

N A T IO N A L LABORATORY

# MPO B593110 - Final Report

C. Brooksby

July 26, 2011

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This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.

#### MPO B593110 - Final Report NSTec Mechanical Engineering Support to the Linear Collider Subsystem Development Program Craig Brooksby, NSTec, 7/14/11

#### The <u>Scope of Work</u> for this MPO was as follows:

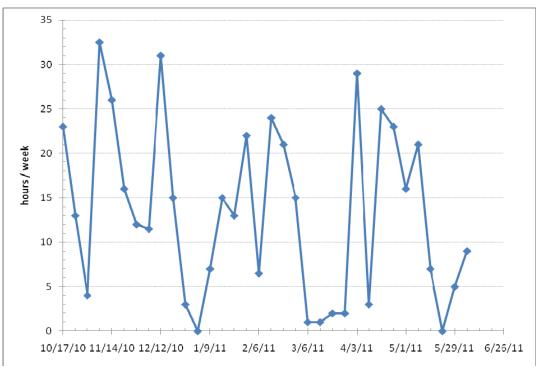
National Security Technologies, LLC (NSTec) shall provide one (1) Mechanical Engineer to support the Linear Collider Subsystem Development Program at Lawrence Livermore National Security, LLC (LLNS). The NSTec Mechanical Engineer's efforts will include engineering, design, and drawing support for the Vacuum Seal Test. NSTec will also provide a final report of the setup and input to LLNL's project management on project status.

The NSTec Mechanical Engineer's efforts will also include engineering, design, and drawing support to the conceptual design for manufacturing of the Flux Concentrator Magnet. NSTec will also contribute to LLNS's final report on the Flux Concentrator Magnet.

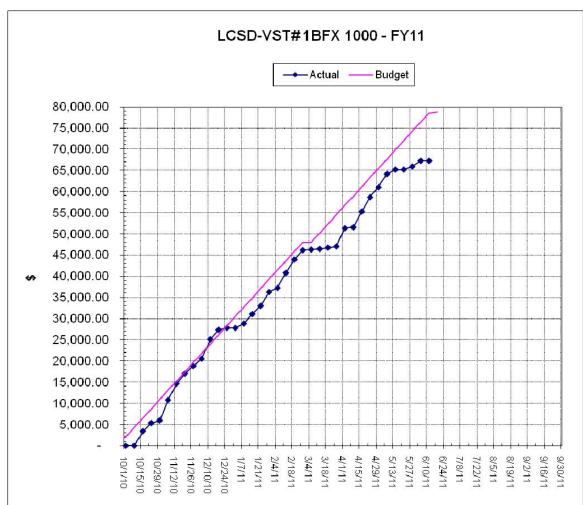
The deliverables are drawings, sketches, engineering documents, and final reports delivered to the LLNS Technical Representative.

#### Time and Effort Summary:

This contract was put in place on 10/4/10 and the project ran until 6/2/11. This contract was funded to a level of \$78,731 of which \$67,253.84 were used. Craig Brooksby, the mechanical engineer, spent 454.5 hours on the project. See **Figure 1** for the profile of the hours spent on the project. This averages to about 13hrs/wk, or about 1/3 time.



**Figure 1 – Engineering Hours per Week spent on project** 



See Figure 2 for a summary of the FY11 budget and spending profile.

Figure 2 - FY11 Budget and Spending Profile

# Linear Collider Subsystem Development - FY11 - Monthly Work Performed Bullet Summary:

#### <u>Oct 10</u>

Started seal assembly layout on ProE. Initial contact with seal and water union companies.

### <u>Nov 10</u>

Worked out basic design of seal assembly and started detail drawings. Researched hollow shaft motors. Found vacuum vessel to use for tests.

#### <u>Dec 10</u>

Found vacuum pumps and valves to use for tests. Worked on motor issues. More ProE modeling and drawings.

### <u>Jan 11</u>

Found new hollow shaft motor that was available. Bearing design. Finalize much of design.

<u>Feb 11</u>

Got detail drawings ready of checking and implemented LLNL's new drawing formats.

# <u>Mar 11</u>

Finished specifying motor with Nick Killingsworth and got final quote and placed orders for this and may other components. Found space in B431 for tests. Updated all detail drawings in prep for fabrication quotes.

## <u>Apr 11</u>

Parts out for fab quotes and then released for fab. Completed assembly drawings. Did several calculations on vacuum vessel and components.

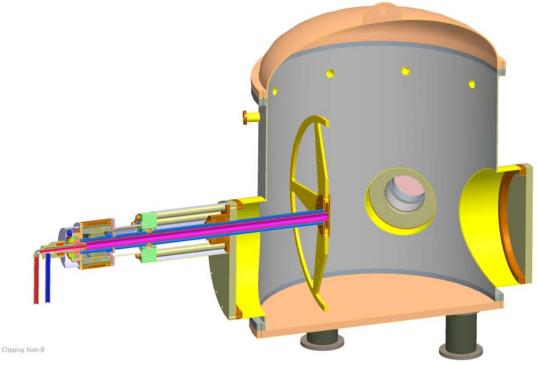
### <u>May 11</u>

More calculations and prep for MESN. Followed all fabrications and purchase of other components.

# **Design Effort Summary:**

Because of LLNL's requirements all the engineering and design effort went into the Vacuum Seal Test part of the Scope of Work. No effort was done on the Flux Concentrator Magnet part of the Scope of Work.

I did all the ProE CAD modeling to design up the configuration for the Vacuum Seal Test. This is shown in **Figure 3**.



# Figure 3 – Vacuum Seal Test Assembly

I worked with the LLNL engineer Lisle Hagler, and the motor and vacuum seal companies, to design the support system for the cantilevered flywheel. See **Figure 4**.

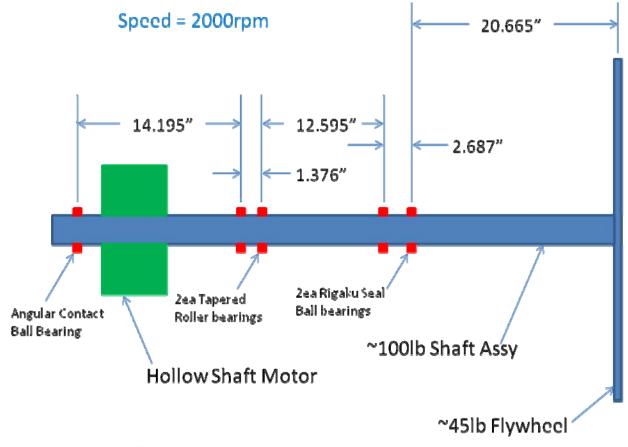
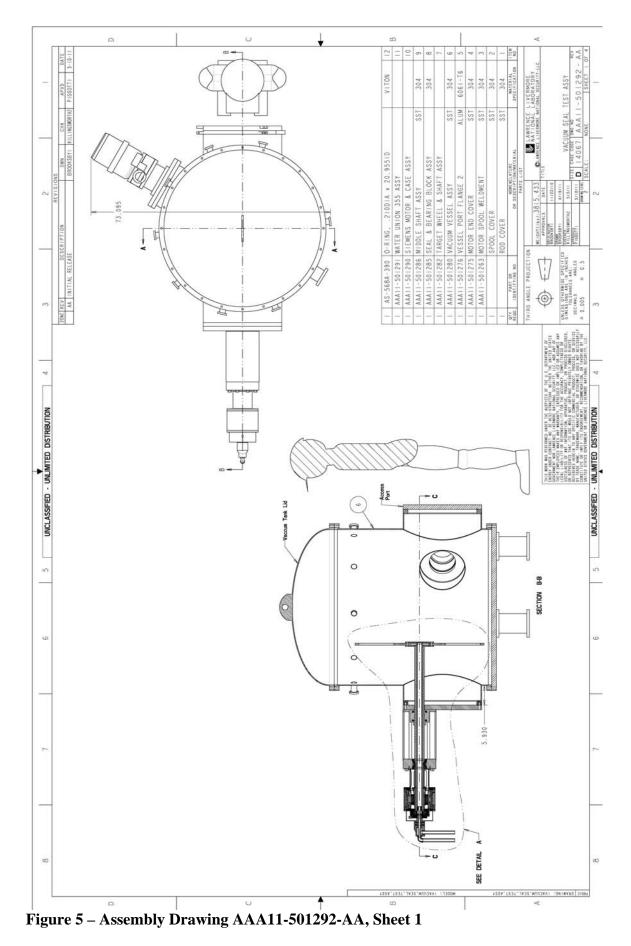
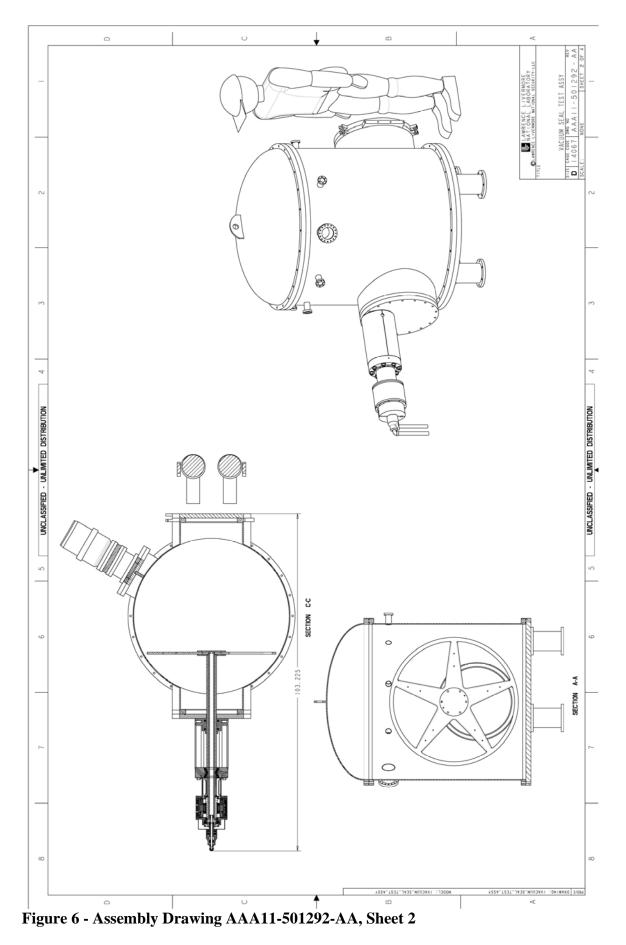


Figure 4 - Vacuum Seal Test Free-Body Diagram (FBD)

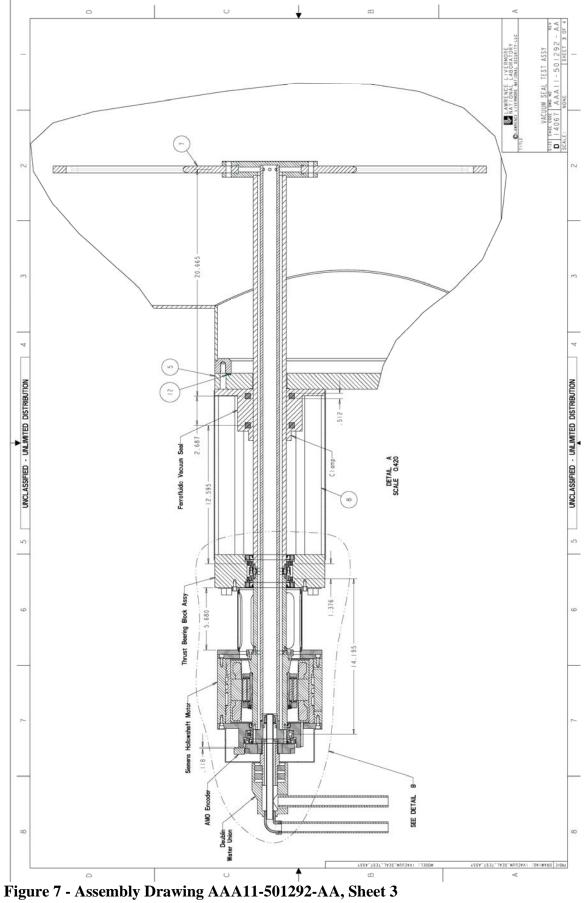
I did all the detail drawings and assembly drawings for the full assembly. See **Figures 5 thru 8** for the four sheets of the main assembly drawing.

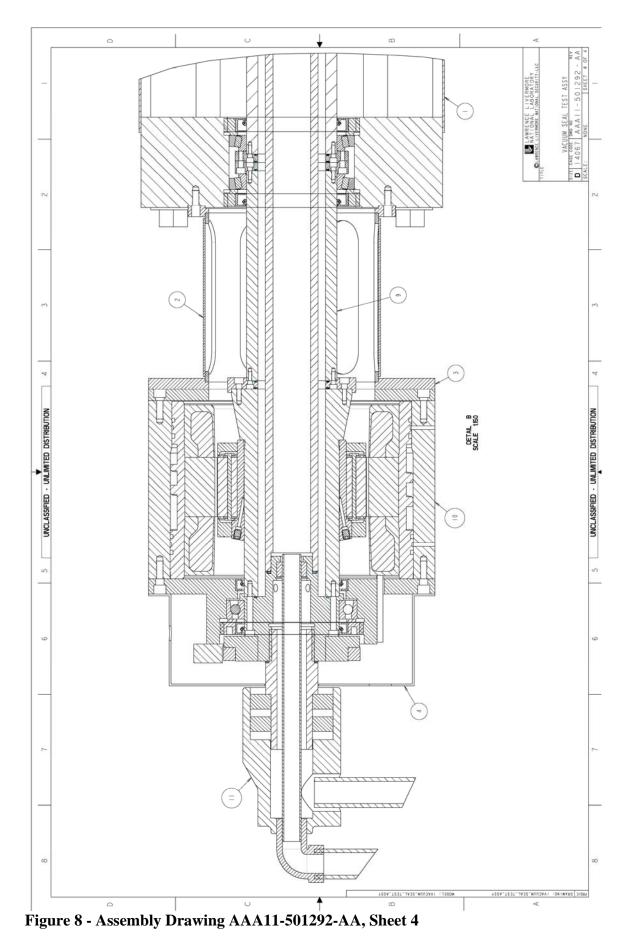


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Page 8

Over the 8 months of the life of this project I completed the 40 detail and assembly drawings shown in **Figure 9**. These drawings and the assembly drawings are attached to the end of this report.

Item #	NUMBER	REV	# SHTS	Org Dwg Size	DRAWING TITLE 3	Qt y
1	AAA11-501253	AA	1	D	Outer Shaft Weldment	1
2	AAA11-501254	AA	1	D	Inner Shaft Weldment	1
3	AAA11-501255	AA	1	D	Shaft - Middle	1
4	AAA11-501256	AA	1	D	Bearing Standoff	8
5	AAA11-501257	AA	1	D	Bearing Block	1
6	AAA11-501258	AA	1	D	Bearing Nut	2
7	AAA11-501259	AA	1	D	Bearing Nut 2	1
8	AAA11-501260	AA	1	D	Motor Spool Flange 1	1
9	AAA11-501261	AA	1	D	Motor Spool Tube	1
10	AAA11-501262	AA	1	D	Motor Spool Flange 2	1
11	AAA11-501263	AA	1	D	Motor Spool Weldment	1
12	AAA11-501264	AA	1	D	Shaft Flange 3	1
13	AAA11-501265	AA	1	D	Shaft Flange 4	1
14	AAA11-501266	AA	1	D	Shaft Flange 5	1
15	AAA11-501267	AA	1	D	Shaft - Motor	1
16	AAA11-501268	AA	1	D	Motor Case Flange 1	1
17	AAA11-501269	AA	1	D	Motor Outer Case	1
18	AAA11-501270	AA	1	D	Motor Case Flange 2	1
19	AAA11-501271	AA	1	D	Water Union 355 Inner Tube	1
20	AAA11-501272	AA	1	D	Water Union PTFE Bearing	1
21	AAA11-501273	AA	1	D	Shaft Flange 7	1
22	AAA11-501274	AA	1	D	Encoder Mounting Disk	1
23	AAA11-501275	AA	1	D	Motor End Cover	1
24	AAA11-501276	AA	1	D	Vessel Port Flange 2	1
25	AAA11-501277	AA	1	D	Vessel Port Flange 1B	1
26	AAA11-501278	AA	1	D	10in CF Spool	1
27	AAA11-501279	AA	1	D	Rod Assy Weldment	8
28	AAA11-501280	AA	1	D	Vacuum Vessel Assy	1
29	AAA11-501281	AA	1	D	Target Wheel Shaft Assy	1
30	AAA11-501282	AA	1	D	Target Wheel & Shaft Assy	1
31	AAA11-501283	AA	1	D	Bearing Nut & Seal Assy 1	1
32	AAA11-501284	AA	1	D	Bearing Block Assy	1
33	AAA11-501285	AA	1	D	Seal & Bearing Block Assy	1
34	AAA11-501286	AA	1	D	Middle Shaft Assy	1
35	AAA11-501287	AA	1	D	Bearing Nut & Seal Assy 2	1
36	AAA11-501288	AA	1	D	Motor Bearing Assy	1
37	AAA11-501289	AA	1	D	Siemens Rotor & Motor Shaft Assy	1
38	AAA11-501290	AA	1	D	Siemens Motor & Case Assy	1
39	AAA11-501291	AA	1	D	Water Union 355 Assy	1
40	AAA11-501292	AA	4	D	Vacuum Seal Test Assy	1
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Figure 9 – Drawing List

I located several major components that were onsite at LLNL that could be used for these tests. These included the main vacuum vessel (**Figure 10**) and the main vacuum turbo pump and valve (**Figure 11**). The main vacuum vessel is 4' in diameter and the main tank section is 4' tall. The vacuum turbo pump is a 1000l/s turbo on a 10" gate valve. I also negotiated the use of the ETA II experimental tunnel as a location to house this experiment.



Figure 10 – Main Vacuum Vessel



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#### Figure 11 – Vacuum Turbo Pump and Gate Valve

I worked all the vendors to specific and order the main components for the test. Shown below are the main rotating vacuum seal from Rigaku (Figure 12) and the rotating water union from Deublin (Figure 13). I also worked closely with Nick Killingsworth to specify the 3" hollow shaft motor from Siemens.

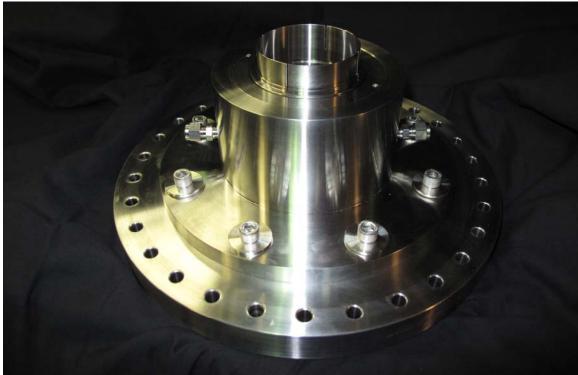


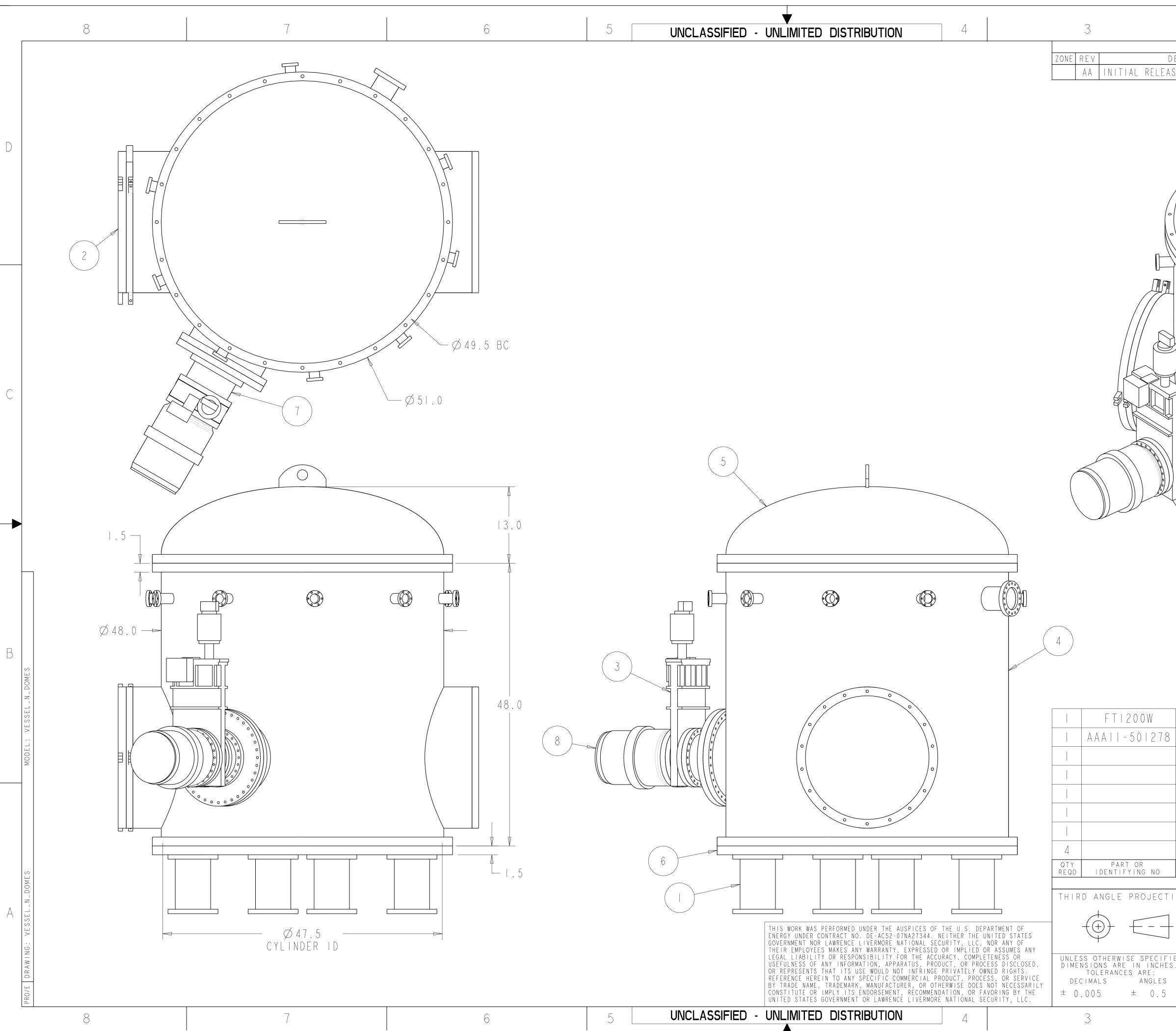
Figure 12 – Rigaku Ferrofluidic Rotating Vacuum Seal with 3" Bore



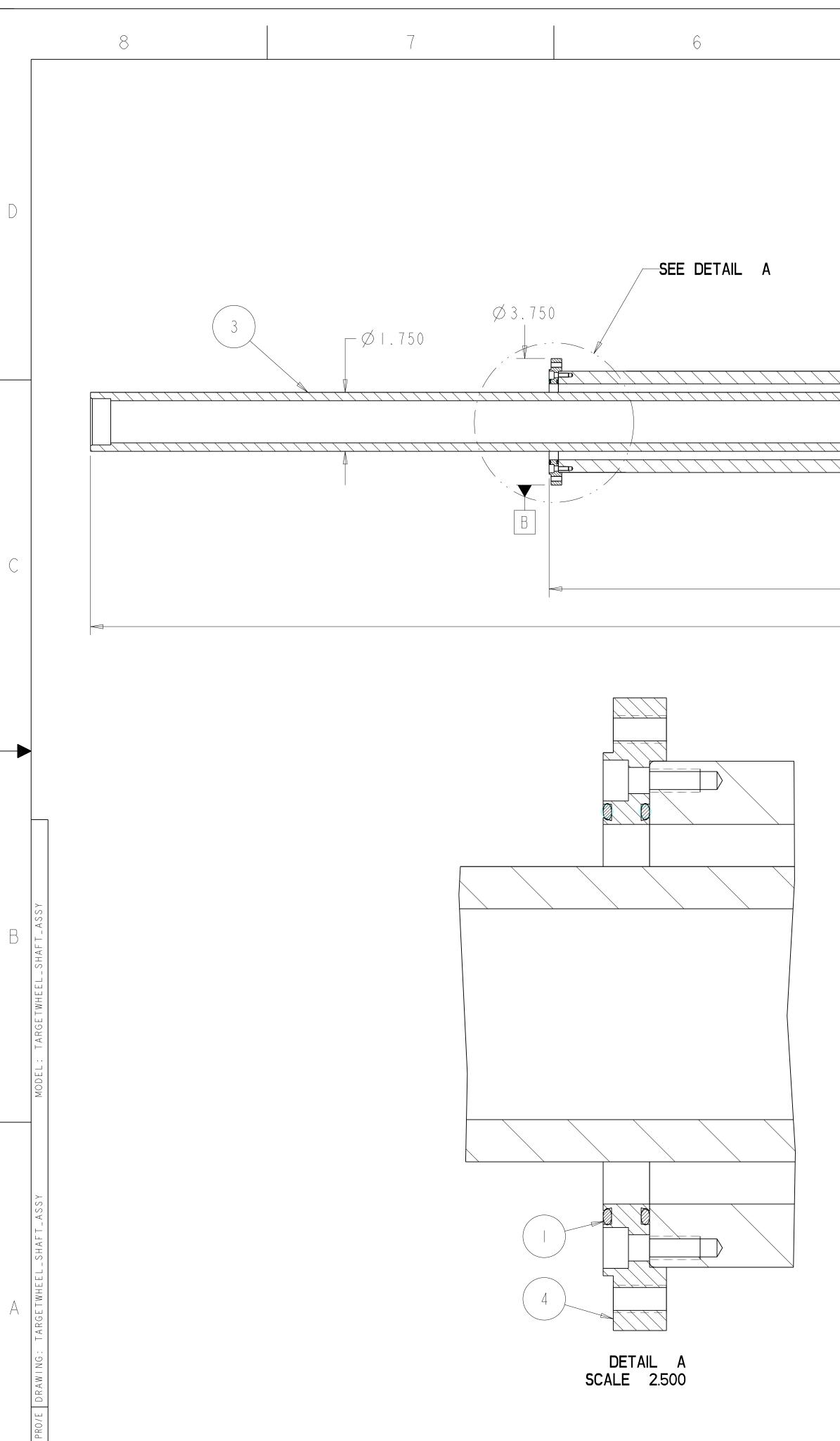
**Figure 13 – Deublin Rotating Water Union** 

# Attachments:

Following this page are attached all the assembly and detailed drawings generated for this project.



