Princeton Plasma Physics Laboratory
Procedure

NSTX-U MIDPLANE FLANGE BAY F REMOVAL AND REINSTALLATION OF MPTS COLLECTION OPTICS BOX

Number: D-NSTXU-DIAG-4076	**Revision: 0**	Effective Date: Expiration Date: *(3yr. unless otherwise stipulated)*

CAT: ☒A1 ☐A2 ☐A3	**Justification:** (If required) CE and/or ES&H Head:

Author: Justin Bradley	Date:
Responsible Engineer: Robert Ellis	Date:

Procedure Requirements
designated by Responsible Engineer

LABWIDE:

√	Work Planning Form # 3063 (ENG-032)		Lockout/Tagout (ESH-016)
	Confined Space Permit (5008, Sec. 8, Chap 5)	√	Lift Procedure (ENG-021)
	Master Equip. List Mod (MC-002/MC-003)	√	ES&H Review (NEPA, IH, etc.)
	RWP (HP-OP-20)	√	Independent Review
√	Walkdown	√	Pre-job Brief
√	Post-job Brief	√	Job Hazard Analysis – JHA (ESH-004)
	T-MOD (ENG-036)		Special archiving requested for completed Run Copies: _____ _____
√	Run Copy Required (performance of procedure must be documented and archived per ENG-030)		

D-SITE SPECIFIC:

√	D-Site Work Permit (OP-AD-09)		Door Permit (OP-G-93)
	Work on Tritium Contaminated Sys. (OP-AD-77)		Activity Certification Committee Review
√	USI Screening (OP-AD-131)		

FOR INSTALLATION PROCEDURES ONLY: Was an ECN required? – No.

If ECN was required, list drawing numbers affected:

MANDATORY REVIEWERS (set according to ENG-030 Attachment 1)
Quality Assurance – Andres Castaneda
ES&H – Neil Gerrish
USI Screener – Stefan Gerhardt

OPTIONAL REVIEWERS (set according to ENG-030 Attachment 1)			
	Decline and sign	Accept – no comment	Accept - comment
ATI – Joe Winston			
RE Diagnostics – Brently Stratton			
Senior Physicist – Benoit Leblanc			
TA Vacuum Systems – Dang Cai			
IH – Neil Gerrish			
Lift Manager – Mike Viola			

REVIEWERS (designated by Chief Engineer for A1)
Independent Reviewer - Mike Kalish

TRAINING (designated by Responsible Engineer)

No training required _____**X**_____ Instructor _____

Personnel (group, job title, or individual name)	Read Only*	Instruction	Hands-On
Lead Technician		√	
Additional Technician(s)		√	
Accountable Technical Individual (ATI)	√		
QA/QC Representative		√	
Field Supervisor		√	

Responsible Engineer _____

* "Read Only" training for Administrative, Alarm Response, and Emergency Operations procedures must be documented on a Record of Training form (attachment 6). The completed Run Copy will serve as the documentation of "Read Only" training for all other types of procedures.

1.0 Purpose:

This procedure will provide instructions for the preparation, lift, removal and replacement of the Multi-Point Thomson Scattering (MPTS) Diagnostic Optics Box. This procedure also provides information and guidance on how to execute the job safely and efficiently while protecting the MPTS optical components. The optical components include the fiber optics holder (FOH) which is permanently attached to the end of the fiber optics, and the mirror optics box (MOB) which normally sits on top of a dedicated column, erected from the NTC ground below bay F. Both components are fragile and require great care during the execution of this job. At the start of this procedure the FOH and the MOB are assembled together and will remain that way throughout the job, we will use the acronym FOH+MOB to refer to this combined apparatus. The lifting of the FOH+MOB is a critical lift to be executed on the NSTX-U 109 level platform.

2.0 Scope:

2.1 This procedure shall be completed using cost center 1160-D1AG-8020.

2.2 This procedure shall cover the following:

2.2.1 Preparing Bay F midplane surrounding area for MOB + FOH removal.

2.2.2 Preparing FOH for lift.

2.2.3 Preparing MOB for lift.

2.2.4 Brining in lift mechanism.

2.2.5 MOB + FOH lift.

2.2.6 Reinstallation.

2.2.7 Testing Optics Box.

3.0 References:

3.1 Drawing No. E9D11026: MPTS Optics Box Lift Device Assembly (Sht. 1-4).

3.2 Drawing No. E9D11228: MPTS Collection Optics Box Laboratory Test Fixture.

3.3 Drawing No. E9D11233: MPTS Collection Optics Box Top Cover Assembly.

3.4 Drawing No. E9D11234: MPTS Collection Optics Box Bezel Window.

3.5 Drawing No. E9D11235: MPTS Collection Optics Box Window.

3.6 Drawing No. E9D11236: MPTS Collection Optics Box Mirror Adjustment Jig.

3.7 Critical Lift Procedure No. D-L-NSTX-1010 “Lift MPTS Optis Box and Move onto Support Table”

4.0 Precautions:

4.1 Individuals are not permitted to lift more than 50 lbs. at any one time. If an object weighs in excess of 50lbs., then it shall be lifted by more than one individual, or with the aid of mechanical system(s).

4.2 An approved method of fall protection shall be stablished for individuals working at elevated positions.

4.3 Use appropriate PPE (per JHA) and/or per guidance from Industrial Hygiene.

4.4 Before removal Health Physics shall survey all materials that were in the test cell during the last run of NSTX or any material or tools left in the test cell overnight.

4.5 No other work will be allowed above or in the vicinity of the MPTS working area during the execution of this procedure.

4.6 The Noise level within the NSTX-U Test Cell shall be kept sufficiently low such that verbal commands can be clearly understood.

5.0 Prerequisites:

5.1 There must be a sufficient number of available personnel required to perform this task completely, the minimum number is 9.

5.2 One individual shall be selected to be the Lead Technician during the execution of this procedure. The Lead Technician shall make decisions when needed to continue and/or stop the work. The Lead Technician will have the responsibility of verifying that each task within sections 5, 6, and 7 have been completed.

Appointed Lead Technician: _____

5.3 Personnel whom the Lead Technician shall work with on this job are:

(1) PPPL Construction Field Supervisor – Joe Winston x2745
(2) COG Physicist – Benoit LeBlanc x2008
(3) COG Engineer – Justin Bradley x3037
(4) PPPL Quality Control Representative
(5) PPPL Qualified Lift Engineer
(6) PPPL Qualified Lift Watch
(7) Two (2) PPPL Qualified Riggers

5.4 Obtain a D-site work permit from the shift supervisor.

Lead Tech: _____ Permit No.: _____

5.5 All workers and Performing Techs must review and sign the Job Hazard Analysis for this job.

Lead Tech: _____ JHA No.: _____

5.6 The Work Control Center must log in this procedure and provide an approved Engineering Work Package before the work can begin. Under no circumstances should the work proceed without the approved “blue or yellow folder” from the WCC.

Lead Tech: _____

5.7 A Lift watch has been established for all stages of the Optics Box Movement.

Lead Tech: _____ Lift Watch: _____

5.8 Benoit LeBlanc is available to Oversee the lifting of the Optics Box during movement and replacement stages.

Lead Tech: _____ B. Leblanc: _____

5.9 A Pre-job Briefing must be completed prior to work starting, including a review of the JHA. The only personnel allowed to work under this procedure are those that attend this briefing.

5.10 All Prerequisites Completed:

COG Engineer Signoff: _____ Date: _____

6.0 Optics Box Movement Procedure:

6.1 ***Preparations:***

6.1.1 Prepare the Midplane Bay F working area for MOB+FOH removal.

6.1.1.1 Remove any handrails obstructing the collection optics box and yellow caution tape off the working area.

Lead Tech: _____

6.1.1.2 Implement any fall protection systems as necessary at the direction of the field supervisor.

Lead Tech: _____

6.1.1.3 All associated fasteners and washers must be saved in separate plastic bags and identified by the type of support (Cone, Groove, Flat Plate, etc.)

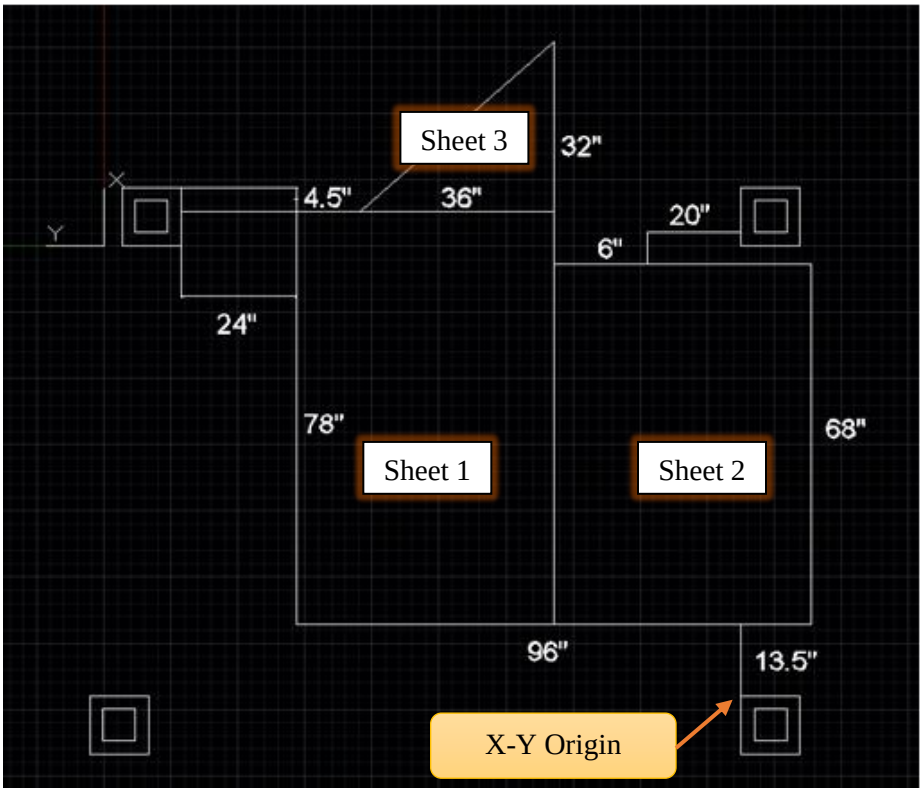
6.1.1.4 Countersink Holes on the 209 platform and lay three sheets of 11ga stainless steel on the platform floor and bolt the sheets down as shown in Figure 1.

Lead Tech: _____

6.1.1.5 Index and mark the locations of the front-feet movement steps of the gantry fixture onto the stainless sheets as per the coordinates provided in Figure 5. Note that the origin of the X-Y coordinates is located at the top left corner of column 1 as shown in figures 1 and 6.

Lead Tech: _____

Figure 1: Bay F Sheet Layout



6.1.1.6 Bring in the MOB+FOH temporary support table, as shown in figure 2, and leave it off to the side of the floor sheets until the MOB+FOH are lifted.

Lead Tech: _____

Figure 2: Temporary MOB+FOH Table

6.1.2 *Preparing the Optics Box (MOB) for lift:*

6.1.2.1 Remove the handles of the Optics Box (see E-9D11233-3) by removing the #10-32 hex cap screws and #10 washers (again ensuring to bag and label the fasteners removed).

