISUALLY INSPECTED PER ASME SECTION VIII, DIVISION 1.
12. 316 STAINLESS STEEL MAY BE USED IN PLACE OF 316H IF THE CARBON CONTENT IS VERIFIED TO BE .04% OR HIGHER ON HEAT ANALYSIS. NO OTHER SUBSTITUTIONS SHALL BE PERMITTED FOR 316H SST.

SPECIFIC NOTES

13. MATERIAL SPECIFICATIONS FOR STAINLESS STEEL SYSTEMS

PIPE:	ASTM-A312-TP316H SST. - SEAMED OR SEAMLESS
PIPE FITTINGS:	ASTM-A403-WP-S 316H SST.
TUBE:	ASTM-A213 TYPE 316H SST. - SEAMLESS
BAR STOCK:	AISI-316H SST PER ASTM A479, ALLOWABLE STRESS PER ASME B31.1
PLATE:	AISI-316H SST PER ASTM A240.
FORGINGS:	ASTM-A182-F316H SST.

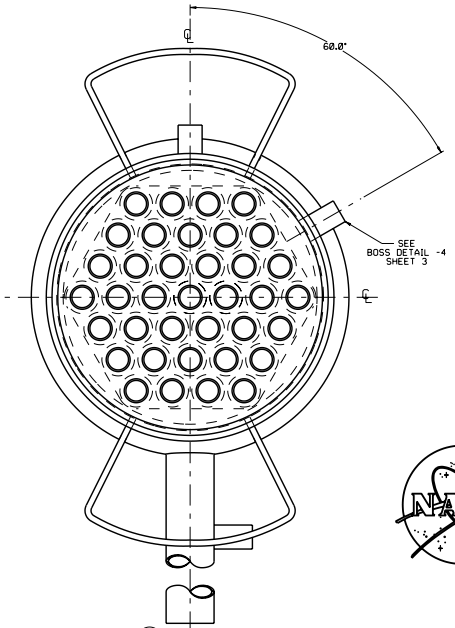
SPECIFIC NOTES

LITHIUM SYSTEM

14. ALL GIRTH AND LONGITUDINAL WELD JOINTS SHALL BE 100% VISUALLY AND 100% RADIOGRAPHICALLY EXAMINED PER ASME SECTION VIII, DIVISION 1.
15. THE PIPING SYSTEM SHALL BE HELIUM LEAK CHECKED USING A HELIUM MASS SPECTROMETER LEAK DETECTOR. ALLOWABLE LEAK RATE = 1 X 10^{-7} CC PER SECOND.
16. THE PIPING SYSTEM SHALL BE CLEANED FOR LIQUID OXYGEN SERVICE PER MSFC-SPEC-1648.
17. ALL MATERIAL IN CONTACT WITH LITHIUM SHALL BE CERTIFIED AND APPROVED BY MATERIALS, PROCESSES AND MANUFACTURING DEPARTMENT.

FIND NO. (1)

SCALE: FULL

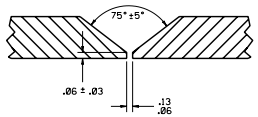


VIEW (A) SECTION (A)

SCALE: FULL SCALE: FULL

SUGGESTED VENDORS:

1. ANVIL INTERNATIONAL INC.
   110 CORPORATE DRIVE
   PORTSMOUTH, NH 03802
   PH. (603) 422-8000



TYPICAL PIPE WELD DETAIL

SCALE: NONE

PRELIMINARY
HAS NOT COMPLETED REVIEW CYCLE
AND IS SUBJECT TO CHANGE
1-16-05

FIND NO.	SHEET NO.	TOT. REQ'D	PART NO.	DESCRIPTION	VEND. NO.	REMARKS
20						
19						
18	2	1	90M11882-18	THERMOWELL		SST SEE NOTE 13
17	1,3	1	90M11882-17	RING		SST SEE NOTE 13
16	2	A/R	90M11882-16	⅜" O.D. X .065" WALL SEAMLESS TUBE		SST SEE NOTE 13
15	1	4	90M11882-15	PIPE PROTECTION SADDLE FOR 5" PIPE	1	FIG. 162A ASTM-A240 316H SST
14	3	A/R	90M11882-14	5/64 DIA ROUND		SST SEE NOTE 13
13	3	37	90M11882-13	HEATER TUBE		SST SEE NOTE 13
12	3	A/R	90M11882-12	½" O.D. X .035" WALL SEAMLESS TUBE		SST SEE NOTE 13
11	2	A/R	90M11882-11	1" O.D. X .095" WALL SEAMLESS TUBE		SST SEE NOTE 13
10	2	1	90M11882-10	6" X 5" SCH 10S CONCENTRIC PIPE REDUCER		SST SEE NOTE 13
9	2	1	90M11882-9	5" SCH 10S PIPE CAP		SST SEE NOTE 13
8	1	A/R	90M11882-8	5" SCH 10S PIPE		SST SEE NOTE 13
7	3	37	90M11882-7	HEATER TUBE TIP		SST SEE NOTE 13
6	1,3	1	90M11882-6	HEATER TUBE ASSEMBLY		SST SEE NOTE 13
5	3	1	90M11882-5	HEATER PLATE		SST SEE NOTE 13
4	1,2	1	90M11882-4	NAK OUTLET		SST SEE NOTE 13
3	1,2	1	90M11882-3	NAK INLET		SST SEE NOTE 13
2	1,2	1	90M11882-2	MONOLITHIC CORE		SST SEE NOTE 13
1	1	-	90M11882-1	MAIN ASSEMBLY		

A=ASSEMBLY/SUB-ASSEMBLY/INSTALLATION E=EXISTING ITEM/FACILITY F=FABRICATED ITEM M=MODIFIED ITEM P=PURCHASED ITEM

90M11882 ~ REVISION

SERVICE: LITHIUM
TEMPERATURE: 50°F TO 860 °F
INTERNAL PRESSURE: 20 PSI
EXTERNAL PRESSURE: 0 PSI

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS ± 1/16 DECIMAL X ± .06 .XX ± .03 .XXX ± .010 ANGLES ± ½°
DO NOT SCALE DRAWING

LOCATION: 9' VC, BLDG. 4655
NEXT ASSEMBLY: 90M11881
LAST DETAIL, SECTION OR VIEW LETTER USED: B

PROJ DESIGN ENGINEER		DATE
TEST ENGINEER/REQUESTER	- -	DATE
STRESS	- -	DATE
MATERIALS	- -	DATE
INDUSTRIAL SAFETY	- -	DATE
PROJ APPROVAL	- -	DATE

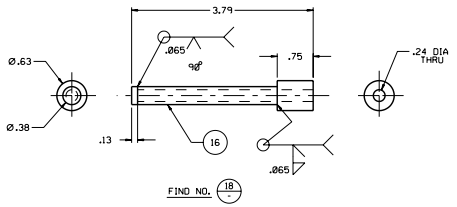
LITHIUM CORE

DETAILER: -
DATE: 10-15-04 ET22
DESIGN: NOTED

SPECIAL TEST EQUIPMENT DESIGN BRANCH
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA

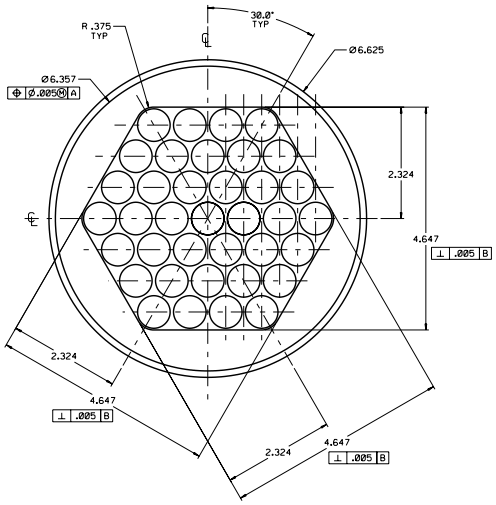
SIZE E | 90M11882 | REV
SHEET 1 OF 3

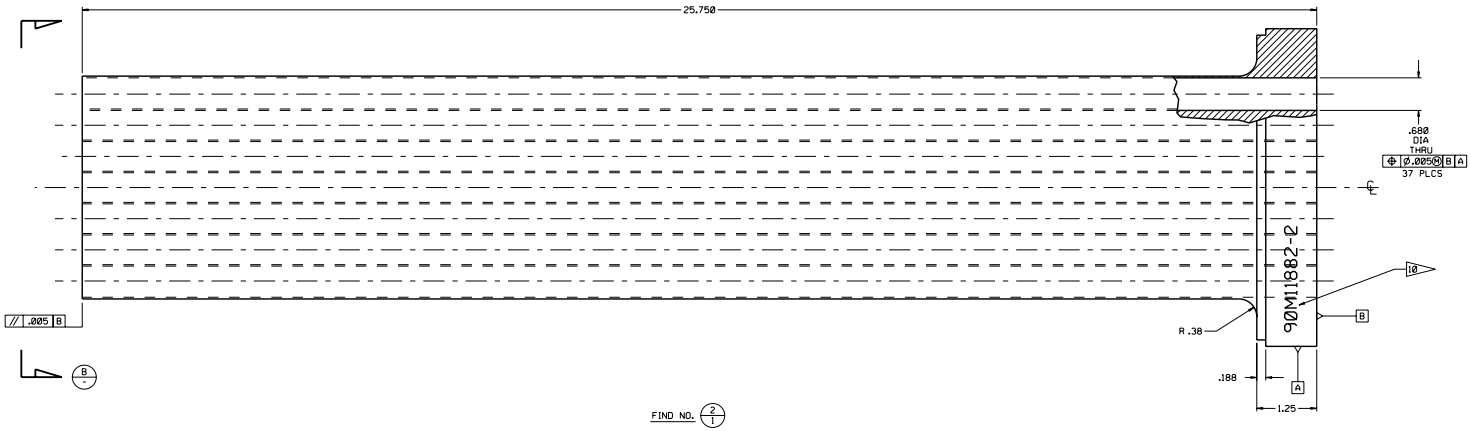
REVISIONS			
SYM	DESCRIPTION	DATE	APPROVED
		- -	
		- -	
		- -	



FIND NO. 18

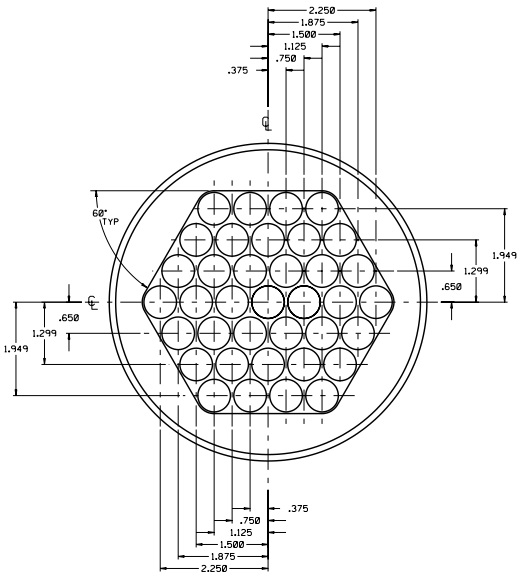
SCALE: FULL





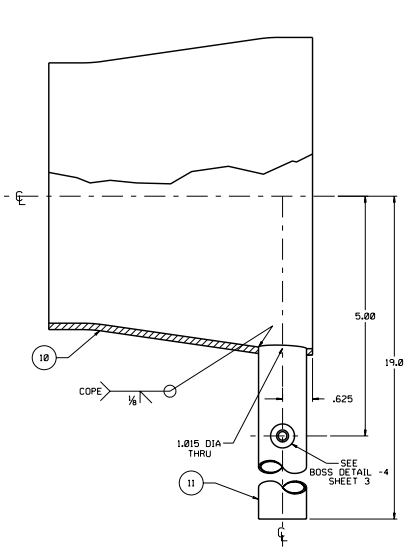
FIND NO. 2

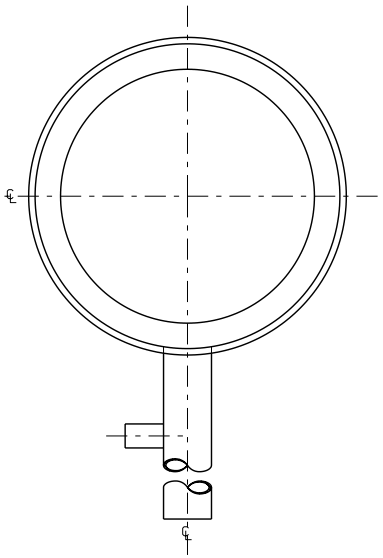
SCALE: FULL



VIEW B

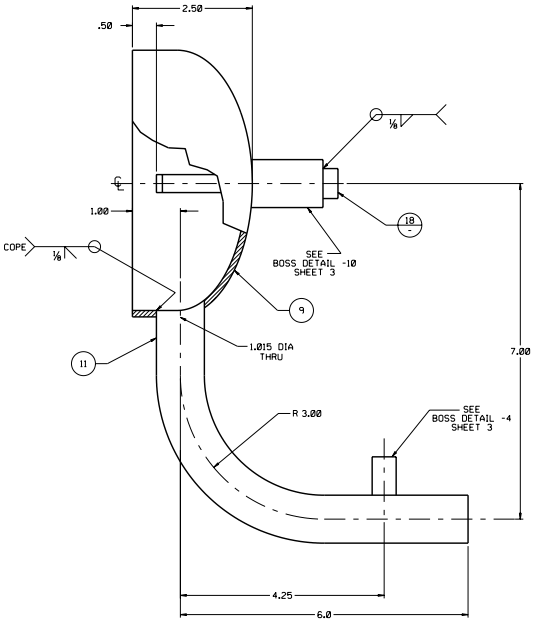
SCALE: FULL





FIND NO. 3

SCALE: FULL

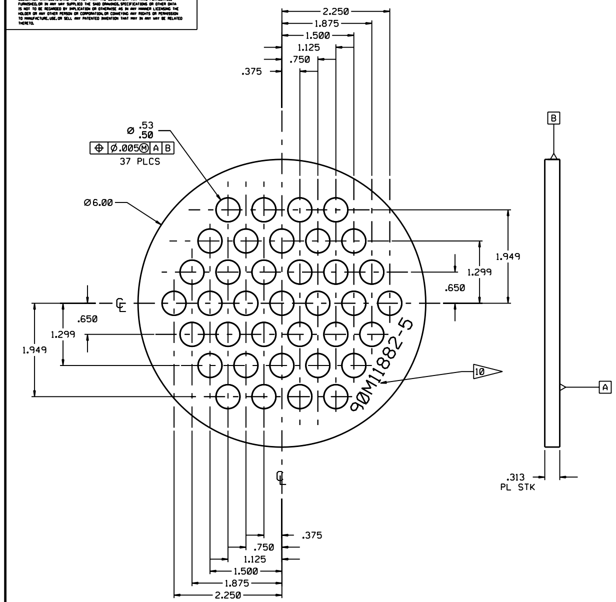


FIND NO. 4

SCALE: FULL

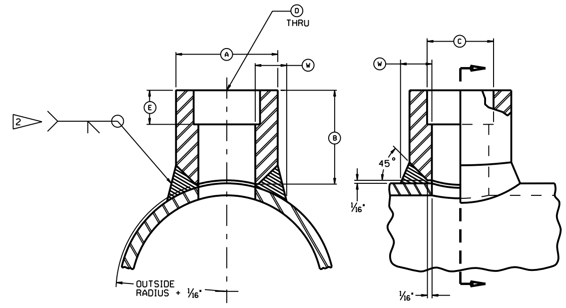
90M11882
SEE SHT1
REVISION

LITHIUM CORE	SPECIAL TEST EQUIPMENT DESIGN BRANCH GEORGE C. MARSHALL SPACE FLIGHT CENTER NATIONAL AERONAUTICS AND SPACE ADMINISTRATION HUNTSVILLE, ALABAMA	
DATE - -	SPACE CODE ET22	DRAWING NO. 90M11882
DETAILER	SCALE NOTED	SHEET 2 OF 3



FIND NO. 5/-

SCALE: FULL



BOSS DETAIL

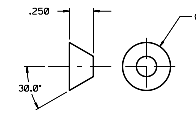
SCALE: NONE

BOSS SIZE-DASH NUMBER	TUBING SIZE OUTSIDE DIA.	(A) BOSS DIA.	(B) BOSS HEIGHT	(C) SOCKET DIA.	(W) WELD (MIN.)	(D) HOLE DIA.	(E) SOCKET DEPTH
-4	1/4"	.50"	.75"	.260"	1/4"	.180"	.25"
-10	5/8"	1.00"	1.50"	.688"	3/8"	.438"	.50"

BOSS DETAIL NOTES: (UNLESS OTHERWISE SPECIFIED)

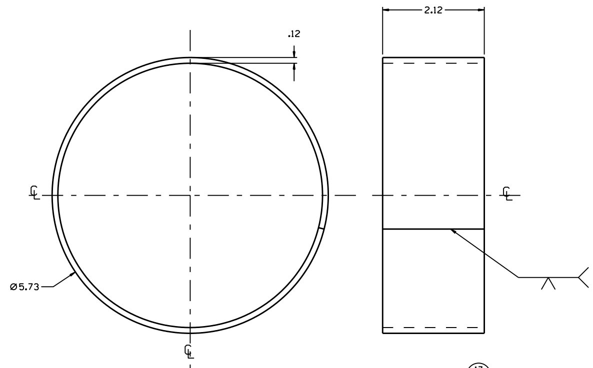
1. REMOVE ALL BURRS AND BREAK ALL SHARP EDGES.

2. ALL BOSS WELDS SHALL BE 100% VISUALLY AND 100% DYE PENETRANT EXAMINED PER ASME B31.1.



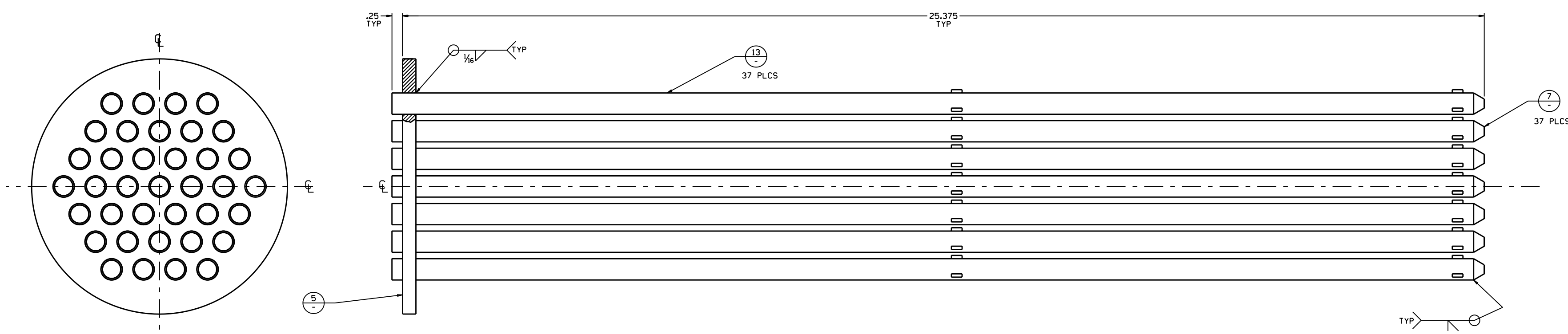
FIND NO. 7/-

SCALE: 2:1



FIND NO. 17/1

SCALE:



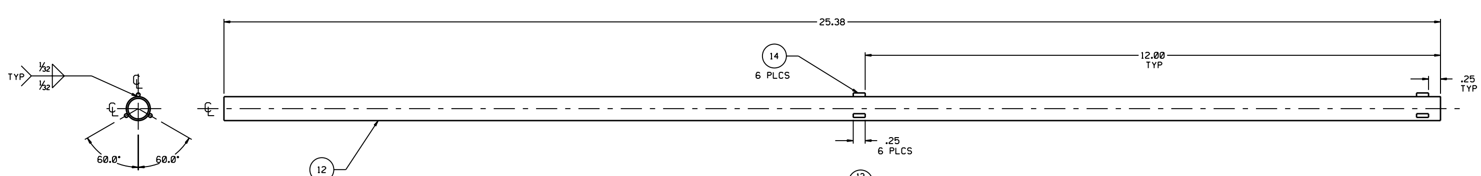
FIND NO. 6/1

SCALE: FULL

90M11882

SEE SHT1

REVISION



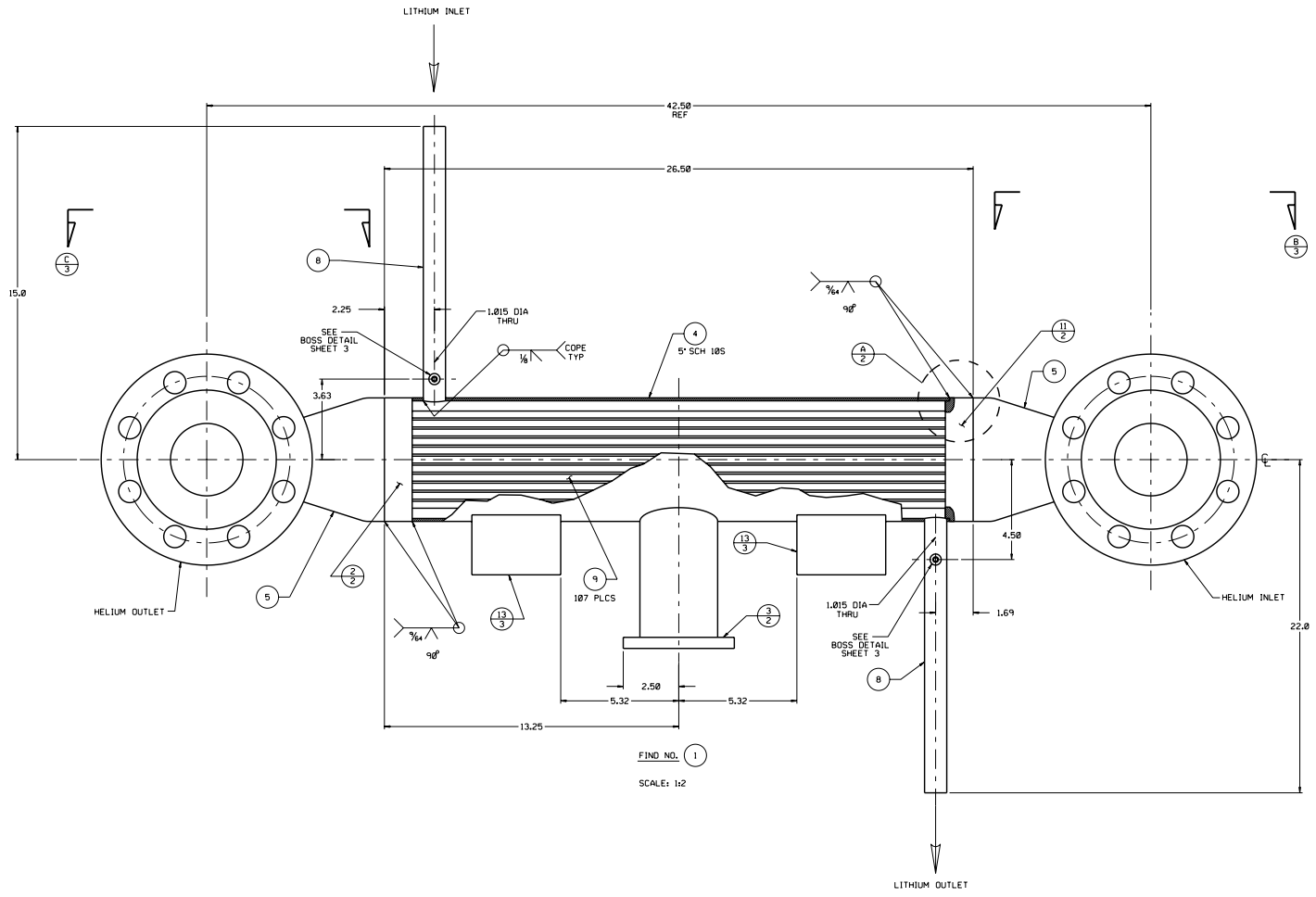
FIND NO. 13/-

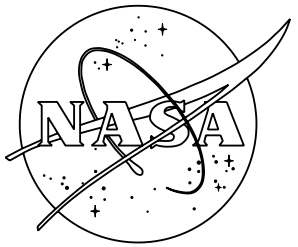
SCALE: FULL

LITHIUM CORE	SPECIAL TEST EQUIPMENT DESIGN BRANCH GEORGE C. MARSHALL SPACE FLIGHT CENTER NATIONAL AERONAUTICS AND SPACE ADMINISTRATION HUNTSVILLE, ALABAMA
DATE - - / OFFICE CODE ET22	DRAWING SIZE E / 90M11882
DETAILER / SCALE NOTED	SHEET 3 OF 3

SECTION D—HEAT EXCHANGER DRAWINGS: T.J. GODFROY

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVED
		- -	
		- -	
		- -	





PRELIMINARY
HAS NOT COMPLETED REVIEW CYCLE
AND IS SUBJECT TO CHANGE
10-28-04

SUGGESTED VENDORS:

1. ANVIL INTERNATIONAL INC.
110 CORPORATE DRIVE
PORTSMOUTH, NH 03802
PH. (603) 422-8000

SPECIFIC NOTES

12 13. MATERIAL SPECIFICATIONS FOR STAINLESS STEEL SYSTEMS

PIPE:	ASTM-A312-TP316H SST. - SEAMED OR SEAMLESS
PIPE FITTINGS:	ASTM-A403-WP-S 316H SST.
TUBE:	ASTM-A213 TYPE 316H SST. - SEAMLESS
BAR STOCK:	AISI-316H SST PER ASTM A479, ALLOWABLE STRESS PER ASME B31.1
PLATE:	AISI-316H SST PER ASTM A240.
PIPE FLANGES:	ASTM-A182-F316H SST.

