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Program - Project - Job: SNS-FE Ion Source/LEBT
LEBT Mechanical Systems

Title: **Fabrication of the 65 kV Insulator for the SNS-Front End Systems**

1. Scope

This report describes the procedure used in fabricating the main insulator flange for the SNS-FE ion source and Low Energy Beam Transport (LEBT). The casting, finish machining, and glue-up of the flange assembly are covered in this report, but the design and analysis is covered in a separate note.

2. Background

The ion source and Low Energy Beam Transport of the SNS Front End systems is designed to produce and transport a 65 mA H- beam at a 6% duty factor and 75 keV energy into the Radio Frequency Quadrupole (RFQ) for further acceleration and beam formation. The ion source plasma generator is floated at a potential of -65 kV with respect to the vacuum chamber, which is at ground potential, by what is termed the Main Insulator. This insulator was designed and built as a cast epoxy structure, with a brass potential screen embedded in the casting. This screen serves to form the voltage field through the insulator bulk to prevent high field gradients at the edges that are detrimental to any insulator's performance.

3. Requirements

A mold was designed and built at LBNL for the fabrication of the main insulator. Its dimensions were built oversize by roughly 1/8" on the diameter to account for shrinkage during the cure, per the vendor's instructions. The epoxy casting is made by Hysol® C9-4190 (red resin, filled with fine silica beads), and HD3485 (hardener). See Appendix A for material specifications.

The adhesive used to bond the flange and the epoxy casting was a two-part epoxy, also manufactured by Hysol®, part number EA 9359.3, 50 ml Sempaks. These are dual-barrel cartridges that must be used with a "gun" to apply, and the epoxy is automatically mixed as it exits the barrels.

4. Design Drawings *(found in Appendix C)*

Insulator Casting Mold Parts:
- 21G7466 Mold Assembly
- 21G7386 Mold Backplate
- 21G7396 Mold Midplate
- 21G7442 Mold Top Plate
- 21G7433 Mold Outer Ring Flange
- 21G7422 Mold Rings
- 21G7453 Wooden Screen Mandrel

Insulator Flange Parts & Ass'y:
- 21G8964 LEBT Insulator flange assembly
- 21G8126 65kV Insulator
- 21C9976 LEBT Insulator Flange
- 21G8131 Brass alignment plugs

5. Procedure

Casting (performed at the vendor):

The first step in fabricating the main insulator was to form the screen. Brass screening material was cut and formed to the mandrel, with sections cut as needed to allow for curvature. The sections that had been cut were soldered to form one continuous curved shape. See Figures 1 and 2.

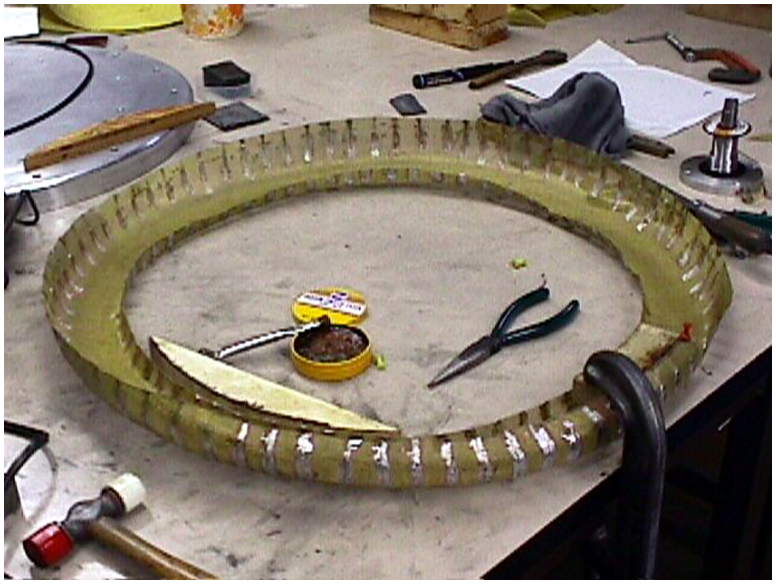
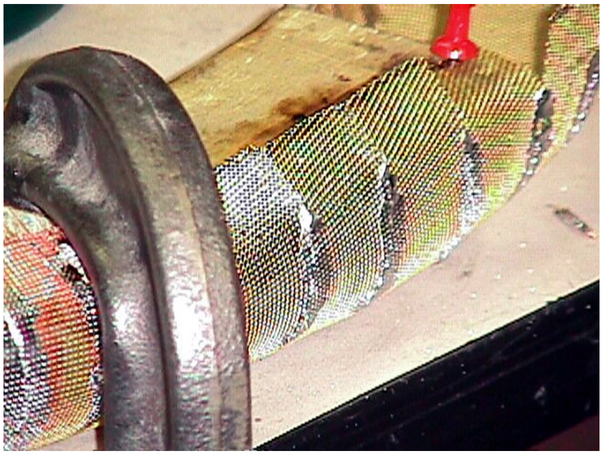
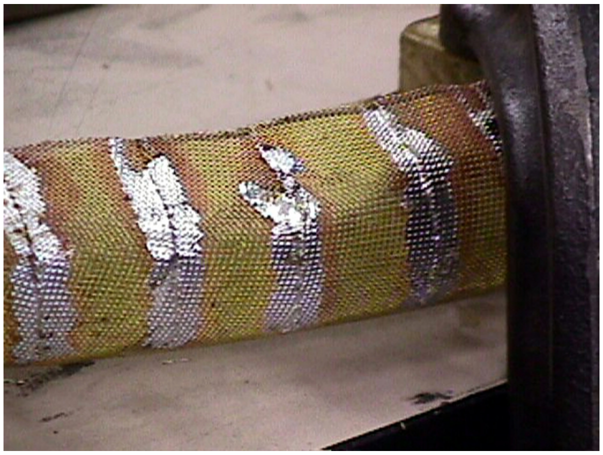


Figure 1. The brass screen during fabrication.



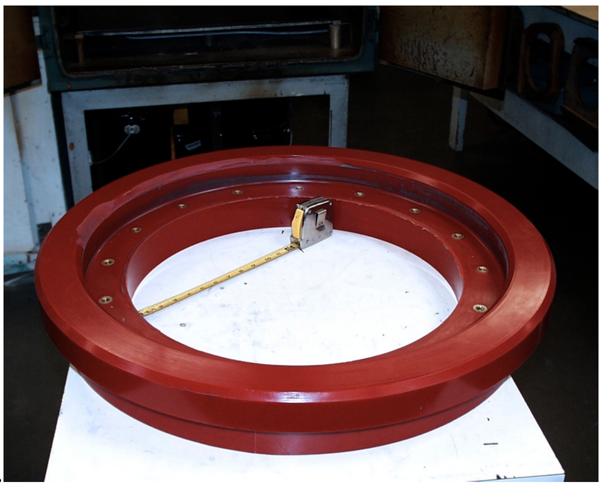
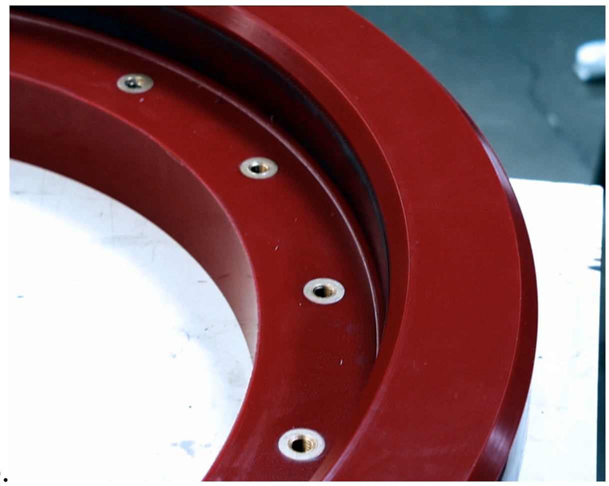


Figures 2. Close-up views of the brass screen soldered at the seams (left and right).

Threaded brass inserts were then attached to the mold midplate (drawing 21G7396) with standard 3/8-16 bolts. The screen ring was then soldered to these inserts at a minimum of eight places—every other bolt—around the ring, providing the electrical connection.

This midplate/screen assembly was then assembled with the casting mold per drawing 21G7466, and all external joints were sealed with RTV sealant. The epoxy was then poured into the mold and allowed to cure in a vacuum oven.

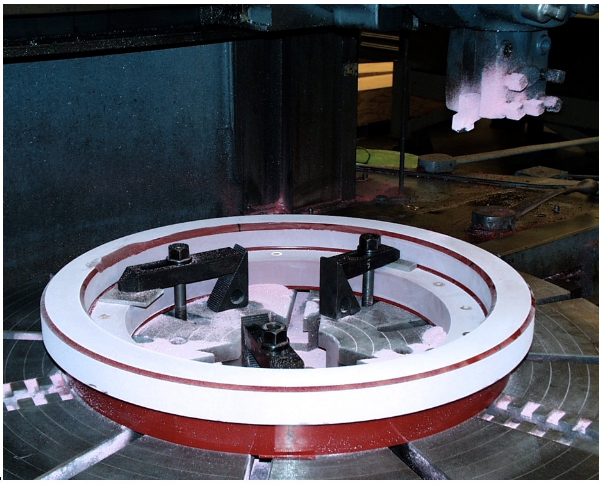
When the epoxy was sufficiently set, it was removed from the oven, the mold was disassembled from the casting, and the casting was then allowed to fully cure. The removal from the mold allowed the casting to shrink as necessary during the cure, not being restrained by the mold's walls and flanges. See Figure 3. The casting was shipped to LBNL after it was fully cured.

a.

b.


Figures 3a and 3b. The fully cured epoxy casting (**a**), and a close up view of the threaded brass inserts (**b**).

Finish Machining (performed at LBNL):
After the casting was received from the vendor, the surfaces needed to be trued up, and radiuses needed to be added to sharp corners. In the end, each surface had at least a skin cut, and dimensions were taken from drawing 21G8126. This work was done on both horizontal and vertical lathes, and only diamond cutters were used. Standard carbide tools became dull after only a few turns on the lathe because of the abrasive nature of the silica-filled epoxy. See Figure 4 for pictures during machining. Note that Figure 4c shows a nozzle attached near the cutter. This is a vacuum nozzle to prevent an excessive amount of dust from being released. This type of dust is potentially detrimental to the machinery because it is abrasive, and fine enough to get into crevices and the workings of the machinery; it can be seen in Figure 4b.

Glue-up of the Insulator Assembly:
After machining, the last step was to glue the LEBT slip flange (21C9976) to the epoxy casting. Figure 5 shows the slip flange that was machined. A set of three fixtures were made to align the bolt hole pattern of the epoxy casting to the bolt pattern of the slip flange; one of them can be seen in Figure 6. The glue-up procedure used the Hysol EA9359.3 adhesive, and was documented in the pictures. See the captions of Figures 7 through 13 for a description of the process.

a. 

b. 

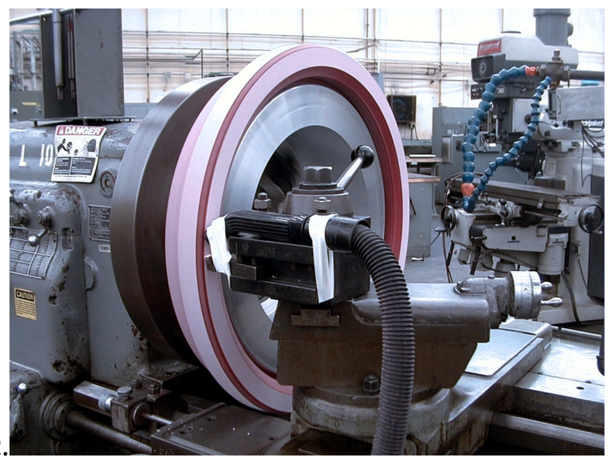
c. 

Figure 4. (**a**) Picture of the casting in a vertical lathe after an operation. (**b**) A close-up view. (**c**) Machining on a horizontal lathe. Note the vacuum nozzle attached to the cutter.

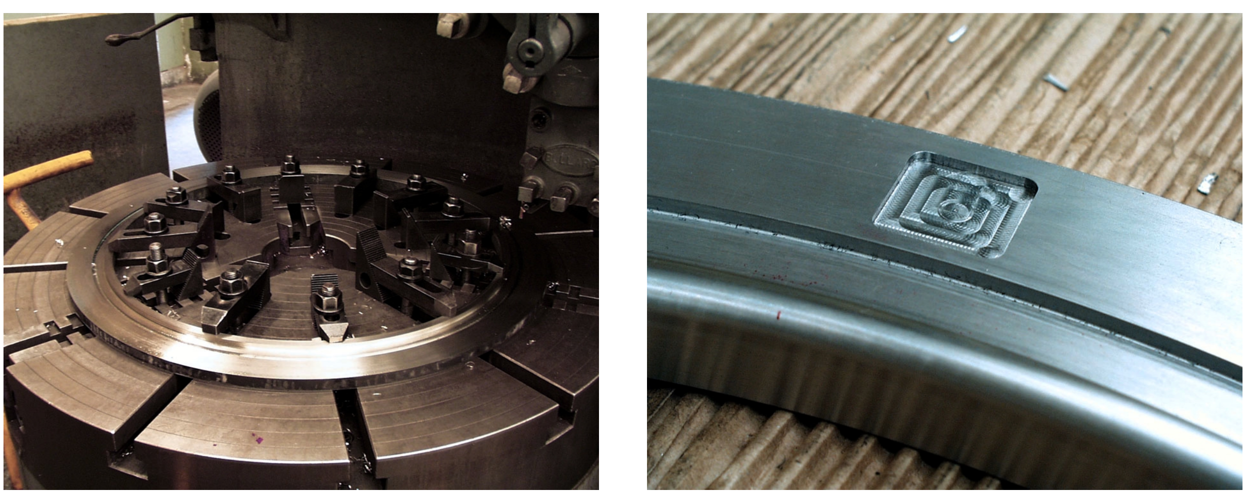


Figure 5. The LEBT slip flange during machining (left), and a detail of the flange pocket (left).