Lead Tech: _____

6.1.3 *Preparing the Fiber Bundle (FOH) for lift:*

6.1.3.1 The fiber bundle must be supported at all stages of lifting to prevent over-flexing and breakage of the internal fibers.

6.1.3.2 Inner and Outer radius gauges are provided for technicians to use during all stages of the collection optics box lift to check the bend radius of the fiber bundle during movement stages. See Figure 3 for images of the radius gauges.

Figure 3: Inner and Outer Radius Gauges (Shown left to right)

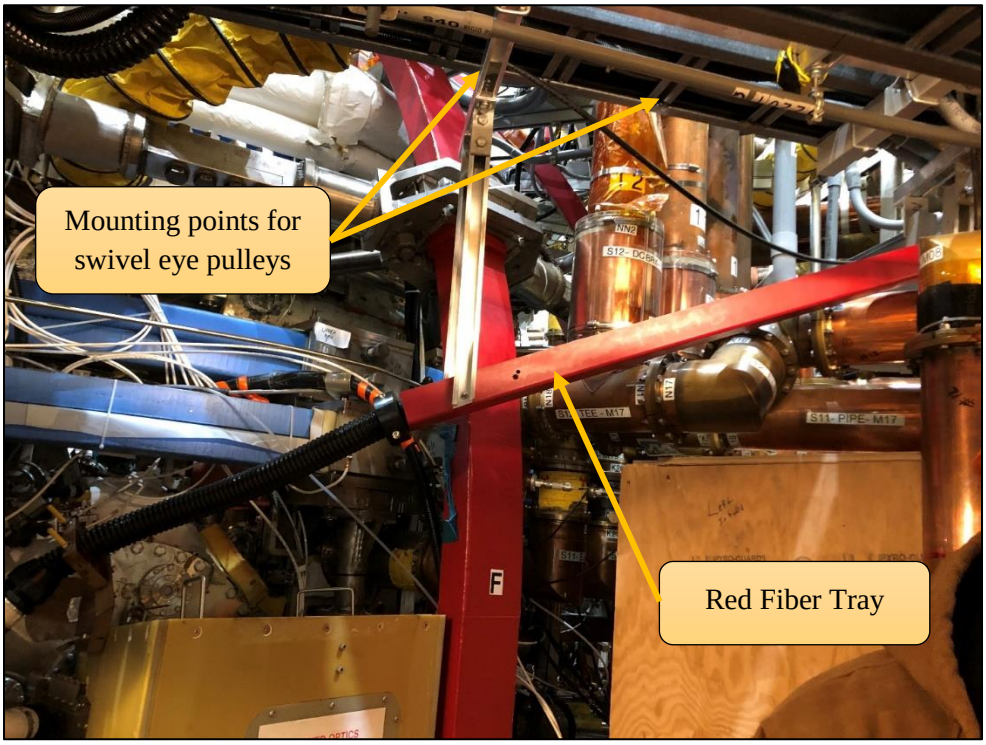
6.1.3.3 The working bend radius of the fiber bundle is an 18 inch radius or 36 inch diameter bend. The provided radius gauges are capable of measuring radii between 7 and 144 inches.

6.1.3.4 The absolute minimum bend radius the fiber bundle can experience is a 16” radius; any movement steps which require bending the bundle tighter than the 18” working radius require the presence of the COG Engineer Justin Bradley and COG Physicist Ben Leblanc.

6.1.3.5 Remove the Fiber Bundle red fiber tray shown in Figure 4.

Lead Tech: _____

Figure 4: Fiber Optics Bundle, Red Fiber Tray



6.1.3.6 Remove any temporary structures supporting the fiber bundle and support the fiber bundle as necessary to prevent flexing beyond the allowable working radius of 18 inches.

6.1.3.7 The bundle is to be supported by a minimum of two (2) ropes mounted through swivel eye pulleys temporarily mounted to the overhead Unistrut as shown in Figure 3. If required, technicians may also support the fiber bundle by hand at the direction of the Lead Technician. Additional ropes and swivel eyes may be used as needed.

6.1.4 *Bring in Lift Mechanism:*

6.1.4.1 Before proceeding any further, all personnel non-essential to this procedure shall vacate the NSTX-U Test Cell. Access to the Test Cell shall be restricted to only personnel essential to the completion of this procedure until the work is complete.

Lead Tech: _____

6.1.4.2 Bring in and prepare Lift Fixture #221 for attachment to the Optics box at the direction of the COG Engineer.

Lead Tech: _____

6.1.4.3 Attach lift fixture #221 to the Optics Box using the lifting hardware per the lift procedure D-L-NSTX-1010 at the direction of the COG engineer.

Lead Tech: _____

6.1.4.4 Perform trial lifts at the direction of the Lead Technician to see how fibers react and how the MOB+FOH react and adjust accordingly. Repeat trial lifts until the load is balanced and ready for movement.

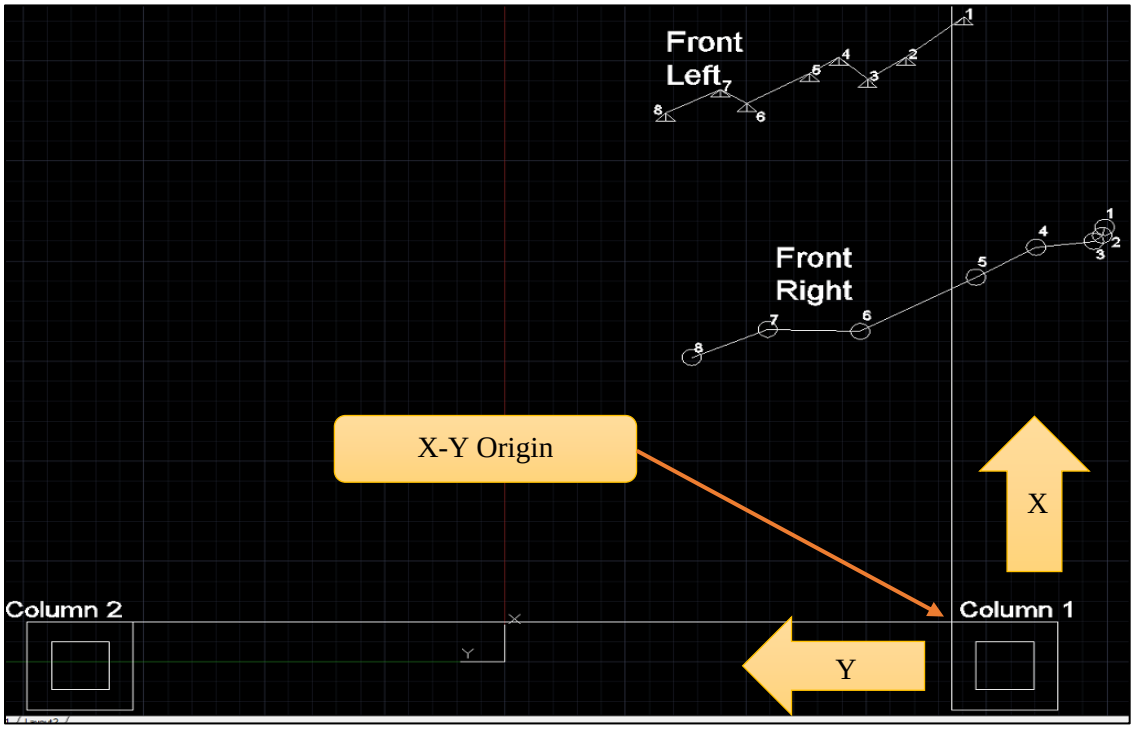
Lead Tech: _____

6.1.5 Lifting and Moving the MOB+FOH:

6.1.5.1 Lift the MOB+FOH in accordance with lift procedure D-L-NSTX-1010.

6.1.5.2 Defer to the following diagram and table shown below in figures 5 and 6 to ensure the Fiber Bundle follows the laid-out fiber path (Points reference column 1).

Figure 5: Lifting Fixture front-caster steps



6.1.5.3 Each step in the movement of the lift fixture and MOB+FOH shall be done with extreme care and without time constraints.

6.1.5.1 During Movement of the FOB+MOH a minimum of two (2) technicians shall support the fiber bundle using the ropes swung through the overhead swivel eye pulleys, with a third technician assigned to check its curvature and provide lifting feedback to the other technicians during the movement steps.

Figure 6: Lifting Fixture front-feet step coordinates on floor sheets

	Front Left			Front Right	
	x	y		x	y
1	75.5	-1.25		49.25	-15.88
2	70.5	4.75		48.25	-15.62
3	67.75	8.75		47.5	-14.75
4	70.5	11.75		46.75	-8.75
5	68.5	14.75		43	-2.5
6	64.75	21.25		36.25	9.5
7	66.5	24		36.5	18
8	63.5	29.75		33	27

6.1.5.2 At the end of each movement step, the supporting ropes for the fiber bundle are to be tied off to a permanent structure in the test cell until ready for the next movement step to prevent loss of support and potential damage to the fiber bundle.

6.1.5.3 Upon completion of all movement steps; Move the temporary table into place to support the MOB+FOH.

Lead Tech: _____

6.1.5.4 Lower the MOB+FOH onto the temporary table and level the optics box on the table using small machinist screw jacks with soft feet to prevent scratching the MOB.

6.1.5.5 Disconnect the MOB+FOH from the lift fixture once the MOB is leveled on the support table.

Lead Tech: _____

6.1.5.6 Secure MOB on the temporary table as per Benoit LeBlanc's instructions.

Lead Tech: _____

6.1.5.7 Make 1 final check of the curvature of the fiber bundle then secure the supporting ropes using a non-slipping knot such as a buntline hitch. Ensure the knot is pulled snug to prevent slipping. Additional rope lines may be attached to the Fiber bundle as needed at the direction of the field supervisor.

6.1.5.8 Caution Tape off the area surrounding the support table and fiber optics bundle and apply signage as follows "CAUTION: FRAGILE OPTICS, DO NOT TOUCH".

Lead Tech: _____

7.0 Final Conditions:

7.1 The Optics Box and Fiber Bundle have been moved off its support and placed on the temporary table.

7.2 The temporary table and Optics Box have been secured to prevent damage.

7.3 All equipment and tools have been removed from the NSTX Test-Cell and properly stored.

8.0 Completion Signoff:

This procedure and post job brief have been completed and verified by the signatures below.