GENERAL NOTES (UNLESS OTHERWISE SPECIFIED)

1. REMOVE ALL BURRS AND BREAK ALL SHARP EDGES.
2. FIELD TO VERIFY ALL TIE-IN CONNECTIONS.
3. ALL PIPE SIZES AND SCHEDULES SHALL CONFORM TO THE DIMENSIONS OF ASME-B36.10 OR ASME-B36.19.
4. ALL FITTINGS SHALL CONFORM TO THE DIMENSIONS OF ASME-B16.9 OR ASME-B16.28. NO BLOCK PATTERN FITTINGS SHALL BE USED. THE CROTCH AREA OF TEES AND CROSSES SHALL BE REINFORCED WITH LONG RADIUS DESIGN TO ELIMINATE SHARP CORNERS.
5. ALL BEVELS FOR BUTTWELDING ENDS OF PIPE FITTINGS, FLANGES, VALVES, AND COMPONENTS SHALL CONFORM TO ASME-B16.25.
6. ALL MACHINED PARTS TO HAVE A 125 MICROINCH ROUGHNESS HEIGHT RATING SURFACE FINISH.
7. THE SYSTEM SHALL BE HYDROSTATED TO 2.24 TIMES THE WORKING PRESSURE OF THE SYSTEM PER ASME SECTION VIII, DIV 1. THE WATER USED SHALL CONTAIN NO MORE THAN 25 PPM OF CHLORIDE FOR SST PIPE (50 PPM FOR C.S.) AND SHALL HAVE ½% BY WEIGHT SODIUM NITRITE AS AN INHIBITOR.
8. ALL SYSTEM WELDS AND STRUCTURAL ATTACHMENTS TO PIPING SHALL BE WELDED PER ASME SECTION VIII, DIVISION 1.
9. THE SYSTEM SHALL BE DESIGNED PER ASME SECTION VIII, DIVISION 1.
10. STEEL STAMP .25 HIGH CHARACTERS AS SHOWN.
11. ALL STEEL SUPPORTS SHALL BE WELDED AND 100% VISUALLY INSPECTED PER ASME SECTION VIII, DIVISION 1.
12. 316 STAINLESS STEEL MAY BE USED IN PLACE OF 316H IF THE CARBON CONTENT IS VERIFIED TO BE .04% OR HIGHER ON HEAT ANALYSIS. NO OTHER SUBSTITUTIONS SHALL BE PERMITTED FOR 316H SST.

SPECIFIC NOTES

LITHIUM SYSTEMS

14. ALL GIRTH AND LONGITUDINAL WELD JOINTS SHALL BE 100% VISUALLY AND 100% RADIOGRAPHICALLY EXAMINED PER ASME SECTION VIII, DIVISION 1.
15. THE PIPING SYSTEM SHALL BE HELIUM LEAK CHECKED USING A HELIUM MASS SPECTROMETER LEAK DETECTOR. ALLOWABLE LEAK RATE = 1 X 10^{-7} CC PER SECOND.
16. THE PIPING SYSTEM SHALL BE CLEANED FOR LIQUID OXYGEN SERVICE PER MSFC-SPEC-164B.

HELIUM SYSTEMS

17. ALL GIRTH AND LONGITUDINAL WELD JOINTS SHALL BE 100% VISUALLY AND 100% RADIOGRAPHICALLY EXAMINED PER ASME SECTION VIII, DIVISION 1.
18. THE PIPING SYSTEM SHALL BE HELIUM LEAK CHECKED USING A HELIUM MASS SPECTROMETER LEAK DETECTOR. ALLOWABLE LEAK RATE = 1 X 10^{-7} CC PER SECOND.
19. THE PIPING SYSTEM SHALL BE CLEANED FOR PNEUMATIC SERVICE PER MSFC-SPEC-164B.
20. ALL MATERIAL IN CONTACT WITH LITHIUM SHALL BE CERTIFIED AND APPROVED BY MATERIALS, PROCESSES AND MANUFACTURING DEPARTMENT.

SERVICE: HELIUM
TEMPERATURE: 50°F TO 860 °F
INTERNAL PRESSURE: 200 PSI
EXTERNAL PRESSURE: 0 PSI

SERVICE: LITHIUM
TEMPERATURE: 50°F TO 860 °F
INTERNAL PRESSURE: 20 PSI
EXTERNAL PRESSURE: 0 PSI

FIND NO.	SHEET NO.	TOT. REQ'D	PART NO.	DESCRIPTION	VEND. NO.	REMARKS
20						
19						
18						
17						
16						
15						
14						
13	1,3	2	90M11883-13	SADDLE ASSEMBLY		
12	3	2	90M11883-12	PIPE PROTECTION SADDLE FOR 5" PIPE	1	FIG. 162A ASTM-A240 316H SST
11	1,2	1	90M11883-11	TUBE PLATE		SST SEE NOTE 13
10	3	2	90M11883-10	3" 900# RF WELD NECK FLANGE W/ SCH 10S BORE		SST SEE NOTE 13
9	1	A/R	90M11883-9	3/16" O.D. X .035" WALL SEAMLESS TUBE		SST SEE NOTE 13
8	1,2	A/R	90M11883-8	1" O.D. X .095" WALL SEAMLESS TUBE		SST SEE NOTE 13
7	2,3	A/R	90M11883-7	3" SCH 10S SEAMLESS PIPE		SST SEE NOTE 13
6	3	2	90M11883-6	3" SCH 10S 90° LONG RADIUS ELBOW		SST SEE NOTE 13
5	1	2	90M11883-5	5" X 3" SCH 10S CONCENTRIC PIPE REDUCER		SST SEE NOTE 13
4	1	A/R	90M11883-4	5" SCH 10S PIPE		SST SEE NOTE 13
3	1,2	1	90M11883-3	SUPPORT		SST SEE NOTE 13
2	1,2	1	90M11883-2	TUBE PLATE		SST SEE NOTE 13
1	1	-	90M11883-1	MAIN ASSEMBLY		

A=ASSEMBLY/SUB-ASSEMBLY/INSTALLATION E=EXISTING ITEM/FACILITY F=FABRICATED ITEM M=MODIFIED ITEM P=PURCHASED ITEM

90M11883
~
REVISION

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS ± 1/16 DECIMAL .X- ± .06 .XX- ± .03 .XXX- ± .010 ANGLES ± 1/2°
DO NOT SCALE DRAWING

LOCATION: 9' VC, BLDG. 4655
NEXT ASSEMBLY: 90M11881
LAST DETAIL, SECTION, OR VIEW LETTER USED: C

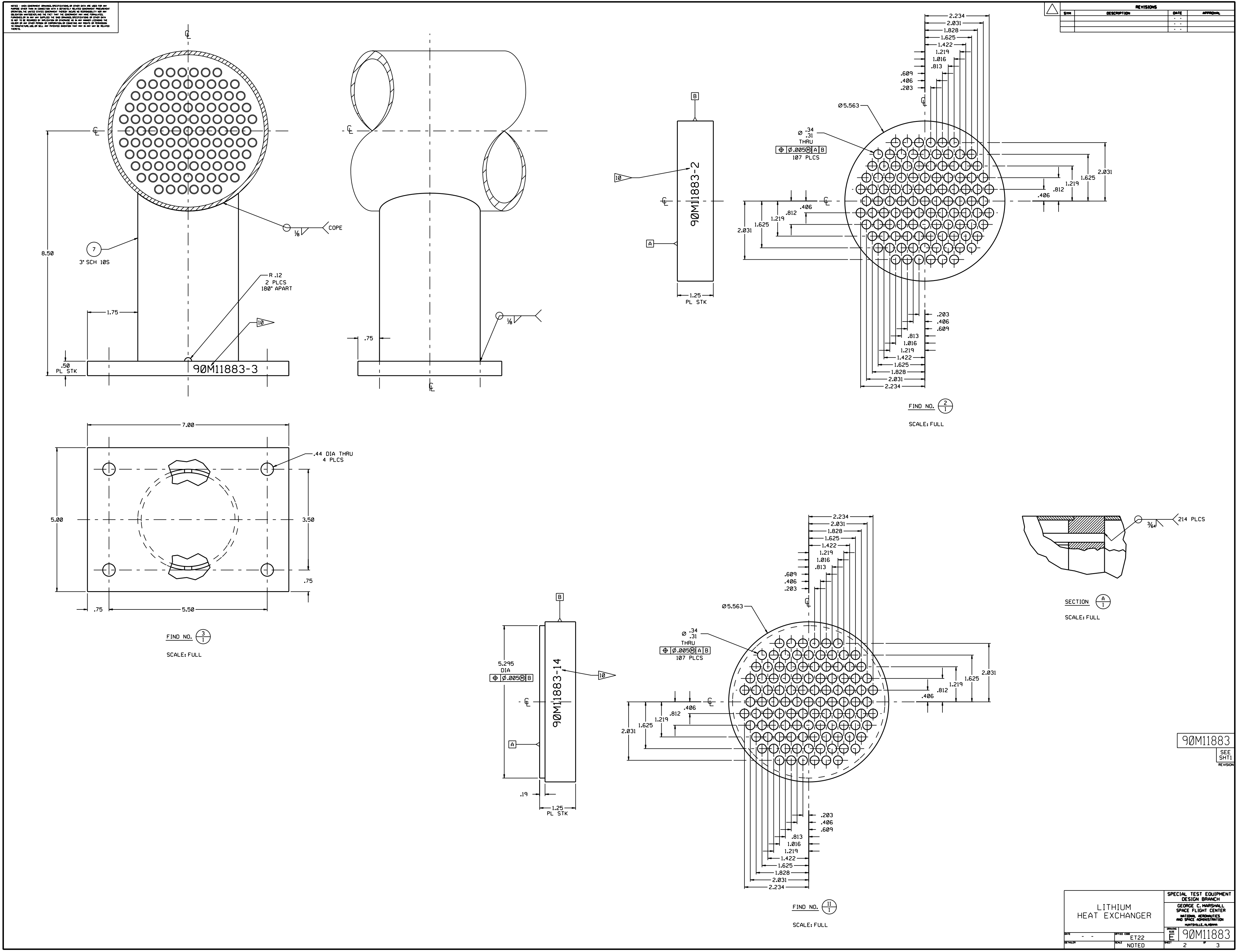
PDS DESIGN ENGINEER	- -	DATE
TEST ENGINEER/REQUESTER	- -	DATE
STRESS	- -	DATE
MATERIALS	- -	DATE
INDUSTRIAL SAFETY	- -	DATE
PDS APPROVAL	- -	DATE

LITHIUM HEAT EXCHANGER

DETAILER
DESIGN
DATE 10-15-04 ET22
SCALE NOTED

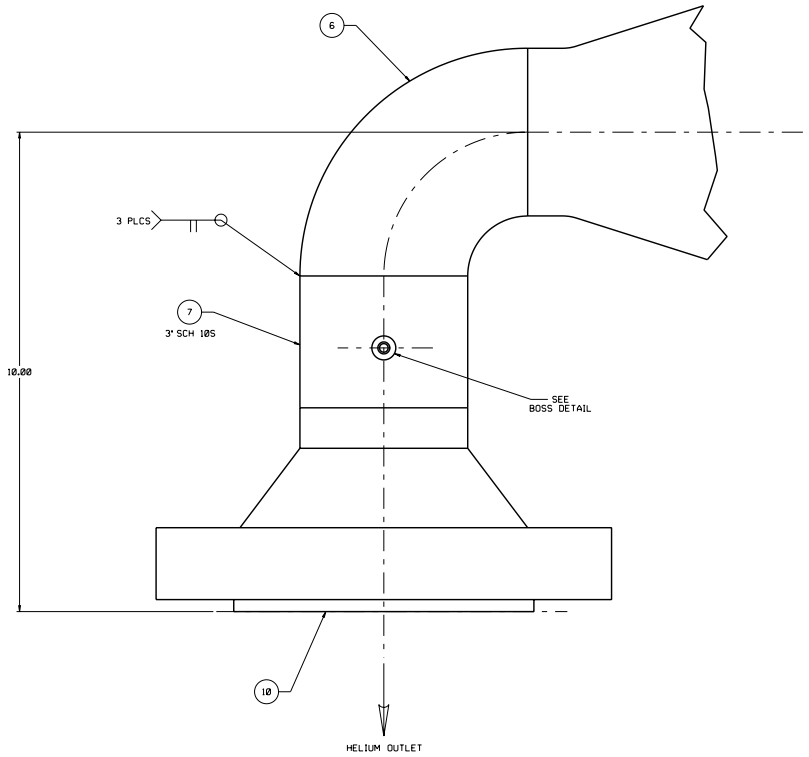
SPECIAL TEST EQUIPMENT DESIGN BRANCH
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA

DRAWING SIZE E
90M11883
SHEET 1 OF 3



REVISIONS
SYM
DESCRIPTION
DATE
APPROVAL
3" SCH 10S
COPE
R .12
2 PLCS
180° APART
8.50
1.75
.50
PL STK
90M11883-3
.75
7.00
.44 DIA THRU
4 PLCS
5.00
3.50
.75
5.50
FIND NO. 3
SCALE: FULL
90M11883-2
1.25
PL STK
Ø5.563
Ø .34 .31 THRU
Ø.005 Ⓜ A B
107 PLCS
2.234
2.031
1.828
1.625
1.422
1.219
1.016
.813
.812
.609
.406
.203
FIND NO. 2
SCALE: FULL
SECTION A
SCALE: FULL
3/64
214 PLCS
5.295
DIA
90M11883-14
.19
FIND NO. 11
SCALE: FULL
90M11883
SEE SHT1
REVISION
LITHIUM
HEAT EXCHANGER
SPECIAL TEST EQUIPMENT
DESIGN BRANCH
GEORGE C. MARSHALL
SPACE FLIGHT CENTER
NATIONAL AERONAUTICS
AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA
ET22
NOTED
E
90M11883
2 OF 3

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVED
		- -	
		- -	
		- -	



VIEW C/1

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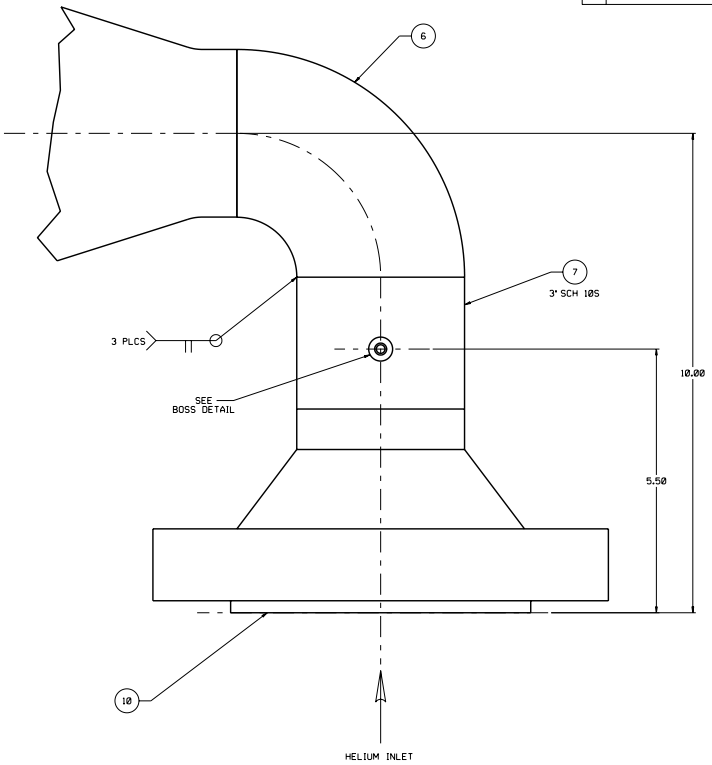
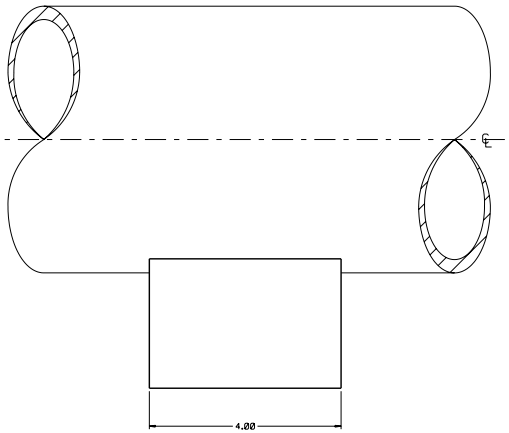


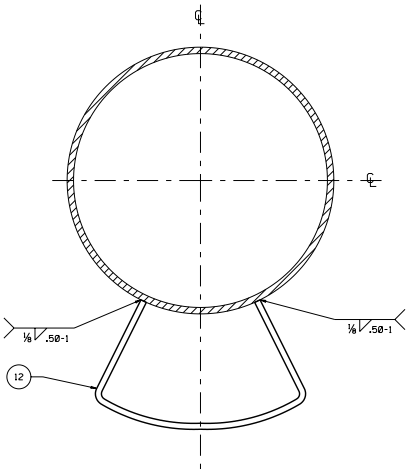
VIEW B/1

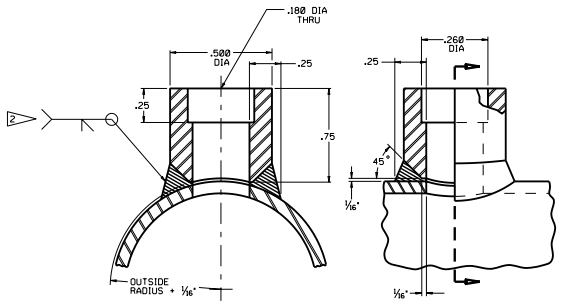
SCALE: FULL



FIND NO. 13/1

SCALE: FULL





BOSS DETAIL

SCALE: NONE

90M11883

SEE SHT1

REVISION

BOSS DETAIL NOTES: (UNLESS OTHERWISE SPECIFIED)

1. REMOVE ALL BURRS AND BREAK ALL SHARP EDGES.
2. ALL BOSS WELDS SHALL BE 100% VISUALLY AND 100% DYE PENETRANT EXAMINED PER ASME B31.1.

LITHIUM HEAT EXCHANGER	SPECIAL TEST EQUIPMENT DESIGN BRANCH GEORGE C. MARSHALL SPACE FLIGHT CENTER NATIONAL AERONAUTICS AND SPACE ADMINISTRATION HUNTSVILLE, ALABAMA	
DATE - -	OFFICE CODE ET22	SIZE E
DETAILER	SCALE NOTED	DRAWING NO. 90M11883
		SHEET 3 OF 3

SECTION E—PUMP HOUSE DRAWINGS: T.J. GODFROY

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVED
		- -	
		- -	
		- -	

GENERAL NOTES (UNLESS OTHERWISE SPECIFIED)

1. REMOVE ALL BURRS AND BREAK ALL SHARP EDGES.
2. FIELD TO VERIFY ALL TIE-IN CONNECTIONS.
3. ALL PIPE SIZES AND SCHEDULES SHALL CONFORM TO THE DIMENSIONS OF ASME-B36.10 OR ASME-B36.19.
4. ALL FITTINGS SHALL CONFORM TO THE DIMENSIONS OF ASME-B16.9 OR ASME-B16.28. NO BLOCK PATTERN FITTINGS SHALL BE USED. THE CROTCH AREA OF TEES AND CROSSES SHALL BE REINFORCED WITH LONG RADIUS DESIGN TO ELIMINATE SHARP CORNERS.
5. ALL BEVELS FOR BUTTWELDING ENDS OF PIPE FITTINGS, FLANGES, VALVES, AND COMPONENTS SHALL CONFORM TO ASME-B16.25.
6. ALL MACHINED PARTS TO HAVE A 125 MICROINCH ROUGHNESS HEIGHT RATING SURFACE FINISH.
7. THE SYSTEM SHALL BE HYDROSTATED TO 1.68 TIMES THE WORKING PRESSURE OF THE SYSTEM PER ASME SECTION VIII, DIV 1. THE WATER USED SHALL CONTAIN NO MORE THAN 25 PPM OF CHLORIDE FOR SST PIPE (50 PPM FOR C.S.) AND SHALL HAVE ½% BY WEIGHT SODIUM NITRITE AS AN INHIBITOR.
8. ALL SYSTEM WELDS AND STRUCTURAL ATTACHMENTS TO PIPING SHALL BE WELDED PER ASME SECTION VIII, DIVISION 1.
9. THE SYSTEM SHALL BE DESIGNED PER ASME SECTION VIII, DIVISION 1.
10. STEEL STAMP .25 HIGH CHARACTERS AS SHOWN.
11. ALL STEEL SUPPORTS SHALL BE WELDED AND 100% VISUALLY INSPECTED PER ASME SECTION VIII, DIVISION 1.
12. ALL PIPE FLANGES SHALL CONFORM TO THE DIMENSIONS AND PRESSURE - TEMPERATURE RATINGS OF ASME-B16.5
13. ALL NON-METALLIC FLAT GASKETS FOR PIPE FLANGES SHALL CONFORM TO THE DIMENSIONS OF ASME-B16.21.
14. ALL PIPE FLANGE BOLT HOLES SHALL STRADDLE THE CENTERLINE OF THE PIPE.
15. BOLTS SHALL BE TORQUED PER MSFC-STD-486B, EXCEPT FOR VENDOR SUPPLIED COMPONENTS, WHICH SHALL BE TORQUED PER VENDOR SPECIFICATIONS. FLANGE JOINT STUDS FOR FLANGES CONTAINING NON-METALLIC FLAT GASKETS OR METALLIC RING SEALS SHALL BE TORQUED AS NECESSARY TO PREVENT LEAKAGE. THERE SHALL BE NO GASKET EXTRUSION OR COLD FLOW.

SPECIFIC NOTES

16. MATERIAL SPECIFICATIONS FOR STAINLESS STEEL SYSTEMS

PIPE:	ASTM-A312-TP316 SST. - SEAMLESS
PIPE FITTINGS:	ASTM-A403-WP-S 316 SST.
TUBE:	ASTM-A213 TYPE 316 SST. - SEAMLESS
BAR STOCK:	AISI-316 SST PER ASTM A479
PLATE:	AISI-316 SST PER ASTM A240.
PIPE FLANGES:	ASTM-A182-F316 SST.
STUD BOLTS:	ASTM-A193-B8 CLASS 1 SST.
HEX HEAD BOLTS:	ASTM-A193-B8 CLASS 1 SST.
HEXAGON NUTS:	ASTM-A194-GR.8 SST.

SPECIFIC NOTES

GASEOUS NITROGEN AND AIR SYSTEM

17. ALL GIRTH WELD JOINTS SHALL BE 100% VISUALLY EXAMINED PER ASME SECTION VIII, DIVISION 1.
18. THE SYSTEM SHALL BE HELIUM LEAK CHECKED USING A HELIUM MASS SPECTROMETER LEAK DETECTOR. ALLOWABLE LEAK RATE = 1×10^{-7} CC PER SECOND.
19. THE SYSTEM SHALL BE CLEANED FOR PNEUMATIC SERVICE PER MSFC-SPEC-164B.
20. FLAT GASKET MATERIAL: JOHN CRANE STYLE 2160G OR EQUAL

SUGGESTED VENDORS:

1. PATHWAY BELLOWS, INC.
   115 FRANKLIN ROAD
   OAK RIDGE, TENNESSEE 37830
   PH. 865-483-7444
2. McMASTER CARR SUPPLY CO.
   P.O. BOX 4355
   CHICAGO, ILLINOIS 60680
   PH. (630) 833-0300
3. MDC VACUUM PRODUCTS CORPORATION
   23842 CABOT BOULEVARD
   HAYWARD, CALIFORNIA 94545
   PH. (510) 265-3500

PRELIMINARY
HAS NOT COMPLETED REVIEW CYCLE
AND IS SUBJECT TO CHANGE
3-25-05

FIND NO.	SHEET NO.	TOT. REQ'D	PART NO.	DESCRIPTION	VEND. NO.	REMARKS
50						
49						
48						
47						
46						
45						
44						
43						
42						
41						
40	2	16	90M11884-40	5/16-24 UNF X 2 LG BOLT FOR 6" CONFLAT FLANGE	3	SST PART NUMBER 190007
39	4	1	90M11884-39	GASKET FOR 6" CONFLAT FLANGE	3	COPPER PART NUMBER 191013
38	4	1	90M11884-38	6" CONFLAT BLANK	3	SST PART NUMBER 110025
37	4	1	90M11884-37	6" CONFLAT FLANGE	3	SST PART NUMBER 110026
36	2	40	90M11884-36	5/16-24 UNF HEX NUT		SST SEE NOTE 16
35	2	24	90M11884-35	5/16-24 UNF X 2.5 LG BOLT FOR 10" CONFLAT FLANGE	3	SST PART NUMBER 190048
34	4	1	90M11884-34	GASKET FOR 10" CONFLAT FLANGE	3	COPPER PART NUMBER 191019
33	4	1	90M11884-33	10" CONFLAT BLANK	3	SST PART NUMBER 110032
32	4	1	90M11884-32	10" CONFLAT FLANGE	3	SST PART NUMBER 110033
31	4	A/R	90M11884-31	4" O.D. X .125" WALL SEAMLESS TUBE		SST SEE NOTE 16
30	4	A/R	90M11884-30	8" O.D. X .125" WALL SEAMLESS TUBE		SST SEE NOTE 16
29	2,4	4	90M11884-29	SUPPORT		SST SEE NOTE 16
28	4	8	90M11884-28	PLATE		SST SEE NOTE 16
27	2,4	1	90M11884-27	SUPPORT		SST SEE NOTE 16
26	3	A/R	90M11884-26	3/8 PLATE		SST SEE NOTE 16
25	2	12	90M11884-25	3/8 FLAT WASHER	2	SST CAT. NO. 90107A031
24	2	6	90M11884-24	3/8-16 UNC 2B HEX NUT		SST SEE NOTE 16
23	2	6	90M11884-23	3/8-16 UNC 2A X 1.5 LG HEX HD BOLT		SST SEE NOTE 16
22	3	6	90M11884-22	1/4-28 UNF HEX NUT		SST SEE NOTE 16
21	3	6	90M11884-21	1/4-28 UNF X 1.25 LG BOLT FOR 2.75" CONFLAT FLANGE	3	SST PART NUMBER 190040
20	2	30	90M11884-20	3/8 X 4.25 LG STUD		SST SEE NOTE 16
19	2,3	A/R	90M11884-19	1" O.D. X .095" WALL SEAMLESS TUBE		SST SEE NOTE 16
18	3	1	90M11884-18	GASKET FOR 2.75" CONFLAT FLANGE	3	COPPER PART NUMBER 191004
17	2	1	90M11884-17	1/4" O-RING X 33.00" O.D.		TEFLON
16	3,4	2	90M11884-16	2", 150 PSIG, 16 CONVOLUTE BELLOWS X 10 INCH LONG	1	316H SST, PART NUMBER 2-AS-WW-150-16-316H
15	3	1	90M11884-15	2.75" CONFLAT BLANK	3	SST PART NUMBER 110008
14	2	1	90M11884-14	FLAT GASKET FOR 2" 300# RF FLANGE		SEE NOTE 20
13	2	76	90M11884-13	5/8 HEX NUT		SST SEE NOTE 16
12	2	8	90M11884-12	5/8 X 3.5 LG STUD		SST SEE NOTE 16
11	2	1	90M11884-11	2" 300# RF BLIND FLANGE		SST SEE NOTE 16
10	3	1	90M11884-10	2" 300# RF SLIP ON FLANGE		SST SEE NOTE 16
9	3	A/R	90M11884-9	2" SCH 40S SEAMLESS PIPE		SST SEE NOTE 16
8	3,4	2	90M11884-8	END PLATE		316H SST PER ASTM A240
7	2,4	2	90M11884-7	SUPPORT PLATE		SST SEE NOTE 16
6	3,4	1	90M11884-6	ANCHOR PLATE		SST SEE NOTE 16
5	2,4	1	90M11884-5	SUPPORT		SST SEE NOTE 16
4	3	1	90M11884-4	2.75" CONFLAT FLANGE	3	SST PART NUMBER 110012
3	2,4	1	90M11884-3	SIDE FLAT HEAD		SST SEE NOTE 16
2	2,3	1	90M11884-2	SHELL		SST SEE NOTE 16
1	2	-	90M11884-1	MAIN ASSEMBLY		