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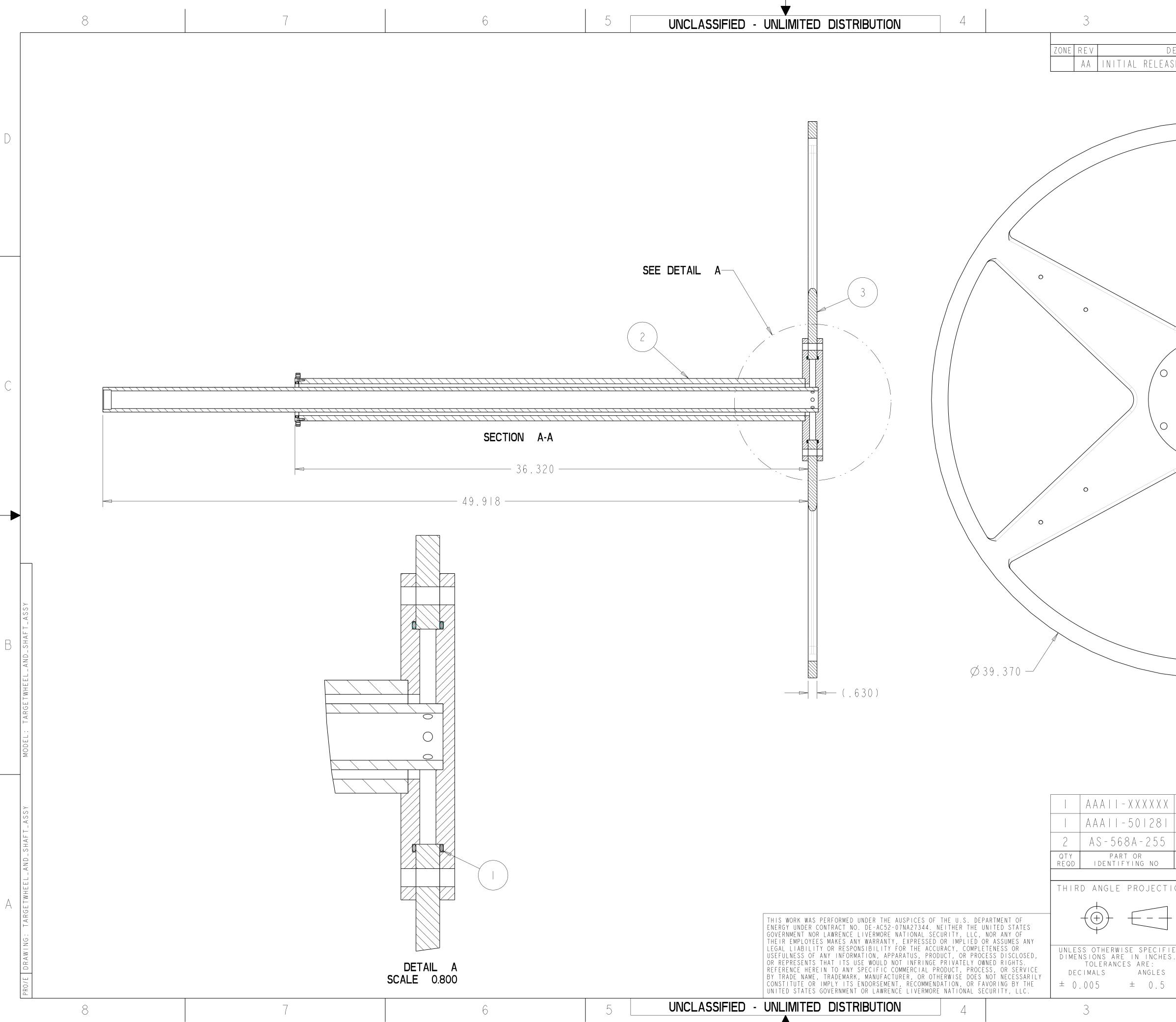
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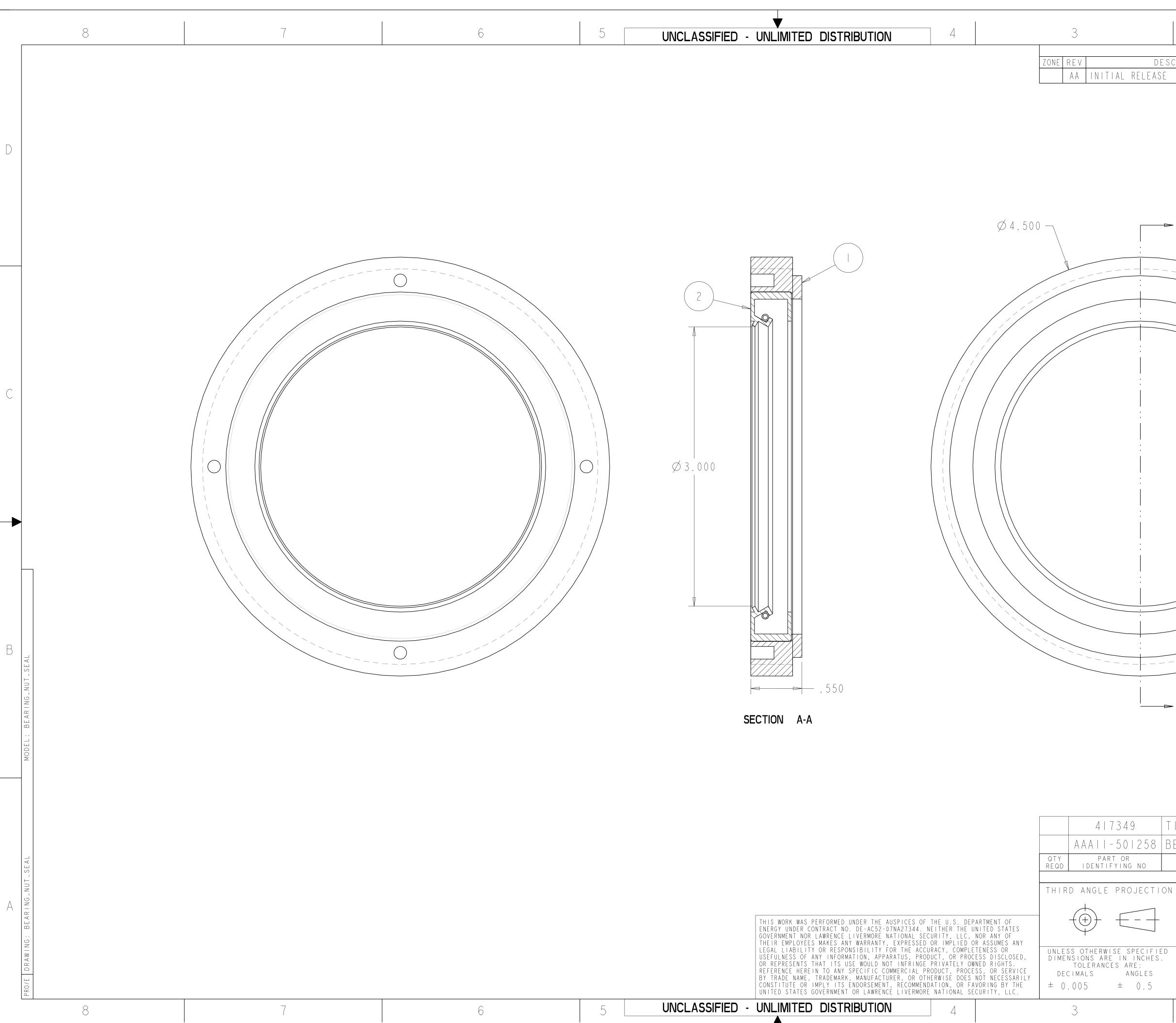
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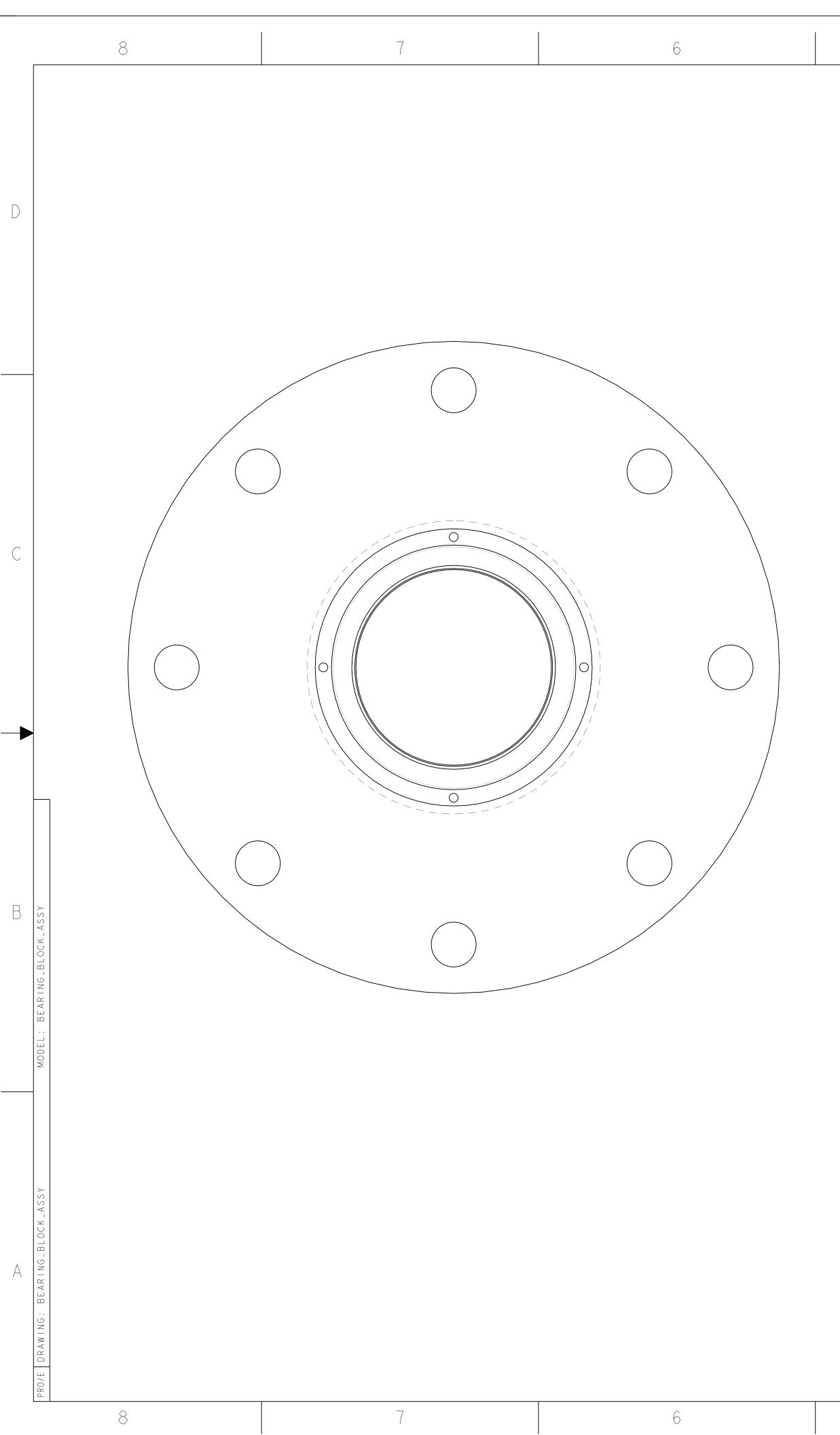
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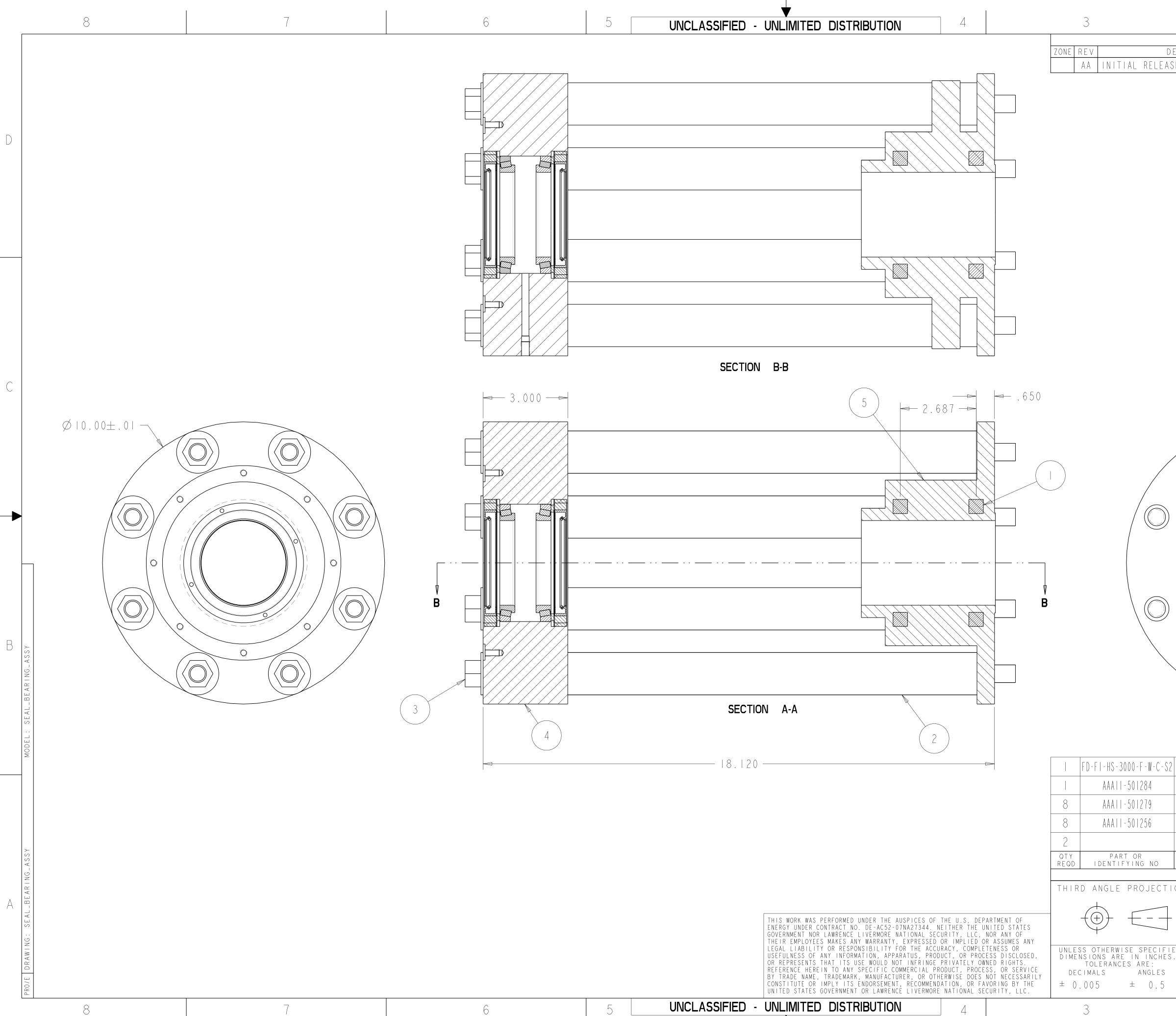


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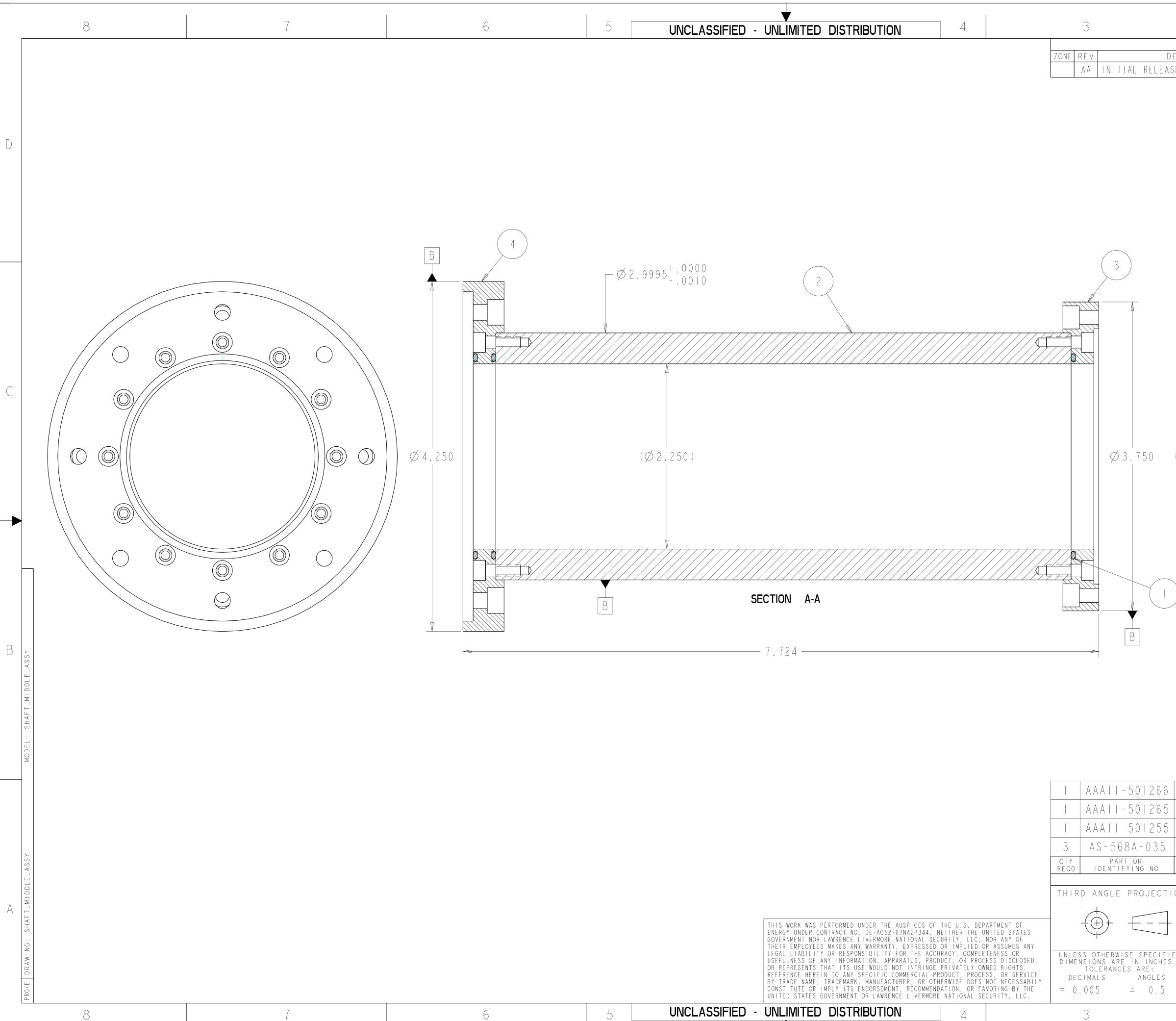


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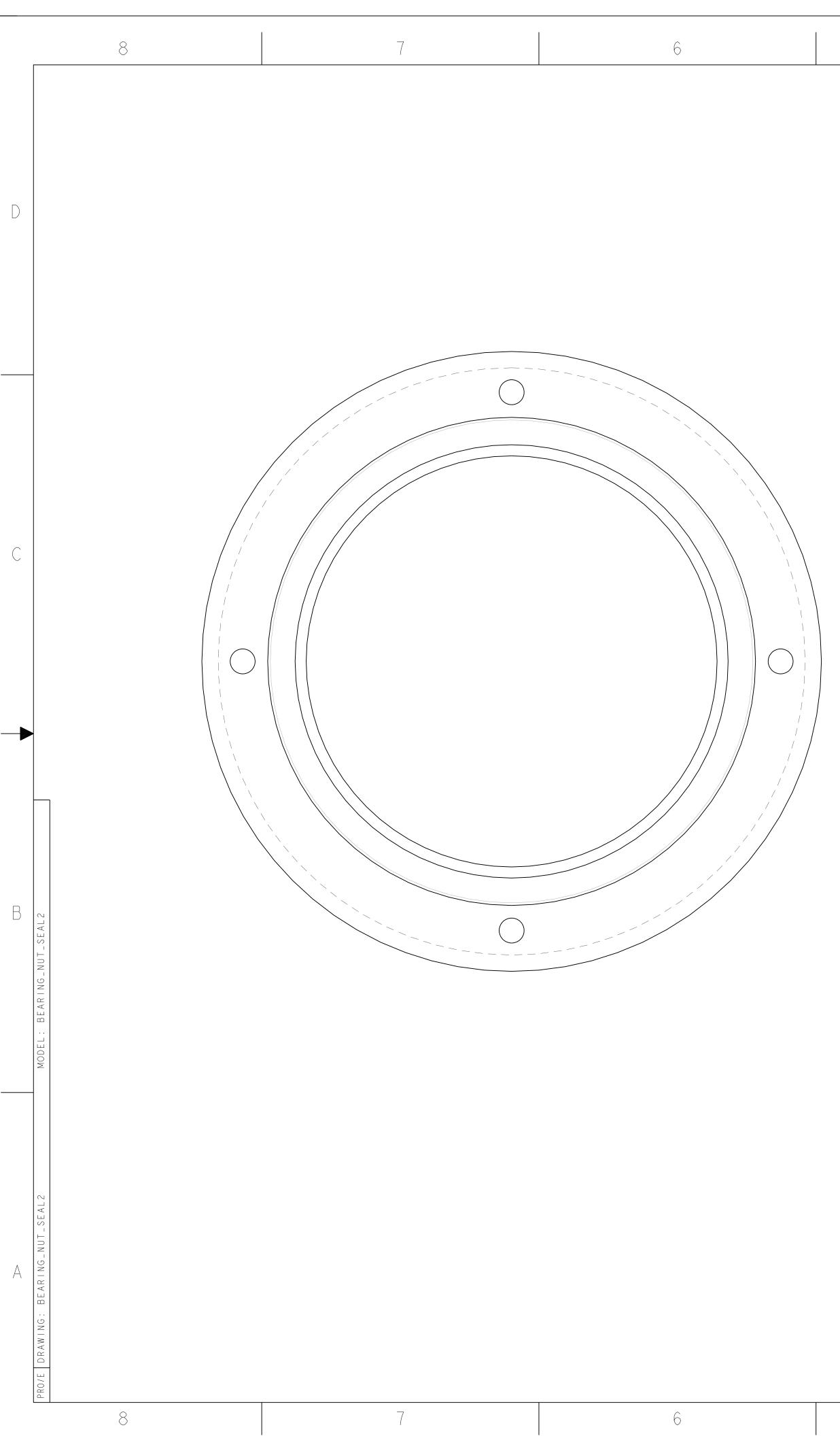
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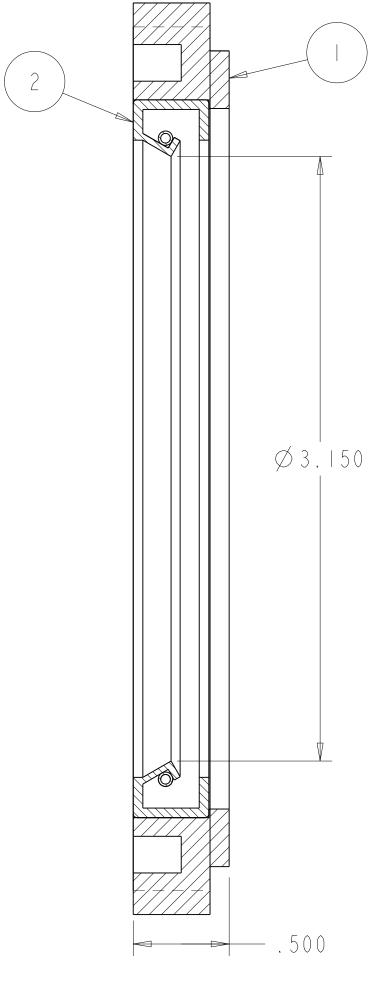
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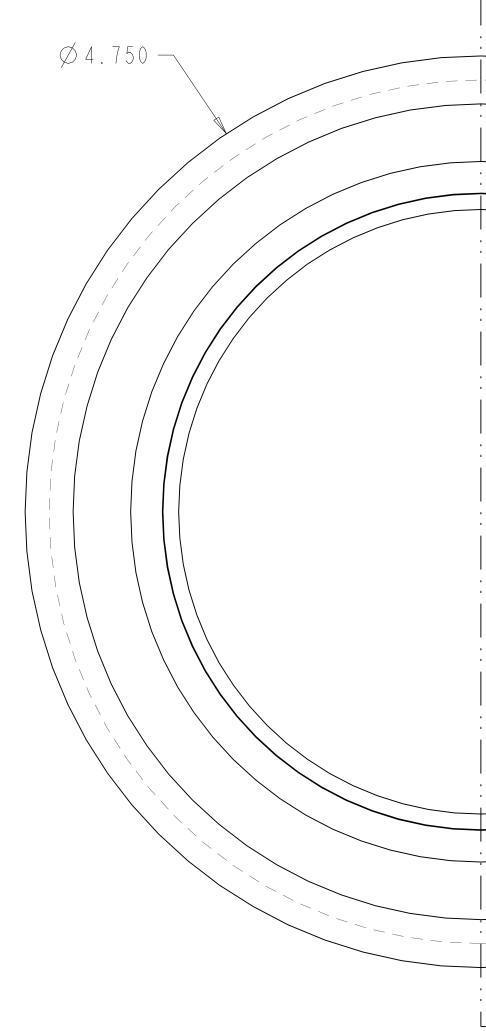


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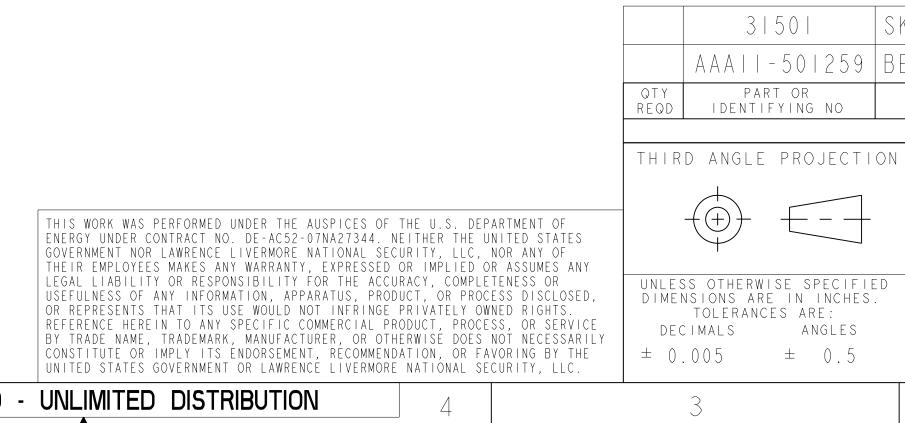