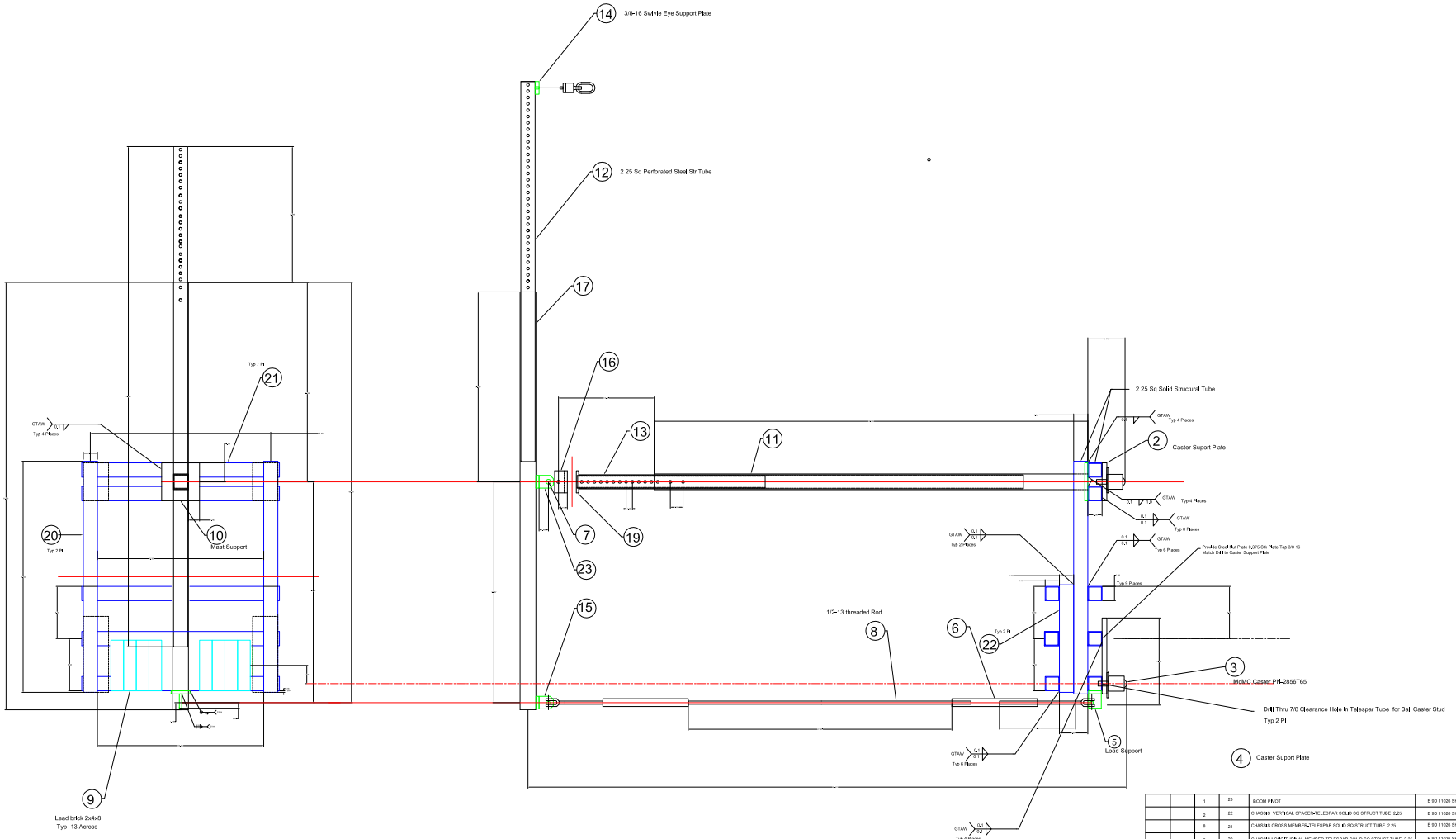
Lead Technician	Signature	Date
ATI	Signature	Date
QA/QC Representative	Signature	Date
Field Supervisor	Signature	Date

Return this completed procedure to the Work Control Center

Comments:

Note: The run copy of this procedure shall be returned to the operations center upon completion

DATE



		1	23	BOOM PIVOT	E 93 11026 SH2	STEEL
		2	22	CHASSIS VERTICAL SPACER-TELESPAR SOLID SQ STRUCT TUBE 2.25	E 93 11026 SH4	STEEL
		8	21	CHASSIS CROSS MEMBER-TELESPAR SOLID SQ STRUCT TUBE 2.25	E 93 11026 SH4	STEEL
		2	20	CHASSIS LONGITUDINAL MEMBER-TELESPAR SOLID SQ STRUCT TUBE 2.25	E 93 11026 SH4	STEEL
		1	19	PIVOT TRANSITION TO MAST CONNECTION	E 93 11026 SH3	STEEL
		1	17	BOOM-TELESPAR SOLID SQ STRUCT TUBE 2.00	E 93 11026 SH2	STEEL
		1	16	PIVOT BOOM TO MAST TRANSITION BRACKET	E 93 11026 SH 4	STEEL
		1	15	TURNBUCKLE LOAD BRACKET	E 93 11026 SH 2	STEEL
		1	14	SWIVEL EYE SUPPORT PLATE	E 93 11026 SH4	STEEL
		1	13	MAST EXTENSION-TELESPAR PERFERATED SQ STRUCT TUBE 2.25	E 93 11026 SH 3	STEEL
		1	12	BOOM EXTENSION -TELESPAR PERFERATED SQ STRUCT TUBE 2.25	E 93 11026 SH2	STEEL
		2	11	MAST COLUMN-TELESPAR SOLID SQ STRUCT TUBE 2.00	E 93 11026 SH3	STEEL
		1	10	MAST SUPPORT PLATE 6x6 OR 6x10 x 0.5 THK	COMMERCIAL	STEEL
		40	9	COUNTERWEIGHT BRICK	COMMERCIAL	COATED LEAD
		1	8	THREADED ROD 1/2-13	COMERCIAL	BRASS
		1	7	PIVOT SLEEVE BEARING McMC 1688K19	COMMERCIAL	BRASS
		2	6	TURNBUCKLE 1/2-13 McMC 3022T54	COMMERCIAL	316 SS
		1	5	TURNBUCKLE LOWER LOAD BRACKET	E 93 11026 SH 4	STEEL
		2	4	REAR CASTER SUPPORT PLATE 3/4 PLATE	E 93 11026 SH 4	STEEL
		4	3	BALL CASTER 2200 LB CAPACITY McMC 6460K34	COMMERCIAL	STEEL
		2	2	FORWARD CASTER SUPPORT PLATE 3/4 PLATE	E 93 11026 SH4	6061T6 Al
			1	3/16-18 SWIVEL EYE	COMMERCIAL	STEEL
		1		MPTS OPTICS BOX LIFT DEVICE	THIS DRAWING	
03	02	01	PART NO.	NOMENCLATURE OR DESCRIPTION	DRAWING NO.	MATERIAL

RELEASED FOR FABRICATION / INSTALLATION
PPPL Drafting:

Weld Note: Welding and Brazing shall be performed In accordance with the requirements of PPPL procedure ENG-037 and AWS D1.1. Visual weld Inspection shal be performed In accordance with the acceptance criteria of AWS D1.1.

APPROVED WELD ENGINEER
MARTIN DENAULT

COMPUTER GENERATED DRAWING MANUAL CHANGES NOT PERMITTED
AutoCAD2000
DO NOT VERIFY INFORMATION BY SCALING DRAWING
SCALE:
NEXT ASSEMBLY

CENTRAL FILES:
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
MACHINE SURFACES 125
BREAK SHARP EDGES .005/.020
TOLERANCES NON-CUMULATIVE

DECIMAL-INCH	FRACTIONS
X ± .100	0°-12° ±1/16
XX ± .030	12°-72° ±1/8
XXX ± .005	72°-120° ±1/4
ANGULAR ±2°-15'	OVER 120° ±1/2

PRINCETON PLASMA PHYSICS LABORATORY
PRINCETON UNIVERSITY
NATIONAL SPHERICAL TORUS EXPERIMENT
MPTS OPTICS BOX
LIFT DEVICE ASSSEMBLY

DIV: FDM
ENG: G LABIK
DWN: G LABIK
CHK: D WESTOVER
DATE: 21 JAN 11
APPROVED: G LABIK
CHK DW | SUPV LM
CADD FILE: 09D110261.DWG
E-9D11026
SHEET 1 OF 4 REV 0

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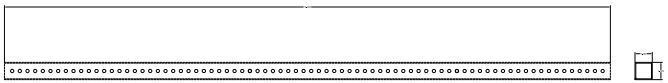
DATE



BOOM

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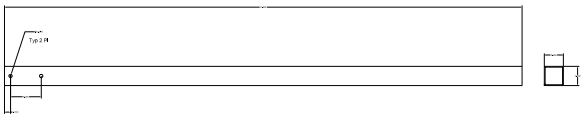
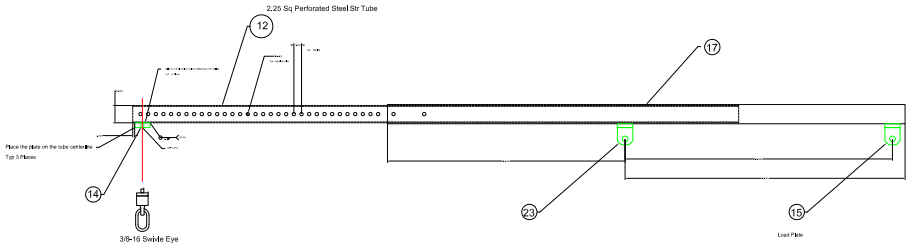
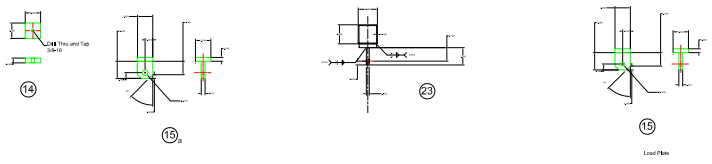
0.105 Wall



BOOM

(17) 2.5 Sq Solid Steel Str Tube
0.105 Wall





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APPROVED WELD ENGINEER
MARTIN DEMAULT

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PPPL Drafting:

		1	17	BOOM SOLID SQ STRUCT TUBE	THIS DRAWING	STEEL
		1	15	TURNBUCKLE LOAD BRACKET	THIS DRAWING	STEEL
		1	23	PIVOT BRACKET	THIS DRAWING	STEEL
		1	12	BOOM EXTENSION PERFERATED SQ STRUCT TUBE	THIS DRAWING	STEEL
03	02	01	PART NO.	NOMENCLATURE OR DESCRIPTION	DRAWING NO.	MATERIAL

COMPUTER GENERATED DRAWING MANUAL CHANGES NOT PERMITTED
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CENTRAL FILES:
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DIMENSIONS ARE IN INCHES
MACHINE SURFACES 125
BREAK SHARP EDGES .005/.020
TOLERANCES NON-CUMULATIVE

DECIMAL-INCH		FRACTIONS	
.X	± .100	0"-12"	±1/16
.XX	± .030	12"-72"	±1/8
.XXX	± .005	72"-120"	±1/4
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LIFT DEVICE BOOM DETAILS

DIV: FOM
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DATE: 20 JAN 11
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CADD FILE: 09D110262.DWG
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SHEET 2 OF 4
REV 0

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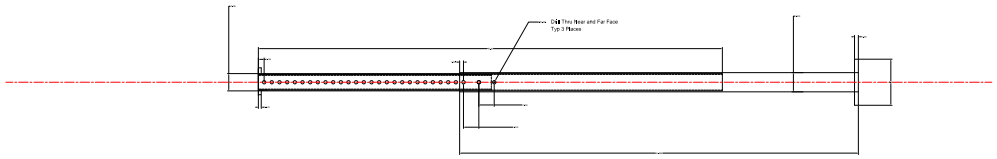