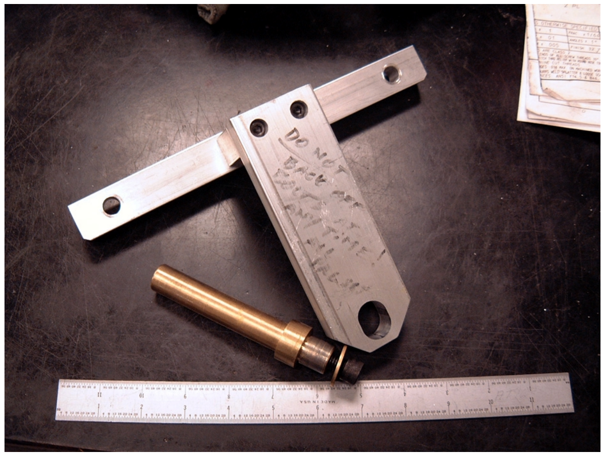


Figure 6. One of the alignment fixtures for the glue-up procedure.

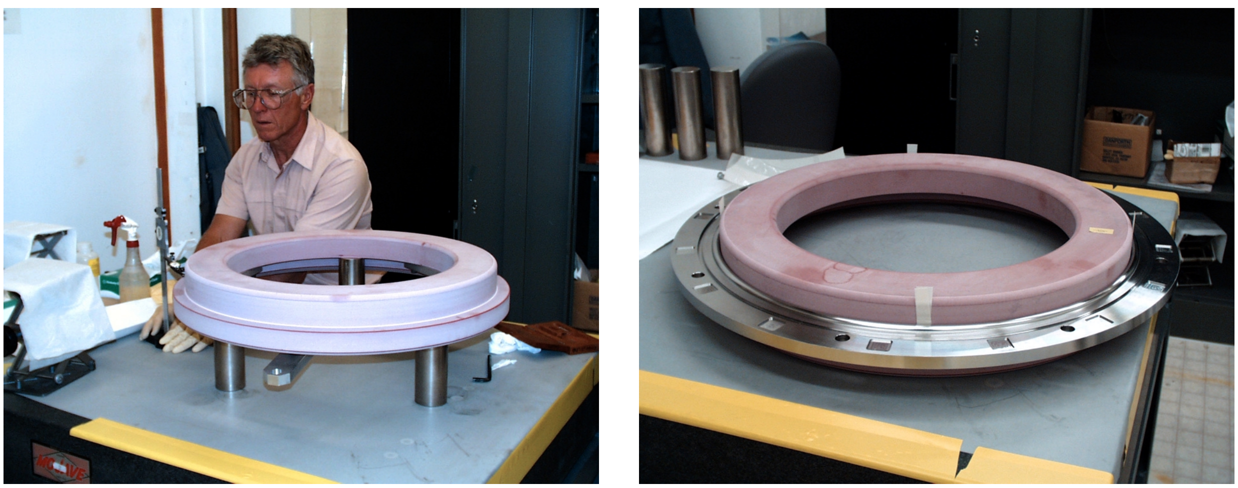


Figure 7. (Left) The epoxy casting being leveled on blocks. (Right) A dry fit of the casting and flange. Note the shim stock used for centering the ring.

Figure 8. Final alcohol wipedown of the epoxy casting (Left) and slip flange surfaces (Right).

Figure 9. Using lab jacks to raise and lower the slip flange onto the casting (both left and right).

Figure 10. Application of the Hysol® adhesive (left), and a detail of the spread-out adhesive (right).

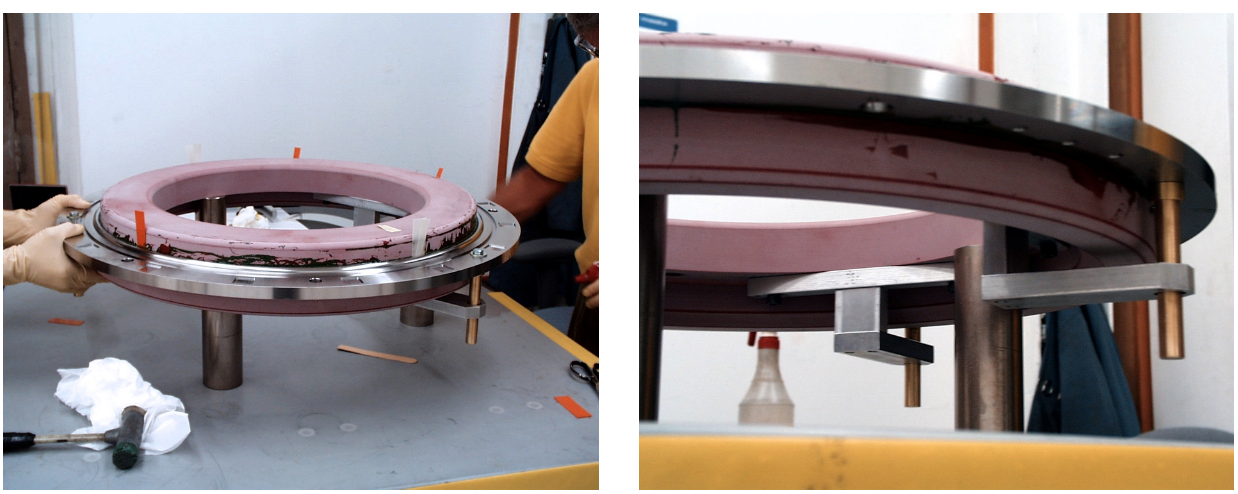


Figure 11. The flange, lowered onto casting (left), and a view from below (right). Note the fixtures.

Figure 12. After lowering the flange, the air pockets and excess epoxy were squeezed out (left). This excess epoxy was wiped an scraped away (right), especially in the triple-point radius shown at left.

Figure 13. A height gauge and C-clamps were used to level the flange with respect to the casting. The assembly was allowed to fully cure before the clamps were removed.

Alignment Plugs and Friction-Free Pads:
The brass alignment plugs (21G8131) were glued into the pockets machined into the epoxy casting. The same Hysol® adhesive was used, and the plugs were machined with a vent groove, to allow both air and excess epoxy to squeeze out. This allowed the plug to sit flush with (or below) the surface of the insulator without any further machining.

The bearing pads were fabricated from stock .0895" thick DU® flat strip material. DU® is a product made by Garlock Bearings that is a steel-backed, porous bronze, PTFE composite bearing matrix. See Appendix B for an excerpt out of their product manual for property specifications. Sixteen 1" squares were cut out of the material and were glued into place, again with the same Hysol® epoxy adhesive.

Insulator Flange Alignment:
After allowing the epoxy adhesive to fully cure on all the parts, the reentrant cylinder was bolted to the insulator flange and their centers were aligned via a Coordinate Measuring Machine. After confirming that the flange and reentrant cylinder were concentric, the alignment holes were drilled as indicated. This completed the insulator flange assembly, and it was then ready for service.

6. Related Documents
SNS-FES Vacuum Systems, Engineering Note M8047, by Dan Cheng

7. SNS-FE Design Personnel
Daniel Cheng, primary Engineer
Sam Mukherjee, Engineer & designer

Appendix A

Epoxy Insulator Manufacturer Info

HYSOL®

SHOCK RESISTANT, LOW EXOTHERM CASTING SYSTEMS
C9-4183 & HD3485 - Filled   C9-4186 & HD3485 - Highly Filled

Our Resin

1.0 DESCRIPTION

HYSOL casting compounds C9-4183 or C9-4186, when used with HYSOL hardener HD3485, are low exotherm, long pot life casting systems. These systems show good shock resistance where low temperature operation is required. They are being widely used for massive castings . . . up to 400 pounds . . . where high electrical insulation properties must be maintained.

1.1 Colored versions exhibiting identical properties to C9-4183 are available as follows: C9-4188 yellow, C9-4190 red, C9-4198 green, C9-4207 blue, C9-4215 black.

2.0 SPECIFICATION OF PRODUCT

	C9-4183*	C9-4186*	HD3485	Test Method
Color			Gardner 4	ASTM D 1544
Color	Tan	Tan		Visual
Amine equivalent (meq $HClO_4$/gm)			7.6-8.6	HYSOL 14 A
Epoxy equivalent weight	335-440	500-618		ASTM D 1652
Filler content, %	48-52	63-67		ASTM D 2584
Specific gravity @ 25°C (77°F)	1.50-1.65	1.75-1.90	1.10-1.20	ASTM D 1475
Viscosity @ 25°C (77°F)				ASTM D 2393
Brookfield RVF				
Spindle 6, Speed 4, cps	70,000-100,000			
Spindle 7, Speed 20, cps		100,000-200,000		
Spindle 3, Speed 10, cps			3,000-4,500	
Shelf life @ 25°C (77°F), months (minimum from date of shipment)	6	12	12	

NOTE: The resin base of these compounds meets the requirements of ASTM D 1763, specification for epoxy resins.

3.0 TYPICAL CURED CHARACTERISTICS

TYPICAL CURED CHARACTERISTICS — Values are not intended for use in preparation of specifications. All measurements taken at 25°C (77°F) unless otherwise noted.

FROM
K.R. ANDERSON
727-2800

DIVISION HEADQUARTERS AND WESTERN PLANT: 15051 E. DON JULIAN ROAD, INDUSTRY, CALIFORNIA 91749 PHONE: 213-968-6511
EASTERN PLANT, FRANKLIN STREET, OLEAN, NEW YORK 14760 PHONE: 716-372-6300
WESTERN PLANT 2850 WILLOW PASS ROAD, PITTSBURG, CALIFORNIA 94565 PHONE: 415-687-4201

3.1 PHYSICAL

	C9-4183/HD3485	C9-4186/HD3485	Test Method
Color	Tan	Tan	Visual
Coefficient of linear thermal expansion, in/in/°C (30°C to 90°C)	78×10^{-6}	68×10^{-6}	ASTM D 1674
Compressive strength, psi	22,000	22,000	ASTM D 695
Density, lb/cu in	0.057	0.063	ASTM D 792
Elongation, %	1.00	1.08	ASTM D 638
Filler content, %	47	62	ASTM D 2584
Flexural strength, psi	17,000	17,000	ASTM D 790
Hardness, Shore D	85	87	ASTM D 2240
Heat deflection temperature @ 264 psi, °C (°F)	80 (176)	80 (176)	ASTM D 648
Izod impact strength, ft-lb/in. of notch	0.23	0.24	ASTM D 256
Linear shrinkage, %	0.4-0.6	0.3-0.4	ASTM D 2566
Moisture absorption (24 hour immersion), %	0.24	0.22	ASTM D 570
Specific gravity	1.53	1.77	ASTM D 792
Tensile strength, psi	6,400	7,000	ASTM D 638
Thermal conductivity, cal x cm/(sec x sq cm x °C)	12×10^{-4}	16×10^{-4}	ASTM D 1674

3.2 CURED ELECTRICAL CHARACTERISTICS

	C9-4183/HD3485	C9-4186/HD3485	
Dielectric strength @ 10 mil thickness, volts/mil	1400	1350	ASTM D 149
Arc resistance, seconds	138	163	ASTM D 495
Guide to operating class, IEEE	130	130	

	C9-4183/HD3485				C9-4186/HD3485			
	25°C		105°C		25°C		105°C	
	K	D	K	D	K	D	K	D
100 Hz	4.4	0.007	6.4	0.324	4.4	0.007	6.4	0.351
100 kHz	4.2	0.012	4.8	0.021	4.3	0.013	4.9	0.024
Vol res	7×10^{13}		1×10^{11}		6×10^{13}		2×10^{10}	

K = Dielectric constant by ASTM D 150
D = Dissipation factor by ASTM D 150
Vol res = Volume resistivity in ohm-cm by ASTM D 257

4.0 HANDLING

	C9-4183/HD3485	C9-4186/HD3485
4.1 Mix ratio, parts by weight*	100/7	100/5
Mix ratio, parts by volume*	100/9	100/7.5
Pot life @ 25°C (77°F) (200 gram mass), hours	24	24
@75°C (167°F) (200 gram mass), hours	3	3
Viscosity @ 75°C (167°F), cps		
Spindle 1, Speed 10	500	
Spindle 4, Speed 20		7,000
Peak exothermic temperature (200 gram mass) °C (°F)	None	None
Gel time @ 75°C (167°F), hours	5	5

\+ To insure complete compatibility of resin and hardener, mix quantities of up to one gallon at approximately 100°C (212°F) and larger quantities at 50-60°C (122-140°F).

*Mix ratio of these materials is fixed by their chemistry. Any attempt to increase or decrease the cure rate by adding more or less hardener will result in degraded materials.

4.2 Mixing Instructions

Heat base to 50°C to 75°C (122°F to 167°F), add hardener, mix, deair and cast into preheated 75°C (167°F) mold. In small masses, it may be necessary to bring the temperature of the mixture to 85°C (185°F) to get complete compatibility of base of hardener.

Filled resins may tend to settle during storage. Thorough mixing is required each time they are used.