A=ASSEMBLY/SUB-ASSEMBLY/INSTALLATION E=EXISTING ITEM/FACILITY F=FABRICATED ITEM M=MODIFIED ITEM P=PURCHASED ITEM

90M11884
~
REVISION

SERVICE: GN2
TEMPERATURE: 50°F TO 302°F
INTERNAL PRESSURE: 42 PSI
EXTERNAL PRESSURE: 0 PSI

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS ± 1/16 DECIMAL X ± .06 .XX ± .03 .XXX ± .010 ANGLES ± 1/2°
DO NOT SCALE DRAWING

PROJ DESIGN ENGINEER	- -	DATE
TEST ENGINEER/REQUESTER	- -	DATE
STRESS	- -	DATE
MATERIALS	- -	DATE
INDUSTRIAL SAFETY	- -	DATE
PROJ APPROVAL	- -	DATE

LOCATION: 9' VC, BLDG. 4655
NEXT ASSEMBLY: 90M11881
LAST DETAIL, SECTION OR VIEW LETTER USED: E

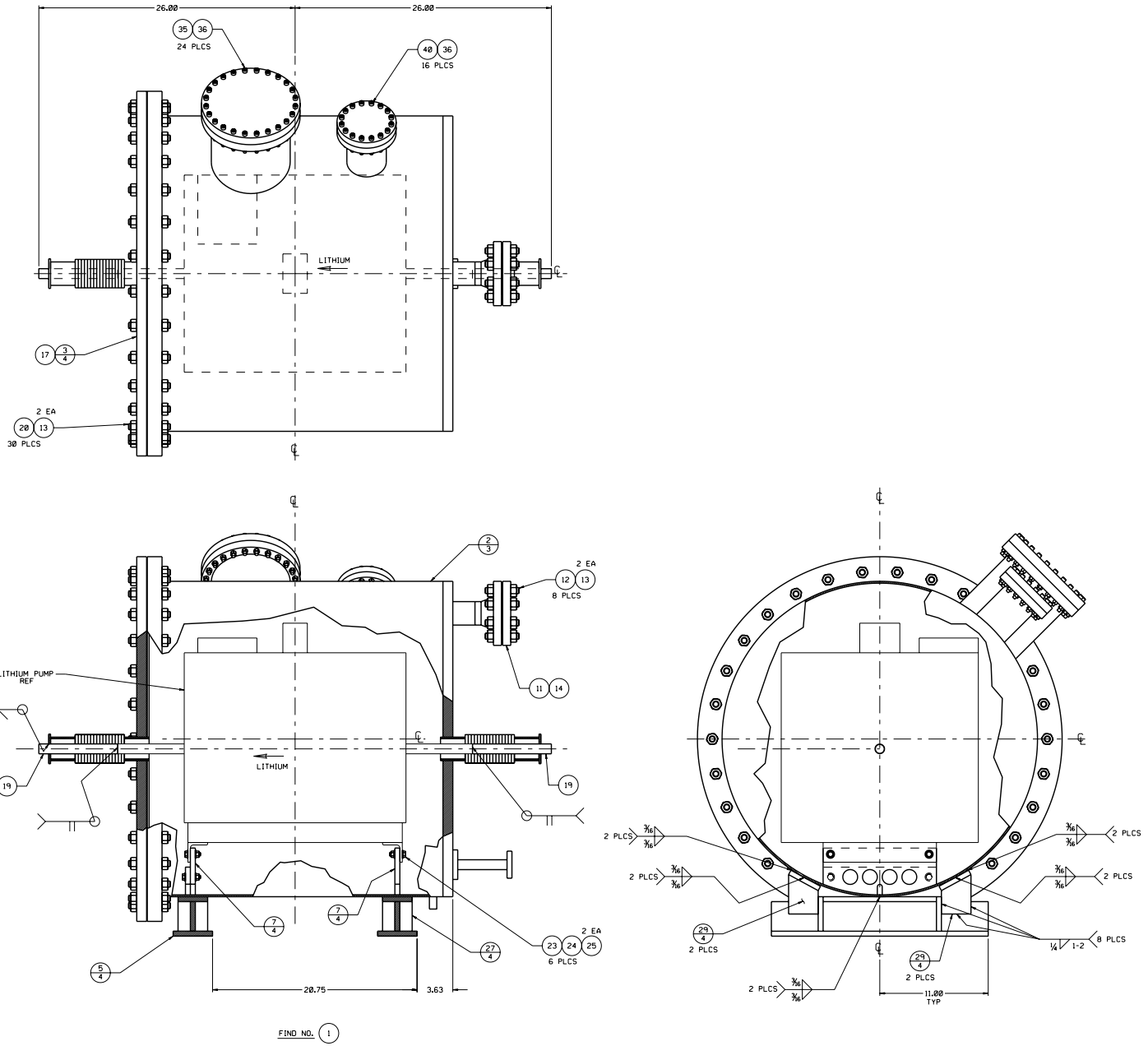
LITHIUM PUMP ENCLOSURE

DESIGN: [illegible] DATE: 10-15-04 APPR DWG: ET22
SCALE: NOTED

SPECIAL TEST EQUIPMENT DESIGN BRANCH
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA

DRAWING SIZE: E | 90M11884
SHEET 1 OF 4

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVED
		- -	
		- -	
		- -	



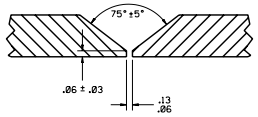
FIND NO. (1)

SCALE: 1:4

90M11884
SEE SHT1
REVISION

LITHIUM PUMP ENCLOSURE	SPECIAL TEST EQUIPMENT DESIGN BRANCH GEORGE C. MARSHALL SPACE FLIGHT CENTER NATIONAL AERONAUTICS AND SPACE ADMINISTRATION HUNTSVILLE, ALABAMA	
DATE - -	OFFICE CODE ET22	SIZE E
DETAILER	SCALE NOTED	DRAWING NO. 90M11884
		SHEET 2 OF 4

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVED
		- -	
		- -	
		- -	



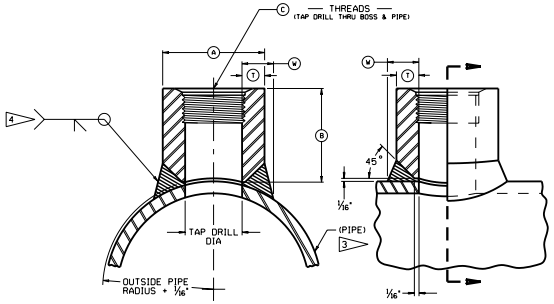
TYPICAL PIPE WELD DETAIL

SCALE: NONE

BOSS DIMENSIONS						
BOSS SIZE-DASH NUMBER	TUBING SIZE OUTSIDE DIA.	(A) BOSS DIA.	(B) BOSS HEIGHT	(C) THREAD SIZE	(W) WELD (MIN.)	(T) WALL THICK.(MIN.)
-4	¼"	.750"	1.250"	AS33649-4	3/16"	.1797"
-6	3/8"	.875"	1.500"	AS33649-6	3/16"	.1797"
-8	½"	1.125"	1.500"	AS33649-8	¼"	.2187"
-10	5/8"	1.250"	1.625"	AS33649-10	¼"	.2187"
-12	¾"	1.500"	1.750"	AS33649-12	5/16"	.2578"
-16	1"	1.750"	1.875"	AS33649-16	5/16"	.2578"
-24	1½"	2.500"	2.125"	AS33649-24	3/8"	.3526"

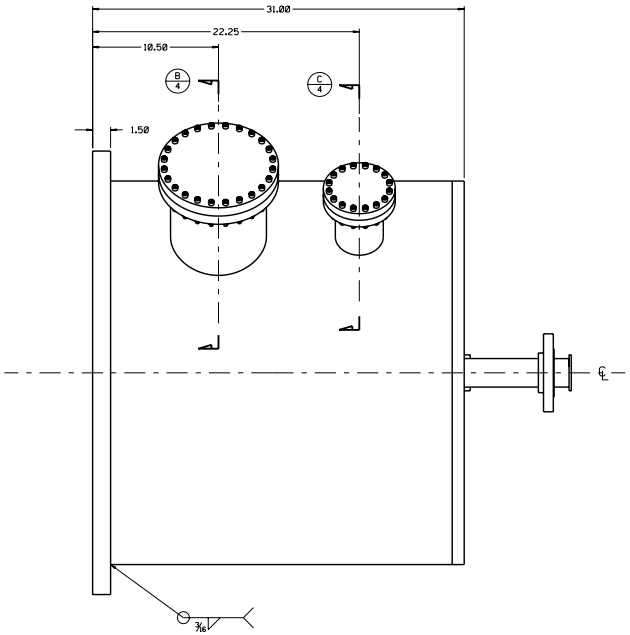
BOSS DETAIL NOTES: (UNLESS OTHERWISE SPECIFIED)

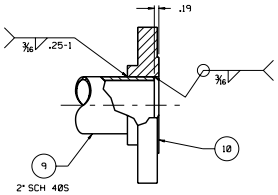
1. REMOVE ALL BURRS AND BREAK ALL SHARP EDGES.
2. MAXIMUM DESIGN PRESSURE - 3000 PSIG @ 70° F.
3. THIS BOSS IS TO BE USED ONLY ON THE FOLLOWING PIPE WEIGHTS OR SCHEDULE NUMBERS; SCHEDULES - 5S, 10S, 40S AND STD. WEIGHT.
4. ALL BOSS WELDS SHALL BE 100% VISUALLY AND 100% DYE PENETRANT EXAMINED PER ASME B31.1.



BOSS DETAIL

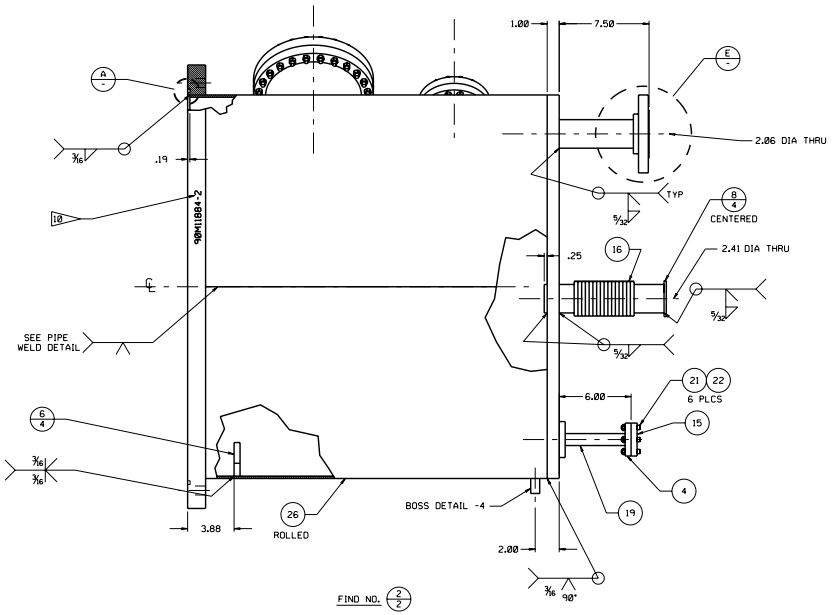
SCALE: NONE





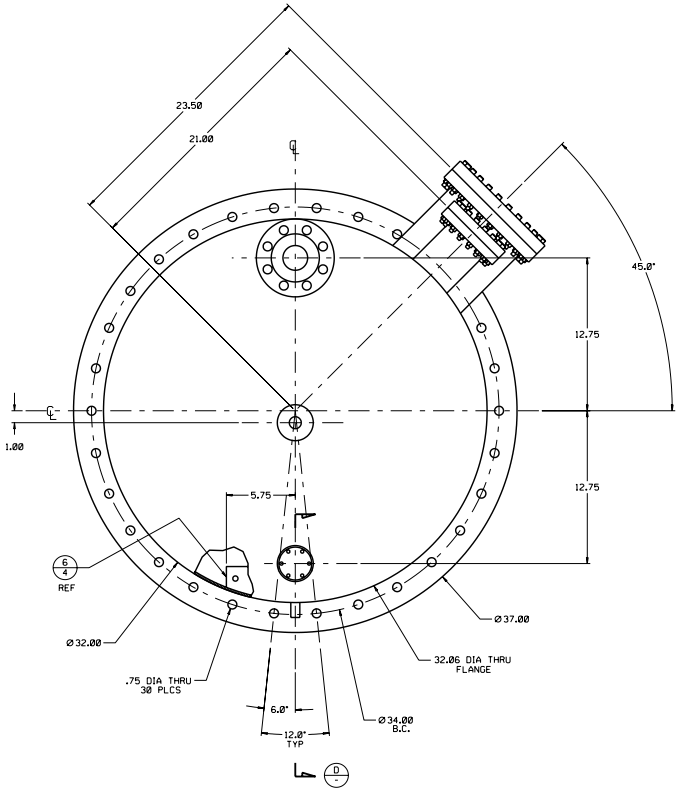
DETAIL E

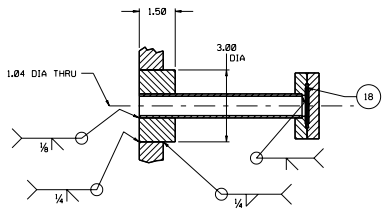
SCALE: 1:2



FIND NO. 2/2

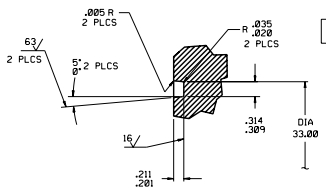
SCALE: 1:4





SECTION D -

SCALE: 1:2



DETAIL A -

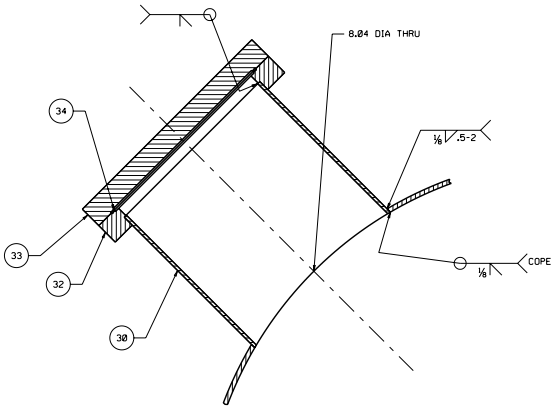
SCALE: N.T.S.

90M11884

SEE SHT1 REVISION

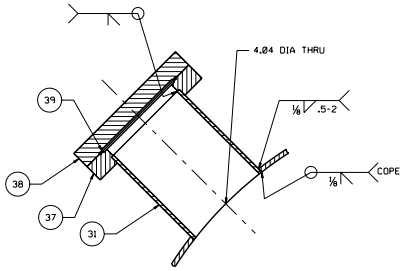
LITHIUM PUMP ENCLOSURE	SPECIAL TEST EQUIPMENT DESIGN BRANCH GEORGE C. MARSHALL SPACE FLIGHT CENTER NATIONAL AERONAUTICS AND SPACE ADMINISTRATION HUNTSVILLE, ALABAMA	
DATE - -	SPEC CODE ET22	SIZE E 90M11884
DETAILER	SCALE NOTED	SHEET 3 OF 4

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVED
		- -	
		- -	
		- -	



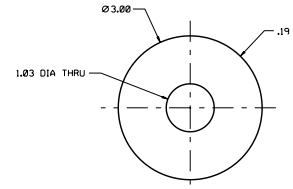
SECTION (8/3)

SCALE: 1:2



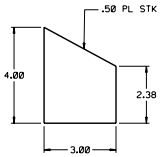
SECTION (C/3)

SCALE: 1:2



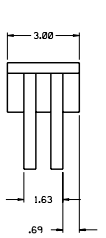
FIND NO. (8/-3)

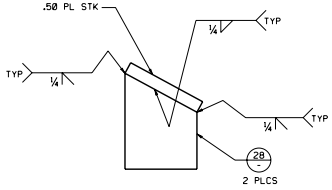
SCALE: FULL



FIND NO. (28/-)

SCALE: 1:2





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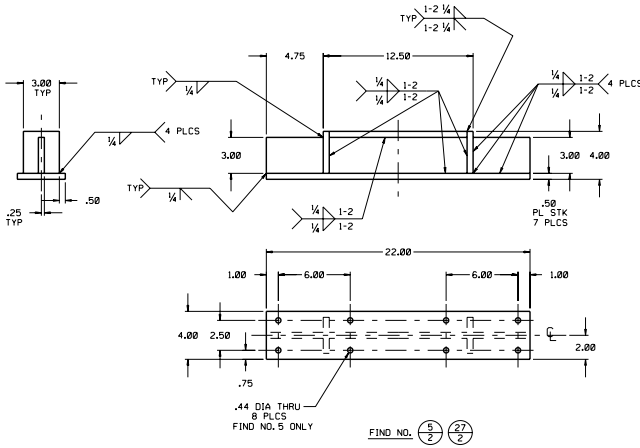
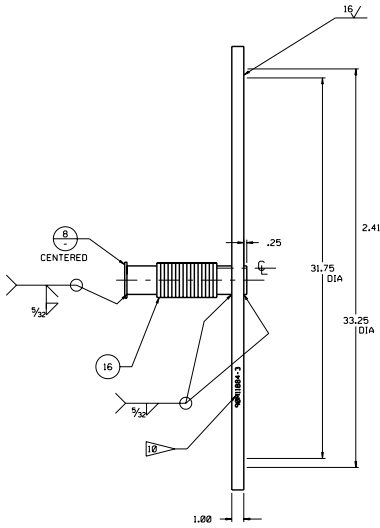
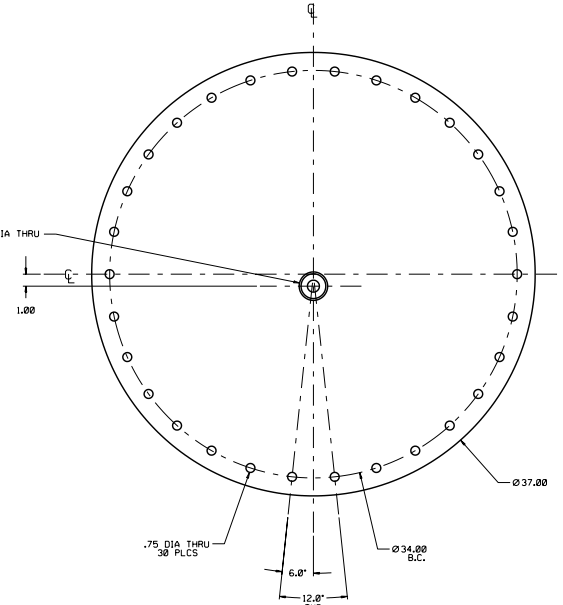
SCALE: 1:2



FIND NO. (5/2) (27/2)

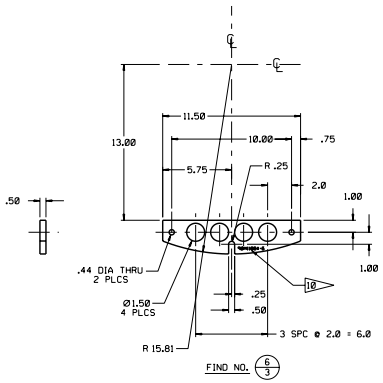
SCALE: 1:4





FIND NO. (3/2)

SCALE: 1:4



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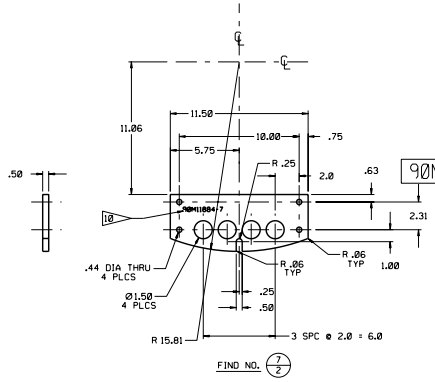


FIND NO. (7/2)

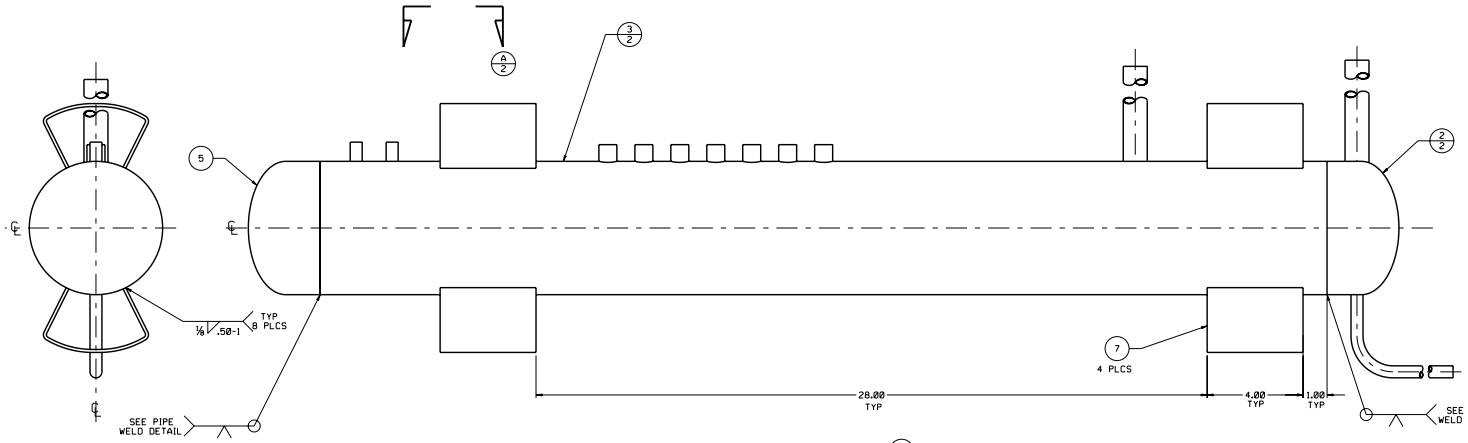
SCALE: 1:4

90M11884
SEE SHT1
REVISION

LITHIUM PUMP ENCLOSURE	SPECIAL TEST EQUIPMENT DESIGN BRANCH GEORGE C. MARSHALL SPACE FLIGHT CENTER NATIONAL AERONAUTICS AND SPACE ADMINISTRATION HUNTSVILLE, ALABAMA
DATE - -	SPACE CODE ET22
DETAILER	SCALE NOTED
	DRAWING NO. 90M11884
	SHEET 4 OF 4

SECTION F—LOWER RESERVOIR DRAWINGS: T.J. GODFROY

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVED
		- -	
		- -	
		- -	



FIND NO. (1)

SCALE: FULL

GENERAL NOTES (UNLESS OTHERWISE SPECIFIED)

1. REMOVE ALL BURRS AND BREAK ALL SHARP EDGES.
2. FIELD TO VERIFY ALL TIE-IN CONNECTIONS.
3. ALL PIPE SIZES AND SCHEDULES SHALL CONFORM TO THE DIMENSIONS OF ASME-B36.10 OR ASME-B36.19.
4. ALL FITTINGS SHALL CONFORM TO THE DIMENSIONS OF ASME-B16.9 OR ASME-B16.28. NO BLOCK PATTERN FITTINGS SHALL BE USED. THE CROTCH AREA OF TEES AND CROSSES SHALL BE REINFORCED WITH LONG RADIUS DESIGN TO ELIMINATE SHARP CORNERS.
5. ALL BEVELS FOR BUTTWELDING ENDS OF PIPE FITTINGS, FLANGES, VALVES, AND COMPONENTS SHALL CONFORM TO ASME-B16.25.
6. ALL MACHINED PARTS TO HAVE A 125 MICROINCH ROUGHNESS HEIGHT RATING SURFACE FINISH.
7. THE SYSTEM SHALL BE HYDROSTATED TO 1.82 TIMES THE WORKING PRESSURE OF THE SYSTEM PER ASME SECTION VIII, DIV 1. THE WATER USED SHALL CONTAIN NO MORE THAN 25 PPM OF CHLORIDE FOR SST PIPE (150 PPM FOR C.S.) AND SHALL HAVE ½% BY WEIGHT SODIUM NITRITE AS AN INHIBITOR.
8. ALL SYSTEM WELDS AND STRUCTURAL ATTACHMENTS TO PIPING SHALL BE WELDED PER ASME SECTION VIII, DIVISION 1.
9. THE SYSTEM SHALL BE DESIGNED PER ASME SECTION VIII, DIVISION 1.
10. STEEL STAMP .25 HIGH CHARACTERS AS SHOWN.
11. ALL STEEL SUPPORTS SHALL BE WELDED AND 100% VISUALLY INSPECTED PER ASME SECTION VIII, DIVISION 1.

SPECIFIC NOTES

12. MATERIAL SPECIFICATIONS FOR STAINLESS STEEL SYSTEMS

PIPE:	ASTM-A312-TP316 SST. - SEAMED OR SEAMLESS
PIPE FITTINGS:	ASTM-A403-WP-S 316 SST.
TUBE:	ASTM-A213 TYPE 316 SST. - SEAMLESS
BAR STOCK:	AISI-316 SST PER ASTM A479
PLATE:	AISI-316 SST PER ASTM A240.
FORGINGS:	ASTM-A182-F316 SST.

SPECIFIC NOTES

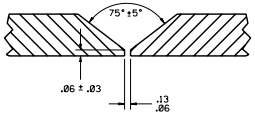
LITHIUM SYSTEM

13. ALL GIRTH AND LONGITUDINAL WELD JOINTS SHALL BE 100% VISUALLY EXAMINED PER ASME SECTION VIII, DIVISION 1 AND 100% LIQUID PENETRANT EXAMINED PER ASME SECTION V, ARTICLE 6.
14. THE PIPING SYSTEM SHALL BE HELIUM LEAK CHECKED USING A HELIUM MASS SPECTROMETER LEAK DETECTOR. ALLOWABLE LEAK RATE = 1 X 10^{-7} CC PER SECOND.
15. THE PIPING SYSTEM SHALL BE CLEANED FOR LIQUID OXYGEN SERVICE PER MSFC-SPEC-164B.
16. ALL MATERIAL IN CONTACT WITH LITHIUM SHALL BE CERTIFIED AND APPROVED BY MATERIALS, PROCESSES AND MANUFACTURING DEPARTMENT.