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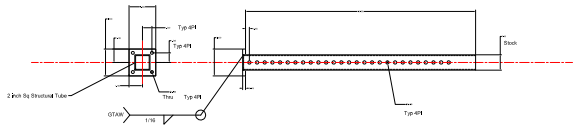

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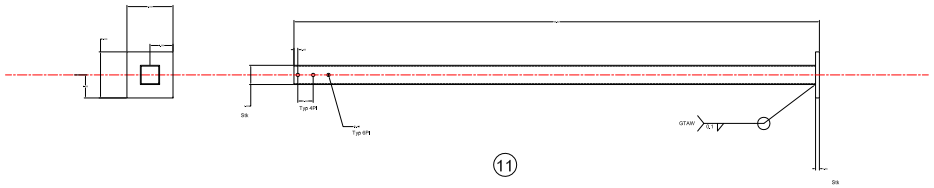
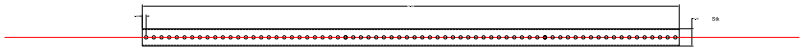


11

2.5 Sq Solid Steel Str Tube
0.105 Wall



13

2.25 Sq Perforated Steel Str Tube

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PPPL Drafting:

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APPROVED WELD ENGINEER
MARTIN DENAULT

			PART NO.	NOMENCLATURE OR DESCRIPTION	DRAWING NO.	MATERIAL
			1	19	PIVOT TRANSITION TO MAST CONNECTION	THIS DRAWING	STEEL
			1	13	MAST EXTENSION-TELESPAR PERFERATED SQ STRUCT TUBE 2.25	THIS DRAWING	STEEL
			2	11	MAST COLUMN-TELESPAR SOLID SQ STRUCT TUBE 2.50	THIS DRAWING	STEEL
			1		MPTS OPTICS BOX LIFT DEVICE		
03	02	01					

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PRINCETON PLASMA PHYSICS LABORATORY
PRINCETON UNIVERSITY
NATIONAL SPHERICAL TORUS EXPERIMENT
MPTS OPTICS BOX
LIFT DEVICE MAST DETAILS

DIV: FDM
ENG: G LABIK
DWN: G LABIK
CHK: D WESTOVER
DATE: 21 JAN 11
APPROVED: G LABIK
CHK DW | SUPV LM
CADD FILE: 09D110263.DWG
E-9D11026
SHEET 3 OF 4
REV 0

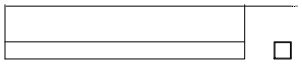
MechExcel

12 13 14 15

DATE

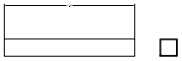
Stk 2.25 Sq Solid Steel Str Tube
0.105 Wall

20



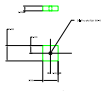
Stk
2.25 Sq Solid Steel Str Tube
0.105 Wall

21



Stk
2.25 Sq Solid Steel Str Tube
0.105 Wall

22



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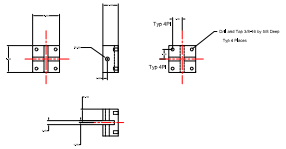

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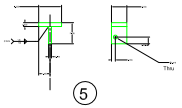

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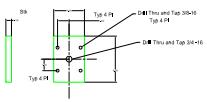

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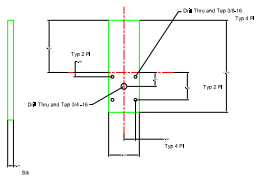


4

Weld Note: Welding and Brazing shall be performed in accordance with the requirements of PPPL procedure ENG-037 and AWS D1.1. Visual weld inspection shall be performed in accordance with the acceptance criteria of AWS D1.1.

APPROVED WELD ENGINEER
MARTIN DENAULT

RELEASED FOR FABRICATION / INSTALLATION
PPPL Drafting:

		2	22	CHASSIS VERTICAL SPACER-TELESPAR SOLID SQ STRUCT TUBE 2.25	THIS DRAWING	STEEL
		8	21	CHASSIS CROSS MEMBER-TELESPAR SOLID SQ STRUCT TUBE 2.25	THIS DRAWING	STEEL
		2	20	CHASSIS LONGITUDINAL MEMBER-TELESPAR SOLID SQ STRUCT TUBE 2.25	THIS DRAWING	STEEL
		1	16	PIVOT BOOM TO MAST TRANSITION BRACKET	THIS DRAWING	STEEL
		1	14	SWIVEL EYE SUPPORT PLATE	THIS DRAWING	STEEL
		1	5	TURNBUCKLE LOWER LOAD BRACKET	THIS DRAWING	STEEL
		2	4	REAR CASTER SUPPORT PLATE 3/4 PLATE	THIS DRAWING	STEEL
		2	2	FORWARD CASTER SUPPORT PLATE 3/4 PLATE	THIS DRAWING	STEEL
		1		MPTS OPTICS BOX LIFT DEVICE		
03	02	01	PART NO.	NOMENCLATURE OR DESCRIPTION	DRAWING NO.	MATERIAL

COMPUTER GENERATED DRAWING MANUAL CHANGES NOT PERMITTED
AutoCAD2000
DO NOT VERIFY INFORMATION BY SCALING DRAWING
SCALE:
NEXT ASSEMBLY

CENTRAL FILES:
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
MACHINE SURFACES 125
BREAK SHARP EDGES .005/.020
TOLERANCES NON-CUMULATIVE

DECIMAL-INCH		FRACTIONS	
X	± .100	0°-12°	±1/16
XX	± .030	12°-72°	±1/8
XXX	± .005	72°-120°	±1/4
ANGULAR	±2°-15'	OVER 120°	±1/2

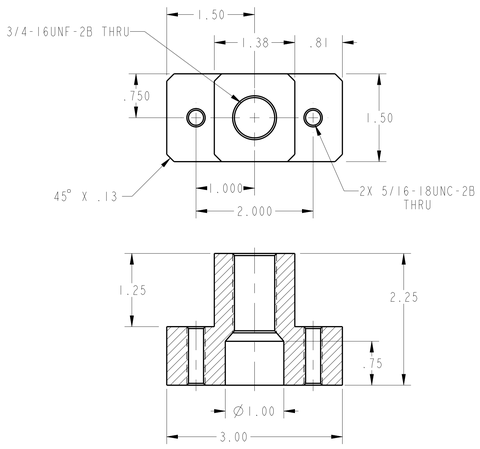
PRINCETON PLASMA PHYSICS LABORATORY
PRINCETON UNIVERSITY
NATIONAL SPHERICAL TORUS EXPERIMENT
MPTS OPTICS BOX
LIFT DEVICE DETAILS

DIV: FDM
ENG: G LABIK
DWN: G LABIK
CHK: D WESTOVER
DATE: 21 JAN 11
APPROVED: G LABIK
CHK DW | SUPV LM
CADD FILE: 09D110264.DWG
E-9D11026
SHEET 4 OF 4
REV 0

MechExcel

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

NO.	REVISION	BY	CH	SUP	APPROVED	DATE



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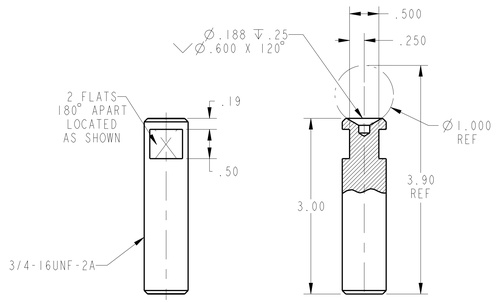

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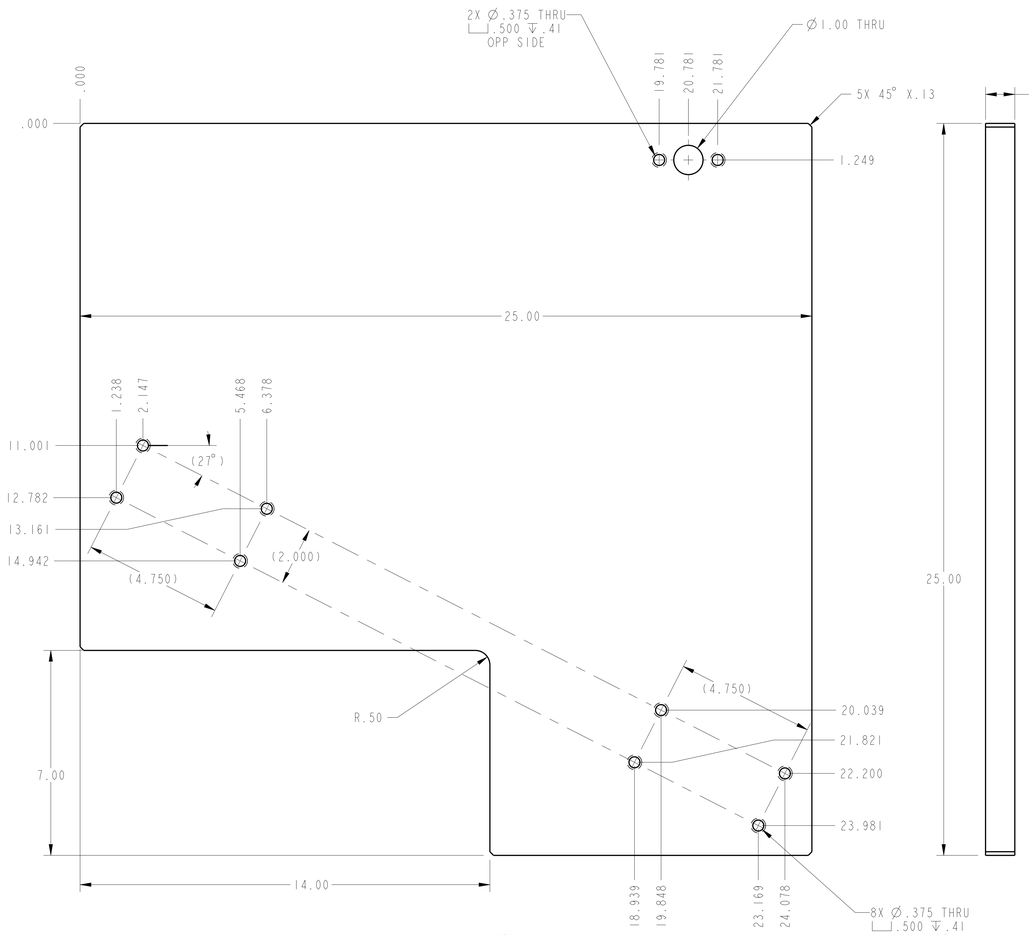