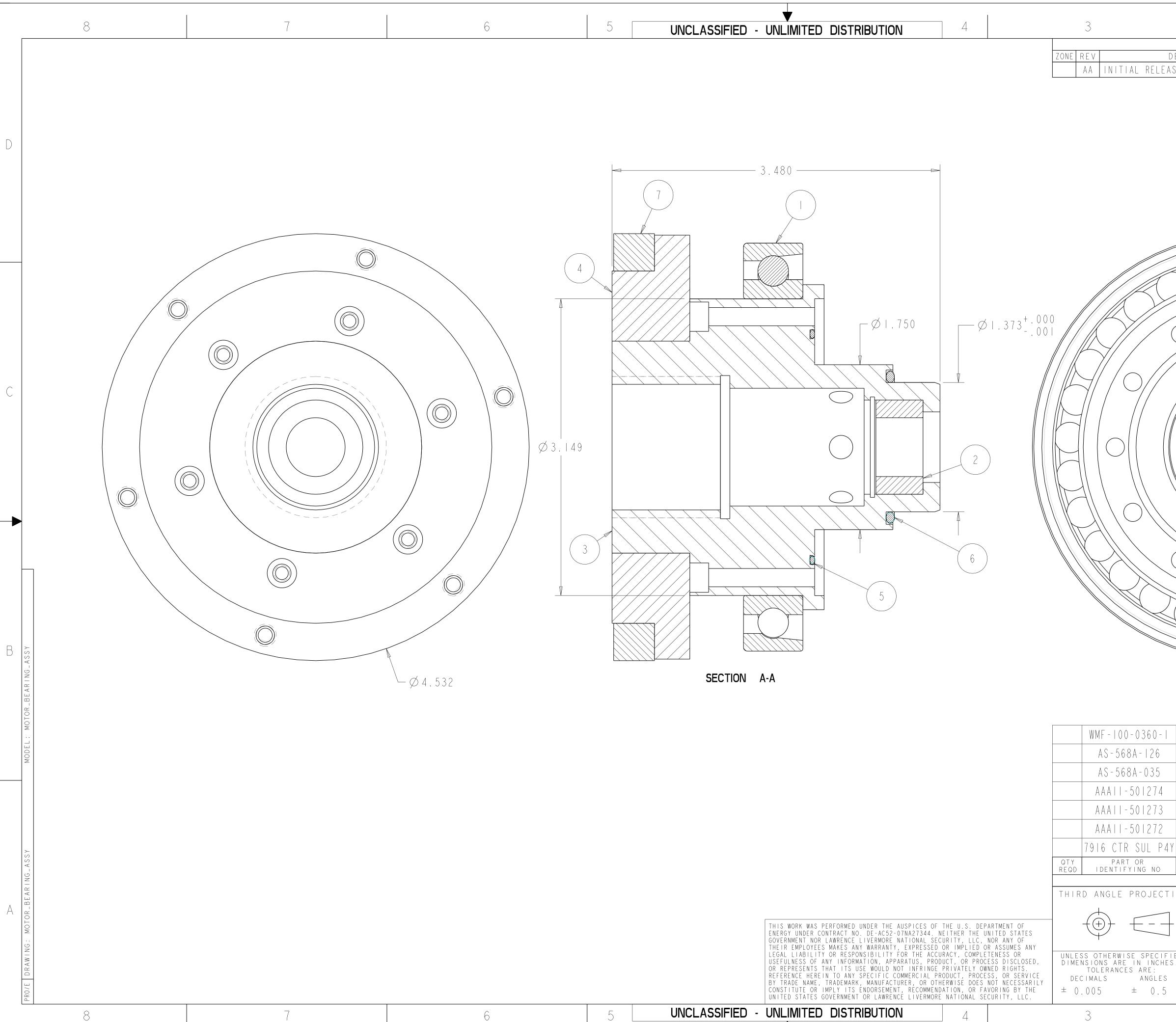
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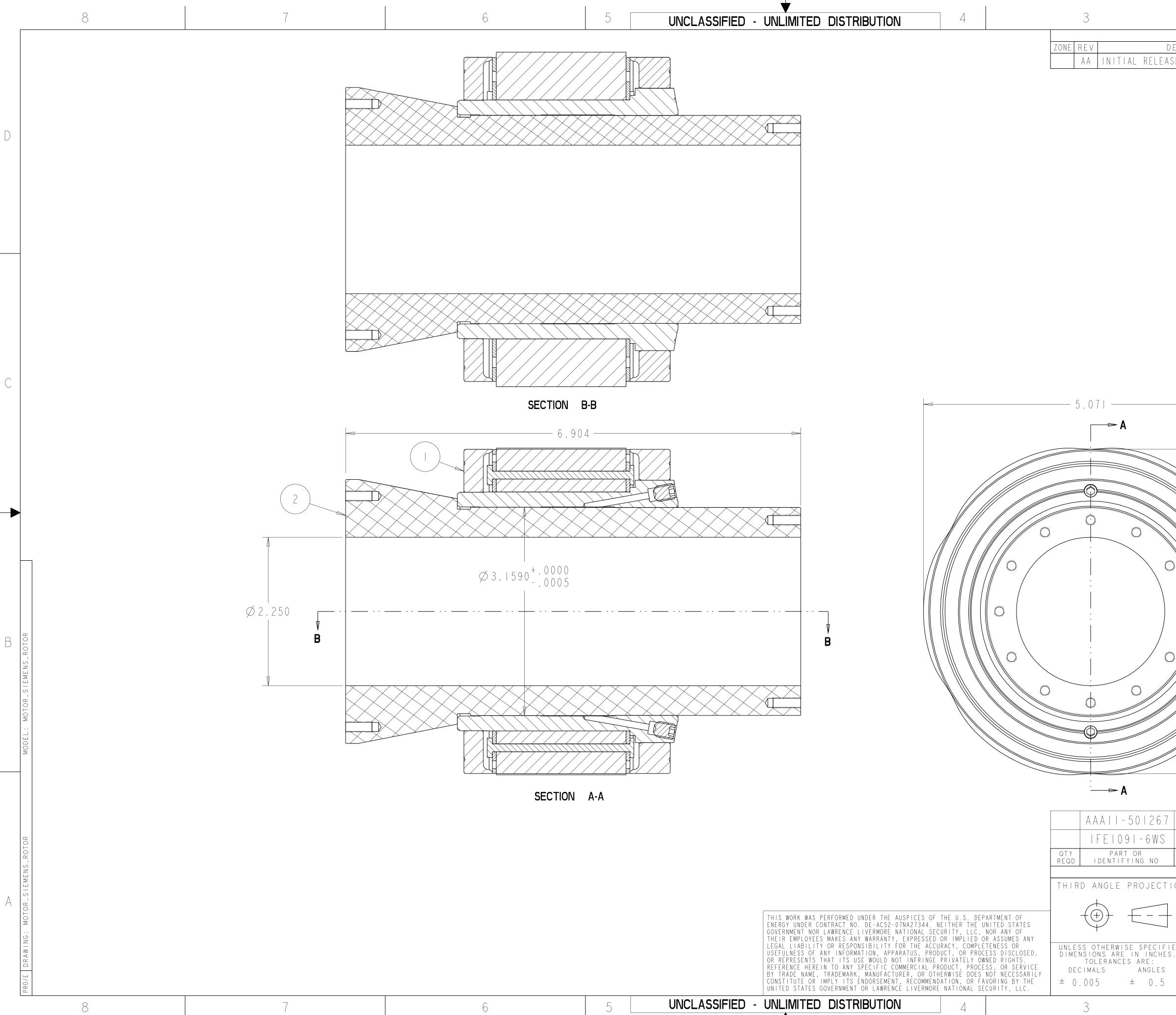




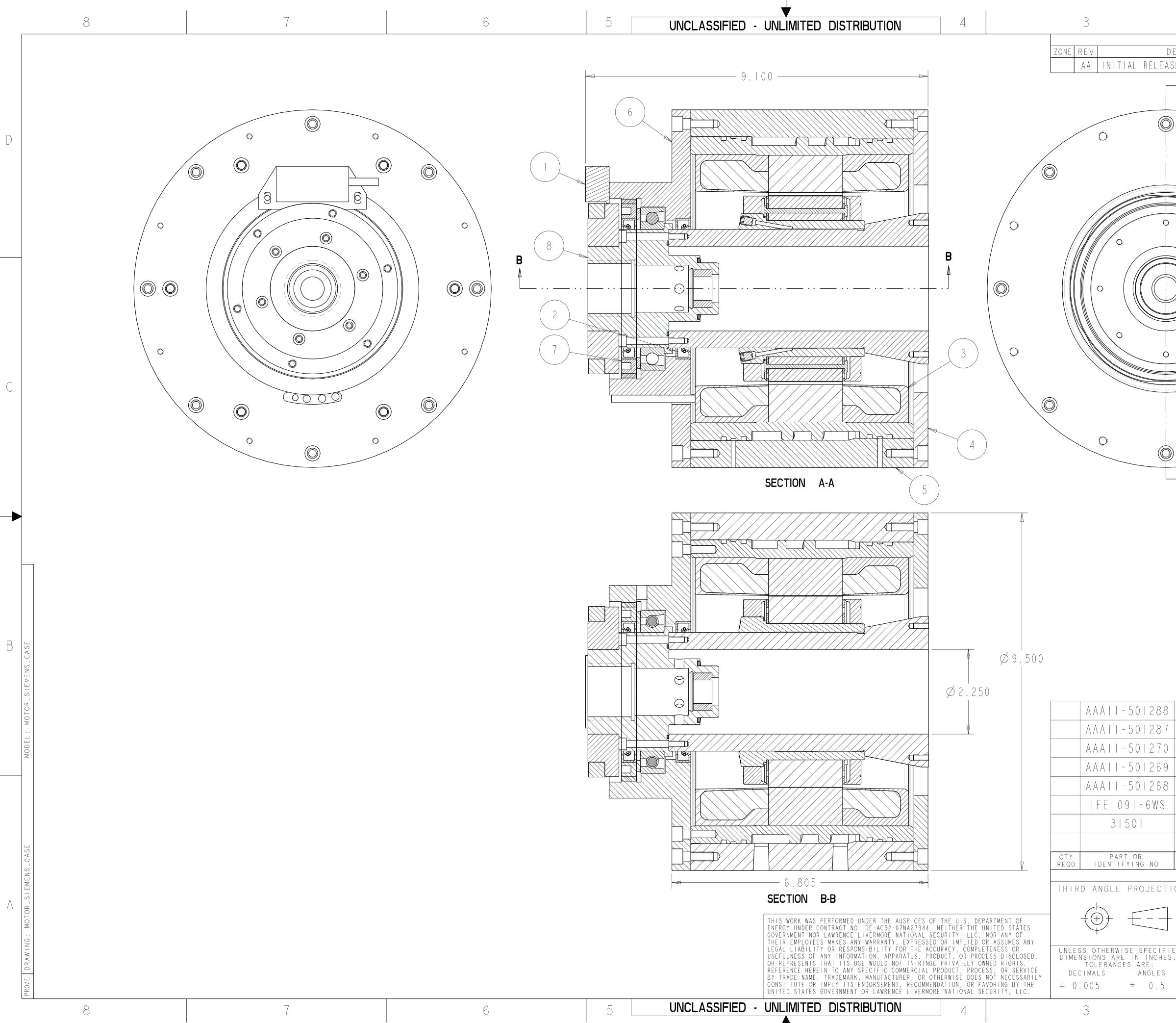




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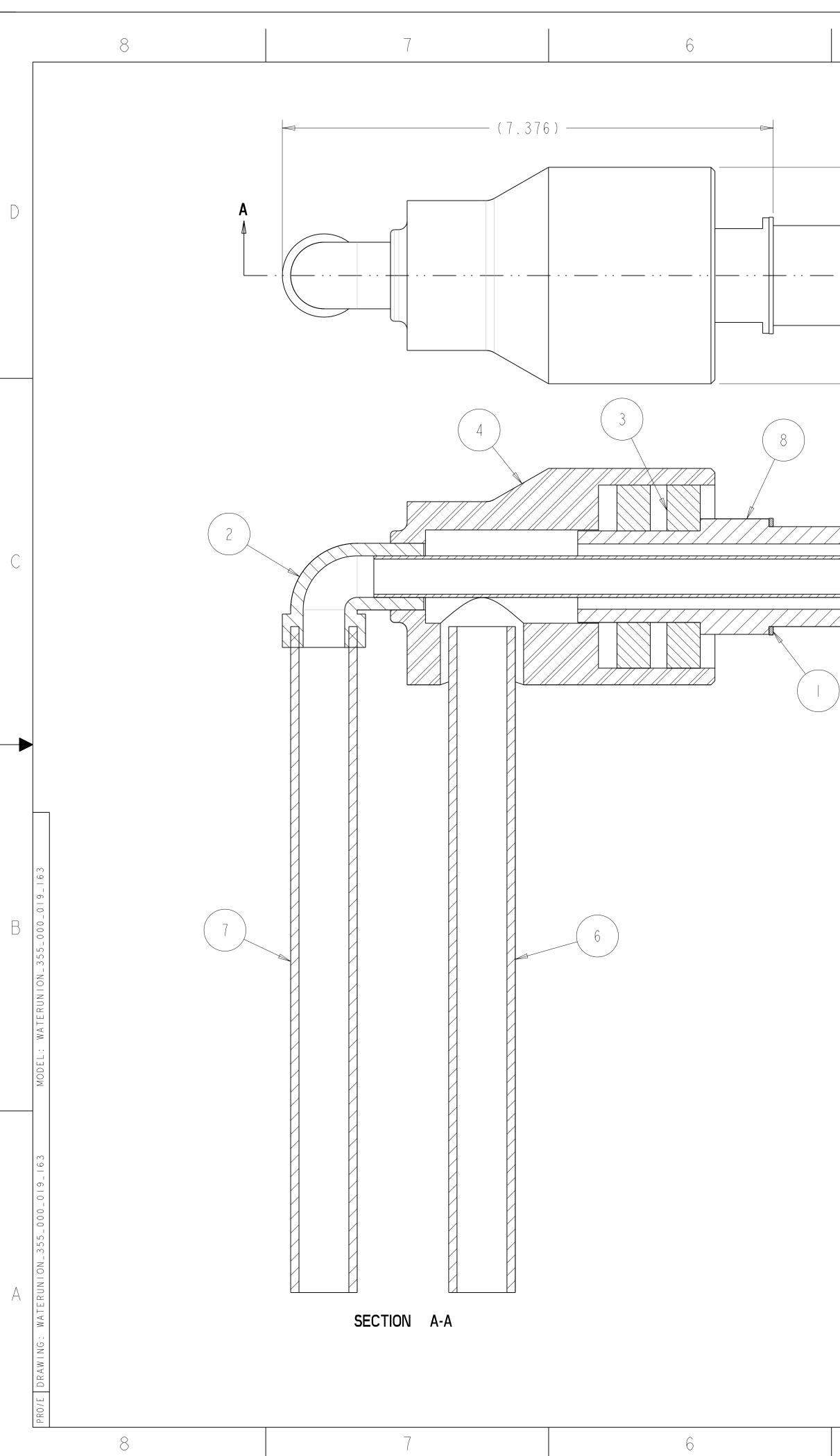


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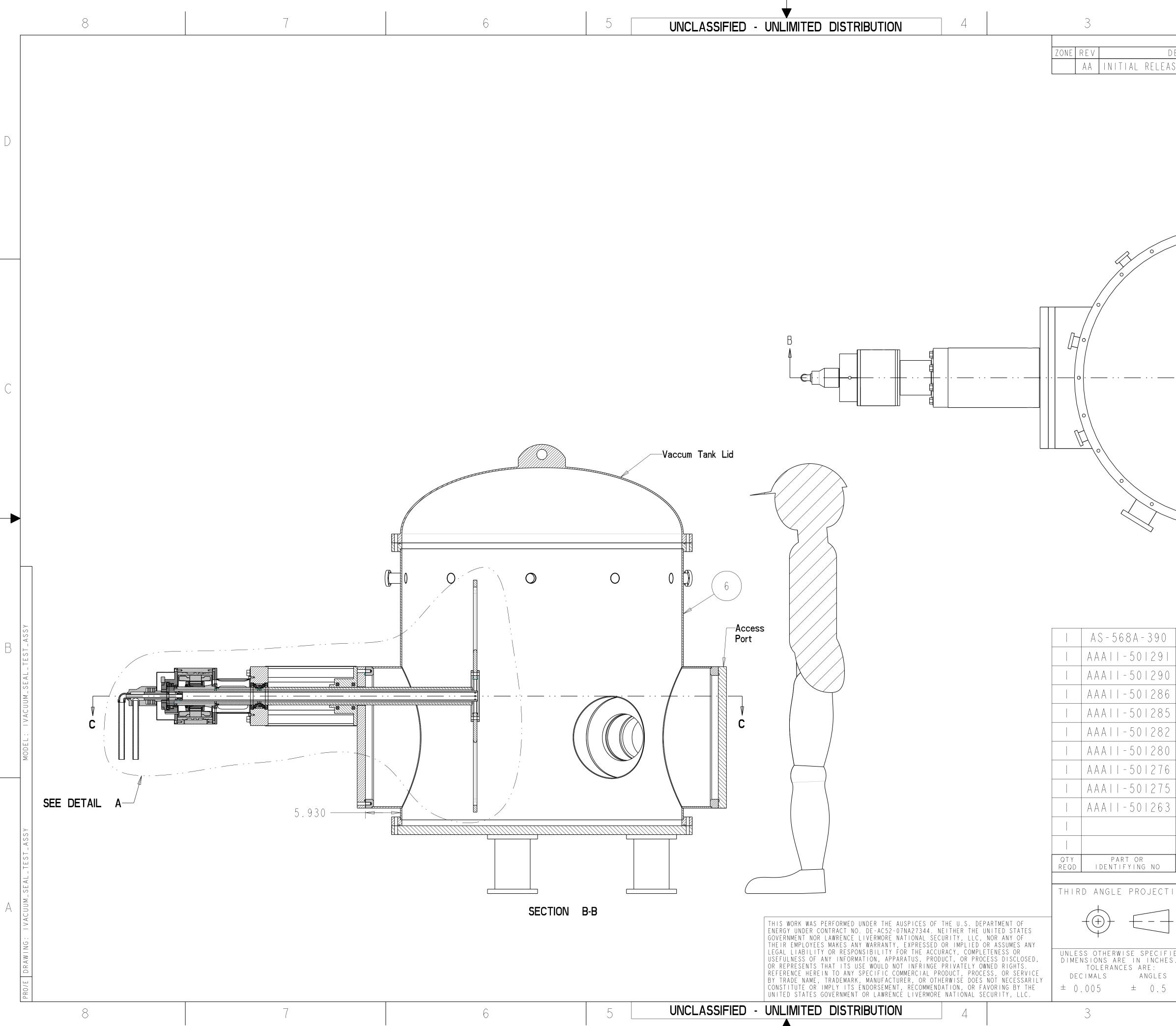




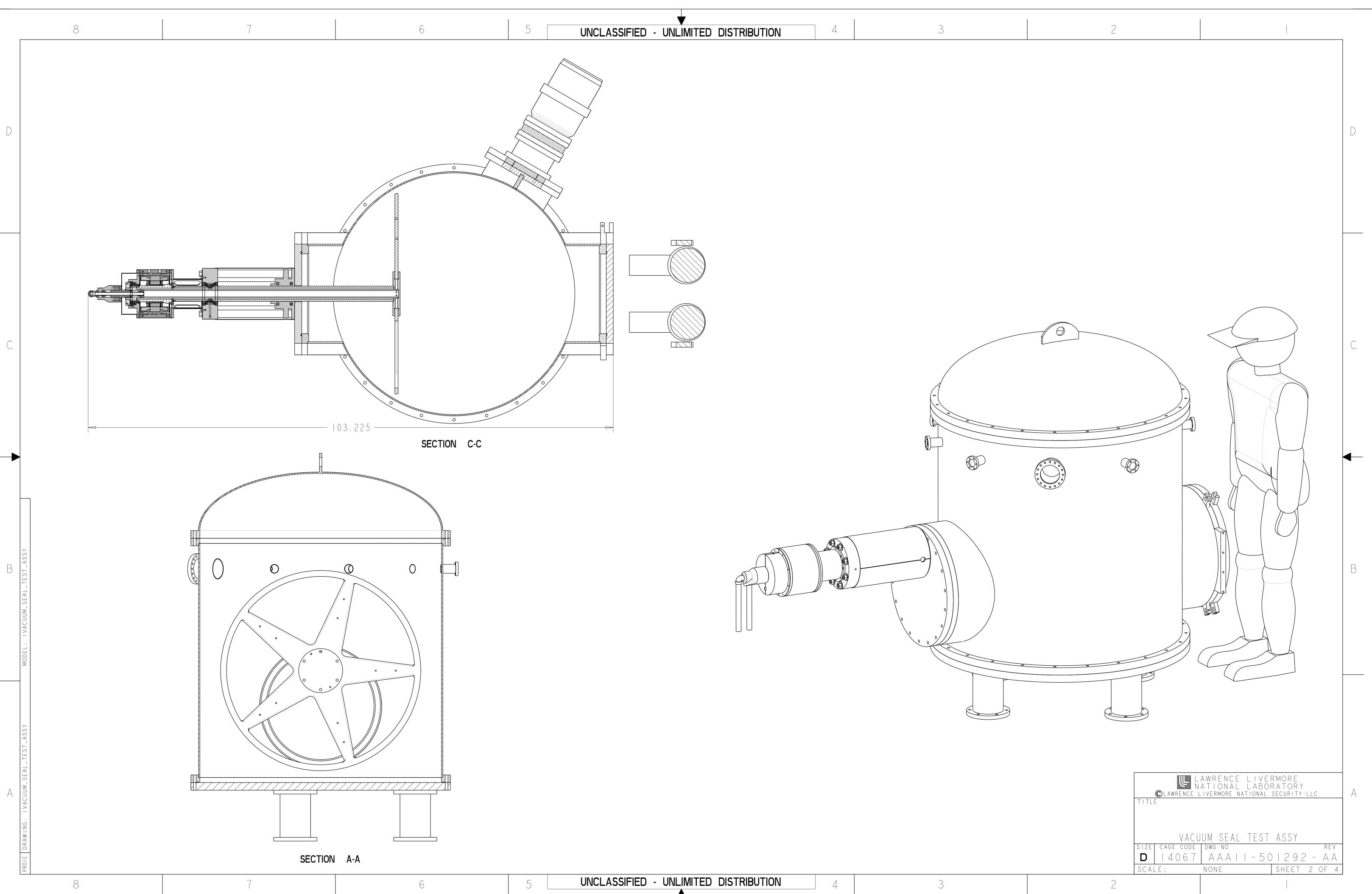
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DESCRIPTION	REVISIONS	DWN	CHK KILLINGSWORTH2		DATE - 10 - 11	
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BEARING NUT MOTOR CASE			ALUM	6061-T6	6	
MOTOR OUTER			ALUM	606I-T6	5	
SIEMENS MOT			ALUM	6061-T6	4	
SKF SEAL, C		)mm CRSH	13 R		2	
ENCODER HEA	D, WMK-201 nomencla		0-3,0-5	MATERIAL	   tem	
	OR DESCRIPTION PARTS LI	I/MATERIAL		SPECIFICATION	NO	
ION WEIGHT(1bs):	19.490	© LAWRENC		IVERMORE ABORATORY Ional security-ll	<u>c </u>	7
APPROVALS originator brookSBY1	DATE TI	TLE				
IED S. BROOKSBYI CHECKED KILLINGSWORTH2	4/19/11	SIEM	ENS MOTOR &	& CASE ASSY		
APPROVED PIGGOTTI	5/10/11 DRAWING LEVEL	ze cage coe 1406	pe dwg no 7 AAAII	- 50   290 -	rev - AA	
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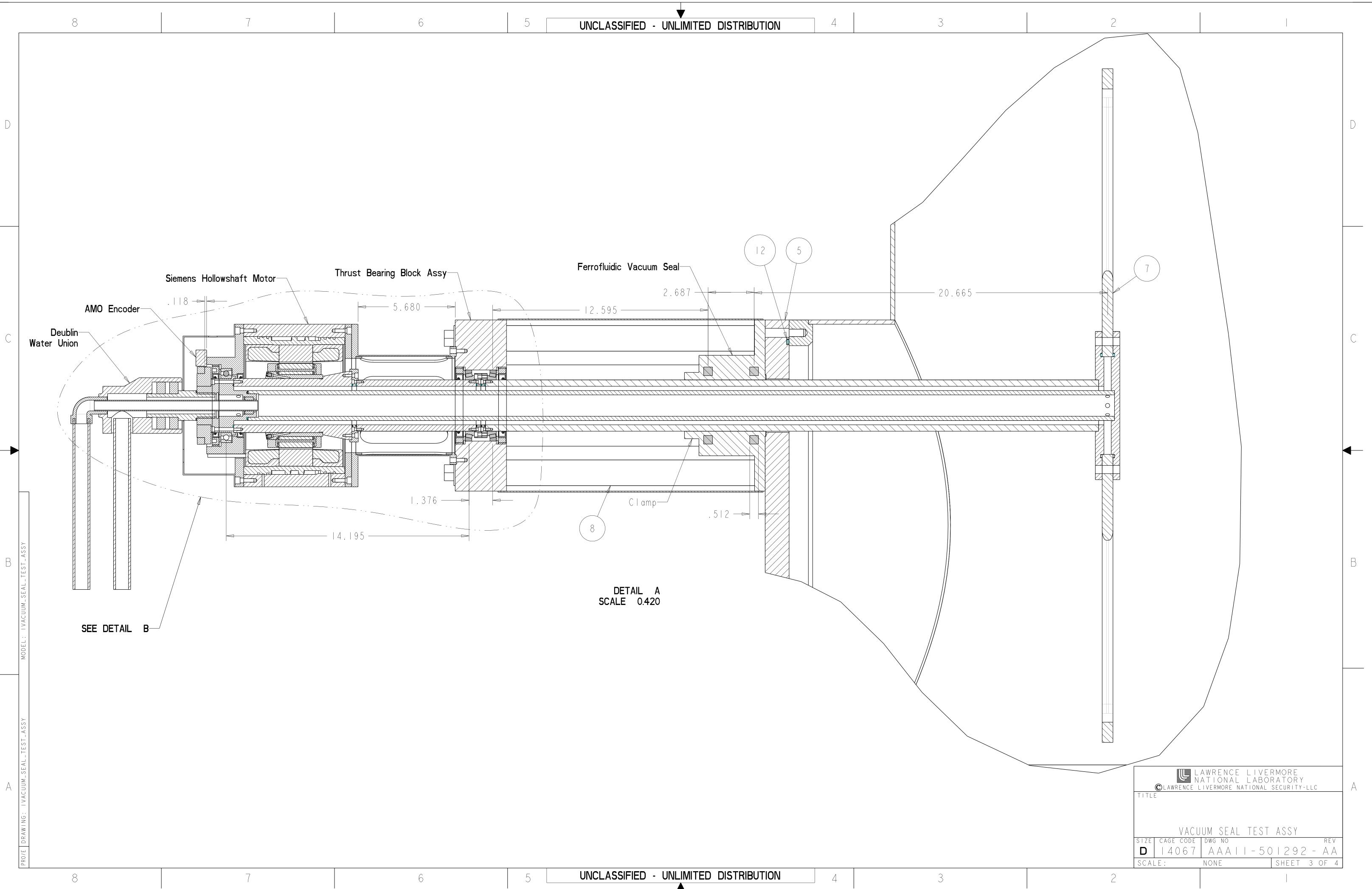


