Author: **James T. Goulding**
Department: **Mechanical Engineering**
Date: **8/18/00**

Program - Project - Job: SNS-FE Project
MEBT Mechanical Systems

Title: **SNS-FE MEBT 30mm & 40mm Beam Position Monitor Mechanical Design**

1. Scope

This engineering note describes the mechanical design for the 30mm Beam Position Monitor (BPM) and the 40mm Beam Position Monitor. It includes a drawing list of mechanical components and assemblies, design background, engineering calculations, outside vendor component information, and rendered pictures.

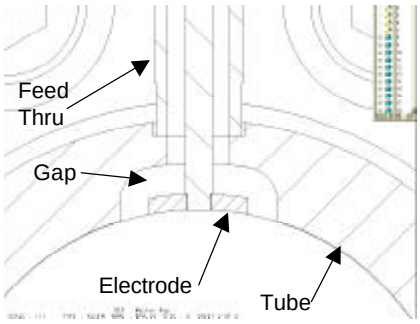
2. Drawings

2.1. 25B170 Rev B 30mm BPM Bellows
2.2. 25B171 Rev B BPM SMA Feed Thru
2.3. 25B172 Rev B 40mm BPM Bellows
2.4. 25B173 Rev C 30mm BPM Bore Tube
2.5. 25B174 Rev E 30mm BPM Electrode Spool
2.6. 25B175 Rev E 30mm BPM Bellows Seal Flange
2.7. 25B176 Rev D 30mm BPM Fixed Flange
2.8. 25B177 Rev D 30mm BPM Split Flange
2.9. 25B178 Rev F 30mm Beam Position Monitor
2.10. 25B179 Rev D 40mm BPM Fixed Flange
2.11. 25B180 Rev E 40mm BPM Electrode Spool
2.12. 25B181 Rev D 40mm BPM Split Flange
2.13. 25B182 Rev D 40mm BPM Bellows Seal Flange
2.14. 25B183 Rev C 40mm BPM Bore Tube
2.15. 25B184 Rev D 40mm Beam Position Monitor
2.16. 25B186 Rev A 30mm QM1 BPM Bellows
2.17. 25B187 Rev B 30mm QM1 Beam Position Monitor
2.18. 25B676 Rev A BPM Assembly Tools

Copies of all drawings are included in Appendix B - active links above are shown in blue.

3. Design Overview

The BPM is based on the design of a 20mm stripline beam position monitor (LANL drawing no. 144Y-618019) that was developed at Los Alamos National Laboratory for the ADT CCDTL. The MEBT design differs from the LANL design in that machining the electrodes from a single spool of stainless steel. The base of the spool electrically shorts the electrodes together. The signal is taken from the free end through a microwave feed-through. The slots in the bore tubes (25B173 & 25B183) and the stripline tines on the electrode spool



(25B174 & 25B180) were designed to maintain a 50Ω impedance. (For details of the electrical analysis, see SNS-Technical Note FE-EE-012.) The grounded stripline design requires half as many feed-throughs and should simplify assembly fixturing.

To maintain the 50Ω impedance, the geometry of the electrode, the slot and the gap between them had to be within a tolerance of ±5% of nominal. The tolerance stack and tolerance sizing calculations are shown in the Appendix. Design issues included sizing the bellows, and having clearance for the mounting hardware.

To help with alignment problems between the RFQ and the MEBT, a longer bellows (full segment vs. half segment) was used on the 30 mm BPM that will be assembled into quadruple magnet one. This significantly increased the amount of X-Y translation motion without significantly increasing the length in the Z direction (beamline). The following table shows a comparison of translational motion between a half segment and a full segment for both the 30 mm and 40 mm bellows:

	Half Segment Translational Offset	**Full Segment Translational Offset**
30 mm Bellows	0.008 in.	0.034 in.
40 mm Bellows	0.008 in.	0.030 in.

All offsets are in a single direction from the center axis of the bellows. See Appendix C for more detailed calculations.

As a note, tests of the electrical properties were made to a welded prototype of the spool and bore tube assemblies. Measurements showed the expected shorted 50Ω shorted behavior, with no spurious resonances below 8 GHz.

4. Reference

4.1. CCDTL BPM Segment 6/7 20mm Bore, Drawing No. 114Y618019 (Los Alamos National Laboratory)
4.2. CCDTL BPM Segment 107/108 25mm Bore, Drawing No. 114Y618050 (Los Alamos National Laboratory)
4.3. Ultra-High Vacuum Microwave Feed-Through, SMA Female (Spec Sheet), Kaman Instrumentation Publication SMA-1000-3/95. (Copy of spec sheet included in Appendix.)
4.4. Contour Plot of Electrostatic Potential (included in the Appendix).
4.5. SNS Technical Note FE-EE-012, *Basic Electrical Design of the MEBT BPM*
4.6. SNS Front End Diagnostic, Linac 2000 Conference, Monterey, CA, Aug. 21-25, 2000
4.7. SNS Technical Note FE-ME-042, *MEBT BPM Electrode Spot Welding*
4.8. Engineering Calculation Notes (included in appendix).
4.9. Standard Bellows Company homepage: www.std-bellows.com

5. Fabrication and Assembly Issues

Most of the component fabrication can be done with conventional milling and turning operations. However, the following features will be done using wire EDM:

- Bore tube inside diameter

- Bore tube slots on inside diameter
- Spool inside diameter
- Spool electrode tines

The wire EDM allows for better precision on the tighter profile callouts. It also allows for better thin wall cuts.

Care must be taken during welding to achieve alignment of some components. Alignment of the electrode spool with respect to the bore tube is achieved using an alignment plate (see DWG 25B130 and DWG 25B185). The fixed O-ring flange must also be carefully aligned with respect to the bore tube to ensure the correct angular location of the flat on top of the flange (see DWG 25B178 and DWG 25B184).

Because of the compact nature of the design, it is extremely difficult to make internal welds. External welding is far more practical. To help minimize the problem of virtual leaks caused by external welds, all fabricated components are ultra-high vacuum cleaned and electropolished before being welded into the assembly. Since they will be sitting on the shelf for months after assembly, another cleaning (water based) may be required. The vacuum in the beam pipe will in the 10^{-6} to 10^{-8} torrs range.

The feed-throughs are connected to the electrode tines to maintain electrical contact. The electrode is made of 316 stainless steel and the feed-through conductor is made of TZM (see spec sheet in Appendix D). Because the melting point of TZM is so high compared to 316 stainless steel, these two materials are not well suited for TIG welding. Spot welding was chosen as the most effect method to connect the tine to the feed-through conductor. See Technical Note FE-ME-042 for details on spot weld settings and technique.

Torch brazing and soldering had been explored as connection method. Finding a suitable solder or braze material was difficult. The main problem was finding a material that would wet to both materials at a temperature low enough not to damage the vacuum seal on the feed-through.

6. SNS-FE Personnel

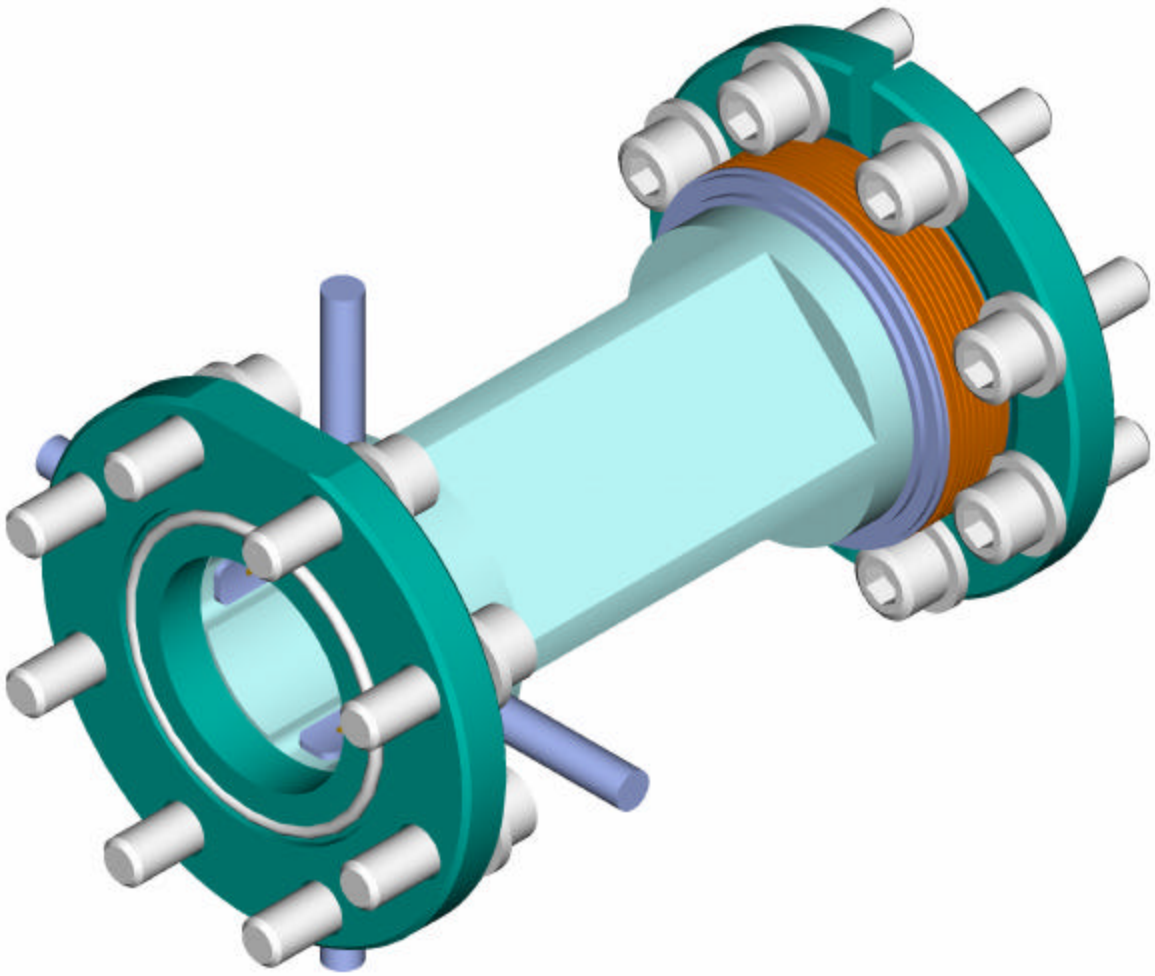
Daryl Oshatz, MEBT Lead Mechanical Engineer
James T. Goulding, Mechanical Engineer
Larry Doolittle, Electrical Engineer
Bob MacGill, Senior Mechanical Engineering Associate
Tom Miller, Mechanical Engineering Associate

7. Appendices

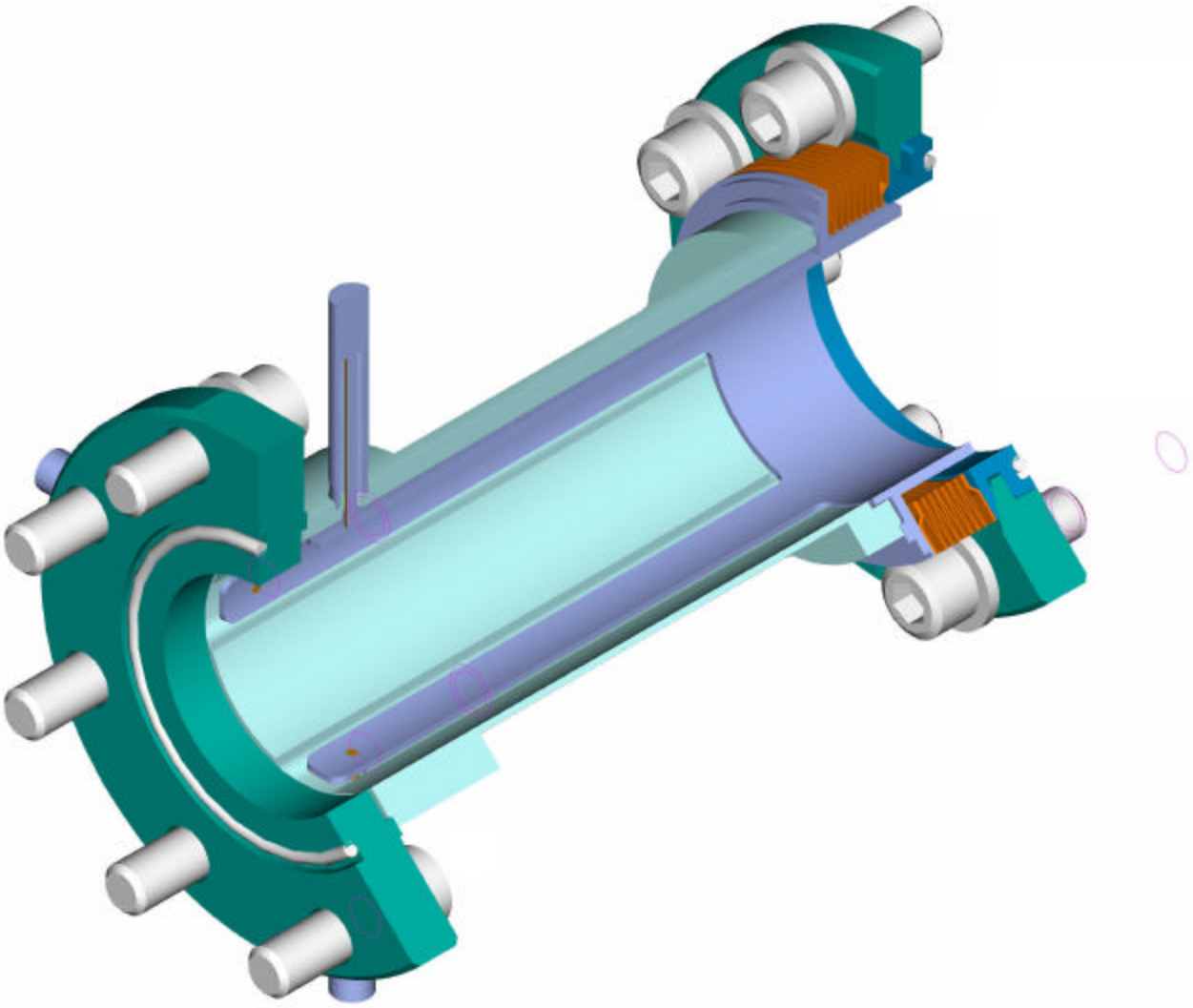
Appendix A: Rendered Pictures of 3-D CAD model
Appendix B: Component and Assembly Drawings
Appendix C: Engineering Calculations and Plots
Appendix D: Vendor Specification Sheets

Appendix A

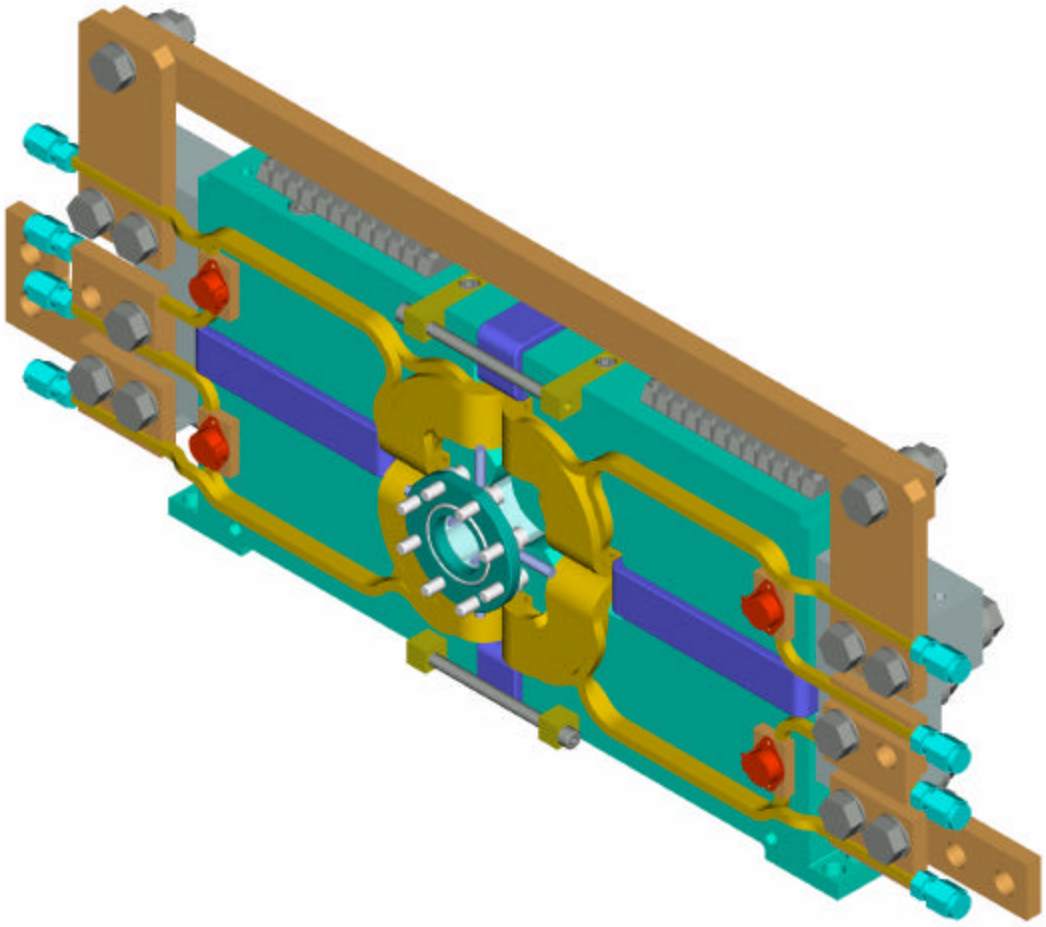
30 mm Beam Position Monitor



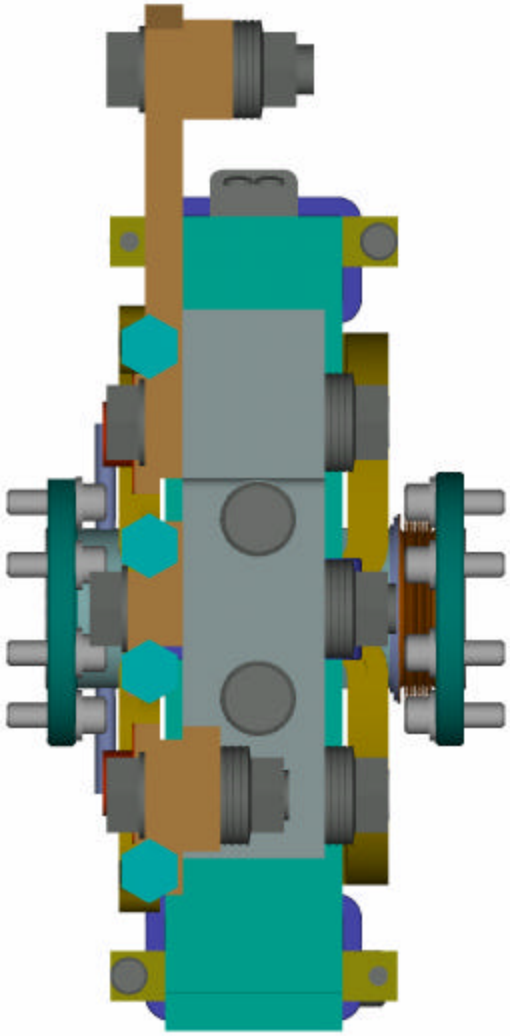
30mm BPM Cross Section View



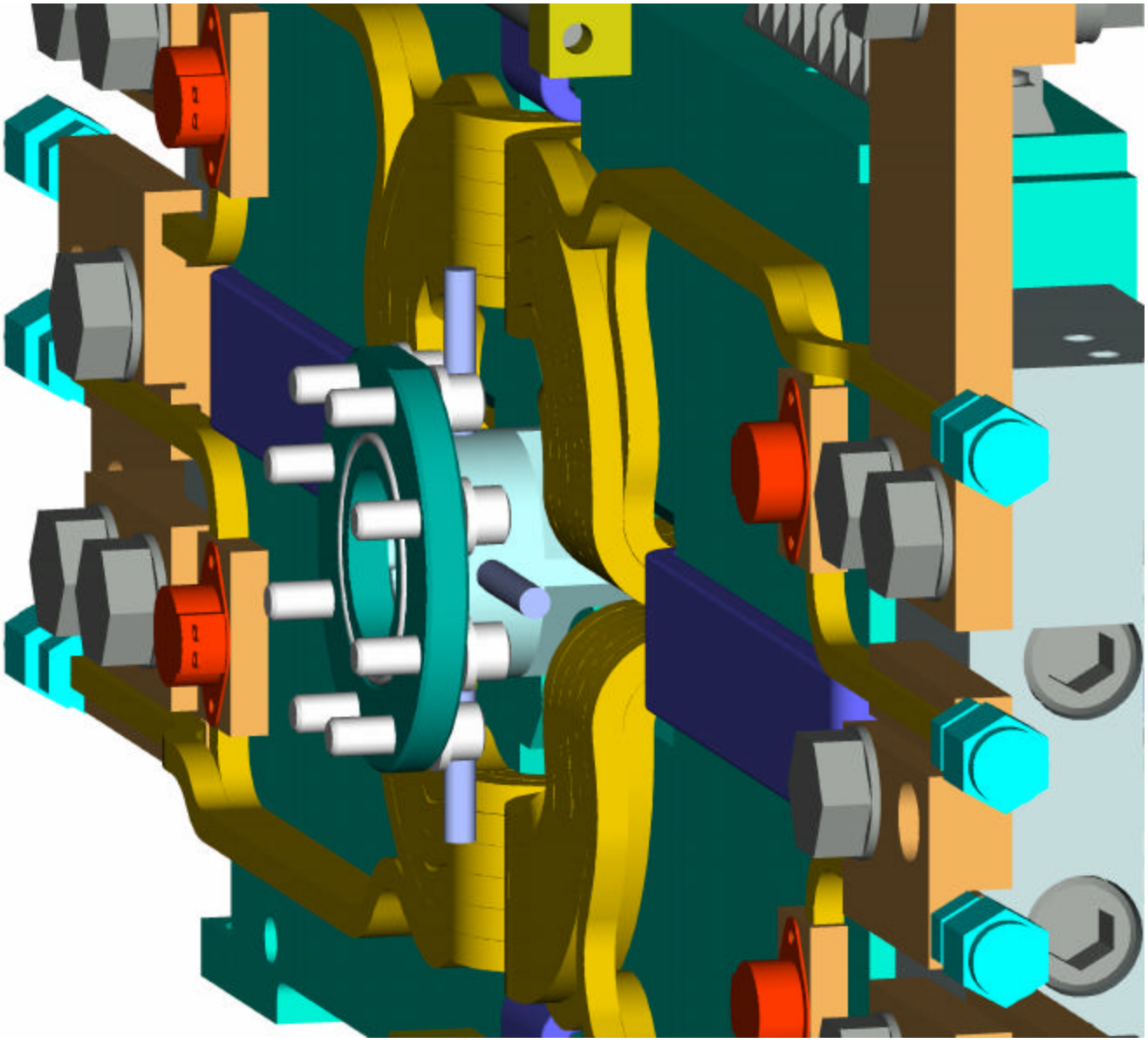
32mm Quadrupole Magnet with
30mm Beam Postion Monitor



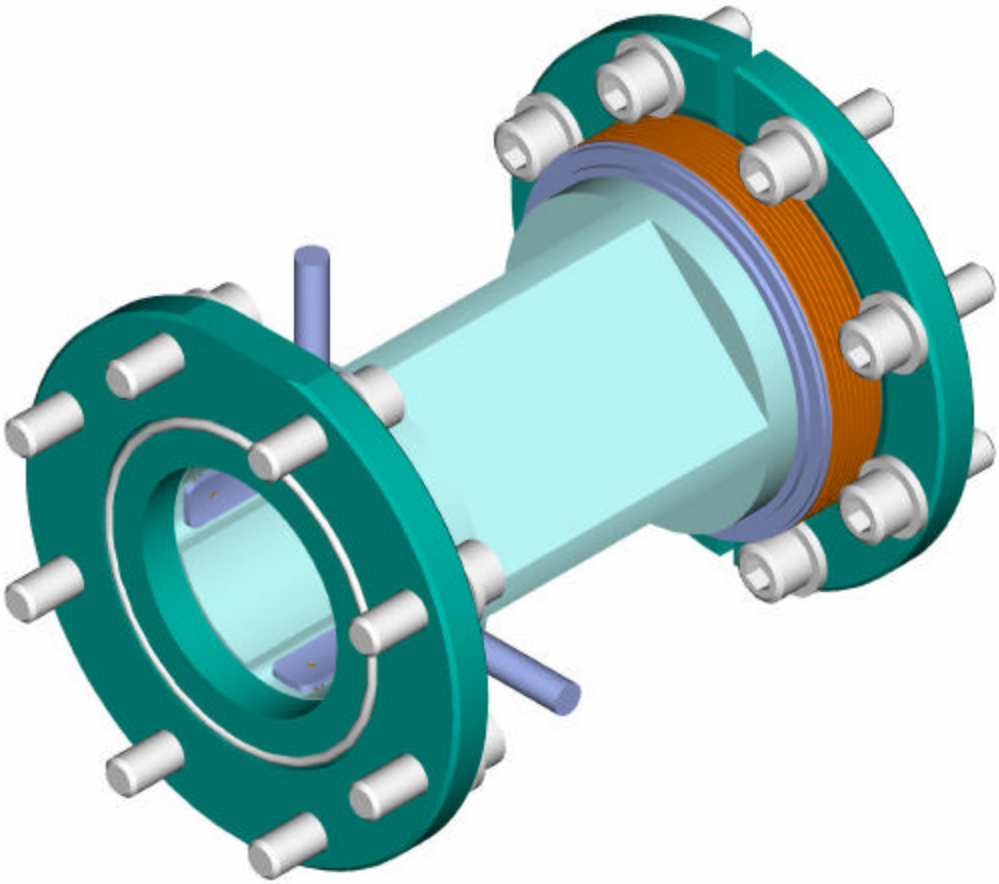
32mm Quadrupole Magnet with
30mm Beam Postion Monitor



