Be Beam Pipe Design

Knut Skarpaas VIII

6/16/06

My Background on this subject-

Came to SLAC 1993 to do the mechanical design of VXD3 and it's associated Beam Pipe for SLD

(SLD used a gas cooled pipe with a working temp of 160K)

Studied past Vertex Detectors and beam pipes for this design

Designed the Beam Pipe which BaBar currently uses

Studied Be corrosion and Be part failure to understand problem

Water cooled Beryllium, high radiation, high current

Designed 1996-1997, fabbed and installed shortly thereafter

- still under water with no leaks

Design challenges-

High heat load – designed for about 1Kw

Water deemed necessary for heat load

Significant effort made to avoid corrosion

High radiation dose – 1Mega rad min. with up to 100Mega rad possible

Dose is high for most plastics

Corrosion protection-

Beryllium and water typically are not a good mix

An initial CLEO pipe failed before installation due to a drop of cooling fluid that dripped on it from a CMM. I was told that the ethylene glycol mix bored a hole in the pipe over night.

There should be no brazes in the water path-

Electrofusion mentioned that the flux used to braze Be gets activated by water and is quite corrosive.

For the BaBar pipe, I used many levels of protection-

Level 1- Use BR154 paint to keep water off the metal (phenolic polymer barrier)

Level 2- BR 154 contains strontium chromate which is a corrosion inhibitor (anodic protection)

Level 3- Layer two of BR154 (pinholes in layer one should not align with pinholes in layer two)

Level 4- Electroless Ni plating of all Be areas exposed to water

Level 5- Beryllium used was a special grade of Be which has low carbon content (Carbon forms are used while compressing the raw Be block. Carbon particles are sites for corrosive galvanic cells on the Be surface)

Level 6- A low conductivity water is used which inhibits corrosion

Level 7- Water system is sub-atmospheric (it will suck air before killing the SVT)

Pipe Geometry / features-

Be pipe is brazed between stainless ends

Two convolution bellows welded to each end

(No moments can be applied to the pipe)

Care must be taken to not twist the pipe.

Conductive fingers inside the bellows take current.

Two water paths machined on the outside of the inner Be pipe.

Water in and out on one end of pipe.

Water path changes width as it turns back to avoid separation

(vapor pockets due to fluid momentum)

Outer, thin Be tube slides over inner pipe to seal water paths

Manifold joins inner and outer tubes at one end

Metallic spacer “glue rings” used to assure glue thickness

External heat shunts on short stainless endpipes

Approx. thicknesses-

Inner gold plating 7 microns

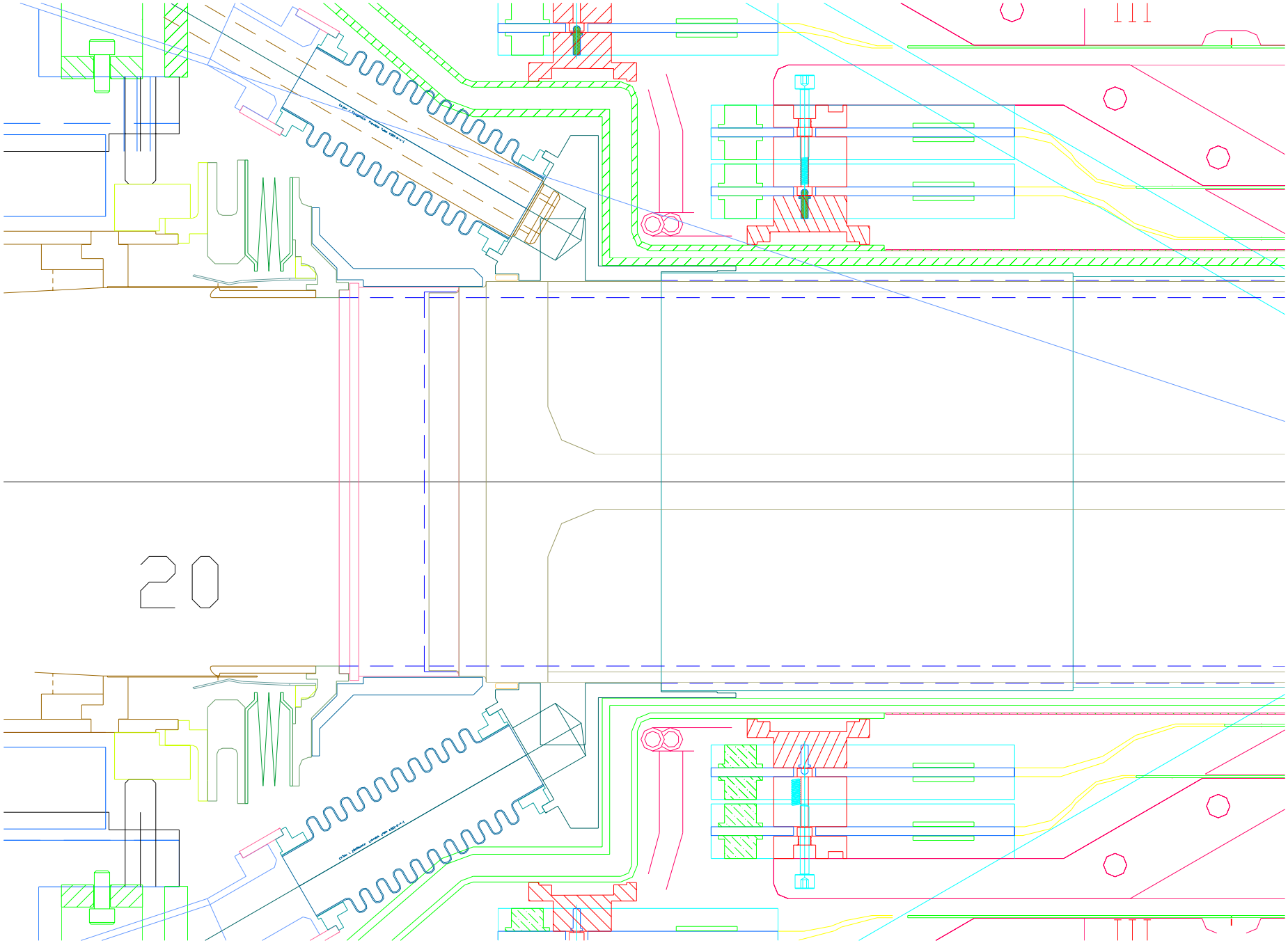
Chromium flash (about 300 Angstroms)