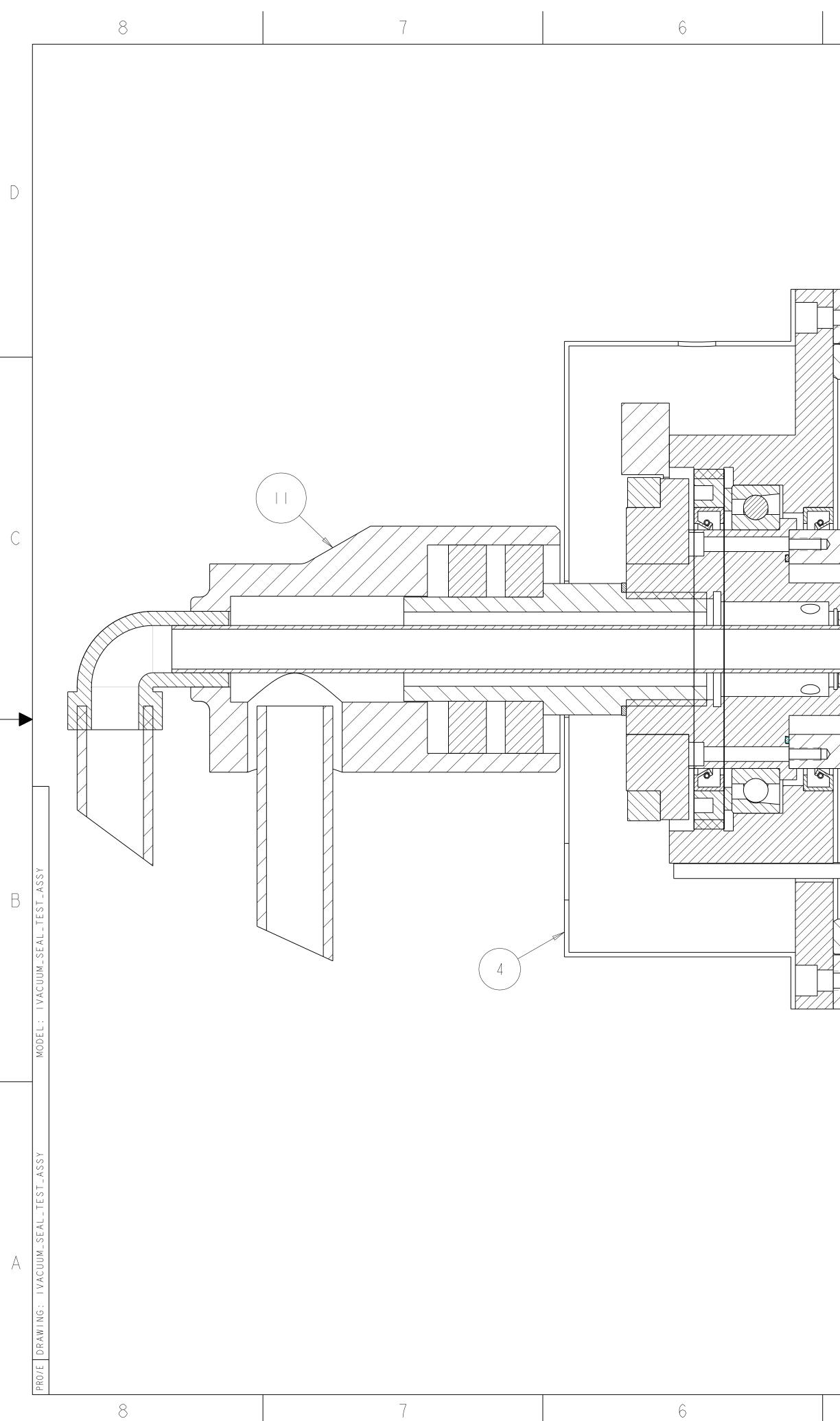
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				NLET WATER PIPE	SST	304	6
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		THIS WORK WAS PERFORMED UNDER THE AUSPICES OF THE U.S. DEPARTMENT OF ENERGY UNDER CONTRACT NO. DE-AC52-07NA27344. NEITHER THE UNITED STATES GOVERNMENT NOR LAWRENCE LIVERMORE NATIONAL SECURITY, LLC, NOR ANY OF THEIR EMPLOYEES MAKES ANY WARRANTY, EXPRESSED OR IMPLIED OR ASSUMES ANY LEGAL LIABILITY OR RESPONSIBILITY FOR THE ACCURACY, COMPLETENESS OR USEFULNESS OF ANY INFORMATION, APPARATUS, PRODUCT, OR PROCESS DISCLOSED, OR REPRESENTS THAT ITS USE WOULD NOT INFRINGE PRIVATELY OWNED RIGHTS. REFERENCE HEREIN TO ANY SPECIFIC COMMERCIAL PRODUCT, PROCESS, OR SERVICE BY TRADE NAME, TRADEMARK, MANUFACTURER, OR OTHERWISE DOES NOT NECESSARILY CONSTITUTE OR IMPLY ITS ENDORSEMENT, RECOMMENDATION, OR FAVORING BY THE UNITED STATES GOVERNMENT OR LAWRENCE LIVERMORE NATIONAL SECURITY, LLC.	THIRD ANGLE PROJECTION UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE: DECIMALS ANGLES ± 0.005 ± 0.5	WEIGHT(Ibs):       07.440       ©LAWRENCE LI         APPROVALS       DATE       TITLE         ORIGINATOR BROOKSBYI       II/22/10       TITLE         DRAWN BROOKSBYI       4/19/11       WATE         CHECKED KILLINGSWORTH2       5/3/11       SIZE         CAGE CODE       14067	vermore natio RUNION 3 dwg no AAAII-	50 29  -	rev A A
5	UNCLASSIFIED -	• UNLIMITED DISTRIBUTION 4	3	2 SCALE: N 2	IONE	SHEET I	OFI



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escripti E	ON	REVISIO	DWN DWN BROOKSBYI	CHK KILLINGSWORTH2		DATE - 10 - 11
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ROD CC				SST SST		
			CLATURE ION/MATERIAL		MATERIAL SPECIFICATION	I TEM NO
A F ORIGIN BROOK DRAWN BROOK		PARTS 15.433 DATE 11/22/10	U	NATIONAL	LIVERMORE LABORATORY TIONAL SECURITY-LL	<u>c</u> A
D CHECKE KILLI	D NGSWORTH2	4/19/11 5/3/11		ACUUM SEAL	TEST ASSY	
.D CHECKE	D NGSWORTH2	5/3/11	V size cage co <b>D</b>   406	DDE DWG NO	<u>test assy</u>  -50 292-	rev - AA
CHECKE KILLI	D NGSWORTH2	5/3/11	SIZE CAGE CO	DDE DWG NO		







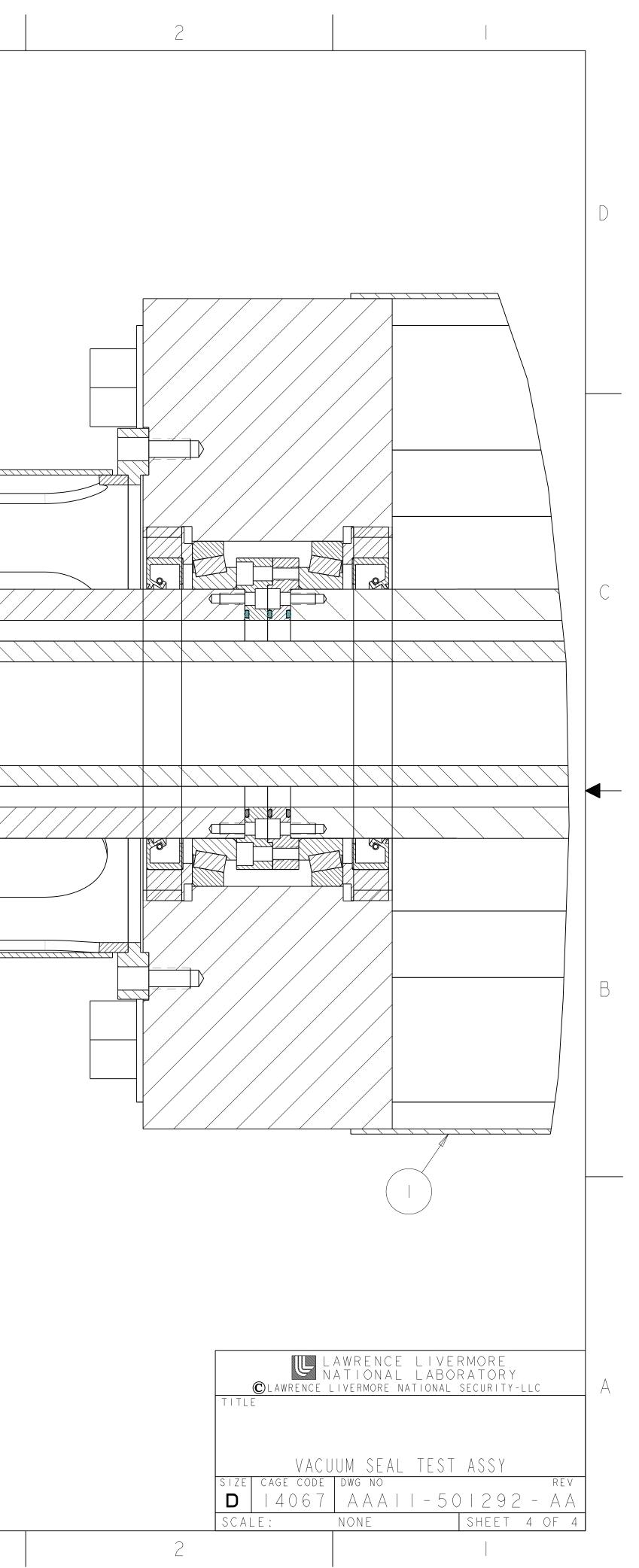
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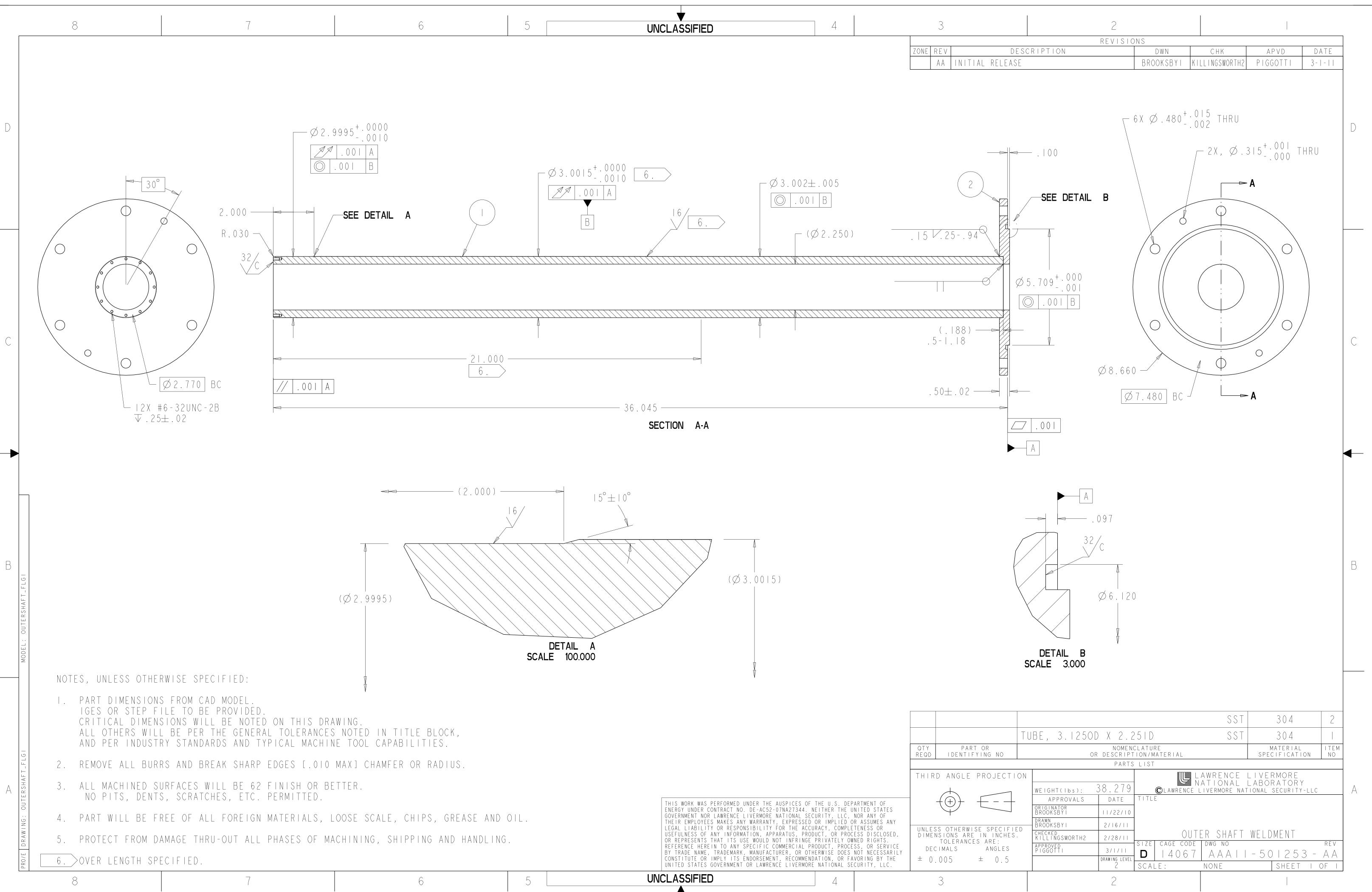
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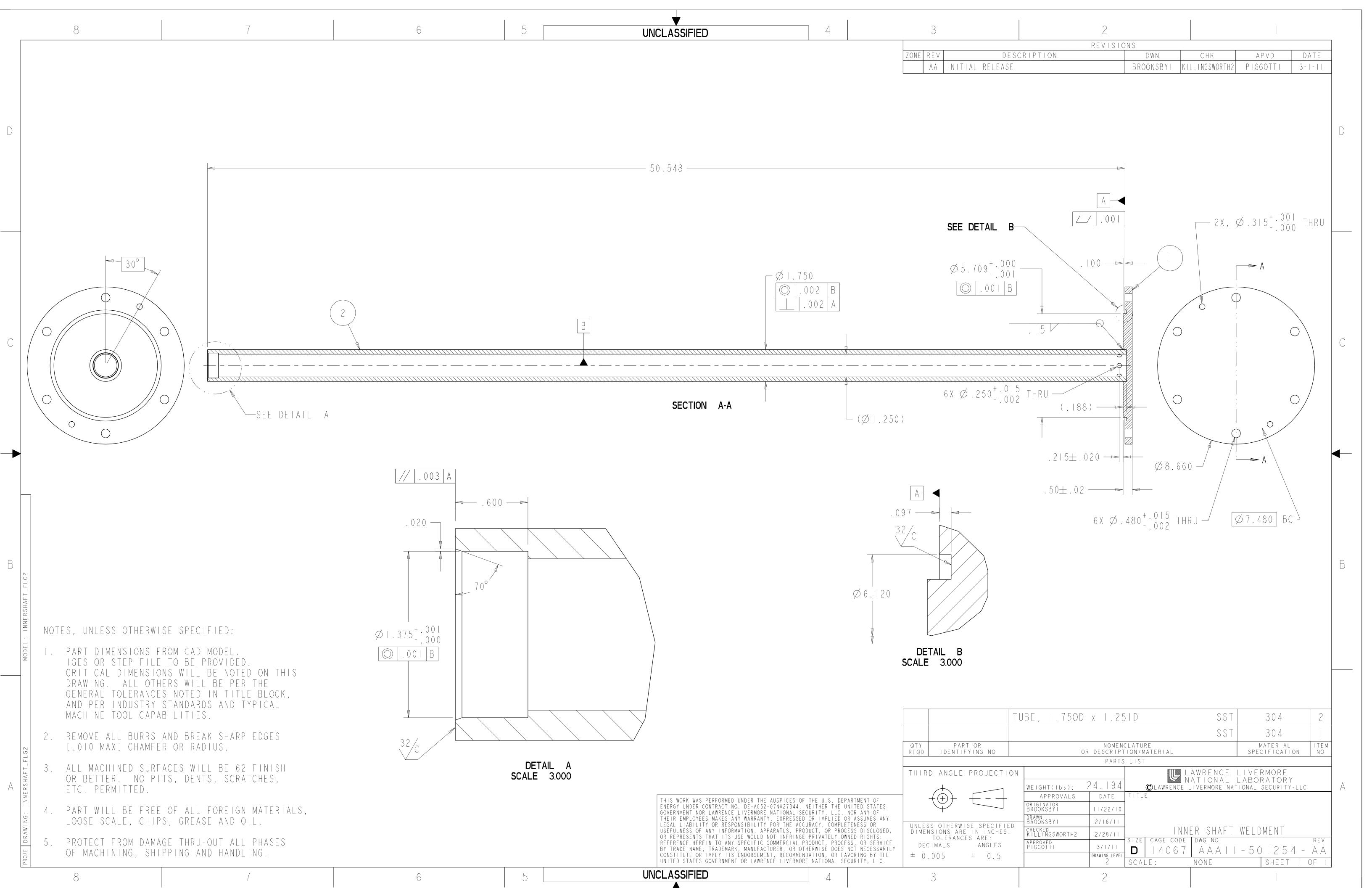
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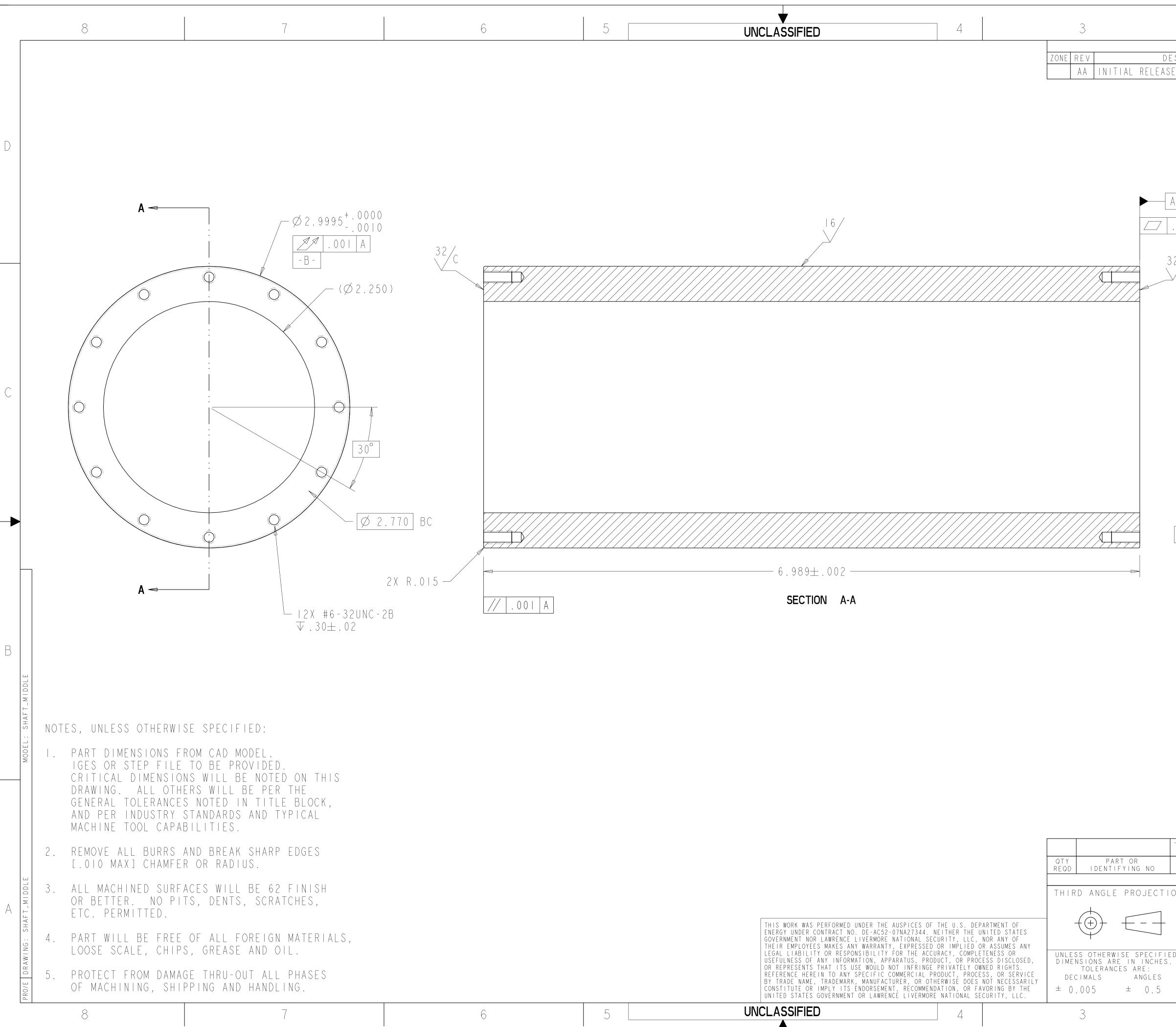
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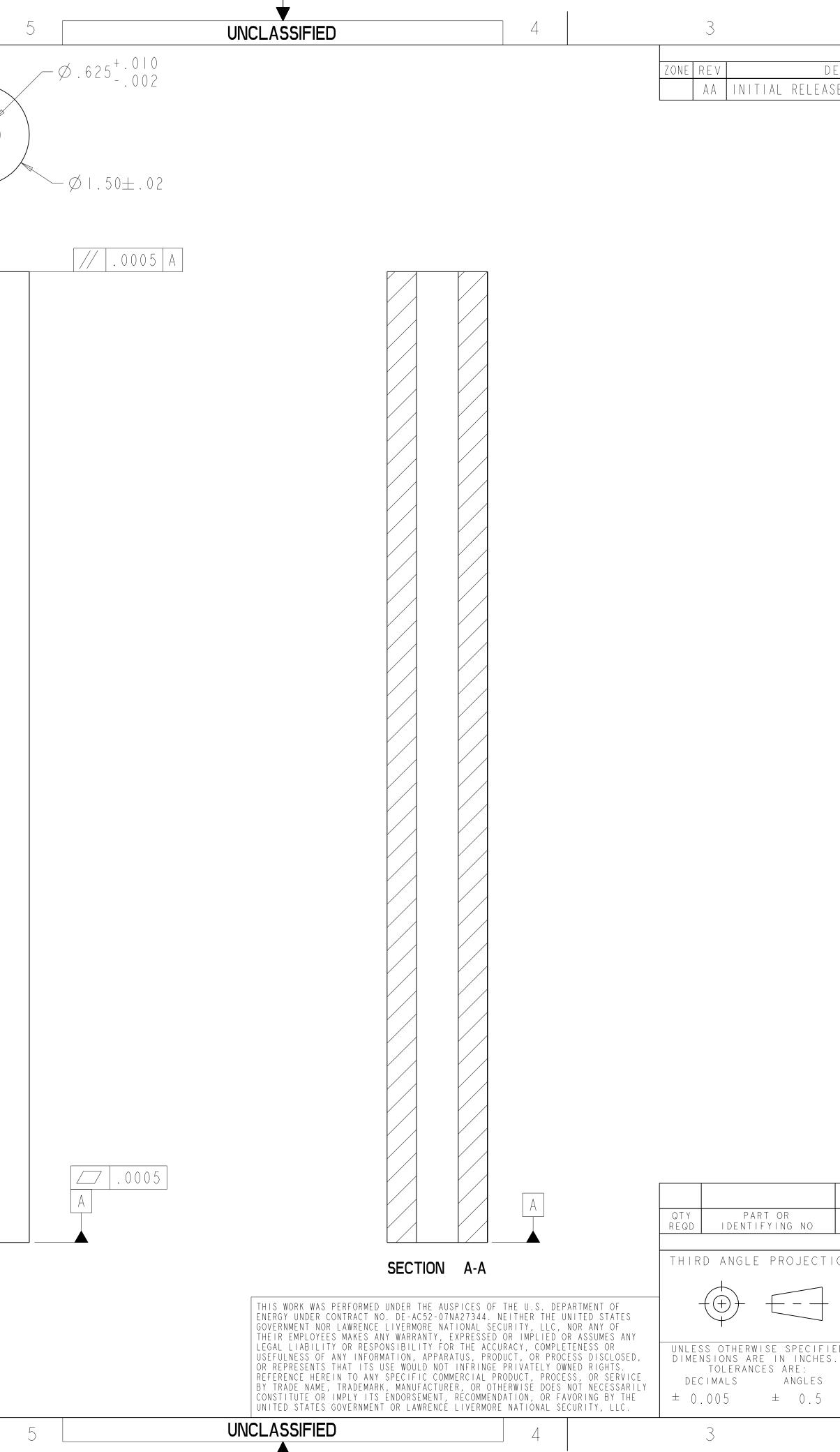