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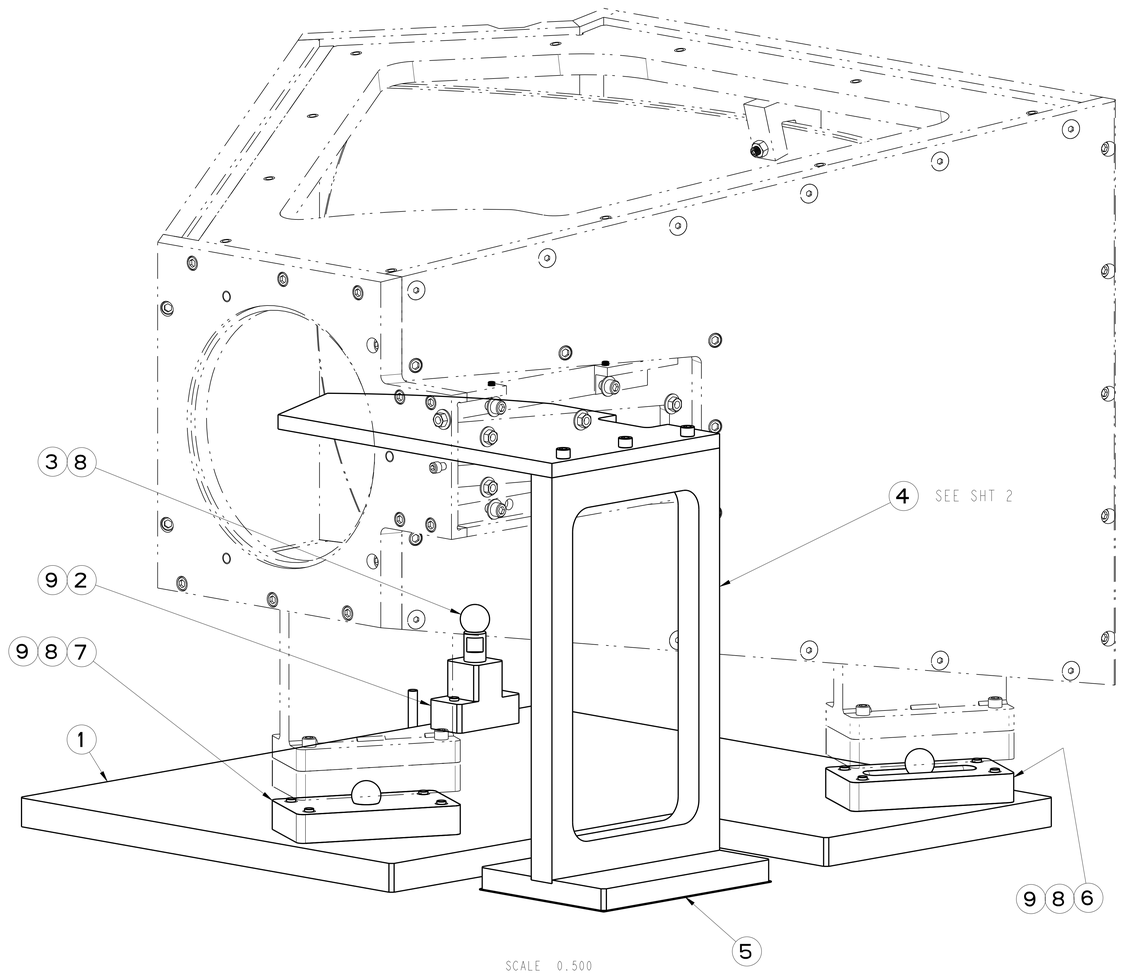


SCALE 0.500

NOTES:
1. UNLESS OTHERWISE SPECIFIED 2 PLACE DECIMAL DIMENSIONS TO BE ±.01.

ITEM NO.	DRAWING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL	QTY REQD
9	NS150792	5/16-18 UNC x 1 3/4 LG HEX SOC HD CAP SCREW	STN STL	10
8	9641K82	BALL, 1in DIA (McMASTER-CARR)	316 SS	3
7	E-9D1126-2	MPTS KENTIC MOUNT 2 (EXISTING)	304 SS	1
6	E-9D1126-1	MPTS KENTIC MOUNT 1 (EXISTING)	304 SS	1
5	E-9D11228-7	SHIM STOCK (THICKNESS AND QTY AS REQUIRED)	SS or PLASTIC	X
4	E-9D11228-01	TEST ARRAY FIXTURE MTG ASSY	SEE SHT 2	1
3	E-9D11228-3	JACK SCREW	304/316 SS	1
2	E-9D11228-2	MPTS MIRROR BOX ADJUSTING BLOCK	304 SS	1
1	E-9D11228-1	BASE PLATE, MPTS TEST FIXTURE	ALUM TOOLING PLATE	1

PARTS LIST

GENERAL NOTES
1. PPPL APPROVED DRAWINGS TAKE PRECEDENCE OVER MODEL DIMENSIONS.
2. WHEN MODELS ARE PROVIDED, VENDOR MUST VERIFY THAT MODEL DIMENSIONS CONFORM WITH PPPL APPROVED DRAWINGS PRIOR TO FABRICATION.

RELEASED FOR FABRICATION / INSTALLATION
PPPL Drafting;

RELEASE LEVEL: Fabrication
DWG VERSION NO: 0.2

WELDING ENGINEER
APPVD: N/A DATE:

COMPUTER GENERATED DRAWING
MANUAL CHANGES NOT PERMITTED
Pro E
DO NOT VERIFY INFORMATION BY SCALING DRAWING
SCALE:
NEXT ASSEMBLY

CENTRAL FILES:
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
MACHINE SURFACES 125
BREAK SHARP EDGES .005/.020
TOLERANCES NON-CUMULATIVE

DECIMAL-INCH	FRACTIONS	ANGULAR
X ±.100	0°-12° ±1/16	
.XX ±.010	12°-72° ±1/8	
.XXX ±.005	72°-120° ±1/4	
ANGULAR ±0°-15'	OVER 120° ±1/2	

PRINCETON PLASMA PHYSICS LABORATORY
PRINCETON UNIVERSITY
NATIONAL SPHERICAL TORUS EXPERIMENT
CENTER STACK UPGRADE
MPTS COLLECTION OPTICS
LABORATORY TEST FIXTURE

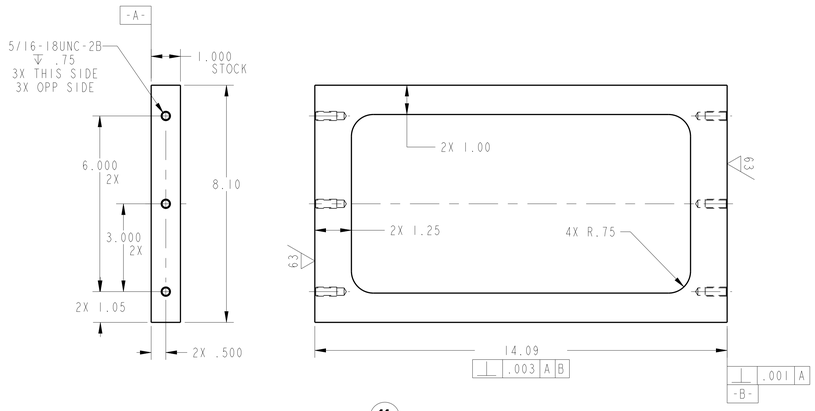
DIV: MECH. ENG. DATE: 6-27-12
ENG: G LABIK APPROVED
DSN: H FEDER G LABIK
CHK: L MORRIS CHK LM SUPV LM

E-9D11228
SHEET 1 OF 2 REV 0

NSTX E-9D11228

EMI

NO.	REVISION	BY	CH	SUP	APPROVED	DATE



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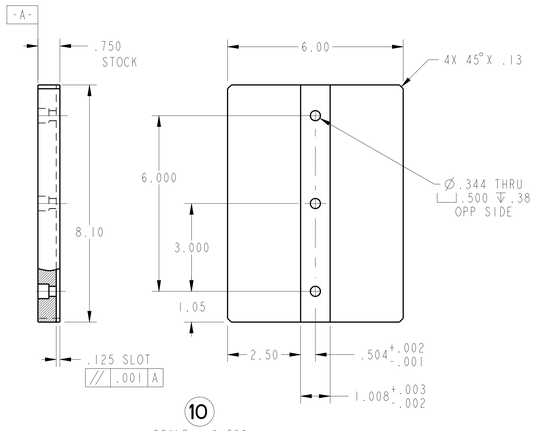

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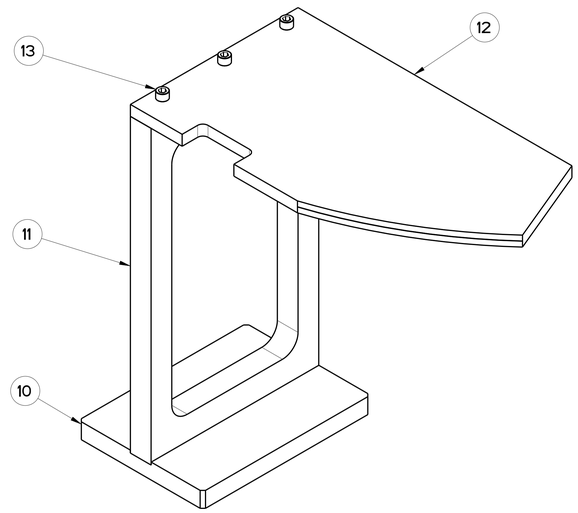

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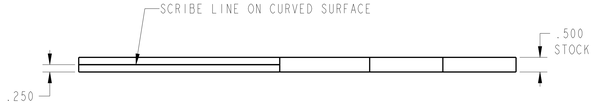
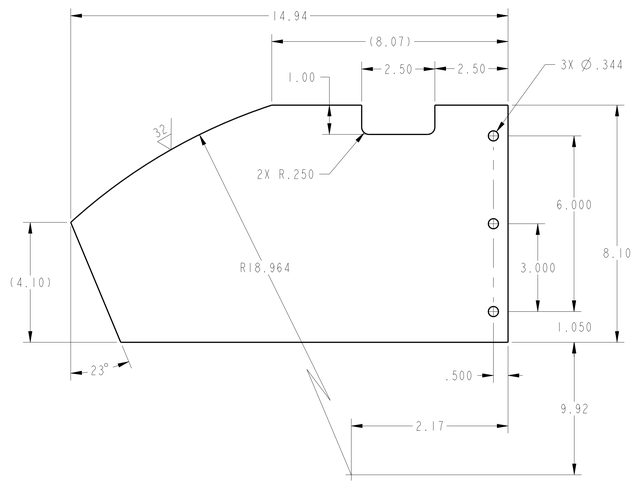




12
SCALE = 0.500

PART NO.	DRAWING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL	QTY REQD
13	150732	5/16-18 UNC x 1 LG HEX SOC HD CAP SCREW	STN STL	6
12	E-9D11228-6	FIBER OPTICS ARRAY DUMMY	ALUM TOOLING PLATE	1
11	E-9D11228-5	VERTICLE SUPPORT, OPTICS ARRAY DUMMY	ALUM TOOLING PLATE	1
10	E-9D11228-4	SUPPORT BASE, OPTICS ARRAY DUMMY	ALUM TOOLING PLATE	1

E-9D11228-01 PARTS LIST

GENERAL NOTES

1. PPPL APPROVED DRAWINGS TAKE PRECEDENCE OVER MODEL DIMENSIONS.
2. WHEN MODELS ARE PROVIDED, VENDOR MUST VERIFY THAT MODEL DIMENSIONS CONFORM WITH PPPL APPROVED DRAWINGS PRIOR TO FABRICATION.

