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DOCUMENTATION PAGE

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SUMMARY		TABLES 0	
This document contains the following design work regarding the IOT Ice Detection Laser: - Attaching a timing belt and pulleys to the focus dial of the laser to that the focus of the laser may be controlled remotely, - Mounting the Laser and a camera on a base plate as a single unit, - Design of a weather resistant housing to protect the laser and camera from wind and rain.			
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ICE DETECTION LASER MODIFICATION, 2006

SR-2006-11

T. Osmond

April 2006

Summary

Ongoing within the Institute for Ocean technology as of the first quarter of 2006, is a research project centered around Institute patented technology developed for Ice Monitoring and Measuring. As part of the Ice Monitoring and Measuring project under the project lead of Robert Gagnon, a laser is controlled from a remote location. It must be controlled and pointed at ice from distances as far away as several hundred feet. There are several modifications and features needed for the laser to be used in the Ice Monitoring and Measuring project. First of all, the operator must have pointing direction control over the laser via remote control. Second, one must be able to focus the laser remotely. And lastly the laser must be contained with a power supply and a video feed camera in a weather resistant housing so that the device can operate in wet weather. Automating the direction of the laser has been accomplished by purchasing a mechanism that allows for remote control of pan and tilt angles. To this mechanism, the weather resistant housing will attach. The tasks of designing the weather resistant housing and the remote control adjustment control over the focus of the laser came to the Design and Fabrication group within the Institute. This report details these designs.

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1.0 – Design Criteria

The laser being used in the Ice Monitoring and Measuring project is a long cylindrically shaped device approximately 24 inches in length and 1.74 inches in diameter, shown in Figure 1. There are focusing screws in the front third of the laser and just ahead of those screws there is a dial that is designed to be turned with the fingers. A small experiment was conducted and it was measured to require approximately 18.9 oz.in of torque to turn the focus dial. It was also decided that approximately 180 degrees of rotation would offer a sufficient range of focus for the Ice Measurement project purposes.

The electro-mechanical device capable of turning the focus dial on the laser proposed by the electronics department is a HiTec HS-785HB Winch Servo (see figure 2). The servo offers 152.75 oz.in of torque, significant strength in shear and at least 1080 degrees rotational range (three rotations). The electronics department claim to be capable of achieving about 1800 degrees rotation (five rotations) using their own drive controller. These parameters define the design criteria for the remote laser focus control.

The challenge was to connect the winch servo to the focus dial translating approximately three rotations on the winch servo into a half turn or 180 degrees rotation on the laser dial without exceeding torque capacity.

The basic concept used to meet this challenge is a system of toothed pulleys and a single sized, trapezoidal-toothed timing belt. One pulley is connected to the servo and another is locked onto the focus dial. A third pulley called the idler is used on the opposite side of the servo to reduce the load on the laser when the timing belt is tightened.

We now have the challenge of tightening the timing belt. This is accomplished by attaching the servo to an adjustable rail that moves up and down in a slot. There are two parts of the adjustable rail, the static piece and the dynamic piece. Tightening the timing belt is simply a matter of tightening the nut on the adjustment screw coming out of the top of the static piece of the rail (see figure 3). A locking screw on the back of the static piece of the rail locks the system in place so that the timing belt will not loosen over time. This whole system of rail and servo is thus attached to the laser.

A split clamp (see figure 4) is used as the connecting mechanism between the Laser and the Servo. The split clamp is also used to hold the laser in place within the housing. The split clamp bolts to a base plate that in turn screws into the housing floor.

Also connected to the base plate is the video feed camera (see figure 5). The camera sits on an adjustable pan\ tilt stand purchased to allow the camera to be adjusted to point in the correct direction and locked in place. It is intended that

the camera should only need to be adjusted once so that it points in line with the laser and should be left in that position for extended periods of time.

The base plate attaches to the bottom of the housing using several screws. Because the camera and laser both mount to the base plate it is intended that if necessary the base plate can be removed and returned to the housing without disturbing the alignment between the laser and the camera nor without needing to readjust the timing belt.

The housing for the laser and camera is a modified design of another housing that has already been used at the Institute for Ocean Technology. A larger housing was used for another Ice Measuring system and the design was found to function properly. Only the dimensions of this newer housing have been changed.