SUGGESTED VENDORS:

1. ANVIL INTERNATIONAL INC.
   110 CORPORATE DRIVE
   PORTSMOUTH, NH 03802
   PH. (603) 422-8000

PRELIMINARY
HAS NOT COMPLETED REVIEW CYCLE
AND IS SUBJECT TO CHANGE
11- 2-04



TYPICAL PIPE WELD DETAIL

SCALE: NONE

FIND NO.	SHEET NO.	TOT. REQ'D	PART NO.	DESCRIPTION	VEND. NO.	REMARKS
20						
19						
18						
17						
16						
15						
14						
13						
12						
11						
10						
9						
8	2	A/R	90M11885-8	½" O.D. X .065" WALL SEAMLESS TUBE		SST SEE NOTE 12
7	1	4	90M11885-7	PIPE PROTECTION SADDLE FOR 5" PIPE	1	FIG. 162A ASTM-A240 316 SST
6	2	A/R	90M11885-6	1" O.D. X .095" WALL SEAMLESS TUBE		SST SEE NOTE 12
5	1,2	2	90M11885-5	5" SCH 10S PIPE CAP		SST SEE NOTE 12
4	2	A/R	90M11885-4	5" SCH 10S PIPE		SST SEE NOTE 12
3	1,2	1	90M11885-3	SHELL		SST SEE NOTE 12
2	1,2	1	90M11885-2	END CAP		SST SEE NOTE 12
1	1	-	90M11885-1	MAIN ASSEMBLY		

A=ASSEMBLY/SUB-ASSEMBLY/INSTALLATION E=EXISTING ITEM/FACILITY F=FABRICATED ITEM M=MODIFIED ITEM P=PURCHASED ITEM

90M11885
~
REVISION

SERVICE: LITHIUM
TEMPERATURE: 50°F TO 400 °F
INTERNAL PRESSURE: 20 PSI
EXTERNAL PRESSURE: 0 PSI

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS ± 1/16
DECIMAL X ± .06
.XX ± .03
.XXX ± .010
ANGLES ± 1/2°
DO NOT SCALE DRAWING

LOCATION: 9' VC, BLDG. 4655
NEXT ASSEMBLY: 90M11881
LAST DETAIL, SECTION OR VIEW LETTER USED: A

PROJ DESIGN ENGINEER	- -	DATE
TEST ENGINEER/REQUESTER	- -	DATE
STRESS	- -	DATE
MATERIALS	- -	DATE
INDUSTRIAL SAFETY	- -	DATE
PROJ APPROVAL	- -	DATE

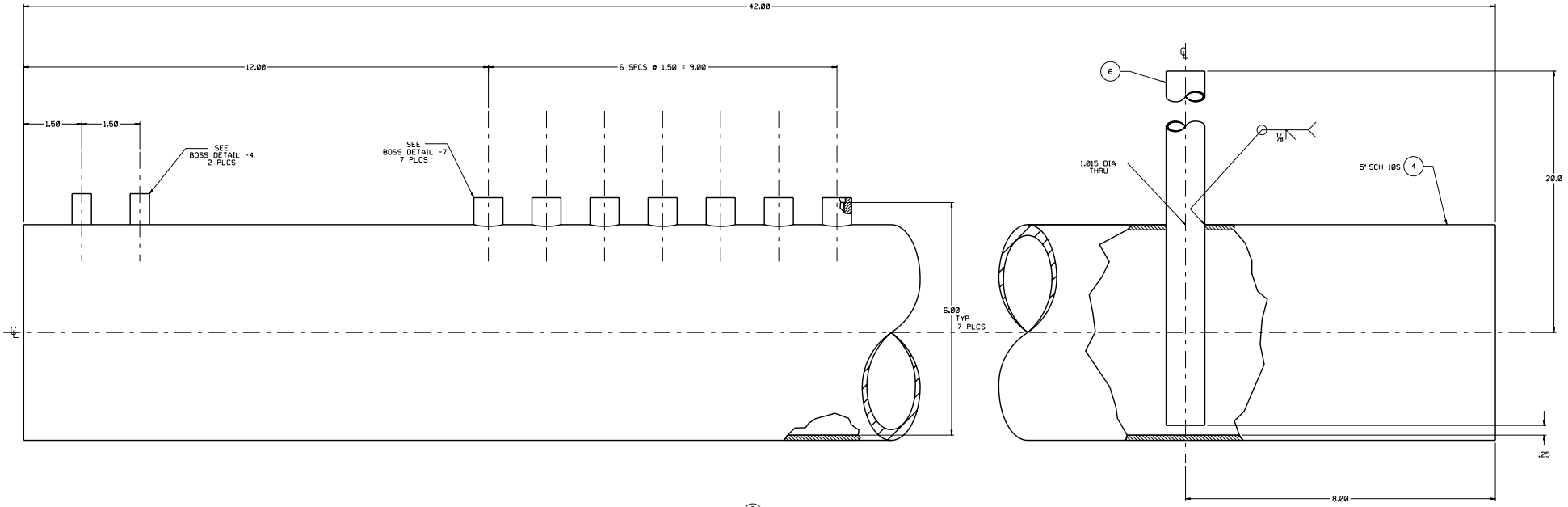
LOWER
LITHIUM RESERVOIR

DETAILER: DATE 10-15-04 ENGR JOB ET22
DESIGN: SCALE NOTED

SPECIAL TEST EQUIPMENT DESIGN BRANCH
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA

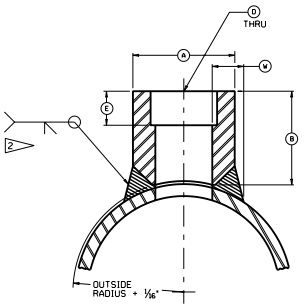
DRAWING SIZE E | 90M11885
SHEET 1 OF 2

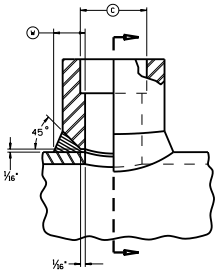
REVISIONS			
SYM	DESCRIPTION	DATE	APPROVED
		- -	
		- -	
		- -	



FIND NO. 3/1

SCALE: FULL





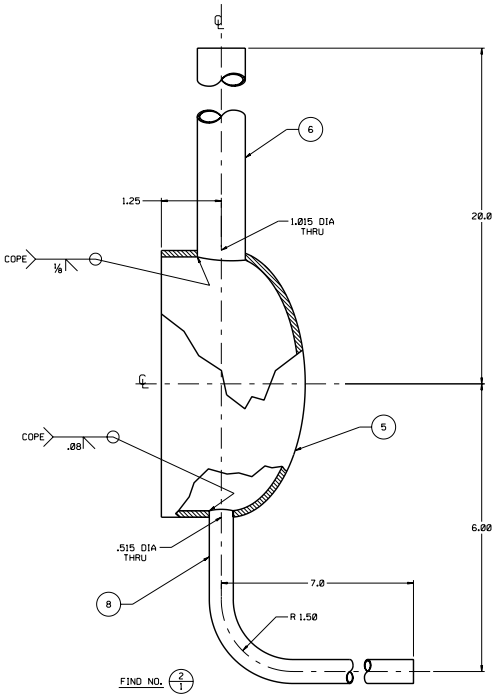
BOSS DETAIL

SCALE: NONE

BOSS DIMENSIONS							
BOSS SIZE-DASH NUMBER	TUBING SIZE OUTSIDE DIA.	(A) BOSS DIA.	(B) BOSS HEIGHT	(C) SOCKET DIA.	(W) WELD (MIN.)	(D) HOLE DIA.	(E) SOCKET DEPTH
-4	1/4"	.50"	.75"	.260"	1/4"	.180"	.25"
-7	7/16"	.75"	.65" REF	.446"	1/4"	.371"	.13"

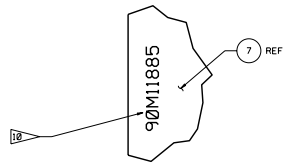
BOSS DETAIL NOTES: (UNLESS OTHERWISE SPECIFIED)

1. REMOVE ALL BURRS AND BREAK ALL SHARP EDGES.
2. ALL BOSS WELDS SHALL BE 100% VISUALLY AND 100% DYE PENETRANT EXAMINED PER ASME B31.1.



FIND NO. 2/1

SCALE: FULL



VIEW A/1

SCALE: FULL

90M11885
SEE SHT 1
REVISION

LOWER LITHIUM RESERVOIR	SPECIAL TEST EQUIPMENT DESIGN BRANCH GEORGE C. MARSHALL SPACE FLIGHT CENTER NATIONAL AERONAUTICS AND SPACE ADMINISTRATION HUNTSVILLE, ALABAMA	
DATE - -	SPACE CODE ET22	DRAWING NO. 90M11885
DETAILER	SCALE NOTED	SHEET 2 OF 2

SECTION G—FACE SEAL DRAWINGS: T.J. GODFROY

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVED
		- -	
		- -	
		- -	

GENERAL NOTES (UNLESS OTHERWISE SPECIFIED)

1. REMOVE ALL BURRS AND BREAK ALL SHARP EDGES.
2. FIELD TO VERIFY ALL TIE-IN CONNECTIONS.
3. ALL MACHINED PARTS TO HAVE A 125 MICROINCH ROUGHNESS HEIGHT RATING SURFACE FINISH.
4. THE SYSTEM SHALL BE HYDROSTATED TO 2.24 TIMES THE WORKING PRESSURE OF THE SYSTEM PER ASME SECTION VIII, DIV 1. THE WATER USED SHALL CONTAIN NO MORE THAN 25 PPM OF CHLORIDE FOR SST PIPE (50 PPM FOR C.S.) AND SHALL HAVE ½% BY WEIGHT SODIUM NITRITE AS AN INHIBITOR.
5. ALL SYSTEM WELDS AND STRUCTURAL ATTACHMENTS TO PIPING SHALL BE WELDED PER ASME SECTION VIII, DIVISION 1.
6. THE SYSTEM SHALL BE DESIGNED PER ASME SECTION VIII, DIVISION 1.
7. STEEL STAMP .25 HIGH CHARACTERS AS SHOWN.

SPECIFIC NOTES

8. MATERIAL SPECIFICATIONS FOR STAINLESS STEEL SYSTEMS

TUBE:	ASTM-A213 TYPE 316 SST. - SEAMLESS
BAR STOCK:	AISI-316 SST PER ASTM A479
PLATE:	AISI-316 SST PER ASTM A240.
FORGINGS:	ASTM-A182-F316 SST.
HEXAGON NUTS:	ASTM-A194-GR.8 SST.

SPECIFIC NOTES

HELIUM SYSTEM

9. ALL GIRTH AND LONGITUDINAL WELD JOINTS SHALL BE 100% VISUALLY AND 100% RADIOGRAPHICALLY EXAMINED PER ASME SECTION VIII, DIVISION 1.
10. THE PIPING SYSTEM SHALL BE HELIUM LEAK CHECKED USING A HELIUM MASS SPECTROMETER LEAK DETECTOR. ALLOWABLE LEAK RATE = 1×10^{-7} CC PER SECOND.
11. THE PIPING SYSTEM SHALL BE CLEANED FOR PNEUMATIC SERVICE PER MSFC-SPEC-164B.

SUGGESTED VENDORS:

1. ALABAMA FLUID SYSTEM TECHNOLOGIES INC.
   237 CAHABA VALLEY PARKWAY
   PELHAM, AL 35124
   PH. (205) 988-4812
2. MDC VACUUM PRODUCTS CORPORATION
   23842 CABOT BOULEVARD
   HAYWARD, CALIFORNIA 94545
   PH. (510) 265-3500
3. McMASTER CARR SUPPLY CO.
   P.O. BOX 4355
   CHICAGO, ILLINOIS 60680
   PH. (630) 833-0300

PRELIMINARY
HAS NOT COMPLETED REVIEW CYCLE
AND IS SUBJECT TO CHANGE
2-17-05

FIND NO.	SHEET NO.	TOT. REQ'D		PART NO.	DESCRIPTION	VEND. NO.	REMARKS
30	2	1		90M11886-30	8" CONFLAT FLANGE	2	316 SST PART NO. 110031
29	3	1		90M11886-29	8" CONFLAT MODIFICATIONS		
28	2,4	1		90M11886-28	HEAT SHIELD ASSEMBLY		
27	4	74		90M11886-27	.156 OD X .094 ID TUBE X .50 LONG	3	ALUMINA CAT. NO. 8746K12
26	4	5		90M11886-26	HEAT SHIELD SHEET		AISI-316 SST PER ASTM A240
25	4	8		90M11886-25	#4 FLAT WASHER	3	SST CAT. NO. 901070A005
24	4	4		90M11886-24	#4-40 UNC HEX NUT	3	SST CAT. NO. 91240A005
23	4	4		90M11886-23	#4-40 UNC X .75 LONG SOCKET HD CAP SCREW	3	SST CAT. NO. 92185A112
22	4	8		90M11886-22	ALUMINA WASHER	3	ALUMINA CAT. NO. 8746K18
21	4	4		90M11886-21	.25 OD X .188 ID TUBE X .500 LONG	3	ALUMINA CAT. NO. 8746K17
20	4	4		90M11886-20	.063 DIA ROD X 3.50 LONG	3	ALUMINA CAT. NO. 87065K41
19	4	8		90M11886-19	.063 DIA ROD X 5.00 LONG	3	ALUMINA CAT. NO. 87065K41
18	4	4		90M11886-18	.063 DIA ROD X 4.00 LONG	3	ALUMINA CAT. NO. 87065K41
17	4	4		90M11886-17	.063 DIA ROD X 2.63 LONG	3	ALUMINA CAT. NO. 87065K41
16	2	40		90M11886-16	5/16 FLAT WASHER	3	316 SST CAT. NO. 901074A030
15	2	40		90M11886-15	5/16-24 UNF 2B HEX NUT		SST SEE NOTE 8
14	2	40		90M11886-14	5/16-24 UNF 2A X 2.25 LG 12 POINT BOLT	2	SST PART NO. 190046
13	2	2		90M11886-13	8" CONFLAT GASKET	2	NICKEL
12	2,3	2		90M11886-12	8" CONFLAT BLANK	2	316 SST PART NO. 110030
11	3	1		90M11886-11	8" CONFLAT NIPPLE	2	316 SST PART NO. 402008
10	4	A/R		90M11886-10	3/8" O.D. X .049" WALL SEAMLESS TUBE		SST SEE NOTE 8
9	4	27		90M11886-9	½ VCR FEMALE NUT	1	316 SST CAT. NO. SS-8-VCR-1
8	4	27		90M11886-8	½ VCR GASKET	1	316 SST CAT. NO. SS-8-VCR-2-VS
7	4	27		90M11886-7	½ VCR MALE NUT	1	316 SST CAT. NO. SS-8-VCR-4
6	4	54		90M11886-6	⅜ VCR SOCKET WELD GLAND	1	316 SST CAT. NO. SS-6-VCR-3
5	4	27		90M11886-5	ELECTRODE		PROVIDED BY TD40
4	3,4	27		90M11886-4	ELECTRODE ASSEMLY		SST SEE NOTE 8
3	4	27		90M11886-3	ELECTRODE SUBASSEMBLY		SST SEE NOTE 8
2	2,3	1		90M11886-2	CHAMBER		SST SEE NOTE 8
1	2	-		90M11886-1	MAIN ASSEMBLY		

A=ASSEMBLY/SUB-ASSEMBLY/INSTALLATION E=EXISTING ITEM/FACILITY F=FABRICATED ITEM M=MODIFIED ITEM P=PURCHASED ITEM

90M11886
~
REVISION

SERVICE: HELIUM
TEMPERATURE: 50°F TO 860 °F
INTERNAL PRESSURE: 2 PSI
EXTERNAL PRESSURE: 0 PSI

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS ± 1/16 | DECIMAL X ± .06, .XX ± .03, .XXX ± .010 | ANGLES ± 1/2°
DO NOT SCALE DRAWING

DESIGN ENGINEER		- -
TEST ENGINEER/REQUESTER		- -
STRESS		- -
MATERIALS		- -
INDUSTRIAL SAFETY		- -
QUALITY APPROVAL		- -

LOCATION: 9' VC, BLDG. 4655
NEXT ASSEMBLY: 90M11881
LAST DETAIL, SECTION, OR VIEW LETTER USED: G

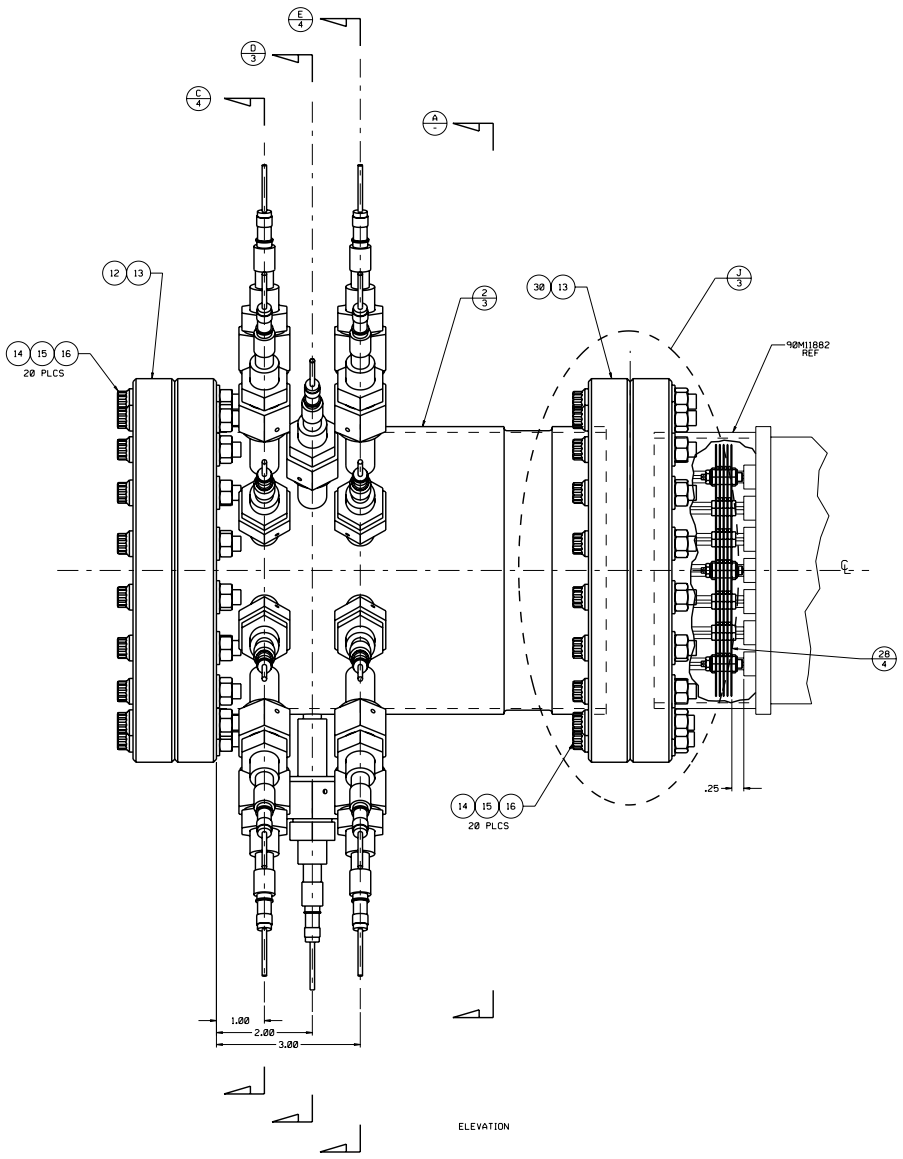
LITHIUM CORE FACE SEALING ASSEMBLY

DESIGN	DATE: 10-15-04	ENTER DWG: ET22
DRAWN		
CHECK		
STAT	NOTED	

SPECIAL TEST EQUIPMENT DESIGN BRANCH
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA

SIZE: E | 90M11886
SHEET 1 OF 4

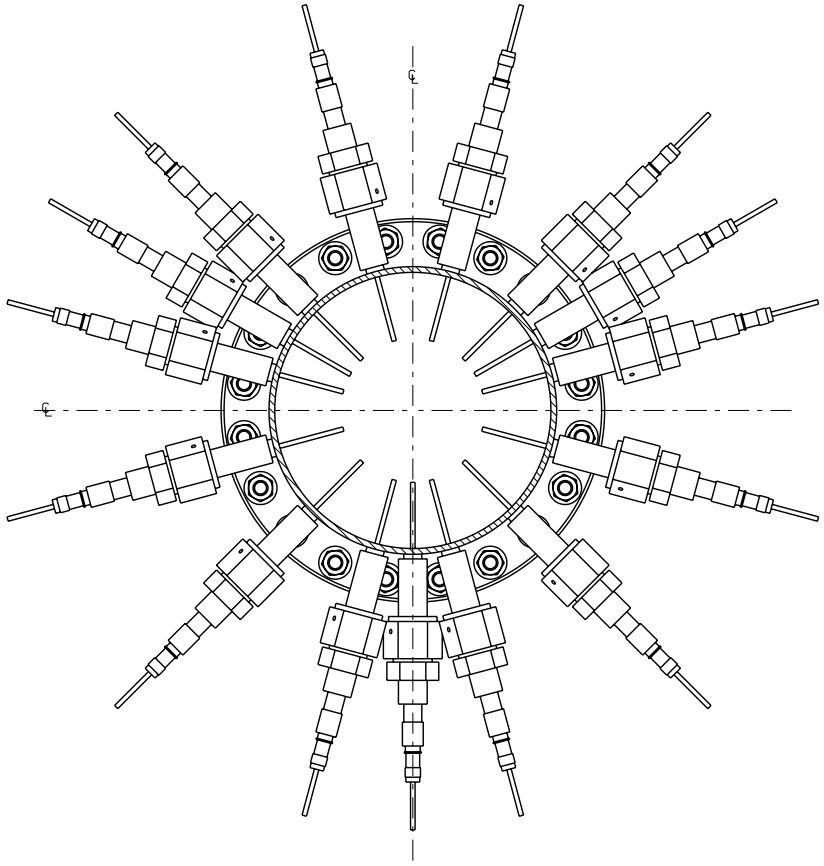
REVISIONS			
SYM	DESCRIPTION	DATE	APPROVED
		- -	
		- -	
		- -	



ELEVATION

FIND NO. (1)

SCALE: FULL



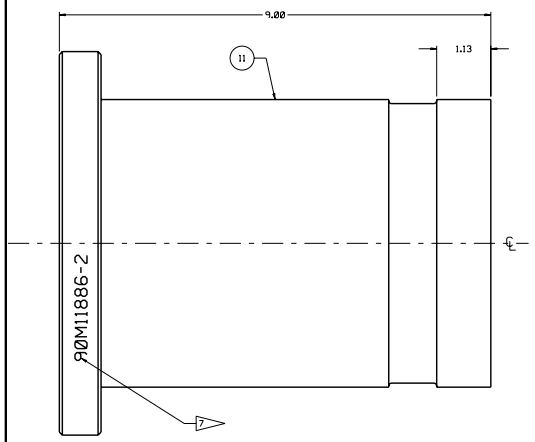
SECTION (A/-)

SCALE: FULL

90M11886
SEE SHT1
REVISION

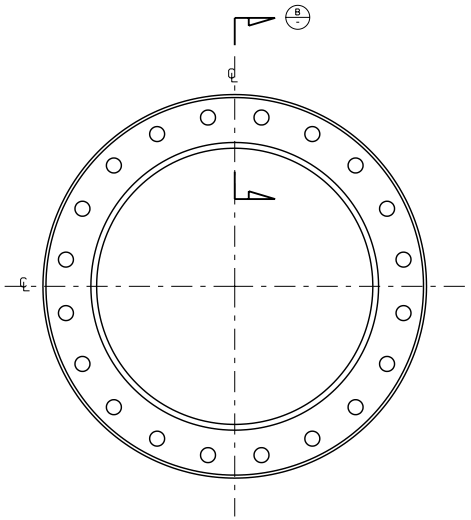
LITHIUM CORE FACE SEALING ASSEMBLY	SPECIAL TEST EQUIPMENT DESIGN BRANCH GEORGE C. MARSHALL SPACE FLIGHT CENTER NATIONAL AERONAUTICS AND SPACE ADMINISTRATION HUNTSVILLE, ALABAMA	
DATE - -	SPACE CODE ET22	SIZE E / 90M11886
DETAILER	SCALE NOTED	SHEET 2 OF 4