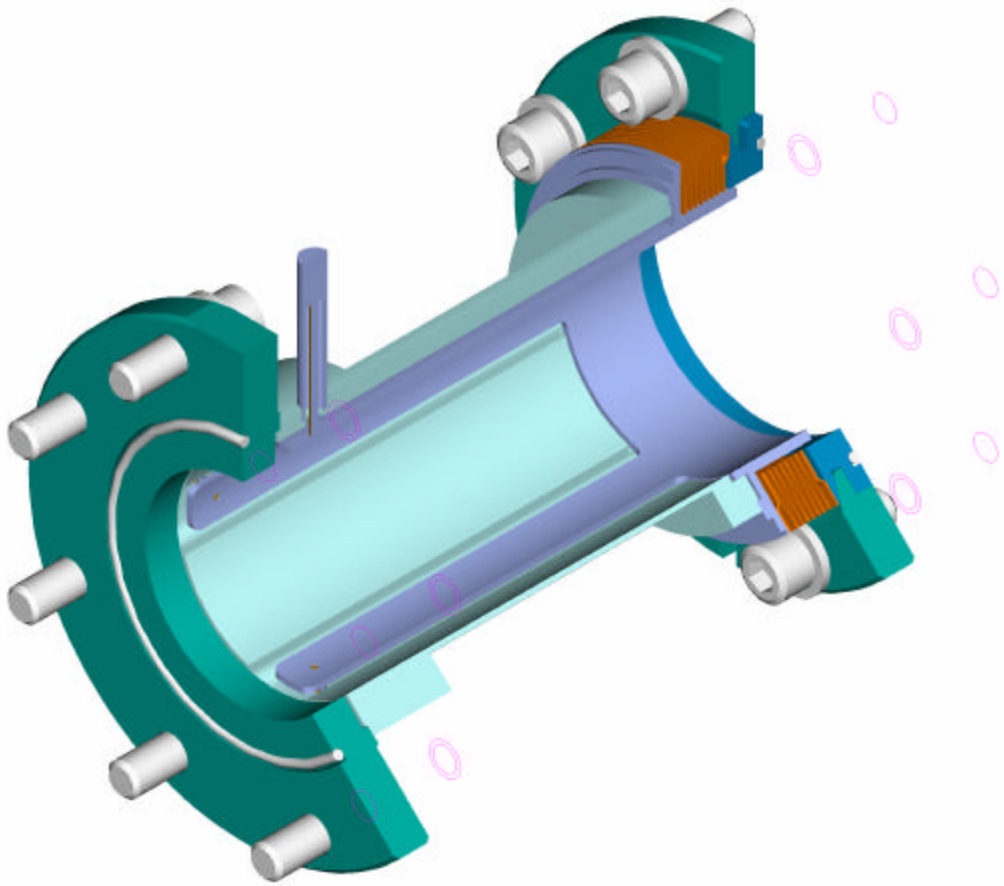
32mm Quadrupole Magnet with
30mm Beam Postion Monitor



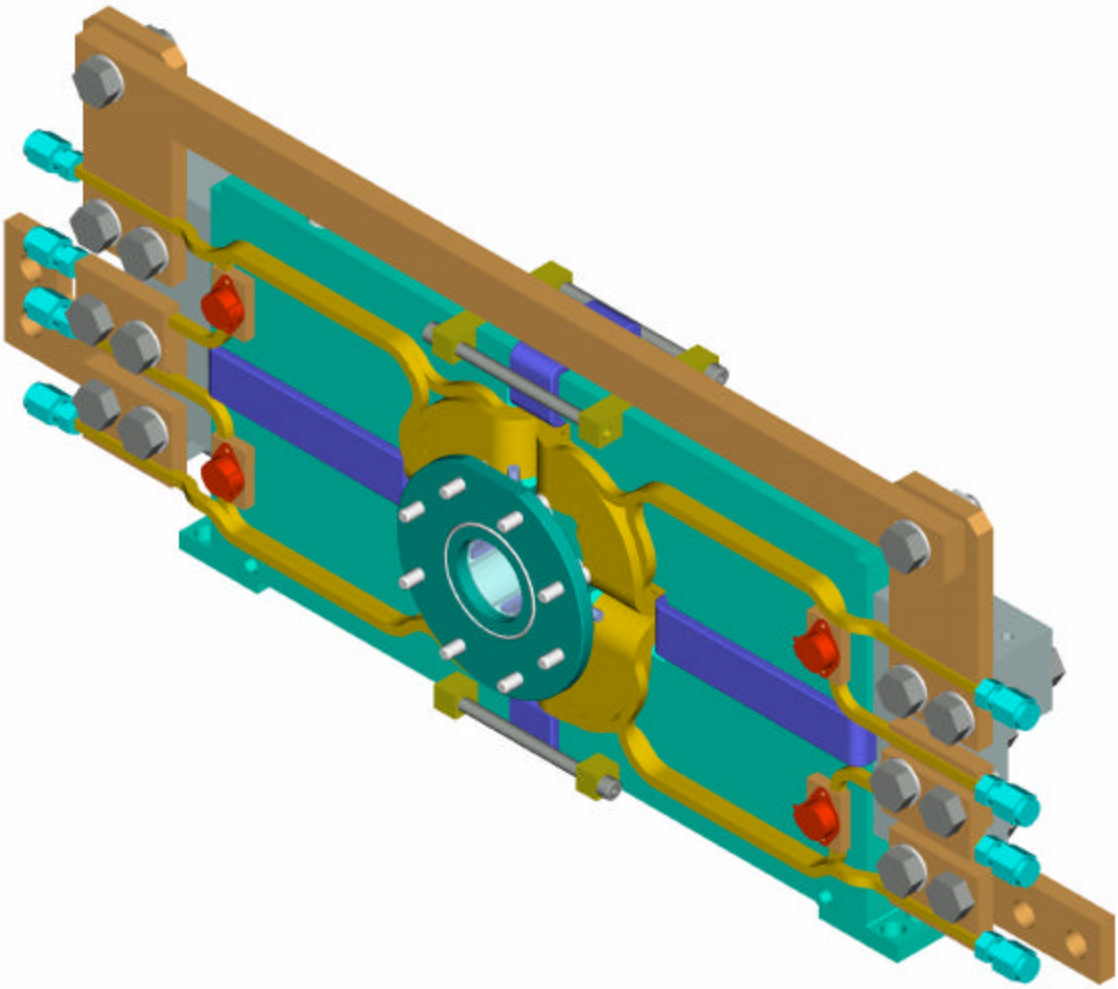
40 mm Beam Position Monitor



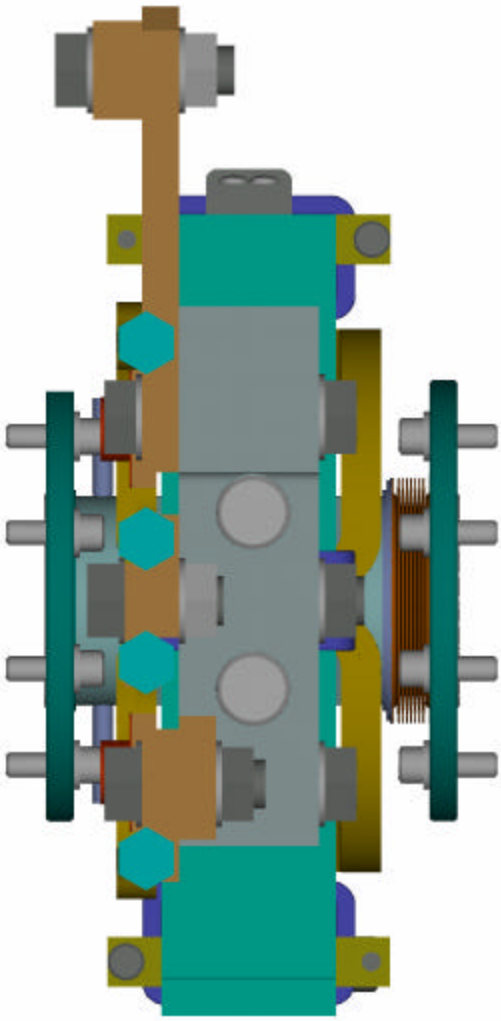
40mm BPM Cross Section View



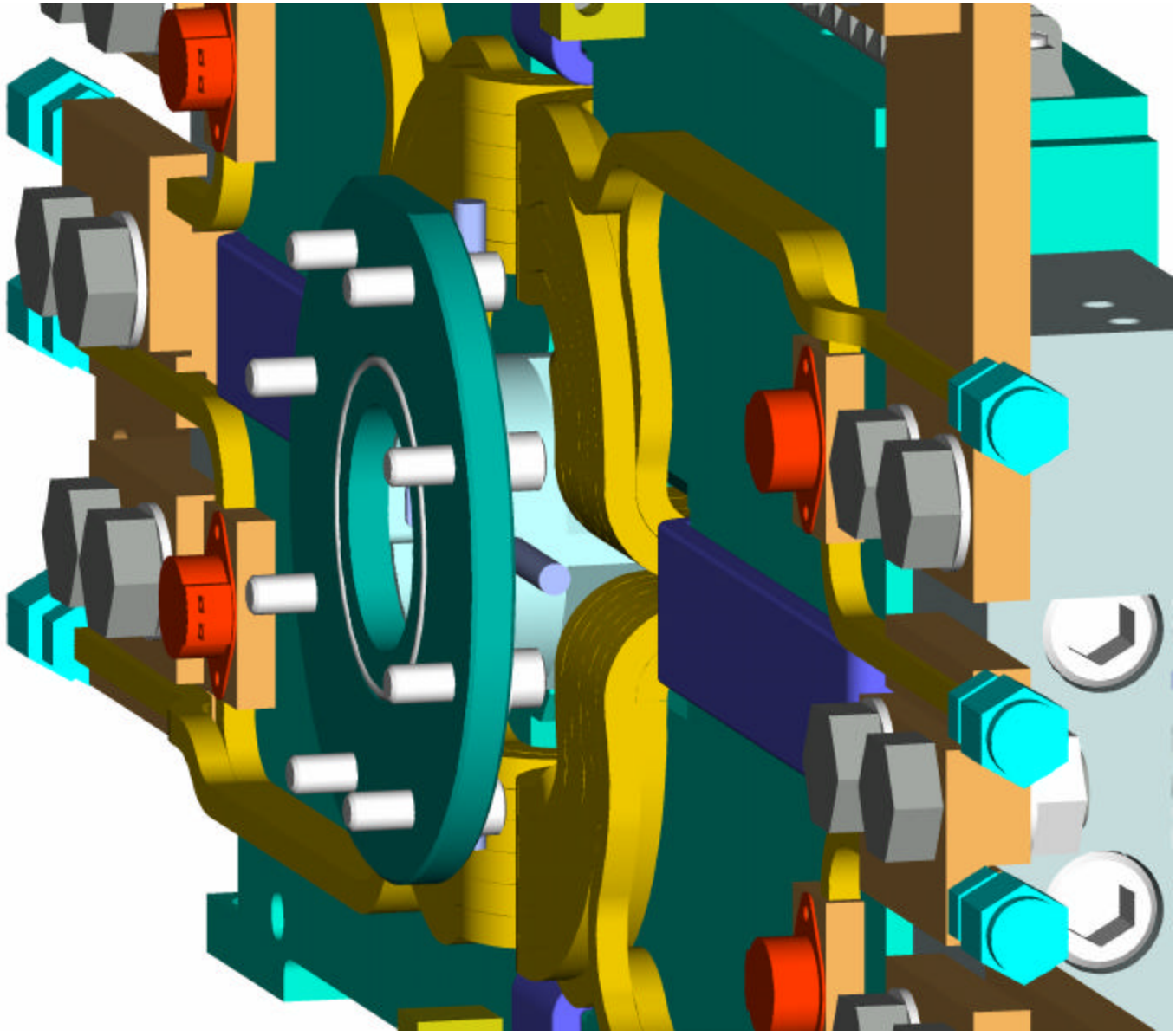
42mm Quadrupole Magnet with
40mm Beam Postion Monitor



42mm Quadrupole Magnet with
40mm Beam Postion Monitor



42mm Quadrupole Magnet with
40mm Beam Postion Monitor



Appendix B

NOTES

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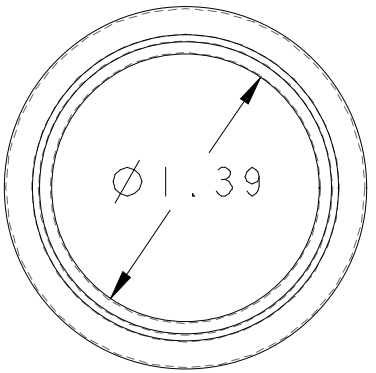
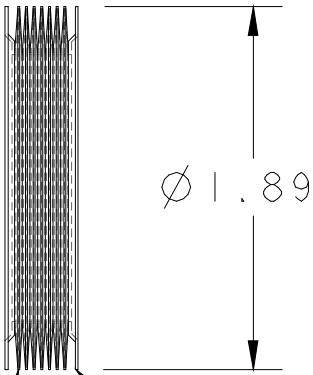
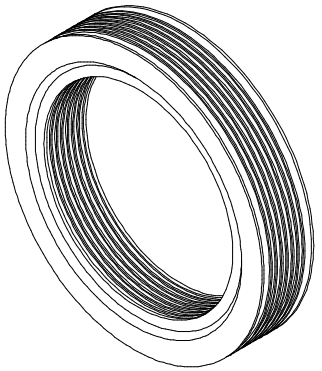




189-139 BELLOWS
1/2 SEGMENT.

STYLE "B" END
FLANGE, BOTH SIDES



REV	DWG	CHK	DATE	CHANGES	DESCRIPTION	MATERIAL
					-	347 STAINLESS STEEL

UNLESS OTHERWISE SPECIFIED
PROJECTION:
TOLERANCES: X.X ±0.1 | FRAC. ±1/64 | X.XX ±0.01 | Angles ±0.5° | X.XXX ±0.005 | FINISH 125

DO NOT SCALE PRINT
THREADS ARE CLASS 2
CHAMFER ENDS OF ALL SCREW TREADS 30°
CUT ROUND, 1.5 THREAD RELIEF ON MACHINED THREADS
BREAK EDGES .016 MAX. ON MACHINED WORK
REMOVE BURRS, WELD SPLATTER & LOOSE SCALE
IN ACCORDANCE WITH ASME Y14.5M & B46.1

SHOP ORDERS
ACCT NO. - | NO. REQD -
DEL TO -
SURFACE TREATMT -
IDENT METHOD TAG
PROJECT NUMBER na
PROJECT NAME N/A
DWG BY GOULDING DATE 17-Dec-99
CHK BY DARYL OSHATZ DATE 4-Jan-00
APR BY DARYL OSHATZ DATE -
SER NO. -
DATE ISSD -
DATE REQD -

ERNEST ORLANDO LAWRENCE
BERKELEY NATIONAL LABORATORY
UNIVERSITY OF CALIFORNIA - BERKELEY

SNS-FES MEBT
MECHANICAL SUBSYSTEMS
30 MM BPM BELLOWS

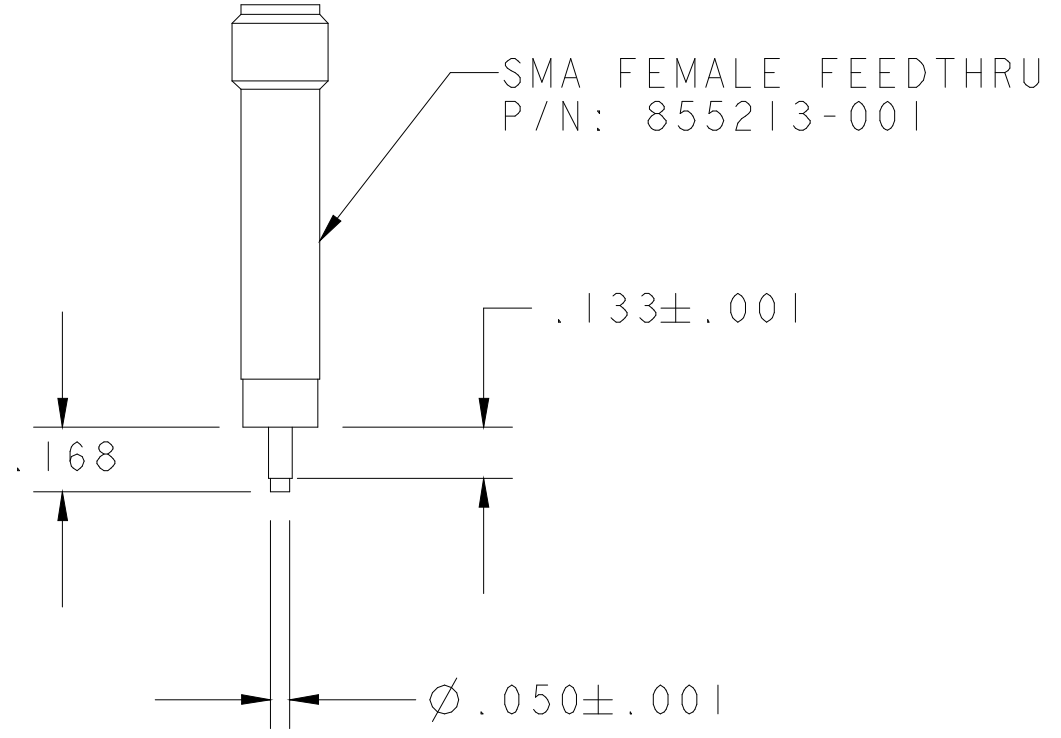
MICROFILMED:
PATENT CLEAR:
DWG. TYPE: PART
SHOWN ON: 25B178
DESIGN ACCT. NO.: XXXX-XX
CATEGORY CODE: FE3313
SCALE: 1/1 DO NOT SCALE PRINTS
SHEET 1 OF 1
DWG. NO. 25B1701 SIZE B REV.

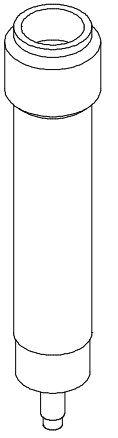
Dwg. File: 25B170 Model File: 25B170

Rev. 1/29/2000 J. R. Osborn

Dwg. No.	Size Rev.
25B171	1B

NOTES
1. ULTRA-HIGH VACUUM MICROWAVE FEED-THROUGH, SMA FEMALE
2. DRAWING FOR PRICING QUOTATION ONLY.





Material -			B - 1/25/00	UPDATED TITLE BLOCK & ADDED P/N NOTE	
Unless Otherwise Noted			Rev Dwn Date	Changes	
.X±0.1 .XX±0.01 .XXX±0.005 X.X°±0.5			LAWRENCE BERKELEY NATIONAL LABORATORY		
Break Edges .016 Max on Machined Work			University of California - Berkeley		
Remove Burrs, Weld Splatter & Loose Scale			SNS-FES MEBT		
In Accordance With ASME Y14.5M 1994 & B46.1			MECHANICAL SUBSYSTEMS		
Account Number	Finish 125		BPM SMA FEED THRU		
Date Issued -	Date Regd -				
Number Required	Deliver To		Do Not Scale Prints	Drawing Scale 2/1	
Surface Treatment -	Identif Method -		Patent Clear -	Category Code FE3313	SHEET 1 OF 1
Drawn By TREVOR GOULDING	Date 17-Dec-99		Micro-Filmed -	Shown on Dwg No. 25B178, 25B184	Dwg. No. 25B171 Size 1 Rev B
Check By DARYL OSHATZ	Date 1-JAN-00		Design Account XXXX-XX	Drawing Type PART	

Drawing: 25B171 Type: PART Model: 25B171

Dwg. No.	Size Rev.
25B172	1B

NOTES

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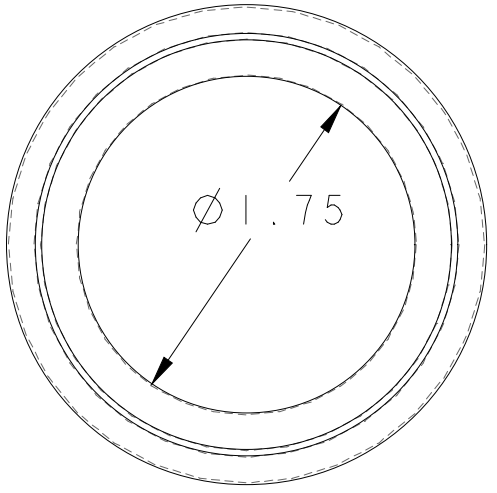
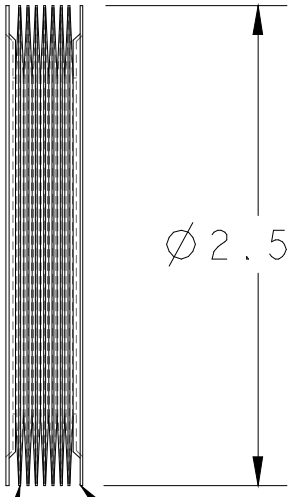
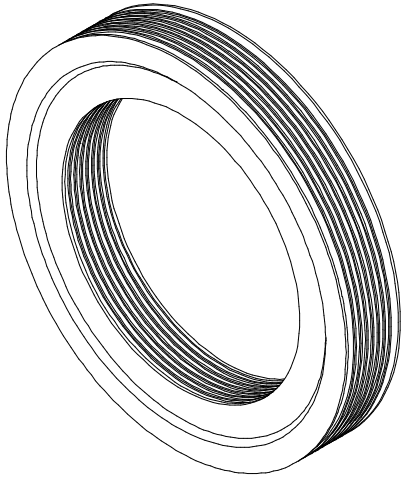




250-175 BELLOWS
1/2 SEGMENT.

STYLE "B" END
FLANGE, BOTH SIDES



Material	347 STAINLESS STEEL			-	-	-	-
Unless Otherwise Noted				Rev	Dwn	Date	Changes
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Break Edges .016 Max on Machined Work				LAWRENCE BERKELEY NATIONAL LABORATORY			
Remove Burrs, Weld Splatter & Loose Scale				University of California - Berkeley			
In Accordance With ASME Y14.5M 1994 & B46.1				SNS-FES MEBT MECHANICAL SUBSYSTEMS 40 MM BPM BELLOWS			
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Date Issued	-	Date Regd	-				
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SHEET 1 OF 1

Dwg. No.	Size	Rev
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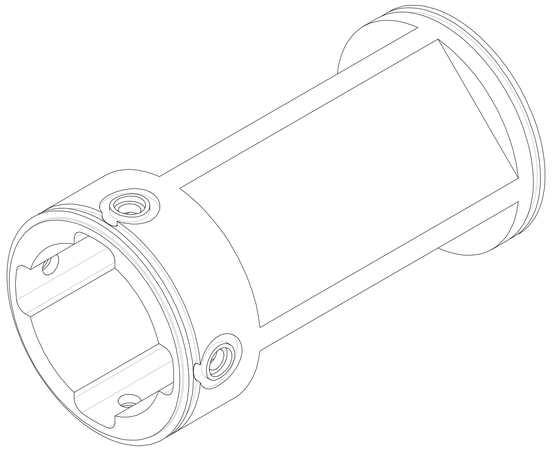

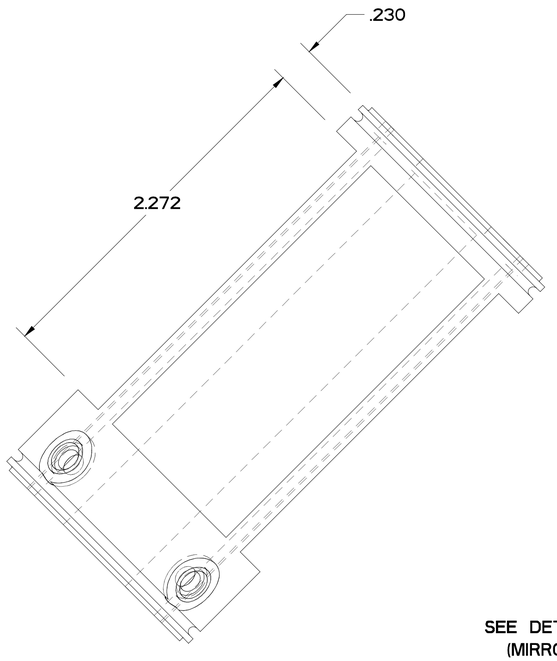

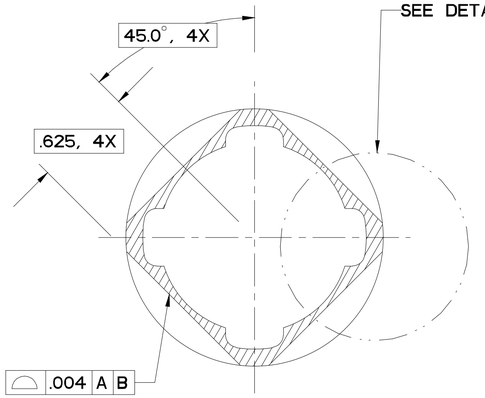

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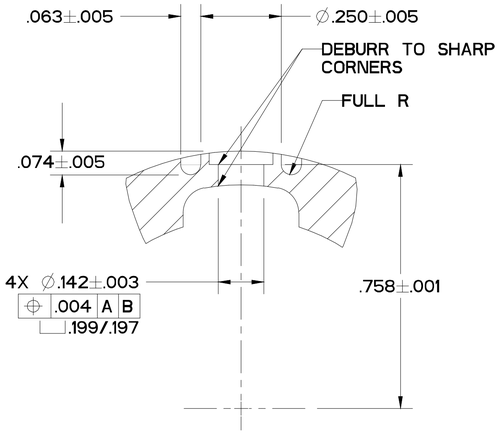

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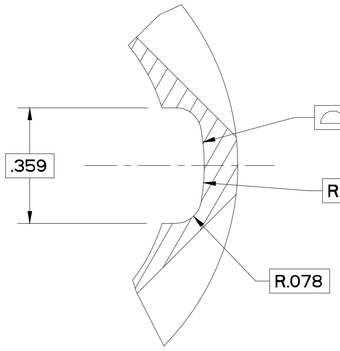
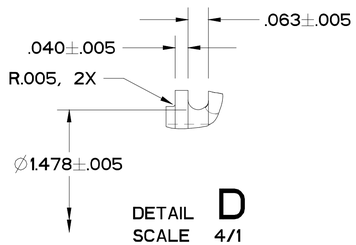


DETAIL B
SCALE 4/1
TYPICAL 4 PLACES



DETAIL D
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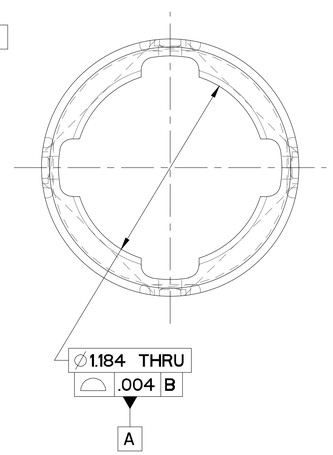
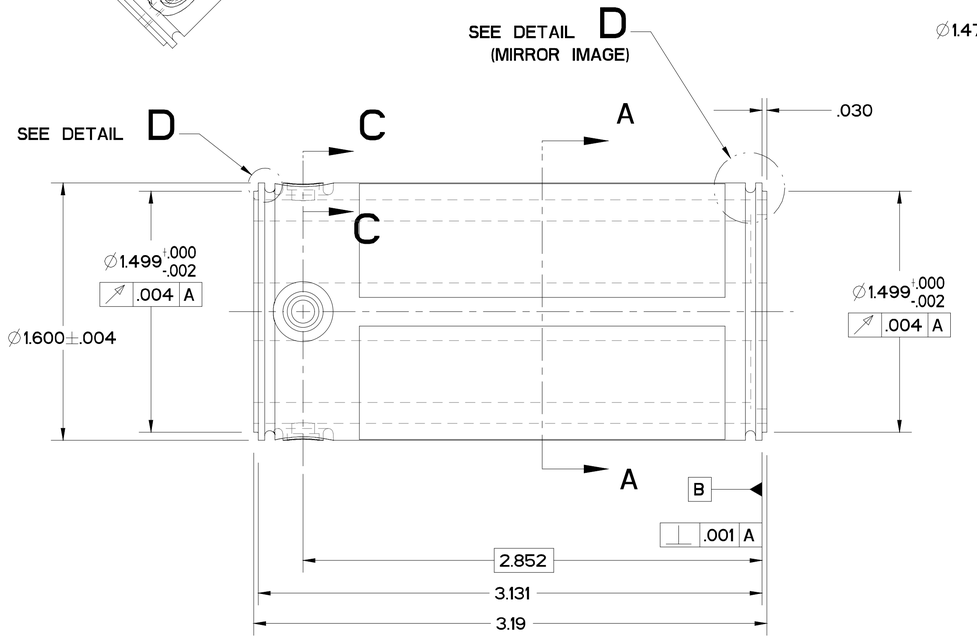
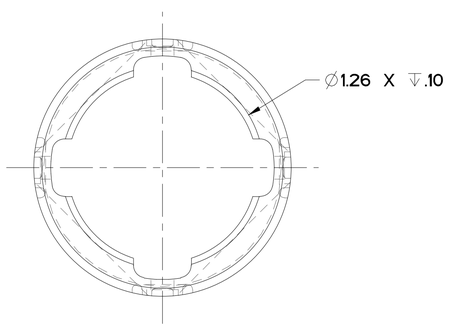