Appendix B

Excerpts from the Specifications of the DU® Pad Material

Full product information can be found at:

http://www.garlockbearings.com/lit/index.cfm

Garlock Bearings LLC
700 Mid Atlantic Parkway, P.O. Box 189, Thorofare, New Jersey 08086
Phone 1-800-222-0147 • Fax 856-848-5115 • www.garlockbearings.com

__DU__® is the highest performance self-lubricating bearing material available anywhere. It offers a combination of properties and capabilities unmatched by any other self-lubricating bearing material and, consequently, has the broadest application range.

DU®...the high performance self-lubricating bearing material

DU bearings combine the advantages of many conventionally lubricated, metallic plain bearings—particularly high load capacity and dimensional rigidity—with the design freedoms of self-lubricating materials, including the ability to operate successfully well beyond the scope of conventional lubricants.

The material: a steel backed composite

The key to the remarkable performance capabilities of DU is its unique method of manufacture. By employing the unique method of sintering and mechanical interlocking by impregnation, DU bearings eliminate the problems of temperature and aging faced by bonded films and fabrics. In addition, the polymeric self-lubricating material in the DU structure does not have to provide structural support. Furthermore, the metal components provide maximum heat dissipation. The photomicrograph above (Figure 1-1) shows the three main elements that make up this composite:

1. Steel backing
This steel backing gives DU its exceptionally high load carrying capacity; thin, compact design; excellent heat dissipation; and dimensional and structural rigidity.

2. Porous bronze innerstructure
This comprises a nominal 0.010 inch (0.25 mm) thick layer of carefully sized bearing quality bronze powder which is sintered onto the steel backing. This porous structure is impregnated with a homogeneous mixture of PTFE (polytetra-fluoroethylene) and lead. In addition to providing maximum thermal conductivity away from the bearing surface, this unique bronze innerstructure also serves as a reservoir for the PTFE-lead mixture.

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DU®

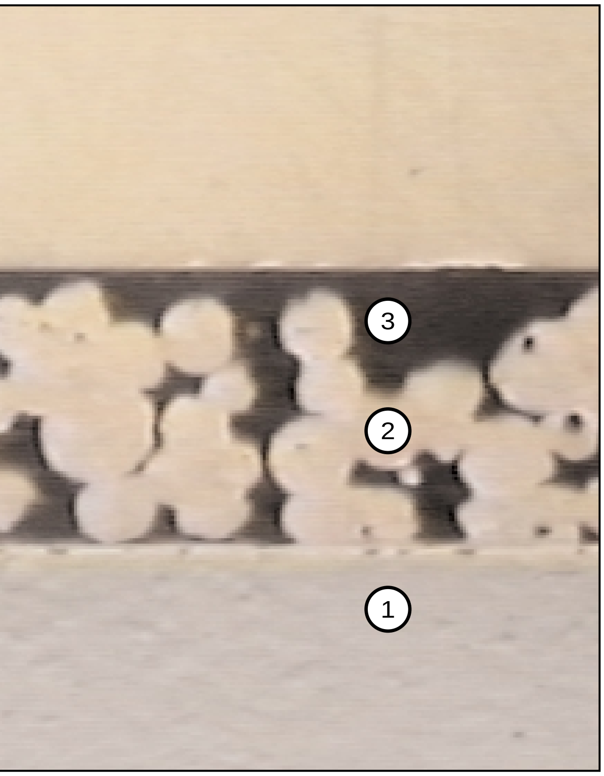

Figure 1-1. DU Photomicrograph Cross Section

3. PTFE-lead overlay

This low friction overlay, approximately 0.001 inch (0.025 mm) thick, provides an excellent initial transfer film which effectively coats the mating surface of the bearing assembly, forming an oxide type solid lubricant film. As this film is depleted, the relative motion of the mating surface continues to draw material from the porous bronze layer.

When conditions are severe, the feed of lubrication is increased. The peaks of porous bronze coming in contact with the mating surface generate localized heat and, due to the high thermal expansion rate of the PTFE, force additional lubricant to the bearing surface. The relative motion of the mating parts wipes the lubricant over the interface, continuously restoring the low friction surface film.

The limits: beyond any self-lubricating bearing material

DU bearings—including plain bearings, thrust washers, flanged bearings and slides—offer these remarkable operating parameters:

Loads – P

Dynamic pressures up to 20,000 psi (140 N/mm^2) and compressive yield strength of 44,000 psi (310 N/mm^2), assuring high load carrying capacity and excellent resistance to shock loading.

Speeds – V

Speeds up to 1000 fpm (5 m/s) without lubrication; 2000 fpm (10 m/s) with lubrication.

Performance – PV

PVs to 50,000 psi-fpm (1.75 N/mm^2 x m/s) for continuous operation, 100,000 psi-fpm (3.50 N/mm^2 x m/s) for short-term use. In actual operation, DU bearings have been successfully used at levels which approach 3,000,000 psi-fpm (105 N/mm^2 x m/s) lubricated.

Temperatures

From -328 to +536ºF (-200 to +280ºC), making it suitable for use in applications well beyond the scope of most liquid lubricants.

Motion

Ideal for all types of rotating, oscillating, and sliding motion, and both radial and thrust loading.

Lubrication

Can be used totally dry, fully lubricated, or with intermittent lubrication and can be used in the presence of many industrial liquids.

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Properties of DU® and DX™ Compared

Properties	DU Bearing Material	DX Bearing Material
Construction		
Backing	Steel	Steel
Innerstructure	Porous copper-tin bronze	Porous copper-tin bronze
Bearing Surface	PTFE / Lead	Acetal with pin indentations
Lubrication	Not required	Initial prelubrication at assembly required
Load Capacity		
Compressive Strength	44,000 psi (310 N/mm^2)	44,000 psi (310 N/mm^2)
Static Load Capacity	36,000 psi (250 N/mm^2)	36,000 psi (250 N/mm^2)
Dynamic Load Capacity	20,000 psi (140 N/mm^2)	20,000 psi (140 N/mm^2)
Speeds	1,000 fpm (5 m/s), dry 2,000 fpm (10 m/s), (lubricated)	100 fpm (0.5 m/s), greased 500 fpm (2.5 m/s), in oil
PV Limits		
Continuous	50,000 psi-fpm (1.75 N/mm^2 x m/s)	80,000 psi-fpm (2.8 N/mm^2 x m/s)
Intermittent	100,000 psi-fpm (3.50 N/mm^2 x m/s)	
Temperature Range	-328 to +536ºF (-200 to +280ºC)	-40 to +210ºF (-40 to +100ºC) intermittent to +260ºF (+125ºC)
Coefficient of Friction		
Static*	0.02 – 0.20	0.015 – 0.15
Dynamic	0.02 – 0.20	0.01 – 0.10
Standard Products	Refer to pages 3-2 to 3-11	Refer to pages 3-12 to 3-13
Sleeve Bearings	Inch and Metric Sizes	Inch (metrics on special order)
Thrust Washers	Inch and Metric Sizes	Inch (metrics on special order)
Flanged Bearings	Inch and Metric Sizes	Not available
Flat Strip	Inch, 18 inch and 8 foot lengths	Inch, 18 inch and 8 foot lengths
Sizing Bearing ID at Assembly	Burnishing	Boring, turning, reaming, broaching

*Static coefficient of friction of the first movement may be greater for a long dwell period under load. Refer to page 4-4.

Table 1-1

Garlock Bearings LLC
700 Mid Atlantic Parkway, P.O. Box 189, Thorofare, New Jersey 08086
Phone 1-800-222-0147 • Fax 856-848-5115 • www.garlockbearings.com

DU® bearings provide economical solutions to many bearing problems, making them ideal for a wide variety of applications.

DU® gives you the widest application range of any self-lubricating bearing

Because of the unique combination of properties and performance capabilities noted on page 1-3 and detailed in later sections, DU bearings have a far greater application range than any other self-lubricating bearing. In fact, in some applications, DU is the only bearing material that can meet the demanding criteria for long life and trouble-free performance, with or without lubrication.

For decades, DU bearings have proven to be the economical solution to a wide range of bearing problems. In many cases, DU bearings completely eliminate the need for lubrication, as well as maintenance, while extending the life of the assembly. These superior bearings can also eliminate the need for hardened shafts and other expensive surface preparation, further reducing the total cost of the bearing assembly. In lubricated applications, DU bearings provide a margin of safety—particularly during start-up, in the event of interruption of lubrication feed, and in highly loaded applications.

Millions of DU bearings are purchased annually for applications as diverse as low speed, high load pivots to high speed, low load gear pump bearings, and virtually everything in between. These are just a few of the reasons why design engineers throughout the world specify DU bearings for their applications:

DU with or without lubrication

DU's unique PTFE-based bearing surface permits smooth, low friction operation with no lubrication, no maintenance, no costly lubrication systems. Where permissible, lubrication further improves the performance of these bearings.

DU bearings are convenient to use

The prefinished surface of DU bearings requires no machining. These thin, compact bearings require minimum space and are located within the housing by interference fit. DU bearings are supplied from stock in a wide range of inch and metric sizes, as outlined on pages 3-2 through 3-11. And these superior bearings are readily available worldwide through an extensive network of distributors and licensees. Special sizes are also available upon request.

DU bearings provide highest performance

As noted on page 1-3, DU bearings take PVs to 100,000 psi-fpm (3.50 N/mm^2 x m/s) or more, operate at temperatures from -328 to +536°F (-200 to +280°C), can be used with fully rotational, oscillatory, and axial sliding motion, take both radial and thrust loads, and resist shock loadings.

DU bearings are reliable

The performance capabilities and predictable wear patterns of DU bearings have been more thoroughly documented, both in the field and in the laboratory, than any other self-lubricating bearing. These bearings are noted for their long, trouble-free life, their tolerance of dusty, dirty environments, and their ability to withstand operating extremes and perform in the presence of most solvents and industrial fluids.

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DU®

Typical DU® bearing applications

The following list covers some of the many types of successful DU bearing applications, as well as some of the special problems solved by this unique bearing material.

Agricultural equipment

A wide range of agricultural vehicles and implements such as tractors, combines, crop sprayers, tillers, harvesters, grain dryers, etc. use DU bearings to eliminate lubrication points. Specific applications include clutches, governor linkage, brake pedals, control pivots, cross shaft linkage, and parking brakes.

Off-highway, truck, and automotive

Typical applications in these areas include earth-movers, graders and other constructional and off-the-highway equipment, trucks, and autos. Specific uses include power steering cylinders, steering gear thrust washers, disc brakes, calipers and pistons, shock absorbers, governor linkage (diesel), windshield wiper motor/transmissions, tilt gear assemblies, hydraulic steering mechanisms, shifter linkage, brake pedal pivots, clutch cross shafts, steering shaft universal joints, throttle bodies, tachometers, fuel pumps, roof actuators, steering pivot tubes, kingpin assemblies, suspension and steering ball joints, yoke assemblies, steering idler arms, torsional supports, and many more. DU bearings are chosen to minimize the need for lubrication and servicing, and for their high reliability even in dirty environments.

Aviation

Aircraft engines, controls, landing gears, sliding wing supports, linkages, brakes, etc. DU bearings are particularly ideal for applications where parts requiring lubrication or servicing are inaccessible, and for their indifference to extremely low temperatures, tolerance of airborne dirt, and ability to operate in the vacuum of outer space.

Business machines

Photocopy machines, typewriters, mail sorters, postage meter systems, computer terminal printers and peripheral equipment, automatic printing devices, mail processing machinery, electric staplers, high speed business machines, photo processing machines, etc.

Garden, lawn, and outdoor equipment

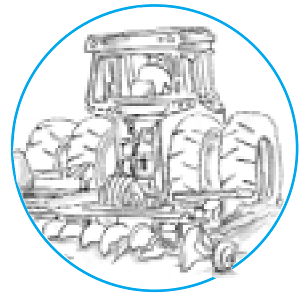
Lawnmowers, garden tractors, fairway mowers, chain saws. Specific applications include starter mechanisms, drive shafts, gears, front mounts, and clutches.

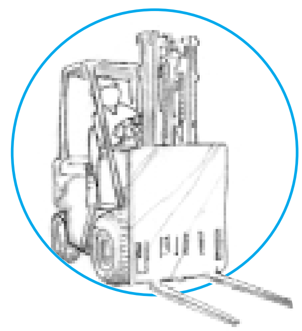
Hydraulics and valves

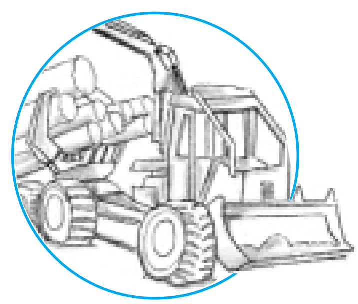
Pumps, including gear, rotary, water, axial piston, and other types; ball, butterfly, poppet steam, check and other valves and valve trunnions; pump pressure and thrust plates, reciprocating air compressors, hydraulic actuators, centrifugal compressors, water hydrants, air regulator lever points, bellows compressors, etc. Several of these applications dramatically demonstrate the unrivaled capabilities of DU bearings. In one gear pump application, for example, PV values approaching 3,000,000 psi-fpm are achieved under fully lubricated (hydrodynamic) conditions, with no bearing failure or premature wear. Although these levels are not maintained for long periods of time, they indicate the fail-safe capabilities of DU bearings under extreme operating conditions.

Home appliances and consumer goods

Tape recorders, refrigerators, air conditioners, cleaners, polishers, sewing machines, ovens, dishwashers, clothes washing machines, and other appliances. Even “domestic” applications like these can destroy ordinary self-lubricating bearings. In the case of the washing machines, DU bearings were the only units which could withstand the punishment of combined rotating and reciprocating motion.