.032” inner Be wall

Ni plating thickness 7 micron on each of two surfaces

.054” water gap

.020” outer Be shell window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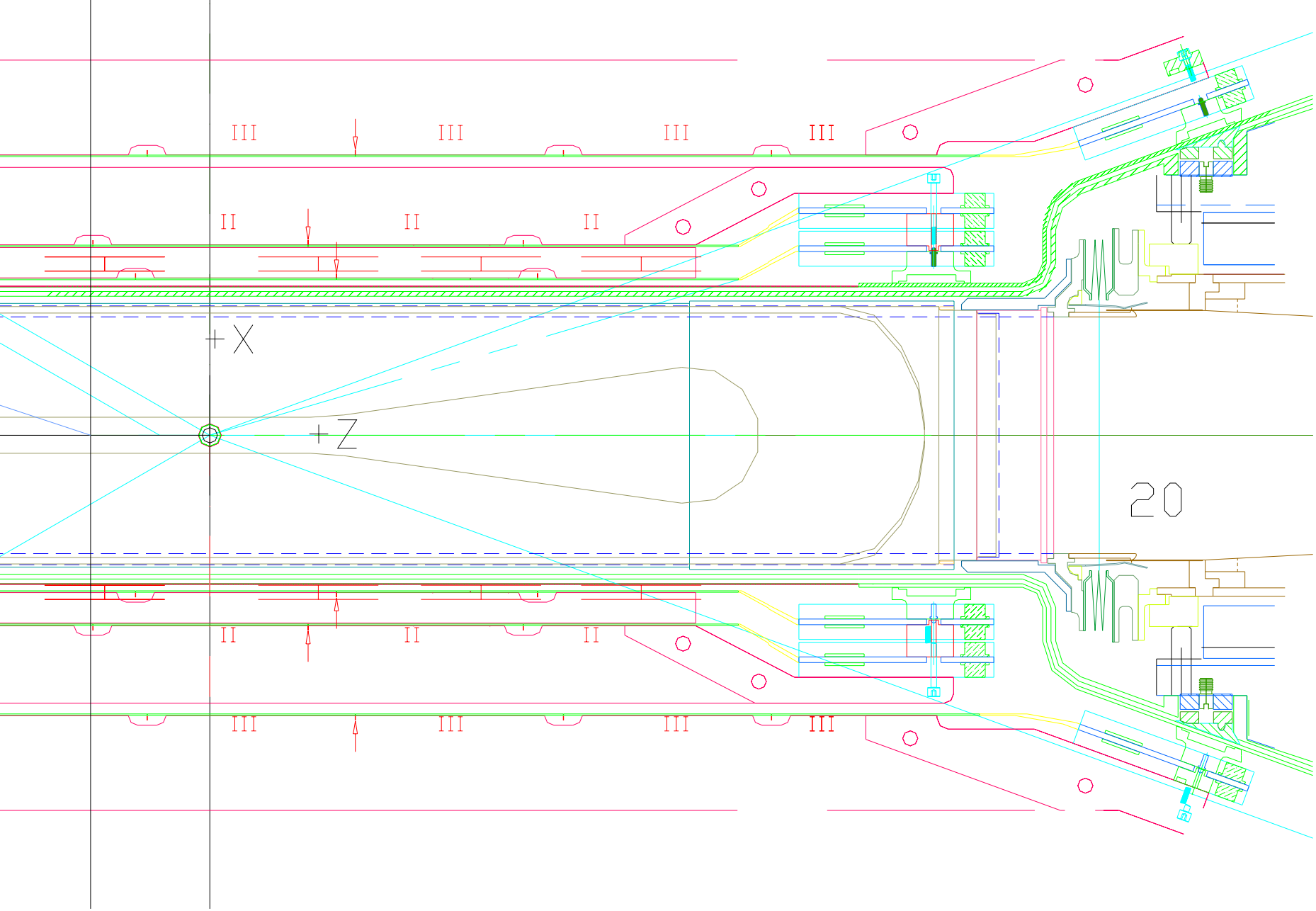
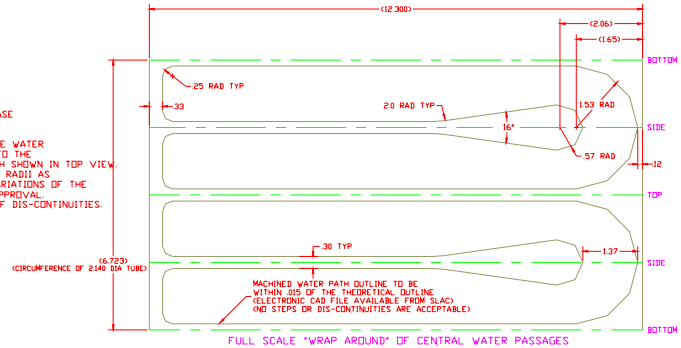