The weather resistant housing is shown in dwg 2096T14 contained in Appendix A. It is primarily composed of lexan. It has a thick bottom to which the base plate for the laser is screwed. Buckles on the side of the housing tighten the top down. The back of the housing has a hinged door that opens down with hinges on the bottom edge. A waterproof hatch is attached to the door so that minor adjustments to the inner contents of the housing may be made if necessary. The front face of the housing contains a slot for glass to be installed. Optical glass will be used as the medium through which the laser beam will pass upon exiting the housing. The top of the housing has an overhanging ledge to protect the front glass to a certain extent from rain falling straight down.

2.0 – Components

There are a number of mechanical and electrical components needed for the laser aspect of the Ice Monitoring and Measuring project. There are components that have been purchased or fabricated by the Institute already and there are components in need of fabrication. There are also components that are to be purchased, some of which require some modifications. All components in need of fabrication or modification have associated drawings included under source file CAD_User:\Projects\42_2096 Ice Detection\TOsmond\Laser.ckd and are contained in Appendix A.

Already in possession by the Institute:

- A 15 mW Melles Griot Laser,
- An Optical Power Zoom Color DSP Camera,
- A pan/tilt adjusting mount for the camera,
- A HiTec HS-785HB Winch Servo that will be used to adjust the focus dial of the laser.

The Institute has also already purchased a remote pan/tilt adjusting mechanism to which the weather resistant housing will mount.

Three pulleys, a timing belt and a clevis pin must be ordered from McMaster-Carr (see Appendix D).

Order:

- 2 x 6495K711,
- 1 x 57105K27,
- 1 x 6484K222,
- 1 x 92735A160.

Two of the pulleys must be bored out to larger diameters as shown in drawings 2096T12, and 2096T13.

The weather resistant housing for the entire system must be fabricated. The housing will be composed mostly of lexan, dwg 2096T14 – 2096T23.

Other components needing to be fabricated include:

- Two pieces for the adjustable rail, dwg 2096T01, 2096T02,
- Components to which the servo will attach, dwg 2096T03 – 2096T05,
- An Angle bar piece connecting the rail to the split clamp, dwg 2096T06,
- A spit clamp, dwg 2096T07,
- A base plate, dwg 2096T11,
- Two idler brackets, dwg 2096T08.
- And mounting bases for both the laser and camera, dwg 2096T09, 2096T10.

A list of all the fasteners needed to fully assemble all components is contained in Appendix C.

3.0 – Calculations

Pulley Gear Ratio

Servo Pulley – Pitch Diameter: 0.637"

Laser Pulley – Pitch Diameter: 2.292"

Ratio: $2.292:0.637 = 3.6:1.0$

Thus 3.6 rotations of the servo will provide a complete rotation of the laser focus dial.

Torque Ratio

Maximum torque for servo: 152.75 oz.in.

Minimum required torque to turn focus dial: 18.9 oz.in

$152.75 \text{ oz.in} * 3.6 = 549.9 \text{ oz.in}$

$549.9 \text{ oz} \gg 18.9 \text{ oz.in}$

Therefore we have acceptable torque from the servo to turn laser focus dial.

Length of Timing Belt

The length of the timing belt was calculated from the dimensions contained in appendix B taken directly from the laser CAD file.

The following calculations were used to determine the necessary belt length:

$$\begin{aligned} 142^\circ * \pi / 180 &= 2.478 \text{ rads} \\ \theta r &= 2.478 * 0.319 = 0.790 \text{ "} \\ 133^\circ * \pi / 180 &= 2.321 \text{ rads} \\ \theta r &= 2.321 * 0.319 = 0.740 \text{ "} \\ 42^\circ * \pi / 180 &= 0.733 \text{ rads} \\ \theta r &= 0.733 * 1.146 = 0.840 \text{ "} \end{aligned}$$

$$\begin{aligned} 2 * 2.425 \text{ "} &= 4.850 \text{ "} \\ 2 * 1.889 \text{ "} &= 3.778 \text{ "} \\ 2 * 0.840 \text{ "} &= 1.680 \text{ "} \\ 1 * 0.790 \text{ "} &= 0.790 \text{ "} \\ 1 * 0.740 \text{ "} &= \underline{0.740 \text{ "}} \\ &11.838 \text{ "} \end{aligned}$$

Because the timing belt may be adjusted to within a range of 0.75" it is clear that a 12" timing belt is the suitable length.