APPLIED MOTION TECHNOLOGIES
568-6690

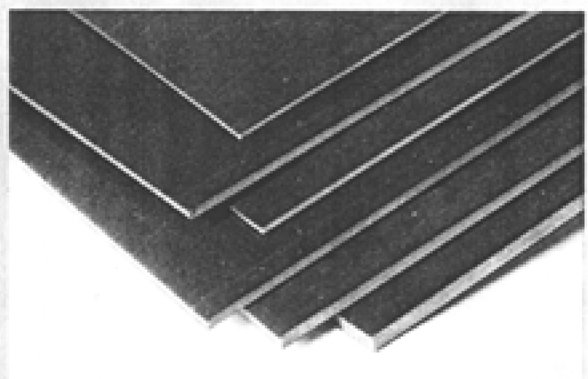
Bearing Length and Part Number								
	4	36DU64	4½	36DU72				
	3¾	40DU60	4	40DU64	4½	40DU72	4¾	40DU76
	4	44DU64	4½	44DU72	4¾	44DU76	5	44DU80
	4	46DU64	4½	46DU72	4¾	46DU76	5	46DU80
	4	48DU64	4½	48DU72	4¾	48DU76	5	48DU80
	4	52DU64	4½	52DU72	4¾	52DU76	5	52DU80
	4	56DU64	4½	56DU72	4¾	56DU76	5	56DU80
	4	58DU64	4½	58DU72	4¾	58DU76	5	58DU80
	4	60DU64	4½	60DU72	4¾	60DU76	5	60DU80
	4	64DU64	4½	64DU72	4¾	64DU76	5	64DU80
	4	68DU64	4½	68DU72	4¾	68DU76	5	68DU80
	4	70DU64	4½	70DU72	4¾	70DU76	5	70DU80
	4	72DU64	4½	72DU72	4¾	72DU76	5	72DU80
	4	76DU64	4½	76DU72	4¾	76DU76	5	76DU80
	4	80DU64	4½	80DU72	4¾	80DU76	5	80DU80
	4	84DU64	4½	84DU72	4¾	84DU76	5	84DU80
	4	88DU64	4½	88DU72	4¾	88DU76	5	88DU80
	4	92DU64	4½	92DU72	4¾	92DU76	5	92DU80
	4	96DU64	4½	96DU72	4¾	96DU76	5	96DU80
	4	100DU64	4½	100DU72	4¾	100DU76	5	100DU80
	4	104DU64	4½	104DU72	4¾	104DU76	5	104DU80
	4	108DU64	4½	108DU72	4¾	108DU76	5	108DU80
	4	112DU64	4½	112DU72	4¾	112DU76	5	112DU80

DU thrust washers – inch sizes

Part Number	Inside Dia. +.010	Outside Dia. −.010	Thick-ness +.0020	Dowel Hole		Housing Recess Depth +.010
				Dia. +.010	P.C. Dia. −.010	
G06DU	.500	.875	.0585	.067	.692	.040
G07DU	.562	1.000	.0585	.067	.786	.040
G08DU	.625	1.125	.0585	.099	.880	.040
G09DU	.687	1.187	.0585	.099	.942	.040
G10DU	.750	1.250	.0585	.099	1.005	.040
G11DU	.812	1.375	.0585	.099	1.099	.040
G12DU	.875	1.500	.0585	.130	1.192	.040
G13DU	.937	1.625	.0585	.130	1.286	.040
G14DU	1.000	1.750	.0585	.130	1.380	.040
G16DU	1.125	2.000	.0585	.161	1.567	.040
G18DU	1.250	2.125	.0585	.161	1.692	.040
G20DU	1.375	2.250	.0585	.161	1.817	.040
G22DU	1.500	2.500	.0585	.192	2.005	.040
G24DU	1.625	2.625	.0585	.192	2.130	.040
G26DU	1.750	2.750	.0585	.192	2.255	.040
G28DU	2.000	3.000	.0895	.192	2.505	.070
G30DU	2.125	3.125	.0895	.192	2.630	.070
G32DU	2.250	3.250	.0895	.192	2.755	.070

Larger diameter and segmented thrust washers can be furnished. Consult factory for details.

DU flat strip material – inch sizes



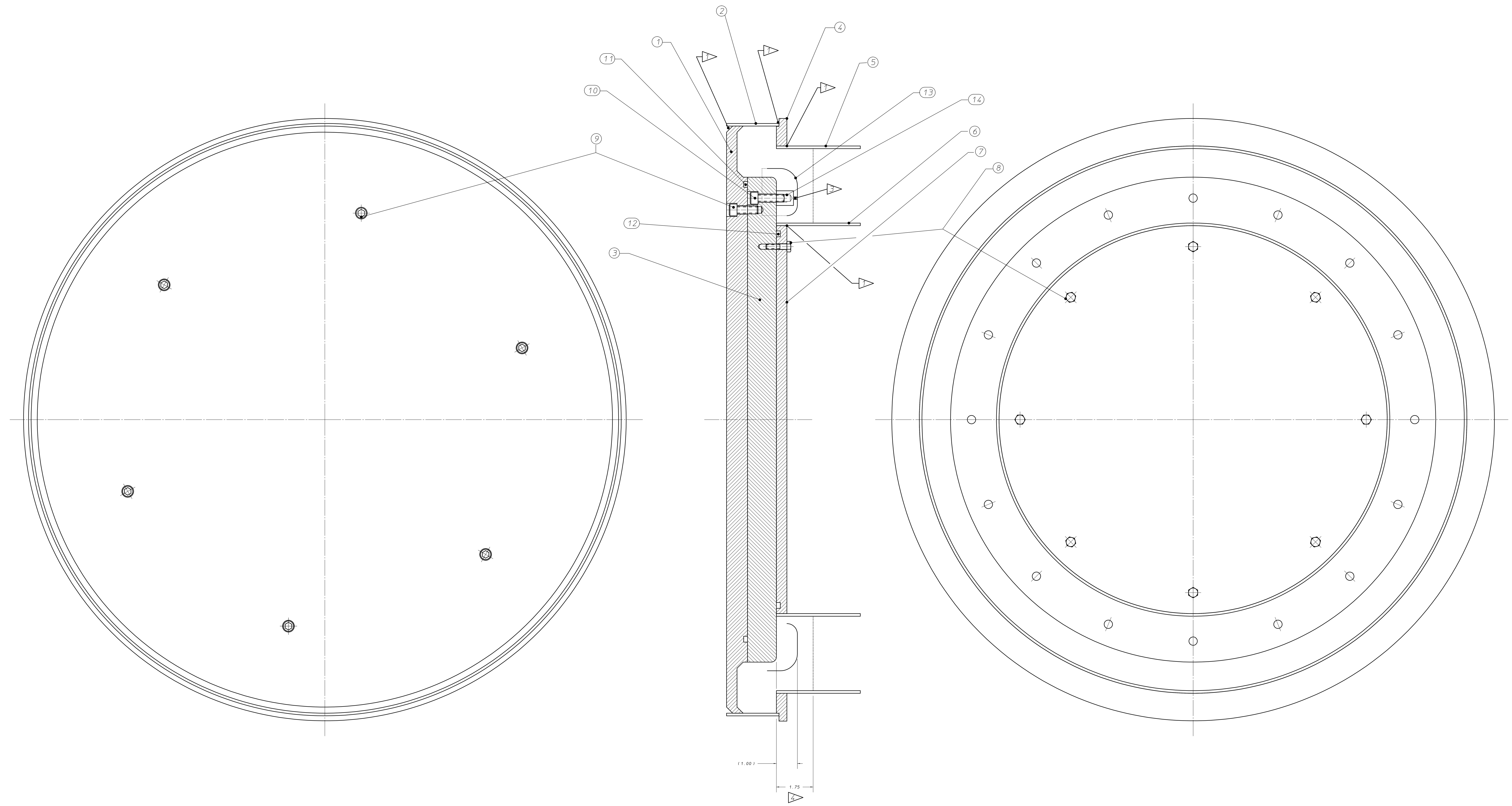
Group	Thickness	Usable Width	Approx. Lbs. Per Ft.
0	.0276/.0296	2¾	0.30
1	.0430/.0450	4¾	0.77
2	.0585/.0605	5	1.06
3	.0738/.0758	5	1.33
4	.0895/.0915	5	1.61
5	.1190/.1210	5½	2.36

Strip material is available in 18-inch and 8-foot lengths. Also available in continuous coil.

Appendix C

Main Insulator Design Drawings

21G7466 Mold Assembly
21G7386A Mold Backplate
21G7396A Mold Midplate
21G7442 Mold Top Plate
21G7433 Mold Outer Ring Flange
21G7422 Mold Rings
21G7453 Wooden Screen Mandrel
21G8964A LEBT Insulator flange assembly
21G8126 65kV Insulator
21C9976A LEBT Insulator Flange
21G8131 Brass alignment plugs



21G7466

NOTES:

1. JOINTS INDICATED SHALL BE SEALED WITH RTV (ITEM 17) TO BE VAC. TIGHT.
2. Ø.250" DOWEL PINS SHALL BE USED WHEN ASSEMBLING PARTS 1 AND 3 TO ENSURE PROPER ALIGNMENT.
3. ITEM 13 SHALL BE SOLDERED TO ITEM 14 AT A MINIMUM OF 8 PLACES TO ENSURE ELECTRICAL CONTACT PRIOR TO POURING OF EPOXY.
4. EPOXY (ITEMS 15 & 16) SHALL BE POURED TO HEIGHT INDICATED AND ALLOWED TO CURE IN A VACUUM ENVIRONMENT.

REQD	ITEM	PART NO	DESCRIPTION
A/R	17	-	RTV SEALANT COMPOUND
A/R	16	-	HYSOL, HD3485 HARDENER
A/R	15	-	HYSOL, C9-4183 CASTING COMPOUND
16	14	-	BRASS INSERTS, TAPPED 3/8-16, .5" KNURLED O.D
1	13	21G7453	MAIN INSULATOR MOLD BRASS SCREEN
1	12	-	O-RING, Ø1/4", 17.70" DIA., VITON
1	11	-	O-RING, Ø1/4", 22.40" DIA., VITON
16	10	-	SHCS, 3/8-16 x 1.25" LONG
6	9	-	SHCS, 3/8-16 x 1" LONG
8	8	-	1/4-20 HEX HEAD SCREW, 1" LONG
1	7	21G7442	MAIN INSULATOR MOLD TOPPLATE
1	6	21G7422-1	INSULATOR MOLD RING, 18.50" I.D
1	5	21G7422-2	INSULATOR MOLD RING, 26.00" O.D
1	4	21G7433	MAIN INSULATOR MOLD OUTER RING PLATE
1	3	21G7296	MAIN INSULATOR MOLD MIDPLATE
1	2	21G7422-3	INSULATOR MOLD RING, 28.00" ID
1	1	21G7386	MAIN INSULATOR MOLD BACKPLATE

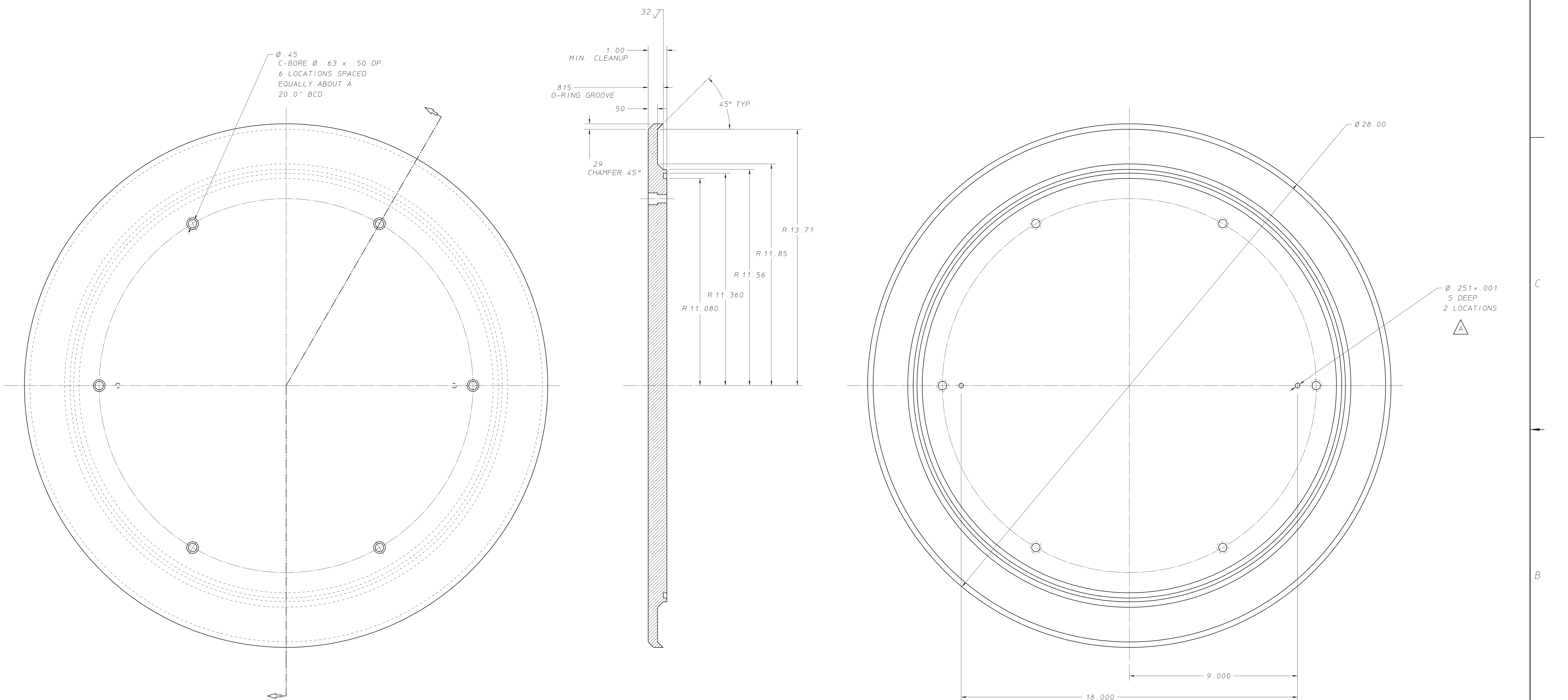
REV	DWG	CHK	ZONE	DATE	CHANGES

UNLESS OTHERWISE SPECIFIED
TOLERANCES: X ± .1 | FRAC ±1/64 | .XX ± .05 | 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 MOLD 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: D. CHENG | DATE 3/3/99
CHK BY | DATE