NOTES

1. ULTRA-HIGH VACUUM CLEANING & PACKAGING REQUIRED.

REV	DWG	CHK	ZONE	DATE	CHANGES
C				11/17/00	ADDED WELD PREPARATIONS TO FEEDTROUGH HOLES
C				11/17/00	ADDED WELD PREPARATIONS TO BOTH ENDS
B				1/26/00	GENERAL CHANGES FOR IMPROVED MANUFACTURABILITY

UNLESS OTHERWISE SPECIFIED
PROJECTION:
TOLERANCES: X.X ± 0.1 | FRAC. ± 1/64 | X.XX ± 0.01 | Angles ± 0.5° | X.XXX ± 0.005 | FINISH 125
DO NOT SCALE PRINT
THREADS ARE CLASS 2
CHAMFER ENDS OF ALL SCREW THREADS 30°
CUT ROUND, 1S THREAD RELIEF ON MACHINED THREADS
BREAK EDGES .06 MAX. ON MACHINED WORK
REMOVE BURRS, WELD SPLATTER & LOOSE SCALE
IN ACCORDANCE WITH ASME Y14.5M & B46.1

SHOP ORDERS
ACCT NO. - | NO. REQD - | SER NO. - | DATE ISSD - | DEL TO - | DATE REQD -
SURFACE TREATMT ELECTROPOLISH
IDENT METHOD TAG
PROJECT NUMBER
PROJECT NAME
DWG BY TREVOR GOULDING | DATE 20-Dec-99
CHK BY | DATE -
APR BY | DATE -

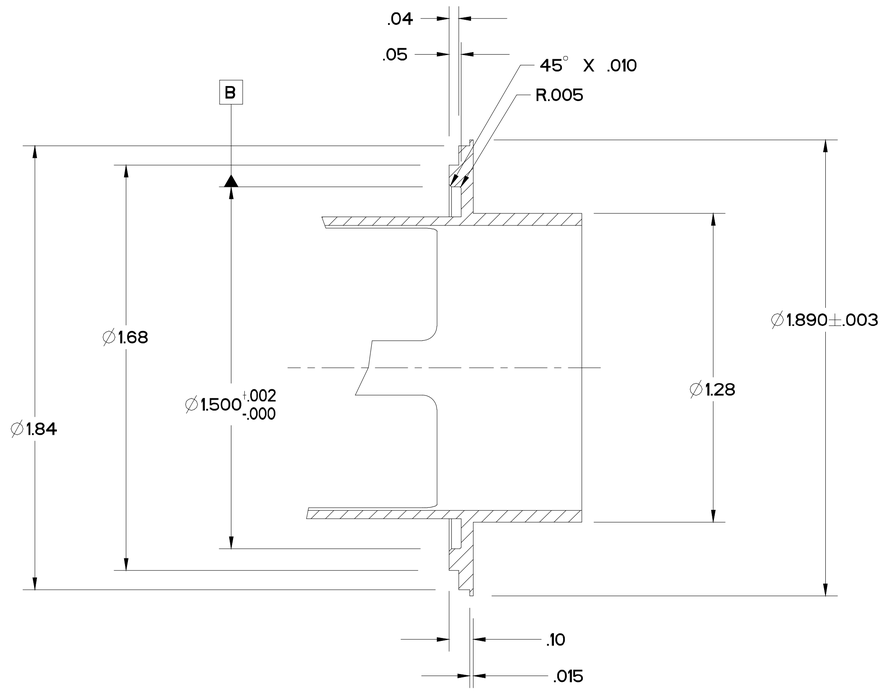
DESCRIPTION	316 STAINLESS STEEL	-
	MATERIAL	MAT. LOCATION

ERNEST ORLANDO LAWRENCE
BERKELEY NATIONAL LABORATORY
UNIVERSITY OF CALIFORNIA - BERKELEY

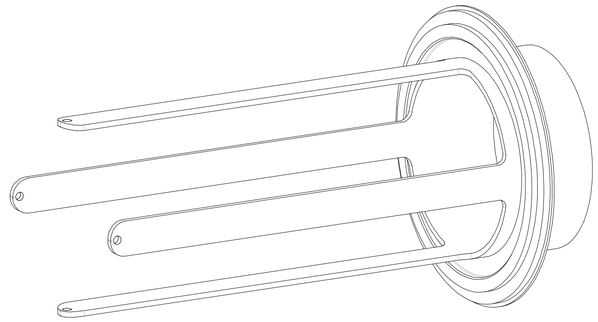
SNS-FES MEBTUBSYSTEMS
MECHANICAL SUBSYSTEMS
30 MM BPM BORE TUBE

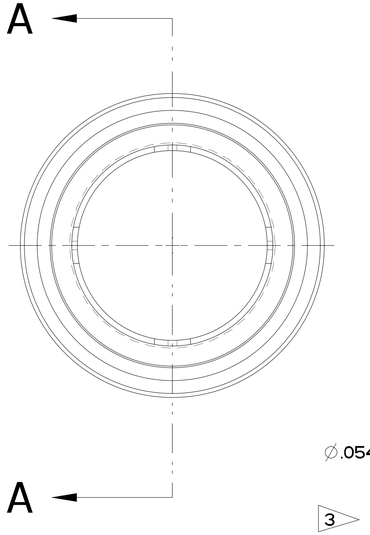
MICROFILMED: | DWG. TYPE PART | SHOWN ON 25B178 | SCALE: 2/1 | DO NOT SCALE PRINTS | SHEET 1 OF 1
PATENT CLEAR: | DESIGN ACCT. NO. | CATEGORY CODE FE3313 | DWG. NO. 25B1734 | SIZE C | REV. C

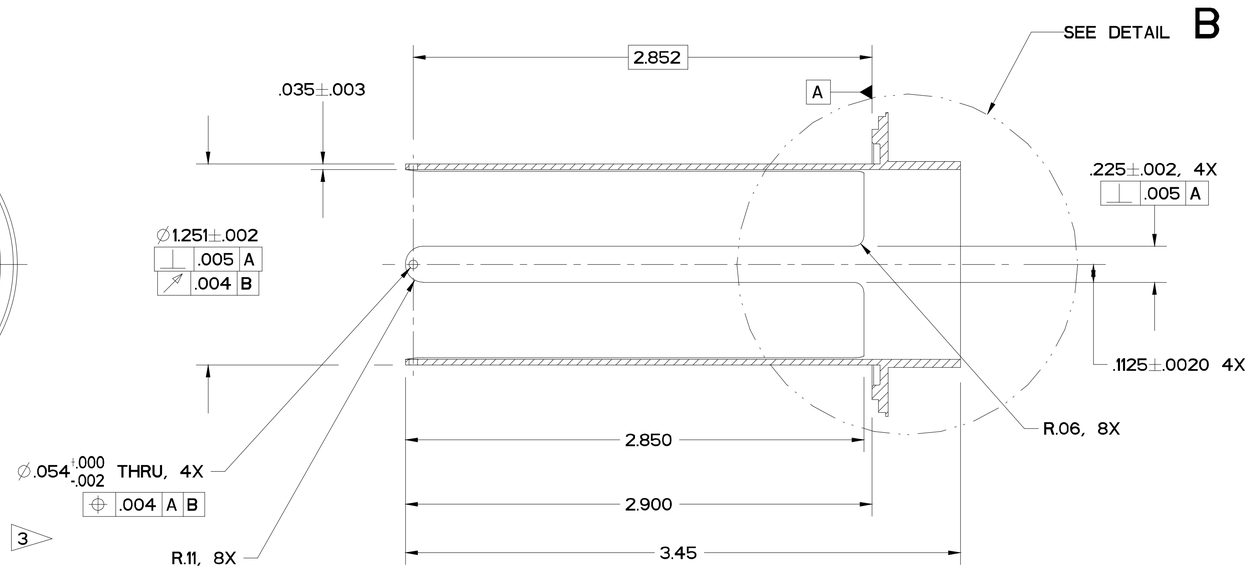
Dwg. File: 25B173 Model File: 25B173



DETAIL B
SCALE 3/1







SECTION A-A

NOTES

1. STRESS RELIEVE PART PRIOR TO FINISH TURNING PROCESSES.
2. DIMENSIONING & TOLERANCING IS PER ANSI Y14.5M-1982. ALL DIMENSIONS ARE IN INCHES. REFERENCE DIMENSIONS ARE SHOWN IN PARETHESIS.
3. DEBURR ENTRANCE AND EXIT OF HOLE TO A SHARP EDGE (4X)
4. POSITIONAL TOLERANCES & DATUM FEATURES OF SIZE APPLY REGARDLESS OF FEATURE SIZE (RFS)
5. SEE 25B178 FOR CLEANING AND HANDLING PROCEDURES.

REV	DWG	CHK	ZONE	DATE	CHANGES
E				11/17/00	MODIFIED DATUM REFERENCES AND NOTES
D				5/30/00	UPDATE BORDER FORMAT
D			A4	5/30/00	CHANGE RADIUS ON TINE ROUND
D			A3	5/30/00	CHANGED TINE LENGTH
C			A8	2/14/00	ADDED NOTE 2.
C			D2	2/14/00	ADDED MISSING DIMENSION
B				1/26/00	GENERAL CHANGES FOR IMPROVED MANUFACTURABILITY

UNLESS OTHERWISE SPECIFIED
PROJECTION:
TOLERANCES: X.X ± 0.0 FRAC. ± 1/64; X.XX ± 0.01 Angles ± 0.5°; X.XXX ± 0.005 FINISH 125
DO NOT SCALE PRINT
THREADS ARE CLASS 2
CHAMFER ENDS OF ALL SCREW TREADS 30°
CUT ROUND, 1.5 THREAD RELIEF ON MACHINED THREADS
BREAK EDGES .06 MAX. ON MACHINED WORK
REMOVE BURRS, WELD SPLATTER & LOOSE SCALE
IN ACCORDANCE WITH ASME Y14.5M & B46.1

DESCRIPTION	316 STAINLESS STEEL	-
	MATERIAL	MAT. LOCATION

SHOP ORDERS
ACCT NO. - | NO. REQD - | SER NO. -
DEL TO - | DATE ISSD - | DATE REQD -
SURFACE TREATMT ELECTROPOLISH
IDENT METHOD TAG
PROJECT NUMBER na
PROJECT NAME SPALLATION NEUTRON SOURCE
DWG BY TREVOR GOULDING | DATE 20-Dec-99
CHK BY DARYL OSHATZ | DATE -
APR BY DARYL OSHATZ | DATE -

ERNEST ORLANDO LAWRENCE
BERKELEY NATIONAL LABORATORY
UNIVERSITY OF CALIFORNIA - BERKELEY

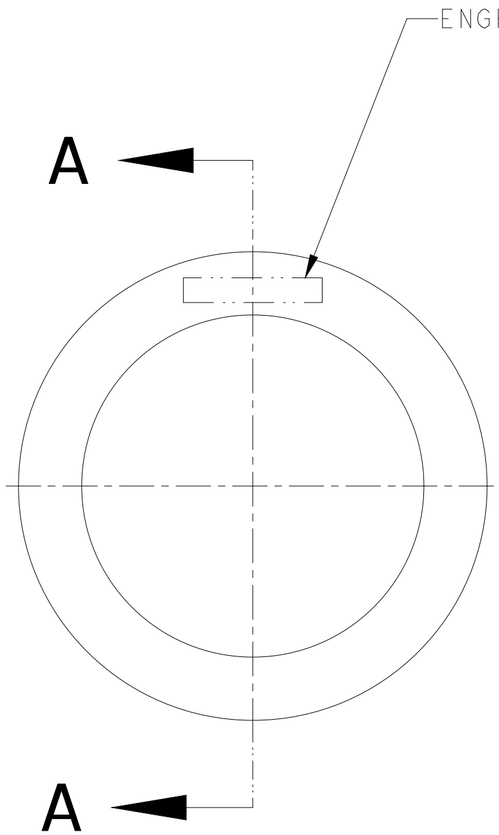
SNS-FES MEBT
MECHANICAL SUBSYSTEMS
30 MM BPM ELECTRODE SPOOL

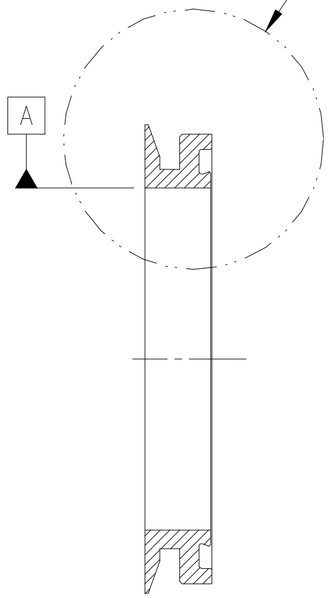
MICROFILMED:	DWG. TYPE	SHOWN ON	SCALE: 2/1	DO NOT SCALE PRINTS
	PART	25B178	SHEET 1 OF 1	
PATENT CLEAR:	DESIGN ACCT. NO.	CATEGORY CODE	DWG. NO.	SIZE / REV.
	-	FE3313	25B1744	E

Dwg. File: 25B174 Model File: 25B174

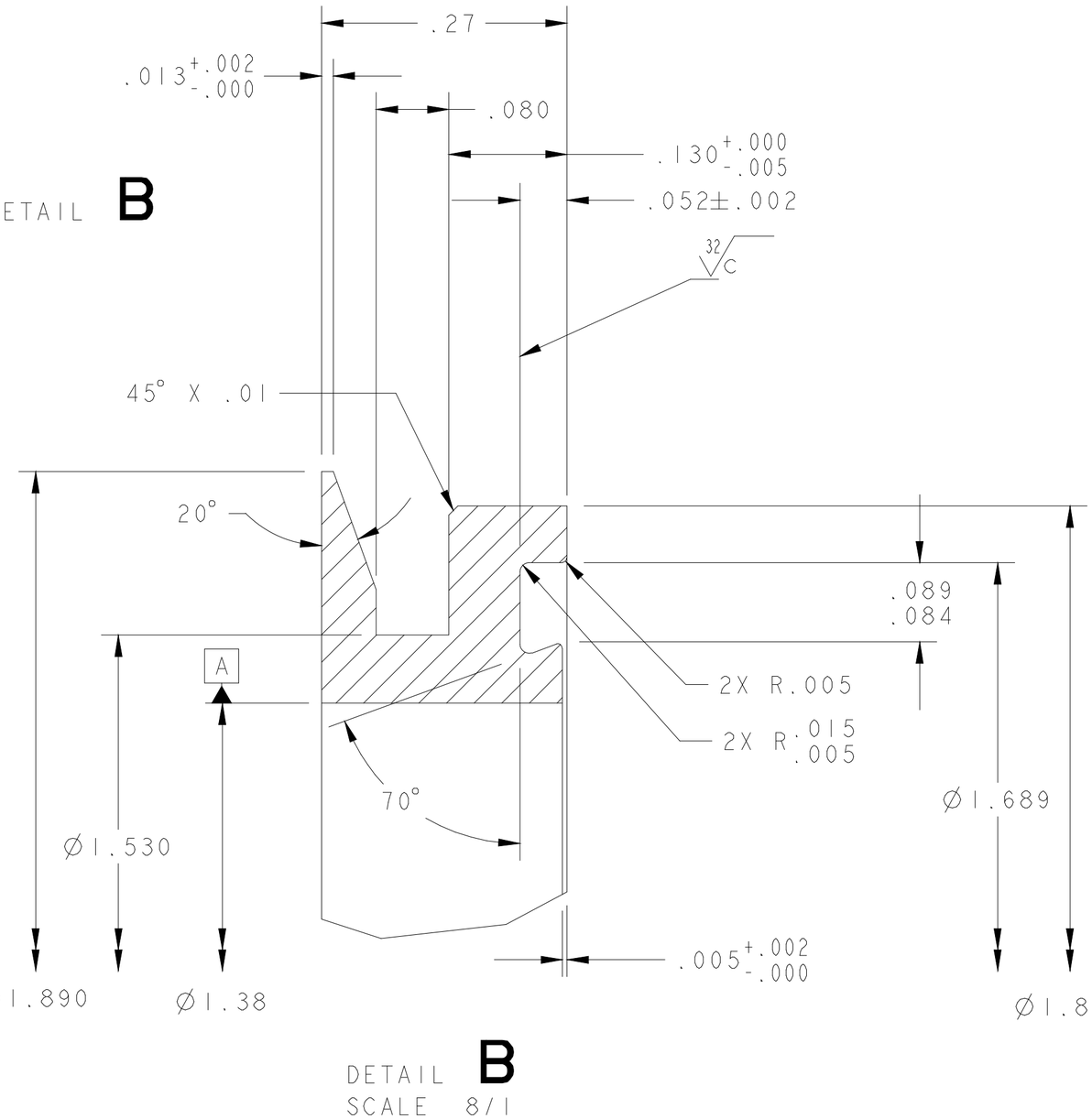
NOTES

1. ULTRA-HIGH VACUUM CLEANING & PACKAGING REQUIRED.





SECTION A-A



DETAIL B
SCALE 8/1

REV	DWG	CHK	ZONE	DATE	CHANGES
E	RLMPAL			8-10-01	REDRAW, CHANGED TITLE TO INCLUDE BEAM PIPES
D				11-17-00	MODIFIED DIMENSIONING TO IMPROVE TOLERANCE STACK UP
C				3-30-00	UPDATE DRAWING BORDER
C				3-30-00	CHANGE SLOT AND ADD STEP
B				1-27-00	ADD NOTE AND UPDATE TITLEBLOCK

UNLESS OTHERWISE SPECIFIED
PROJECTION:
TOLERANCES: X.X ± 0.1 | FRAC. ± 1/64 | X.XX ± 0.01 | Angles ± 0.5° | X.XXX ± 0.005 | FINISH 125

DO NOT SCALE PRINT

THREADS ARE CLASS 2
CHAMFER ENDS OF ALL SCREW TREADS 30°
CUT ROUND, 1.5 THREAD RELIEF ON MACHINED THREADS
BREAK EDGES .016 MAX. ON MACHINED WORK
REMOVE BURRS, WELD SPLATTER & LOOSE SCALE
IN ACCORDANCE WITH ASME Y14.5M & B46.1

-	316 STAINLESS STEEL	-
DESCRIPTION	MATERIAL	MAT. LOCATION

SHOP ORDERS

ACCT NO.	NO. REQD	SER NO.	-
DEL TO		DATE ISSD	-
		DATE REQD	-
SURFACE TREATMT	ELECTROPOLISH		
IDENT METHOD	TAG		
PROJECT NUMBER	na		
PROJECT NAME	-		
DWG BY	TREVOR GOULDING	DATE	16-DEC-00
CHK BY	DARYL OSHATZ	DATE	
APR BY	DARYL OSHATZ	DATE	

ERNEST ORLANDO LAWRENCE
BERKELEY NATIONAL LABORATORY
UNIVERSITY OF CALIFORNIA - BERKELEY

SNS

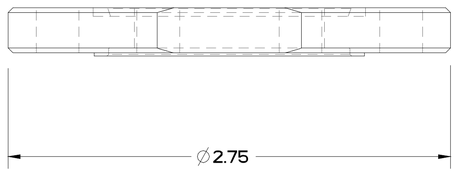
SMS-FES MEBT
MECHANICAL SUBSYSTEMS
30 MM BPM/BP BELLOWS SEAL FLANGE

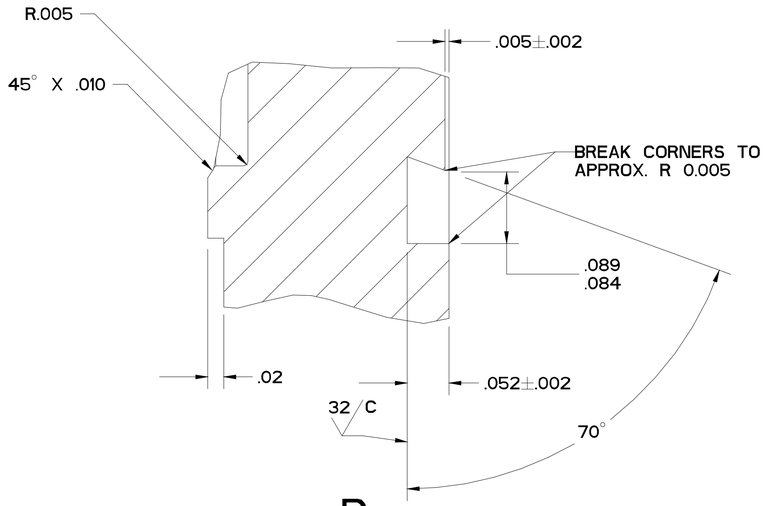
MICROFILMED:	DWG. TYPE	SHOWN ON	SCALE: 2/1	DO NOT SCALE PRINTS
	PART	-	SHEET 1 OF 1	
PATENT CLEAR:	DESIGN ACCT. NO.	CATEGORY CODE	DWG. NO.	SIZE / REV.
	-	FE3313	25B1753	E

Dwg. File: 25B1753 Model File: 25B175

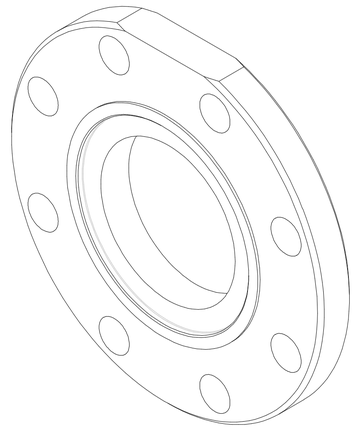
DWG. NO. 25B1753 SIZE E REV. SH. 1

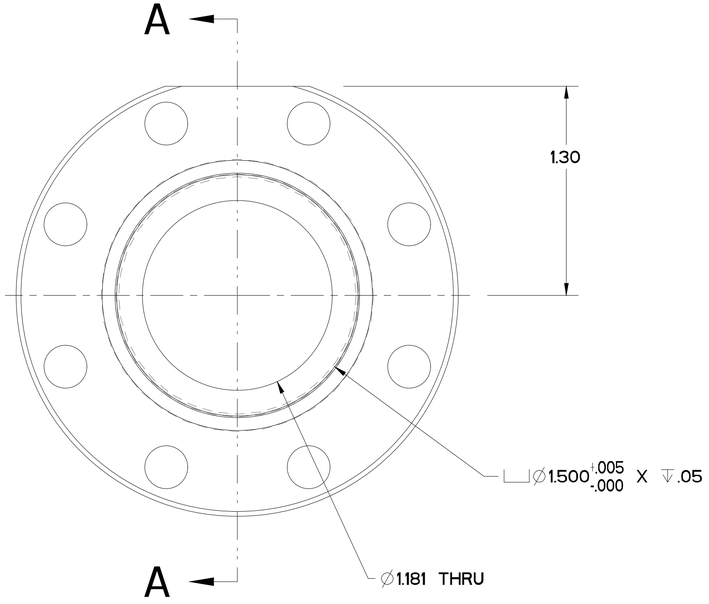
Rev. 1/31/2000 J. R. Oldrid

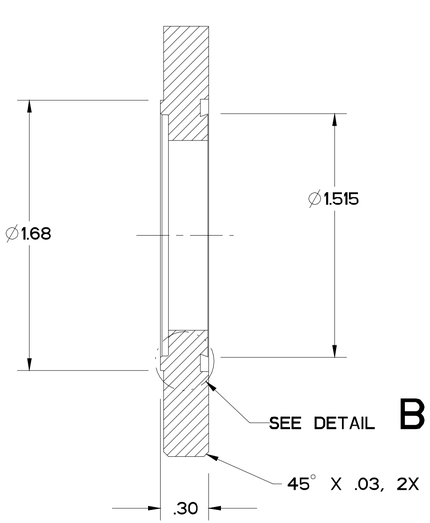




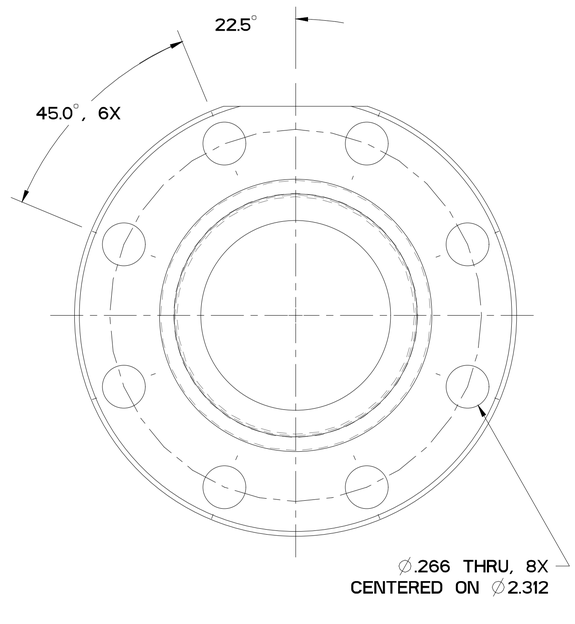
DETAIL B
SCALE 10/1







SECTION A-A



NOTES

1. ULTRA-HIGH VACUUM CLEANING & PACKAGING REQUIRED.

REV	DWG	CHK	ZONE	DATE	CHANGES
D				11/17/00	MODIFIED O-RING GROOVE AND WELD PREP.
C				3/30/00	REPLACE DRAWING BORDER
C			C4	3/30/00	CHANGED SLOT & ADDED STEP
B				1/27/00	ADDED NOTE & UPDATED TITLE BLOCK
B			A6	1/27/00	INCREASE C'BORE DEPTH
B			D5	1/27/00	ADDED CHAMFER & ROUND

UNLESS OTHERWISE SPECIFIED
PROJECTION:
TOLERANCES: X.X ± 0.1 | FRAC. ± 1/64 | X.XX ± 0.01 | Angles ± 0.5° | X.XXX ± 0.005 | FINISH 125
DO NOT SCALE PRINT
THREADS ARE CLASS 2
CHAMFER ENDS OF ALL SCREW TREADS 30°
CUT ROUND, 1.5 THREAD RELIEF ON MACHINED THREADS
BREAK EDGES .06 MAX. ON MACHINED WORK
REMOVE BURRS, WELD SPLATTER & LOOSE SCALE
IN ACCORDANCE WITH ASME Y14.5M & B46.1

SHOP ORDERS — SBR NO. -
ACCT NO. - | NO. REQD - | DATE ISSD -
DEL TO - | DATE REQD -
SURFACE TREATMT ELECTROPOLISH
IDENT METHOD TAG
PROJECT NUMBER na
PROJECT NAME -
DWG BY TREVOR GOULDING | DATE 16-Dec-99
CHK BY DARYL OSHATZ | DATE -
APR BY DARYL OSHATZ | DATE -