III
III
III
III
II
II
II
+X
+Z
20
II
II
II
III
III
III
III

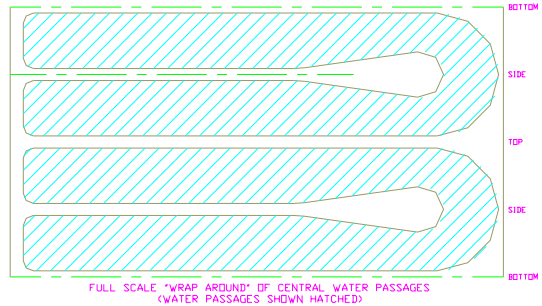
PROJECTION

REV	DESCRIPTION	DRN	CHK	APP	DATE
1	REVISED PER VENDOR INPUT	KSVIR			4-8-99

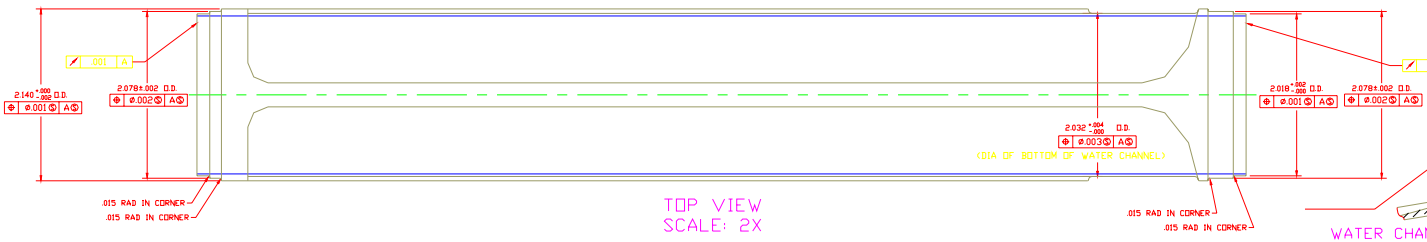
NOTES:
1. BERYLLIUM TUBE IS TO BE MACHINED FROM SOLID TUBE OR BAR STOCK.
2. THIS BEAMPIPE MUST BE LEAKTIGHT WHEN TESTED ON A MASS SPECTROMETER HELIUM LEAK DETECTOR. ANY LEAKAGE WHEN TESTED WITH A MINIMUM LEAK DETECTOR SENSITIVITY OF 2×10^{-8} STD CC/SEC PER LEAK RATE METER DIVISION WILL BE CAUSE FOR REJECTION.
3. ALL SURFACES WHICH HAVE BEEN EDMed MUST BE POST MACHINED TO EASE CLEANING FOR UHV.
4. FABRICATE AS PER SLAC SPECIFICATION PS-343-410-40
5. THE FULL SCALE "WRAP AROUND" VIEW REPRESENTS THE OUTLINE OF THE WATER PASSAGES CUT INTO THE BEAM PIPE. THE PATTERN IS AS PROJECTED TO THE SURFACE OF THE PART (ø2.140) WITHOUT RADII. CUT PATTERN TO DEPTH SHOWN IN TOP VIEW. THE COMPLETE OUTLINE OF THE WATER PATH WILL HAVE FILLETS AND RADII AS SHOWN IN THE "WATER CHANNEL / RIB DETAIL" AS SHOWN, SLIGHT VARIATIONS OF THE PROFILE MAY BE ACCEPTABLE TO EASE MACHINING WITH PRIOR SLAC APPROVAL. ALL SURFACES WITHIN THE WATER PATH WILL BE SMOOTH AND FREE OF DIS-CONTINUITIES.



FULL SCALE "WRAP AROUND" OF CENTRAL WATER PASSAGES



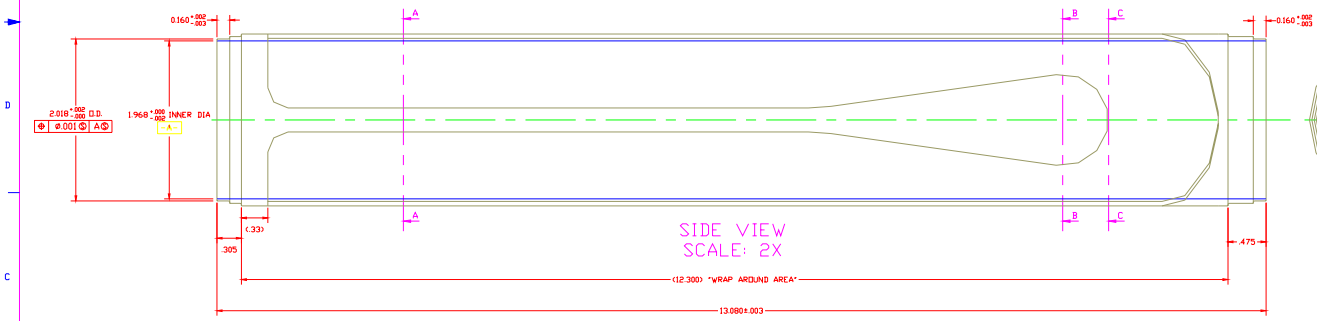
FULL SCALE "WRAP AROUND" OF CENTRAL WATER PASSAGES
(WATER PASSAGES SHOWN HATCHED)



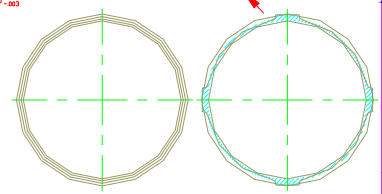
TOP VIEW
SCALE: 2X

NOTE:
VARIATIONS OF THE WATER CHANNEL PROFILE MAY BE ACCEPTABLE TO EASE MACHINING. CALL / FAX SLAC ENGINEER TO GAIN APPROVAL.

WATER CHANNEL / RIB DETAIL
SCALE: 4X

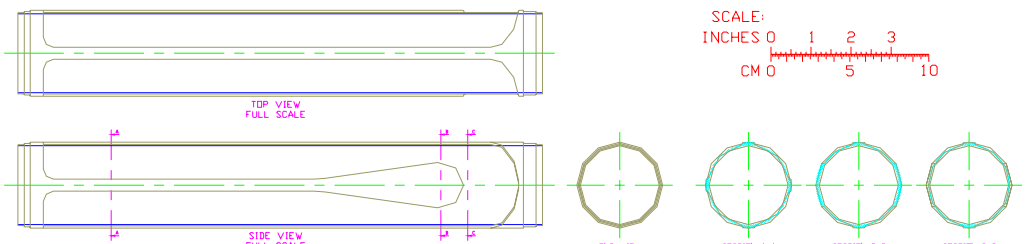


SIDE VIEW
SCALE: 2X


END VIEW
SCALE: 2X

SECTION A-A
SCALE: 2X

ULTRA HIGH VAC PART
FABRICATE PER PS-343-410-40



DO NOT SCALE WATER PATH FROM SIDE, TOP, OR END VIEWS (USE ROLL UP VIEW)

MATERIAL IS STRUCTURAL BERYLLIUM BLOCK (S-65 SCREENED FOR LOW CARBON CONTENT)

ITEM NO	PREF	BASE STOCK OR PART NO	SUFF	TITLE OR DESCRIPTION	QTY

DIMENSIONING AND TOLERANCING IS IN ACCORDANCE WITH ANSI Y14.5M-1982
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES
BREAK EDGES .005
INTERNAL CORNERS .005 R Max
FRACTIONS ± 1/64
DEC x ± .1
xx ± .01
xxx ± .004
ANGLES ± 1/4 ALL SURFS