LAWRENCE BERKELEY LABORATORY
UNIVERSITY OF CALIFORNIA-BERKELEY
SNS-FES ION SOURCE AND LEBT
MECHANICAL SYSTEMS
LEBT MAIN INSULATOR MOLD ASSEMBLY

PATENT CLEAR | DWG TYPE: ASSEMBLY | SHOWN ON | SCALE 2:1 | DO NOT SCALE PRINTS
MICROFILMED | DESIGN ACCT NO: 8210-11 | CATEGORY CODE: FE3111 | DWG NO: 21G7466 | SIZE | REV



21G7386A

A/R	1	-	ALUMINUM PLATE, 1" THICK, 6061-T6
REQD	ITEM	PART NO.	DESCRIPTION

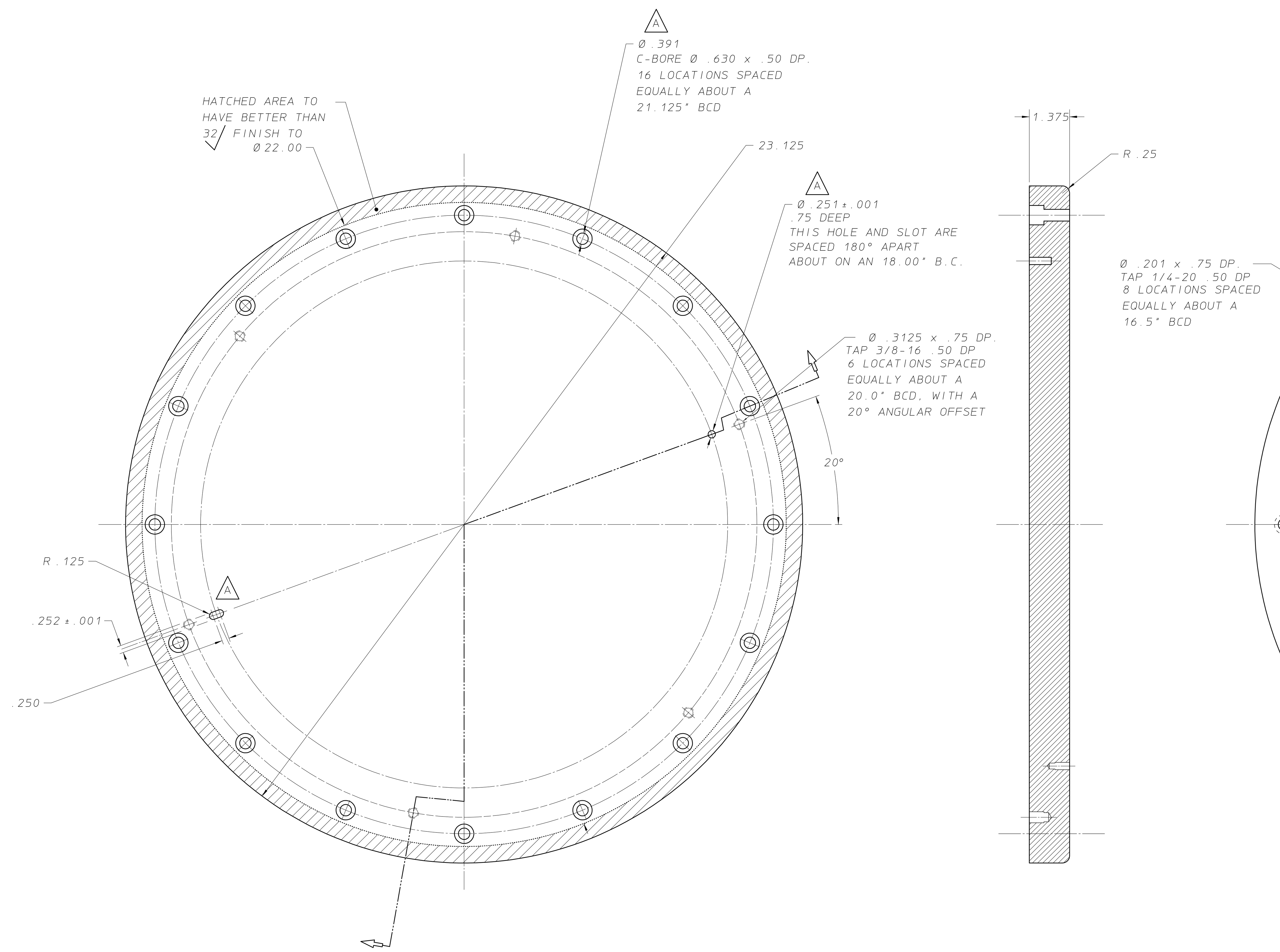
REV	DWG	CHK	ZONE	DATE	CHANGES
A	DWC		C2,C3	11/6/99	ADDED Ø.251 ± .001 DOWEL HOLES

UNLESS OTHERWISE SPECIFIED
TOLERANCES: .X ± .1 FRAC. ±1/64; .XX ± .01 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 .020 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 D. CHENG DATE 3/3/99
CHK. BY DATE

LAWRENCE BERKELEY LABORATORY
UNIVERSITY OF CALIFORNIA-BERKELEY
SNS-FE
PROTOTYPE LEBT
MAIN INSULATOR MOLD BACKPLATE

PATENT CLEAR | DWG. TYPE DETAIL | SHOWN ON 21G7466 | SCALE 1:2 | DO NOT SCALE PRINTS
MICROFILMED | DESIGN ACCT. NO. 8210-14 | CATEGORY CODE FE1100 | DWG. NO. 21G7386 | SIZE | REV. A



21G7296A

REQD	ITEM	PART NO.	DESCRIPTION
A/R	1	-	ALUMINUM PLATE, TYPE 6061, 1.5" STOCK

REV	DWG	CHK	ZONE	DATE	CHANGES
A	DWC		C6	11/6/99	CHANGED Ø.450 THRU HOLE TO Ø.391
A	DWC		C5,B7	11/6/99	ADDED ALIGNMENT HOLE AND SLOT

UNLESS OTHERWISE SPECIFIED

TOLERANCES: .X ± .1 | FRAC. ±1/64 | .XX ± .01 | ANGLES ± 1° | .XXX ± .005 | FINISH 125

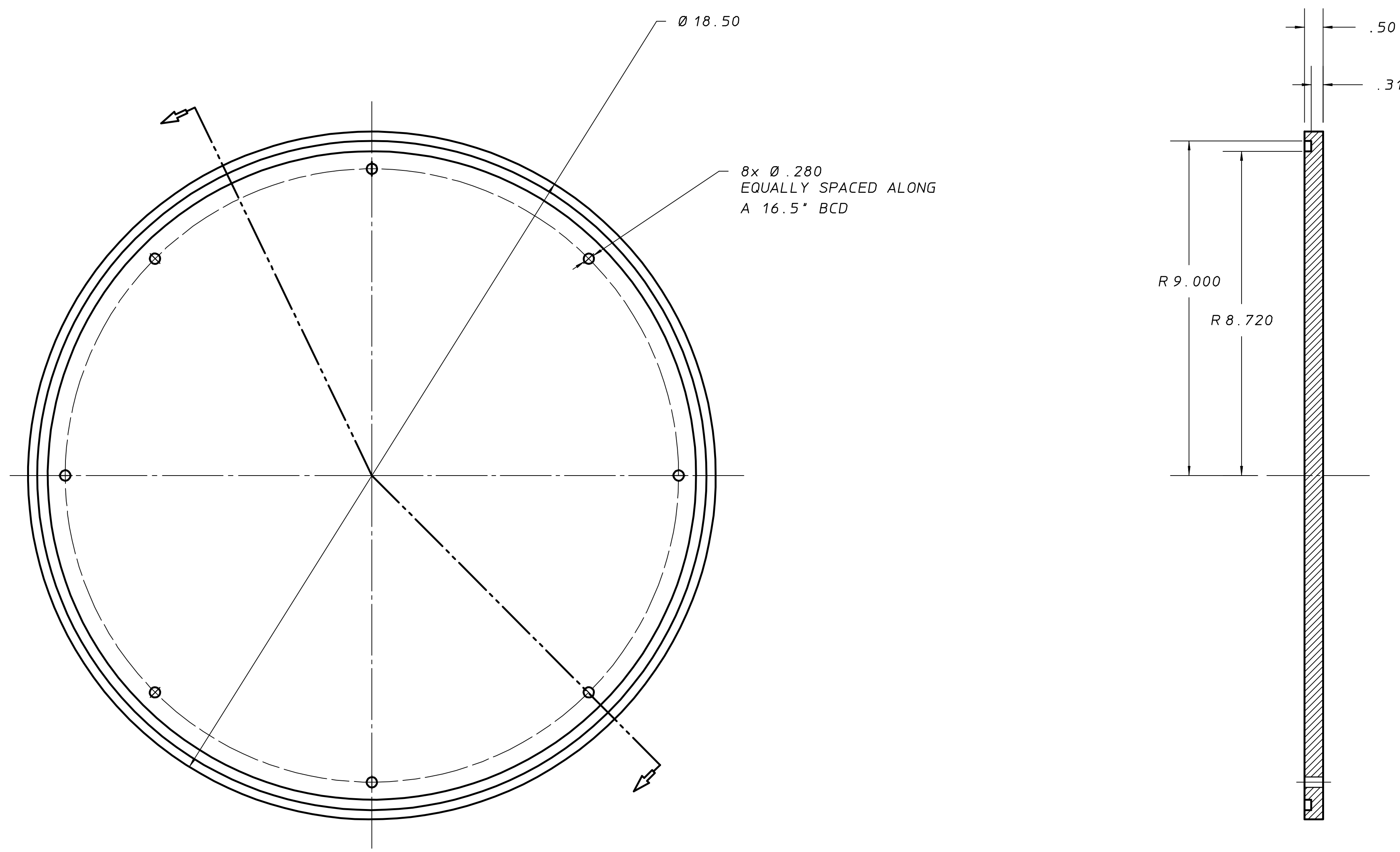
THREADS ARE CLASS 2
CHAMFER ENDS OF ALL SCREW THREADS 30°.
CUT 1.5 PITCH THRD RELIEF WITH ROUND NOSE TOOL ON MACHINE CUT THREADS.
BREAK EDGES .020 MAX. ON MACHINED WORK
REMOVE BURRS WELD SPLATTER & LOOSE SCALE
REFERENCES: ANSI Y14.5 & B46.1.

SHOP ORDERS
ACCT. NO. | SERIAL NO.
DATE ISSD | DATE REQD. | NO. REQD.
DELIVER TO
SURFACE TREATMENT: DEGREASE
IDENT. METH.: TAG
DWG. BY: D. CHENG | DATE: 3/3/99
CHK. BY | DATE

LAWRENCE BERKELEY LABORATORY
UNIVERSITY OF CALIFORNIA-BERKELEY
SNS-FES ION SOURCE AND LEBT
PROTOTYPE LEBT
MAIN INSULATOR MOLD MIDPLATE

PATENT CLEAR	DWG. TYPE	SHOWN ON	SCALE	DO NOT SCALE PRINTS
	DETAIL	21G7466	FULL	
MICROFILMED	DESIGN ACCT. NO.	CATEGORY CODE	DWG. NO.	SIZE / REV.
	8210-14	FE1111	21G7396	A

21G7442	REQD	ITEM	PART NUMBER	DESCRIPTION
				ALUMINUM PLATE, .5" STOCK, 19" x 19"



REV	DWN	CHK	DATE	DESCRIPTION

UNLESS OTHERWISE SPECIFIED

TOLERANCE .X ± .1 .XX ± .01 .XXX ± .005

SURFACE FINISH 125 ✓

1. SAWED, FLAMECUT, SHEARED OR CUT STOCK FINISH.
2. THREADS CLASS 2.
3. CHAMFER ENDS OF ALL SCREW THRDS 30°.
4. 1 1/2 PITCH RELIEF WITH ROUND NOSE TOOL ON ALL MACHINE CUT THRDS.
5. BREAK EDGES .020 MAX. ON MACHINE WORK.
6. REMOVE BURRS, LOOSE SCALE AND WELD SPLATTER.
7. REF.-USASI OR ASA STDS SECT Y-14 & B46-1.