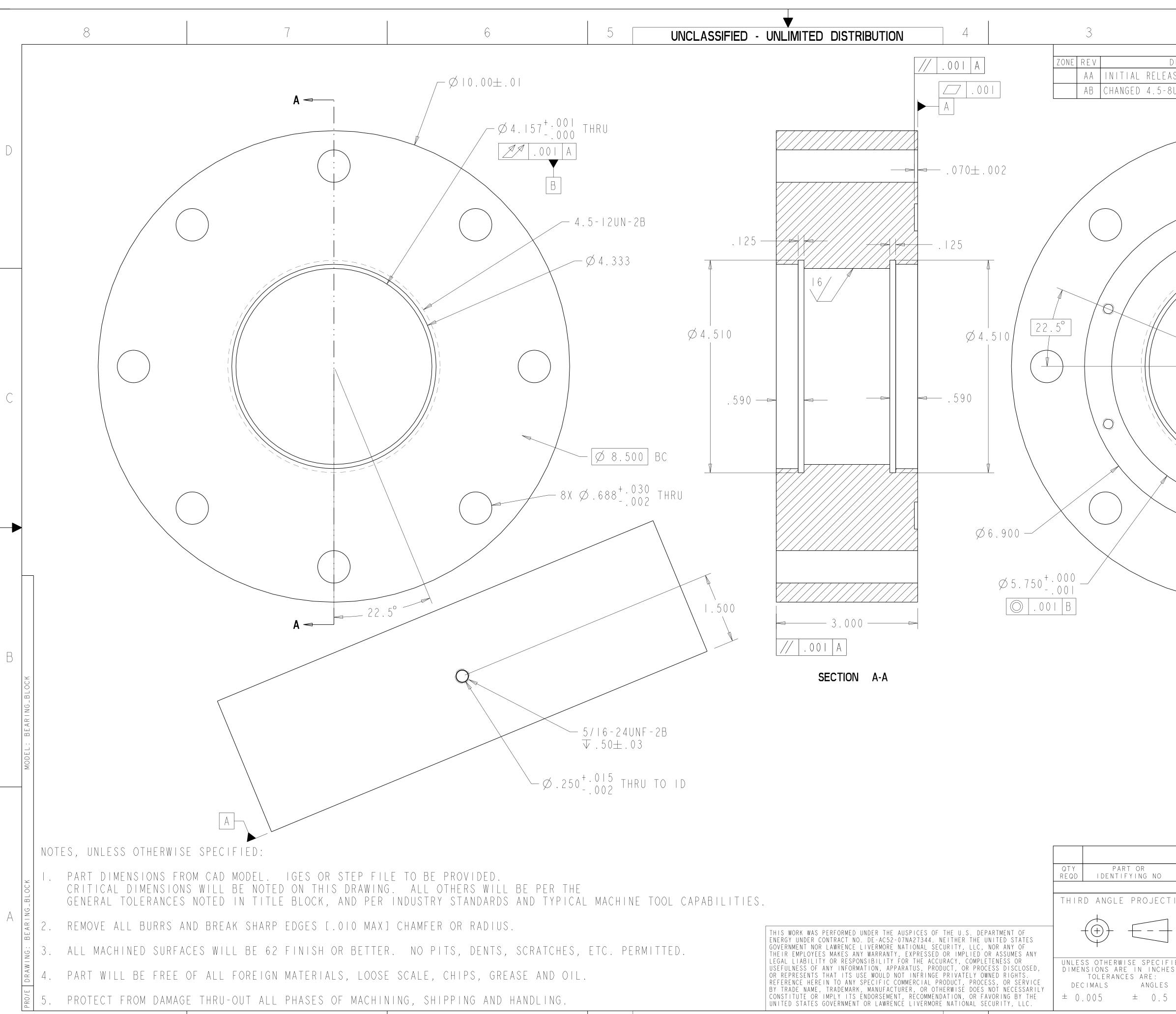


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WEIGHT(Ibs) APPROVAL ORIGINATOR BROOKSBYI		CLAWRENCE LIVERMORE	E NATIONAL SECURITY-LL	<u> </u>
DRAWN BROOKSBYI CHECKED KILLINGSWORTH	2/16/11		- MIDDLE	REV
APPROVED PIGGOTTI	3/I/II D	ALE: NONE	.     - 50   255   Sheet I	
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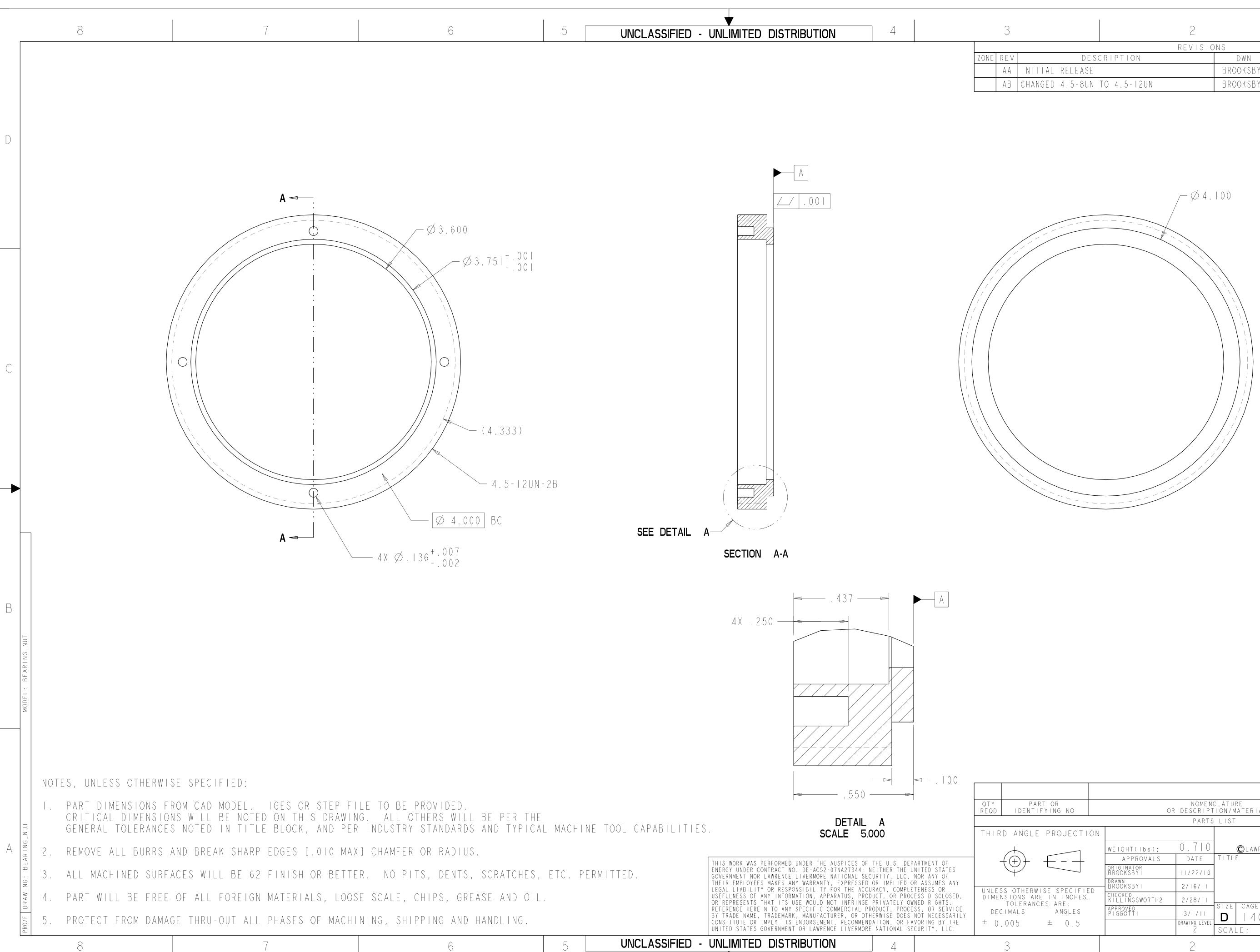


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	1	OR DESCRIPT PARTS	ION/MATERIAL LIST	AWRENCE L	SPECIFICATIO	DN NO	
_	WEIGHT(Ibs): APPROVALS ORIGINATOR BROOKSBYI	6.056 DATE 11/22/10			ONAL SECURITY-		A
IED S.	DRAWN BROOKSBYI CHECKED KILLINGSWORTH2 APPROVED PIGGOTTI	2/16/11 2/28/11 3/1/11	SIZE CAGE CODE	EARING ST		REV	
		DRAWING LEVEL. 2 2	<b>D</b>   4067 SCALE:	AAAII NONE	- 50   256   Sheet 	o – AA I OF I	



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MACHINE TOOL CAPABILITIES.			RD ANGLE PROJECTI
ETC. PERMITTED.	THIS WORK WAS PERFORMED UNDER THE AUSPICES OF THE U.S. DEP ENERGY UNDER CONTRACT NO. DE-AC52-07NA27344. NEITHER THE U GOVERNMENT NOR LAWRENCE LIVERMORE NATIONAL SECURITY, LLC, THEIR EMPLOYEES MAKES ANY WARRANTY, EXPRESSED OR IMPLIED C	INITED STATES NOR ANY OF DR ASSUMES ANY	
	LEGAL LIABILITY OR RESPONSIBILITY FOR THE ACCURACY, COMPLE USEFULNESS OF ANY INFORMATION, APPARATUS, PRODUCT, OR PROC OR REPRESENTS THAT ITS USE WOULD NOT INFRINGE PRIVATELY OW REFERENCE HEREIN TO ANY SPECIFIC COMMERCIAL PRODUCT, PROCE BY TRADE NAME, TRADEMARK, MANUFACTURER, OR OTHERWISE DOES CONSTITUTE OR IMPLY ITS ENDORSEMENT, RECOMMENDATION, OR FA	CESS DISCLOSED, DIME VNED RIGHTS. SS, OR SERVICE DE NOT NECESSARILY	SS OTHERWISE SPECIFII NSIONS ARE IN INCHES TOLERANCES ARE: CIMALS ANGLES .005 ± 0.5
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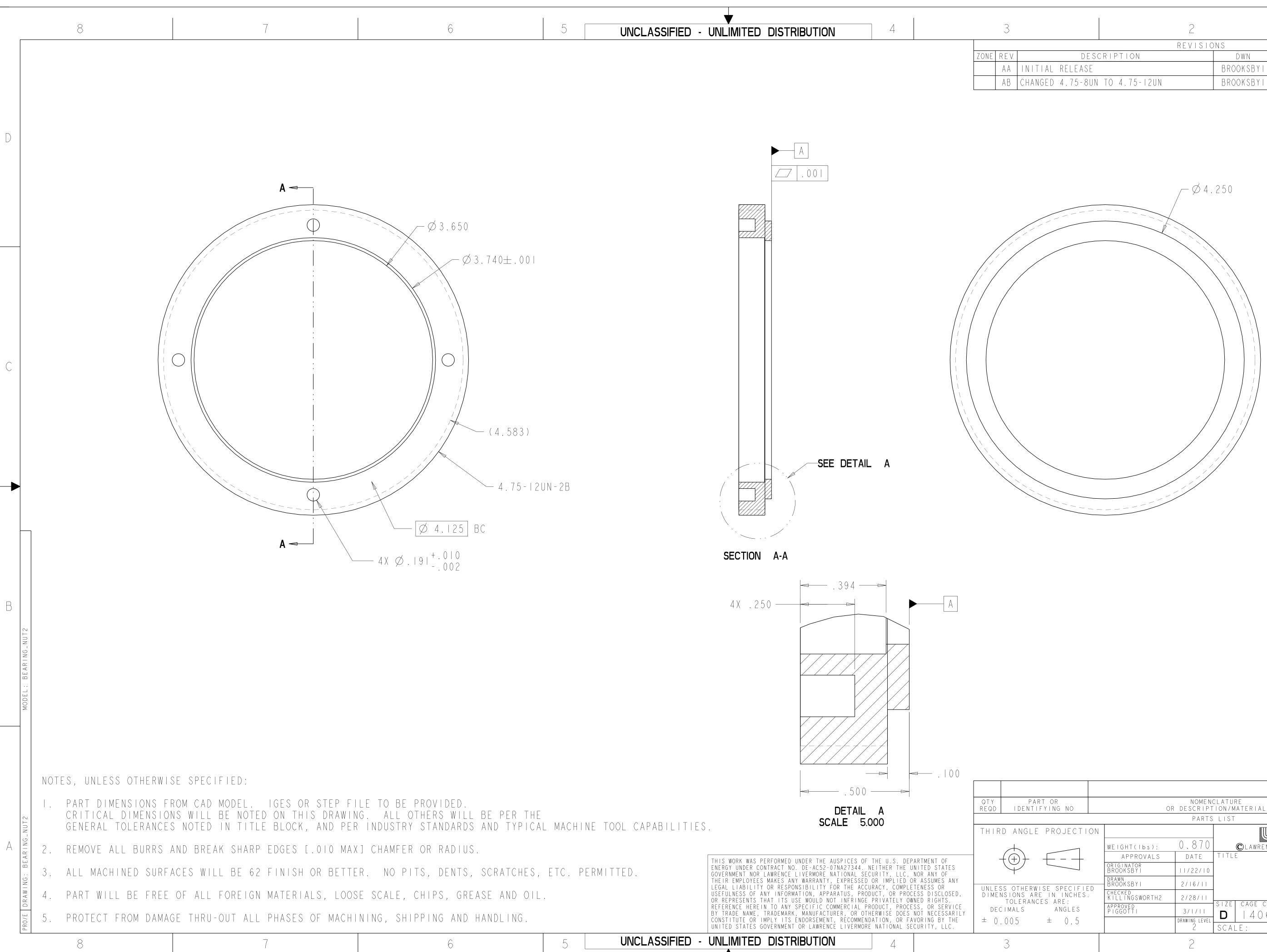
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ASE	REVISIONSSCRIPTIONDWNCHKAPVDBROOKSBYIKILLINGSWORTH2PIGGOTTITO 4.5-I2UNBROOKSBYIKILLINGSWORTH2PIGGOTTI	DATE 3-I-II 5-4-II
	4.5-8UN-2B	D
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	Ø 6.375 B ₩.50±.03	SC B
T I O N	WEIGHT(Ibs): 17.952 APPROVALS DATE ORIGINATOR BROOKSBYI DRAWN BROOKSBYI 2/16/11 2/16/11	AL ITEM NO RY TY-LLC A 57 - AB



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DWN	СНК	APVD	DATE				
BROOKSBYI	KILLINGSWORTH2	PIGGOTTI	3 -   -				
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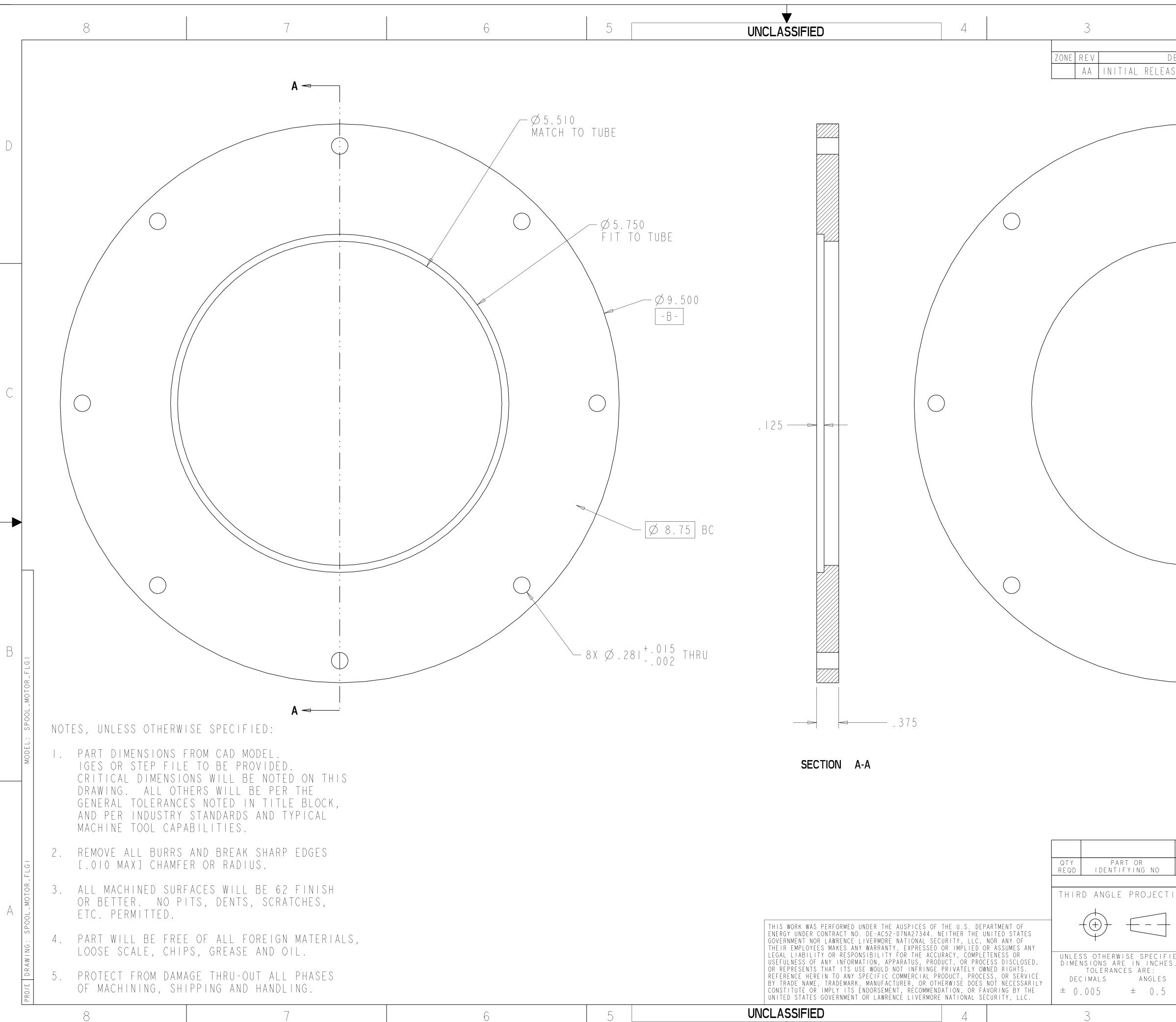
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	NOMENCLATURE OR DESCRIPTION/MATERIAL				MATERIAL SPECIFICATION	I T E M N O
		PARTS	LIST			
ION	WEIGHT(Ibs):	EIGHT(165): 0.710 LAWRENCE LIVERMORE NATIONAL LABORATORY ©LAWRENCE LIVERMORE NATIONAL SECURITY-L				
- IED S.	APPROVALS	DATE	TITLE			
	ORIGINATOR BROOKSBYI	11/22/10				
	drawn Brooksbyi	2/16/11				
	CHECKED KILLINGSWORTH2	2/28/11		BEARING	NUI	
	APPROVED PIGGOTTI	3/1/11	D 4067	dwg no AAAII	-501258 -	rev A B
		drawing level 2	SCALE:	NONE	SHEET I	OF I
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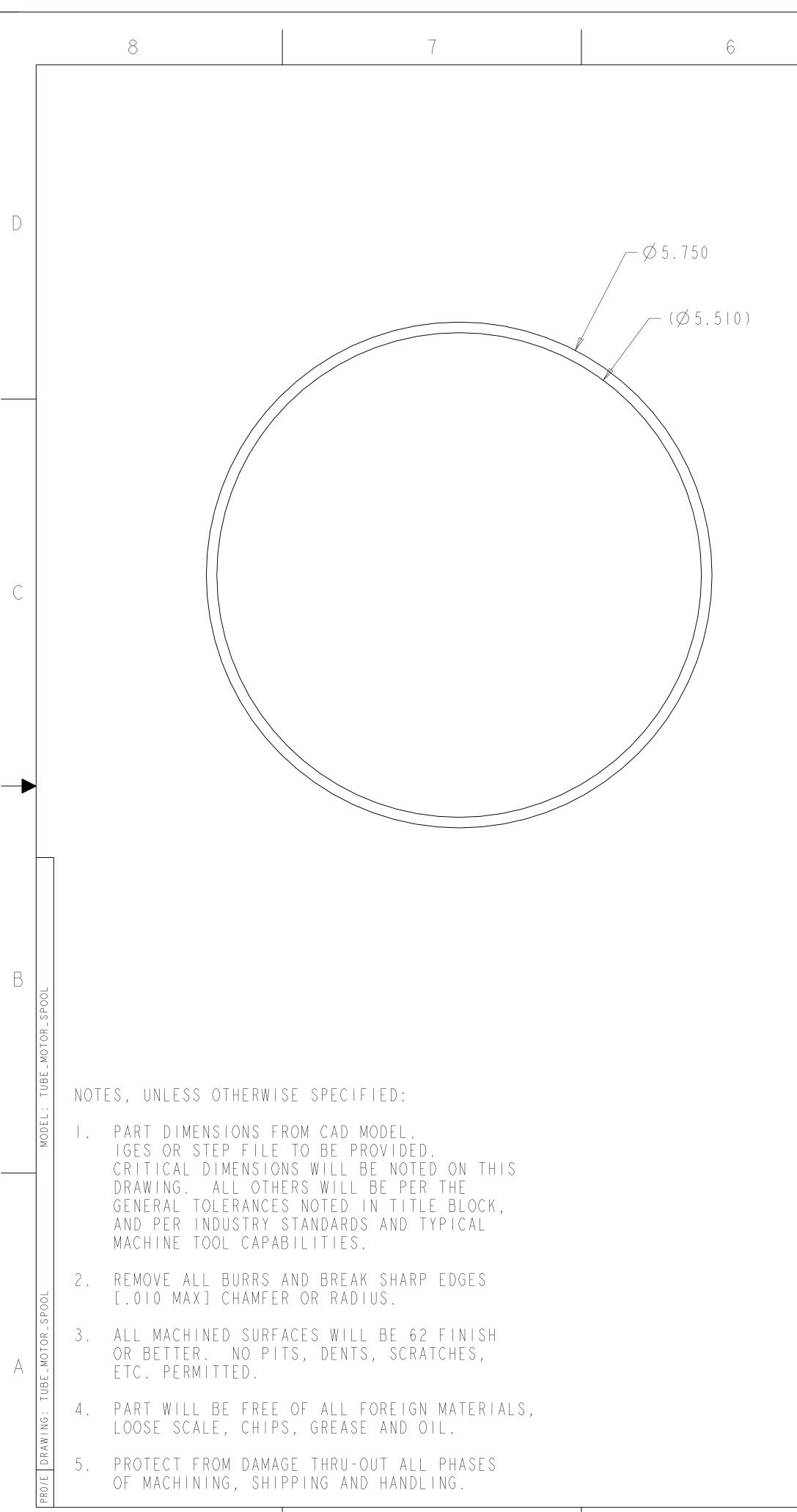


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BROOKSBYI	KILLINGSWORTH2	PIGGOTTI	3 -   -		
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	dwn Brooksby i	DWN CHK BROOKSBYI KILLINGSWORTH2	DWN CHK APVD BROOKSBYI KILLINGSWORTH2 PIGGOTTI		

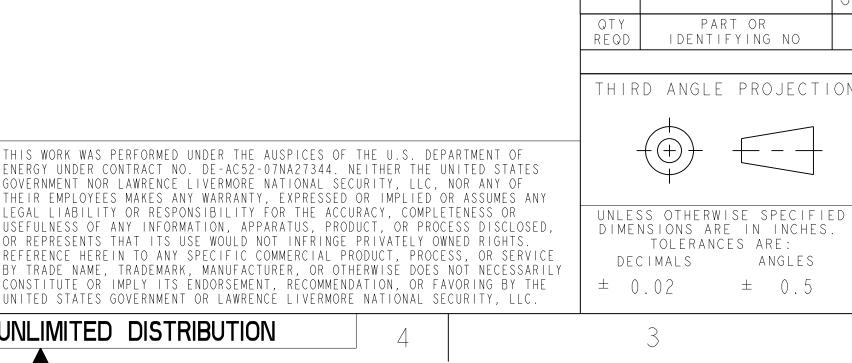
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NOMENCLATURE MATERIAL ITEM OR DESCRIPTION/MATERIAL SPECIFICATION NO					
	PARTS	LIST			
			ERMORE		
WEIGHT(Ibs):	0.870		ORATORY L SECURITY-LLC A		
APPROVALS	DATE	TITLE			
ORIGINATOR BROOKSBYI	/22/ 0				
DRAWN BROOKSBYI	2/16/11				
CHECKED KILLINGSWORTH2	2/28/11				
APPROVED PIGGOTTI	3/ /		$\frac{\text{ReV}}{501259 - \text{AR}}$		
	drawing level		SHEET I OF I		
•	2				
	WEIGHT(Ibs): APPROVALS ORIGINATOR BROOKSBYI DRAWN BROOKSBYI CHECKED KILLINGSWORTH2 APPROVED	OR DESCRIPTIN PARTS WEIGHT(Ibs): 0.870 APPROVALS DATE ORIGINATOR BROOKSBYI 11/22/10 DRAWN BROOKSBYI 2/16/11 CHECKED KILLINGSWORTH2 2/28/11 APPROVED PIGGOTTI 3/1/11 DRAWING LEVEL	NOMENCLATURE OR DESCRIPTION/MATERIAL SPARTS LIST PARTS LIST WEIGHT(Ibs): 0.870 APPROVALS DATE ORIGINATOR BROOKSBYI 11/22/10 DRAWN BROOKSBYI 2/16/11 CHECKED KILLINGSWORTH2 2/28/11 APPROVED PIGGOTTI 3/1/11 DRAWING LEVEL DRAWING LEVEL DRAWING LEVEL DRAWING LEVEL DRAWING LEVEL DRAWING LEVEL DRAWING LEVEL SIZE CAGE CODE DWG NO 14067 AAAII - 5		