SCALE: PER VIEW | DO NOT SCALE DRAWING | NEXT ASSEMBLY: SA-343-410-02

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DRAWN	KNUT SKARPAAS	2-28-96
CHKD	KNUT SKARPAAS	
APPVD	MARTIN VERSEN	
APPVD	NANCY PALMER	

PEP-II IR VACUUM BEAM PIPE BRAZEMENT BEAM PIPE

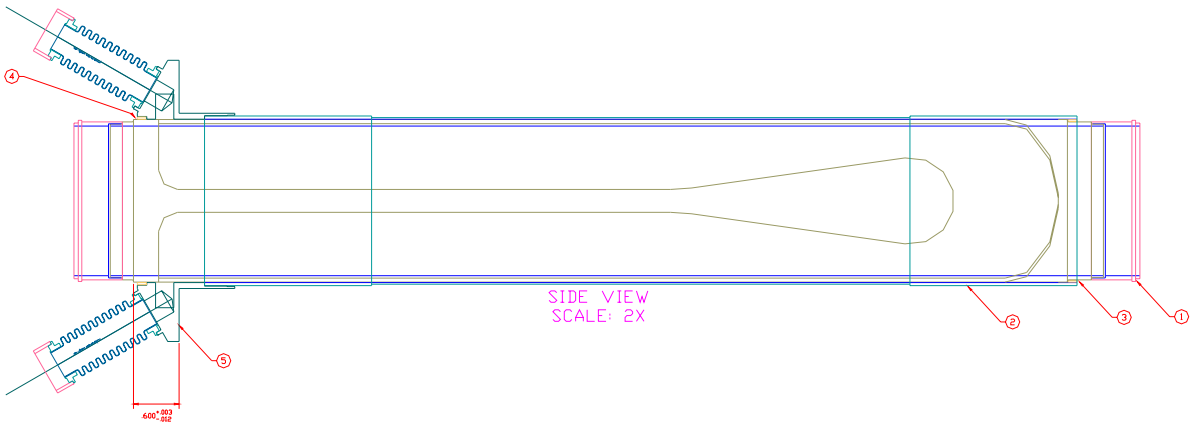
PF-343-410-03 A1 | E

PEP2 IR VAC BEAM PIPE BRAZE

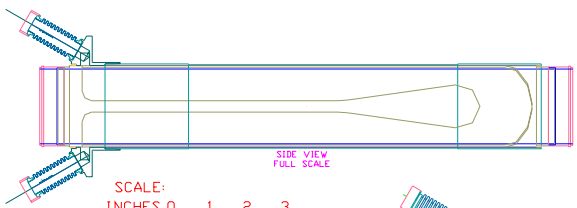
PROJECTION

REV	DESCRIPTION	DRN	CHK	APP	DATE
1	REVISED PER VENDOR INPUT	KSVIE			4-15-97

NOTES:
1. ASSEMBLE AND CHECK FIT OF ALL COMPONENTS.
   INSPECT PAINT.
2. SLIDE CLEAN COMPONENTS ON TO BEAM PIPE AND CAP ENDS.
   MOUNT BRAZEMENT IN A FIXTURE TO ASSURE CORRECT ROTATIONAL ORIENTATION.
   USE AN ALUMINUM TEMPLATE AND A SQUARE TO OBTAIN CORRECT ROTATIONAL AND LONGITUDINAL ALIGNMENT OF THE MANIFOLD.
   (THE FLATS ON THE MANIFOLD AND THE SIDE RIBS ON THE BRAZEMENT SHOULD BE ALIGNED TO WITHIN 0.7°.)
   APPLY SLAC APPROVED EPOXY NEAR ENDS OF WATER JACKET.
   SLIDE WATER SHELL BACK AND FORTH OVER GLUE (±.25").
   APPLY GLUE TO OUTSIDE OF WATER JACKET NEAR MANIFOLD AND SLIDE MANIFOLD ON.
   APPLY GLUE TO EACH GLUE RING AND SLIDE INTO POSITION.
   CURE EPOXY (ELEVATED TEMP).
3. FLOW BR154 THROUGH WATER CHANNELS.
   BAKE BR154 TO CURE.
   IF THE PAINT SAMPLES SHOW THAT THE FLOWED PAINT IS LESS THAN .0004" THICK, A SECOND FLOW THROUGH AND BAKE MAY BE REQUIRED
4. PAINT AND ADHESIVE MUST NOT BLOCK PASSAGES.
5. FABRICATE PER SLAC SPECIFICATION # PS-343-410-40



SIDE VIEW
SCALE: 2X



SIDE VIEW
FULL SCALE

SCALE:
INCHES 0 1 2 3
CM 0 5 10

SIDE VIEW
FULL SCALE

ULTRA HIGH VAC PART
FABRICATE PER PS-343-410-40

ITEM NO	PREF/ STOCK OR PART NO	BASE	SUFF	TITLE OR DESCRIPTION	QTY
5	SA-343-410-08			MANIFOLD WELDMENT	1
4	PF-343-410-07			MANIFOLD GLUE RING	1
3	PF-343-410-06			WATER JACKET GLUE RING	1
2	PF-343-410-05			WATER JACKET	1
1	SA-343-410-02			BEAM PIPE BRAZEMENT	1

DIMENSIONING AND TOLERANCING IS IN ACCORDANCE WITH ANSI Y14.5M-1982
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES
BREAK EDGES .005
INTERNAL CORNERS .005 R MAX
FRACTIONS ± 1/64
DEC x ± .1
xx ± .01
xxx ± .004
ANGLES ± 1/2° ALL CUTS 63

SCALE: PER VIEW
DO NOT SCALE DRAWING
NEXT ASSEMBLY: SA-343-410-00

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	NAME	APPROVAL
ENGR	KNUT SKARPAAS 3-5-97	KNUT SKARPAAS
DRFT	KNUT SKARPAAS	MARTIN NEWBERY
CHKD	NADINE KURITA	NANCY PALMER