SHOP ORDERS

ACCT NO		SER NO
DATE ISSD	DATE REQD	NO REQD
DELIVER TO		
SURFACE TREATMENT DEGREASE		
IDENTIFIC METHOD TAG		
DWG BY D. CHENG		DATE 3/3/99
CHK BY		DATE

LAWRENCE BERKELEY LABORATORY
UNIVERSITY OF CALIFORNIA-BERKELEY

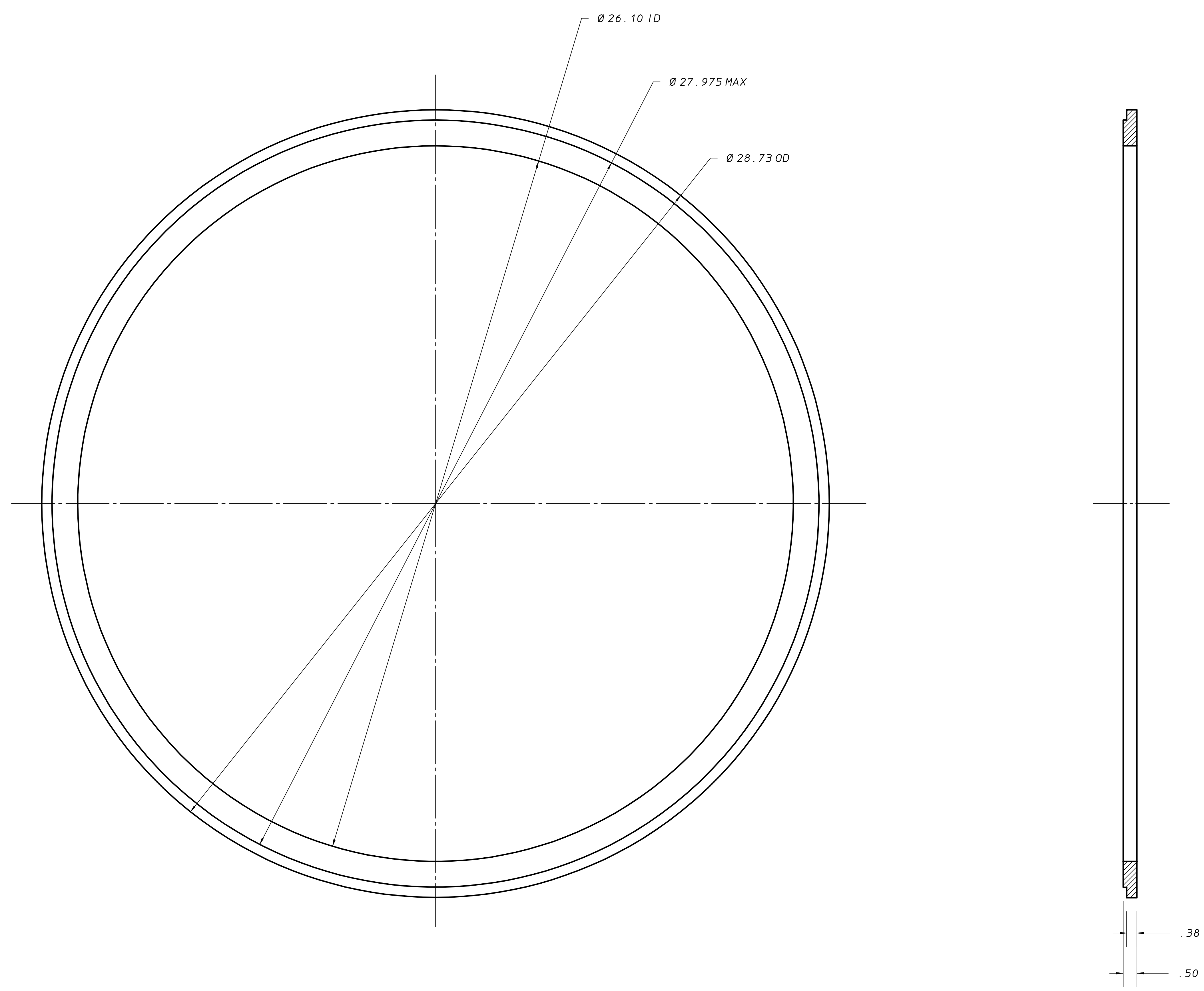
SNS-FES ION SOURCE AND LEBT

PROTOTYPE LEBT

MAIN INSULATOR MOLD TOP PLATE

PAT CLEAR	DWG TYPE DETAIL	SHOWN ON 21G7466	SCALE: 1 : 4 DO NOT SCALE PRINTS
MICROFILMED	DESIGN ACCT NO 8210-14	CATEGORY CODE FE3111	DWG NO 21G7442 REV

REQ	ITEM	PART NUMBER	DESCRIPTION
			ALUMINUM PLATE, .5" STK, 29" SQ.



21G7433

REV	DWG	CHK	ZONE	DATE	CHANGES

UNLESS OTHERWISE SPECIFIED

TOLERANCES		
	.X ± .1	FRAC. ±1/64
	.XX ± .01	ANGLES ±.01°
	.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 D. CHENG
DATE 3/3/99
CHK. BY
DATE

LAWRENCE BERKELEY LABORATORY
UNIVERSITY OF CALIFORNIA-BERKELEY

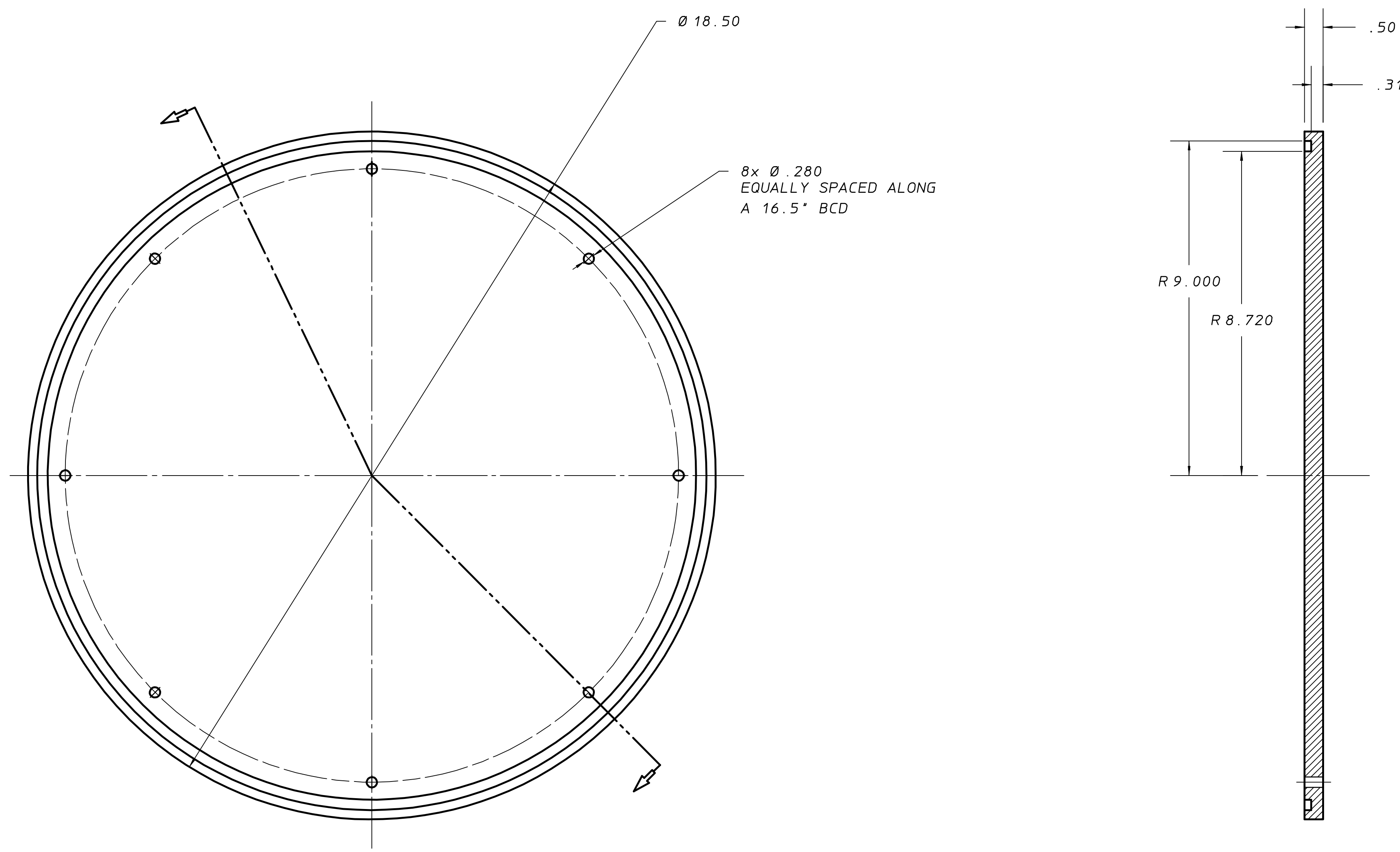
SNS-FE

PROTOTYPE LEBT

MAIN INSULATOR MOLD OUTER RING PLATE

PATENT CLEAR	DWG. TYPE	SHOWN ON	SCALE	DO NOT SCALE PRINTS
	DETAIL	21G7466	1 : 4	
MICROFILMED	DESIGN ACCT. NO.	CATEGORY CODE	DWG. NO.	SIZE / REV.
	8210-14	FE1100	21G7433	

21G7442	REQD	ITEM	PART NUMBER	DESCRIPTION
				ALUMINUM PLATE, .5" STOCK, 19" x 19"



REV	DWN	CHK	DATE	DESCRIPTION

UNLESS OTHERWISE SPECIFIED

TOLERANCE .X ± .1 .XX ± .01 .XXX ± .005

SURFACE FINISH 125 ✓

1. SAWED, FLAMECUT, SHEARED OR CUT STOCK FINISH.
2. THREADS CLASS 2.
3. CHAMFER ENDS OF ALL SCREW THRDS 30°.
4. 1 1/2 PITCH RELIEF WITH ROUND NOSE TOOL ON ALL MACHINE CUT THRDS.
5. BREAK EDGES .020 MAX. ON MACHINE WORK.
6. REMOVE BURRS, LOOSE SCALE AND WELD SPLATTER.
7. REF.-USASI OR ASA STDS SECT Y-14 & B46-1.

SHOP ORDERS

ACCT NO		SER NO
DATE ISSD	DATE REQD	NO REQD
DELIVER TO		
SURFACE TREATMENT DEGREASE		
IDENTIFIC METHOD TAG		
DWG BY D. CHENG		DATE 3/3/99
CHK BY		DATE