-	316 STAINLESS STEEL	-
DESCRIPTION	MATERIAL	MAT. LOCATION

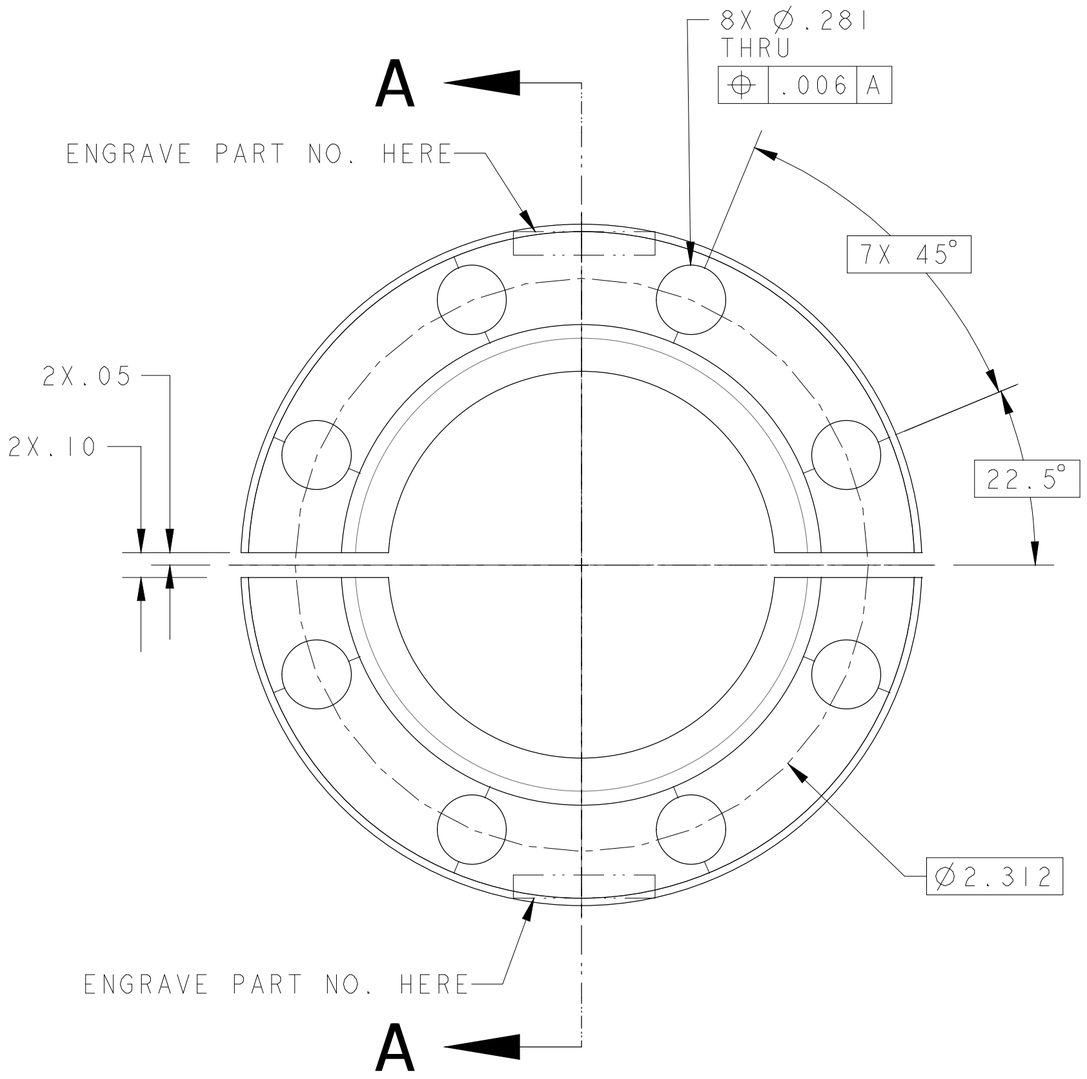
ERNEST ORLANDO LAWRENCE
BERKELEY NATIONAL LABORATORY
UNIVERSITY OF CALIFORNIA - BERKELEY

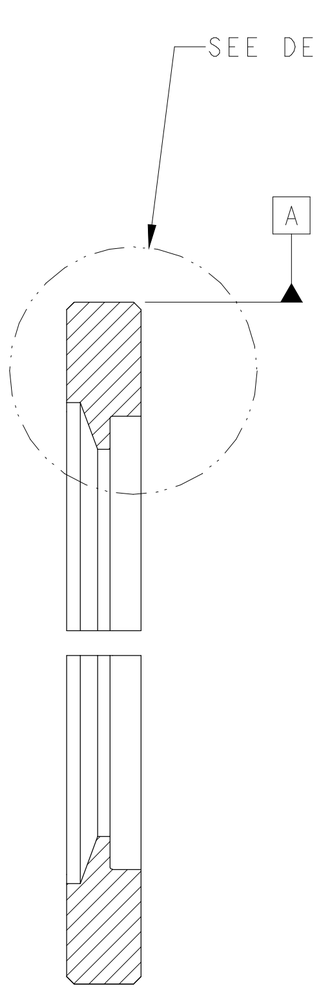
SMS-FES MEBT
MECHANICAL SUBSYSTEMS
30 MM BPM FIXED FLANGE

MICROFILMED:	DWG. TYPE	SHOWN ON	SCALE: 2/1	DO NOT SCALE PRINTS
	PART	25B178	SHEET 1 OF 1	
PATENT CLEAR:	DESIGN ACCT. NO.	CATEGORY CODE	DWG. NO.	SIZE / REV.
	-	FE3313	25B1764	D

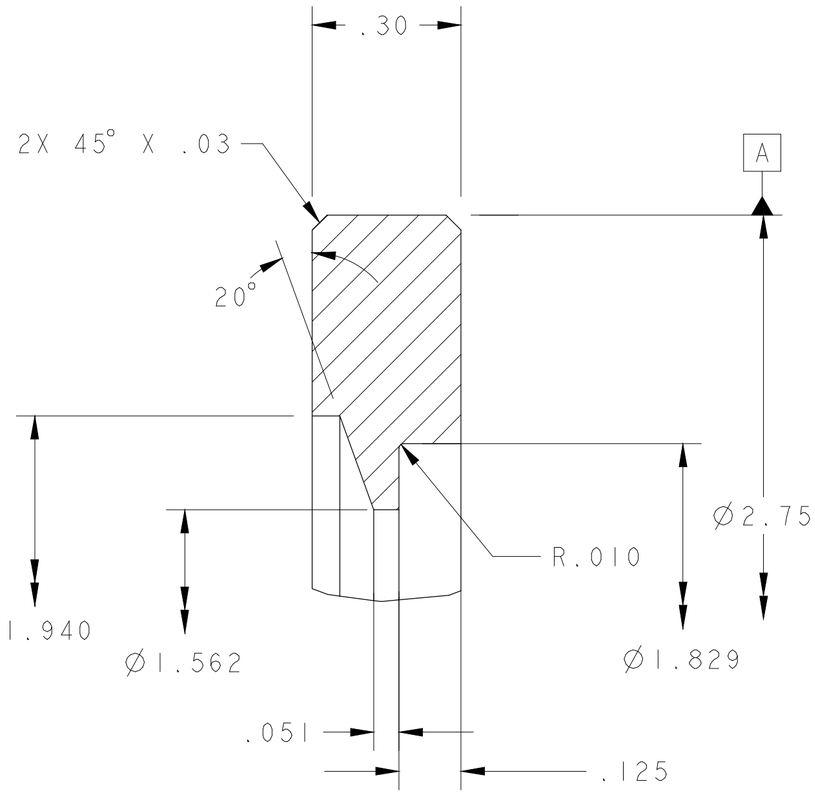
Dwg. File: 25B176 Model File: 25B178

NOTE:
1. ULTRA-HIGH VACUUM CLEANING & PACKAGING REQUIRED.
2. FURNISH AS A SET





SECTION A-A



DETAIL B
SCALE 4/1

REV	DWG	CHK	ZONE	DATE	CHANGES
D	RLM	PAL		08-03-01	REDRAW
C	TG			11-17-00	MODIFIED DIMS AND HOLE TO IMPROVE ASSY MATING
B	TG			01-27-00	ADDED NOTE AND UPDATED TITLEBLOCK
A	TG			12-16-99	INITIAL RELEASE

UNLESS OTHERWISE SPECIFIED
PROJECTION:
TOLERANCES: X.X ± 0.1 | FRAC. ± 1/64 | X.XX ± 0.01 | Angles ± 1.0° | X.XXX ± 0.005 | FINISH 125

DO NOT SCALE PRINT
THREADS ARE CLASS 2
CHAMFER ENDS OF ALL SCREW TREADS 30°
CUT ROUND, 1.5 THREAD RELIEF ON MACHINED THREADS
BREAK EDGES .016 MAX. ON MACHINED WORK
REMOVE BURRS, WELD SPLATTER & LOOSE SCALE
IN ACCORDANCE WITH ASME Y14.5M & B46.1

-	SS 304L	-
DESCRIPTION	MATERIAL	MAT. LOCATION

SHOP ORDERS — SER NO. -

ACCT NO.	NO. REQD	DATE ISSD	-
DEL TO		DATE REQD	-
SURFACE TREATMT	-		
IDENT METHOD	TAG		
PROJECT NUMBER	na		
PROJECT NAME	N/A		
DWG BY	R LA MANTIA	DATE	08-03-01
CHK BY	PAL	DATE	08-03-01
APR BY	DPO	DATE	08-03-01

ERNEST ORLANDO LAWRENCE BERKELEY NATIONAL LABORATORY
UNIVERSITY OF CALIFORNIA - BERKELEY

SNS-FES MEBT
BEAM PIPES
30 MM BP/ BPM SPLIT FLANGE

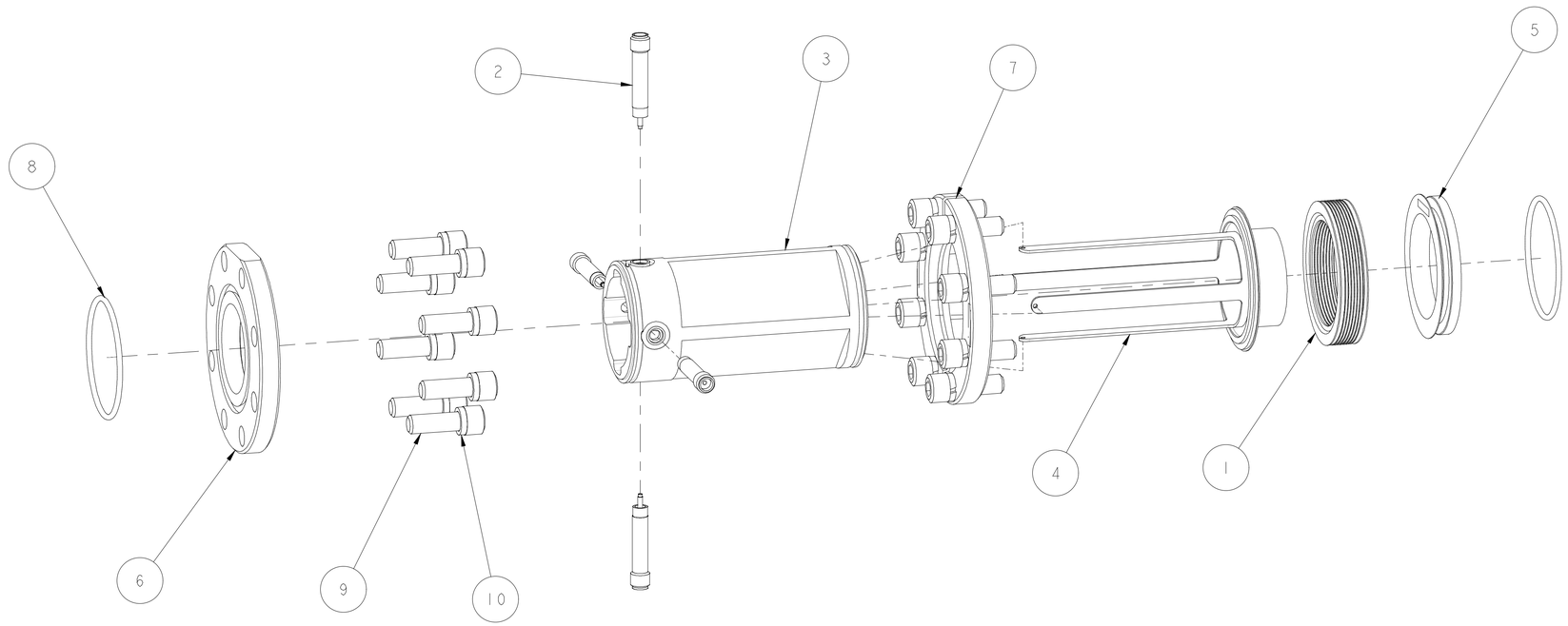
MICROFILMED:	DWG. TYPE	SHOWN ON	SCALE: 2/1	DO NOT SCALE PRINTS
	PART	25B603	SHEET 1 OF 1	
PATENT CLEAR:	DESIGN ACCT. NO.	CATEGORY CODE	DWG. NO.	SIZE / REV.
	-	FE3312	25B1773	D

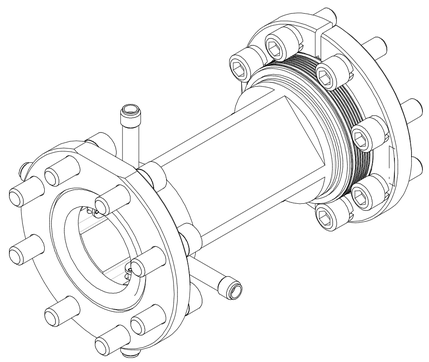
Dwg. File: 25B177 Model File: 25B177

DWG. NO. 25B1773 | SIZE D | REV. | SH. 1

Rev. 1/28/2009 JL Osborn

NOTES
1. FINISHED PART TO BE VACUUM TIGHT. LEAK RATE NOT TO EXCEED 1x10^-8 torr l/sec. He.
ALL WELDS ARE TO BE MINIMUM HEAT FUSION WELDS. ASSEMBLE AS FOLLOWS:
   1.1. ALIGN BORE TUBE (25B173) WITH ELECTRODE SPOOL (25B174) USING ASSEMBLY TOOL 25B676-1. SECURE WITH TOOL 25B626-2, AND WELD.
   1.2. MOUNT HEAT SINK 25B676-3 TO SMA FEED THRU (25B171), ASSEMBLE TO SUB-ASSEMBLY OF 1.1, (ABOVE). SECURE WITH TOOL 25B676-4 AND WELD, 4 PLACES. DO NOT OVERHEAT FEED THRU.
   1.3. LEAK CHECK ASSEMBLY AND REPAIR IF REQUIRED.
   1.4. SPOT WELD PER LBNL ENGINEERING NOTE FE-ME-042. LEAK CHECK ASSEMBLY.
   1.5. ALIGN SUB-ASSEMBLY OF 1.4 (ABOVE) WITH FIXED FLANGE (25B176). SECURE WITH TOOL 25B676-2 AND WELD.
   1.6 USE AEROSEAL CLAMP OR EQUAL TO ALIGN SEAL FLANGE (25B175) WITH BELLOWS (25B170). WELD.
   1.7 ALIGN SUB-ASSEMBLY OF 1.5 (ABOVE) WITH SUB-ASSEMBLY OF 1.6 (ABOVE) AS DESCRIBED IN 1.6. WELD.
   1.8. LEAK CHECK.
2. ASSEMBLE IN CLEAN ENVIRONMENT. AFTER ASSEMBLY, WRAP TO MAINTAIN CLEANLINESS.





ITEM	PART NO	REQD	DESCRIPTION	MATERIAL
10	-	16	LOCK WASHER, SPRING, HIGH COLLAR, .25"	SS 18-8
9		16	SCR, SCH, .25-28 UNF X .75 LG	SS 18-8
8		2	2-029 O-RING SEAL	VITON
7	25B177	1	30 MM BP/ BPM SPLIT FLANGE	SS 304L
6	25B176	1	30 MM BPM FIXED FLANGE	316 STAINLESS STEEL
5	25B175	1	30 MM BPM/BP BELLOWS SEAL FLANGE	316 STAINLESS STEEL
4	25B174	1	30 MM BPM ELECTRODE SPOOL	316 STAINLESS STEEL
3	25B173	1	30 MM BPM BORE TUBE	316 STAINLESS STEEL
2	25B171	4	BPM SMA FEED THRU	-
1	25B170	1	30 MM BPM BELLOWS	347 STAINLESS STEEL

REV	DWG	CHK	ZONE	DATE	CHANGES
F	PL	DPO		2/10/02	ADDED NOTES 1.1-1.8. 1/4-28 SCREWS WERE 1/4-20. 1/4" HI-COLLAR WASHERS WERE FLAT, NARROW. B/M ITEMS RENUMBERED.
E				9/26/01	UPDATED ASSEMBLY MODEL
D				11/20/00	UPDATED ASSEMBLY MODEL
C			D7	8/18/00	ADDED PERPENDICULARITY TOLERANCE
B			B1-5	1/27/00	ADDED WELD SIZES TO SYMBOLS
B				1/27/00	CHANGED ORIENTATION OF EXPLODED VIEW
B				1/27/00	ADDED NOTE & UPDATED TITLE BLOCK

UNLESS OTHERWISE SPECIFIED
PROJECTION:
TOLERANCES: X.X ± 0.1 | FRAC. ± 1/64 | X.XX ± 0.03 | Angles ± 0.5° | X.XXX ± 0.010 | FINISH 125
DO NOT SCALE PRINT
THREADS ARE CLASS 2
CHAMFER ENDS OF ALL SCREW TREADS 30°
CUT ROUND, 1.5 THREAD RELIEF ON MACHINED THREADS
BREAK EDGES .016 MAX. ON MACHINED WORK
REMOVE BURRS, WELD SPLATTER & LOOSE SCALE
IN ACCORDANCE WITH ASME Y14.5M & B46.1

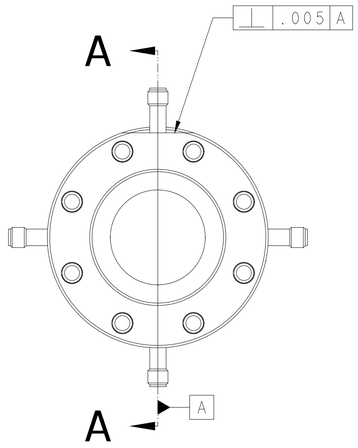
SHOP ORDERS
ACCT NO. - | NO. REQD -
DEL TO -
SURFACE TREATMT SEE NOTES (PAGE 2)
IDENT METHOD TAG
PROJECT NUMBER
PROJECT NAME
DWG BY TREVOR GOULDING | DATE 17-Dec-99
CHK BY | DATE 12-Jan-00
APR BY | DATE -
SER NO. -
DATE ISSD -
DATE REQD -

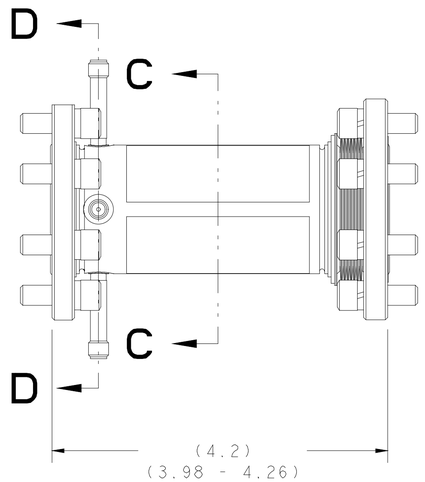
ERNEST ORLANDO LAWRENCE BERKELEY NATIONAL LABORATORY
UNIVERSITY OF CALIFORNIA - BERKELEY

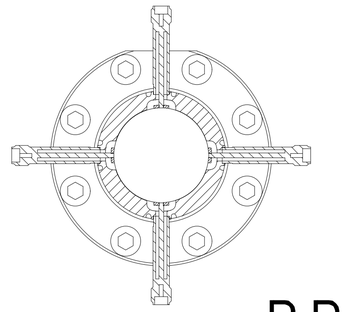
SMS-FES MEBT
MECHANICAL SUBSYSTEMS
30 MM BEAM POSITION MONITOR

MICROFILMED:
PATENT CLEAR:
DWG. TYPE ASSEM
SHOWN ON
DESIGN ACCT. NO.
CATEGORY CODE FE3313
SCALE: 1/1 DO NOT SCALE PRINTS
SHEET 1 OF 2
DWG. NO. 25B1784 SIZE F REV.

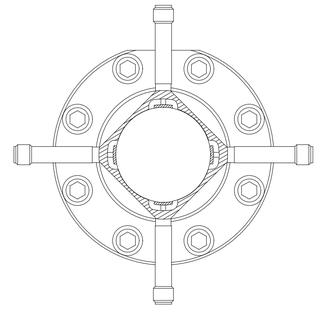
Dwg. File: 25B1784.Mcad | Fr: 25B158



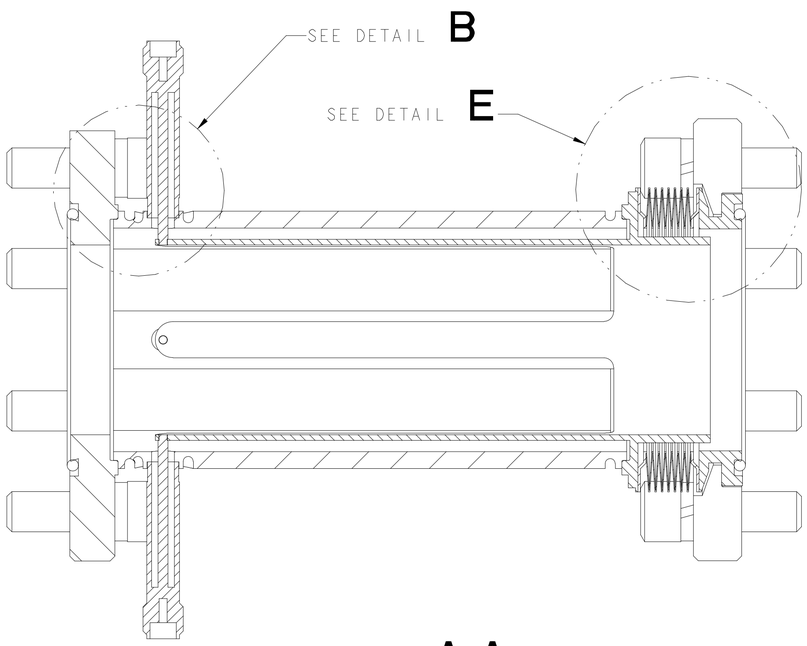




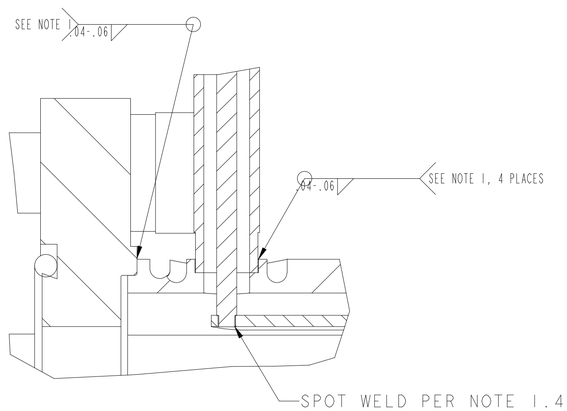
SECTION D-D



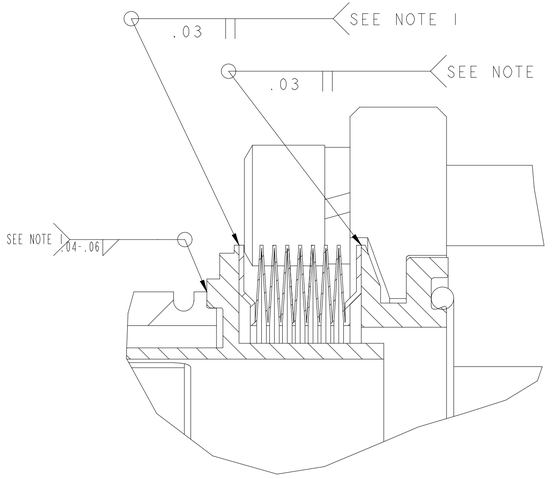
SECTION C-C



SECTION A-A
SCALE 2/1



DETAIL B
SCALE 4/1



DETAIL E
SCALE 4/1

UNLESS OTHERWISE SPECIFIED
PROJECTION:
TOLERANCES
X.X ± 0.1 | FRAC. ± 1/64
X.XX ± 0.03 | Angles ± 0.5°
X.XXX ± 0.010 | FINISH 125
DO NOT SCALE PRINT
THREADS ARE CLASS 2
CHAMFER ENDS OF ALL SCREW TREADS 30°
CUT ROUND, 1.5 THREAD RELIEF ON MACHINED THREADS
BREAK EDGES .016 MAX. ON MACHINED WORK
REMOVE BURRS, WELD SPLATTER & LOOSE SCALE
IN ACCORDANCE WITH ASME Y14.5M & B46.1

SHOP ORDERS

ACCT NO. -	NO. REQD -	SER NO. -	
DEL TO -		DATE ISSD -	
		DATE REQD -	
SURFACE TREATMT	SEE NOTES (PAGE 2)		
IDENT METHOD	TAG		
PROJECT NUMBER			
PROJECT NAME			
DWG BY	TREVOR GOULDING	DATE	22-Dec-99
CHK BY		DATE	-
APR BY		DATE	-

ERNEST ORLANDO LAWRENCE
BERKELEY NATIONAL LABORATORY
UNIVERSITY OF CALIFORNIA - BERKELEY

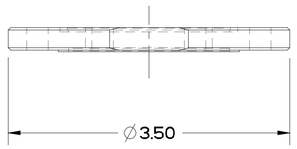
SNS

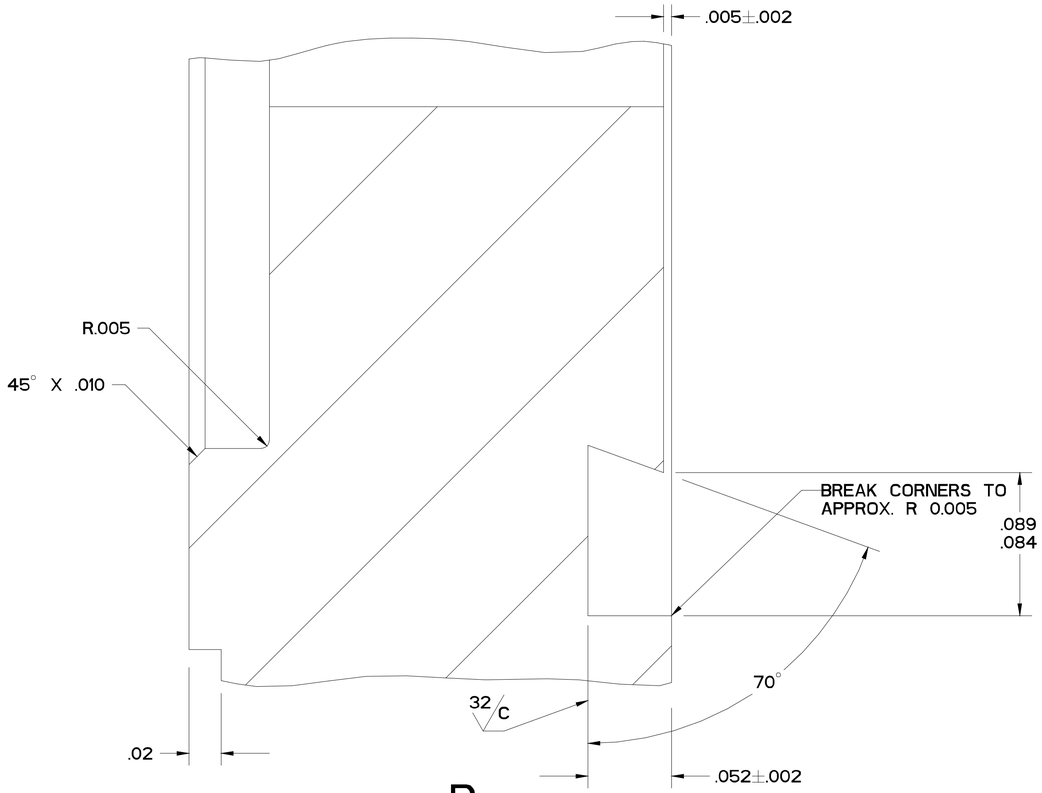
SMS-FES MEBT
MECHANICAL SUBSYSTEMS
30 MM BEAM POSITION MONITOR

MICROFILMED:	DWG. TYPE ASSEM	SHOWN ON	SCALE: 1/1	DO NOT SCALE PRINTS
			SHEET 2 OF 2	
PATENT CLEAR:	DESIGN ACCT. NO.	CATEGORY CODE FE3313	DWG. NO. 25B1784	SIZE F / REV.