PEP-II IR VACUUM
VERTEX VAC CHAM ASSY
BEAM PIPE ASSY

SA-343-410-01 A1 E

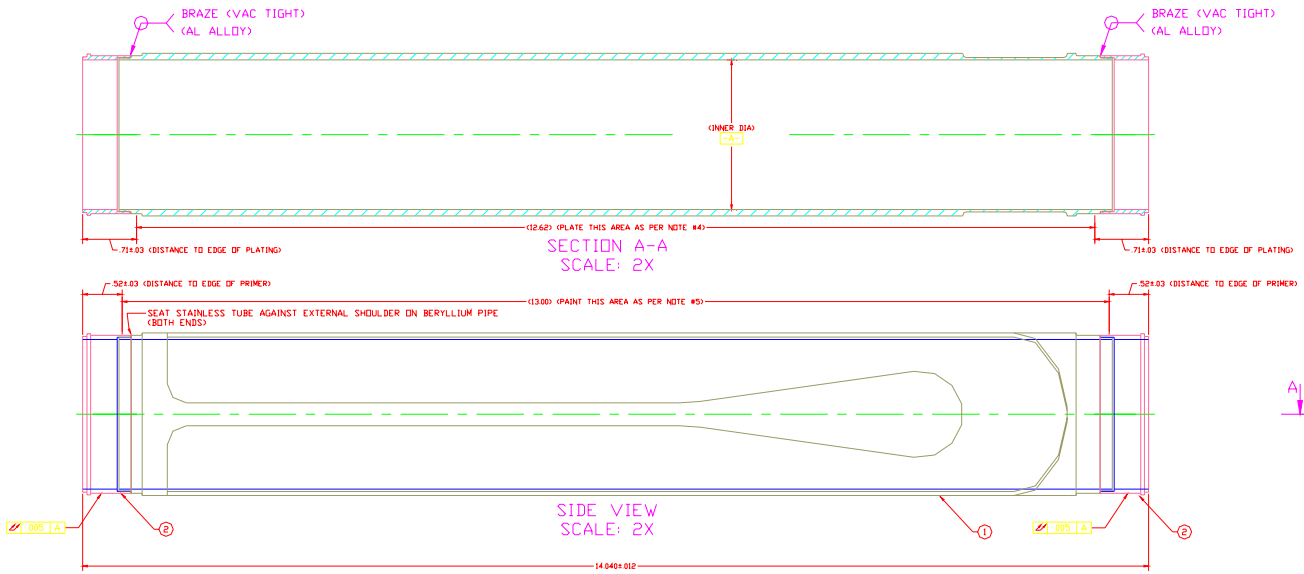
PEP2 IR VAC VTX BP ASSY

SA-343-410-01-A1

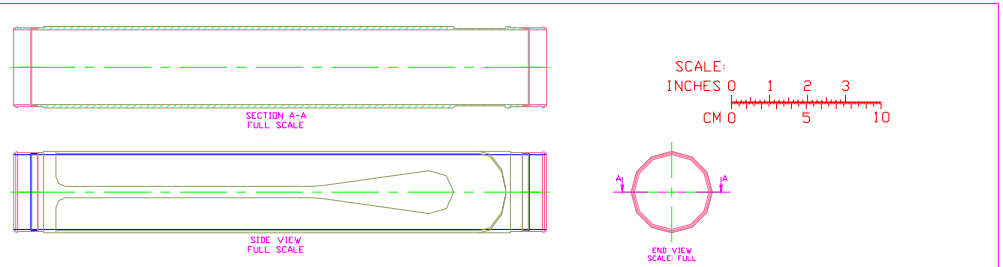
PROJECTION

REV	DESCRIPTION	DRN	CHK	APP	DATE
1	REVISED PER VENDOR INPUT	KSVIS			4-8-97

NOTES:
1. BRAZE MATERIAL MUST REMAIN WITHIN .25" OF EACH BRAZE LONGITUDINALLY.
   BRAZE MATERIAL MUST REMAIN WITHIN .006" OF BRAZE RADIALLY.
   VERIFY FLUX REMOVAL WITH SILVER NITRATE TEST AFTER BRAZING.
2. THIS PIPE MUST BE LEAKTIGHT WHEN TESTED ON A MASS SPECTROMETER HELIUM LEAK DETECTOR. ANY LEAKAGE WHEN TESTED WITH A MINIMUM LEAK DETECTOR SENSITIVITY OF 2×10^{-10} STD CC/SEC PER LEAK RATE METER DIVISION WILL BE CAUSE FOR REJECTION. LEAK TESTING IS DONE BEFORE COATINGS ARE APPLIED.
3. THE FINAL PART MUST BE DELIVERED TO SLAC DIMENSIONALLY CORRECT IN A STRESS FREE CONDITION. (STRESS RELIEVE AS REQUIRED.)
4. PLATE AREA SHOWN ON OUTSIDE SURFACE OF BERYLLIUM TUBE WITH 7±1 MICRONS OF ELECTROLESS NICKEL.
   POLYMER BASED LIQUID MASKS ARE NOT PERMITTED INSIDE THE PIPE FOR VACUUM REASONS.
   LIQUID MASKS MAY BE USED ON THE OUTSIDE SURFACES OF THE PIPE. DRY RUBBER STOPPERS AND / OR O-RINGS MAY ALSO BE USED. PLATING PROCEDURE / MASKING METHOD TO BE APPROVED BY SLAC.
5. APPLY BR154 EPOXY PRIMER TO LOCATION SHOWN ON EXTERIOR OF PIPE.
   PAINT APPLICATION PROCEDURE TO BE APPROVED BY SLAC.
   KEEP ENDS PLUGGED WHILE WORKING ON PIPE TO AVOID INTERNAL CONTAMINATION.
   PURGE PIPE WITH DRY NITROGEN WHILE BAKING PAINT.
   (THIS PIPE IS TO BE WATER COOLED AFTER ASSEMBLY. THE PURPOSE OF THE PAINT AND PLATING IS CORROSION RESISTANCE.)
6. THE FINAL SUB ASSEMBLY MUST BE CLEANED FOR UHV AND STORED IN A DRY, SEALED CONTAINER
7. FABRICATE AS PER SLAC SPECIFICATION PS-343-410-40



ULTRA HIGH VAC PART
FABRICATE PER PS-343-410-40



ITEM NO	PREF STOCK OR PART NO	BASE SUFF	TITLE OR DESCRIPTION	QTY
2	PE-343-410-04		BEAM PIPE EXTENSION	2
1	PE-343-410-03		BE BEAM PIPE	1