LAWRENCE BERKELEY LABORATORY
UNIVERSITY OF CALIFORNIA-BERKELEY

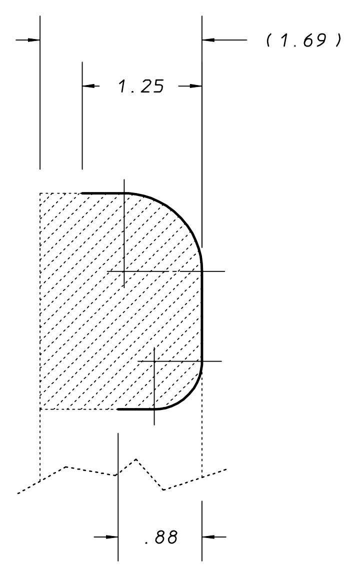
SNS-FES ION SOURCE AND LEBT

PROTOTYPE LEBT

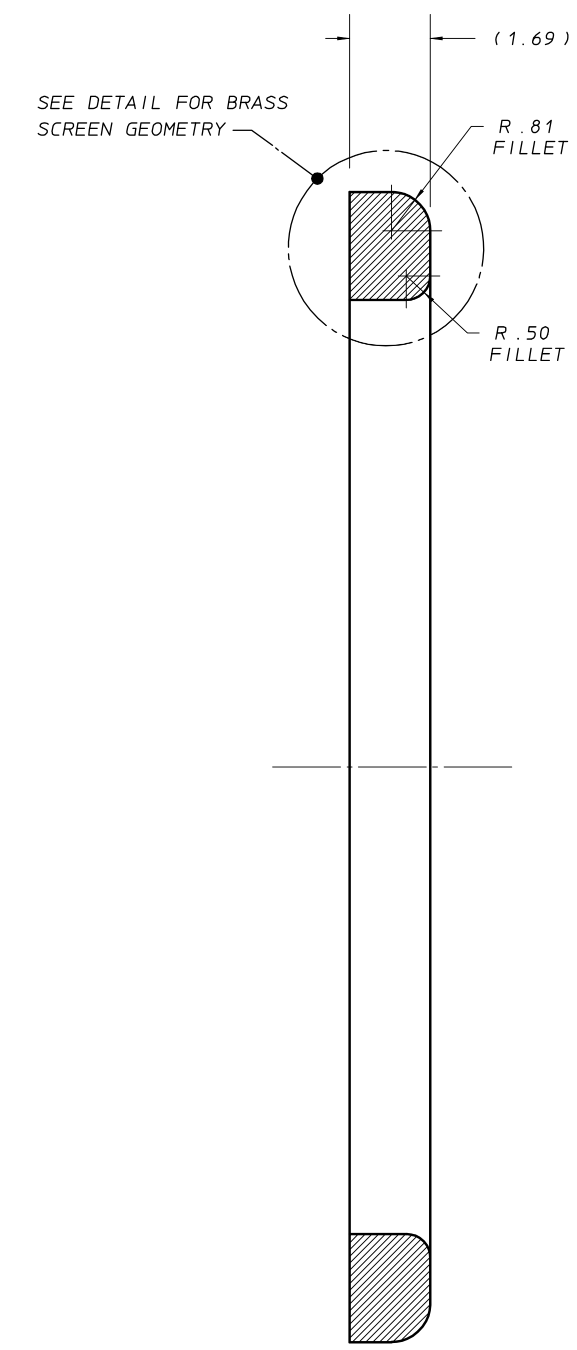
MAIN INSULATOR MOLD TOP PLATE

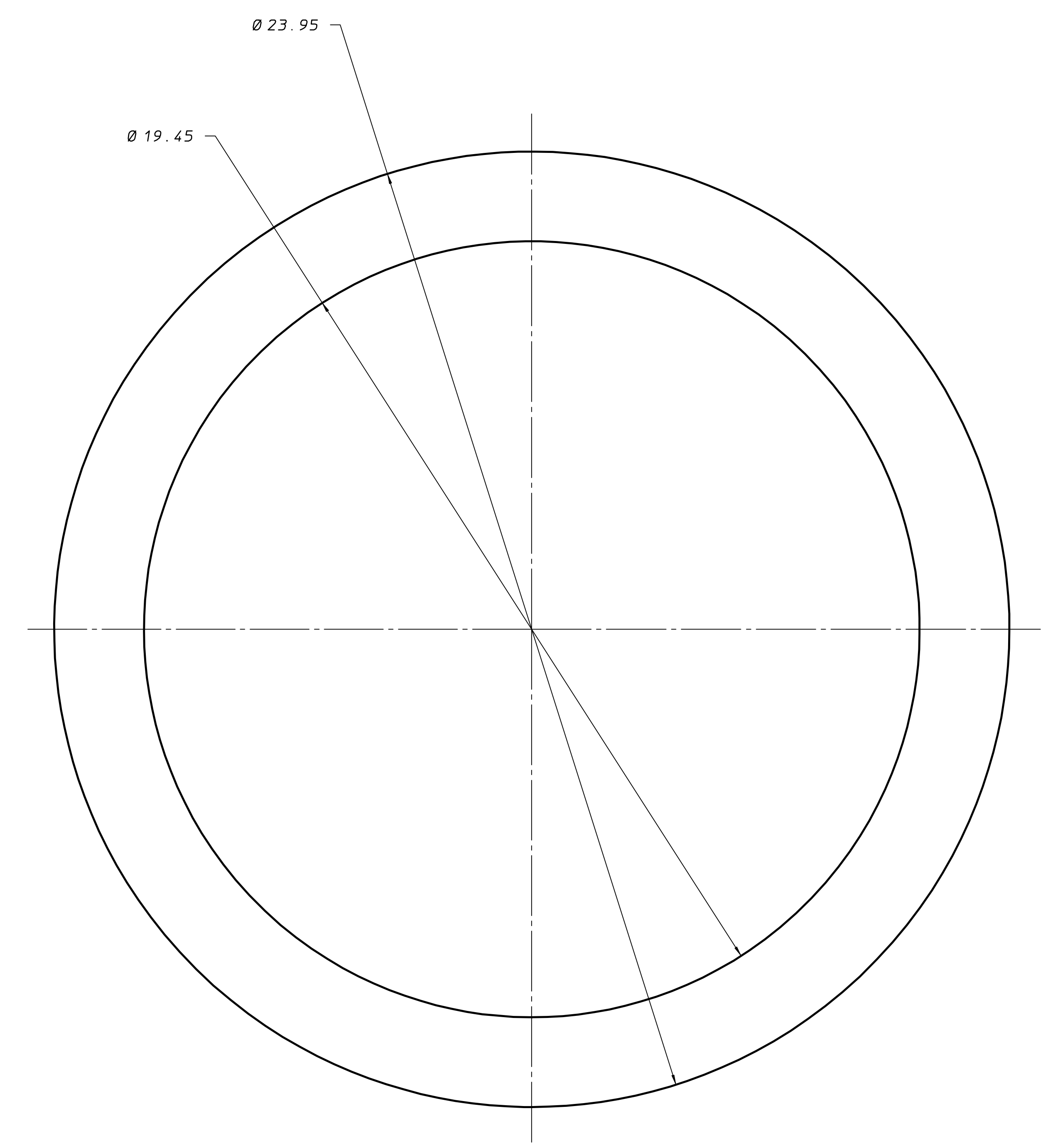
PAT CLEAR	DWG TYPE DETAIL	SHOWN ON 21G7466	SCALE: 1:4 DO NOT SCALE PRINTS
MICROFILMED	DESIGN ACCT NO 8210-14	CATEGORY CODE FE3111	DWG NO 21G7442 REV

REQ	ITEM	PART NUMBER	DESCRIPTION
A/R	1	-	PLYWOOD, 1.5" THICK STOCK
A/R	2	-	SCREEN, BRASS NET



DETAIL OF SCREEN
SCALE 2:1





21G7453

NOTES:
1. THIS WOODEN MANDREL IS TO BE USED TO FORM THE BRASS SCREEN'S SHAPE
2. BRASS SCREEN SHALL BE FORMED TO DIMENSIONS SHOWN IN DETAIL AND SOLDERED WHERE NECESSARY.

REV	DWG	CHK	ZONE	DATE	CHANGES

UNLESS OTHERWISE SPECIFIED

TOLERANCES		
	.X ± .1	FRAC. ±1/64
	.XX ± .05	ANGLES ±.01°
	.XXX ± .005	FINISH 125

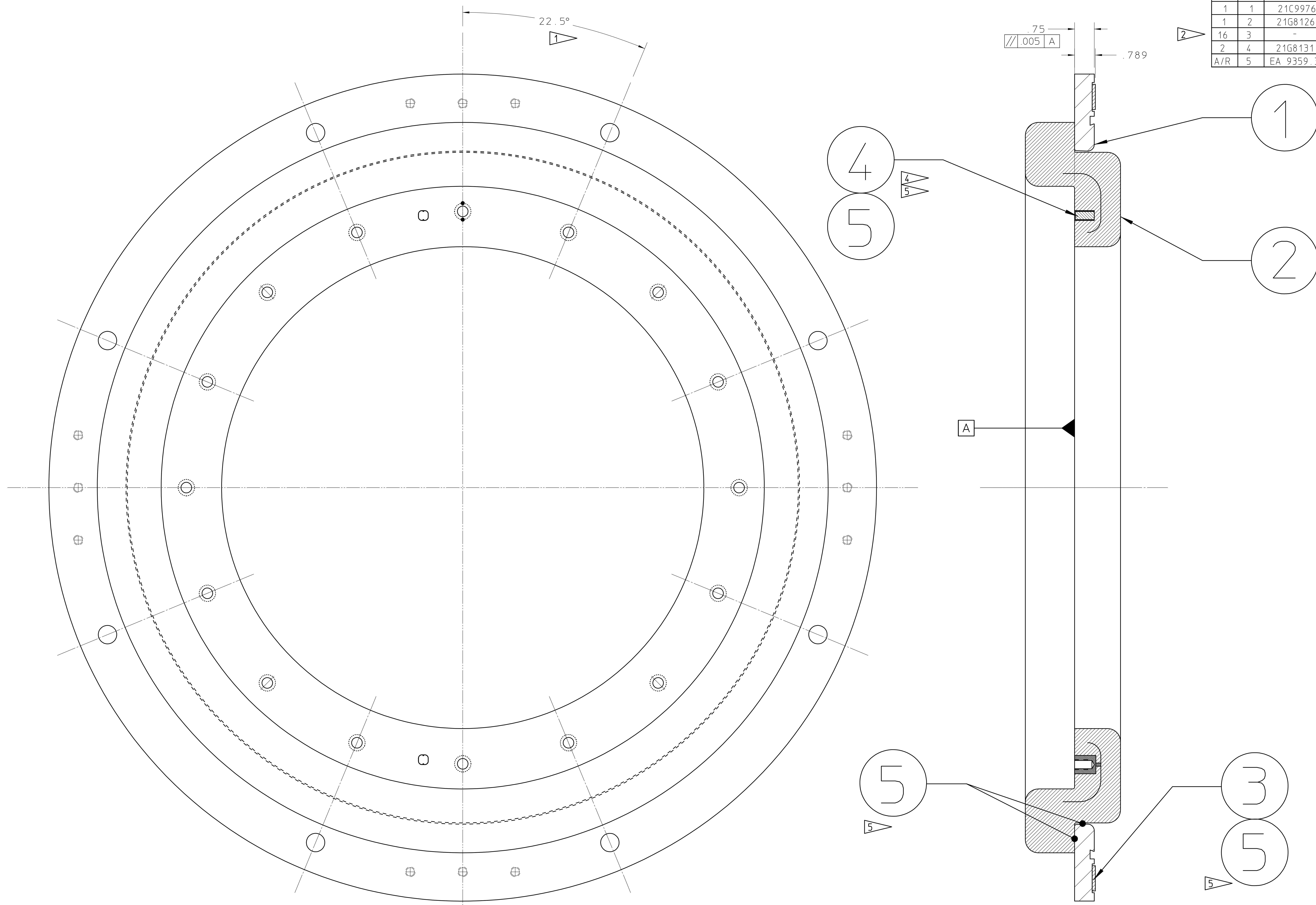
THREADS ARE CLASS 2
CHAMFER ENDS OF ALL SCREW THREADS 30°.
CUT 1.5 PITCH THRD RELIEF WITH ROUND NOSE TOOL ON MACHINE CUT THREADS.
BREAK EDGES .016 MAX. ON MACHINED WORK
REMOVE BURRS WELD SPLATTER & LOOSE SCALE
REFERENCES: ANSI Y14.5 & B46.1.

SHOP ORDERS
ACCT. NO. | SERIAL NO.
DATE ISSD | DATE REQD. | NO. REQD.
DELIVER TO
SURFACE TREATMENT DEGREASE
IDENT. METH. TAG
DWG. BY D. CHENG | DATE 3/3/99
CHK. BY | DATE

LAWRENCE BERKELEY LABORATORY
UNIVERSITY OF CALIFORNIA-BERKELEY
SNS-FE
PROTOTYPE LEBT
MAIN INSULATOR MOLD SCREEN & MANDREL

PATENT CLEAR	DWG. TYPE DETAIL	SHOWN ON 21G7466	SCALE 1:4	DO NOT SCALE PRINTS
MICROFILMED	DESIGN ACCT. NO. 8210-14	CATEGORY CODE FE1100	DWG. NO. 21G7453 SIZE	REV.

REQ	ITEM	PART NUMBER	DESCRIPTION
1	1	21C9976	LEBT INSULATOR FLANGE
1	2	21G8126	65 KV INSULATOR FINISH MACHINING
16	3	-	DU BEARING PAD MATERIAL, .0895" THK X 1" SQUARE
2	4	21G8131	BRASS ALINGMENT PLUG
A/R	5	EA 9359.3	HYSOL 2-PART ADHESIVE, 50 ML SEMPAK



NOTE:

1. THIS ANGLE SETS THE ORIENTATION OF THE HOLE PATTERN OF THE STEEL FLANGE WITH RESPECT TO THE EPOXY CASTING.
2. DU BEARING PAD MATERIAL CAN BE OBTAINED IN 5" X 18" SHEETS FROM APPLIED MOTION TECHNOLOGY OAKLAND, CA (510) 568-6690
3. WIPE ALL PARTS DOWN WITH ACETONE, FOLLOWED BY ALCOHOL PRIOR TO GLUE-UP OF ALL PARTS.
4. ENSURE THAT ITEM 4 SITS FLUSH OR BELOW THE SURFACE BEFORE BEING ALLOWED TO SET.
5. ALL EXCESS EPOXY SHALL BE WIPED UP USING ALCOHOL AND WIPES,