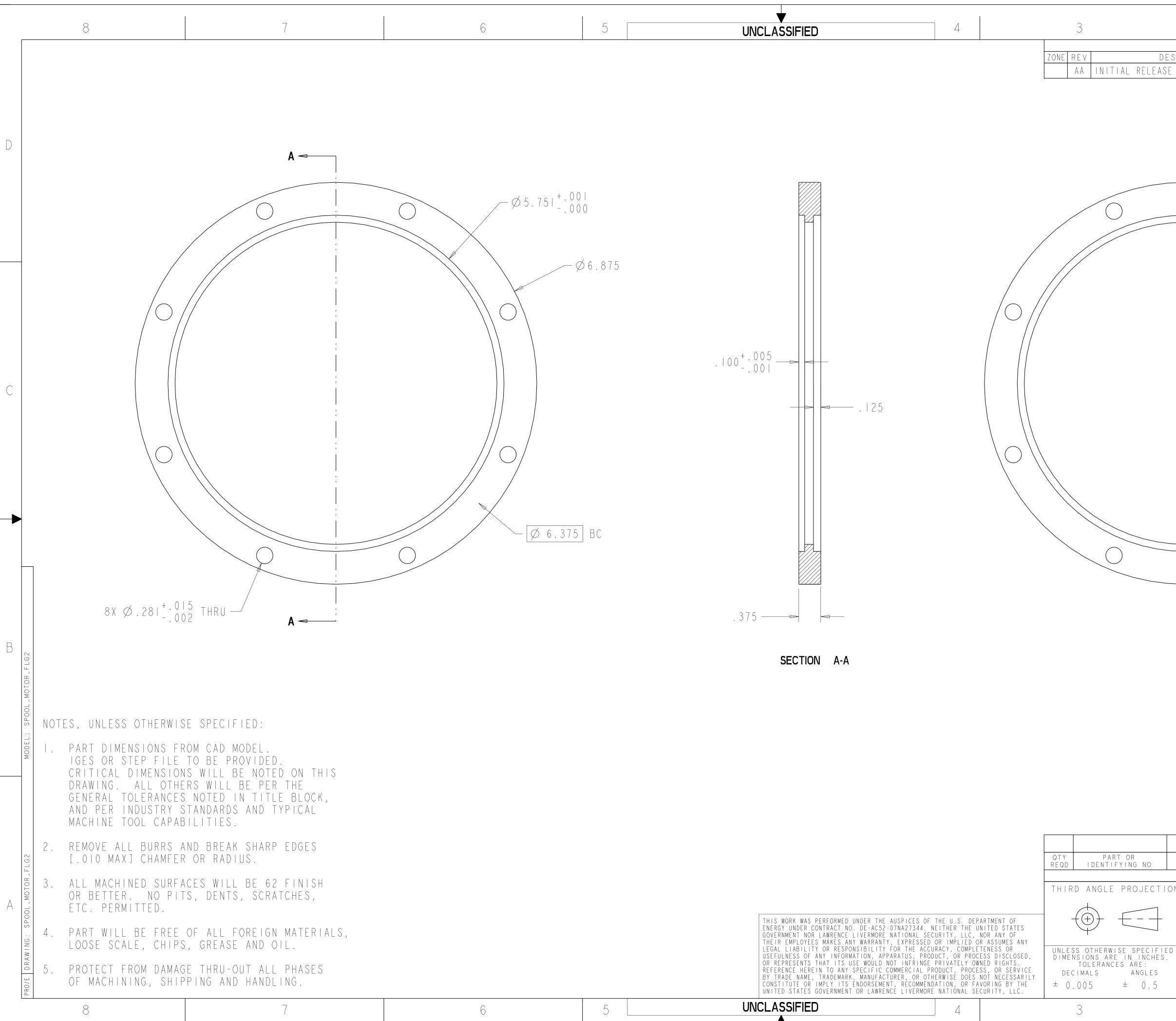


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	ORIGINATOR BROOKSBYI	11/22/10					
)	DRAWN BROOKSBYI CHECKED	2/16/11		10TOR SPOOL			
	CHECKED KILLINGSWORTH2 APPROVED PIGGOTTI	3/1/11	SIZE CAGE C	ODE DWG NO		REV	
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		DRAWING LEVEL	SCALE:	NONE	SHEET	I OF I	

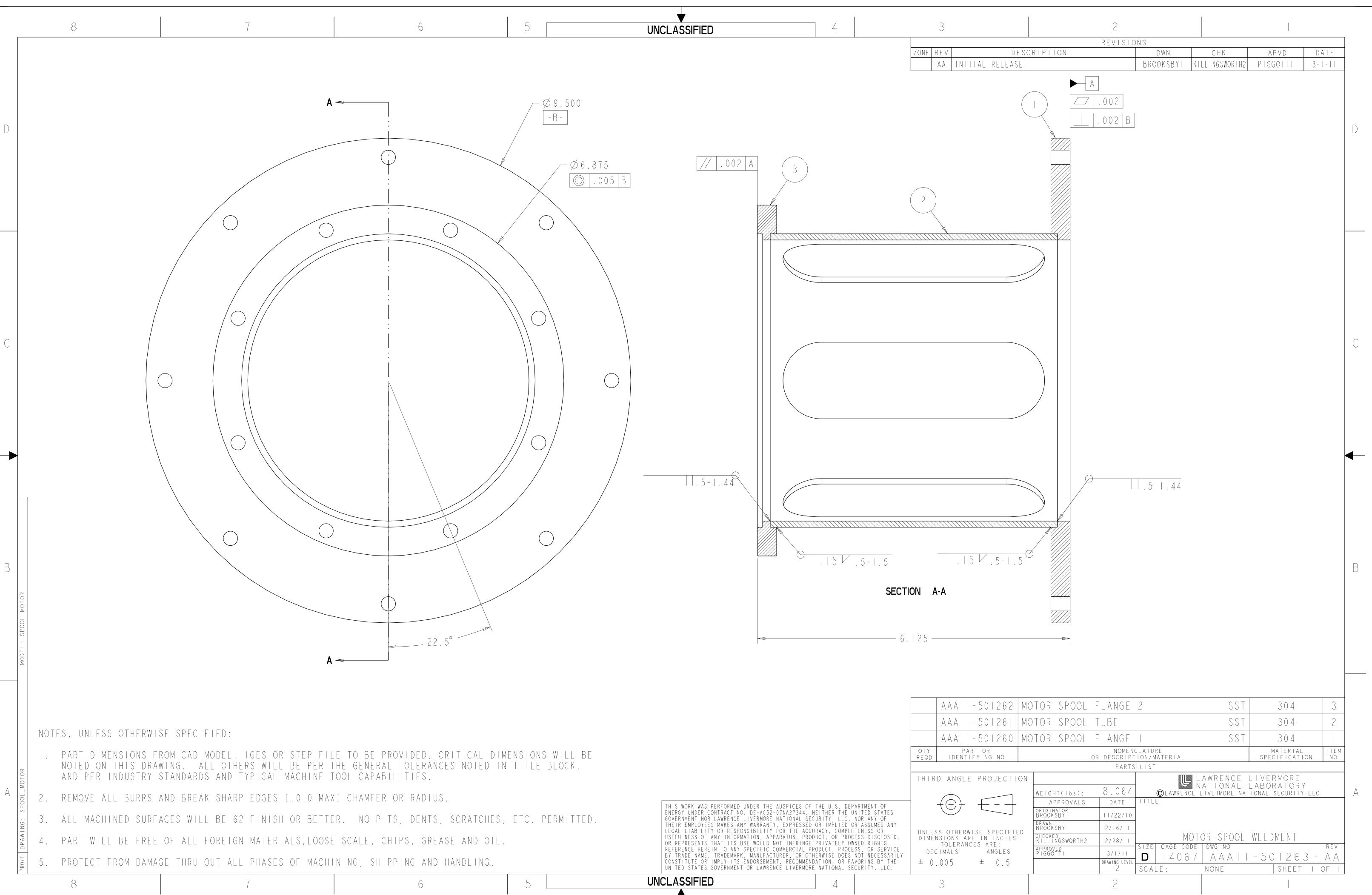


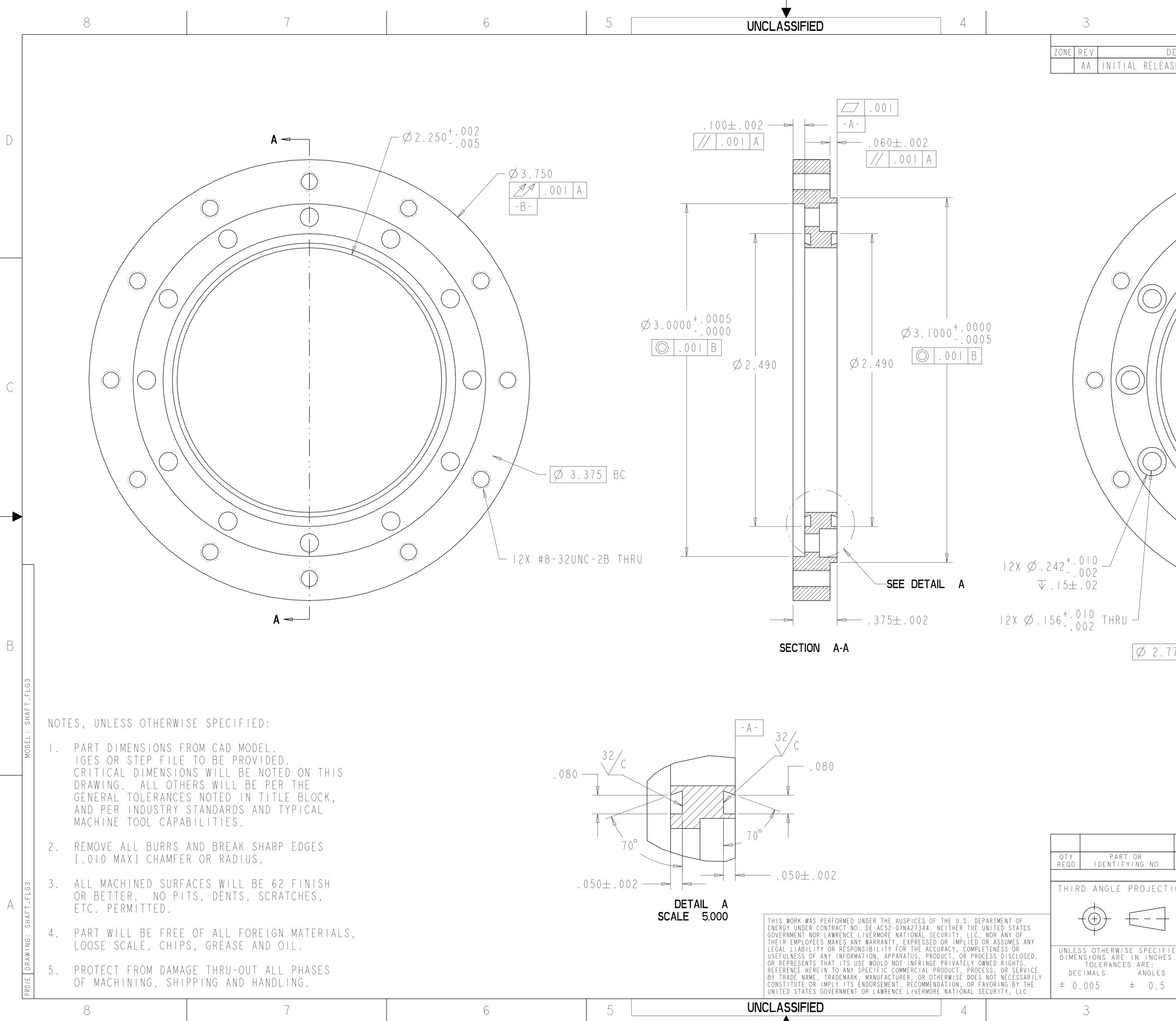
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THIS V ENERGY	WORK WAS PERFORMED UNDER THE AUSPICES OF THE U.S. DEPARTMENT OF Y UNDER CONTRACT NO. DE-AC52-07NA27344. NEITHER THE UNITED STATES NMENT NOR LAWRENCE LIVERMORE NATIONAL SECURITY, LLC, NOR ANY OF EMPLOYEES MAKES ANY WARRANTY, EXPRESSED OR IMPLIED OR ASSUMES ANY	THIRD ANGLE PROJECTION WEIGHT(Ibs): APPROVALS ORIGINATOR BROOKSBYI	I.914       Image: Constraint of the second se	A
LEGAL USEFUL OR REF REFERE BY TRA	LIABILITY OR RESPONSIBILITY FOR THE ACCURACY, COMPLETENESS OR LNESS OF ANY INFORMATION, APPARATUS, PRODUCT, OR PROCESS DISCLOSED, PRESENTS THAT ITS USE WOULD NOT INFRINGE PRIVATELY OWNED RIGHTS. ENCE HEREIN TO ANY SPECIFIC COMMERCIAL PRODUCT, PROCESS, OR SERVICE ADE NAME, TRADEMARK, MANUFACTURER, OR OTHERWISE DOES NOT NECESSARILY	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE: DECIMALS ANGLES PROVED PIGGOTTI	2/16/11       MOTOR SPOOL TUBE         2/28/11       SIZE CAGE CODE DWG NO         3/1/11       D       14067       AAAII - 501261 - AB	
5 UNCLASSIFIED - UNLI	D STATES GOVERNMENT OR LAWRENCE LIVERMORE NATIONAL SECURITY, LLC.	$\begin{array}{c} \pm 0.02 \\ \hline 3 \\ \end{array}$	2 SCALE: NONE SHEET I OF I	]



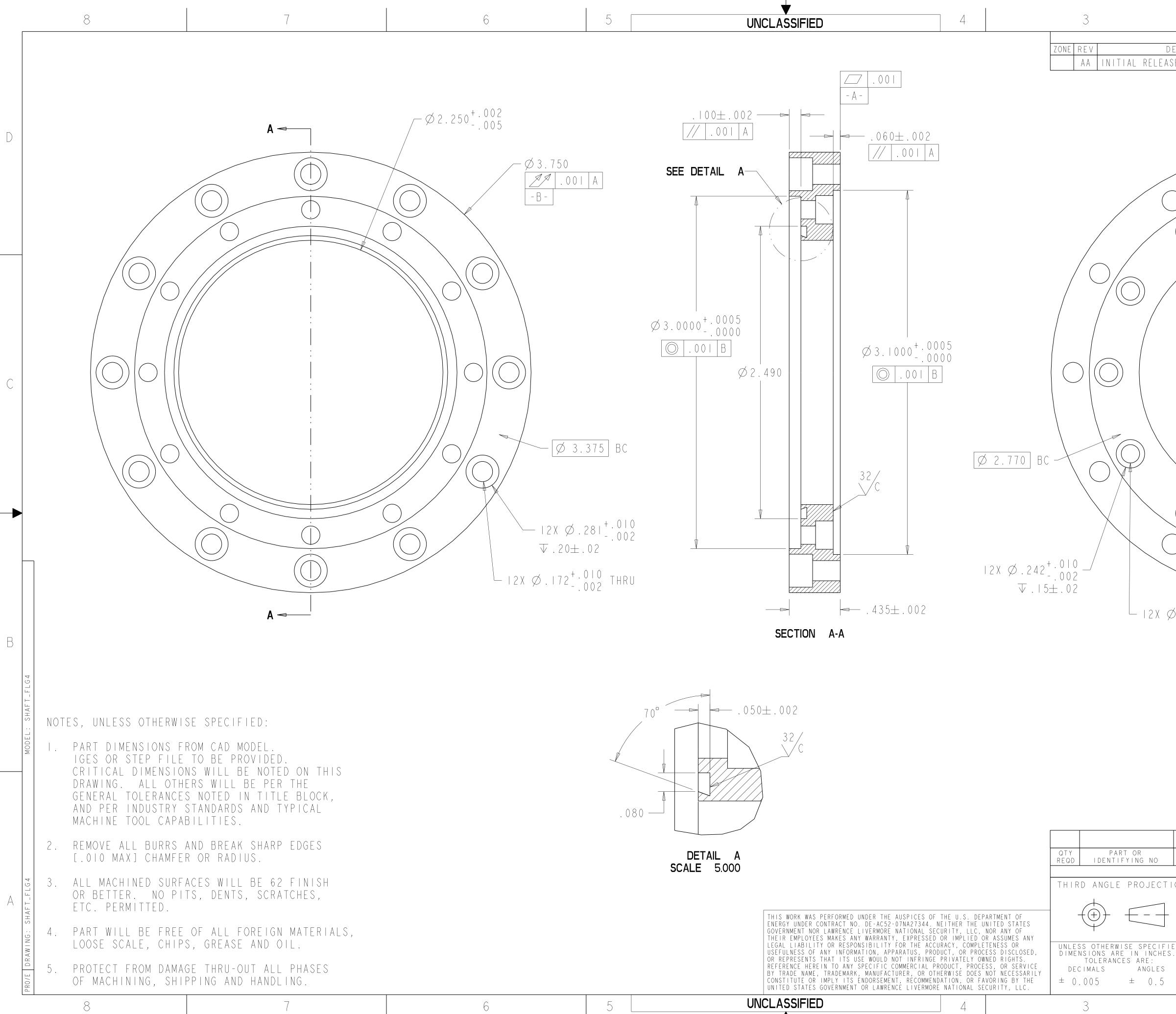


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ιUΝ	WEIGHT(Ibs): 1.234	Ű	LAWRENCE L NATIONAL L CELIVERMORE NAT	ABORATOR	Í-LLC	А
	APPROVALS DATE ORIGINATOR BROOKSBYI II/22/10					
E D	DRAWN BROOKSBYI 2/16/11 CHECKED KILLINGSWORTH2 2/28/11	M	OTOR SPOOL	FLANGE 2		
	APPROVED PIGGOTTI 3/I/II DRAWING LEVE	D 406	7 AAAII	- 50   26		
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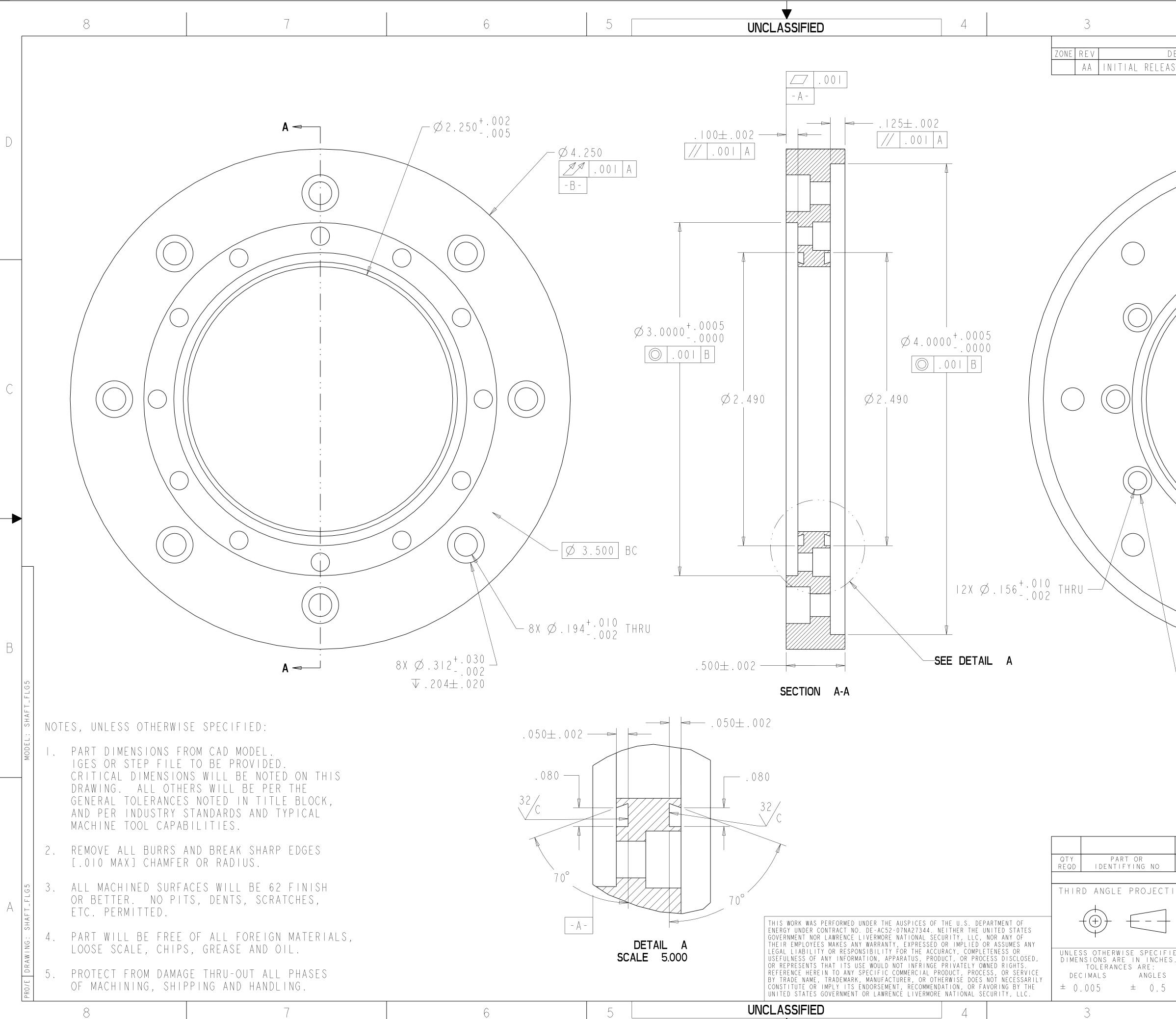




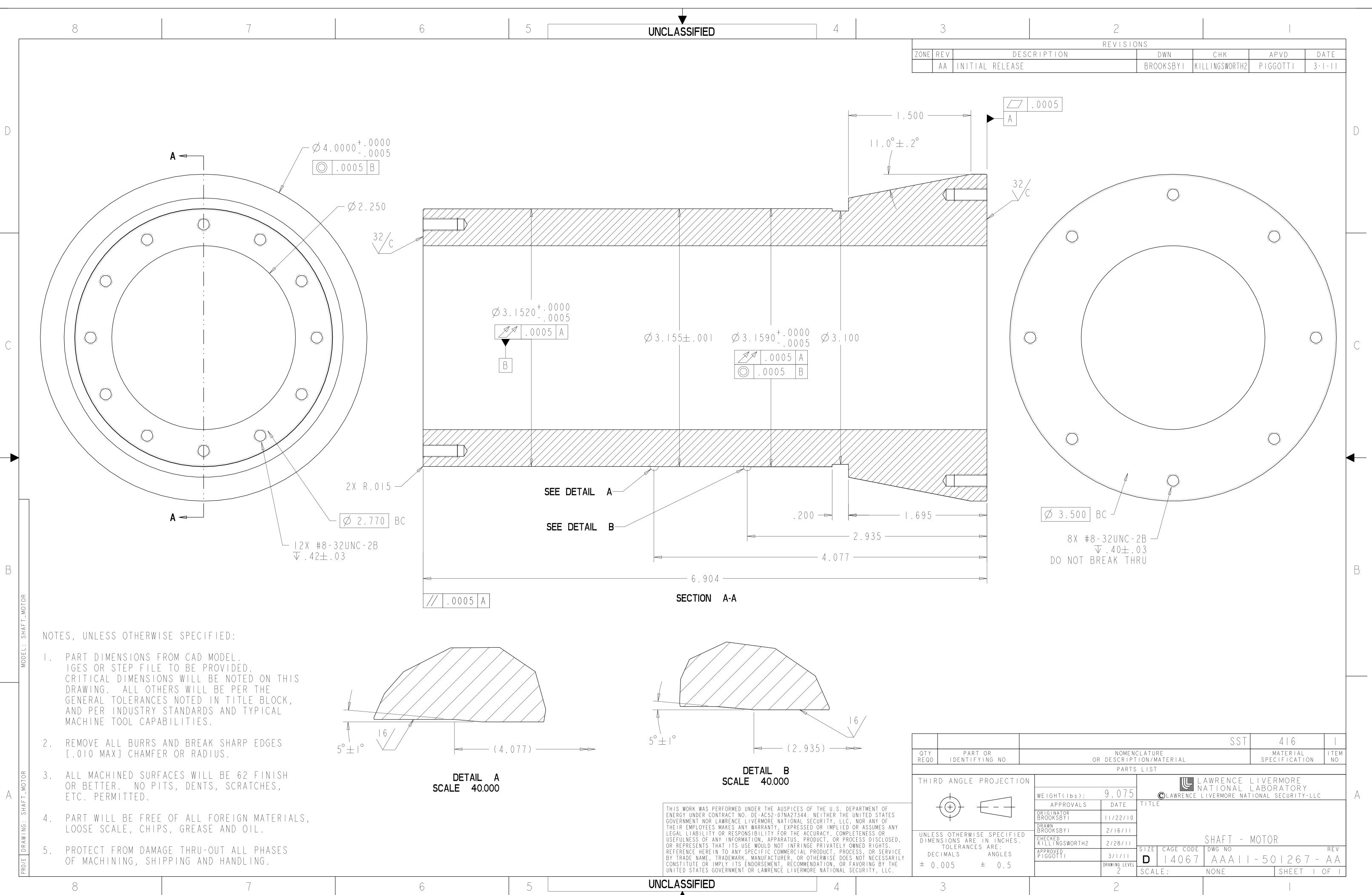
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I O N - I E D S .	APPROVALS ORIGINATOR BROOKSBYI DRAWN BROOKSBYI CHECKED KILLINGSWORTH2 APPROVED PIGGOTTI	D. 543     ©LAWR       DATE     TITLE       11/22/10     2/16/11       2/28/11     SIZE		DNAL SECURITY-LLC	
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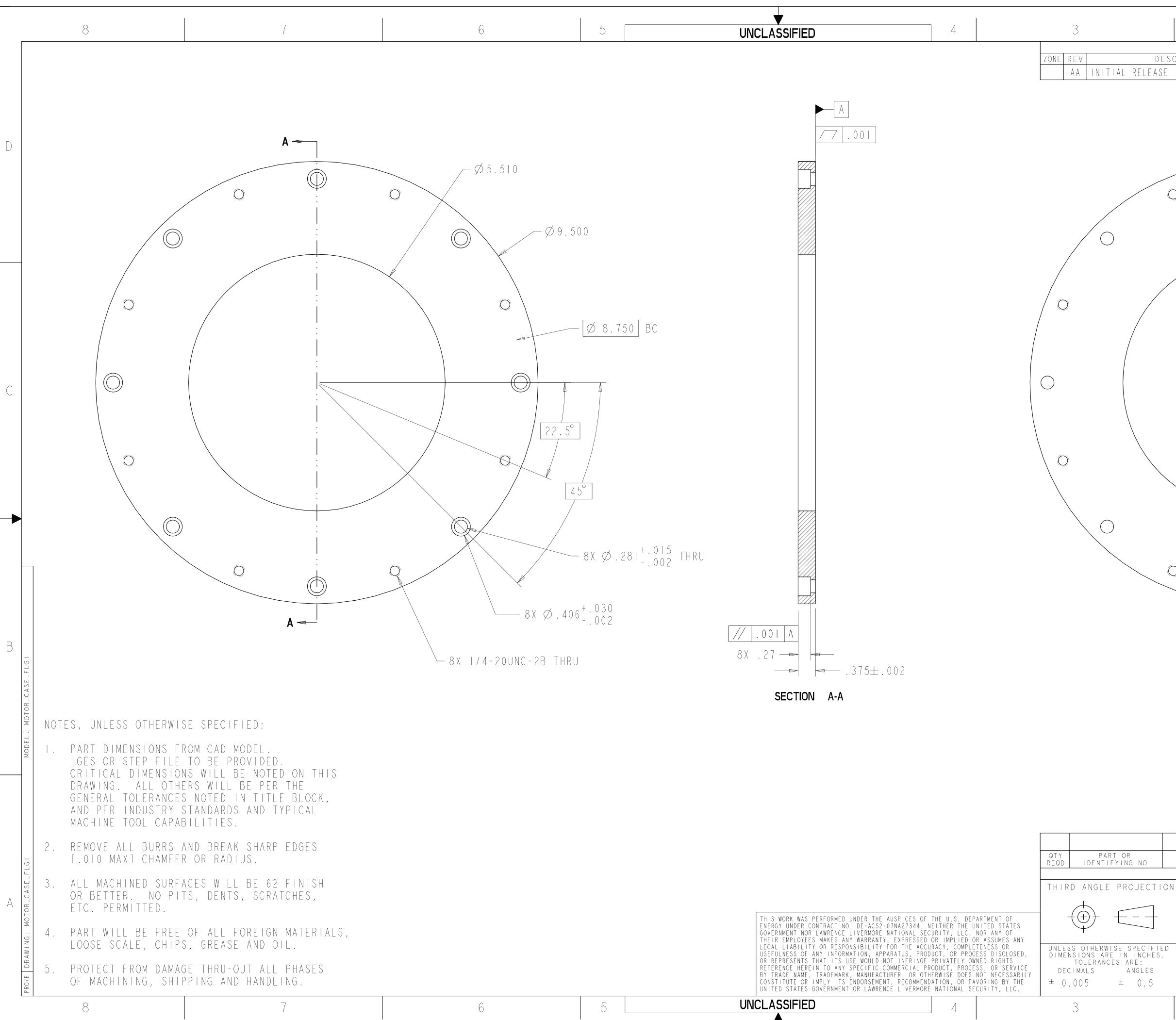