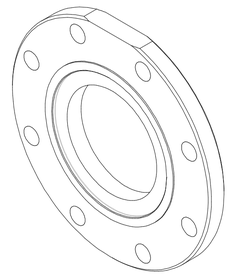
Dwg. Files: 25B1784_Mech1 Files: 25B1784

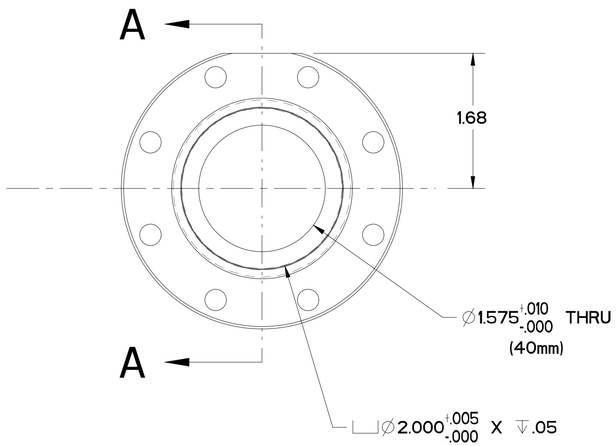
DWG. NO.	SIZE	REV.	SH.
25B1794	D	1	

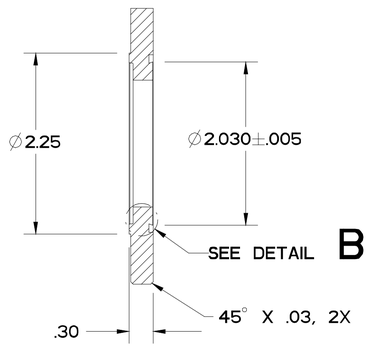




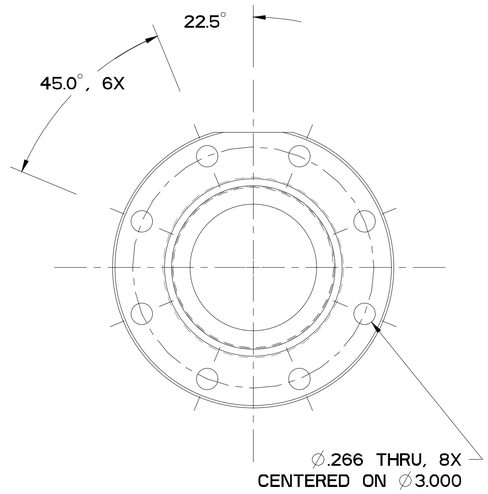
DETAIL B
SCALE 20/1







SECTION A-A



NOTES

1. ULTRA-HIGH VACUUM CLEANING & PACKAGING REQUIRED.

REV	DWG	CHK	ZONE	DATE	CHANGES
D	AZ			11/21/00	MODIFIED O-RING GROOVE AND WELD PREP.
C				3/30/00	REPLACED DRAWING BORDER
C			A6	3/30/00	CHANGED SLOT & ADDED STEP
B				1/27/00	ADDED NOTE & UPDATED TITLE BLOCK
B			A6	1/27/00	INCREASED C'BORE DEPTH
B			D5	1/27/00	ADDED CHAMFER AND ROUND

UNLESS OTHERWISE SPECIFIED

PROJECTION:

TOLERANCES

X.X ± 0.1	FRAC. ± 1/64
X.XX ± 0.01	Angles ± 0.5°
X.XXX ± 0.005	FINISH 32

DO NOT SCALE PRINT

THREADS ARE CLASS 2
CHAMFER ENDS OF ALL SCREW TREADS 30°
CUT ROUND, 1.5 THREAD RELIEF ON MACHINED THREADS
BREAK EDGES .016 MAX. ON MACHINED WORK
REMOVE BURRS, WELD SPLATTER & LOOSE SCALE
IN ACCORDANCE WITH ASME Y14.5M & B46.1

SHOP ORDERS

ACCT NO.	-	NO. REQD -	SER NO. -
DEL TO	-		DATE ISSD -
SURFACE TREATMT	ELECTROPOLISH		DATE REQD -
IDENT METHOD	TAG		
PROJECT NUMBER	na		
PROJECT NAME	-		
DWG BY	TREVOR GOULDING	DATE 11-Jan-00	
CHK BY	DARYL OSHATZ	DATE -	
APR BY	DARYL OSHATZ	DATE -	

DESCRIPTION	MATERIAL	MAT. LOCATION
-	316 STAINLESS STEEL	-

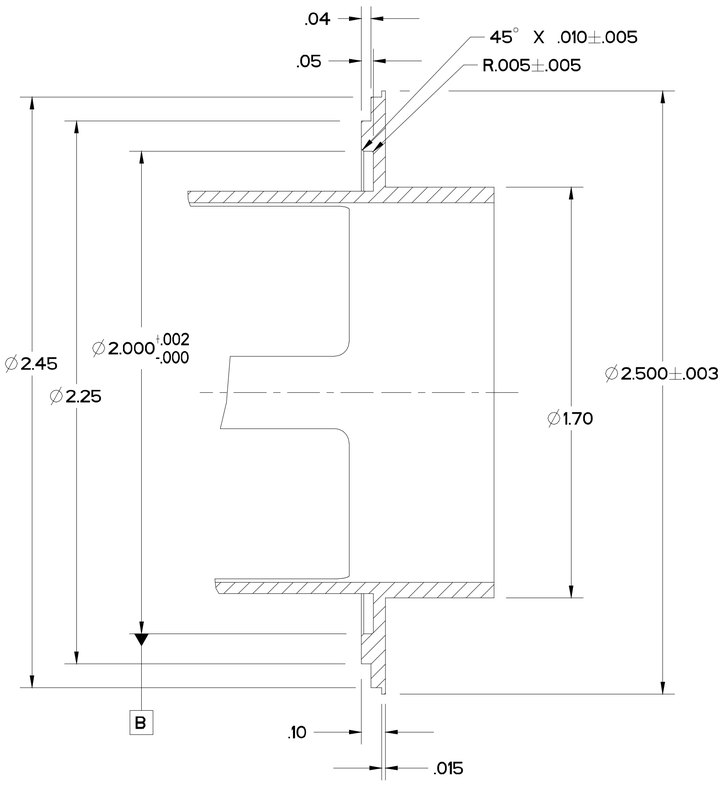
ERNEST ORLANDO LAWRENCE
BERKELEY NATIONAL LABORATORY
UNIVERSITY OF CALIFORNIA - BERKELEY

SNS

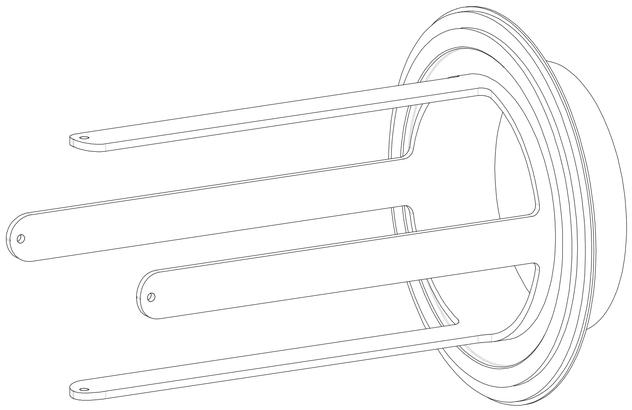
SMS-FES MEBT
MECHANICAL SUBSYSTEMS
40 MM BPM FIXED FLANGE

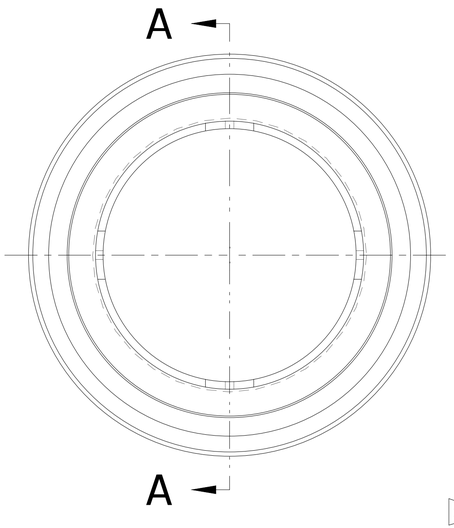
MICROFILMED:	DWG. TYPE	SHOWN ON	SCALE: 1/1	DO NOT SCALE PRINTS
	PART	25B184	SHEET 1 OF 1	
PATENT CLEAR:	DESIGN ACCT. NO.	CATEGORY CODE	DWG. NO.	SIZE / REV.
	-	FE3313	25B1794	D

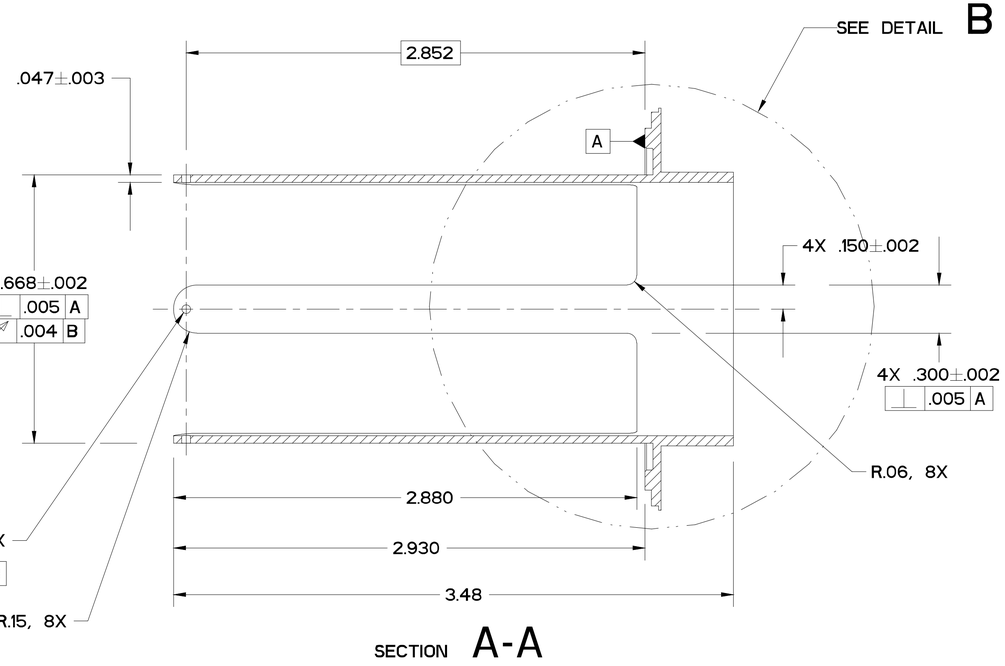
Dwg. File: 25B179 Model File: 25B179



DETAIL B
SCALE 3/1







SECTION A-A

NOTES

1. STRESS RELIEVE PART PRIOR TO FINISH TURNING PROCESSES.
2. DIMENSIONING & TOLERANCING IS PER ANSI Y14.5M-1982. ALL DIMENSIONS ARE IN INCHES. REFERENCE DIMENSIONS ARE SHOWN IN PARETHESIS.
3. DEBURR ENTRANCE AND EXIT OF HOLE TO A SHARP EDGE (4X)
4. POSITIONAL TOLERANCES & DATUM FEATURES OF SIZE APPLY REGARDLESS OF FEATURE SIZE (RFS)
5. SEE 25B178 FOR CLEANING AND HANDLING PROCEDURES.

REV	DWG	CHK	ZONE	DATE	CHANGES
E	AZ		C8	3/4/01	ADDED DIMENSION ∅2.25
D	AZ			5/30/00	UPDATE BORDER FORMAT
D	AZ		A4	5/30/00	CHANGE RADIUS ON TINE ROUND
D	AZ		A3	5/30/00	CHANGED TINE LENGTH
C			A8	2/14/00	ADDED NOTE 2
C			D7	2/14/00	ADDED MISSING DIMENSION
B				1/27/00	GENERAL CHANGES FOR IMPROVED MANUFACTURABILITY

UNLESS OTHERWISE SPECIFIED
PROJECTION:
TOLERANCES: X.X ± 0.0 | FRAC. ± 1/64 | X.XX ± 0.01 | Angles ± 0.5° | X.XXX ± 0.005 | FINISH 125
DO NOT SCALE PRINT
THREADS ARE CLASS 2
CHAMFER ENDS OF ALL SCREW TREADS 30°
CUT ROUND, 1.5 THREAD RELIEF ON MACHINED THREADS
BREAK EDGES .016 MAX. ON MACHINED WORK
REMOVE BURRS, WELD SPLATTER & LOOSE SCALE
IN ACCORDANCE WITH ASME Y14.5M & B46.1

SHOP ORDERS
ACCT NO. - | NO. REQD - | SER NO. - | DATE ISSD - | DEL TO - | DATE REQD -
SURFACE TREATMT ELECTROPOLISH
IDENT METHOD TAG
PROJECT NUMBER
PROJECT NAME SPALLATION NEUTRON SOURCE
DWG BY TREVOR GOULDING DATE 11-Jan-00
CHK BY DARYL OSHATZ DATE 12-Jan-00
APR BY DARYL OSHATZ DATE 12-Jan-00

DESCRIPTION	MATERIAL	MAT. LOCATION
	316 STAINLESS STEEL	-

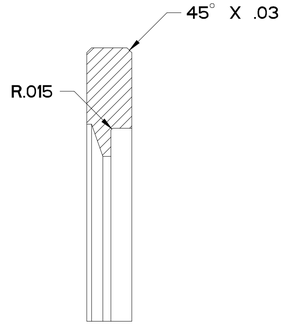
ERNEST ORLANDO LAWRENCE
BERKELEY NATIONAL LABORATORY
UNIVERSITY OF CALIFORNIA - BERKELEY

SNS-FES MEBT
MECHANICAL SUBSYSTEMS
40 MM BPM ELECTRODE SPOOL

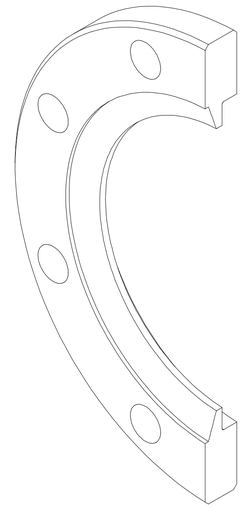
MICROFILMED: | PATENT CLEAR:
DWG. TYPE PART | SHOWN ON 25B184 | SCALE: 2/1 | DO NOT SCALE PRINTS
DESIGN ACCT. NO. | CATEGORY CODE FE3313 | DWG. NO. 25B1804 | SIZE | REV. E
SHEET 1 OF 1

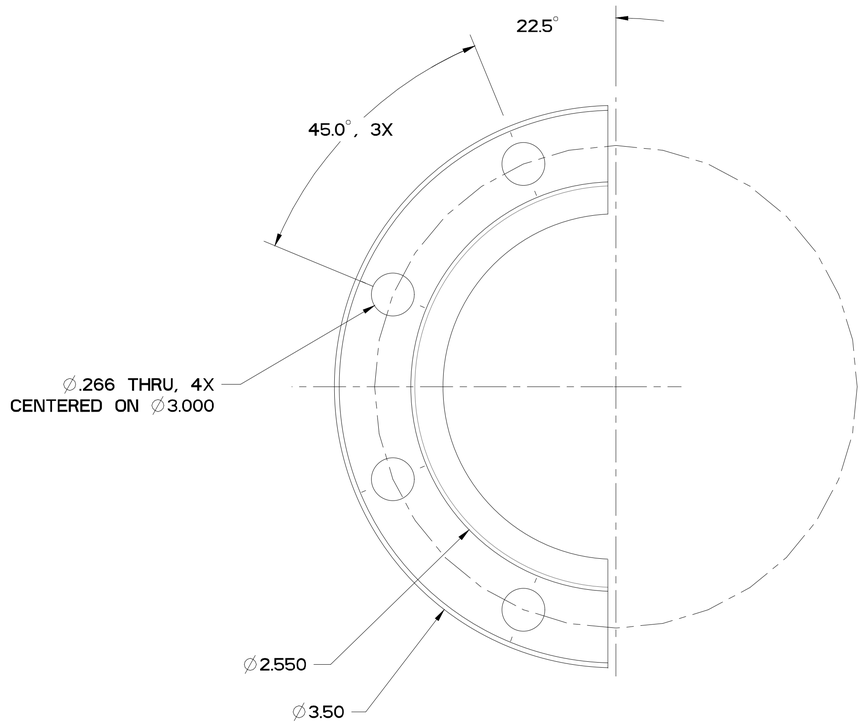
Dwg. File: 25B1804 Model File: 25B180

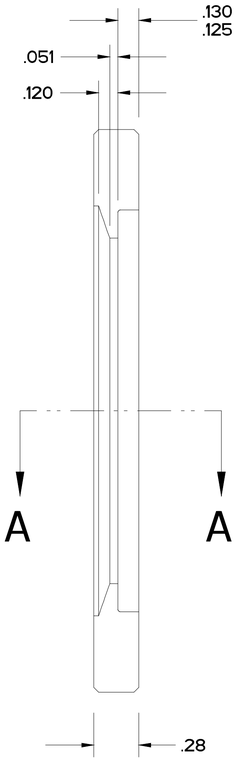
DWG. NO. 25B1814 | SIZE D | REV. 1 | SH. 1

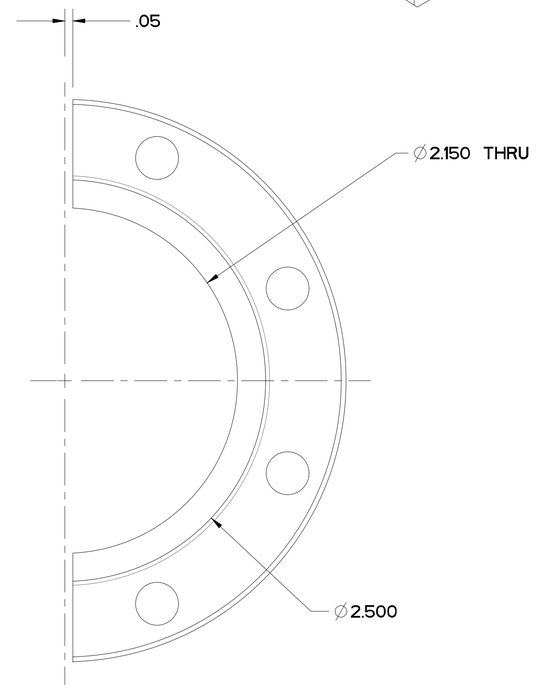


SECTION A-A









25B181 4D

NOTES

1. ULTRA-HIGH VACUUM CLEANING & PACKAGING REQUIRED.

REV	DWG	CHK	ZONE	DATE	CHANGES
D	AZ			12/20/00	ADDED MISSING DIAMETER DIMENSION IN 2D
C	AZ			11/21/00	MODIFIED DIMENSIONING AND HOLE TO IMPROVE ASSEMBLY MATING
B				1/27/00	ADDED NOTE & UPDATED TITLE BLOCK

UNLESS OTHERWISE SPECIFIED

PROJECTION:

TOLERANCES

X.X ± 0.1	FRAC. ± 1/64
X.XX ± 0.01	Angles ± 0.5°
X.XXX ± 0.005	FINISH 125

DO NOT SCALE PRINT

THREADS ARE CLASS 2

CHAMFER ENDS OF ALL SCREW TREADS 30°

CUT ROUND, 15 THREAD RELIEF ON MACHINED THREADS

BREAK EDGES .016 MAX. ON MACHINED WORK

REMOVE BURRS, WELD SPLATTER & LOOSE SCALE

IN ACCORDANCE WITH ASME Y14.5M & B46.1

SHOP ORDERS

ACCT NO. N	NO. REQD N	SER NO. -	
DEL TO N		DATE ISSD -	
SURFACE TREATMT -		DATE REQD -	
IDENT METHOD TAG			
PROJECT NUMBER			
PROJECT NAME			
DWG BY TREVOR GOULDING		DATE 21-Nov-00	
CHK BY		DATE N	
APR BY		DATE N	

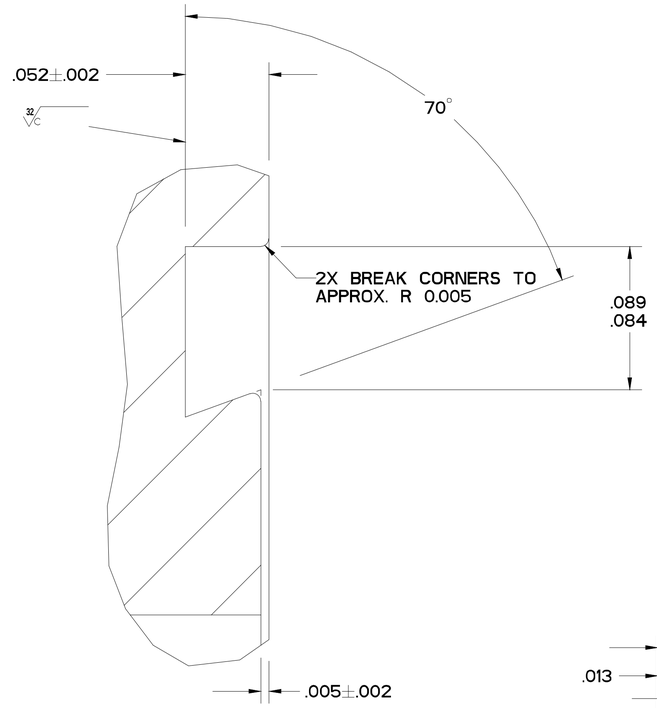
DESCRIPTION	316 STAINLESS STEEL	-
	MATERIAL	MAT. LOCATION

ERNEST ORLANDO LAWRENCE
BERKELEY NATIONAL LABORATORY
UNIVERSITY OF CALIFORNIA - BERKELEY

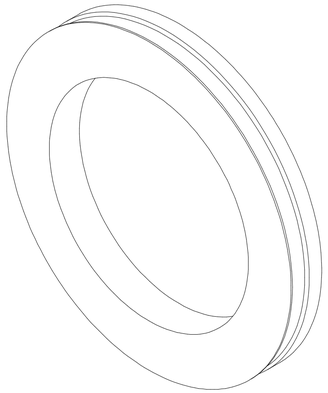
SMS-FES MEBT
MECHANICAL SUBSYSTEMS
40 MM BPM SPLIT FLANGE

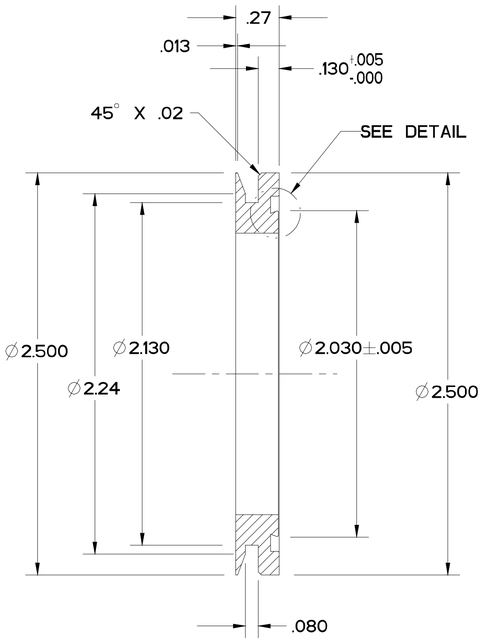
MICROFILMED:	DWG. TYPE	SHOWN ON	SCALE: 2/1	DO NOT SCALE PRINTS
	PART	25B184	SHEET 1 OF 1	
PATENT CLEAR:	DESIGN ACCT. NO.	CATEGORY CODE	DWG. NO.	SIZE / REV.
		FE3313	25B1814	D

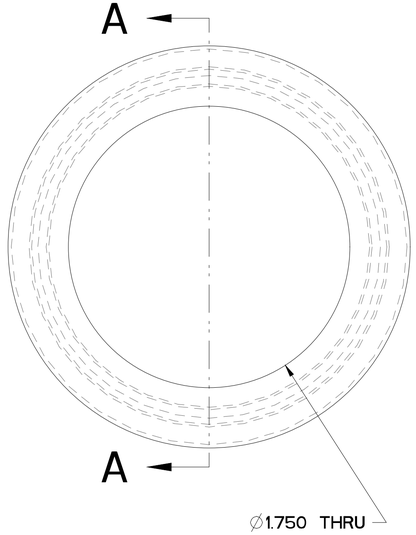
Dwg. File: 25B1814 Model File: 25B181



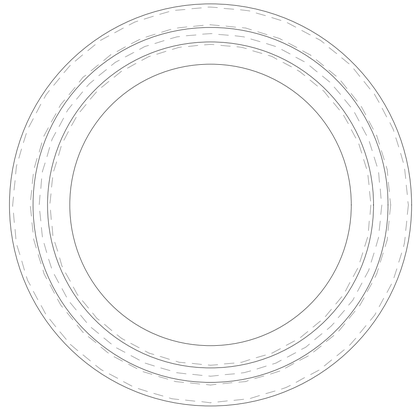
DETAIL B
SCALE 20/1







SECTION A-A



NOTES

1. ULTRA-HIGH VACUUM CLEANING & PACKAGING REQUIRED.

REV	DWG	CHK	ZONE	DATE	CHANGES
D	AZ			11/21/00	MODIFIED DIMENSIONING TO IMPROVE TOLERANCE STACK UP
C				3/30/00	REPLACED DRAWING BORDER
C			D7	3/30/00	CHANGED SLOT & ADDED STEP
B				1/27/00	ADDED NOTE & UPDATED TITLE BLOCK

UNLESS OTHERWISE SPECIFIED

PROJECTION:

TOLERANCES: X.X ± 0.1 | FRAC. ± 1/64 | X.XX ± 0.01 | Angles ± 0.5° | X.XXX ± 0.005 | FINISH 125

DO NOT SCALE PRINT

THREADS ARE CLASS 2
CHAMFER ENDS OF ALL SCREW TREADS 30°
CUT ROUND, 15 THREAD RELIEF ON MACHINED THREADS
BREAK EDGES .016 MAX. ON MACHINED WORK
REMOVE BURRS, WELD SPLATTER & LOOSE SCALE
IN ACCORDANCE WITH ASME Y14.5M & B46.1