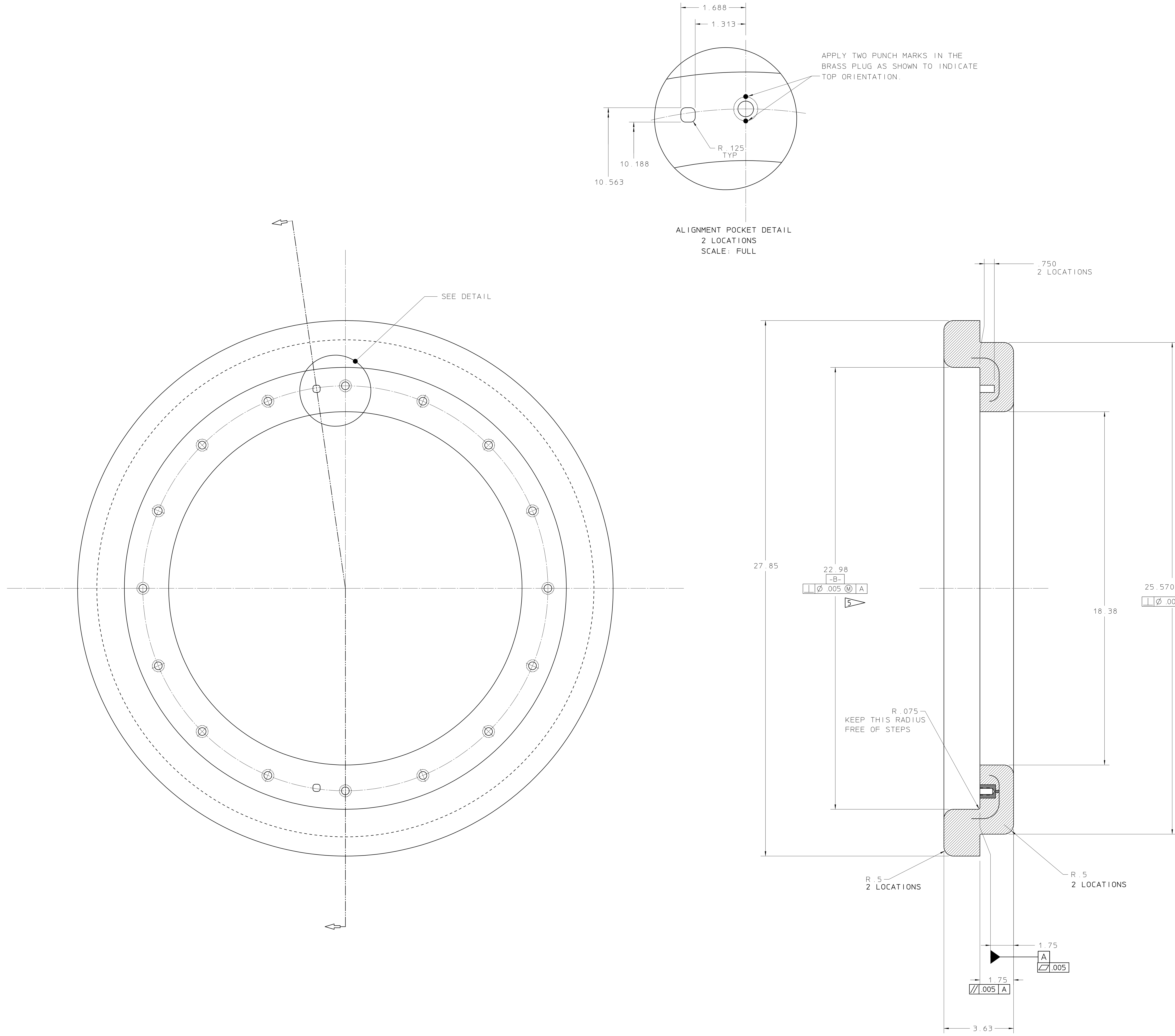
21G8964A

REV	DWG	CHK	ZONE	DATE	CHANGES
A	DWC		-	10/27/01	GENERAL GEOMETRY UPDATE

UNLESS OTHERWISE SPECIFIED
TOLERANCES: .X ± .1 — FRAC. ±1/64 — .XX ± .01 — ANGLES ±1° — .XXX ± .005 — FINISH 64
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: S. MUKHERJEE — DATE 06-04-99
CHK. BY: D. CHENG — DATE 6/15/99

LAWRENCE BERKELEY LABORATORY
UNIVERSITY OF CALIFORNIA-BERKELEY
SNS - FRONT END SYSTEM
ION SOURCE PROTOTYPE DESIGN
LEBT INSULATOR FLANGE ASSEMBLY
PATENT CLEAR — DWG. TYPE: ASSEMBLY — SHOWN ON — SCALE: FULL — DO NOT SCALE PRINTS
MICROFILMED — DESIGN ACCT. NO.: 8210-14 — CATEGORY CODE: FE1100 — DWG. NO.: 21G8964 — SIZE — REV.: A



NOTES:

1. USE NO OILS.
2. PART SHALL BE CAST WITH HYSOL EPOXY C9-4190 AND HD3485 IN MOLD DESIGNED IN DWG. 21G7466.
3. PART MAY BE WIPED DOWN WITH ACETONE, FOLLOWED BY ALCOHOL.
4. DIAMOND TOOLS ARE REQUIRED TO MACHINE ALL SURFACES.
5. DATUM -B- SHALL BE CONCENTRIC TO THE EXISTING BOLT HOLD PATTERN IN THE EPOXY CASTING.

21G8126

REQD	ITEM	PART NO	DESCRIPTION

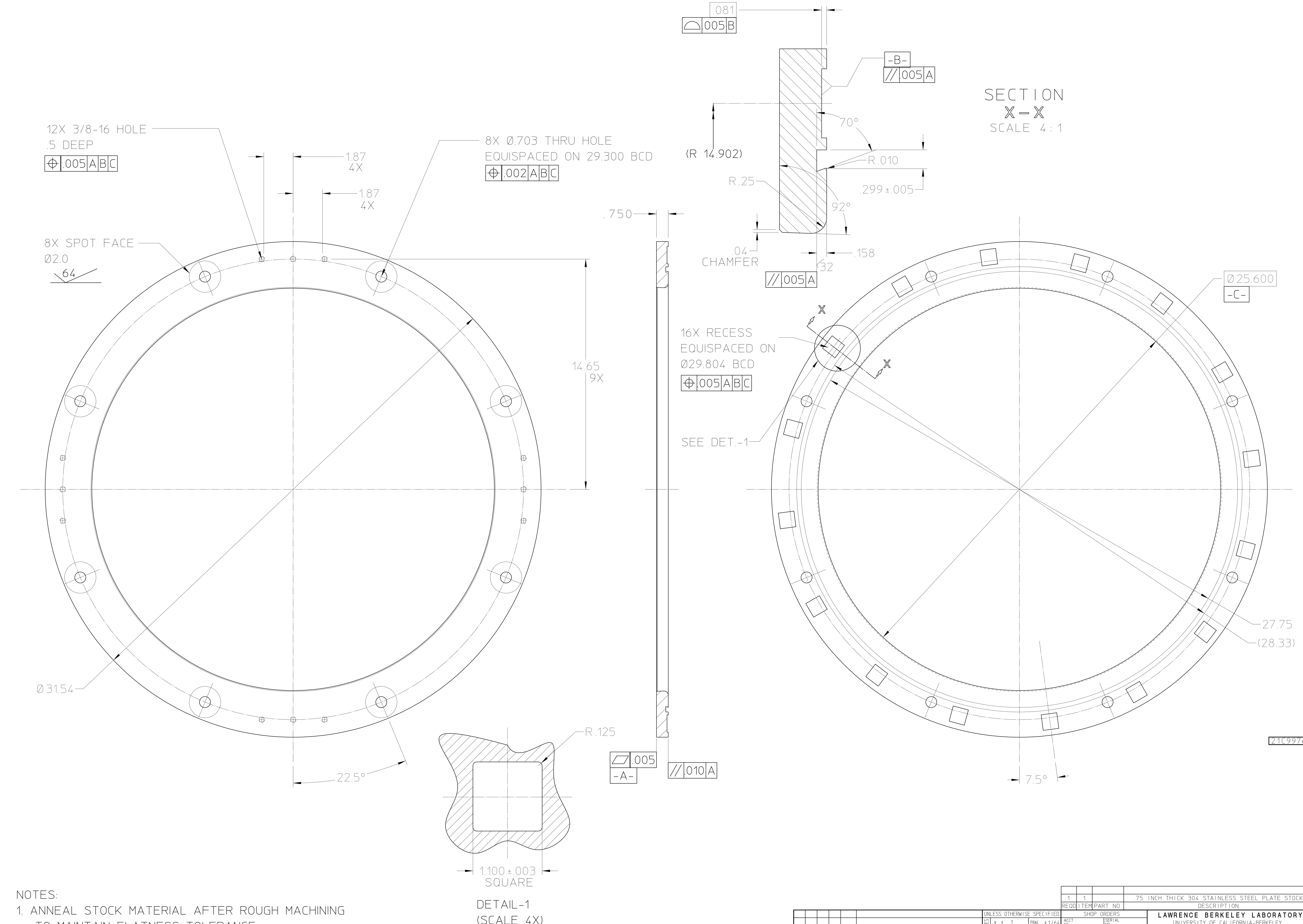
UNLESS OTHERWISE SPECIFIED
TOLERANCES: X ± .1 — FRAC ±1/64; XX ± .01 — ANGLES ± 1°; XXX ± .005 — FINISH 64
THREADS ARE CLASS 2
CHAMFER ENDS OF ALL SCREW THREADS 30°
CUT 1.5 PITCH THRD RELIEF WITH ROUND NOSE TOOL ON MACHINE CUT THREADS.
BREAK EDGES .016 MAX. ON MACHINED WORK
REMOVE BURRS WELD SPLATTER & LOOSE SCALE
REFERENCES: ANSI Y14.5 & B46.1

REV	DWG	CHK	ZONE	DATE	CHANGES

SHOP ORDERS — ACCT NO — SERIAL NO — DATE ISSD — DATE REQD — NO REQD — DELIVER TO
SURFACE TREATMENT: ALCOHOL WIPE
IDENT METH: TAG
DWG BY: D.CHENG — DATE: 5-10-99
CHK BY — DATE

LAWRENCE BERKELEY LABORATORY
UNIVERSITY OF CALIFORNIA-BERKELEY
SNS-FRONT END SYSTEMS
ION SOURCE AND LEBT MECHANICAL
65KV FINISH MACHINING

PATENT CLEAR	DWG. TYPE	SHOWN ON	SCALE	DO NOT SCALE PRINTS
	DET	21G8964	FULL	
MICROFILMED	DESIGN ACCT. NO	CATEGORY CODE	DWG. NO.	SIZE / REV
	8212-A1	FE3130	21G8126	



NOTES:

1. ANNEAL STOCK MATERIAL AFTER ROUGH MACHINING TO MAINTAIN FLATNESS TOLERANCE.

2. REMOVE ALL SHARP CORNERS.

REQD	ITEM	PART NO.	DESCRIPTION
1	1		.75 INCH THICK 304 STAINLESS STEEL PLATE STOCK

REV	DWG	CHK	ZONE	DATE	CHANGES
A	DWC		-	10/25/01	GENERAL GEOMETRY UPDATE

UNLESS OTHERWISE SPECIFIED

TOLERANCES: .X ± .1 | FRAC. ±1/64 | .XX ± .01 | 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

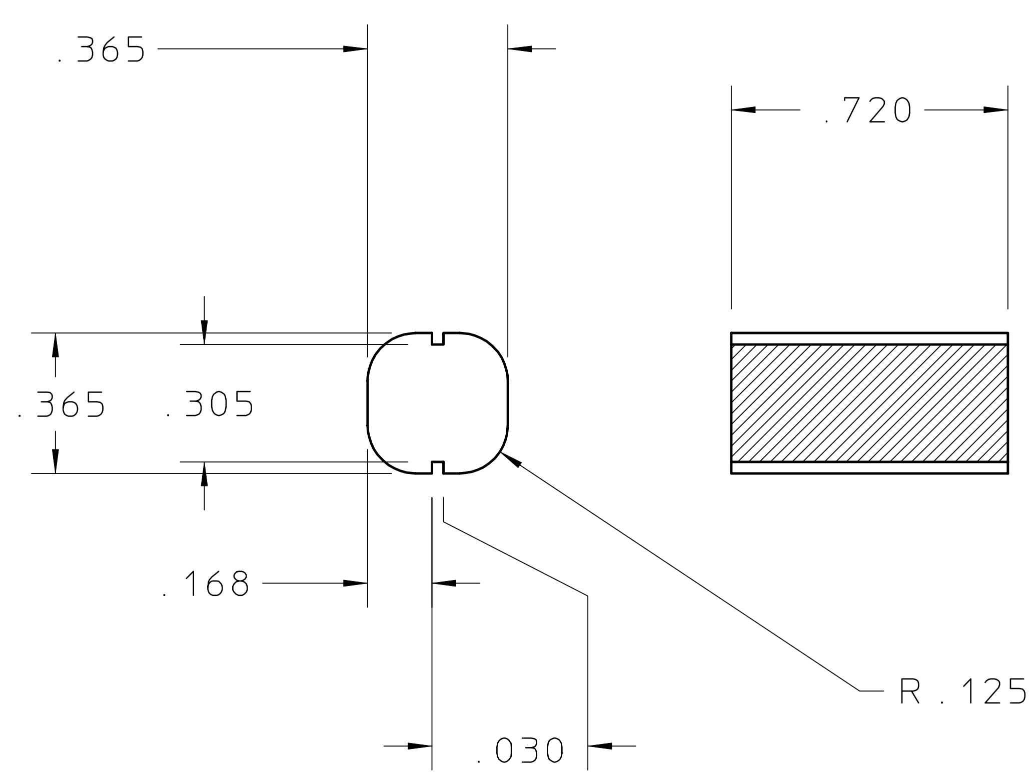
DWG. BY: S. MUKHERJEE — DATE 05-18-99

CHK. BY: D. CHENG — DATE 11-11-99

LAWRENCE BERKELEY LABORATORY
UNIVERSITY OF CALIFORNIA-BERKELEY
SNS - FRONT END SYSTEM
ION SOURCE PROTOTYPE DESIGN
LEBT INSULATOR FLANGE

PATENT CLEAR	DWG. TYPE	SHOWN ON	SCALE	DO NOT SCALE PRINTS
	DETAIL	21G8964	1:2	
MICROFILMED	DESIGN ACCT. NO.	CATEGORY CODE	DWG. NO.	SIZE / REV.
	8210-14	FE1100	21C9976	A

Dwg. No. 21G8131 Size Rev



Material - BRASS ROD STOCK		- - - -	
Unless Otherwise Noted		Rev Dwn Date Changes	
.X ± .1 .XX ± .025 .XXX ± .005 Angles ± .5°		LAWRENCE BERKELEY LABORATORY	
Break Edges .016 Max on Machined Work Remove Burrs Weld Splatter and Loose Scale References: ANSI Y 14.5 & B46.1		University of California - Berkeley	
		SNS-FES ION SOURCE AND LEBT	
Account Number -	Finish ✓ 64	MECHANICAL SYSTEMS	
Date Issued -	Date Reqd -	BRASS ALIGNMENT PLUG	
Number Required -	Deliver To -	Shown on Dwg No. 21G8964	
Surface Treatment Degrease	Identific Method Tag	Patent Clear	Category Code FE-3111 — Do not Scale Prints
Drawn By D. CHENG	Date 6-8-99	Micro-Filmed	Drawing Scale Full — Dwg. No. 21G8131 Size Rev
Check By D. CHENG	Date 6-11-99	Design Account 8210-14	Drawing Type Detail