RELEASED FOR FABRICATION / INSTALLATION
PPPL Drafting:

RELEASE LEVEL: Fabrication
DWG VERSION NO: 0.2

WELDING ENGINEER
APPVD: DATE:

COMPUTER GENERATED DRAWING
MANUAL CHANGES NOT PERMITTED
Pro E
DO NOT VERIFY INFORMATION BY SCALING DRAWING
SCALE:
NEXT ASSEMBLY

CENTRAL FILES:
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
MACHINE SURFACES 125
BREAK SHARP EDGES .005/.020
TOLERANCES NON-CUMULATIVE

DECIMAL-INCH	FRACTIONS
X ±.100	0°-12° ±1/16
.XX ±.010	12°-72° ±1/8
.XXX ±.005	72°-120° ±1/4
ANGULAR ±0°-15'	OVER 120° ±1/2

PRINCETON PLASMA PHYSICS LABORATORY
PRINCETON UNIVERSITY
NATIONAL SPHERICAL TORUS EXPERIMENT
CENTER STACK UPGRADE
MPTS COLLECTION OPTICS
LABORATORY TEST FIXTURE

DIV: MECH. ENG. DATE: 6-27-12
ENG: G LABIK APPROVED
DSN: H FEDER G LABIK
CHK: L MORRIS CHK LM SUPV LM

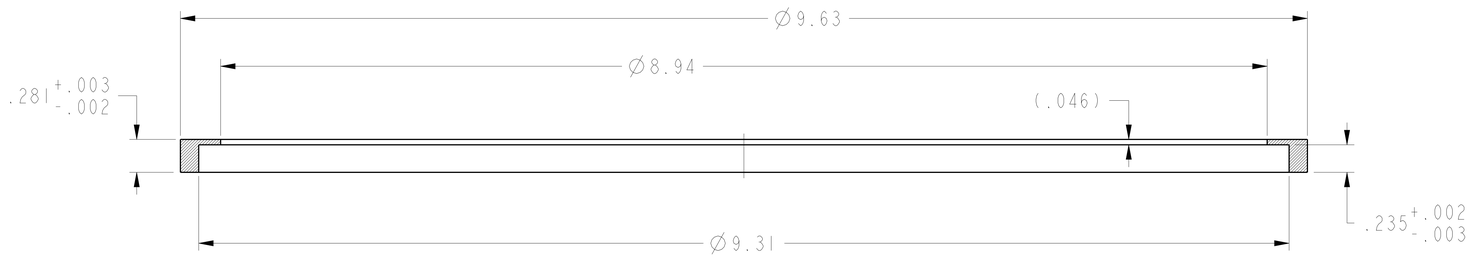
E-9D11228

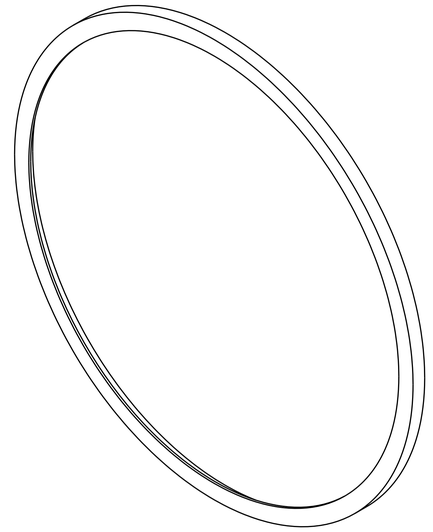
SHEET 2 OF 2 REV 0

EMI

NSTX-E-9D11228

NO.	REVISION	BY	CH	SUP	APPROVED	DATE





SCALE 1.000

NOTES:

1. UNLESS OTHERWISE SPECIFIED 2 PLACE DECIMAL DIMENSIONS TO BE ±.01.
2. MATERIAL - 316 SS.
3. REFERENCE PERMEABILITY USING A SEVERN GAGE SHALL NOT EXCEED
   BASE MATERIAL - 1.2
   FABRICATED PART - 1.4

NSTX-E-9D11234

GENERAL NOTES

1. PPPL APPROVED DRAWINGS TAKE PRECEDENCE OVER MODEL DIMENSIONS.
2. WHEN MODELS ARE PROVIDED, VENDOR MUST VERIFY THAT MODEL DIMENSIONS CONFORM WITH PPPL APPROVED DRAWINGS PRIOR TO FABRICATION.

MAGNETIC PERMEABILITY REQUIREMENT (SEE NOTES)

YES [X] NO [ ]

RELEASED FOR FABRICATION / INSTALLATION
PPPL Drafting:

RELEASE LEVEL: Fabrication
DWG VERSION NO: 0.2

WELDING ENGINEER
APPVD: N/A DATE:

COMPUTER GENERATED DRAWING
MANUAL CHANGES NOT PERMITTED
Pro E
DO NOT VERIFY INFORMATION BY SCALING DRAWING
SCALE: 2.00
NEXT ASSEMBLY

CENTRAL FILES:
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
MACHINE SURFACES 125
BREAK SHARP EDGES .005/.020
TOLERANCES NON-CUMULATIVE
DECIMAL-INCH: .X ±.100; .XX ±.030; .XXX ±.010; ANGULAR ±0°-15'
FRACTIONS: 0°-12' ±1/16; 12°-72' ±1/8; 72°-120' ±1/4; OVER 120° ±1/2

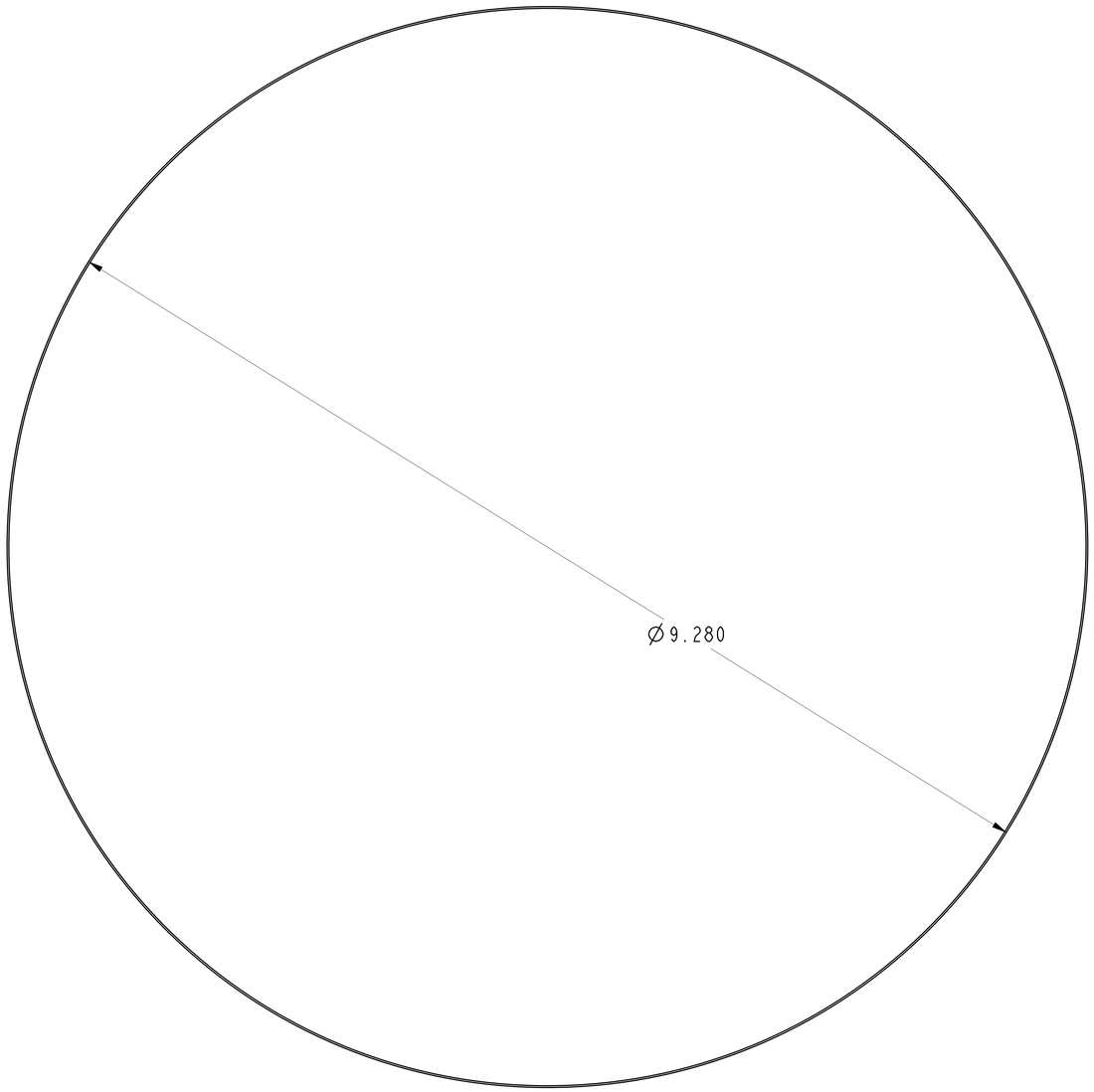
PRINCETON PLASMA PHYSICS LABORATORY
PRINCETON UNIVERSITY
NATIONAL SPHERICAL TORUS EXPERIMENT
CENTER STACK UPGRADE
MPTS - COLLECTION OPTICS BOX
BEZEL, WINDOW

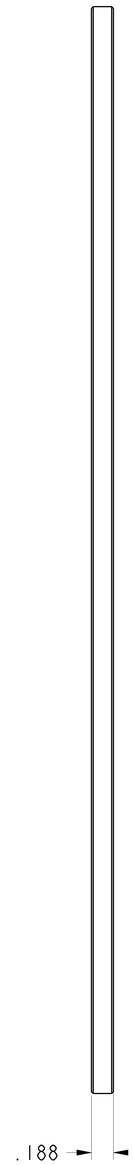
DIV: MECH. ENG. DATE: 9-21-12
ENG: G LABIK APPROVED
DSN: H FEDER G LABIK
CHK: L MORRIS CHK LM SUPV LM

E-9D11234

SHEET 1 OF 1 REV 0

NO.	REVISION	BY	CH	SUP	APPROVED	DATE





NOTES:

1. UNLESS OTHERWISE SPECIFIED 2 PLACE DECIMAL DIMENSIONS TO BE ±.01.
2. SPECIFICATIONS

   MATERIAL - FUSED QUARTZ.

   DIAMETER TOLERANCE; ±.01in [.25mm].

   THICKNESS TOLERANCE; ±.005in [.125mm].

   SURFACE ACCURACY: ~5 PER INCH.

   SURFACE QUALITY: 60-40 SCRATCH-DIG OR BETTER.

   PARALLELISM; <15′

   EDGES; FINE GROUND AND BEVELED.