SHOP ORDERS

ACCT NO. -	NO. REQD -	SER NO. -	
DEL TO -		DATE ISSD -	
		DATE REQD -	
SURFACE TREATMT	ELECTROPOLISH		
IDENT METHOD	TAG		
PROJECT NUMBER	na		
PROJECT NAME	-		
DWG BY	TREVOR GOULDING	DATE 11-Jan-00	
CHK BY	DARYL OSHATZ	DATE -	
APR BY	DARYL OSHATZ	DATE -	

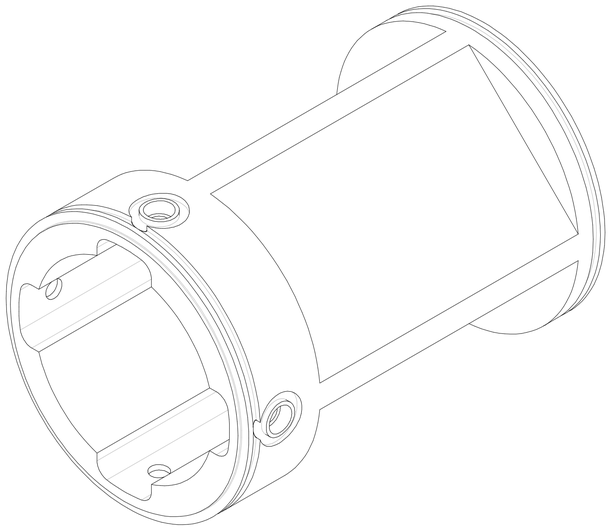
DESCRIPTION	MATERIAL	MAT. LOCATION
-	316 STAINLESS STEEL	-

ERNEST ORLANDO LAWRENCE
BERKELEY NATIONAL LABORATORY
UNIVERSITY OF CALIFORNIA - BERKELEY

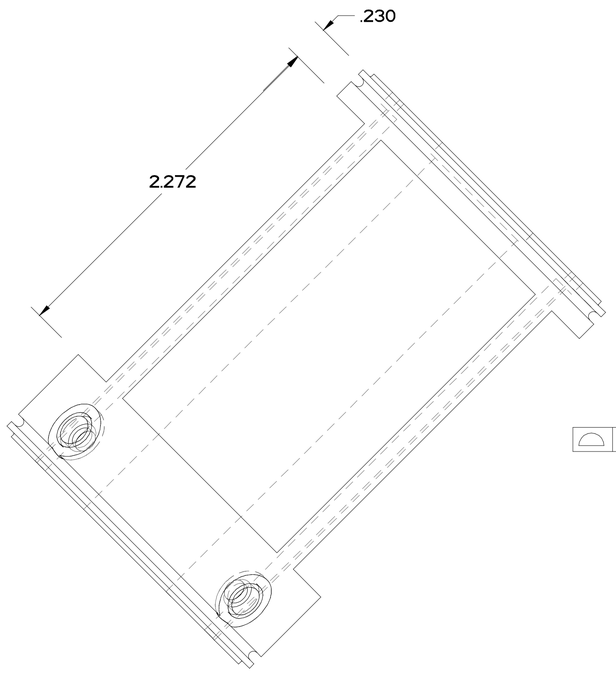
SMS-FES MEBT
MECHANICAL SUBSYSTEMS
40 MM BPM BELLOWS SEAL FLANGE

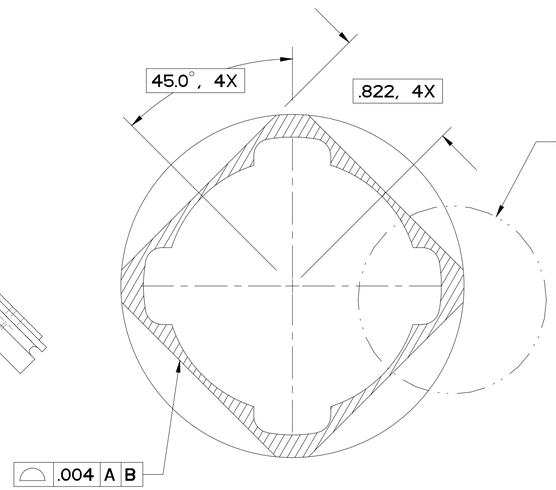
MICROFILMED:	DWG. TYPE	SHOWN ON	SCALE: 2/1	DO NOT SCALE PRINTS
	PART	25B184	SHEET 1 OF 1	
PATENT CLEAR:	DESIGN ACCT. NO.	CATEGORY CODE	DWG. NO.	SIZE / REV.
	-	FE3313	25B1824	D

Dwg. File: 25B1824 Model File: 25B182

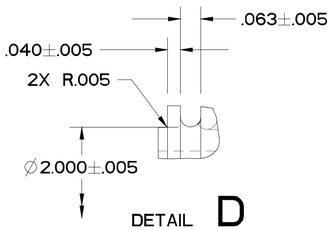


SCALE 2/1

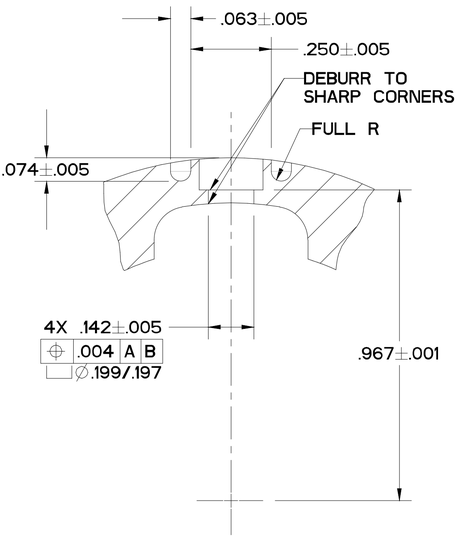




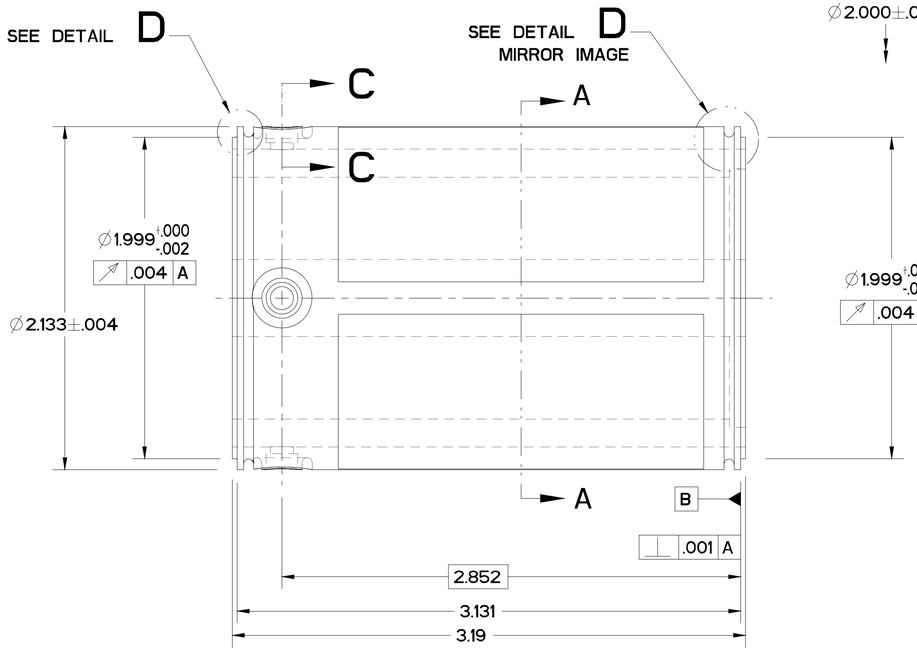
SECTION A-A

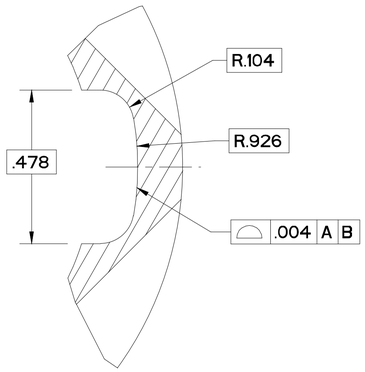


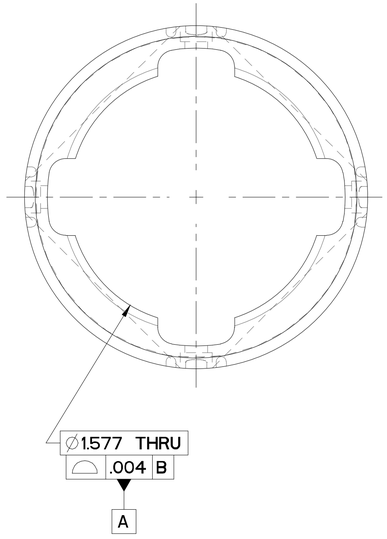
DETAIL D
SCALE 4/1



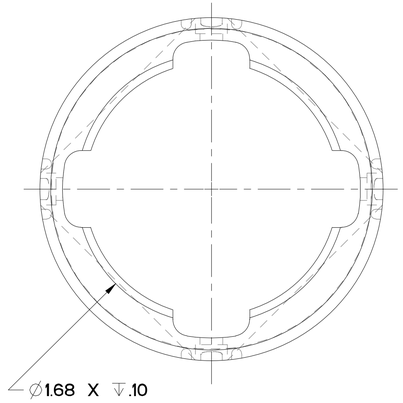
SECTION C-C
SCALE 4/1







DETAIL B
SCALE 4/1
TYPICAL 4 PLACES



25B183 4C

NOTES

1. ULTRA-HIGH VACUUM CLEANING & PACKAGING REQUIRED.

REV	DWG	CHK	ZONE	DATE	CHANGES
C	AZ			11/17/00	ADDED WELD PREPARATIONS TO FEDDTROUGH HOLES
C	AZ			11/17/00	ADDED WELD PREPARATIONS TO BOTH ENDS
B				1/27/00	GENERAL CHANGES FOR IMPROVED MANUFACTURABILITY

UNLESS OTHERWISE SPECIFIED

PROJECTION:

TOLERANCES

X.X ± 0.1	FRAC. ± 1/64
X.XX ± 0.01	Angles ± 0.5°
X.XXX ± 0.005	FINISH 125

DO NOT SCALE PRINT

THREADS ARE CLASS 2
CHAMFER ENDS OF ALL SCREW TREADS 30°
CUT ROUND, 15 THREAD RELIEF ON MACHINED THREADS
BREAK EDGES .06 MAX. ON MACHINED WORK
REMOVE BURRS, WELD SPLATTER & LOOSE SCALE
IN ACCORDANCE WITH ASME Y14.5M & B46.1

DESCRIPTION	MATERIAL	MAT. LOCATION
	316 STAINLESS STEEL	-

SHOP ORDERS

ACCT NO.	NO. REQD	SER NO.	-
DEL TO		DATE ISSD	-
SURFACE TREATMT	ELECTROPOLISH	DATE REQD	-
IDENT METHOD	TAG		
PROJECT NUMBER			
PROJECT NAME			
DWG BY	TREVOR GOULDING	DATE	21-Nov-00
CHK BY		DATE	
APR BY		DATE	

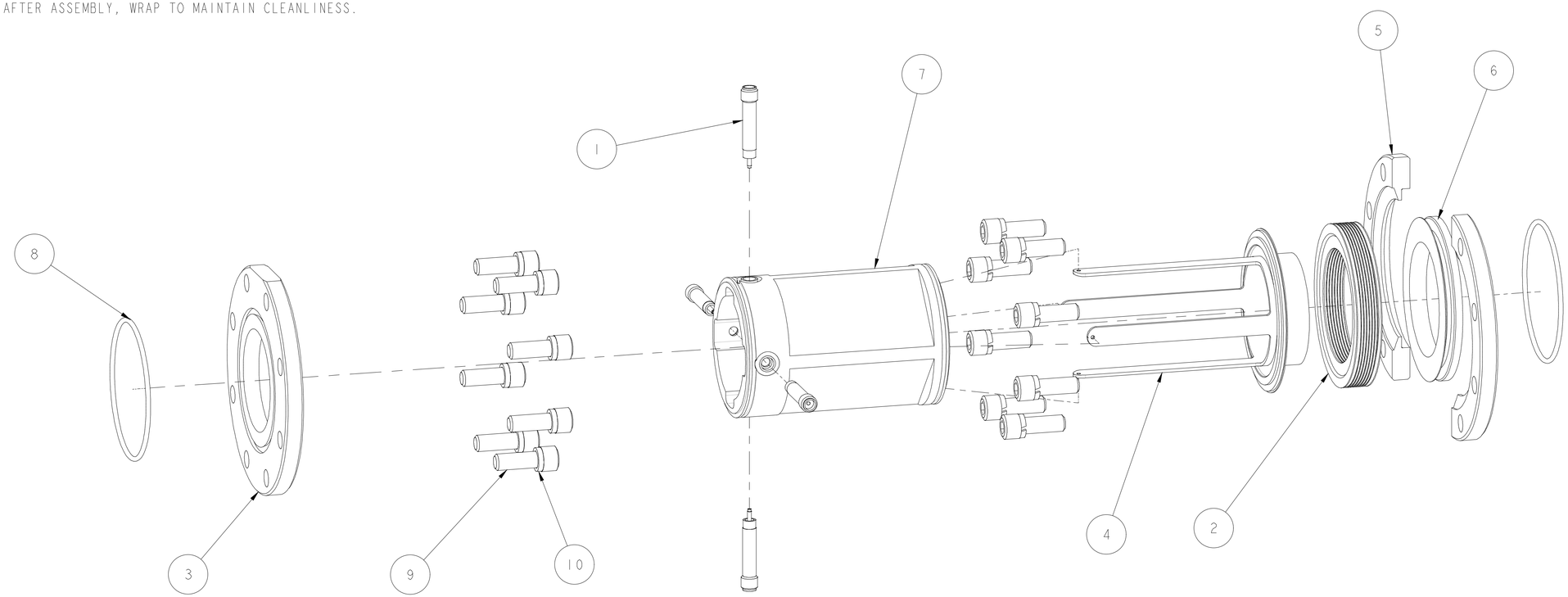
ERNEST ORLANDO LAWRENCE
BERKELEY NATIONAL LABORATORY
UNIVERSITY OF CALIFORNIA - BERKELEY

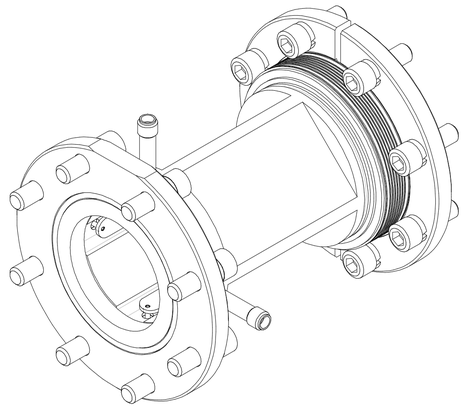
SNS-FES MEBT
MECHANICAL SUBSYSTEMS
40 MM BPM BORE TUBE

MICROFILMED:	DWG. TYPE	SHOWN ON	SCALE: 2/1	DO NOT SCALE PRINTS
	PART	25B184	SHEET 1 OF 1	
PATENT CLEAR:	DESIGN ACCT. NO.	CATEGORY CODE	DWG. NO.	SIZE / REV.
		FE3313	25B1834	C

Dwg. File: 25B1834 Model File: 25B183

NOTES
1. FINISHED PART TO BE VACUUM TIGHT. LEAK RATE NOT TO EXCEED 1x10^-8 torr l/sec. He.
ALL WELDS ARE TO BE MINIMUM HEAT FUSION WELDS. ASSEMBLE AS FOLLOWS:
   1.1. ALIGN BORE TUBE (25B183) WITH ELECTRODE SPOOL (25B180) USING ASSEMBLY TOOL 25B676-1.
        SECURE WITH TOOL 25B626-2, AND WELD.
   1.2. MOUNT HEAT SINK 25B676-3 TO SMA FEED THRU (25B171), ASSEMBLE TO SUB-ASSEMBLY OF 1.1, (ABOVE).
        SECURE WITH TOOLS 25B676-4 AND 25B676-5. WELD, 4 PLACES. DO NOT OVERHEAT FEED THRU.
   1.3. LEAK CHECK ASSEMBLY AND REPAIR IF REQUIRED.
   1.4. SPOT WELD PER LBNL ENGINEERING NOTE FE-ME-042. LEAK CHECK ASSEMBLY.
   1.5. ALIGN SUB-ASSEMBLY OF 1.4 (ABOVE) WITH FIXED FLANGE (25B179). SECURE WITH TOOL 25B676-2 AND WELD.
   1.6 USE AEROSEAL CLAMP OR EQUAL TO ALIGN SEAL FLANGE (25B182) WITH BELLOWS (25B172). WELD.
   1.7 ALIGN SUB-ASSEMBLY OF 1.5 (ABOVE) WITH SUB-ASSEMBLY OF 1.6 (ABOVE) AS DESCRIBED IN 1.6. WELD.
   1.8. LEAK CHECK.
2. ASSEMBLE IN CLEAN ENVIRONMENT. AFTER ASSEMBLY, WRAP TO MAINTAIN CLEANLINESS.





ITEM	PART NO	REQD	DESCRIPTION	MATERIAL
10	-	16	LOCK WASHER, SPRING, HIGH COLLAR, .25"	SS 18-8
9		16	SCREW, MODIFIED, .25-28 UNF X .72 LG	SS 18-8
8	-	2	2-033 O-RING	VITON
7	25B183	1	40 MM BPM BORE TUBE	316 STAINLESS STEEL
6	25B182	1	40 MM BPM BELLOWS SEAL FLANGE	316 STAINLESS STEEL
5	25B181	2	40 MM BPM SPLIT FLANGE	316 STAINLESS STEEL
4	25B180	1	40 MM BPM ELECTRODE SPOOL	316 STAINLESS STEEL
3	25B179	1	40 MM BPM FIXED FLANGE	316 STAINLESS STEEL
2	25B172	1	40 MM BPM BELLOWS	347 STAINLESS STEEL
1	25B171	4	BPM SMA FEED THRU	-

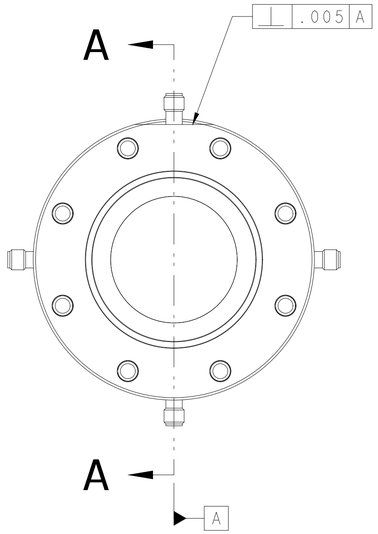
REV	DWG	CHK	ZONE	DATE	CHANGES
D	PL	DPO		2/10/02	ADDED WELDING AND FABRICATION NOTES 1.1-1.8.
C			D7	8/18/00	ADDED PERPENDICULARITY TOLERANCE
B			B1-5	1/27/00	ADDED WELD SIZES TO SYMBOLS
B				1/27/00	CHANGED ORIENTATION OF EXPLODED VIEW
B				1/27/00	ADDED NOTE & UPDATED TITLE BLOCK

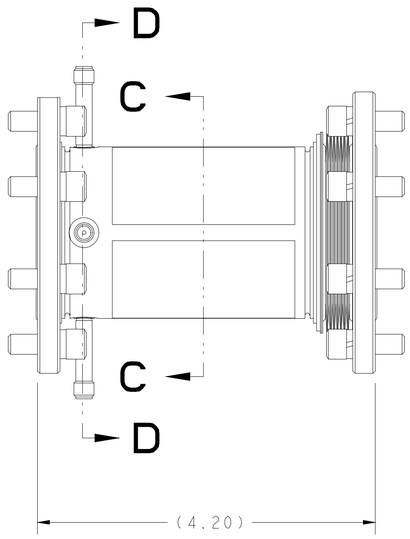
UNLESS OTHERWISE SPECIFIED
PROJECTION:
TOLERANCES: X.X ± 0.1 FRAC. ± 1/64; X.XX ± 0.03 Angles ± 0.5°; X.XXX ± 0.010 FINISH 125
DO NOT SCALE PRINT
THREADS ARE CLASS 2
CHAMFER ENDS OF ALL SCREW TREADS 30°
CUT ROUND, 1.5 THREAD RELIEF ON MACHINED THREADS
BREAK EDGES .016 MAX. ON MACHINED WORK
REMOVE BURRS, WELD SPLATTER & LOOSE SCALE
IN ACCORDANCE WITH ASME Y14.5M & B46.1

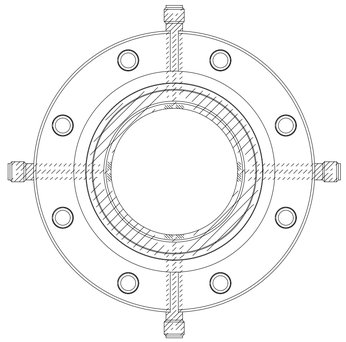
SHOP ORDERS
ACCT NO. -
NO. REQD -
DEL TO -
SER NO. -
DATE ISSD -
DATE REQD -
SURFACE TREATMT SEE NOTES (PAGE 2)
IDENT METHOD TAG
PROJECT NUMBER
PROJECT NAME
DWG BY TREVOR GOULDING DATE 11-Jan-00
CHK BY DATE
APR BY DATE -

ERNEST ORLANDO LAWRENCE BERKELEY NATIONAL LABORATORY
UNIVERSITY OF CALIFORNIA - BERKELEY
SNS
SMS-FES MEBT
MECHANICAL SUBSYSTEMS
40 MM BEAM POSITION MONITOR
MICROFILMED:
DWG. TYPE ASSEM
SHOWN ON
SCALE: 1/1 DO NOT SCALE PRINTS
SHEET 1 OF 2
PATENT CLEAR:
DESIGN ACCT. NO. FE3313
CATEGORY CODE
DWG. NO. 25B1844
SIZE D
REV.

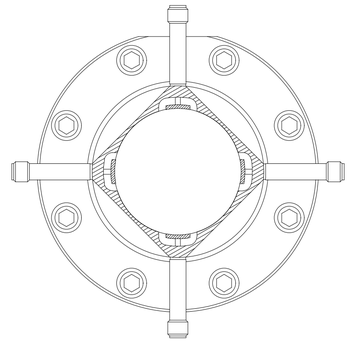
Dwg. Files: 25B184_Mod#1 Files: 25B184



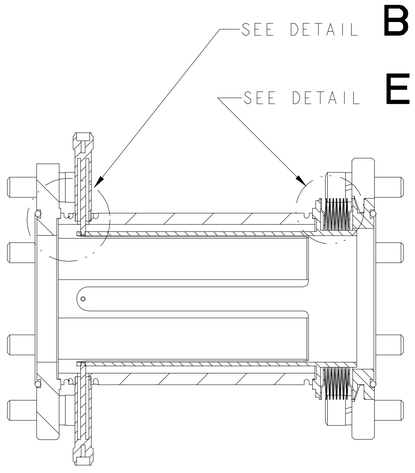




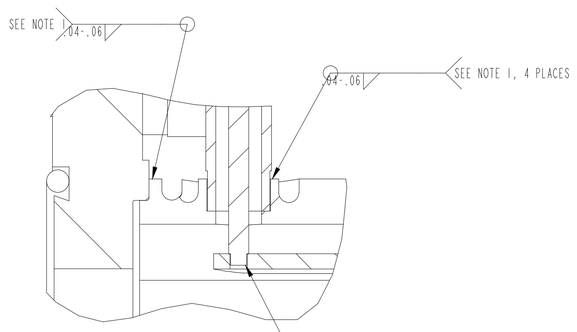
SECTION **D-D**



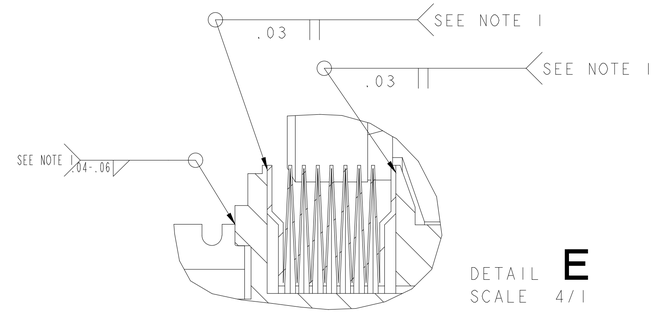
SECTION **C-C**



SECTION **A-A**



DETAIL **B**
SCALE 4/1



DETAIL **E**
SCALE 4/1

UNLESS OTHERWISE SPECIFIED		**SHOP ORDERS**	SER NO. -
PROJECTION:		ACCT NO. -	NO. REQD. -
TOLERANCES: X.X ± 0.1	FRAC. ± 1/64	DEL TO -	DATE ISSD -
X.XX ± 0.03	Angles ± 0.5°	SURFACE TREATMT SEE NOTES (PAGE 2)	DATE REQD -
X.XXX ± 0.010	FINISH 125	IDENT METHOD TAG	
DO NOT SCALE PRINT		PROJECT NUMBER	
THREADS ARE CLASS 2		PROJECT NAME	
CHAMFER ENDS OF ALL SCREW TREADS 30°		DWG BY TREVOR GOULDING	DATE 11-Jan-00
CUT ROUND, 1.5 THREAD RELIEF ON MACHINED THREADS		CHK BY	DATE -
BREAK EDGES .016 MAX. ON MACHINED WORK		APR BY	DATE -
REMOVE BURRS, WELD SPLATTER & LOOSE SCALE			
IN ACCORDANCE WITH ASME Y14.5M & B46.1			

ERNEST ORLANDO LAWRENCE BERKELEY NATIONAL LABORATORY
UNIVERSITY OF CALIFORNIA - BERKELEY

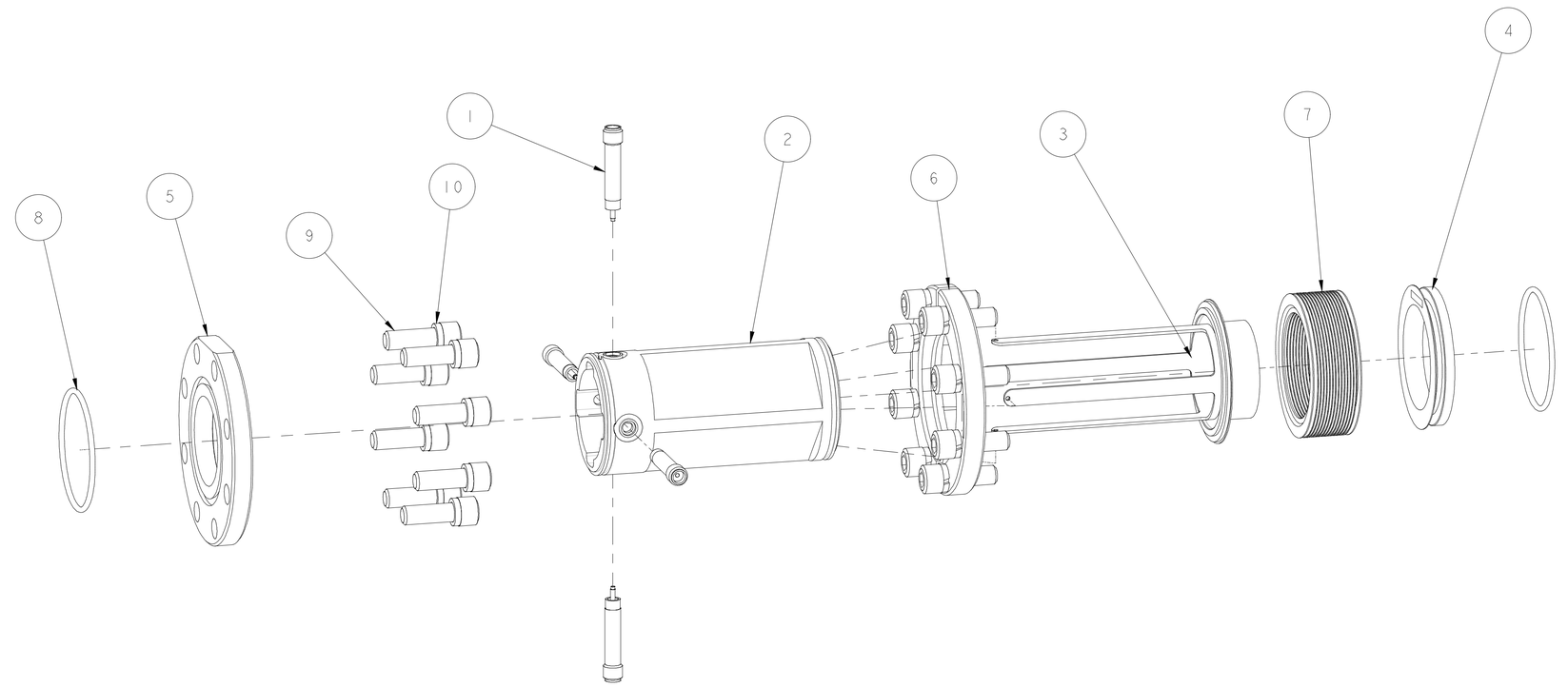
SNS

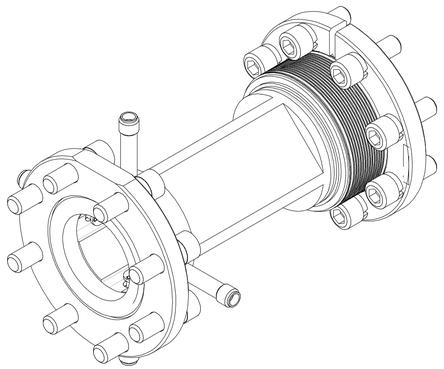
SMS-FES MEBT
MECHANICAL SUBSYSTEMS
40 MM BEAM POSITION MONITOR

MICROFILMED:	DWG. TYPE ASSEM	SHOWN ON	SCALE: 1/1	DO NOT SCALE PRINTS
			SHEET 2 OF 2	
PATENT CLEAR:	DESIGN ACCT. NO.	CATEGORY CODE FE3313	DWG. NO. 25B1844	SIZE D / REV.