4.0 – Figures

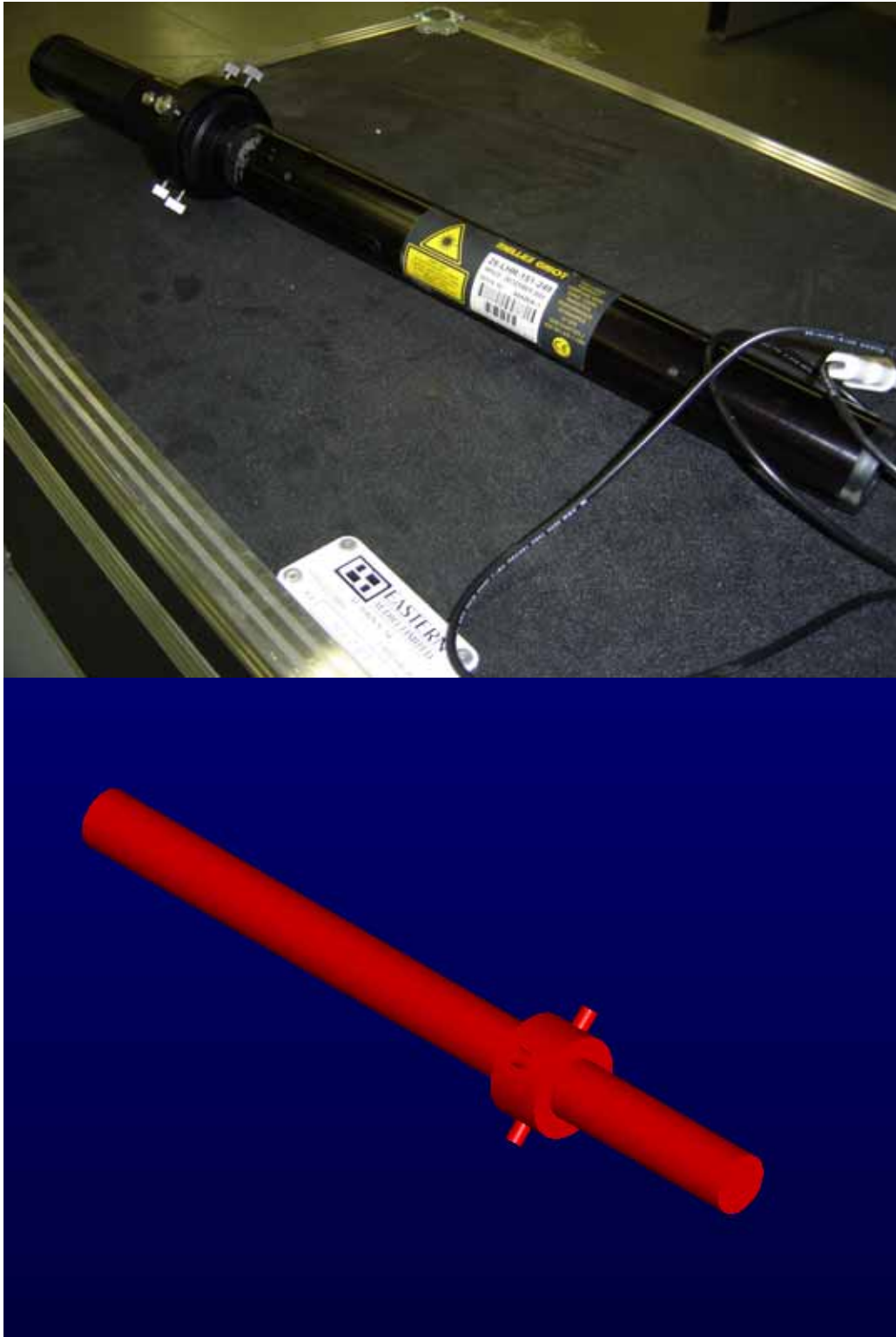


Figure 1 – Ice Measuring Laser

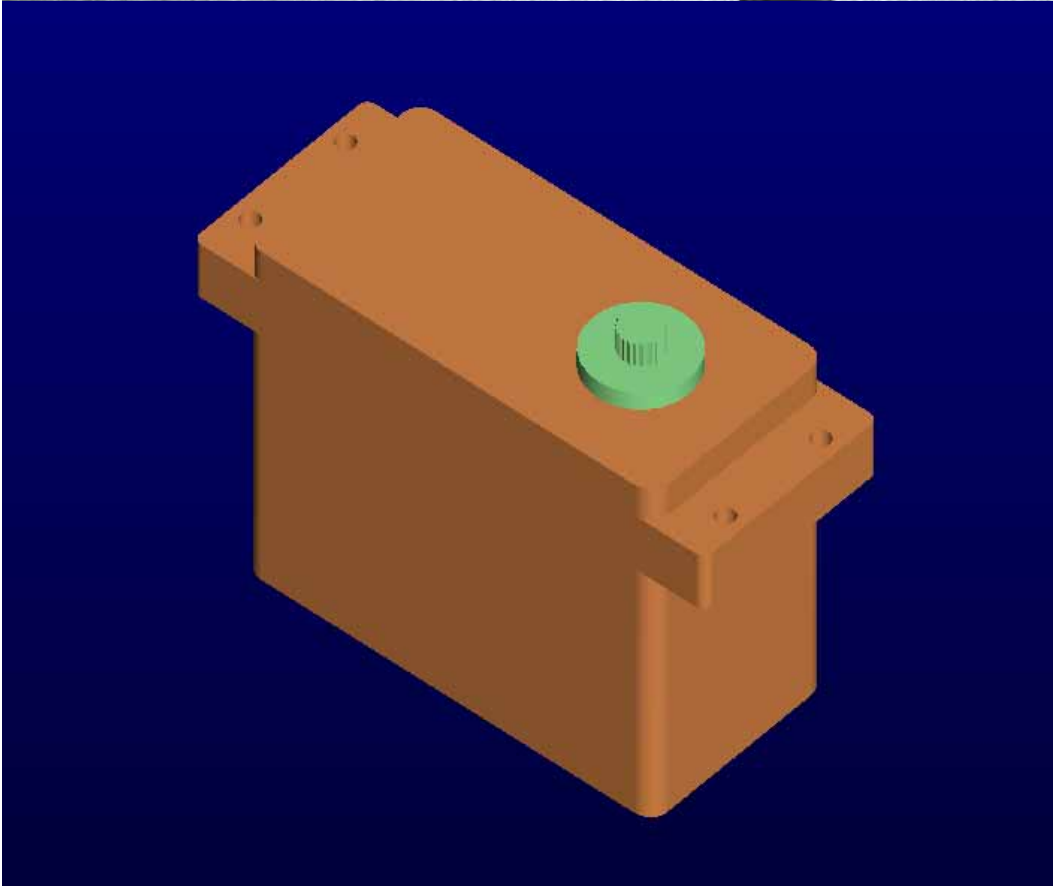


Figure 2 – Winch Servo