NSTX-E-9D11235

GENERAL NOTES

1. PPPL APPROVED DRAWINGS TAKE PRECEDENCE OVER MODEL DIMENSIONS.
2. WHEN MODELS ARE PROVIDED, VENDOR MUST VERIFY THAT MODEL DIMENSIONS CONFORM WITH PPPL APPROVED DRAWINGS PRIOR TO FABRICATION.

MAGNETIC PERMEABILITY REQUIREMENT (SEE NOTES)

YES | | NO | X

RELEASED FOR FABRICATION / INSTALLATION
PPPL Drafting:

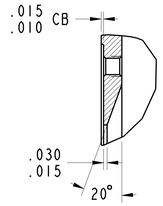
RELEASE LEVEL: WIP
DWG VERSION NO: 0.0

WELDING ENGINEER
APPVD: N/A DATE:

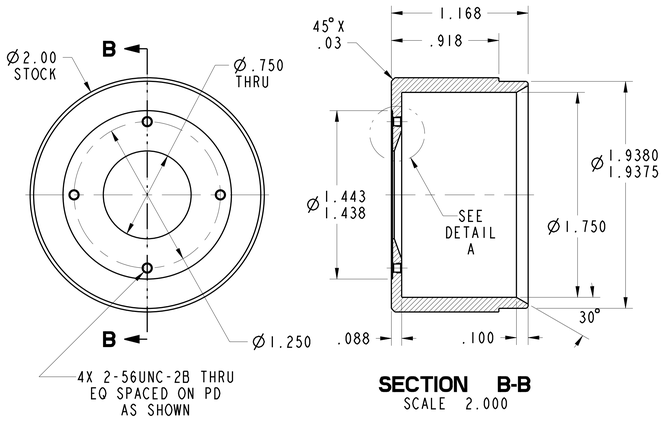
COMPUTER GENERATED DRAWING MANUAL CHANGES NOT PERMITTED	CENTRAL FILES: UNLESS OTHERWISE SPECIFIED	PRINCETON PLASMA PHYSICS LABORATORY PRINCETON UNIVERSITY	
Pro E	DIMENSIONS ARE IN INCHES MACHINE SURFACES 125	NATIONAL SPHERICAL TORUS EXPERIMENT	
DO NOT VERIFY INFORMATION BY SCALING DRAWING	BREAK SHARP EDGES .005/.020	CENTER STACK UPGRADE MPTS - COLLECTION OPTICS BOX WINDOW	
SCALE: 2.00	TOLERANCES NON-CUMULATIVE	DIV: MECH. ENG. DATE: 9-21-12	
NEXT ASSEMBLY	DECIMAL-INCH: .X ±.100, ~~.XX ±.030~~, .XXX ±.010, ANGULAR ±0°-15′ / FRACTIONS: 0°-12° ±1/16, 12°-72° ±1/8, 72°-120° ±1/4, OVER 120° ±1/2	ENG: G LABIK APPROVED; DSN: H FEDER G LABIK; CHK: L MORRIS CHK LM SUPV LM	E-9D11235
		SHEET 1 OF 1	REV 0

EMI

NO.	REVISION	BY	CH	SUP	APPROVED	DATE



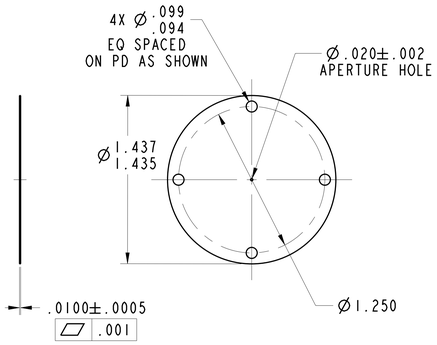
DETAIL A
SCALE 4.000



SECTION B-B
SCALE 2.000

2

SCALE 2.000



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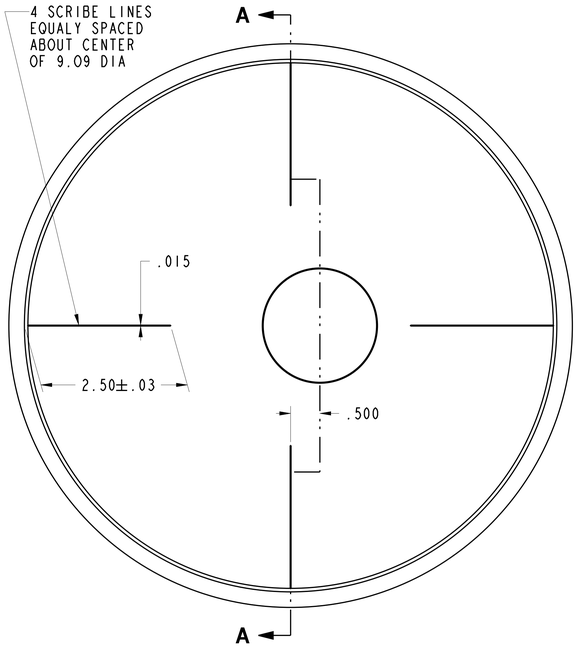
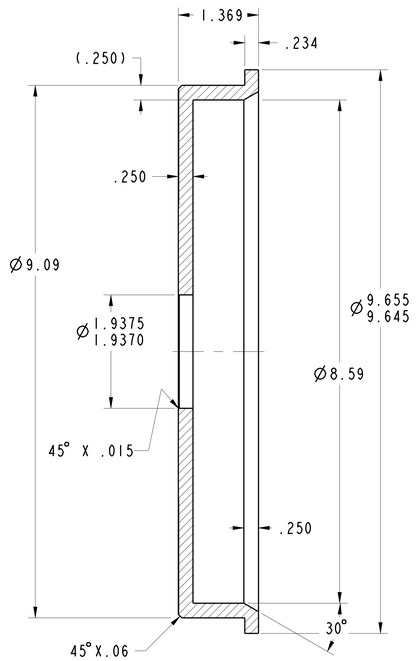
SCALE 2.000

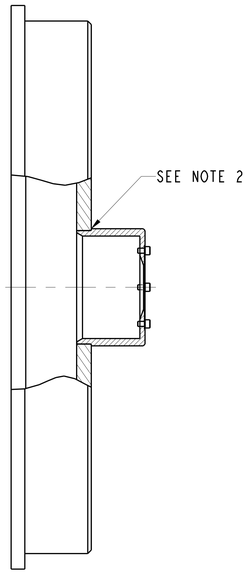




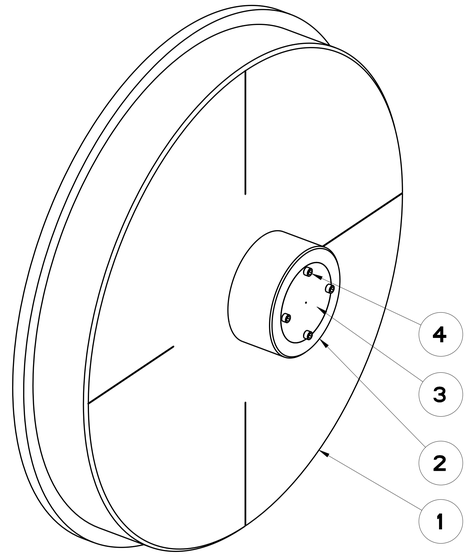
SECTION A-A
SCALE 1.000

1

SCALE 1.500



PARTIAL SECTION C-C



SCALE 1.000

RELEASED FOR FABRICATION / INSTALLATION
PPPL Drafting:

NOTES:

1. UNLESS OTHERWISE SPECIFIED
   2 PLACE DECIMAL DIMENSIONS TO BE ±.01.
2. PRESS ITEM 2 INTO ITEM 1 AGAINST SHOULDER
   AND TO APPROX ANGULAR POSITION AS SHOWN.

ITEM NO.	DRAWING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL	QTY REQD
4	150667	# 2-56 UNC x 1/8 LG HEX SOC HD CAP SCREW	STN STL	4
3	E-9D11236-3	APERTURE DISC	302/304 SS	1
2	E-9D11236-2	MOUNTING, APERTURE DISC	ALUMINUM	1
1	E-9D11236-1	HOUSING, APERTURE DISC MTG	ALUMINUM	1

PARTS LIST

GENERAL NOTES
1. PPPL APPROVED DRAWINGS TAKE PRECEDENCE OVER MODEL DIMENSIONS.
2. WHEN MODELS ARE PROVIDED, VENDOR MUST VERIFY THAT MODEL DIMENSIONS CONFORM WITH PPPL APPROVED DRAWINGS PRIOR TO FABRICATION.

MAGNETIC PERMEABILITY REQUIREMENT (SEE NOTES)
YES [ ] NO [X]

RELEASE LEVEL: FABRICATION
DWG VERSION NO: 0.4

WELDING ENGINEER
APPVD: N/A DATE:

COMPUTER GENERATED DRAWING
MANUAL CHANGES NOT PERMITTED
Pro E
DO NOT VERIFY INFORMATION BY SCALING DRAWING
SCALE:
NEXT ASSEMBLY

CENTRAL FILES:
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
MACHINE SURFACES 125
BREAK SHARP EDGES .005/.020
TOLERANCES NON-CUMULATIVE

DECIMAL-INCH		FRACTIONS	
.X	±.100	0°-12°	±1/16
~~.00~~	~~±.030~~	12°-72°	±1/8
.XXX	±.010	72°-120°	±1/4
ANGULAR	±0°-15'	OVER 120°	±1/2