DIMENSIONING AND TOLERANCING IS IN ACCORDANCE WITH ANSI Y14.5M-1982.
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES
BEAM EDGES .005
INTERNAL CORNERS .005 R MAX
FRACTIONS ± 1/64
DEC .x ± .1 .xx ± .01 .xxx ± .004
ANGLES ± 1/2 ALL SURFS 63

SCALE: PER VIEW | DO NOT SCALE DRAWING | NEXT ASSEMBLY: SA-343-410-01

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	NAME	DATE
DRN	KNUT SKARPAAS	3-5-97
DRN	KNUT SKARPAAS	
CHK	MARK KURITA	

APPROVALS
KNUT SKARPAAS
MARTIN HERSEY
WANLY PAZNER

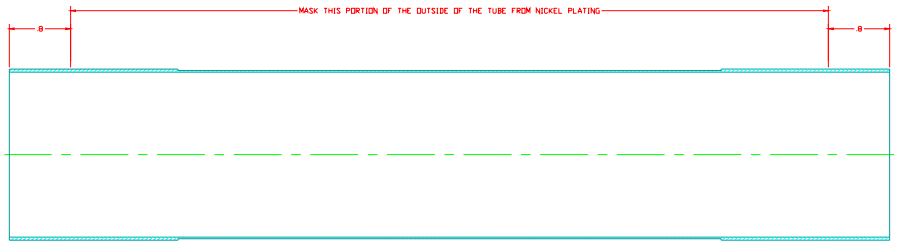
PEP-II IR VACUUM
BEAM PIPE ASSY
BEAM PIPE BRAZEMENT

SA-343-410-02 A1 | E

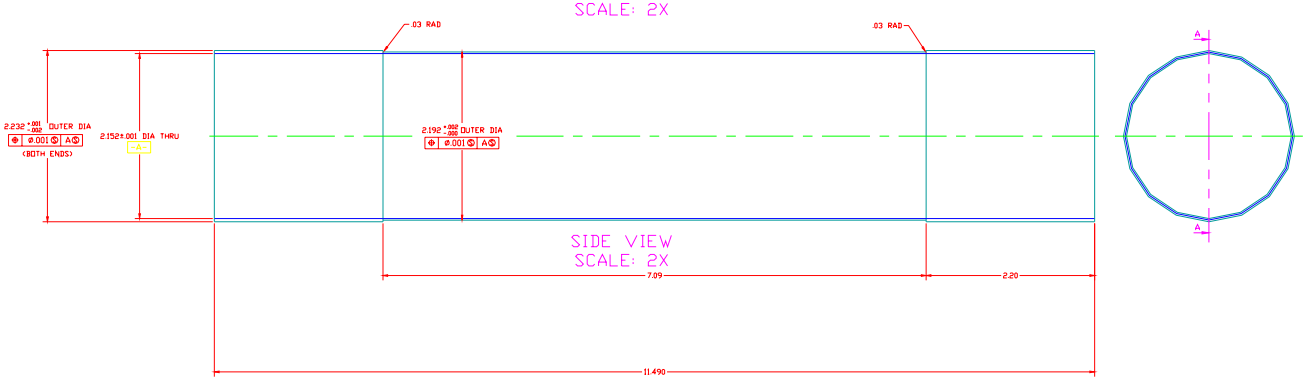
PEP2 IR VAC BP BRAZEMENT

PROJECTION

REV	DESCRIPTION	DRN	CHK	APP	DATE
E	PF-343-410-05 A0				

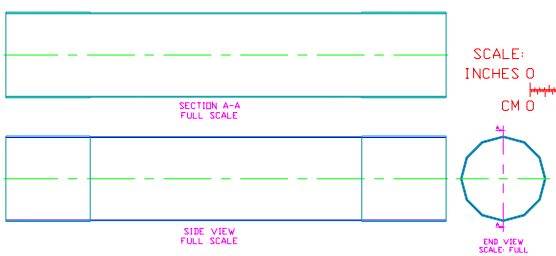


SECTION A-A
SCALE: 2X



SIDE VIEW
SCALE: 2X

NOTES:
1. BERYLLIUM TUBE IS TO BE MACHINED FROM A SOLID TUBE OR BAR STOCK.
2. STRESS RELIEVE AS REQUIRED.
3. THIS PIPE MUST BE LEAKTIGHT WHEN TESTED ON A MASS SPECTROMETER HELIUM LEAK DETECTOR. ANY LEAKAGE WHEN TESTED WITH A MINIMUM LEAK DETECTOR SENSITIVITY OF 2×10^{-10} STD CC/SEC PER LEAK RATE METER DIVISION WILL BE CAUSE FOR REJECTION. LEAK TESTING IS DONE BEFORE COATINGS ARE APPLIED.
4. PLATE INSIDE SURFACE, ENDS, AND WITHIN .8 INCH FROM EACH END ON THE OUTER SURFACE OF THE PIPE WITH 7±1 MICRONS OF ELECTROLESS NICKEL AS SHOWN. THE USE OF A MASKING COMPOUND IS PERMITTED IF RESIDUE DOES NOT HARM PAINT ADHESION.
5. APPLY BRI54 EPOXY PRIMER TO ALL SURFACES OF PIPE. PAINT APPLICATION PROCEDURE TO BE APPROVED BY SLAC. (THIS PIPE IS TO BE WATER COOLED AFTER ASSEMBLY. THE PURPOSE OF THE PAINT AND PLATING IS CORROSION RESISTANCE.)