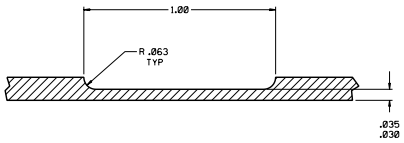
REVISIONS			
SYM	DESCRIPTION	DATE	APPROVED
		- -	
		- -	
		- -	



FIND NO. 2/2

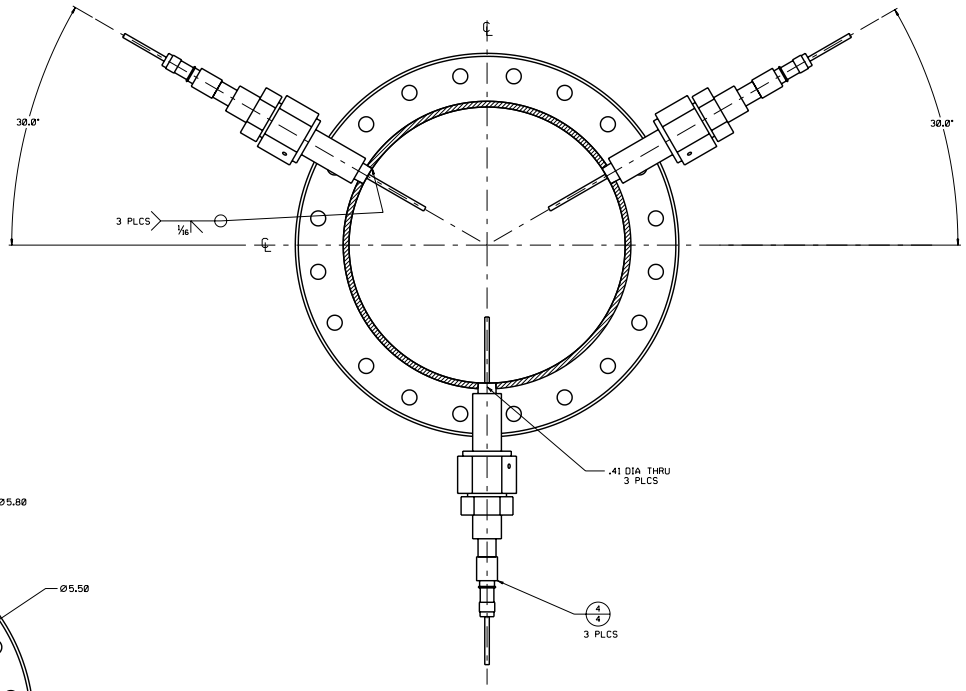
SCALE: FULL





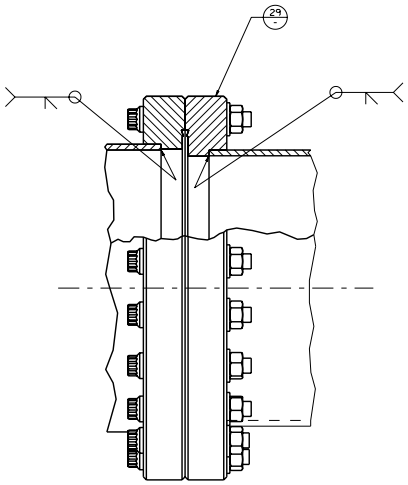
SECTION B/-

SCALE: 4:1



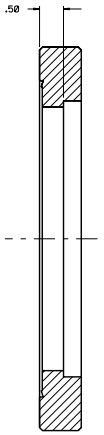
SECTION D/2

SCALE: FULL
SECTION C NOT SHOWN



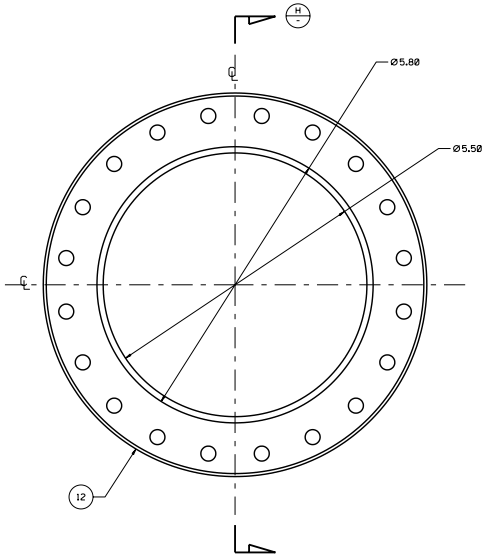
DETAIL J/2

SCALE: FULL



SECTION H/-

SCALE: FULL

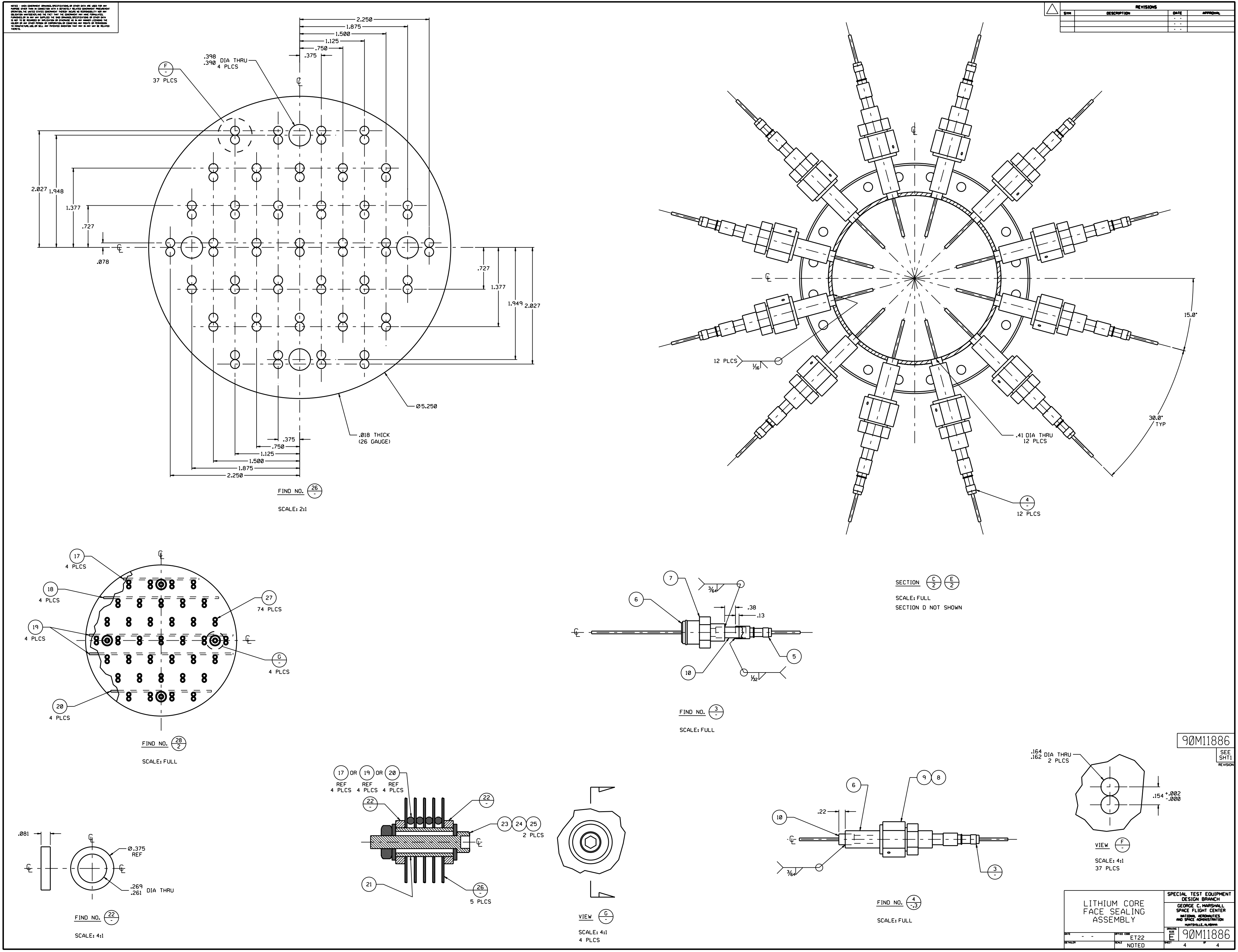


FIND NO. 29/-

SCALE: FULL

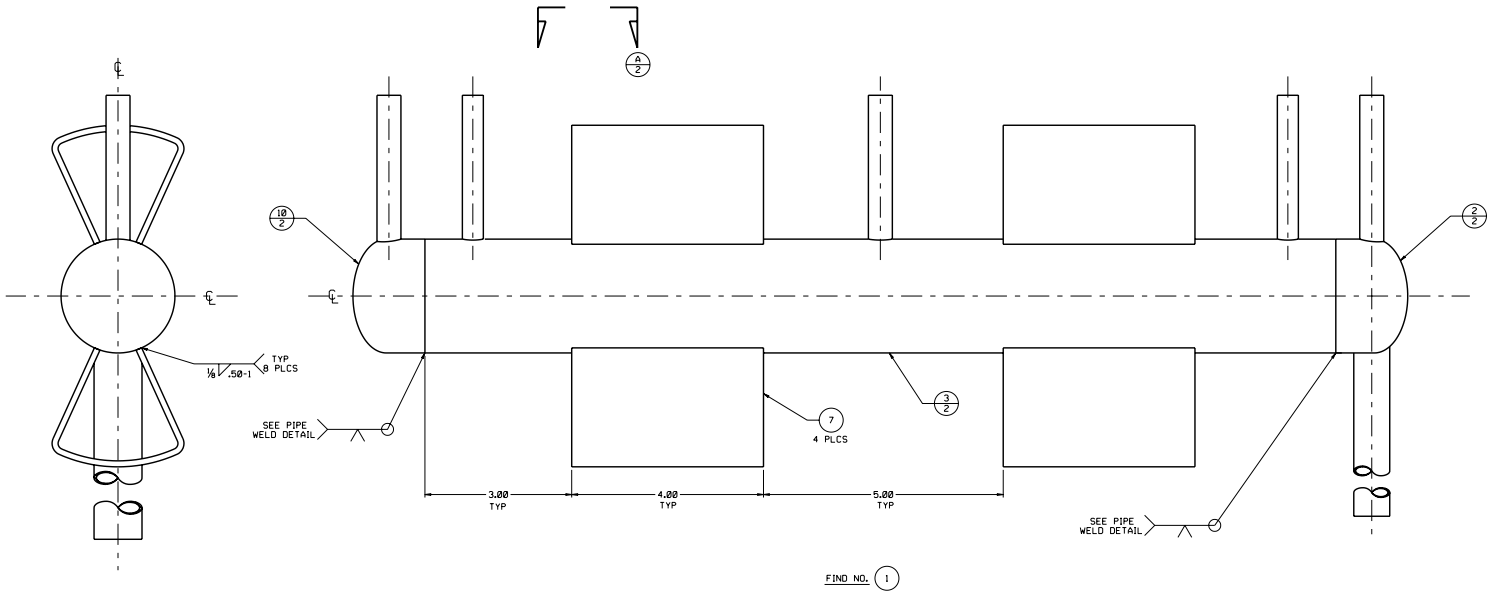
90M11886
SEE SHT1
REVISION

LITHIUM CORE FACE SEALING ASSEMBLY	SPECIAL TEST EQUIPMENT DESIGN BRANCH GEORGE C. MARSHALL SPACE FLIGHT CENTER NATIONAL AERONAUTICS AND SPACE ADMINISTRATION HUNTSVILLE, ALABAMA	
DATE - -	OFFICE CODE ET22	SIZE E
DETAILER	SCALE NOTED	DRAWING NO. 90M11886
		SHEET 3 OF 4


FIND NO. 26
SCALE: 2:1
.018 THICK (26 GAUGE)
Ø5.250
.398 .390 DIA THRU 4 PLCS
F 37 PLCS
SECTION C/2 E/2
SCALE: FULL
SECTION D NOT SHOWN
12 PLCS
.41 DIA THRU 12 PLCS
15.0°
30.0° TYP
4 12 PLCS
FIND NO. 28/2
SCALE: FULL
17 4 PLCS
18 4 PLCS
19 4 PLCS
20 4 PLCS
27 74 PLCS
G 4 PLCS
FIND NO. 3
SCALE: FULL
FIND NO. 22
SCALE: 4:1
Ø.375 REF
.269 .261 DIA THRU
17 OR 19 OR 20 REF 4 PLCS
23 24 25 2 PLCS
26 5 PLCS
VIEW G
SCALE: 4:1
4 PLCS
FIND NO. 4/-3
SCALE: FULL
VIEW F
SCALE: 4:1
37 PLCS
.164 .162 DIA THRU 2 PLCS
.154 +.002 -.000
90M11886
SEE SHT1
REVISION
LITHIUM CORE FACE SEALING ASSEMBLY
SPECIAL TEST EQUIPMENT DESIGN BRANCH
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA
ET22
NOTED
E 90M11886
4 OF 4

SECTION H—EXPANSION TANK DRAWINGS: T.J. GODFROY

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVED
		- -	
		- -	
		- -	



FIND NO. (1)

SCALE: FULL

NASA

GENERAL NOTES (UNLESS OTHERWISE SPECIFIED)

1. REMOVE ALL BURRS AND BREAK ALL SHARP EDGES.
2. FIELD TO VERIFY ALL TIE-IN CONNECTIONS.
3. ALL PIPE SIZES AND SCHEDULES SHALL CONFORM TO THE DIMENSIONS OF ASME-B36.10 OR ASME-B36.19.
4. ALL FITTINGS SHALL CONFORM TO THE DIMENSIONS OF ASME-B16.9 OR ASME-B16.28. NO BLOCK PATTERN FITTINGS SHALL BE USED. THE CROTCH AREA OF TEES AND CROSSES SHALL BE REINFORCED WITH LONG RADIUS DESIGN TO ELIMINATE SHARP CORNERS.
5. ALL BEVELS FOR BUTTWELDING ENDS OF PIPE FITTINGS, FLANGES, VALVES, AND COMPONENTS SHALL CONFORM TO ASME-B16.25.
6. ALL MACHINED PARTS TO HAVE A 125 MICROINCH ROUGHNESS HEIGHT RATING SURFACE FINISH.
7. THE SYSTEM SHALL BE HYDROSTATED TO 2.24 TIMES THE WORKING PRESSURE OF THE SYSTEM PER ASME SECTION VIII, DIV 1. THE WATER USED SHALL CONTAIN NO MORE THAN 25 PPM OF CHLORIDE FOR SST PIPE (50 PPM FOR C.S.) AND SHALL HAVE ½% BY WEIGHT SODIUM NITRITE AS AN INHIBITOR.
8. ALL SYSTEM WELDS AND STRUCTURAL ATTACHMENTS TO PIPING SHALL BE WELDED PER ASME SECTION VIII, DIVISION 1.
9. THE SYSTEM SHALL BE DESIGNED PER ASME SECTION VIII, DIVISION 1.
10. STEEL STAMP .25 HIGH CHARACTERS AS SHOWN.
11. ALL STEEL SUPPORTS SHALL BE WELDED AND 100% VISUALLY INSPECTED PER ASME SECTION VIII, DIVISION 1.

SPECIFIC NOTES

12. MATERIAL SPECIFICATIONS FOR STAINLESS STEEL SYSTEMS

PIPE:	ASTM-A312-TP316 SST. - SEAMED OR SEAMLESS
PIPE FITTINGS:	ASTM-A403-WP-S 316 SST.
TUBE:	ASTM-A213 TYPE 316 SST. - SEAMLESS
BAR STOCK:	AISI-316 SST PER ASTM A479
PLATE:	AISI-316 SST PER ASTM A240.
FORGINGS:	ASTM-A182-F316 SST.

PRELIMINARY
HAS NOT COMPLETED REVIEW CYCLE
AND IS SUBJECT TO CHANGE
11- 2-04

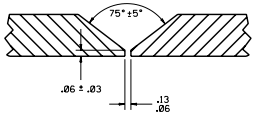
SUGGESTED VENDORS:

1. ANVIL INTERNATIONAL INC.
110 CORPORATE DRIVE
PORTSMOUTH, NH 03802
PH. (603) 422-8000

SPECIFIC NOTES

LITHIUM SYSTEM

13. ALL GIRTH AND LONGITUDINAL WELD JOINTS SHALL BE 100% VISUALLY EXAMINED PER ASME SECTION VIII, DIVISION 1 AND 100% LIQUID PENETRANT EXAMINED PER ASME SECTION V, ARTICLE 6.
14. THE PIPING SYSTEM SHALL BE HELIUM LEAK CHECKED USING A HELIUM MASS SPECTROMETER LEAK DETECTOR. ALLOWABLE LEAK RATE = 1 X 10^{-7} CC PER SECOND.
15. THE PIPING SYSTEM SHALL BE CLEANED FOR LIQUID OXYGEN SERVICE PER MSFC-SPEC-164B.
16. ALL MATERIAL IN CONTACT WITH LITHIUM SHALL BE CERTIFIED AND APPROVED BY MATERIALS, PROCESSES AND MANUFACTURING DEPARTMENT.



TYPICAL PIPE WELD DETAIL

SCALE: NONE

FIND NO.	SHEET NO.	TOT. REQ'D	PART NO.	DESCRIPTION	VEND. NO.	REMARKS
20						
19						
18						
17						
16						
15						
14						
13						
12						
11						
10	1,2	1	90M11887-10	END CAP		SST SEE NOTE 12
9	2	A/R	90M11887-9	⅜" O.D. X .065" WALL SEAMLESS TUBE		SST SEE NOTE 12
8	2	A/R	90M11887-8	½" O.D. X .065" WALL SEAMLESS TUBE		SST SEE NOTE 12
7	1	4	90M11887-7	PIPE PROTECTION SADDLE FOR 2" PIPE	1	FIG.162A ASTM-A240 316 SST
6	2	A/R	90M11887-6	¾" O.D. X .095" WALL SEAMLESS TUBE		SST SEE NOTE 12
5	2	2	90M11887-5	2" SCH 80S PIPE CAP		SST SEE NOTE 12
4	2	A/R	90M11887-4	2" SCH 80S PIPE		SST SEE NOTE 12
3	1,2	1	90M11887-3	SHELL		SST SEE NOTE 12
2	1,2	1	90M11887-2	END CAP		SST SEE NOTE 12
1	1	-	90M11887-1	MAIN ASSEMBLY		

A=ASSEMBLY/SUB-ASSEMBLY/INSTALLATION E=EXISTING ITEM/FACILITY F=FABRICATED ITEM M=MODIFIED ITEM P=PURCHASED ITEM

90M11887
~
REVISION

SERVICE: LITHIUM
TEMPERATURE: 50°F TO 860 °F
INTERNAL PRESSURE: 20 PSI
EXTERNAL PRESSURE: 0 PSI

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS ± 1/16 | DECIMAL X ± .06, .XX ± .03, .XXX ± .010 | ANGLES ± 1/2°
DO NOT SCALE DRAWING

	PROJ DESIGN ENGINEER	DATE - -
	TEST ENGINEER/REQUESTER	DATE - -
	STRESS	DATE - -
	MATERIALS	DATE - -
	INDUSTRIAL SAFETY	DATE - -
	PROJ APPROVAL	DATE - -

UPPER
LITHIUM RESERVOIR

SPECIAL TEST EQUIPMENT DESIGN BRANCH
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA

LOCATION	9' VC, BLDG. 4655		
NEXT ASSEMBLY	90M11881	LAST DETAIL, SECTION OR VIEW LETTER USED	A
DESIGN		DATE	10-27-04
DRAWN	ET22	DATE	
CHECK		DATE	
STRESS		DATE	
RELEASE	NOTED	DATE	

SIZE E | 90M11887
SHEET 1 OF 2

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVED
		- -	
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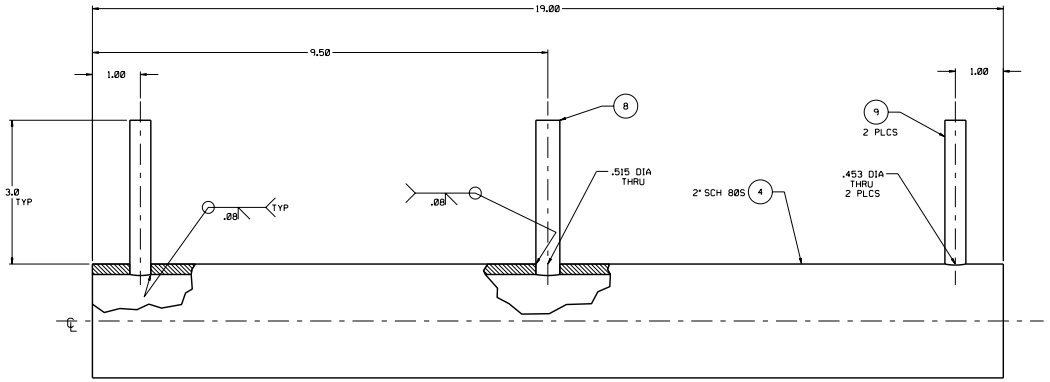

FIND NO. 3/1

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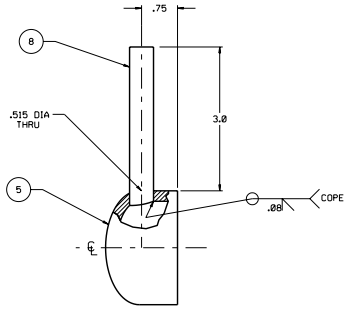

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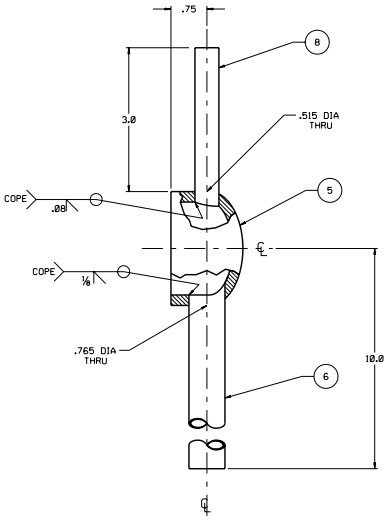

FIND NO. 2/1

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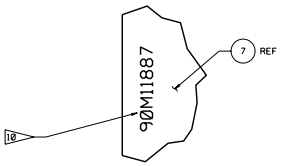

VIEW A/1

SCALE: FULL

90M11887
SEE SHT1
REVISION

UPPER LITHIUM RESERVOIR	SPECIAL TEST EQUIPMENT DESIGN BRANCH GEORGE C. MARSHALL SPACE FLIGHT CENTER NATIONAL AERONAUTICS AND SPACE ADMINISTRATION HUNTSVILLE, ALABAMA	
DATE - -	OFFICE CODE ET22	DRAWING SIZE E 90M11887
DETAILER	SCALE NOTED	SHEET 2 OF 2

SECTION I—CALCULATION OF REQUIRED TRANSDUCER STANDOFF LENGTHS: E.T. STEWART

Pressure Transducer Stand-Off Tube Length Estimates, 12/8/04

Eric Stewart, Eric.T.Stewart@nasa.gov , (256) 544-7099

These plots are ***not*** the temperatures along the length of the tube. They are the end temperatures for a given length. In other words, to use the plots, for a given x-value (i.e., tube length) the value of the plot is the temperature at the end. The straight line shows the target end temperature 453 K (180 C). The intersection of this line with the curve gives the required tube length. The center curve is the preferred plot with the upper and lower being an approximated error bound.

The required tube length is not greatly sensitive to the lithium-circuit temps because even though the amount of heat to be rejected rises as the lithium-circuit temp rises so does the ability to reject heat via radiation. The error bounds spread (i.e., increase) as the lithium-circuit temp rises because of the averaging of the end temperature and the lithium circuit temp used for both the effective heat transfer coefficient and the lithium thermal conductivity. I assumed that the tubes were radiating with an unobstructed view to chamber walls at 28 C. I assumed the emissivity of steel tubing to be 0.2, which should be in the ball park and is dependent on surface finish/condition. Raising emissivity would shorten the required tube while lowering would lengthen it.

The x-axis is stand-off tube length in meters while the y-axis is the lithium circuit temperature in Kelvin.

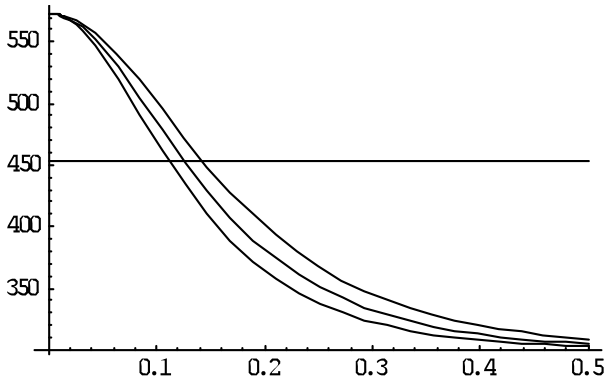

Figure 1: Tube end temperature (K) versus tube length (m) for a lithium-circuit temperature of 300 C

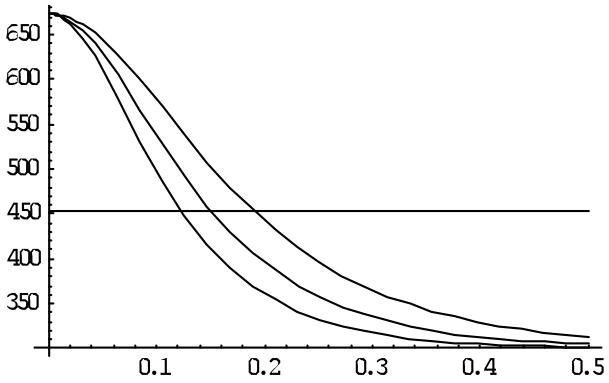

Figure 2: Tube end temperature (K) versus tube length (m) for a lithium-circuit temperature of 400 C

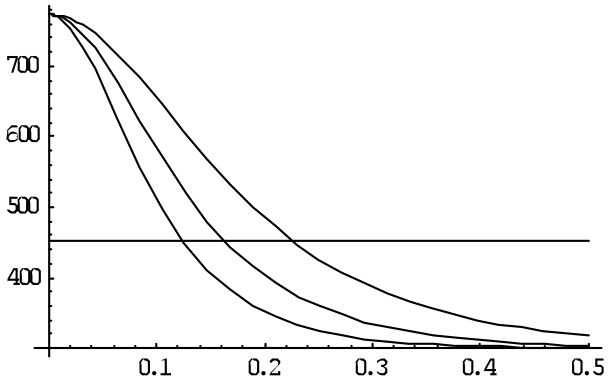

Figure 3: Tube end temperature (K) versus tube length (m) for a lithium-circuit temperature of 500 C

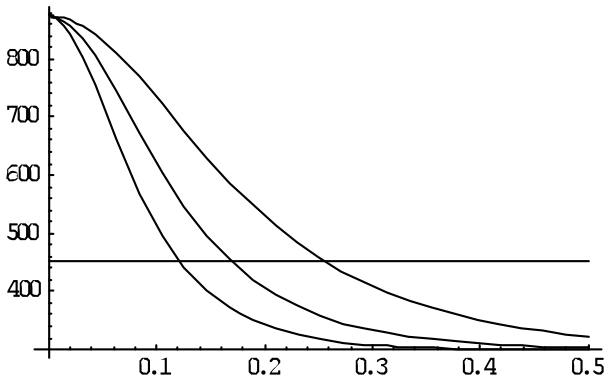

Figure 4: Tube end temperature (K) versus tube length (m) for a lithium-circuit temperature of 600 C

SECTION J—CART DRAWINGS: T.J. GODFROY

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVAL
		- -	
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GENERAL NOTES

1. REMOVE ALL BURRS AND BREAK ALL SHARP EDGES.
2. COPE TO FIT AS REQUIRED.
3. ALL ALUMINUM WELDS SHALL CONFORM TO MSFC-SPEC-504C, CLASS III, WELDING,ALUMINUM ALLOYS. NO PREPRODUCTION WELDS REQUIRED. VISUAL INSPECTION ONLY.
4. INSTALL HELICAL INSERTS PER MANUFACTURER'S RECOMMMENDATION.
5. INSTALL HELICAL INSERTS AFTER WELDING AND AT FINAL ASSEMBLY.
6. CLEAN FOR VACUUM SERVICE PER MIL-STD-1246C LEVEL 1000A, SINGLE WRAP AFTER CLEANING.
7. AT FINAL ASSEMBLY, CLEANLINESS SHALL BE MAINTAINED TO VC LEVEL PER JSC-SN-C-0005C. WIPE FIND NO.1 WITH ETHYL 200 PROOF ALCOHOL OR 70% ISOPROPYL ALCOHOL.
8. BOLTS SHALL BE TORQUED PER MSFC-STD-486B. LUBRICATE LIGHTLY WITH BRAYCOTE 601 PRIOR TO INSTALLATION. TORQUE FASTENERS PER TABLE BELOW, AT FINAL ASSEMBLY UNLESS OTHERWISE SPECIFIED.

SIZE	TORQUE
3/8-16	115-135 LB.-IN.