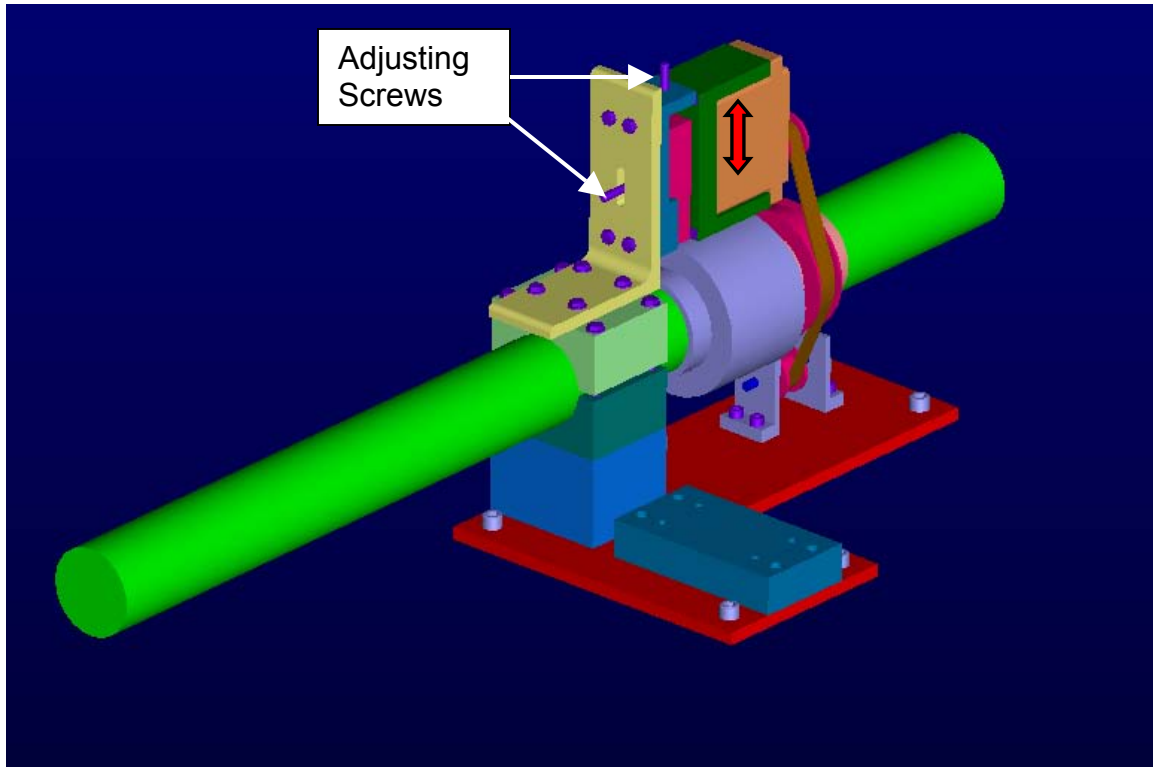


Figure 3 – Timing Belt Adjustment Screws

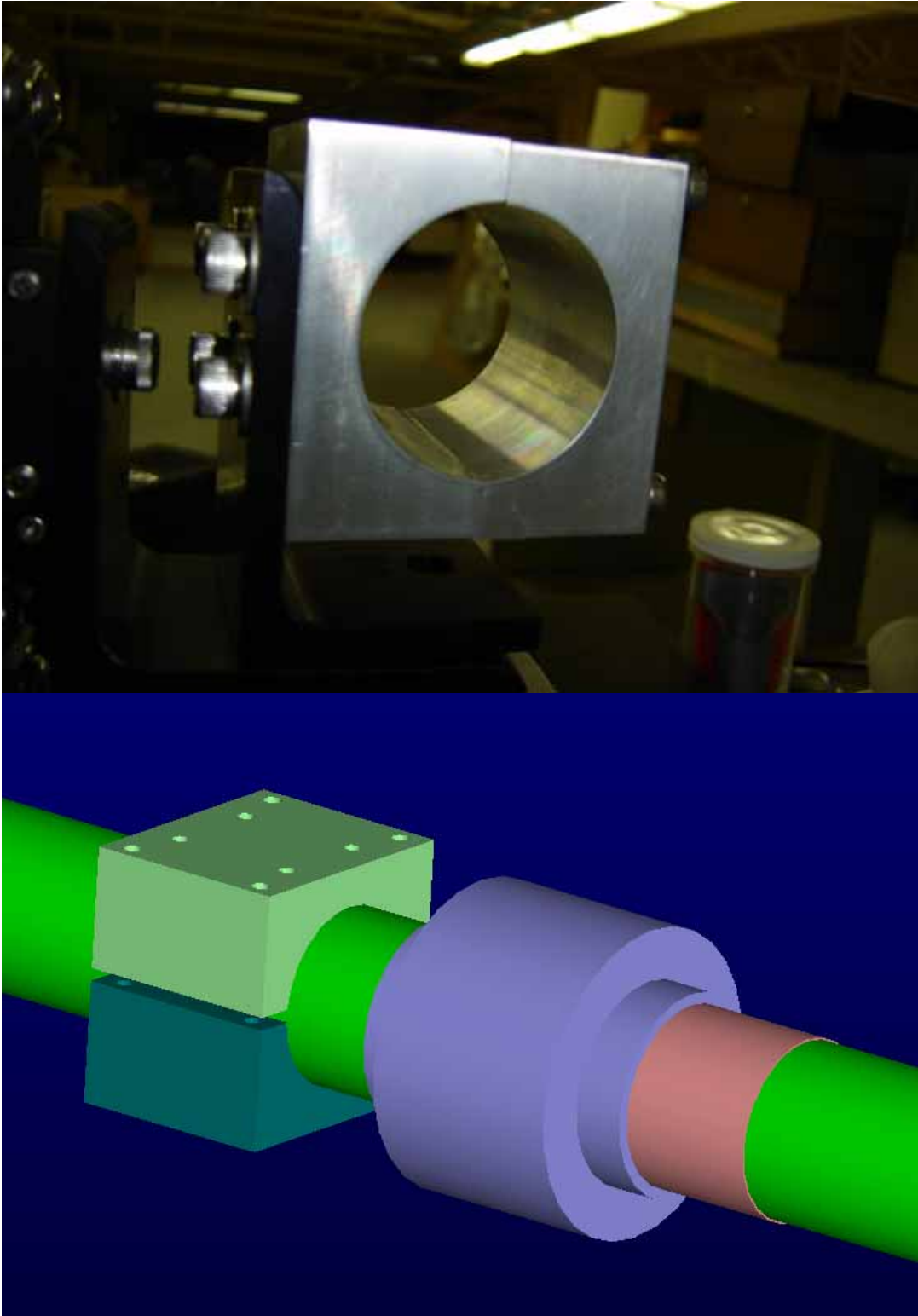