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	PARTS		LAWRENCE I NATIONAL I	_ I VERMORE		
WEIGHT(Ibs)		©LAWRENC TITLE	NATIONAL I E livermore nat	ABORATORY	-LLC	A
APPROVAL ORIGINATOR BROOKSBYI	LS DATE 11/22/10					
DRAWN BROOKSBYI CHECKED KILLINGSWORT	2/16/11 TH2 2/28/11		SHAFT FLA	NGE 4		
APPROVED PIGGOTTI	3/1/11	D 406	DE DWG NO	- 50   26 \$	rev 5 - A A	
		SCALE:	NONE	SHEET	I OF I	
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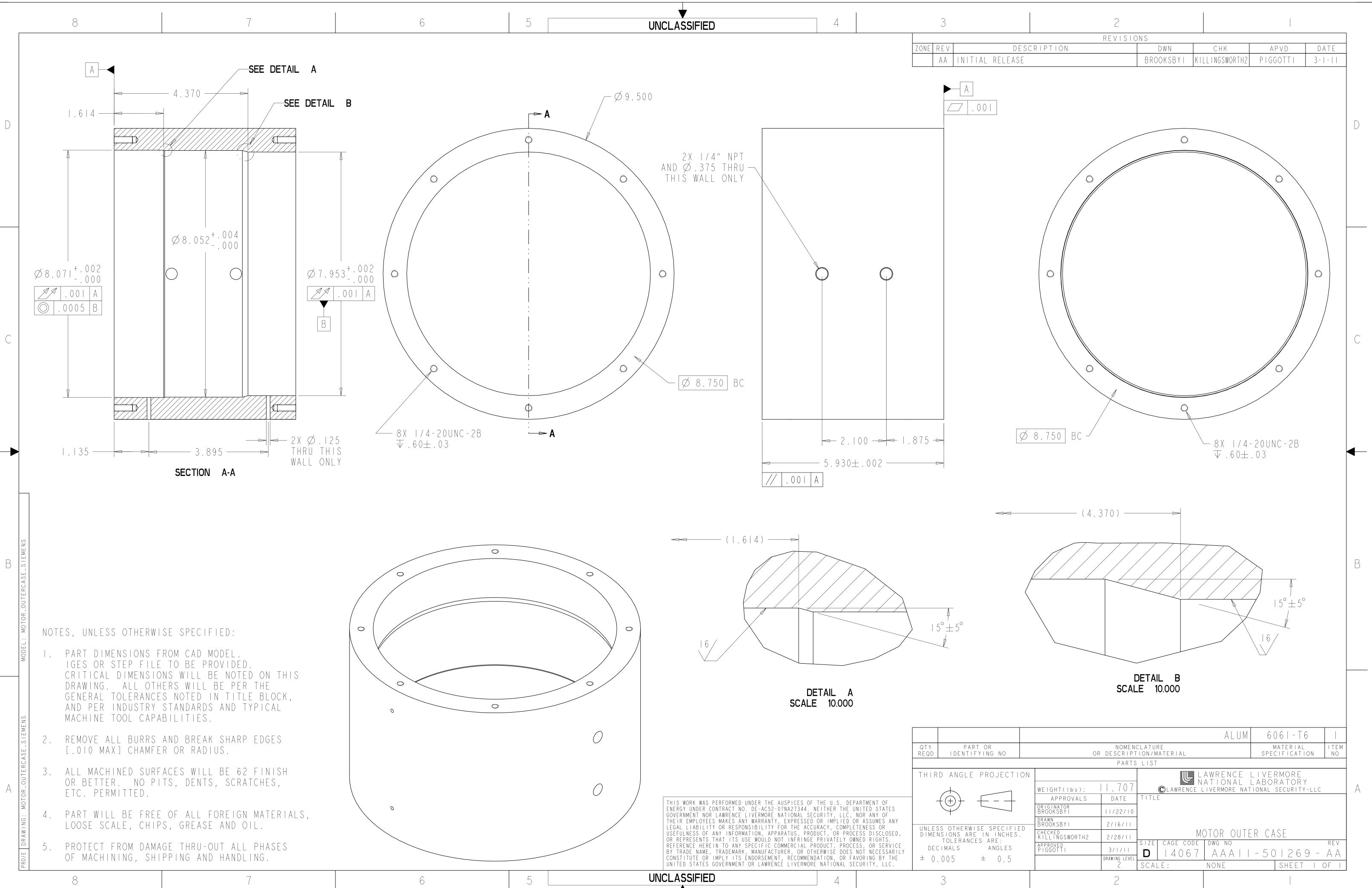


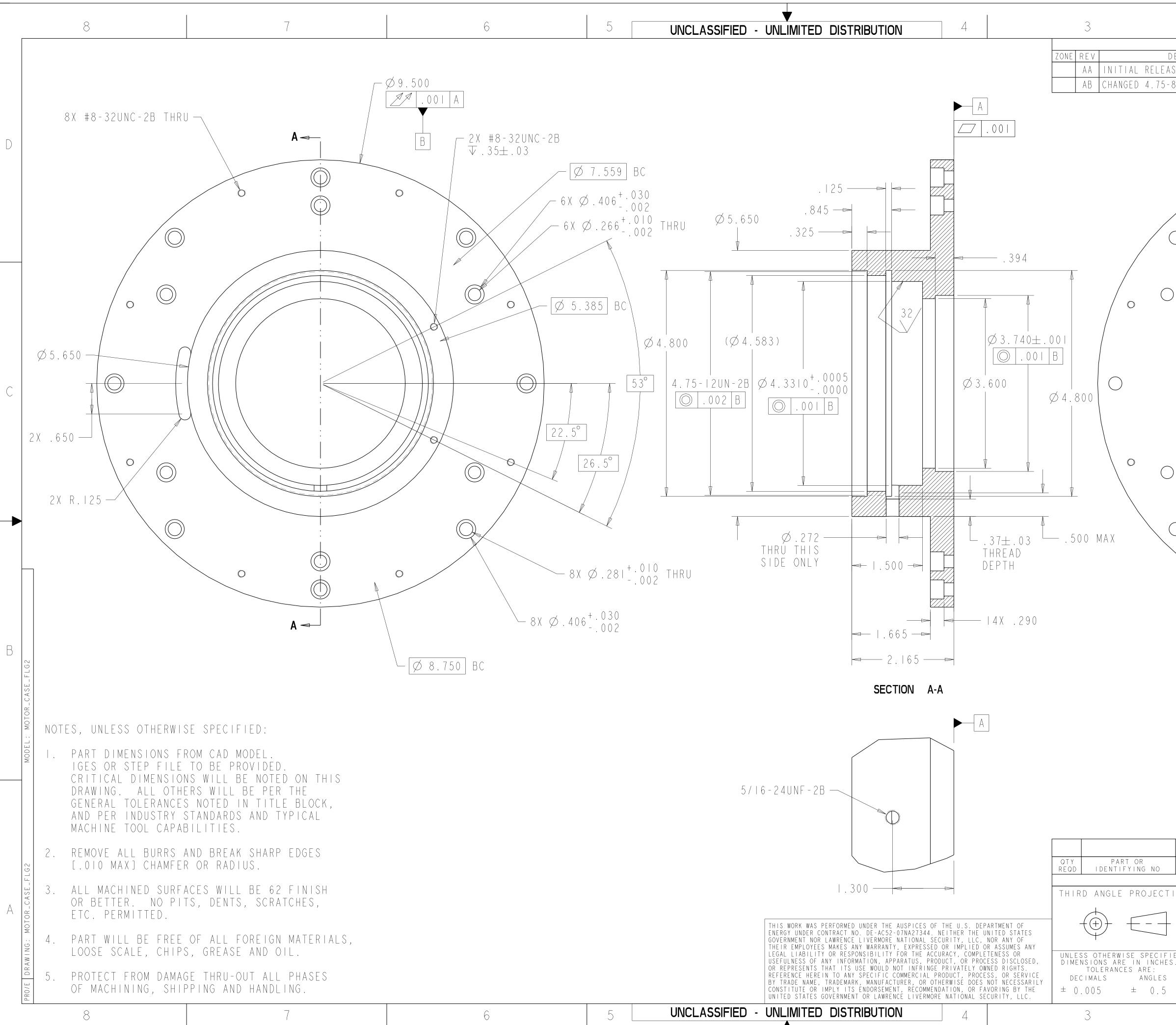
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- WEIGHT(Ibs): APPROVALS ORIGINATOR BROOKSBYI DRAWN BROOKSBYI IED S. CHECKED KILLINGSWORTH APPROVED PIGGOTTI	DATE     TIT       11/22/10     2/16/11       2     2/28/11       3/1/11     D       DRAWING LEVEL     D	SH, e cage code dw 14067/	AFT FLANG VG NO AAAII-5 DNE	E 5	REV



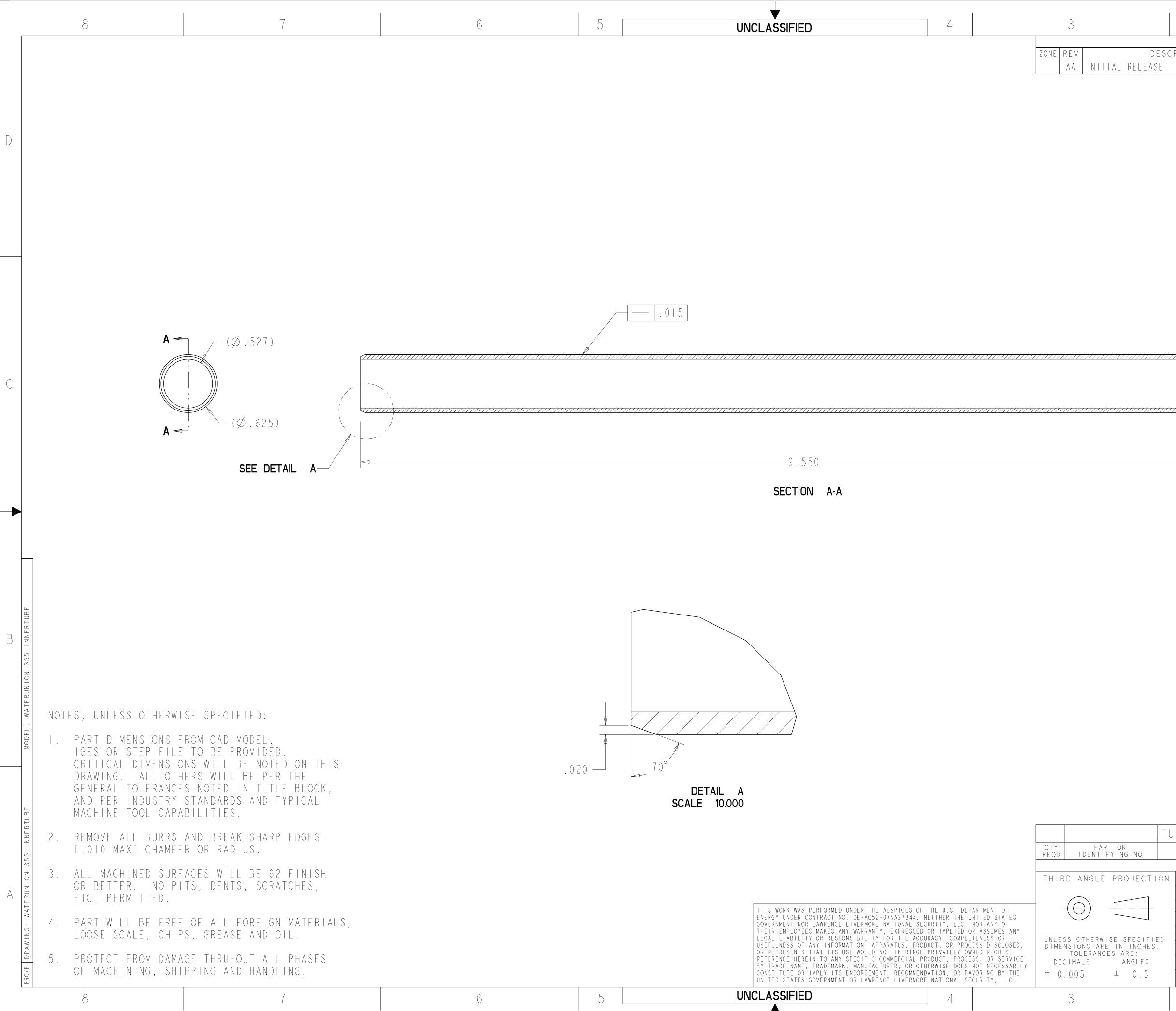


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N WEIGHT(Ibs) APPROVAL ORIGINATOR BROOKSBYI	OR DESCRIPT PARTS : 1.687		ALUM LAWRENCE I NATIONAL I CE LIVERMORE NAT	_ABORATOR)	ON NO
BROOKSBYI DRAWN BROOKSBYI CHECKED KILLINGSWORTI APPROVED PIGGOTTI	2/16/11	size cage co D 406 Scale:		FLANGE   -501263 sheet	rev 8 - AA 1 OF 1





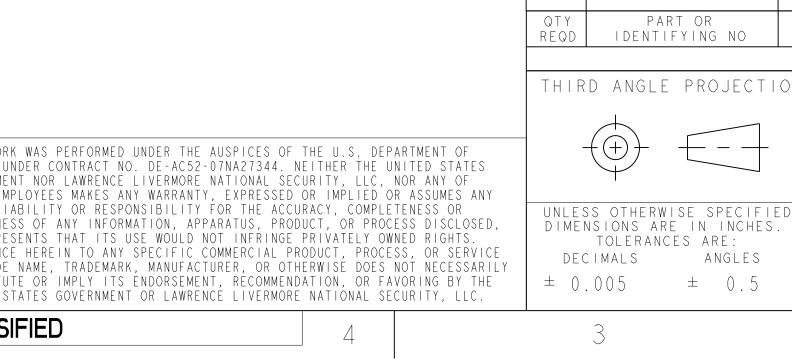
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ON	1 200		LAWRENCE L NATIONAL L	_ I VERMORE _ ABORATOR	Y	,
WEIGHT(1bs): APPROVALS	4.390 Date	© LAWRE TITLE	NCE LIVERMORE NAT	IONAL SECURIT	Y-LLC	А
ORIGINATOR BROOKSBYI	II/22/10	-				
DRAWN	2/16/11	-				
CHECKED KILLINGSWORTH2		- 	MOTOR CASE I	FLANGE 2		
APPROVED PIGGOTTI	3/1/11	size cage c D   4 0	CODE DWG NO	-50127	rev O - AB	
	DRAWING LEVEL	<b>D</b>   140   SCALE :	NONE	SHEET		
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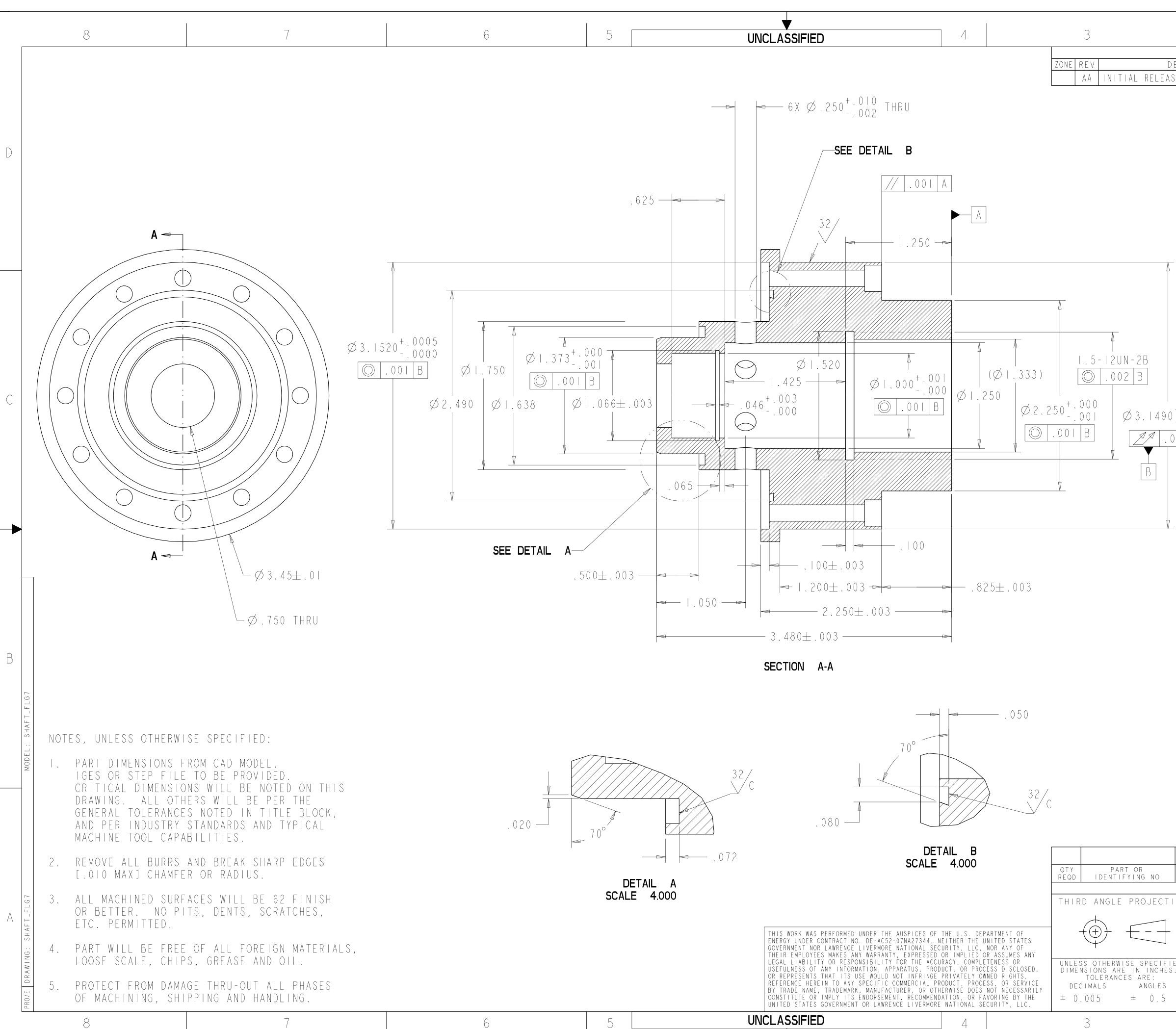


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			-		REVISI CRIPTION	ONS DWN	CHK APVD	DATE	
				AA INITIAL RELEASE		BROOKSBYI KIL	LINGSWORTH2 PIGGOTTI	3 -   -	
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			-	QTY PART OR REQD IDENTIFYING NO	OR DESCRIP	NCLATURE TION/MATERIAL S LIST	MATERIA SPECIFICAT	L ITEM ION NO	
				THIRD ANGLE PROJECTION	и weight(ibs): 0.242	CIAWRENCE I	AWRENCE LIVERMORE ATIONAL LABORATOR IVERMORE NATIONAL SECURIT	Y Y-1   C	А
	THIS WORK WAS PERFORMED UNDER THE AUS ENERGY UNDER CONTRACT NO. DE-AC52-071	SPICES OF THE U.S. DEPARTMEN NA27344. NEITHER THE UNITED	INT OF STATES		APPROVALS DATE ORIGINATOR BROOKSBYI II/22/10	TITLE			τ Λ
	GOVERNMENT NOR LAWRENCE LIVERMORE NA THEIR EMPLOYEES MAKES ANY WARRANTY, E LEGAL LIABILITY OR RESPONSIBILITY FOR USEFUINESS OF ANY INFORMATION APPARA	IIONAL SECURITY, LLC, NOR A EXPRESSED OR IMPLIED OR ASSI R THE ACCURACY, COMPLETENES ATUS, PRODUCT. OR PROCESS D	SUMES ANY SUMES ANY SS OR DISCLOSED	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:	DRAWN	_	JNION 355 INNER T	IB F	
	THIS WORK WAS PERFORMED UNDER THE AUS ENERGY UNDER CONTRACT NO. DE-AC52-071 GOVERNMENT NOR LAWRENCE LIVERMORE NA THEIR EMPLOYEES MAKES ANY WARRANTY, E LEGAL LIABILITY OR RESPONSIBILITY FOF USEFULNESS OF ANY INFORMATION, APPAR OR REPRESENTS THAT ITS USE WOULD NOT REFERENCE HEREIN TO ANY SPECIFIC COM BY TRADE NAME, TRADEMARK, MANUFACTURE CONSTITUTE OR IMPLY ITS ENDORSEMENT, UNITED STATES GOVERNMENT OR LAWRENCE	INFRINGE PRIVATELY OWNED R MERCIAL PRODUCT, PROCESS, OI ER, OR OTHERWISE DOES NOT NI RECOMMENDATION OF SAMOPLIN	RIGHTS. DR SERVICE NECESSARILY	DECIMALS ANGLES	PIGGOTTI 3/1/11	SIZE CAGE CODE		R E V	
F	CONSTITUTE OR IMPLY ITS ENDORSEMENT, UNITED STATES GOVERNMENT OR LAWRENCE UNCLASSIFIED		Y, LLC.	$\pm 0.005 \pm 0.5$	DRAWING LEVE			T I OF I	
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C				Ø.625 <sup>+</sup> .000 000 Ø1.000 <sup>+</sup> .000 002
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А	PRO/E DRAWING: WATERUNION_355_PTFE_BEARING C	MACHINE TOOL CAP REMOVE ALL BURRS [.010 MAX] CHAMF ALL MACHINED SUR OR BETTER. NO P ETC. PERMITTED. PART WILL BE FRE LOOSE SCALE, CHI PROTECT FROM DAM	ABILITIES. AND BREAK SHARP EDGES	6

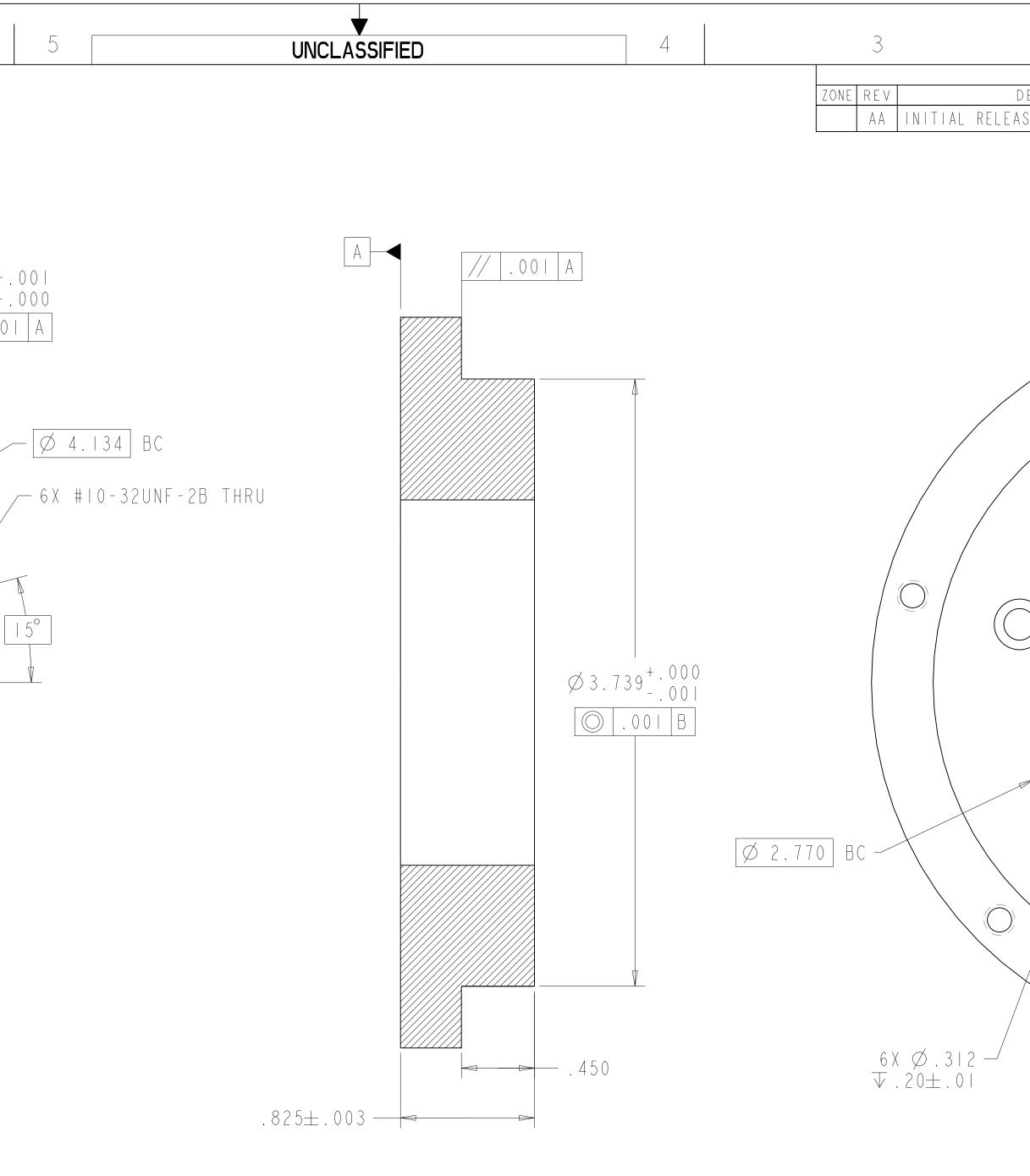
6 5	UNCLASSIFIED 4	3 2 I REVISIONS ZONE REV DESCRIPTION DWN CHK APVD DATE
		AA INITIAL RELEASE BROOKSBYI KILLINGSWORTH2 PIGGOTTI 3-1-11
Ø.625 <sup>+.002</sup>		
Ø I.000 <sup>+</sup> .000 002	. 500	
	SECTION A-A	B
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TERIALS, NSES	THIS WORK WAS PERFORMED UNDER THE AUSPICES OF THE U.S. DEPARTMENT OF ENERGY UNDER CONTRACT NO. DE-AC52-07NA27344. NEITHER THE UNITED STATES GOVERNMENT NOR LAWRENCE LIVERMORE NATIONAL SECURITY, LLC, NOR ANY OF THEIR EMPLOYEES MAKES ANY WARRANTY, EXPRESSED OR IMPLIED OR ASSUMES ANY LEGAL LIABILITY OR RESPONSIBILITY FOR THE ACCURACY, COMPLETENESS OR USEFULNESS OF ANY INFORMATION, APPARATUS, PRODUCT, OR PROESS DISCLOSED, OR REPRESENTS THAT ITS USE WOULD NOT INFRINGE PRIVATELY OWNED RIGHTS. REFERENCE HEREIN TO ANY SPECIFIC COMMERCIAL PRODUCT, PROCESS, OR SERVICE BY TRADE NAME, TRADEMARK, MANUFACTURER, OR OTHERWISE DOES NOT NECESSARILY CONSTITUTE OR IMPLY ITS ENDORSEMENT, RECOMMENDATION, OR FAVORING BY THE UNITED STATES GOVERNMENT OR LAWRENCE LIVERMORE NATIONAL SECURITY, LLC.	OTY       PART OR IDENTIFYING NO       NOMENCLATURE OR DESCRIPTION/MATERIAL       MATERIAL SPECIFICATION       ITEM NO         PARTS LIST         THIRD ANGLE PROJECTION         WEIGHT(Ibs): 0.010         WEIGHT(Ibs): 0.010         WEIGHT(Ibs): 0.010         WEIGHT(Ibs): 0.010         OPROVALS         DATE         TITLE         WATER UNION PTFE BEARING         SIZE CAGE CODE DWG NO         REV         DECIMALS ANGLES
6 5	BY TRADE NAME, TRADEMARK, MANUFACTURER, OR OTHERWISE DOES NOT NECESSARILY CONSTITUTE OR IMPLY ITS ENDORSEMENT, RECOMMENDATION, OR FAVORING BY THE UNITED STATES GOVERNMENT OR LAWRENCE LIVERMORE NATIONAL SECURITY, LLC.	DECIMALS     ANGLES       ± 0.005     ± 0.5       Piggotti     3/1/11     D     1 4067     A A A I I - 50 I 272 - A A       2     DRAWING LEVEL     SCALE:     NONE     SHEET I OF I       3     2     I