SUGGESTED VENDORS:

1. FOR MATERIAL ONLY

   L. MILLER AND SONS
   606 TRIANA BOULEVARD NW
   HUNTSVILLE, ALABAMA 35805
   PH. 205-536-1521

2. McMASTER CARR SUPPLY CO.
   P.O. BOX 4355
   CHICAGO, ILLINOIS 60680
   PH. (312) 833-0300

3. HAMILTON CASTER & MFG. CO.
   1637 DIXIE HWY.
   HAMILTON, OH 45011-4087
   PH. (513) 863-3300

PRELIMINARY
HAS NOT COMPLETED REVIEW CYCLE
AND IS SUBJECT TO CHANGE
05-26-04

FIND NO.	SHEET NO.	NO. REQ'D FOR F.N. 1	NO. REQ'D FOR F.N. 2	NO. REQ'D FOR F.N. 3	NO. REQ'D FOR F.N. 4	NO. REQ'D FOR F.N. 5	NO. REQ'D FOR F.N. 6	NO. REQ'D FOR F.N. 7	NO. REQ'D FOR F.N. 38	TOT. REQ'D		PART NO.	DESCRIPTION	VEND. NO.	REMARKS
39	6,7						1	1		12	F	90M11720-39	4 X 4 X 3/8 ANGLE X 5" LG.	1	AL ALLOY 6061-T6
38	4,8		1						X	1	A	90M11720-38	PIVOT BEAM FOR UPPER SUPPORT		
37	2,7	2								2	F	90M11720-37	1" ROUND BAR X 18" LG	1	MAT: 316 STAINLESS STEEL, V.P.N. 8936K213
36	2	6								6	P	90M11720-36	V-GROOVE CASTER	3	HEAVY DUTY STAINLESS STL CASTER #8-WHS-6SVB
35	2	4								4	P	90M11720-35	2500 LB SAFETY HOIST RING	2	MAT: CORROSION RESTISTANT STEEL, V.P.N. 3145T25
34	5,7				2	2				12	P	90M11720-34	1/2" FLAT WASHER	2	MAT: 18-8 STAINLESS STEEL, V.P.N. 98017A210
33	5,7				2	2				12	P	90M11720-33	1/2 -13 UNC-2B NUT	2	MAT: 18-8 STAINLESS STEEL, V.P.N. 94252A712
32	5,7				1	1				6	P	90M11720-32	1/2 -13 UNC-2A X 6" LG STUD	2	MAT: 18-8 STAINLESS STEEL, V.P.N. 95412A736
31	5	12								12	P	90M11720-31	1-8 UNC-2B NUT	2	MAT: 18-8 STAINLESS STEEL, V.P.N. 94252A725
30	5	6								6	P	90M11720-30	1-8 UNC-2A X 6" LG STUD	2	MAT: 316 STAINLESS STEEL, V.P.N. 96545A370
29	2	24								24	P	90M11720-29	3/8 FLAT WASHER AN960	2	MAT: 18-8 STAINLESS STEEL, V.P.N. 92141A831
28	2	24								24	P	90M11720-28	3/8 - 16 UNC-2A X 1" LG SOC HEAD CAP SCREW	2	MAT: 18-8 STAINLESS STEEL, V.P.N. 92196A624
27	2	24								24	P	90M11720-27	3/8 - 16 HELICAL INSERT X .56 LG.	2	MAT: 18-8 STAINLESS STEEL, V.P.N 91732A21
26	3			3						3	F	90M11720-26	4 X 4 1/4 SQ TUBING X 46.69 LG.	1	AL ALLOY 6061-T6
25	3			2						2	F	90M11720-25	4 X 4 X 1/4 SQ TUBING X 115" LG.	1	AL ALLOY 6061-T6
24	4		2							2	F	90M11720-24	18" LG STIFFENING PLATE FOR TOP FRAME	1	AL ALLOY 6061-T6
23	4		2							2	F	90M11720-23	17" LG STIFFENING PLATE FOR TOP FRAME	1	AL ALLOY 6061-T6
22	5					1				4	F	90M11720-22	4 X 4 X 1/4 SQ TUBING X 12" LG.	1	AL ALLOY 6061-T6
21	5,7				1					2	F	90M11720-21	4 X 4 X 1/4 SQ TUBING X 14.5" LG.	1	AL ALLOY 6061-T6
20	2,5	16								16	P	90M11720-20	1" WASHER	2	MAT: 18-8 STAINLESS STEEL, V.P.N. 98017A230
19	4,8		4							4	F	90M11720-19	END CAP	1	AL ALLOY 6061-T6
18	3,6			3						3	F	90M11720-18	WHEEL SPACER FOR LOWER SIDE	1	AL ALLOY 6061-T6
17	5,7,8				1	1				6	F	90M11720-17	SPACER TO GO BETWEEN TWO FRAMES	1	AL ALLOY 6061-T6
16	7,8								2	2	F	90M11720-16	PIVOT BRACKET FOR UPPER FRAME	1	AL ALLOY 6061-T6
15	4,5		2							2	F	90M11720-15	4 X 4 X 1/4 SQ TUBING X 120.00" LG.	1	AL ALLOY 6061-T6
14	4,7		1							1	F	90M11720-14	4 X 4 X 3/8 ANGLE X 14.5" LG	1	AL ALLOY 6061-T6
13	3,6			1						1	F	90M11720-13	PLATE FOR JACK TO MOUNT ON	1	AL ALLOY 6061-T6
12	4,8		7						1	8	F	90M11720-12	4 X 4 X 1/4 SQ TUBING X 69.56" LG.	1	AL ALLOY 6061-T6
11	6,7						2	2		24	F	90M11720-11	GUSSET	1	AL ALLOY 6061-T6
10	3,6			3						3	F	90M11720-10	WHEEL SPACER FOR HIGHER SIDE	1	AL ALLOY 6061-T6
9	3,6			4						4	F	90M11720-9	PIVOT CONNECTOR FOR LOWER SUPPORT	1	AL ALLOY 6061-T6
8	2,8	1								1	F	90M11720-8	TOP PLATE	1	AL ALLOY 6061-T6
7	5,7				1	1			X	6	A	90M11720-7	ANGLE BRACKET ASSEMBLY FOR UPPER FRAME		
6	3,6			6					X	6	A	90M11720-6	ANGLE BRACKET ASSEMBLY FOR LOWER FRAME		
5	4,5		4						X	4	A	90M11720-5	TOP FRAME TIE DOWN ASSEMBLY X 12" LG		
4	4,7		2						X	2	A	90M11720-4	TOP FRAME TIE DOWN ASSEMBLY X 14.5" LG		
3	2,3	1							X	1	A	90M11720-3	BOTTOM FRAME ASSEMBLY		
2	2,4	1							X	1	A	90M11720-2	TOP FRAME ASSEMBLY		
1	2									-	A	90M11720-1	TILT TABLE ASSEMBLY		

A=ASSEMBLY/SUB-ASSEMBLY/INSTALLATION E=EXISTING ITEM/FACILITY F=FABRICATED ITEM M=MODIFIED ITEM P=PURCHASED ITEM

90M11720

~ REVISION

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ARE:
FRACTIONS ± 1/16 DECIMAL X ± .06 .XX ± .03 .XXX ± .010 ANGLES ± 1/2°
DO NOT SCALE DRAWING

LOCATION 9'VC/4655
NEXT ASSEMBLY 90M11880
LAST DETAIL, SECTION OR VIEW LETTER USED F

ITEM DESIGN ENGINEER - - DATE
TEST ENGINEER/REQUESTER - - DATE
STRESS - - DATE
MATERIALS - - DATE
INDUSTRIAL SAFETY - - DATE
ITEM APPROVAL - - DATE

TILT TABLE

DETAILER JME DATE 05-26-04 ENTER SIZE ED38
DESIGNER JDD SCALE NONE

SPECIAL TEST EQUIPMENT DESIGN GROUP
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA

DRAWING SIZE E | 90M11720
SHEET 1 OF 8

REVISIONS

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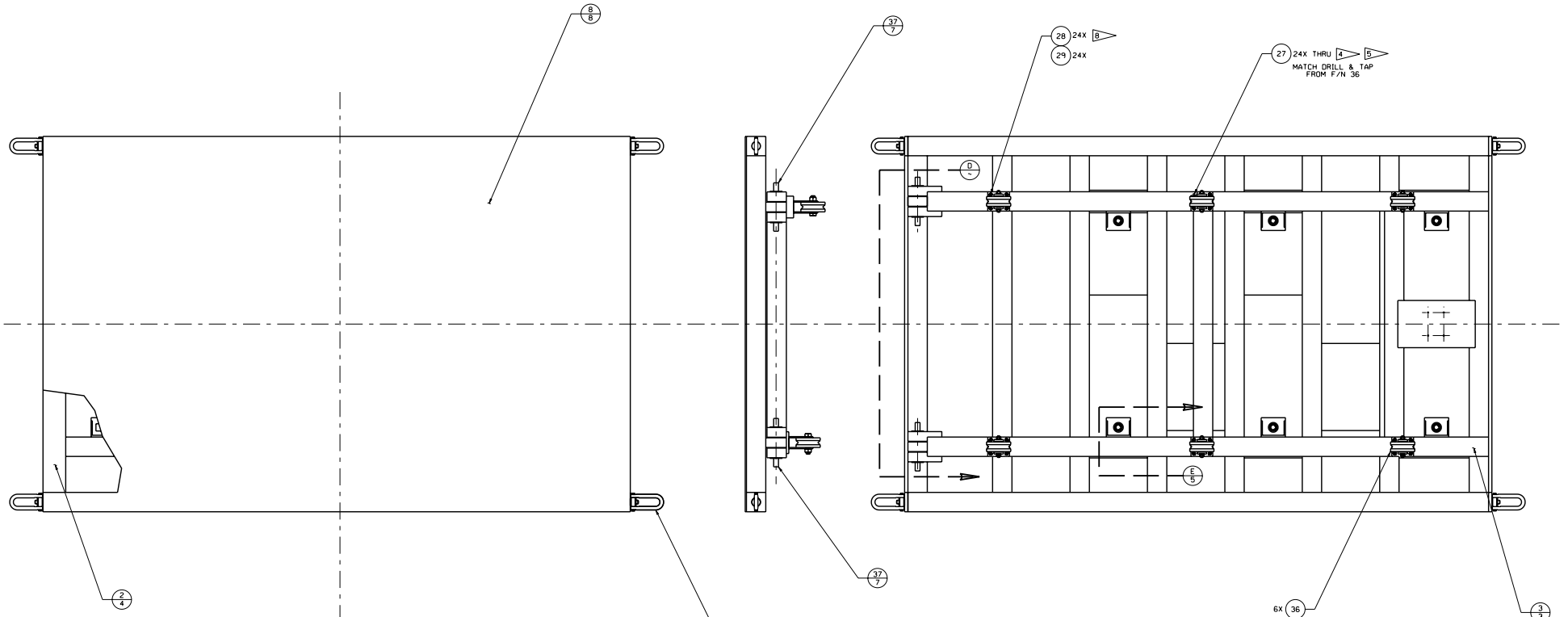

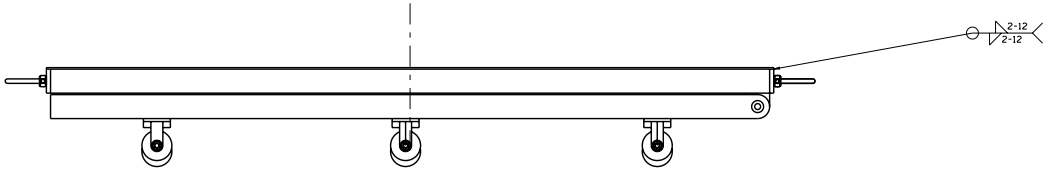

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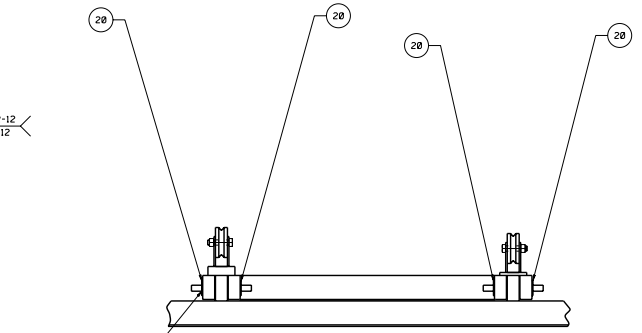

SECTION D

SCALE: 1:8

90M11720

SEE SHT1

REVISION

PRELIMINARY
HAS NOT COMPLETED REVIEW CYCLE
AND IS SUBJECT TO CHANGE
05-26-04

TILT TABLE		SPECIAL TEST EQUIPMENT DESIGN GROUP GEORGE C. MARSHALL SPACE FLIGHT CENTER NATIONAL AERONAUTICS AND SPACE ADMINISTRATION HUNTSVILLE, ALABAMA
DATE 05-26-04	OFFICE CODE ED38	SIZE E
DETAILER JME	SCALE NOTED	DRAWING NO. 90M11720
		SHEET 2 OF 8

REVISIONS

SYM	DESCRIPTION	DATE	APPROVED
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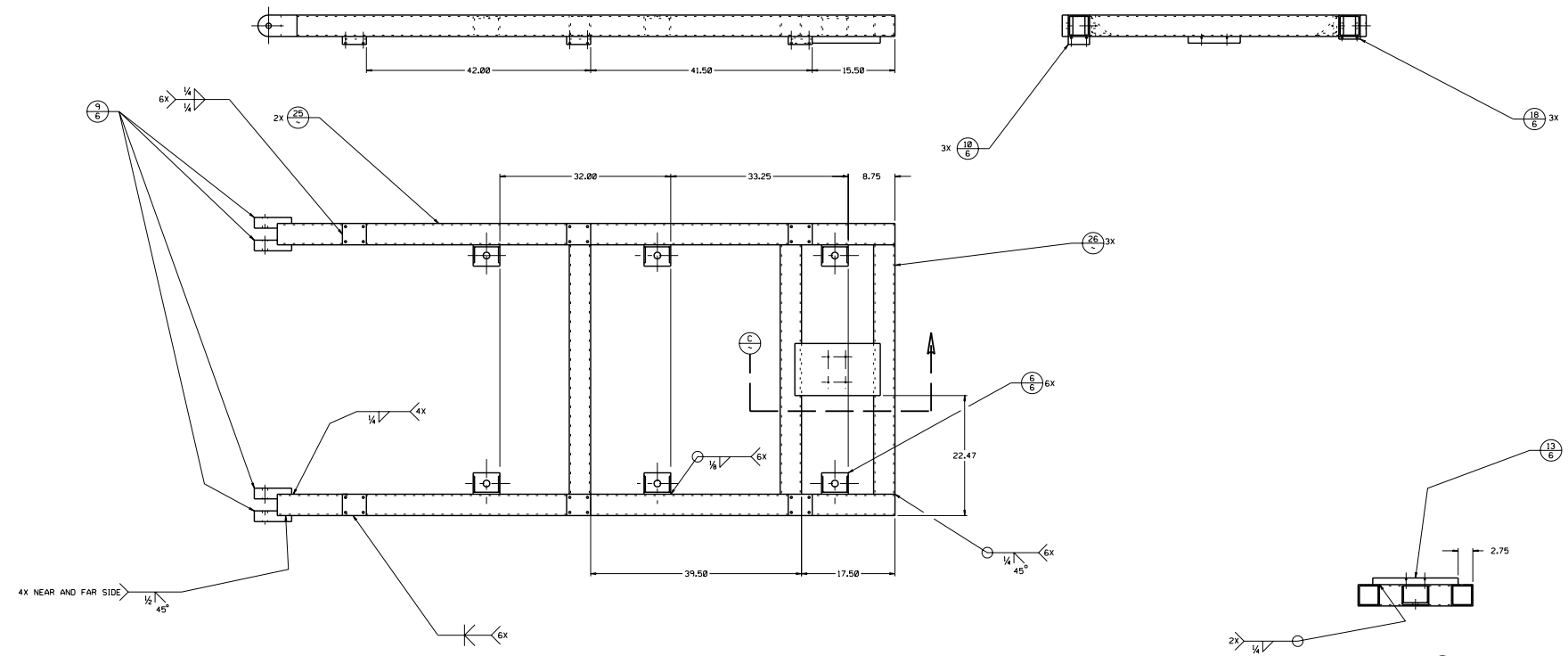

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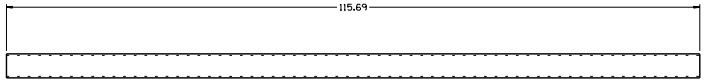
SCALE: 1:8

SECTION C/~

SCALE: 1:8



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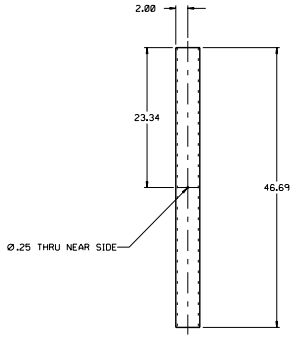

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SCALE: 1:8

PRELIMINARY
HAS NOT COMPLETED REVIEW CYCLE
AND IS SUBJECT TO CHANGE
05-26-04

90M11720
SEE SHT1
REVISION

TILT TABLE	SPECIAL TEST EQUIPMENT DESIGN GROUP GEORGE C. MARSHALL SPACE FLIGHT CENTER NATIONAL AERONAUTICS AND SPACE ADMINISTRATION HUNTSVILLE, ALABAMA
DATE 05-26-04 / OFFICE CODE ED38	DRAWING SIZE E / 90M11720
DETAILER JME / SCALE NOTED	SHEET 3 OF 8

REVISIONS

SYM	DESCRIPTION	DATE	APPROVED
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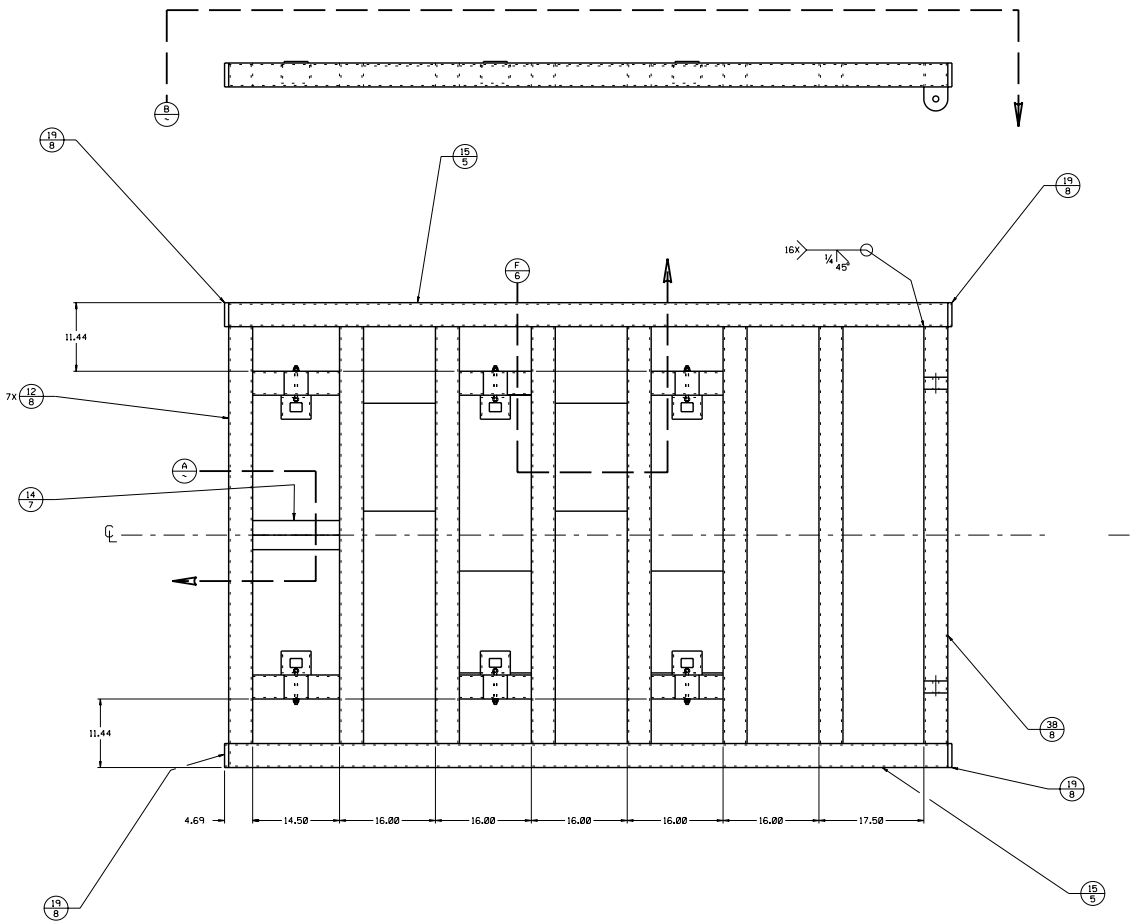

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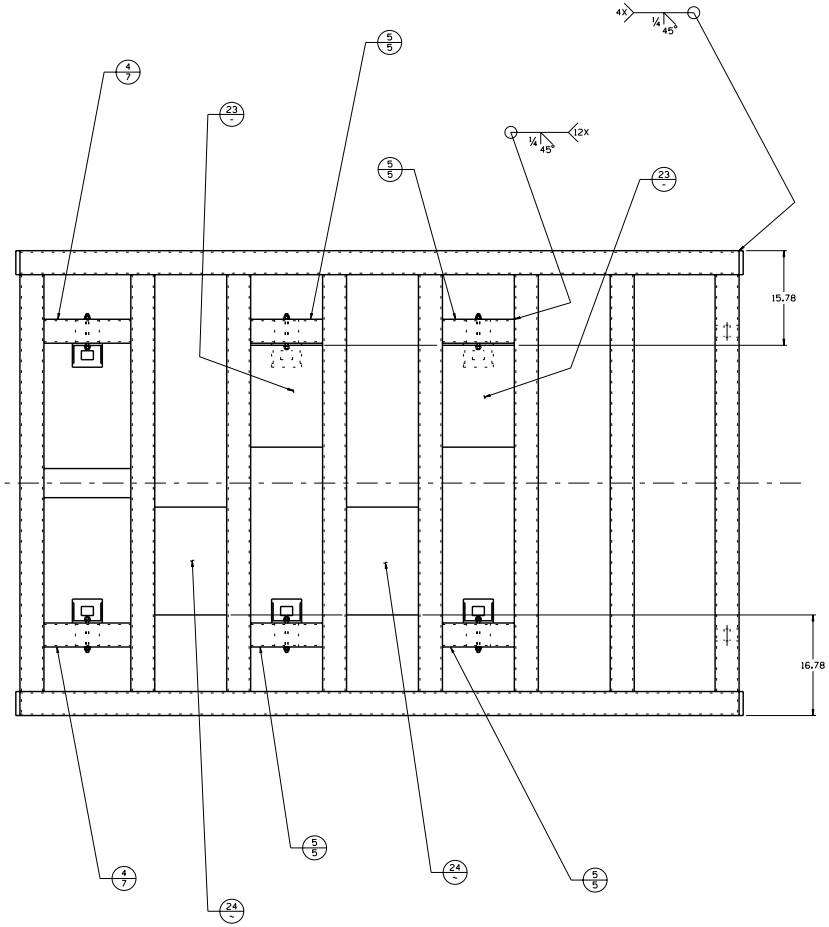

VIEW 8

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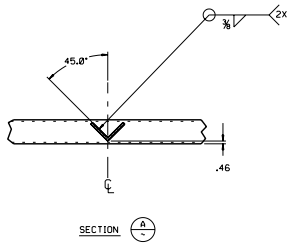

SECTION A

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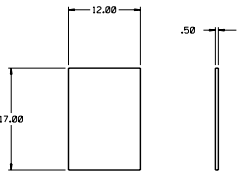

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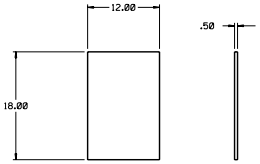

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90M11720

SEE SHT1 REVISION

PRELIMINARY
HAS NOT COMPLETED REVIEW CYCLE
AND IS SUBJECT TO CHANGE
05-26-04

TILT TABLE		SPECIAL TEST EQUIPMENT DESIGN GROUP GEORGE C. MARSHALL SPACE FLIGHT CENTER NATIONAL AERONAUTICS AND SPACE ADMINISTRATION HUNTSVILLE, ALABAMA
DATE 05-26-04	OFFICE CODE ED38	SIZE E 90M11720
DETAILER JME	SCALE NOTED	SHEET 4 OF 8

REVISIONS			
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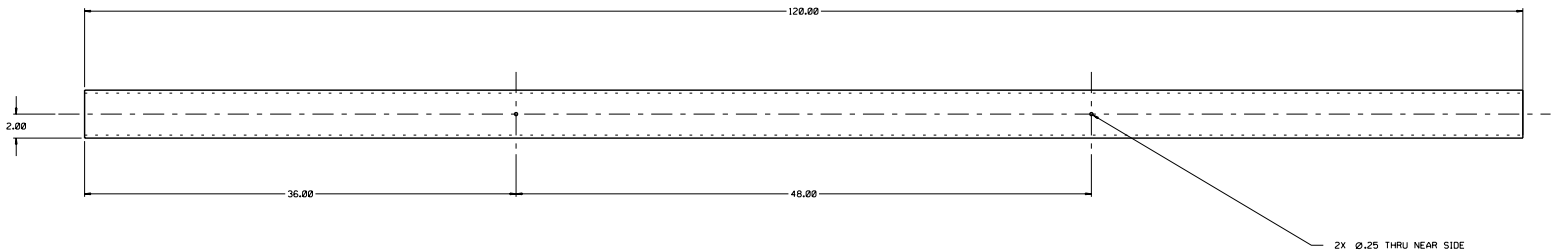

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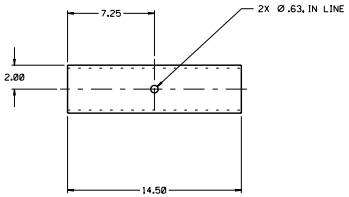
PRELIMINARY
HAS NOT COMPLETED REVIEW CYCLE
AND IS SUBJECT TO CHANGE
05-26-04



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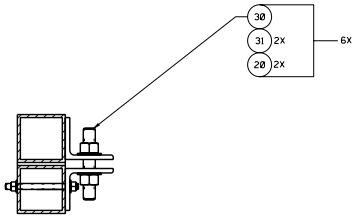
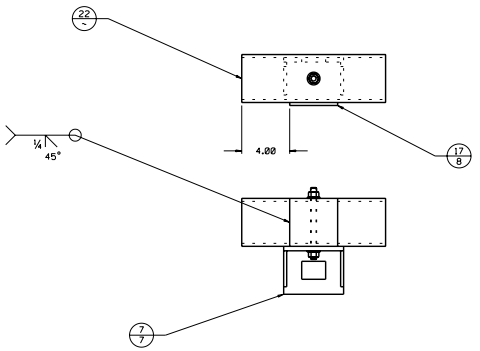
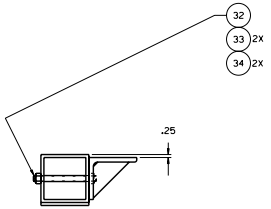


SECTION E/2

SCALE: 1:4

GUSSETS REMOVED FOR CLARITY





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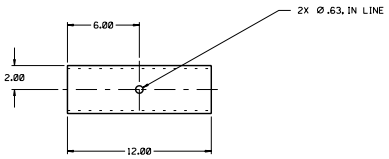

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90M11720
SEE SHT1
REVISION

TILT TABLE		SPECIAL TEST EQUIPMENT DESIGN GROUP GEORGE C. MARSHALL SPACE FLIGHT CENTER NATIONAL AERONAUTICS AND SPACE ADMINISTRATION HUNTSVILLE, ALABAMA
DATE 05-26-04	OFFICE CODE ED38	SIZE E
DETAILER JME	SCALE NOTED	DRAWING NO. 90M11720
		SHEET 5 OF 8

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVED
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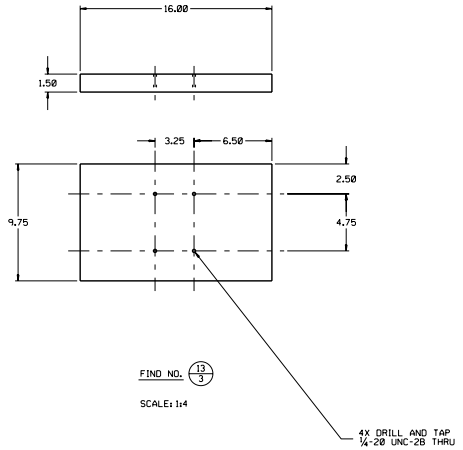

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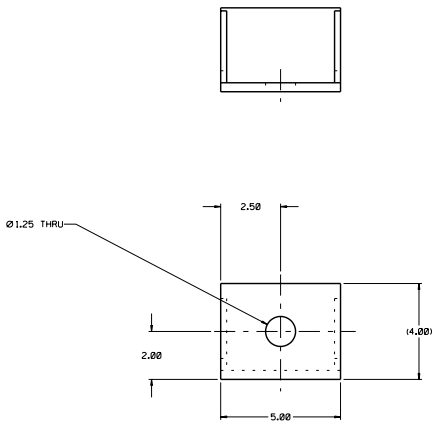

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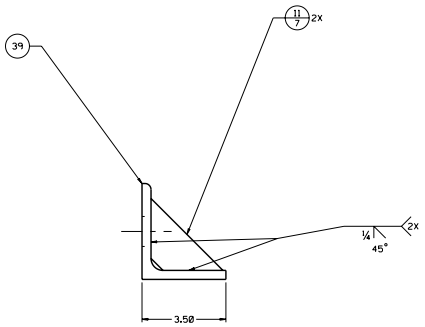

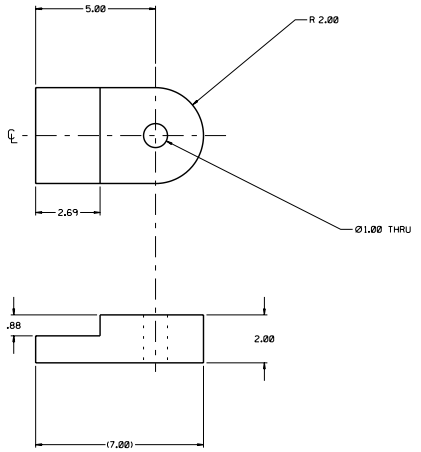

FIND NO. 9/3

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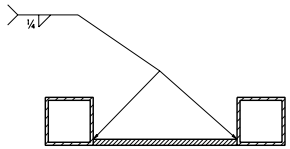
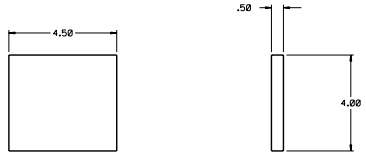


SECTION F/4 TYP. 4 PLCS.