Figure 4 – Split Clamp Used to Hold Laser



Figure 5 – Camera and Pan/Tilt Mechanism

5.0 – Appendices

Appendix A – Drawings

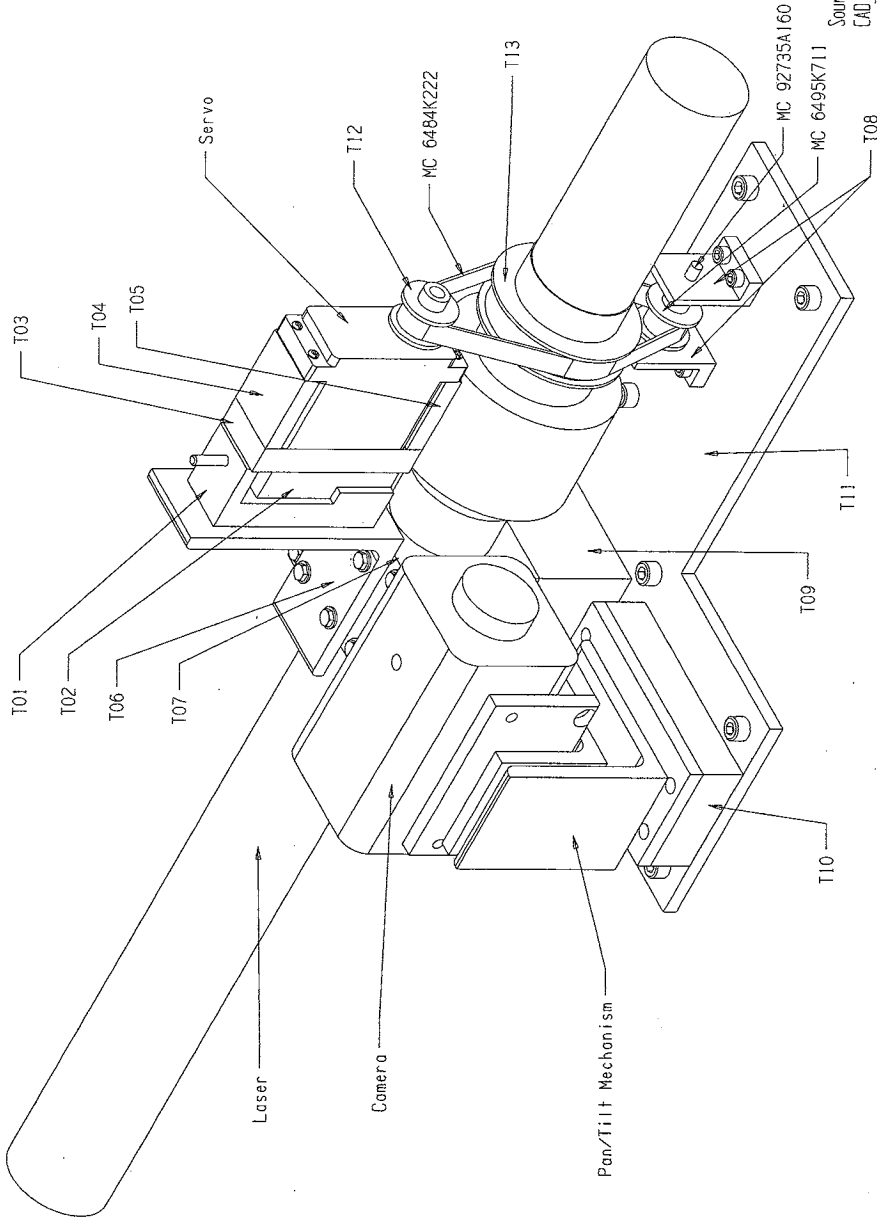