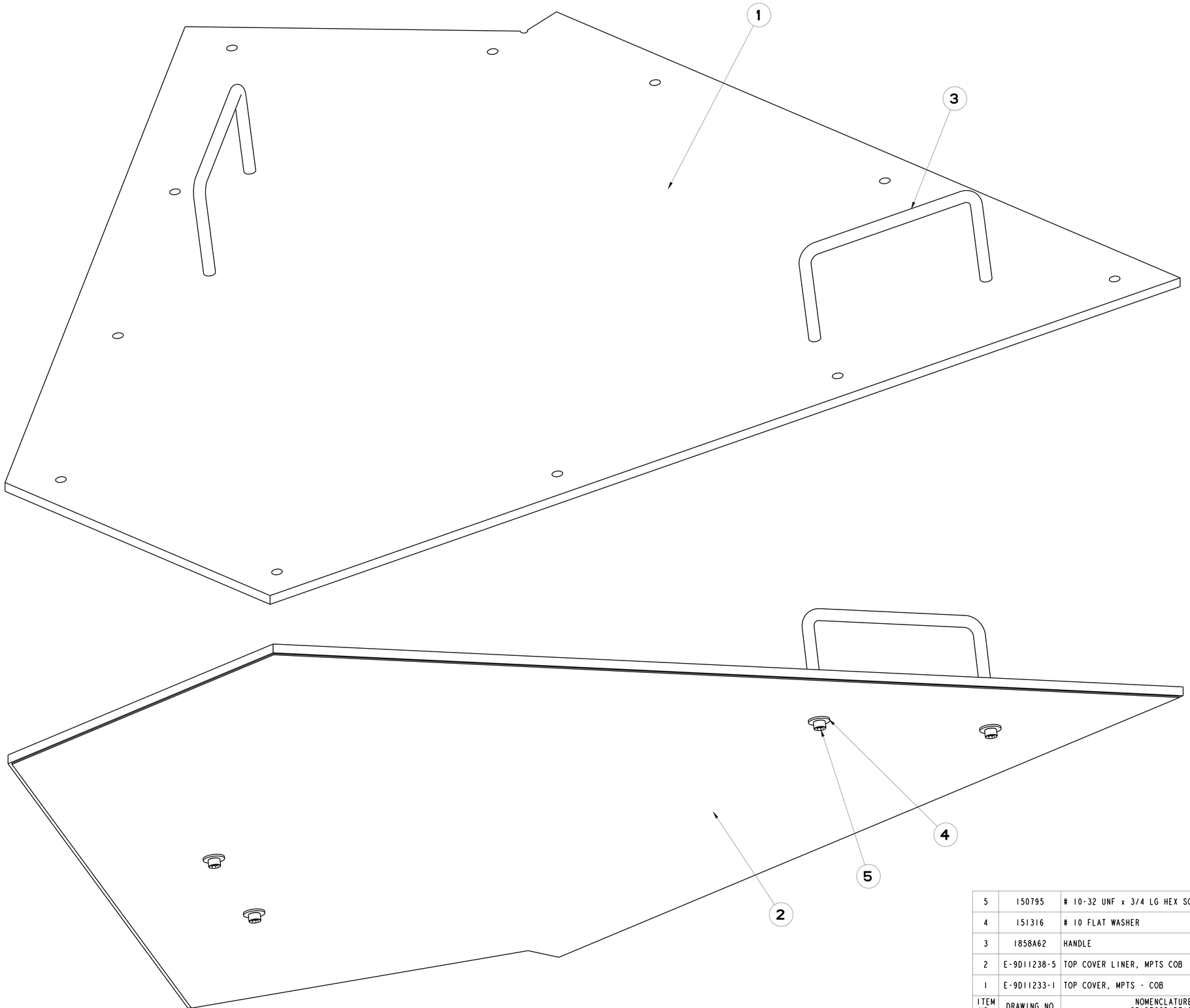
PRINCETON PLASMA PHYSICS LABORATORY
PRINCETON UNIVERSITY
NATIONAL SPHERICAL TORUS EXPERIMENT
CENTER STACK UPGRADE
MPTS - COLLECTION OPTICS BOX
MIRROR ALIGNMENT JIG

DIV: MECH. ENG.	DATE: 11-19-12		
ENG: G LABIK	APPROVED	E-9D11236	
DSN: H FEDER	G LABIK		
CHK: L MORRIS	CHK LM / SUPV LM	SHEET 1 OF 1	REV 0

EM1

NSTX-E-9D11236

NO.	REVISION	BY	CH	SUP	APPROVED	DATE
1	REVISED PER ECN 7125	HF	LM	LM	G. LABIK	10-8-13
2	REVISED PER ECN 7147	HF	LM	LM	G LABIK	11-5-13



ITEM NO.	DRAWING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL	QTY REQD
5	150795	# 10-32 UNF x 3/4 LG HEX SOC HD CAP SCREW	STN STL	4
4	151316	# 10 FLAT WASHER	316 S/S	4
3	1858A62	HANDLE (MCMASTER-CARR)	304 SS	2
2	E-9D11238-5	TOP COVER LINER, MPTS COB	BLK DELRIN 1/32	1
1	E-9D11233-1	TOP COVER, MPTS - COB	G-11	1

PARTS LIST

NSTX-E-9D11233

GENERAL NOTES

1. PPPL APPROVED DRAWINGS TAKE PRECEDENCE OVER MODEL DIMENSIONS.
2. WHEN MODELS ARE PROVIDED, VENDOR MUST VERIFY THAT MODEL DIMENSIONS CONFORM WITH PPPL APPROVED DRAWINGS PRIOR TO FABRICATION.

MAGNETIC PERMEABILITY REQUIREMENT (SEE NOTES)

YES | NO X

RELEASED FOR FABRICATION / INSTALLATION
PPPL Drafting:

RELEASE LEVEL: Fabrication
DWG VERSION NO: 2.1

WELDING ENGINEER
APPVD: N/A DATE:

COMPUTER GENERATED DRAWING
MANUAL CHANGES NOT PERMITTED
Pro E
DO NOT VERIFY INFORMATION BY SCALING DRAWING
SCALE: 1.000
NEXT ASSEMBLY

CENTRAL FILES:
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
MACHINE SURFACES 125
BREAK SHARP EDGES .005/.020
TOLERANCES NON-CUMULATIVE

DECIMAL-INCH		FRACTIONS	
.X	±.100	0°-12°	±1/16
.XX	±.030	12°-72°	±1/8
.XXX	±.010	72°-120°	±1/4
ANGULAR	±0°-15'	OVER 120°	±1/2

PRINCETON PLASMA PHYSICS LABORATORY
PRINCETON UNIVERSITY
NATIONAL SPHERICAL TORUS EXPERIMENT
CENTER STACK UPGRADE
MPTS- COLLECTION OPTICS BOX
TOP COVER ASSY

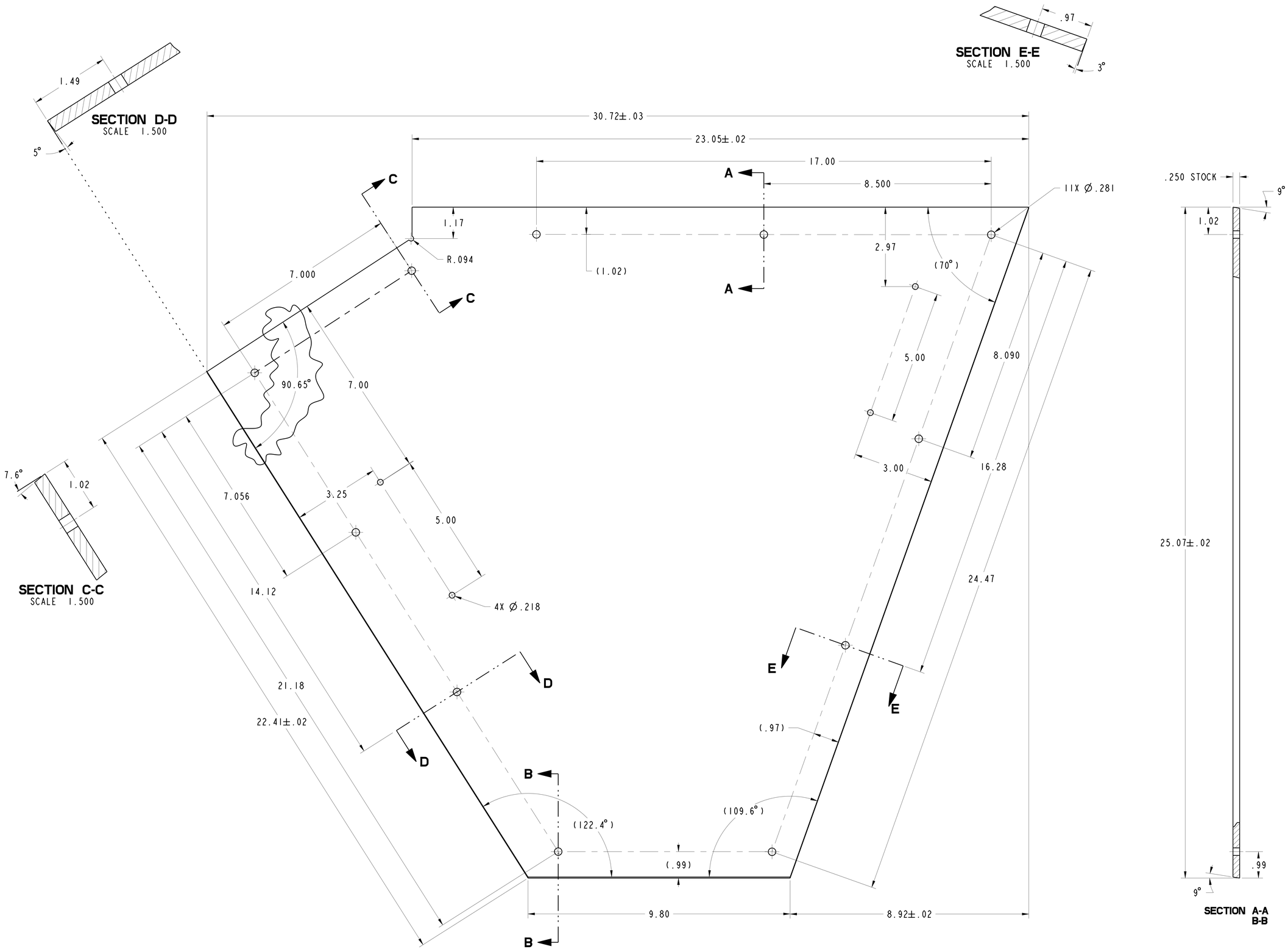
DIV: MECH. ENG. DATE: 9-21-12
ENG: G LABIK APPROVED
DSN: H FEDER G LABIK
CHK: L MORRIS CHK LM SUPV LM

E-9D11233

SHEET 1 OF 2 REV 2

EMI

NO.	REVISION	BY	CH	SUP	APPROVED	DATE



1	E-9D11233-1	TOP COVER, MPTS - COB	G-11
	DRAWING NUMBER	DESCRIPTION	MATERIAL

NOTES:
1. UNLESS OTHERWISE SPECIFIED 2 PLACE DECIMAL DIMENSIONS TO BE ±.01

RELEASED FOR FABRICATION / INSTALLATION
PPPL Drafting:

GENERAL NOTES
1. PPPL APPROVED DRAWINGS TAKE PRECEDENCE OVER MODEL DIMENSIONS.
2. WHEN MODELS ARE PROVIDED, VENDOR MUST VERIFY THAT MODEL DIMENSIONS CONFORM WITH PPPL APPROVED DRAWINGS PRIOR TO FABRICATION.

MAGNETIC PERMEABILITY REQUIREMENT (SEE NOTES)
YES [ ] NO [X]

RELEASE LEVEL: Fabrication
DWG VERSION NO: 2.1

WELDING ENGINEER
APPVD: _____ DATE: _____

COMPUTER GENERATED DRAWING
MANUAL CHANGES NOT PERMITTED
Pro E
DO NOT VERIFY INFORMATION BY SCALING DRAWING
SCALE: .750
NEXT ASSEMBLY

CENTRAL FILES:
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
MACHINE SURFACES 125
BREAK SHARP EDGES .005/.020
TOLERANCES NON-CUMULATIVE

DECIMAL-INCH		FRACTIONS	
.X	±.100	0°-12°	±1/16
.XX	±.030	12°-72°	±1/8
.XXX	±.010	72°-120°	±1/4
ANGULAR	±0°-15'	OVER 120°	±1/2

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MPTS- COLLECTION OPTICS BOX
TOP COVER ASSY

DIV: MECH. ENG.	DATE: 9-21-12		
ENG: G LABIK	APPROVED	E-9D11233	
DSN: H FEDER	G LABIK		
CHK: L MORRIS	CHK LM / SUPV LW	SHEET 2 OF 2	REV 2

NSTX-E-9D11233