SCALE: 1:4

FIND NO. 10/3

SCALE: 1:2



FIND NO. 18/3

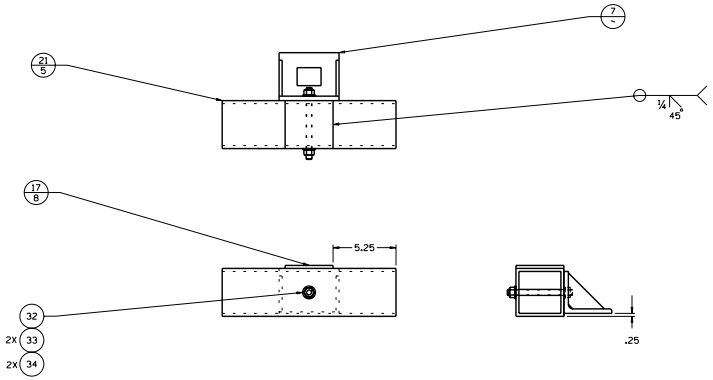
SCALE: 1:2

PRELIMINARY
HAS NOT COMPLETED REVIEW CYCLE
AND IS SUBJECT TO CHANGE
05-26-04

90M11720
SEE SHT1
REVISION

TILT TABLE		SPECIAL TEST EQUIPMENT DESIGN GROUP GEORGE C. MARSHALL SPACE FLIGHT CENTER NATIONAL AERONAUTICS AND SPACE ADMINISTRATION HUNTSVILLE, ALABAMA
DATE 05-26-04	OFFICE CODE ED38	SIZE E
DETAILER JME	SCALE NOTED	DRAWING NO. 90M11720
		SHEET 6 OF 8

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVED
		- -	
		- -	
		- -	



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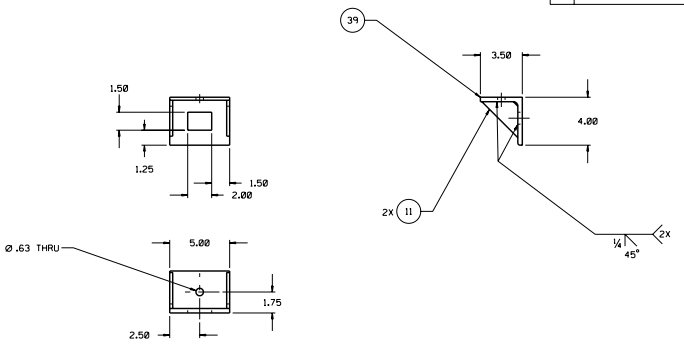
SCALE: 1:4



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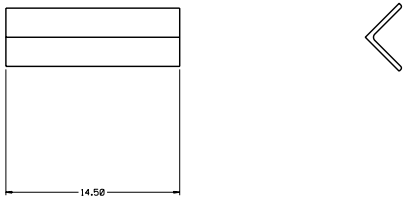

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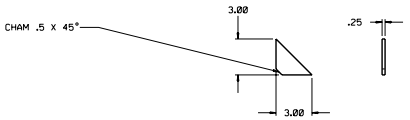

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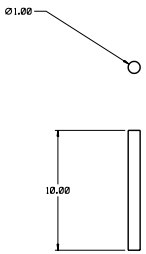

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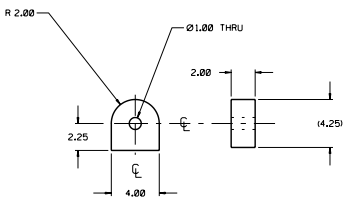

FIND NO. 16/8

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PRELIMINARY
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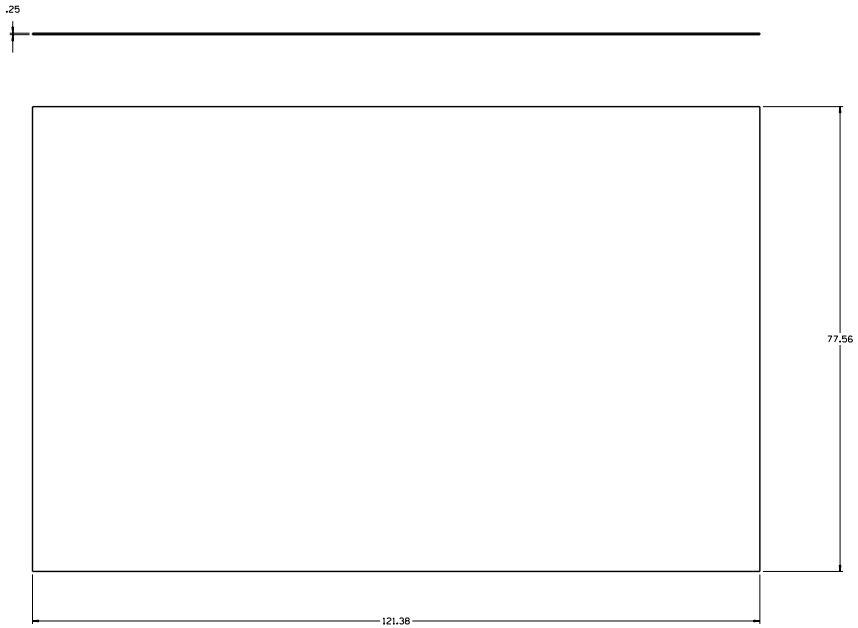
AND IS SUBJECT TO CHANGE
05-26-04

90M11720
SEE SHT1
REVISION

TILT TABLE		SPECIAL TEST EQUIPMENT DESIGN GROUP GEORGE C. MARSHALL SPACE FLIGHT CENTER NATIONAL AERONAUTICS AND SPACE ADMINISTRATION HUNTSVILLE, ALABAMA
DATE 05-26-04	OFFICE CODE ED38	SIZE E — 90M11720
DETAILER JME	SCALE NOTED	SHEET 7 OF 8

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVED
		- -	
		- -	
		- -	

PRELIMINARY
HAS NOT COMPLETED REVIEW CYCLE
AND IS SUBJECT TO CHANGE
05-26-04



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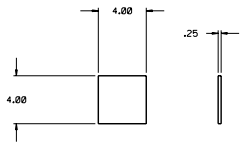
SCALE: 1:8



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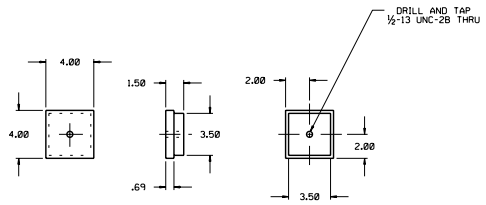
SCALE: 1:4



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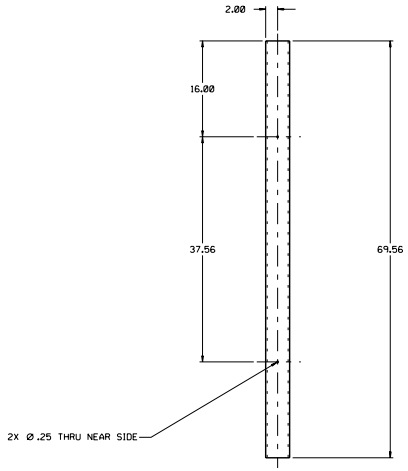
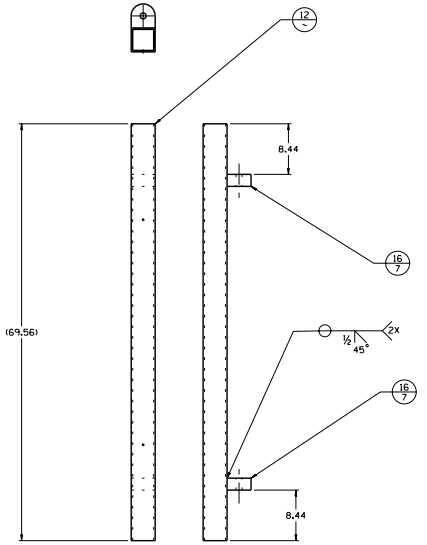
SCALE: 1:4



FIND NO. 12/4

SCALE: 1:8



FIND NO. 38/4

SCALE: 1:8

90M11720
SEE SHT1
REVISION

TILT TABLE	SPECIAL TEST EQUIPMENT DESIGN GROUP GEORGE C. MARSHALL SPACE FLIGHT CENTER NATIONAL AERONAUTICS AND SPACE ADMINISTRATION HUNTSVILLE, ALABAMA	
DATE 05-26-04	SPACE CODE ED38	SIZE E
DETAILER JME	SCALE NOTED	DRAWING NO. 90M11720
		SHEET 8 OF 8

SECTION K—HEAT EXCHANGER ANALYSIS: T.J. GODFROY

Appendix L: NaK Heat Exchanger Analysis

This analysis assesses the axial temperature profiles along the length of two heat exchanger options, one measuring 0.6 meters the other 1.2. The inlet NaK-78 conditions and heat exchanger geometric cross-section values used in the assessment in include:

NaK flow rate	1	kg/s
NaK inlet temp	923	K
He pressure	200	psi

Number of tubes	107	
OD of tubes	0.3125	in
ID of tubes	0.2565	in
Tube length	0.6096	m
flow area per tube	3.3337E-05	m2
Total flow area	0.0035671	m2
HT perimeter	2.66819391	m
Total HT area	1.62653101	m2
ID of shell	5.295	in

Figures 1 to 12 show results for He (mdot 0.1 kg/s, 0.2 kg/s), N2 (mdot 0.1 kg/s, 0.2 kg/s), and He-Ar (mdot 0.2 kg/s, 0.3 kg/s) with heat rejection rates of 30 and 60 kW. The NaK inlet temperature was assumed fixed at 650 ^{o}C (923K). The He/Ar mixture is 80% helium by volume. See captions of each plot for specific conditions.