Dwg. Files: 25B184_Mod4 | Files: 25B184

NOTES
1. FINISHED PART TO BE VACUUM TIGHT. LEAK RATE NOT TO EXCEED 1x10^-8 torr l/sec. He.
ALL WELDS ARE TO BE MINIMUM HEAT FUSION WELDS. ASSEMBLE AS FOLLOWS:
   1.1. ALIGN BORE TUBE (25B173) WITH ELECTRODE SPOOL (25B174) USING ASSEMBLY TOOL 25B676-1. SECURE WITH TOOL 25B626-2, AND WELD.
   1.2. MOUNT HEAT SINK 25B676-3 TO SMA FEED THRU (25B171), ASSEMBLE TO SUB-ASSEMBLY OF 1.1, (ABOVE). SECURE WITH TOOL 25B676-4 AND WELD, 4 PLACES. DO NOT OVERHEAT FEED THRU.
   1.3. LEAK CHECK ASSEMBLY AND REPAIR IF REQUIRED.
   1.4. SPOT WELD PER LBNL ENGINEERING NOTE FE-ME-042. LEAK CHECK ASSEMBLY.
   1.5. ALIGN SUB-ASSEMBLY OF 1.4 (ABOVE) WITH FIXED FLANGE (25B176). SECURE WITH TOOL 25B676-2 AND WELD.
   1.6 USE AEROSEAL CLAMP OR EQUAL TO ALIGN SEAL FLANGE (25B175) WITH BELLOWS (25B186). WELD.
   1.7 ALIGN SUB-ASSEMBLY OF 1.5 (ABOVE) WITH SUB-ASSEMBLY OF 1.6 (ABOVE) AS DESCRIBED IN 1.6. WELD.
   1.8. LEAK CHECK.
2. ASSEMBLE IN CLEAN ENVIRONMENT. AFTER ASSEMBLY, WRAP TO MAINTAIN CLEANLINESS.





ITEM	PART NO	REQD	DESCRIPTION	MATERIAL
10	-	16	LOCK WASHER, SPRING, HIGH COLLAR, .25"	SS 18-8
9		16	SCR, SCH, .25-28 UNF X .75 LG	SS 18-8
8		2	2-029 O-RING SEAL	VITON
7	25B186	1	30 MM QMI BPM BELLOWS	347 STAINLESS STEEL
6	25B177	1	30 MM BP/ BPM SPLIT FLANGE	SS 304L
5	25B176	1	30 MM BPM FIXED FLANGE	316 STAINLESS STEEL
4	25B175	1	30 MM BPM/BP BELLOWS SEAL FLANGE	316 STAINLESS STEEL
3	25B174	1	30 MM BPM ELECTRODE SPOOL	316 STAINLESS STEEL
2	25B173	1	30 MM BPM BORE TUBE	316 STAINLESS STEEL
1	25B171	4	BPM SMA FEED THRU	-

REV	DWG	CHK	ZONE	DATE	CHANGES
B				2/10/02	ADDED NOTES 1.1-1.8. 1/4-28 SCREWS WERE 1/4-20. 1/4" HI-COLLAR WASHERS WERE FLAT, NARROW. B/M ITEMS RENUMBERED.
A				5/23/00	INITIAL RELEASE

UNLESS OTHERWISE SPECIFIED
PROJECTION:
TOLERANCES: X.X ± 0.1 | FRAC. ± 1/64; X.XX ± 0.03 | Angles ± 0.5°; X.XXX ± 0.010 | FINISH 125
DO NOT SCALE PRINT
THREADS ARE CLASS 2
CHAMFER ENDS OF ALL SCREW TREADS 30°
CUT ROUND, 1.5 THREAD RELIEF ON MACHINED THREADS
BREAK EDGES .016 MAX. ON MACHINED WORK
REMOVE BURRS, WELD SPLATTER & LOOSE SCALE
IN ACCORDANCE WITH ASME Y14.5M & B46.1

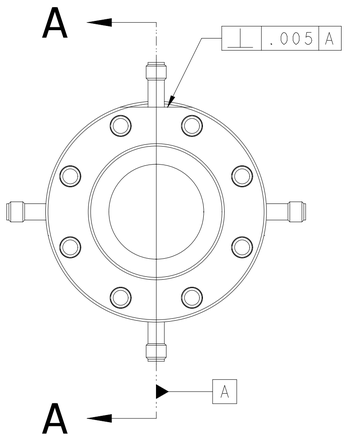
SHOP ORDERS
ACCT NO. -
NO. REQD -
DEL TO -
SER NO. -
DATE ISSD -
DATE REQD -
SURFACE TREATMT SEE NOTES (PAGE 2)
IDENT METHOD TAG
PROJECT NUMBER 25B187
PROJECT NAME
DWG BY TREVOR GOULDING DATE 23-May-00
CHK BY DPO DATE -
APR BY DPO DATE -

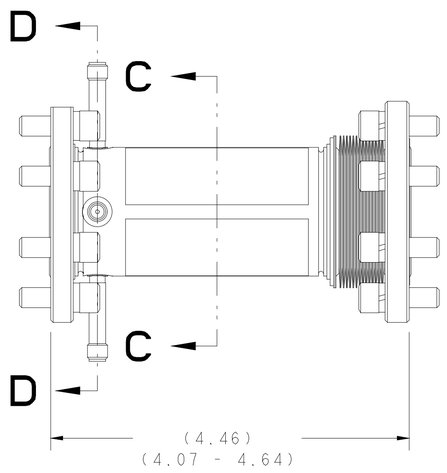
ERNEST ORLANDO LAWRENCE BERKELEY NATIONAL LABORATORY
UNIVERSITY OF CALIFORNIA - BERKELEY

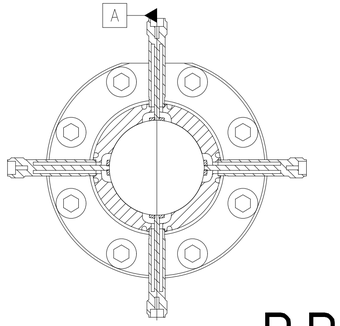
SMS-FES MEBT
MECHANICAL SUBSYSTEMS
30 MM QMI BEAM POSITION MONITOR

MICROFILMED:
PATENT CLEAR:
DWG. TYPE ASSEM
SHOWN ON
SCALE: 1/1
DO NOT SCALE PRINTS
SHEET 1 OF 2
DESIGN ACCT. NO. FE3313
CATEGORY CODE
DWG. NO. 25B1874
SIZE
REV. B

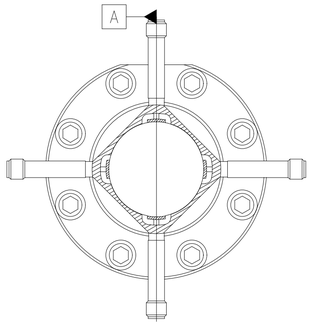
Dwg. Files: 25B187_Mod4 | Files: 25B187



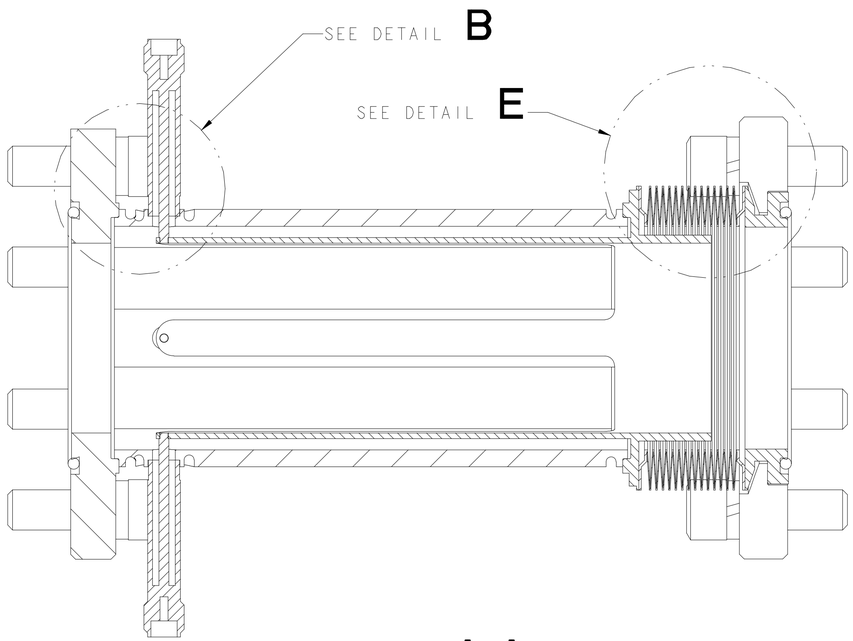




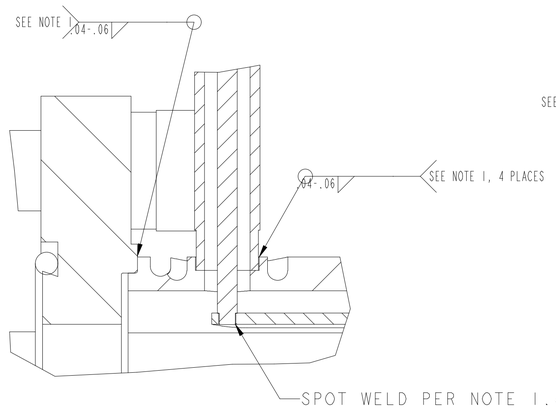
SECTION **D-D**



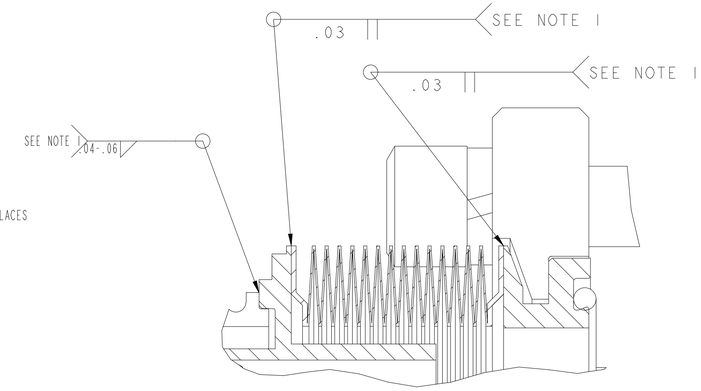
SECTION **C-C**



SECTION **A-A**
SCALE 2/1



DETAIL **B**
SCALE 4/1

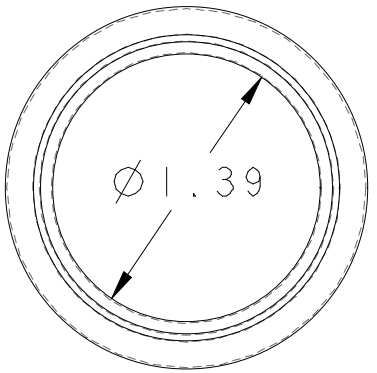


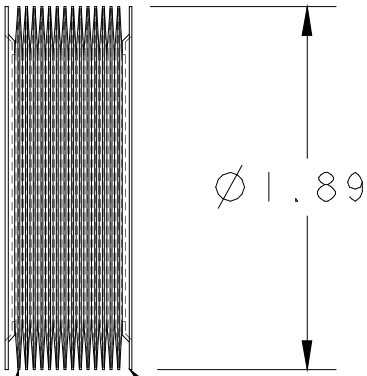
DETAIL **E**
SCALE 4/1

UNLESS OTHERWISE SPECIFIED	SHOP ORDERS	SER NO. -	ERNEST ORLANDO LAWRENCE BERKELEY NATIONAL LABORATORY UNIVERSITY OF CALIFORNIA - BERKELEY
PROJECTION:	ACCT NO. - NO. REQD -	DATE ISSD -	
TOLERANCES: X.X ± 0.1 FRAC. ± 1/64; X.XX ± 0.03 Angles ± 0.5°; X.XXX ± 0.010 FINISH 125	DEL TO -	DATE REQD -	SMS-FES MEBT MECHANICAL SUBSYSTEMS 30 MM QMI BEAM POSITION MONITOR
DO NOT SCALE PRINT	SURFACE TREATMT SEE NOTES (PAGE 2)		
THREADS ARE CLASS 2 CHAMFER ENDS OF ALL SCREW TREADS 30° CUT ROUND, 1.5 THREAD RELIEF ON MACHINED THREADS BREAK EDGES .016 MAX. ON MACHINED WORK REMOVE BURRS, WELD SPLATTER & LOOSE SCALE IN ACCORDANCE WITH ASME Y14.5M & B46.1	IDENT METHOD TAG		
	PROJECT NUMBER 25B187		
	PROJECT NAME		MICROFILMED: / DWG. TYPE ASSEM / SHOWN ON / SCALE: 1/1 DO NOT SCALE PRINTS / SHEET 2 OF 2
	DWG BY TREVOR GOULDING	DATE 23-May-00	
	CHK BY DPO	DATE -	PATENT CLEAR: / DESIGN ACCT. NO. / CATEGORY CODE FE3313 / DWG. NO. 25B1874 / SIZE B / REV.
	APR BY DPO	DATE -	

NOTES

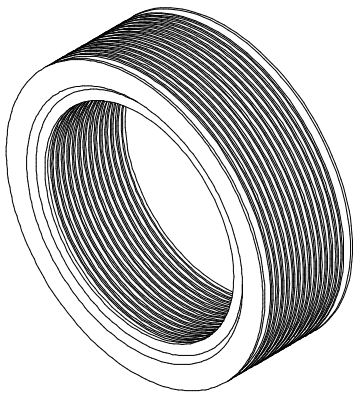
1. STANDARD BELLOWS P/N: 189-139-1-B*B* *H= 1.89in
2. DRAWING FOR PRICING QUOTATION ONLY.





189-139 BELLOWS
1 SEGMENT.

STYLE "B" END
FLANGE, BOTH SIDES



REV	DWG	CHK	DATE	CHANGES
				-

DESCRIPTION

347 STAINLESS STEEL

MATERIAL

UNLESS OTHERWISE SPECIFIED

PROJECTION:

TOLERANCES:
- X.X ±0.1
- X.XX ±0.01
- X.XXX ±0.005
- FRAC. ±1/64
- Angles ±0.5°
- FINISH 125

DO NOT SCALE PRINT

THREADS ARE CLASS 2
CHAMFER ENDS OF ALL SCREW TREADS 30°
CUT ROUND, 1.5 THREAD RELIEF ON MACHINED THREADS
BREAK EDGES .016 MAX. ON MACHINED WORK
REMOVE BURRS, WELD SPLATTER & LOOSE SCALE
IN ACCORDANCE WITH ASME Y14.5M & B46.1

SHOP ORDERS

ACCT NO. -	NO. REQD -	SER NO. -	
DEL TO -		DATE ISSD -	
SURFACE TREATMT -		DATE REQD -	
IDENT METHOD TAG			
PROJECT NUMBER na			
PROJECT NAME N/A			
DWG BY GOULDING	DATE 23-May-00		
CHK BY None	DATE -		
APR BY None	DATE -		

ERNEST ORLANDO LAWRENCE BERKELEY NATIONAL LABORATORY
UNIVERSITY OF CALIFORNIA - BERKELEY

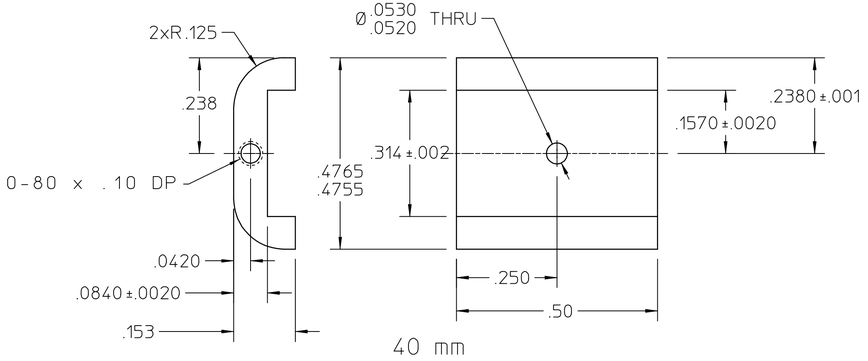
SNS-FES MEBT
MECHANICAL SUBSYSTEMS
30 MM QMI BPM BELLOWS

MICROFILMED:	DWG. TYPE	SHOWN ON	SCALE: 1/1	DO NOT SCALE PRINTS
	PART	25B178	SHEET 1 OF 1	
PATENT CLEAR:	DESIGN ACCT. NO. XXXX-XX	CATEGORY CODE FE3313	DWG. NO. 25B1861	SIZE / REV. A

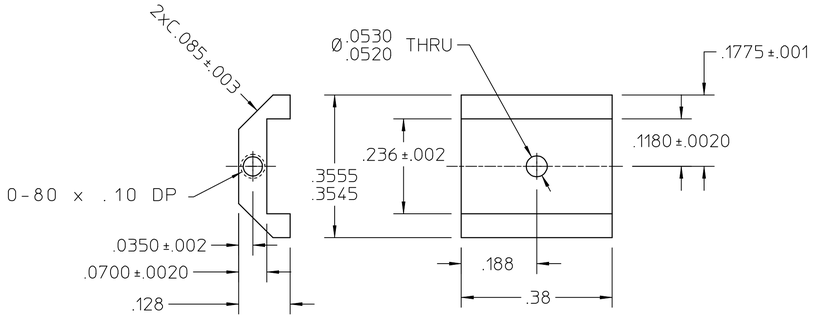
Dwg. File: 25B186 Model File: 25B186

Rev. 1/29/2000 J. R. Osborn

REQ	ITEM	PART NUMBER	DESCRIPTION

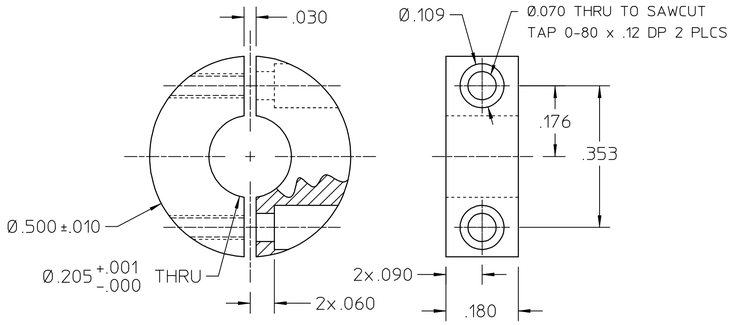


40 mm



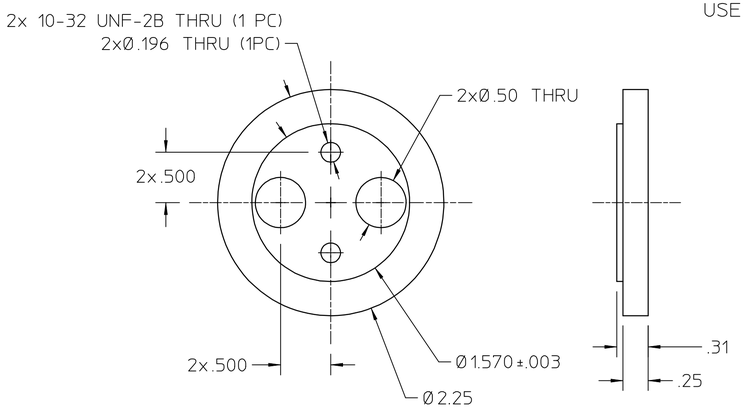
30 mm

25B676-1 ALIGNMENT TOOLS 2 EA REQ'D
MAT'L: ALUMINUM BRONZE
USE WITH Ø0.052 GAGE PIN

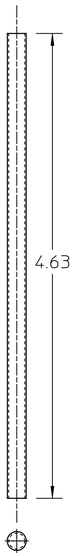


25B676-3 HEAT SINKS 2 EA REQ'D
MAT'L: COPPER
USE WITH 2 EA 0-80 x .25 LG STAINLESS SHCS

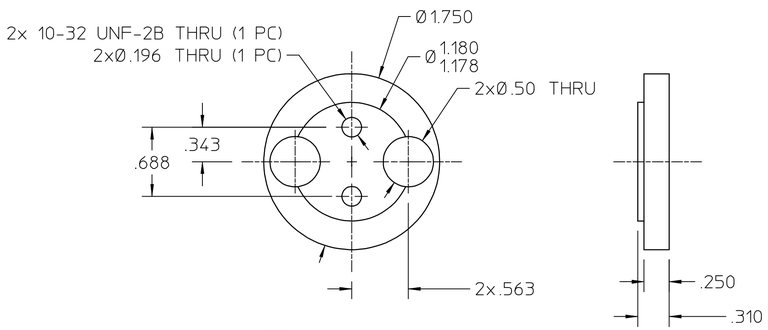
25B676-2 CLAMPING TOOLS
MAT'L: AS SHOWN
USE WITH 2 EA 10-32 WING NUTS



40 mm
1 EA REQ'D AS SHOWN IN DETAIL
MAT'L: 6061 ALUMINUM

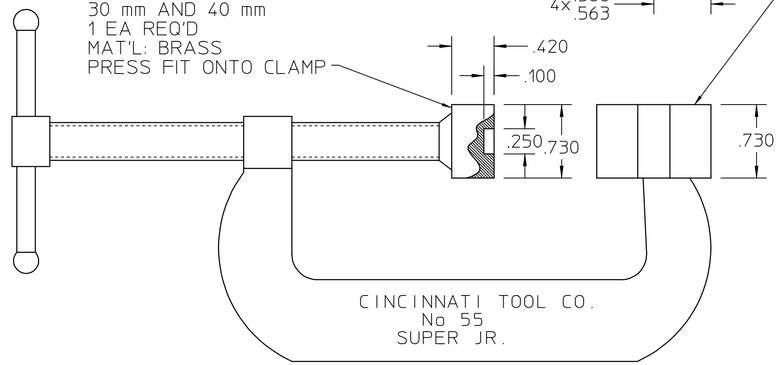


30 mm AND 40 mm
2 EA REQ'D
MAT'L: 304 STAINLESS STEEL



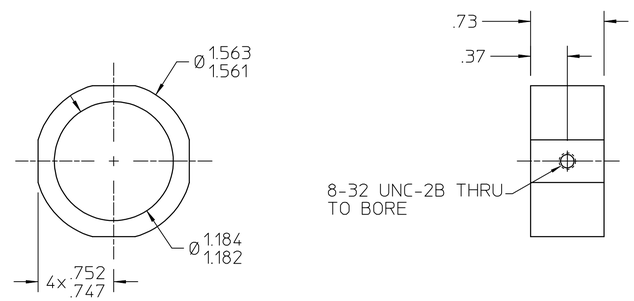
30 mm
1 EA REQ'D AS SHOWN IN DETAIL
MAT'L: 6061 ALUMINUM

25B676-4 FEEDTHRU CLAMPING TOOLS
1 EA REQ'D
MAT'L: AS SHOWN



25B6764

25B676-5 40mm CLAMP ADAPTER
1 EA. REQ'D
MAT'L: MILD STEEL
USE WITH 1 EA 8-32 x .12 SET SCREW



REV	DWG	CHK	ZONE	DATE	CHANGES
A	TM	TM		10/07/01	INITIAL RELEASE

UNLESS OTHERWISE SPECIFIED
TOLERANCES: .X ± .1 | FRAC ±1/64 | .XX ± .02 | ANGLES ± 1° | .XXX ± .005 | FINISH 125
THREADS ARE CLASS 2
CHAMFER ENDS OF ALL SCREW THREADS 30°.
CUT 1.5 PITCH THRD RELIEF WITH ROUND NOSE TOOL ON MACHINE CUT THREADS
BREAK EDGES .016 MAX. ON MACHINED WORK
REMOVE BURRS WELD SPLATTER & LOOSE SCALE
REFERENCES: ANSI Y14.5 & B46.1.