MATERIAL IS STRUCTURAL BERYLLIUM BLOCK (S-65 SCREENED FOR LOW CARBON CONTENT)

ITEM NO	PREF	BASE STOCK OR PART NO	SUFF	TITLE OR DESCRIPTION	QTY

DIMENSIONING AND TOLERANCING IS IN ACCORDANCE WITH ANSI Y14.5M-1982
SCALE: PER VIEW
DO NOT SCALE DRAWING
NEXT ASSEMBLY: SA-343-410-01

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES: BREAK EDGES .005 MATERIAL CORNERS .005 R MAX FRACTIONS ± 1/64 XX ± .1 .X ± .05 .XX ± .004 ANGLES ± 1/4 ALL SURFS 63

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DRAWN KNUT SKARPAAS 2-27-95
CHKD KNUT SKARPAAS
MAXINE KURITA
APPROVALS
KNUT SKARPAAS
MARTIN NEWBURY
NANCY PALMER

PEP-II IR VACUUM
BEAM PIPE ASSY
WATER JACKET

PF-343-410-05 A0 E

PEP2 IR VAC BP WTR JACKET

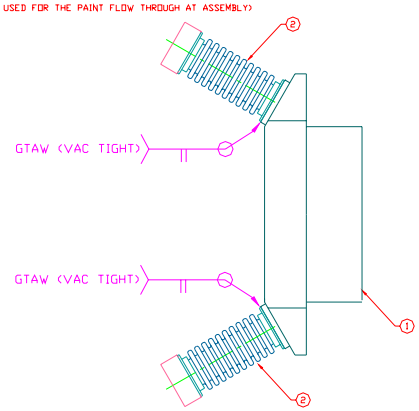
PF-343-410-04-A1

PF-343-410-05-A0

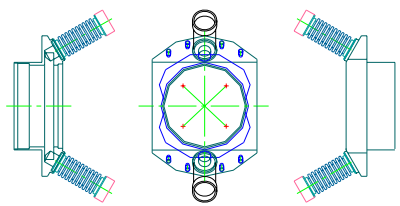
PROJECTION

REV	DESCRIPTION	DRN	CHK	APP	DATE
D	OV 80-010-SA-343-410				

NOTES:
1. CHECK FIT OF ALL COMPONENTS (INCLUDING THE FILLER TUBE, WHICH WILL BE USED FOR THE PAINT FLOW THROUGH AT ASSEMBLY)
2. WELD A BELLOWS ASSEMBLY TO EACH OF THE WELD PREPS ON THE MANIFOLD
3. STRAIN RELEIVE THE BELLOWS AND LEAK CHECK THE SUB-ASSY
4. NICKS, SCRATCHES, AND / OR DENTS ARE NOT PERMITTED ON THE BELLOWS.
5. SHIELD THIN BELLOWS CONVOLUTIONS FROM ARC WANDER WHILE WELDING
6. PLACE THE SUB ASSEMBLY IN A CLEAN, PROTECTIVE CONTAINER



SIDE VIEW
SCALE: 2X



END VIEW
SCALE: FULL

SIDE VIEW
SCALE: FULL

ITEM NO	PREF/ STOCK OR PART NO	BASE	SUFF	TITLE OR DESCRIPTION	QTY
2	SA-343-410-10			WATER BELLOWS WELDMENT	2
1	PF-343-410-09			MANIFOLD	1

DO NOT SCALE DRAWING — SCALE: PER VIEW — NEXT ASSEMBLY: SA-343-410-01

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES:
BREAK EDGES .005
INTERNAL CORNERS .005 R MAX
FRACTIONS ± 1/64
DEC .x ± .1
.xx ± .02
.xxx ± .004
ANGLES ± 1/2° ALL SURFS 63

DRAWN AND TOLERANCING IS IN ACCORDANCE WITH ANSI Y14.5M-1982

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	NAME	APPROVAL
ENGR	KNUT SKARPAAS 3-10-97	
DRFT	KNUT SKARPAAS	KNUT SKARPAAS
CHKD	SHAINE KURTA	MARTIN HOFBERT
		NANCY PALMER

PEP-II IR VACUUM
BEAM PIPE ASSY
MANIFOLD WELDMENT

SA-343-410-08 A0 — D

PEP2 IR VAC BP MANF VL3

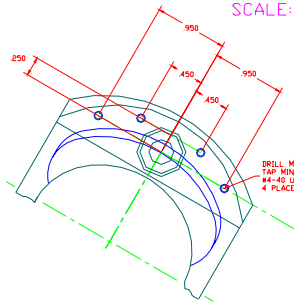
SA-343-410-08-A0

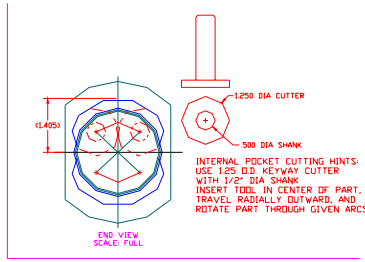
PROJECTION

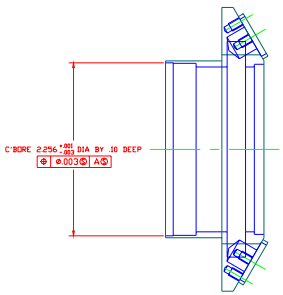
REV	DESCRIPTION	DRN	CHK	APP	DATE
J	OV 60-01Y-EPE-Jd				

NOTES:
1. THIS COMPONENT MUST BE LEAKTIGHT WHEN BOTH ENDS AND BOTH WELD PREPS ARE PLUGGED

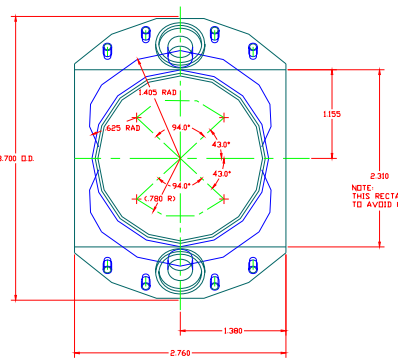
AUX VIEW
TYPICAL OF 2 LOCATIONS
SCALE: 2X