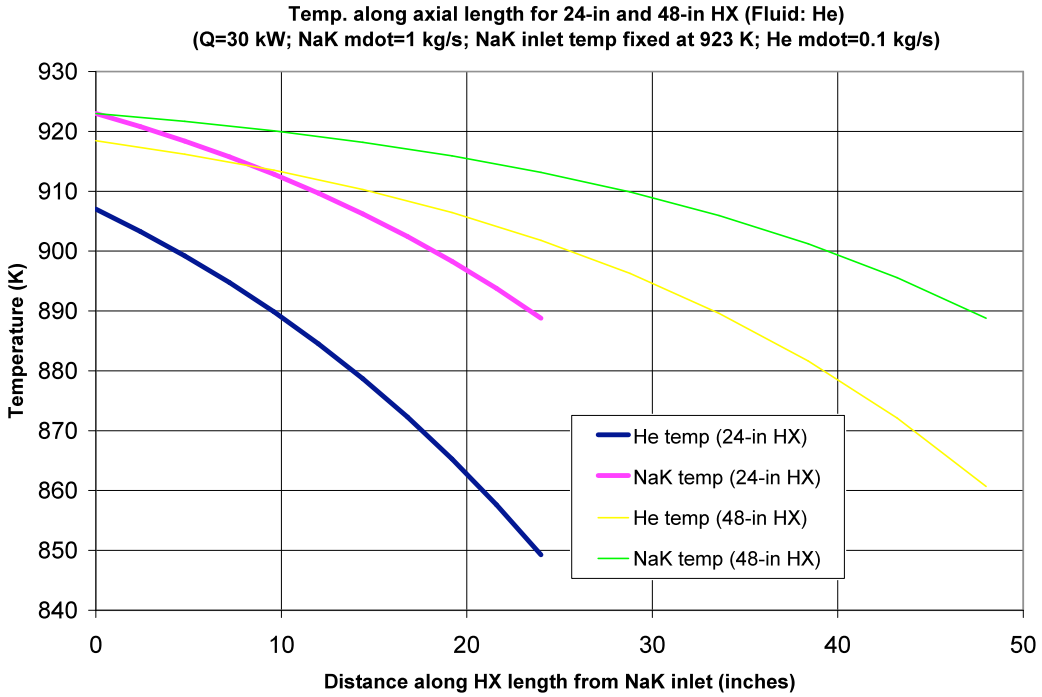


Figure 1: Fluid Helium (flow rate 0.1 kg/sec), heat rejection 30 kW

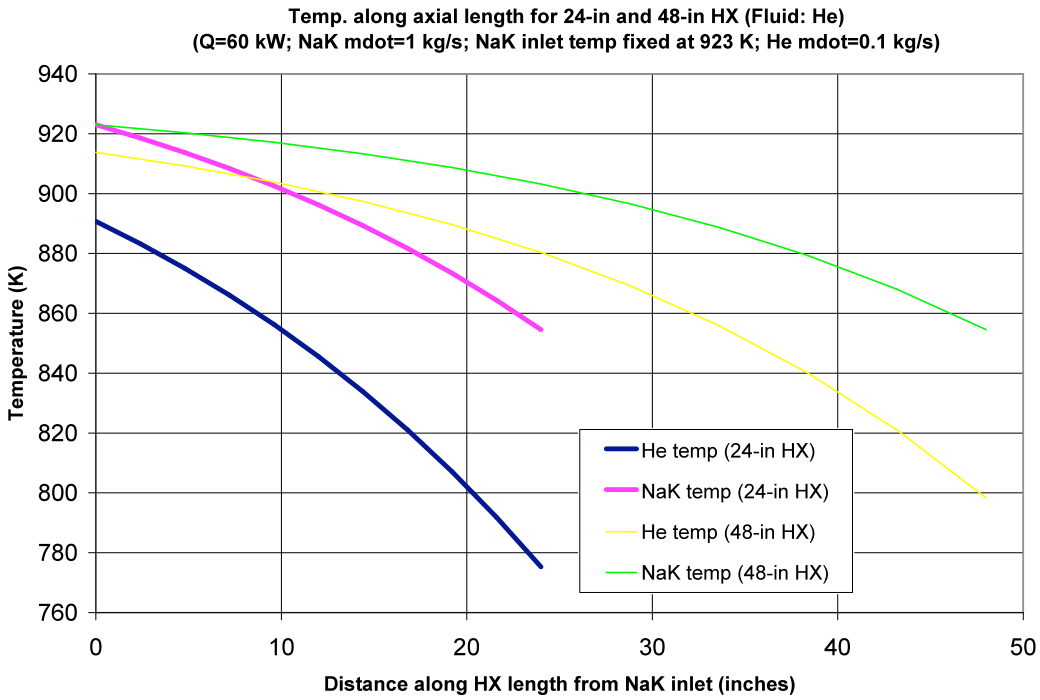


Figure 2: Fluid Helium (flow rate 0.1 kg/sec), heat rejection 60 kW

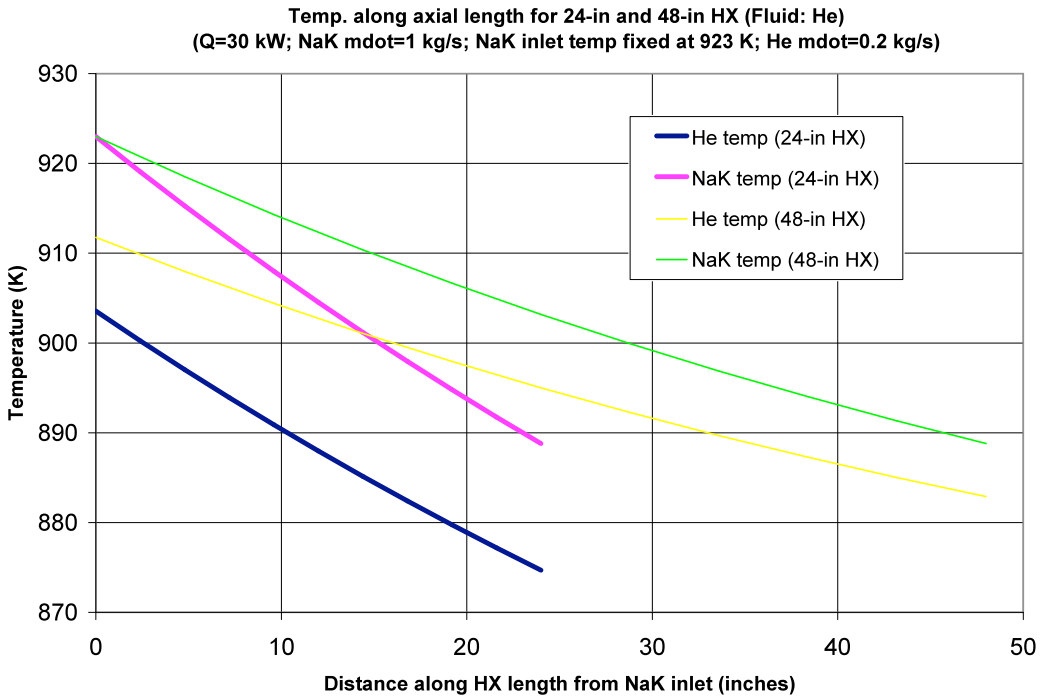


Figure 3: Fluid Helium (flow rate 0.2 kg/sec), heat rejection 30 kW

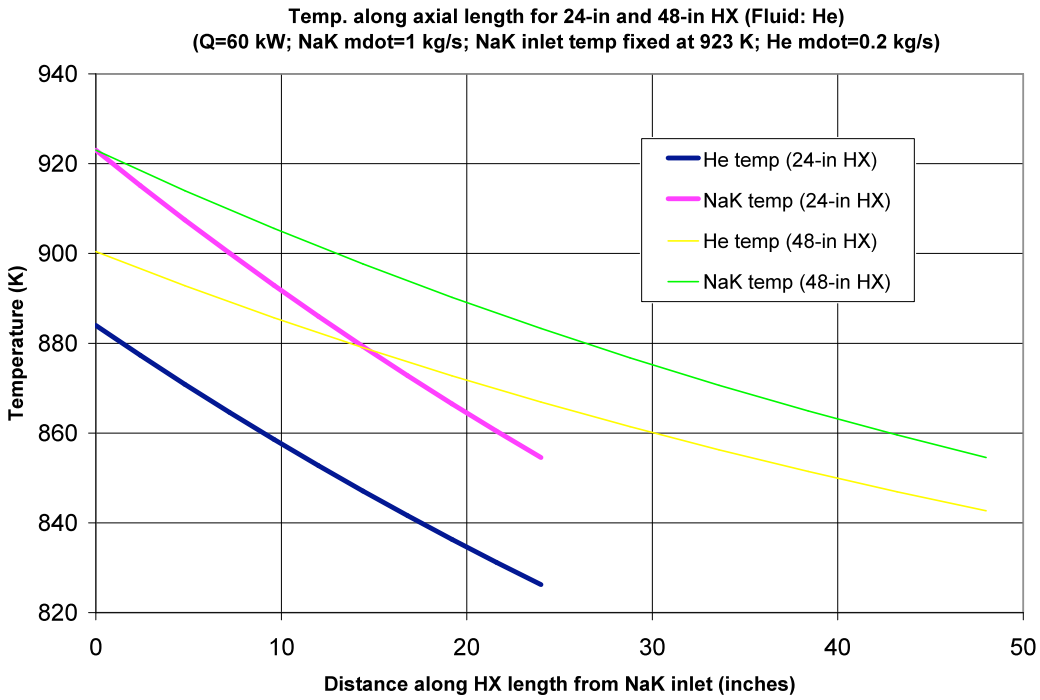


Figure 4: Fluid Helium (flow rate 0.2 kg/sec), heat rejection 60 kW

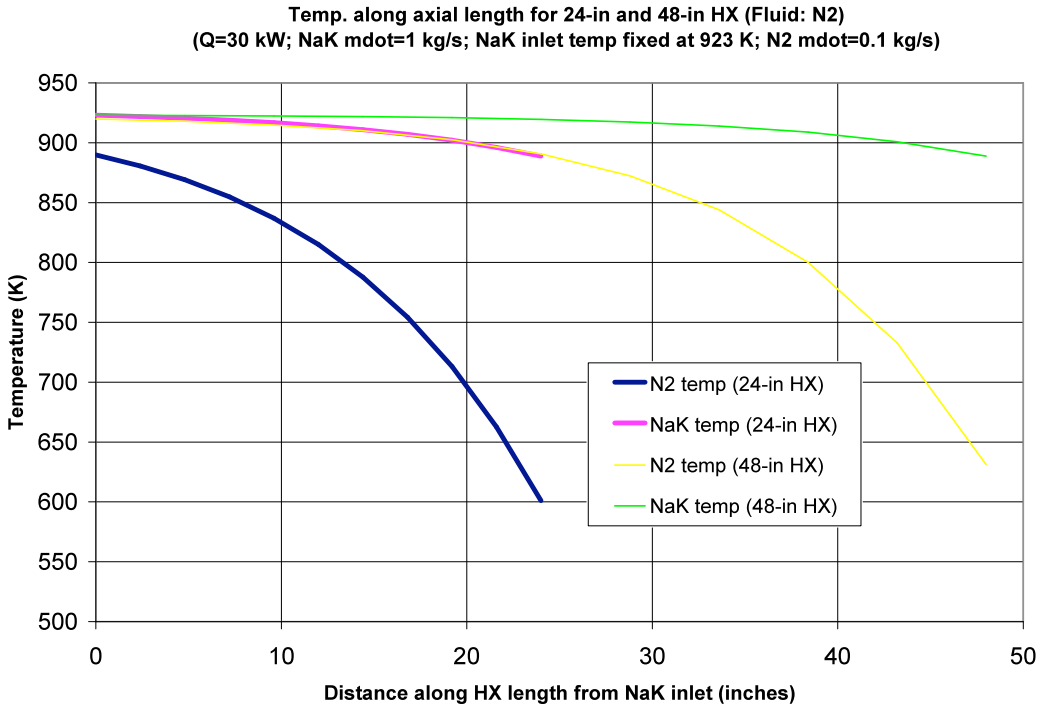


Figure 5: Fluid Nitrogen (flow rate 0.1 kg/sec), heat rejection 30 kW

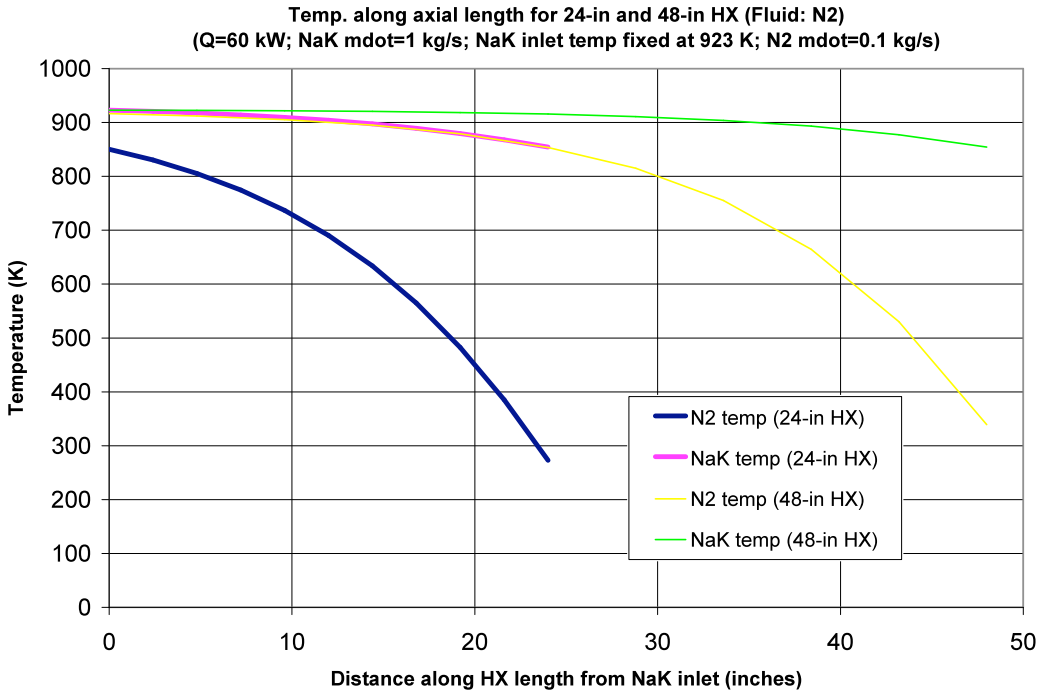


Figure 6: Fluid Nitrogen (flow rate 0.1 kg/sec), heat rejection 60 kW

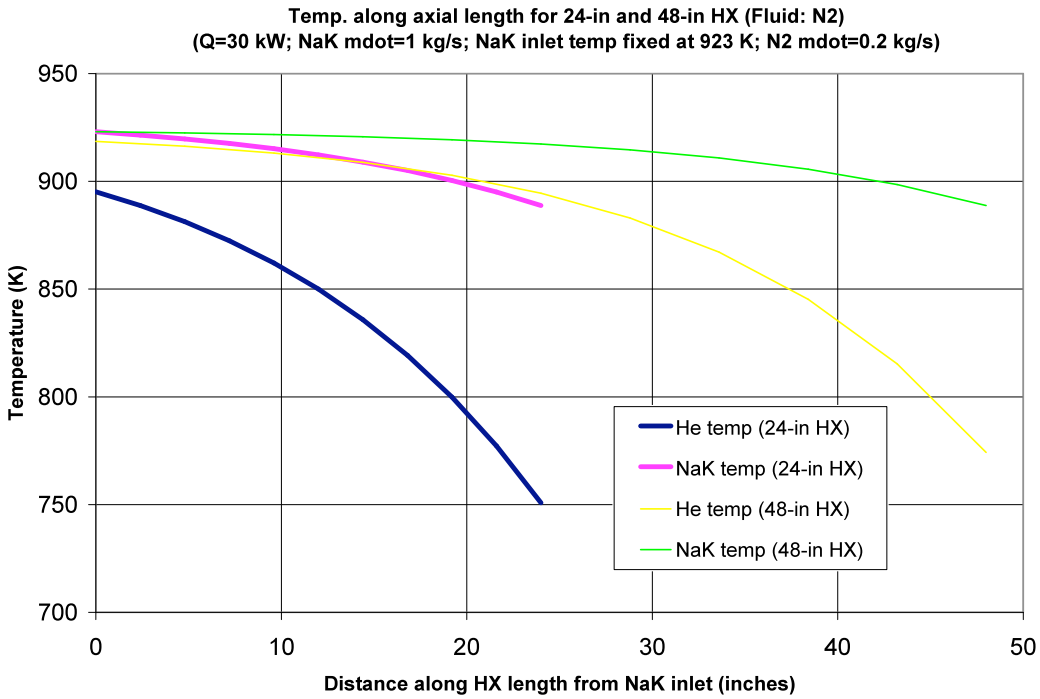


Figure 7: Fluid Nitrogen (flow rate 0.2 kg/sec), heat rejection 30 kW

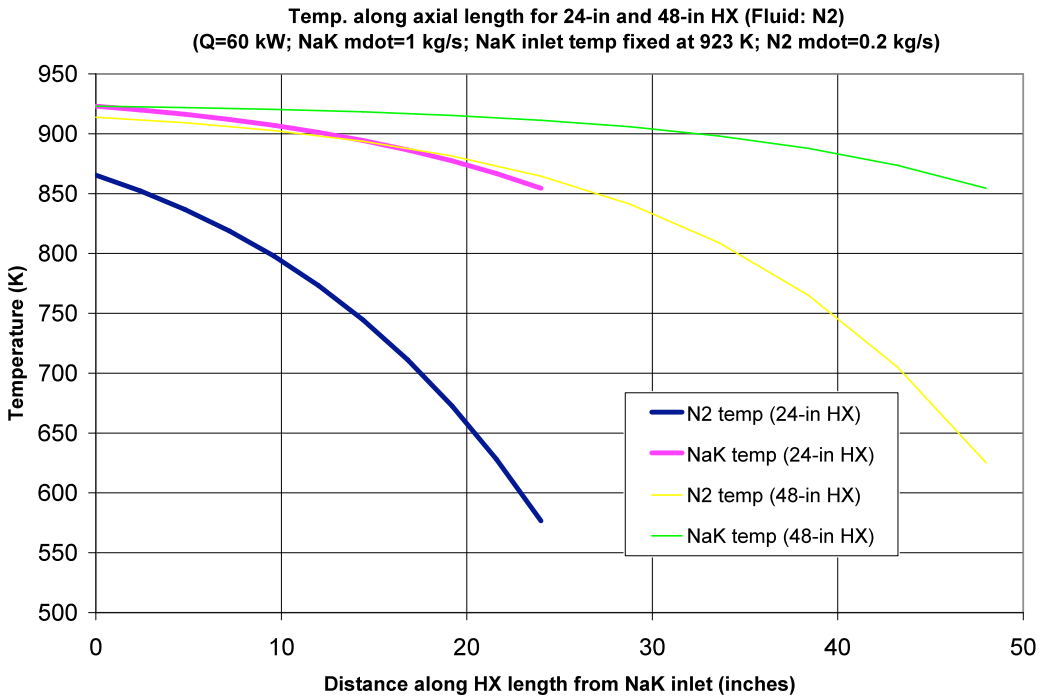


Figure 8: Fluid Nitrogen (flow rate 0.2 kg/sec), heat rejection 60 kW

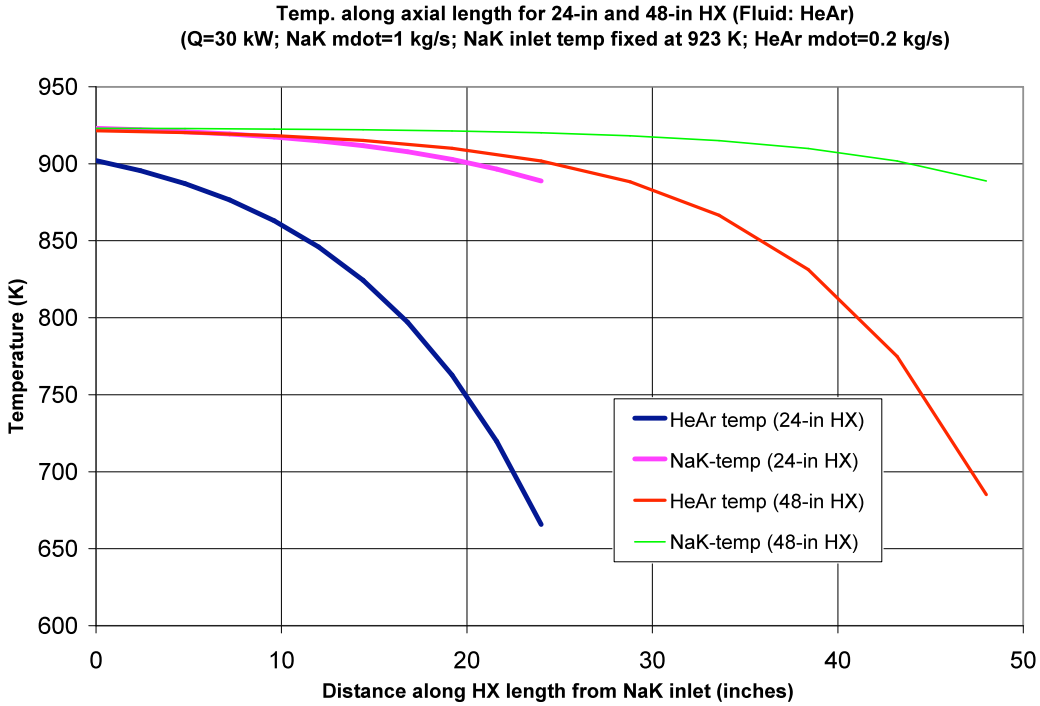


Figure 9: Fluid Helium Argon (flow rate 0.2 kg/sec), heat rejection 30 kW

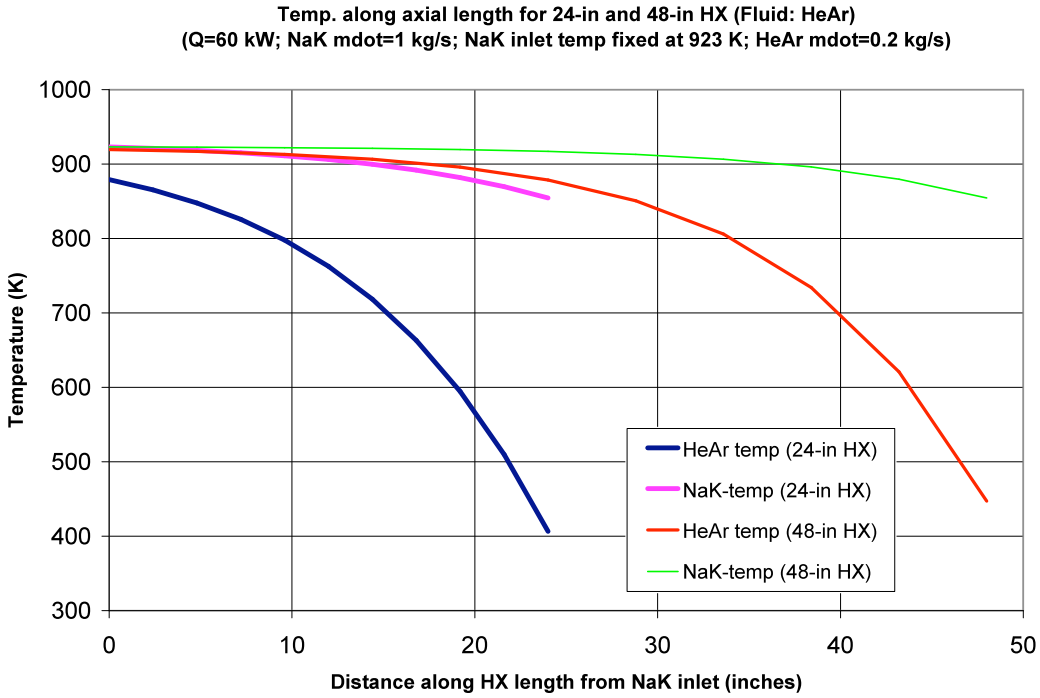


Figure 10: Fluid Helium Argon (flow rate 0.2 kg/sec), heat rejection 60 kW

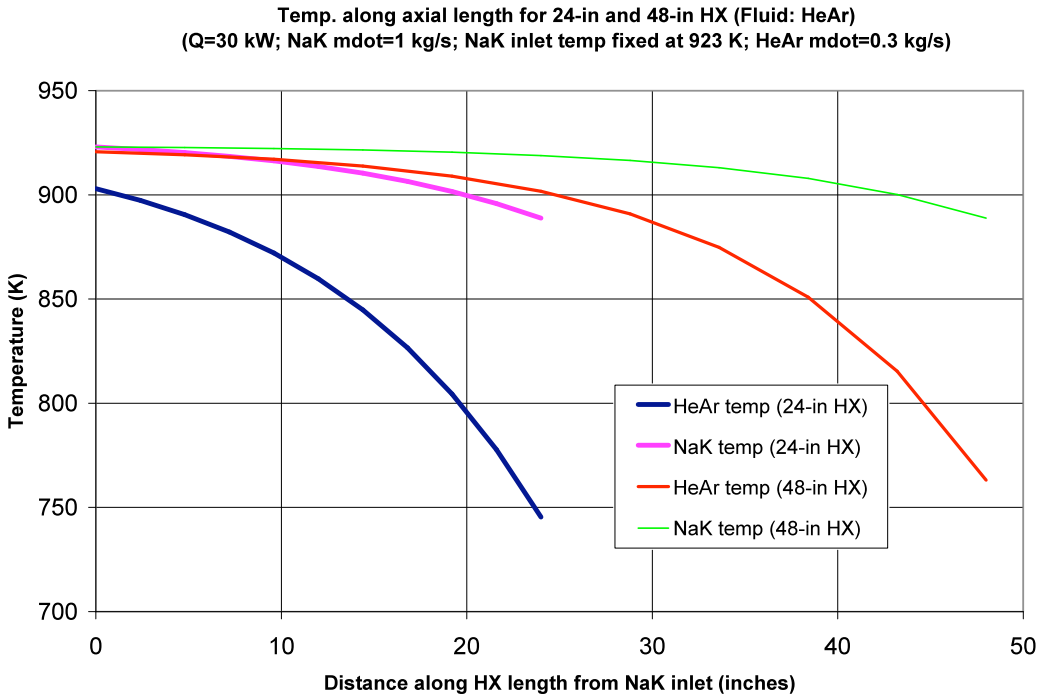


Figure 11: Fluid Helium Argon (flow rate 0.3 kg/sec), heat rejection 30 kW

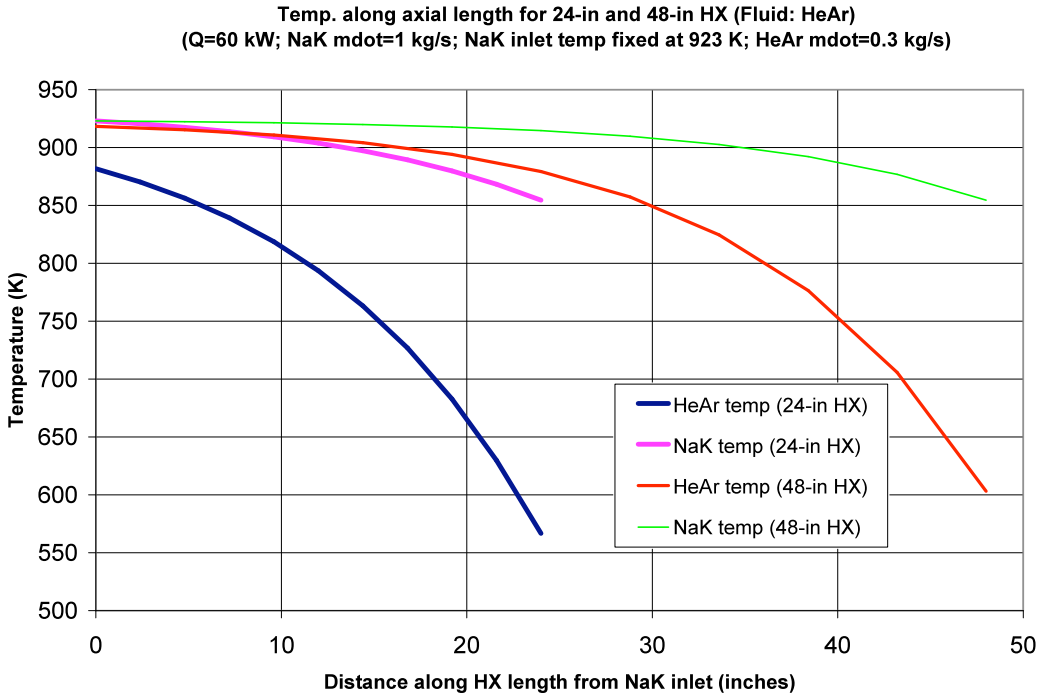


Figure 12: Fluid Helium Argon (flow rate 0.3 kg/sec), heat rejection 60 kW

SECTION L—ELECTROMAGNETIC PUMP EXHAUST CALCULATIONS: N.O. RHYS

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The following three pages comprise an estimate of the pressure drop along the exhaust tube exiting the EM pump housing. This analysis assumes simple straight tubing, no elbows, no fittings. Actual pressure drop is expected to exceed this estimate as components are added to the exhaust tube.

Page 1: Gas Properties and Flow Rates (GN2, 30 psi, 60 C, 0.1 kg/s)
Page 2: Pressure Drop if 2" Tubing is used = 0.33 psi
Page 3: Pressure Drop if 1" Tubing is used = 10.42 psi

The calculations show that 2" tubing should be specified for fabrication of the exhaust tube.

$g := 32.2 \frac{ft}{sec^2}$ $Mwt := 28 \frac{kg}{mole}$ $k := 1.4$ $Rbar := 8315 \frac{joule}{mole \cdot K}$

$Rgas := \frac{Rbar}{Mwt}$ $Rgas = 296.96 \cdot \frac{joule}{kg \cdot K}$ $Rgas = 0.071 \cdot \frac{BTU}{lb \cdot R}$

$\rho air := 0.07528 \frac{lb}{ft^3}$

$P1 := 30\ psi$ $Temp1 := 333\ K$ $\rho := \frac{P1}{Rgas \cdot Temp1}$

$P1 = 2 \cdot atm$ $Temp1 = 599.4 \cdot R$

$\rho = 2.092 \cdot \frac{kg}{m^3}$

$\mu := 0.000012 \frac{lb}{ft \cdot sec}$ $SG := \frac{\rho}{\rho air}$

$\mu = 0.000179 \cdot poise$ $SG = 1.73$ $\rho = 0.1306 \cdot \frac{lb}{ft^3}$

Desired Flow Rates

$mdot := .1 \frac{kg}{sec}$ $Q := \frac{mdot}{\rho}$ $Qs := \left(mdot \cdot 13.55 \cdot \frac{ft^3}{lb}\right) \frac{60\ sec}{min}$

$mdot = 0.22 \cdot \frac{lb}{sec}$ $Q = 1.69 \cdot \frac{ft^3}{sec}$ $Qs = 179.24 \cdot \frac{ft^3}{min}$

$Q = 101.3 \cdot \frac{ft^3}{min}$

Component #1: Exhaust Tubing (Diameter = 2 inches)

$L := 20\ ft$ $P1 = 30 \cdot psi$ $Temp1 = 599.4 \cdot R$

$Dtube := 2\ in$ $Atube := \pi \cdot \frac{Dtube^2}{4}$

$Dtube = 0.17 \cdot ft$ $Atube = 0.0218 \cdot ft^2$

$Atube = 3.14 \cdot in^2$

$Vtube := \frac{Q}{Atube}$ $Re := \frac{\rho \cdot Vtube \cdot Dtube}{\mu}$ $\varepsilon := 0.0003\ ft$

$Vtube = 77.4 \cdot \frac{ft}{sec}$ $Re = 1.4 \cdot 10^5$ $\frac{\varepsilon}{Dtube} = 0.0018$

Lookup f using Moody Chart, Re, ε/Dtube . . .

$f := 0.024$

$P2 := P1 - \frac{\rho \cdot Vtube^2}{2} \cdot \left(1 + f \cdot \frac{L}{Dtube}\right)$ $P2 = 29.67 \cdot psi$

$Pdrop := P1 - P2$

$Pdrop = 0.33 \cdot psi$

Component #1: Exhaust Tubing (Diameter = 1 inches)

$L := 20\ ft$ $P1 = 30 \cdot psi$ $Temp1 = 599.4 \cdot R$

$Dtube := 1\ in$ $Atube := \pi \cdot \frac{Dtube^2}{4}$

$Dtube = 0.08 \cdot ft$ $Atube = 0.0055 \cdot ft^2$

$Atube = 0.79 \cdot in^2$

$Vtube := \frac{Q}{Atube}$ $Re := \frac{\rho \cdot Vtube \cdot Dtube}{\mu}$ $\varepsilon := 0.0003\ ft$

$Vtube = 309.6 \cdot \frac{ft}{sec}$ $Re = 2.8 \cdot 10^5$ $\frac{\varepsilon}{Dtube} = 0.0036$

Lookup f using Moody Chart, Re, ε/Dtube . . .

$f := 0.028$

$P2 := P1 - \frac{\rho \cdot Vtube^2}{2} \cdot \left(1 + f \cdot \frac{L}{Dtube}\right)$ $P2 = 19.58 \cdot psi$

$Pdrop := P1 - P2$

$Pdrop = 10.42 \cdot psi$

SECTION M—REMOTE OPERATED VALVE SPECULATIONS: T.J. GODFROY

Pneumatic Actuators

Features

- Reliable piston design for enhanced cycle life
- Low actuation pressure

Actuator Series

- 6 series actuator for 4U, 6U, and 8U series valves. See the *Swagelok Pneumatic Actuators for B and U Series Bellows Valves* catalog for more information.
- 8 series actuator for 12U series valves

Actuation Modes

Normally closed—air opens, spring closes
Normally open—air closes, spring opens
Double acting—air opens and closes

Materials of Construction

Component	Actuator Series 6	Actuator Series 8
	Material	
Housing	Cast aluminum	
External hardware	Stainless steel	
O-rings	Buna N	Fluorocarbon FKM

Technical Data

Valve Series	Actuator Series	Pressure Rating psig (bar)	Temperature Rating °F (°C)	Air Displacement in.³ (cm³)	Weight lb (kg)
4U, 6U, 8U	6	65 to 150 (4.4 to 10.3)	−10 to 300 (−23 to 148)	0.88 (14.4)	C—7.3 (3.3) O—4.9 (2.2) D—4.8 (2.1)
12U, 12UA	8	40 to 150 (2.7 to 10.3)		C—2.9 (47.5) O—3.0 (49.2) D—2.4 (39.3)	C—24 (10.9 O—13 (5.9) D—11.5 (5.2)

Dimensions and Ordering Information

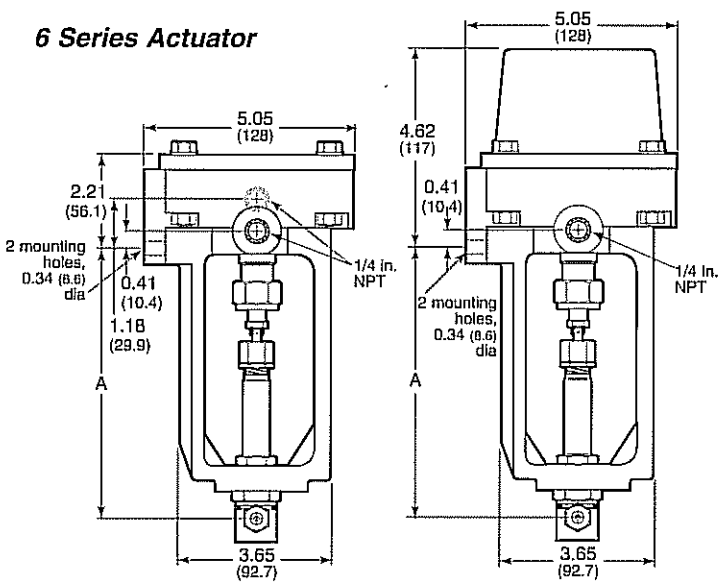
Add an actuator series designator, then an actuation mode designator to the valve ordering number.

Example: SS-4UW-**6C**

Dimensions, in inches (millimeters), are for reference only and are subject to change.

Actuator Series	Designator	Actuation Mode	Designator
6	-6	Normally closed	C
		Normally open	O
8	-8	Double acting	D

6 Series Actuator

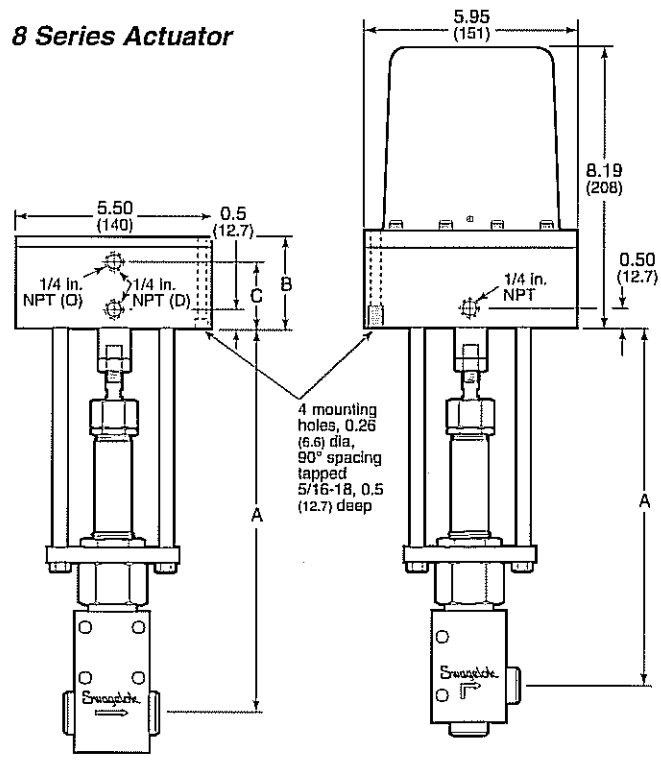


Normally open and double acting

Normally closed

Valve Series	Actuator Series	Dimensions, in. (mm) A	B	C
4U	6	6.60 (168)	—	—
6U, 8U		6.76 (172)		
12U	8	10.47 (266)	O—2.75 (69.9)	D—1.88 (47.8)
12UA		10.03 (255)	D—2.56 (65.0)	O—1.75 (44.5)

8 Series Actuator



Normally open and double acting

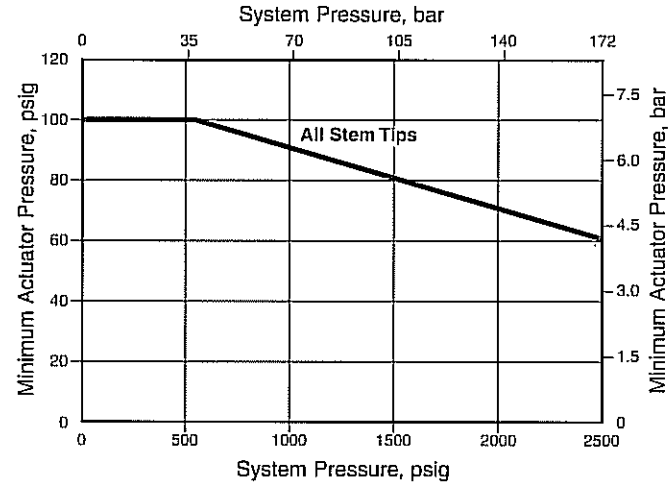
Normally closed

Pneumatic Actuator Performance

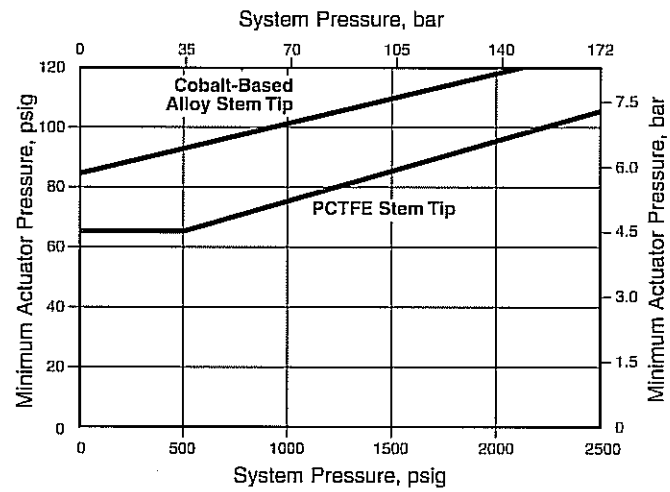
6 Series Actuator

The minimum actuation pressure for normally closed, normally open, and double-acting actuators is 65 psig (4.4 bar).

8 Series Normally Closed Actuator



8 Series Normally Open Actuator



8 Series Double-Acting Actuator