SHOP ORDERS
ACCT NO. | SERIAL NO
DATE ISSD | DATE REQD. | NO. REQD.
DELIVER TO
SURFACE TREATMENT: DEGREASE
IDENT. METH.: TAG
DWG. BY: T. MILLER | DATE: 10-07-01
CHK. BY: T. MILLER | DATE: 10-07-01

LAWRENCE BERKELEY LABORATORY
UNIVERSITY OF CALIFORNIA-BERKELEY

SNS-FES

MECHANICAL SUBSYSTEMS

BEAM POSITION MONITOR ASSEMBLY TOOLS

PATENT CLEAR	DWG TYPE	SHOWN ON	SCALE VARIOUS	DO NOT SCALE PRINTS
	C-D	-		
MICROFILMED	DESIGN ACCT. NO.	CATEGORY CODE	DWG. NO.	SIZE / REV.
	-	FE3313	25B6764	A

Appendix C

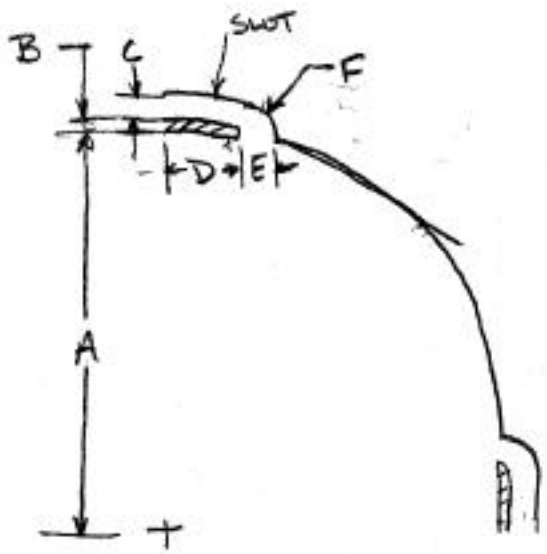
TREVOR GOULDING BPM DESIGN 1/6/00

TOLERANCE STACK UP ANALYSIS

ASSUMPTIONS:

1. THE DIMENSIONS OF THE ELECTRODE AND THE SLOT MUST STAY WITHIN 5% OF NOMINAL (PER RECOMMENDATION OF LARRY DOOLITTLE. (SEE
2. RSS (ROOT SUM SQUARED) METHOD WILL BE USED FOR ALL TOLERANCE STACK UP ANALYSIS

ELECTRODE AND SLOT GEOMETRY



NOT TO SCALE

DIMENSION MAINTAIN SO Ω RESISTANCE (PROVIDED BY LARRY DOOLITTLE)

DIMENSIONS IN MM.

A → 15.00
B → 0.889
C → 1.761
D → 2.862
E → 1.703
F → 1.983

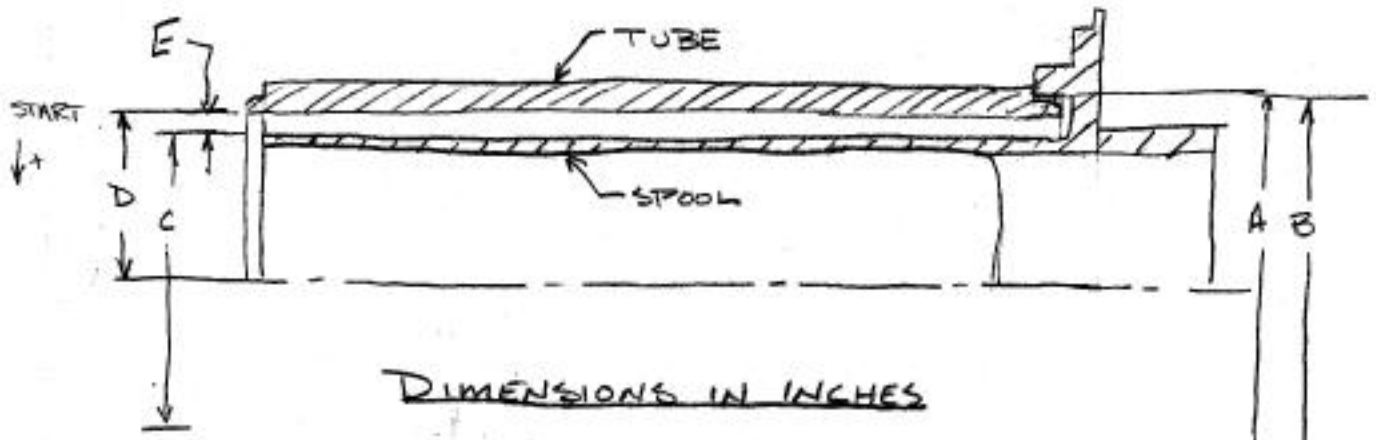
DIMENSION C IS CRITICAL AT ±5% OF NOMINAL

1.761 ± 0.088 → 0.069 ± 0.0035 in

TOLERANCE STACKS MUST BE

≤ ± 0.003 in ←

TREVOR GOULDING BPM DESIGN 1/6/00



DIMENSIONS IN INCHES

A (TUBE DIA)	$1.500^{+0.000}_{-0.002}$	$\rightarrow 1.499 \pm 0.001$
B (SPOOL DIA)	$1.500^{+0.002}_{-0.000}$	$\rightarrow 1.501 \pm 0.001$
C (SPOOL DIA)	1.251 ± 0.002	
D (TUBE RAD)	0.695 ± 0.002	
E (GAP)		

$$E_{NOM} = D_{NOM} - \frac{A_{NOM}}{2} + \frac{B_{NOM}}{2} - \frac{C_{NOM}}{2} = 0.695 - \frac{1.500}{2} + \frac{1.500}{2} - \frac{1.251}{2} = 0.070$$

$$T_E = \sqrt{T_D^2 + (1/2 T_A)^2 + (1/2 T_B)^2 + (1/2 T_C)^2} = \sqrt{(0.002)^2 + (1/2 \cdot 0.001)^2 + (1/2 \cdot 0.001)^2 + (1/2 \cdot 002)^2} = 0.003$$

$E = 0.070 \pm 0.003$

DIMENSIONS IN INCHES

A (TUBE O.D.)	1.600	± 0.004
B (FEED THRU COND)	0.133	± 0.001
C (C'BORE)	0.042	± 0.001
D (TUBE SLOT RAD)	0.695	± 0.002
E (GAP)		

$$E_{NOM} = B_{NOM} + C_{NOM} - \frac{A_{NOM}}{2} + D_{NOM} = 0.133 + 0.042 - \frac{1.600}{2} + .695 = 0.070$$

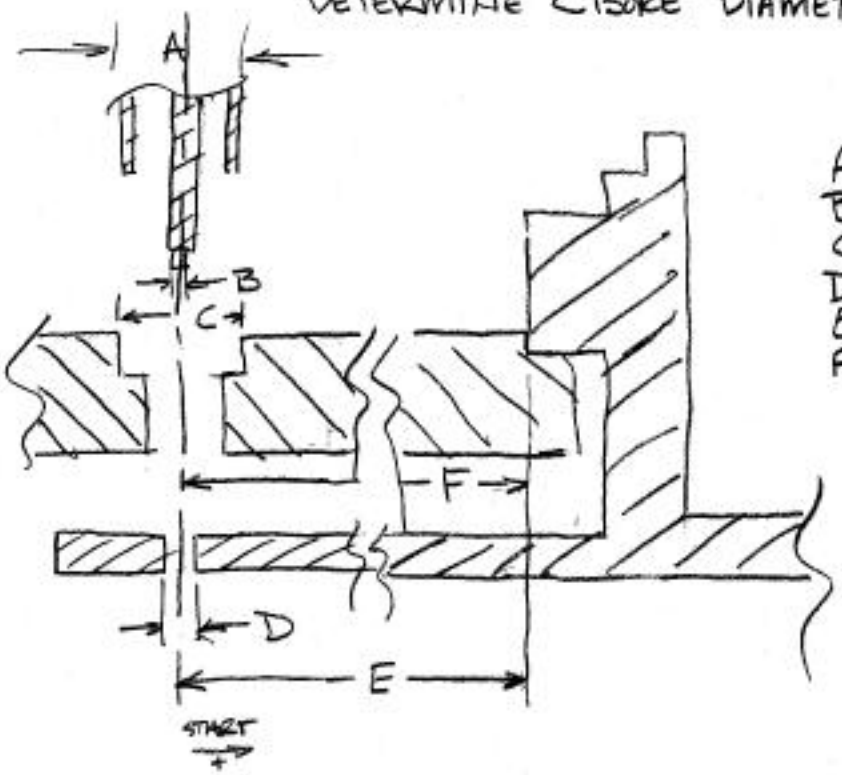
$$T_E = \sqrt{T_B^2 + T_C^2 + (1/2 T_A)^2 + T_D^2} = \sqrt{0.001^2 + 0.001^2 + (1/2 \cdot 0.004)^2 + 0.002^2} = 0.003$$

$E_1 = 0.070 \pm 0.003$

TREVOR GOULDING BPM DESIGN 1/6/00

DETERMINE C'BORE DIAMETER & TOLERANCE

DIMENSION IN INCHES



A	(FEEDTHRU)	0.199 ± 0.001
B	(FEEDTHRU)	0.050 ± 0.001
C	(C'BORE)	
D	(SPOOL HOLE)	0.059 ± 0.002
E	(SPOOL HOLE)	2.852 ± 0.005
F	(C'BORE)	2.852 ± 0.003

A MINIMUN GAP OF 0.005" ARDUND SHOULD BE MAINTAINED BETWEEN THE C'BORE AND THE FEED-THRU

$$C_{min} = 2(F_{NOM} - E_{NOM} + \tfrac{1}{2}D_{MIN} - \tfrac{1}{2}B_{MAX} + \tfrac{1}{2}A_{MIN}) + 0.005$$

$$= 2(F_{NOM} - E_{NOM}) + D_{MIN} - B_{MAX} + A_{MIN} + 0.005$$

$$= 2(2.852 - 2.852) + 0.052 - 0.051 + 0.193 + 0.005$$

$$= 0.199$$

$$C_{max} = 2(F_{max} - E_{min} + \tfrac{1}{2}D_{max} - \tfrac{1}{2}B_{min} + \tfrac{1}{2}A_{max})$$

$$= 2(F_{max} - E_{min}) + D_{max} - B_{min} + A_{max}$$

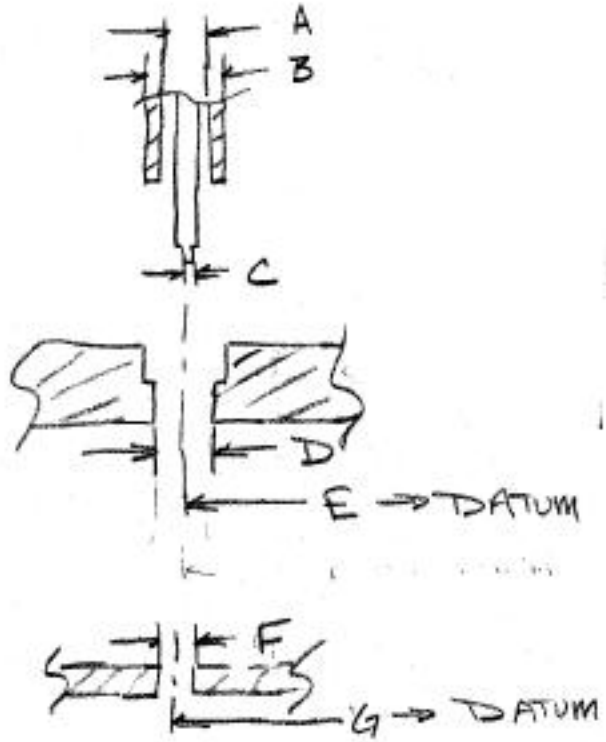
$$= 2(2.855 - 2.849) + 0.056 - 0.049 + 0.195$$

$$= 0.214$$

$$C = {}^{0.214}_{0.199} \cong \underline{0.207 \pm 0.007}$$

TREVOR GOULDING BPM DESIGN 1/19/00

DETERMINE THAT C'BORE WILL ADEQUATELY SEAT FEED THRU



DIMENSIONS IN INCHES

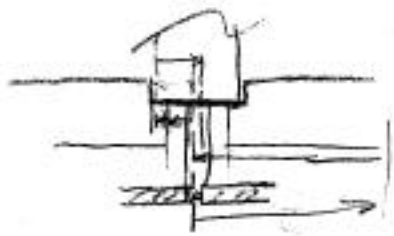
A	(FEED THRU)	0.142 ± 0.001
B	(FEED THRU)	0.194 ± 0.001
C	(FEED THRU)	0.050 ± 0.001
D	(TUBE HOLE)	0.142 ± 0.003
E	(TUBE HOLE)	2.852 ± 0.003
F	(SPOOL HOLE)	0.054 ± 0.002
G	(SPOOL HOLE)	2.852 ± 0.003
H	(GAP)	

FEED THRU WALL THICKNESS

$WALL_{MIN} = 1/2 (A_{MIN} - B_{MAX})$

$= 1/2 (0.193 - 0.193)$

$= 0.025$



WORST CASE ENGAGEMENT

$H = 1/2\, B_{MIN} + 1/2\, C_{MIN} - 1/2\, F_{MAX} + G_{MIN} - E_{MAX} - 1/2\, D_{MAX}$

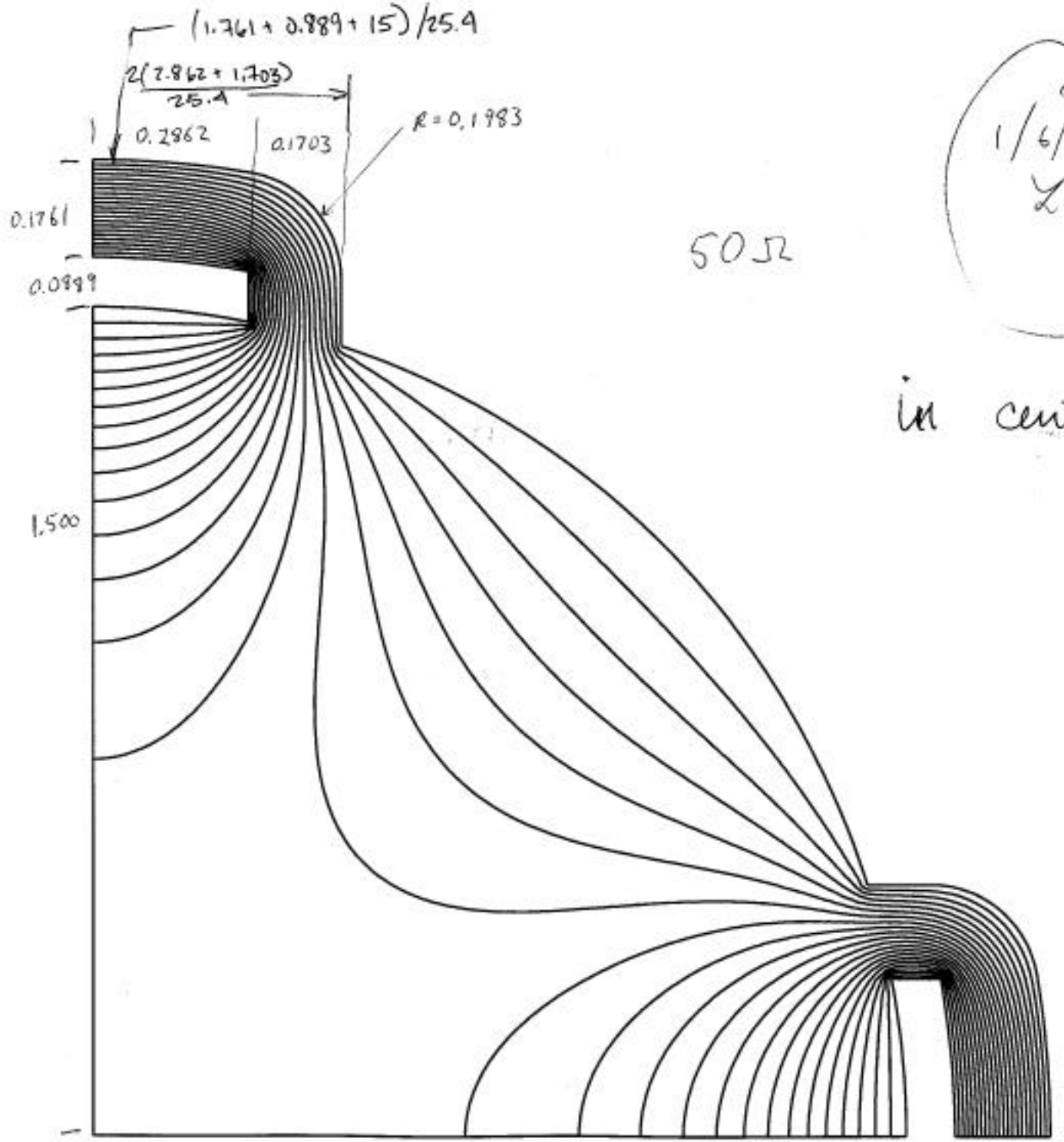
$= (1/2)\, 0.193 + (1/2)\, 0.049 - 1/2\, (0.056) + 2.849 - 2.855 - (1/2)\, 0.145$

$= 0.015$

$\%\ \text{TOTAL WALL ENGAGEMENT} = \frac{WALL_{MIN} + H}{2(WALL_{MIN})} (100)$

$= \frac{0.025 + 0.015}{2(0.025)}$

$= 80\ \%$ okay



50 Ω

1/6/00
LRD

in centimeters

ITEM-PRODUCTS.COM

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ENGINEERING NOTE

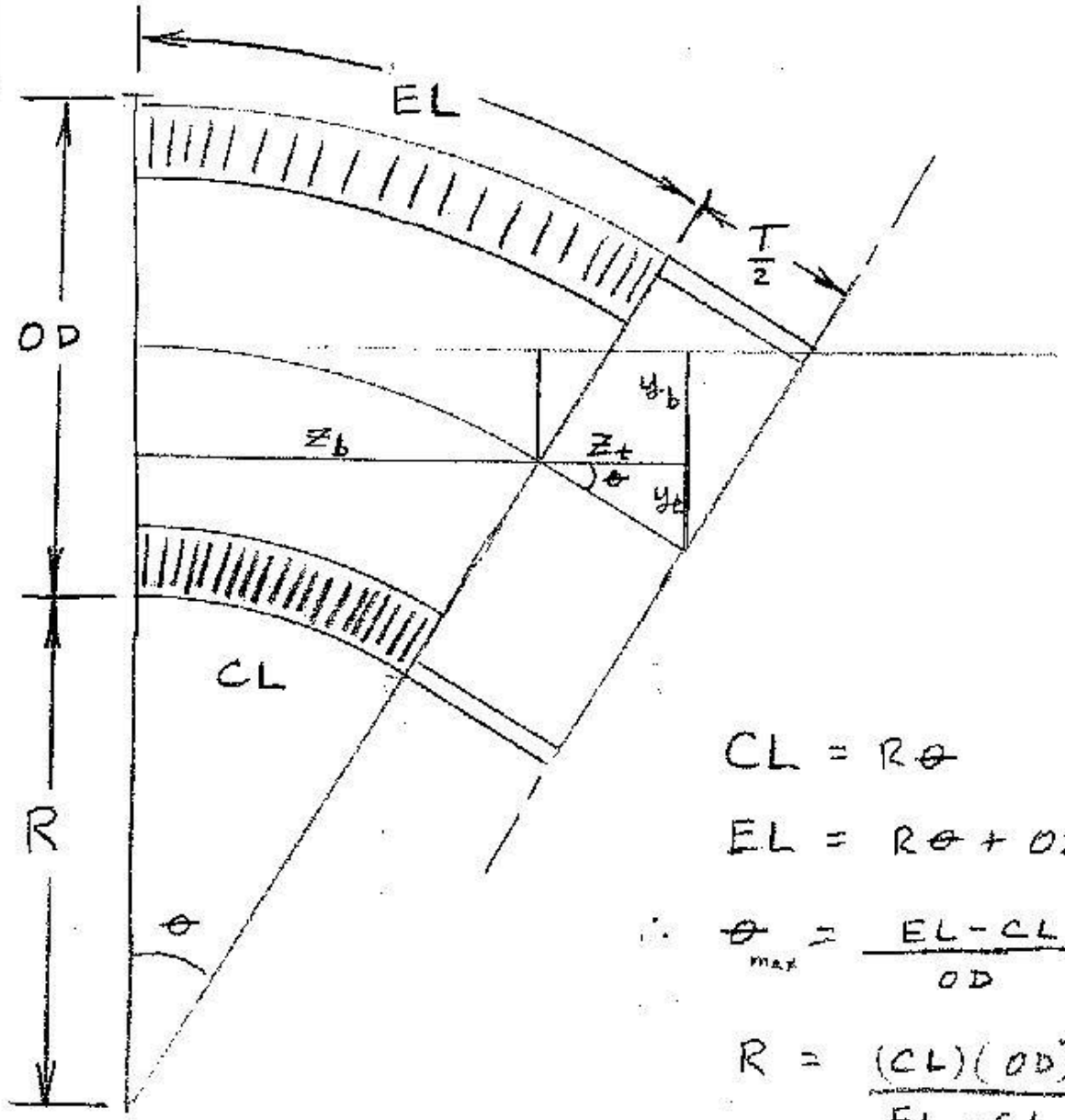
CODE	SERIAL	PAGE
		1 of

AUTHOR	DEPARTMENT	LOCATION	DATE

PROGRAM — PROJECT — JOB

TITLE

Lateral Offset Bellows Design



$$CL = R\theta$$

$$EL = R\theta + OD\,\theta$$

$$\therefore \theta_{max} = \frac{EL - CL}{OD}$$

$$R = \frac{(CL)(OD)}{EL - CL}$$

$$y_b = \left(R + \frac{OD}{2}\right)(1 - \cos\theta)$$

$$Z_b = \left(R + \frac{OD}{2}\right)\sin\theta$$

COMPARISON 30mm BPM BELLOWS

1/2 SEG OFFSET

O.D. = 1.89

$EL = 0.374/4$
$= 0.185$ ←

$CL = 0.174/4$
$= 0.043$ ←

$\theta_{max} = \frac{EL - CL}{OD}$
$= \frac{0.185 - 0.043}{(1.89)}$
$= 0.075$ ←

$R = \frac{CL(OD)}{EL - CL}$
$= \frac{0.043\ (1.89)}{0.185 - 0.043}$
$= 0.572$ ←

$Y = (R + \frac{OD}{2})(1 - \cos\theta)$
$= (0.572 + \frac{(1.89)}{2})(1 - \cos(0.075))$
$= 0.004$ ←

TOTAL OFFSET = 2Y
$= 2(0.004)$
$= 0.008$ in ←

FULL SEG OFFSET

$EL = 0.374/2$
$= 0.37$ ←

$CL = 0.174/2$
$= 0.085$ ←

$\theta_{max} =$
$= \frac{0.37 - 0.085}{(1.89}$
$= 0.151$ ←

$R =$
$= \frac{0.085\ (1.89)}{0.37 - 0.085}$
$= 0.56$ ←

$Y =$
$= (0.564 + \frac{(1.89)}{2})(1 - \cos(0.151))$
$= 0.17$ ←

TOTAL OFFSET =
$= 2(0.17)$
$= 0.034$ in ←

COMPARISON 40 mm BPM BELLOWS

½ SEG OFFSET OD = 2.5"

$EL = 0.79/4$
$= 0.198$ ←

$CL = 0.20/4$
$= 0.050$ ←

$\Theta_{max} = \frac{EL - CL}{OD}$
$= \frac{0.198 - 0.050}{2.5}$
$= 0.059$ ←

$R = \frac{CL(OD)}{EL - CL}$
$= \frac{0.05(2.5)}{0.198 - 0.05}$
$= 0.845$ ←

$Y = (R + \frac{OD}{2})(1 - \cos\theta)$
$= (0.845 + \frac{2.5}{2})(1 - \cos(0.059))$
$= 0.004$ ←

TOTAL OFFSET = $2Y$
$= 2(0.004)$
$= 0.008"$ ←

FULL SEG OFFSET

$EL = 0.79/2$
$= 0.395$ ←

$CL = 0.20/2$
$= 0.10$ ←

$\Theta_{max} =$
$= \frac{0.395 - 0.1}{2.5}$
$= 0.118$ ←

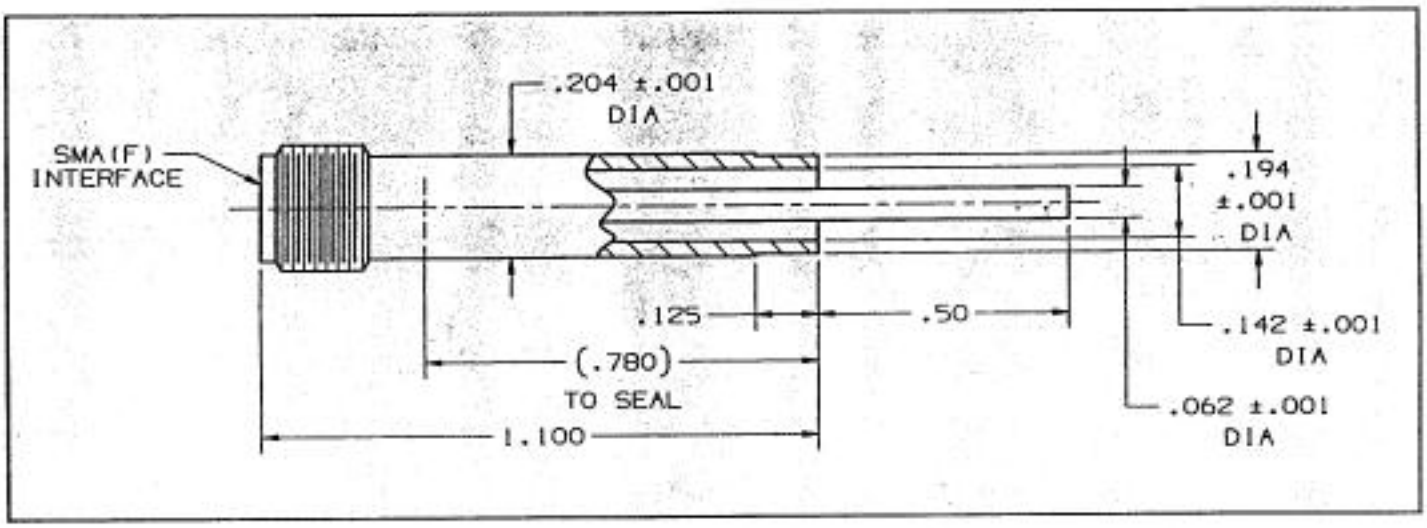
$R =$
$= \frac{0.10(2.5)}{0.395 - 0.10}$
$= 0.847$ ←

$Y =$
$= (0.847 + \frac{2.5}{2})(1 - \cos(0.118))$
$= 0.015$ ←

TOTAL OFFSET =
$= 2(0.015)$
$= 0.030"$ ←

Appendix D

ULTRA-HIGH VACUUM MICROWAVE FEED-THROUGH, SMA FEMALE



SPECIFICATIONS

Impedance: 50 ohms.

Frequency range: DC to 20 GHz.

VSWR: 1.03:1 max to 3 GHz;
1.15:1 max to 20 GHz.

Insertion loss: 0.10 dB max @ 3 GHz.;
0.50 dB max @ 20 GHz.

Insulation resistance: $>10^{12}$ ohms.

Voltage: 1,500 VRMS.

Operating temperature range:
Based on outer body material -
304 stainless steel: 77°K to 573°K
(-196°C to +300°C).
316 stainless steel: 4°K to 573°K
(-269°C to +300°C).
Inconel®: 77°K to 773°K (-196°C to +500°C).

Hermeticity: $<1x10^{-11}$ cc He/sec.

Radiation: >200 megarads gamma.

Connector interface: SMA per MIL-C-39012.

Materials:
Outer body: 304 stainless steel, 316L stainless steel, or Inconel®.
Center conductor: TZM molybdenum per ASTM B365.
Insulator: AL_2O_3 strengthened boro-silicate seal (130,000 psi compressive strength).
Connector contact: Gold-plated BeCu.

Weldability: Laser, e-beam, TIG.

Custom materials: Cupronickel, monel, and titanium.

KAMAN
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