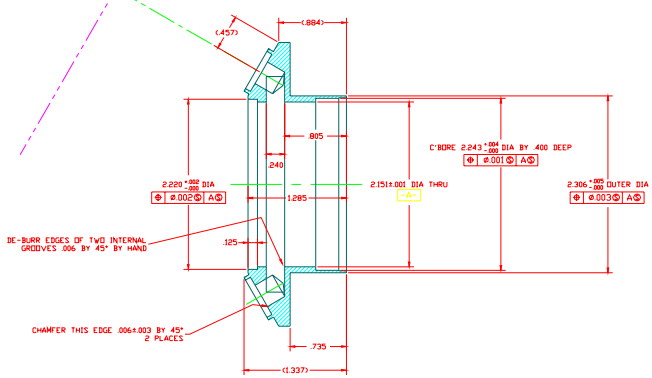


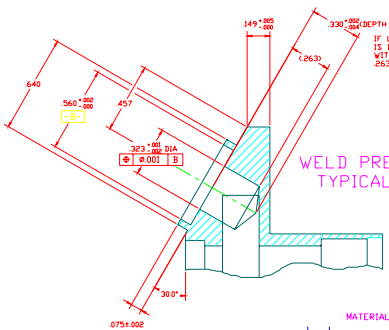
SIDE VIEW
SCALE: 2X



NOTE:
THIS RECTANGULAR AREA MUST BE MILLED OUT TO AVOID HITTING THE WELD PREPS

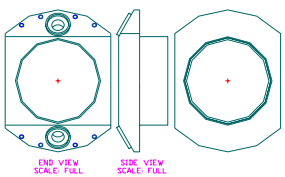
END VIEW
SCALE: 2X

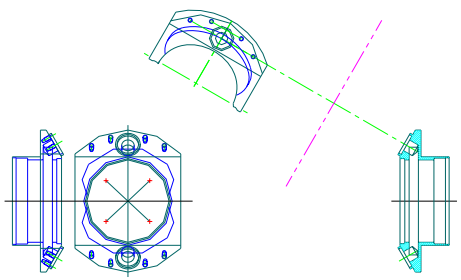




IF LOCATIONAL ACCURACY OF .323 DIA DRILL IS DIFFICULT TO OBTAIN, DRILL TO .330 DEEP WITH A SLIGHTLY SMALLER 135° DRILL AND BORE .263 DEEP TO .323 +.001 -.000 DIA

WELD PREP / C'BORE DETAIL
TYPICAL OF 2 LOCATIONS
SCALE: 4X





SCALE:
INCHES 0 1 2 3
CM 0 5 10

MATERIAL: 304L ST STEEL (BAR STOCK)

ITEM NO	PREF	BASE STOCK OR PART NO	SUFF	TITLE OR DESCRIPTION	QTY

DIMENSIONING AND TOLERANCING IS IN ACCORDANCE WITH ANSI Y14.5M-1982
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES:
BREAK EDGES .005
INTERNAL CORNERS .005 R MAX
FRACTIONS ± 1/64
DEC .x ± .1
.xx ± .02
.xxx ± .004
ANGLES ± 1/4° ALL SURFS 63

SCALE: PER VIEW
DO NOT SCALE DRAWING
NEXT ASSEMBLY: SA-343-410-08

STANFORD LINEAR ACCELERATOR CENTER
U.S. DEPARTMENT OF ENERGY
STANFORD UNIVERSITY
STANFORD, CALIFORNIA

DRAWN KNUT SKARPAAS 3-30-97
DESIGN KNUT SKARPAAS
CHKD MARTIN MURTA

APPROVALS
KNUT SKARPAAS
MARTIN MURTA
NANCY PALMER

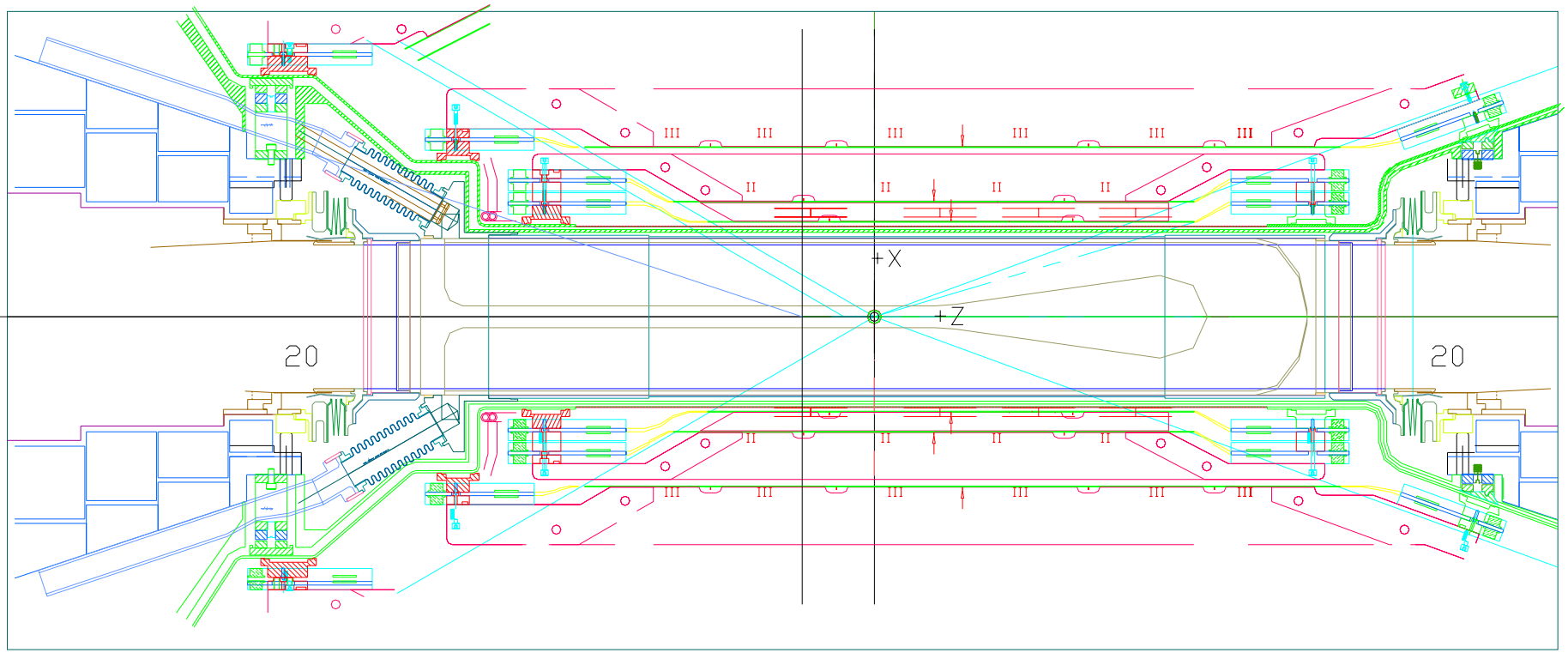
PEP-II IR VACUUM MANIFOLD WELDMENT MANIFOLD

PF-343-410-09 A0 E

SHT 1 OF 1

PEP2 IR VAC BP MANIFOLD

PF-343-410-09-A0


+X
+Z
20
20
III
III
III
III
III
III
II
II
II
II
II
II
II
II
III
III
III
III
III
III