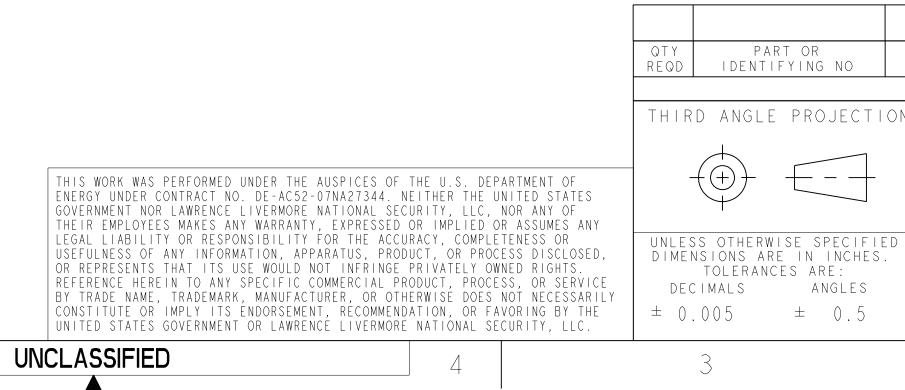


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Δ	$\begin{array}{c} 12X \ \emptyset . \ 312 \\ \overline{\nabla} . \ 20 \pm . \ 01 \end{array} \qquad \left[ \begin{array}{c} -12X \ \emptyset . \ 194^{+} . \ 010 \\ \ 002 \end{array} \right] THRU \\ \overline{\psi} \ 2.770 \ BC \end{array}$	
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	6X #8-32UNC-2B ▼.35±.02	B
T I O N	SST     304     I       NOMENCLATURE OR DESCRIPTION/MATERIAL     MATERIAL SPECIFICATION     ITEM NO       PARTS LIST       WEIGHT(Ibs): 3.373 APPROVALS     IST       CLAWRENCE LIVERMORE NATIONAL LABORATORY NATIONAL LABORATORY CLAWRENCE LIVERMORE NATIONAL SECURITY-LLC       ORIGINATOR BROOKSBY1       STZE CAGE CODE       DWG NO       REV PIGGOTI1       STZE CAGE CODE       DWG NO       REV PIGGOTI1       STZE CAGE CODE       DWG NO       REV PIGGOTI1       SCALE: NONE       SCALE: NONE	A

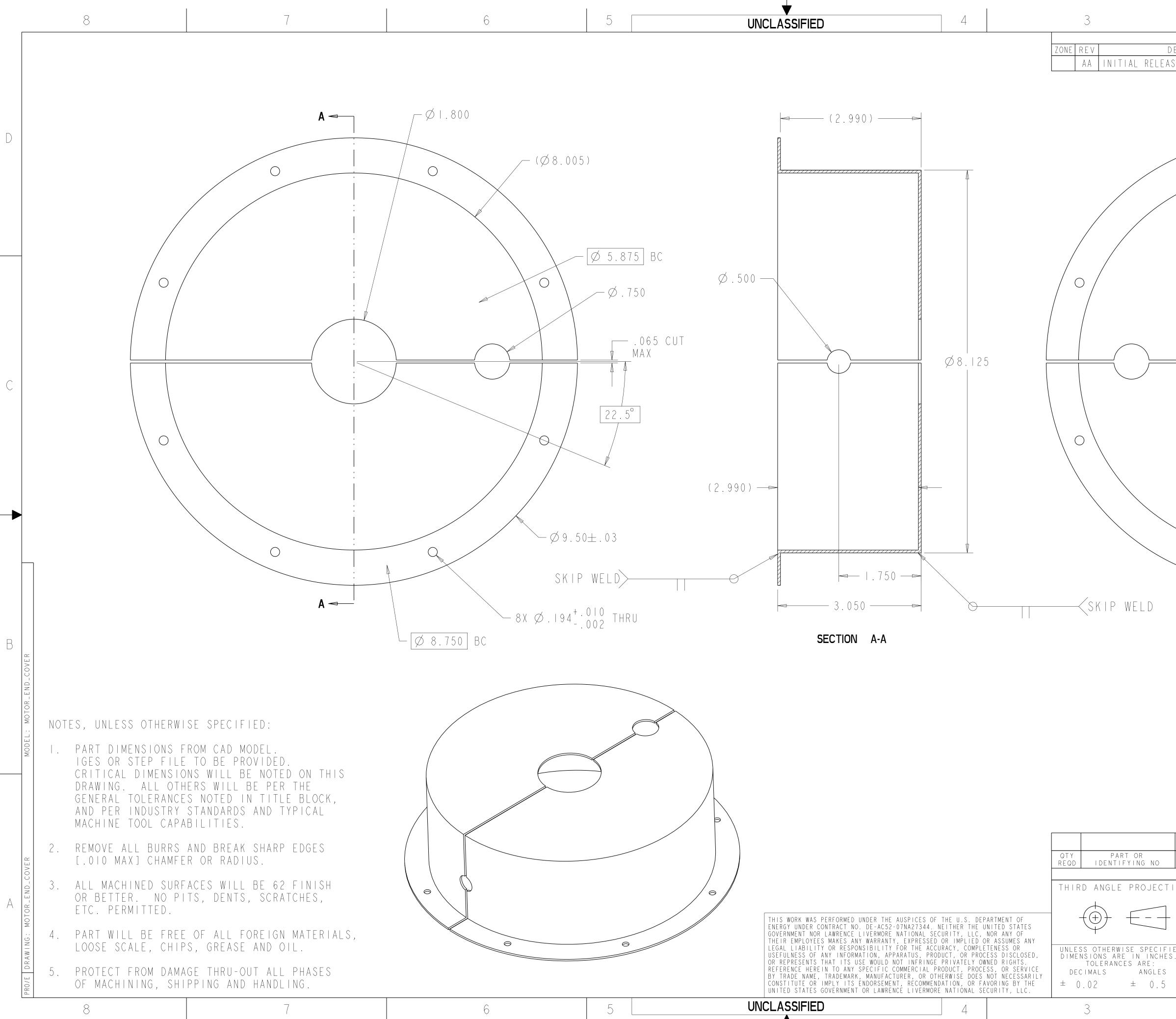
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B			Ø 4.50±.01
	I. PART DIMENSIONS FI IGES OR STEP FILE CRITICAL DIMENSION DRAWING. ALL OTH GENERAL TOLERANCES	ROM CAD MODEL. TO BE PROVIDED. NS WILL BE NOTED ON THIS ERS WILL BE PER THE S NOTED IN TITLE BLOCK, STANDARDS AND TYPICAL	
A	I.OIO MAX] CHAMFE 3. ALL MACHINED SURF OR BETTER. NO PI ETC. PERMITTED.	ACES WILL BE 62 FINISH TS, DENTS, SCRATCHES,	
	LOOSE SCALE, CHIPS 5. PROTECT FROM DAMAG	OF ALL FOREIGN MATERIALS, S, GREASE AND OIL. GE THRU-OUT ALL PHASES PPING AND HANDLING.	
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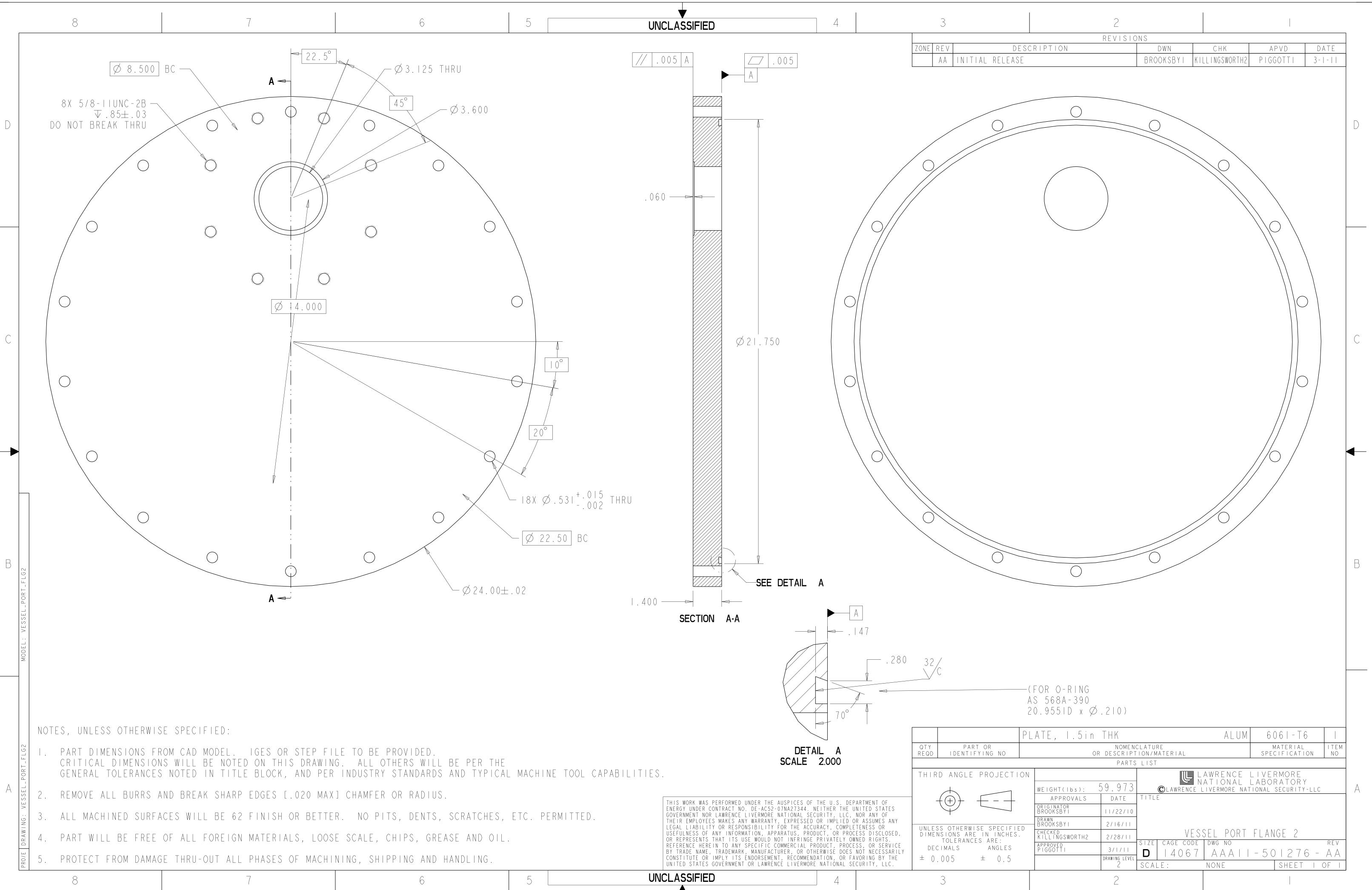


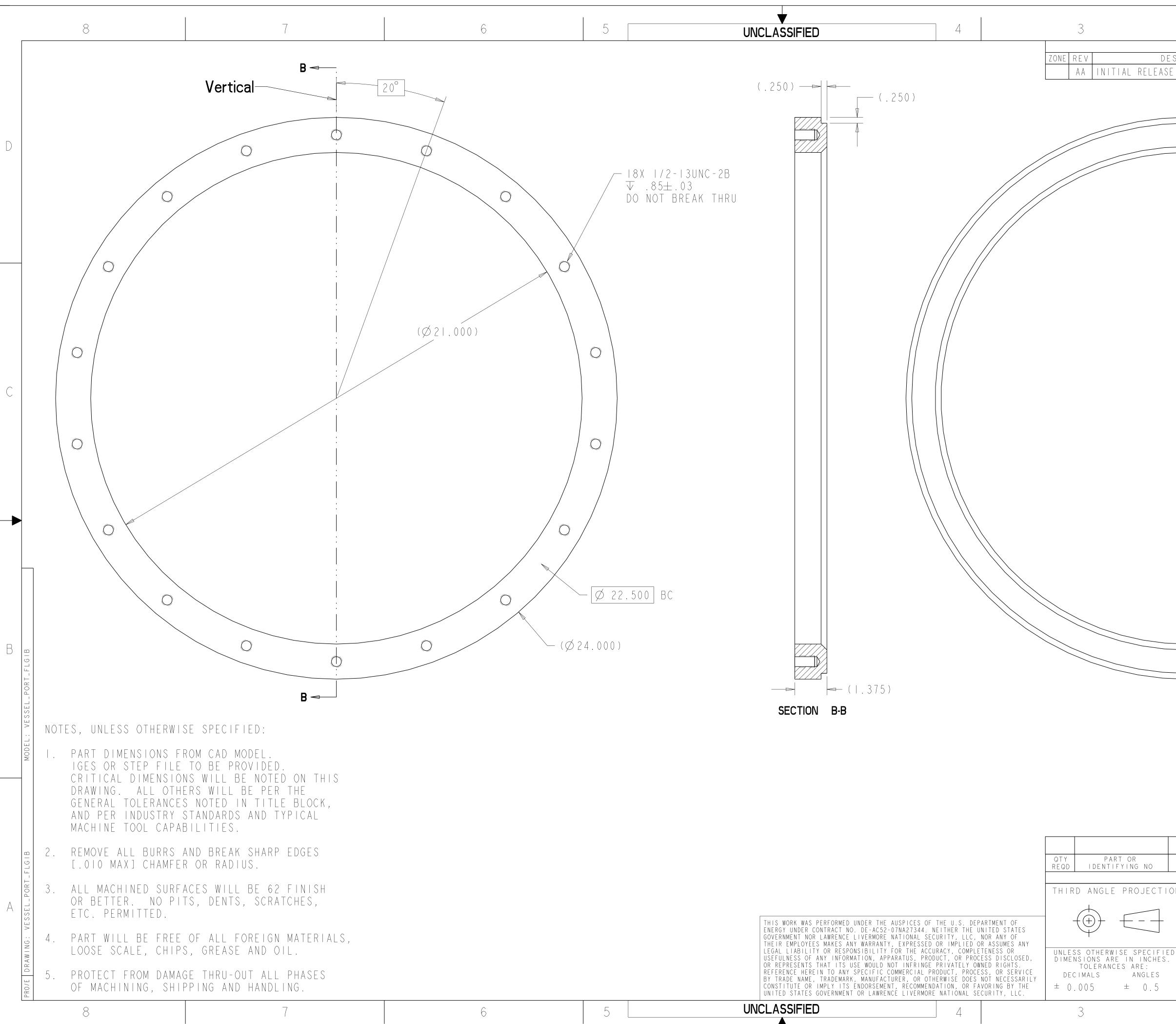


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	<u>бх</u>	Ø.194 <sup>+</sup>	010 .002 THRU				В
- OI B IED CI S. K	OF EIGHT(Ibs): APPROVALS RIGINATOR ROOKSBYI RAWN ROOKSBYI HECKED ILLINGSWORTH2 PPROVED IGGOTTI	C DESCRIPT PARTS 0.724 DATE 11/22/10 2/16/11 2/28/11	©LAWRENG TITLE	NATIONAL <u>celivermore nat</u> ICODER MOUN de dwg no	6061-TO MATERIAL SPECIFICATI LIVERMORE LABORATORY IONAL SECURITY TING DISK - 50127 SHEET	ON NO	A

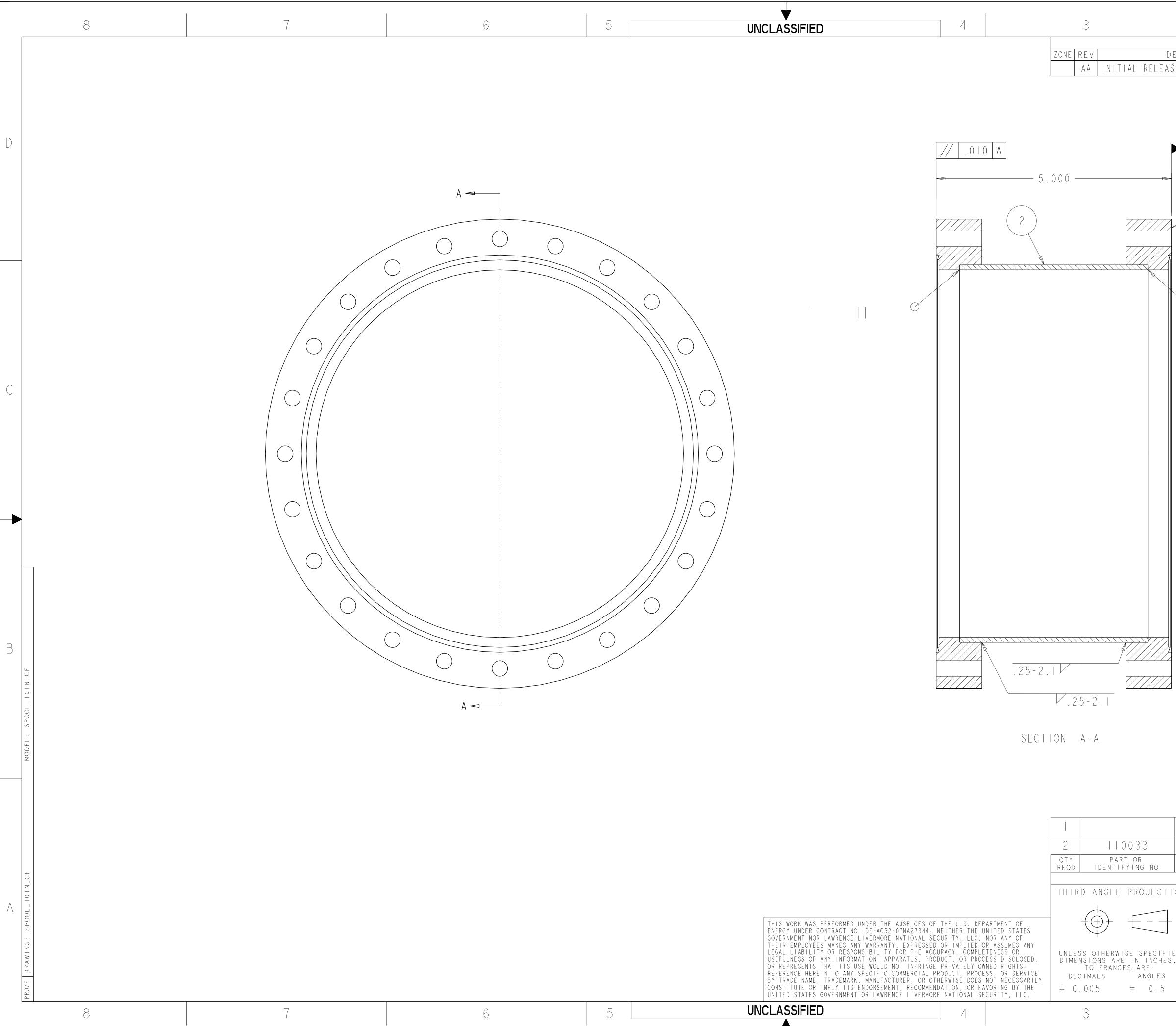


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ON WEIGHT(Ibs): APPROVALS ORIGINATOR BROOKSBYI DRAWN BROOKSBYI	2.444 DATE 11/22/10 2/16/11	LAWRENCE NATIONAL AWRENCE LIVERMORE	E LIVERMORE L LABORATORY <u>NATIONAL SECURITY-L</u>	<u>lc</u> A
D CHECKED KILLINGSWORTH2 APPROVED PIGGOTTI	2/28/11 SIZE CA		ND COVER	





		2 REVISION	19				
DESCR ISE	RIPTION		DWN BROOKSBYI	CHK KILLINGSWORTH2	APVD PIGGOTTI	DATE 3-1-11	
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_		PARTS 39.054	on/material list	SST LAWRENCE L NATIONAL L CE LIVERMORE NAT	304 material specificati i V E R MOR E A B OR A T OR Y ional security		A
IED - S.	DRAWN BROOKSBYI CHECKED KILLINGSWORTH2 APPROVED PIGGOTTI	2/16/11 2/28/11 3/1/11 DRAWING LEVEL	VE Size cage co D 1406 Scale:		ELANGE IB - 50127   Sheet 	rev 7 – AA 1 OF 1	



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des Ase	CRIPTION	REVISIO	DWN	CHK KILLINGSWORTH2		DATE 3- -
	A					
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	Oin CF FL	OD x 7.81 ANGE, MDC or descript parts	CLATURE ION/MATERIAL LIST	SST SST LAWRENCE L	304 304 MATERIAL SPECIFICATION	2 I ITEM NO
IED S.	WEIGHT(Ibs) APPROVAL ORIGINATOR BROOKSBYI DRAWN BROOKSBYI CHECKED KILLINGSWORT APPROVED PIGGOTTI	-S DATE   /22/10 2/16/11   +2 2/28/11	CLAWRENCE TITLE SIZE CAGE COD	l0in CF S	<u>ional security-ll</u> SPOOL	REV

	8 7	6 5	UNCLASSIFIED	4   3     ZONE   REV     AA   INITIAL	2 REVISIONS TION DWN CHK APVD DATE BROOKSBYI KILLINGSWORTH2 PIGGOTTI 3/1/11
D					D
С		8.94			C (Ø.625)
A D E [	NOTES, UNLESS OTHERWISE SPECIFIED: I. PART DIMENSIONS FROM CAD MODEL. IGES OR STEP FILE TO BE PROVIDED. CRITICAL DIMENSIONS WILL BE NOTED ON THIS DRAWING. ALL OTHERS WILL BE PER THE GENERAL TOLERANCES NOTED IN TITLE BLOCK, AND PER INDUSTRY STANDARDS AND TYPICAL MACHINE TOOL CAPABILITIES.				Β
WING: THREADED_ROD_ASSYI	<ol> <li>REMOVE ALL BURRS AND BREAK SHARP EDGES         <ol> <li>OIO MAXJ CHAMFER OR RADIUS.</li> <li>ALL MACHINED SURFACES WILL BE 62 FINISH OR BETTER. NO PITS, DENTS, SCRATCHES, ETC. PERMITTED.</li> </ol> </li> <li>PART WILL BE FREE OF ALL FOREIGN MATERIALS, LOOSE SCALE, CHIPS, GREASE AND OIL.</li> <li>PROTECT FROM DAMAGE THRU-OUT ALL PHASES OF MACHINING, SHIPPING AND HANDLING.</li> <li>8</li> </ol>	6 5	OR REPRESENTS THAT ITS USE WOULD N OR REPRESENTS THAT ITS USE WOULD N REFERENCE HEREIN TO ANY SPECIFIC C BY TRADE NAME, TRADEMARK, MANUFACT CONSTITUTE OR IMPLY ITS ENDORSEMEN	AUSPICES OF THE U.S. DEPARTMENT OF 07NA27344. NEITHER THE UNITED STATES NATIONAL SECURITY, LLC, NOR ANY OF , EXPRESSED OR IMPLIED OR ASSUMES ANY FOR THE ACCURACY, COMPLETENESS OR ARATUS, PRODUCT, OR PROCESS DISCLOSED, OT INFRINGE PRIVATELY OWNED RIGHTS.	SST       304       I         NOMENCLATURE         MATERIAL       SPECIFICATION         PARTS LIST         IGHT(16s):       1.828         IGHT(16s):       1.828         CLAWRENCE LIVERMORE         ATIONAL LABORATORY         OLAWRENCE LIVERMORE NATIONAL SECURITY-LLC         TITLE         ROD ASSY WELDMENT         INTER COLSPANE"         REV         AA A I I - 50 I 279 - AA         Z