Appendix B – Timing Belt Dimensions

Appendix C – Fastener List

Appendix D – Data Sheets

APPENDIX A – DRAWINGS

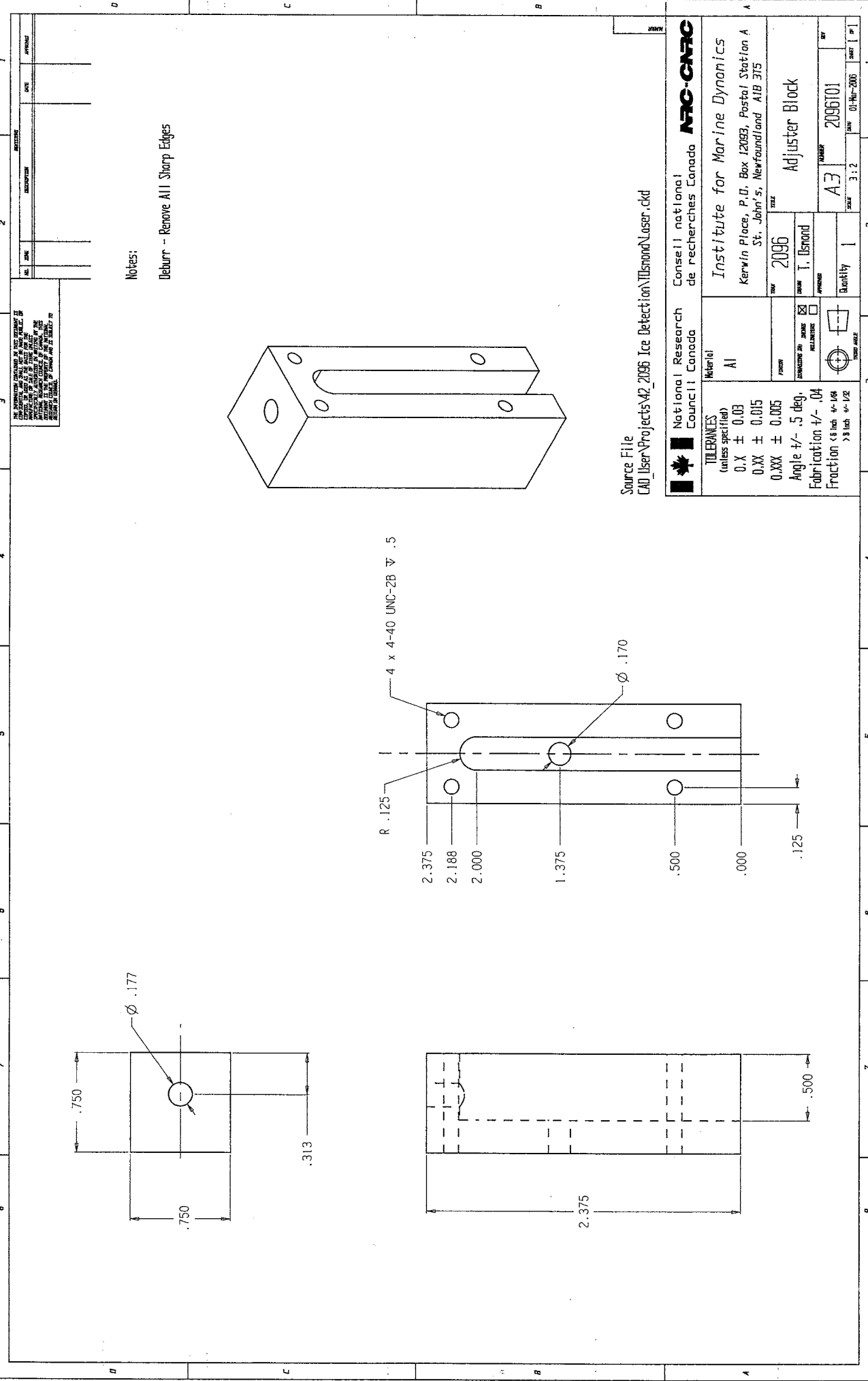
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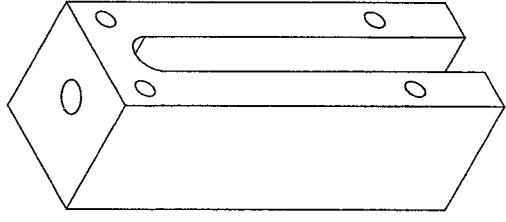
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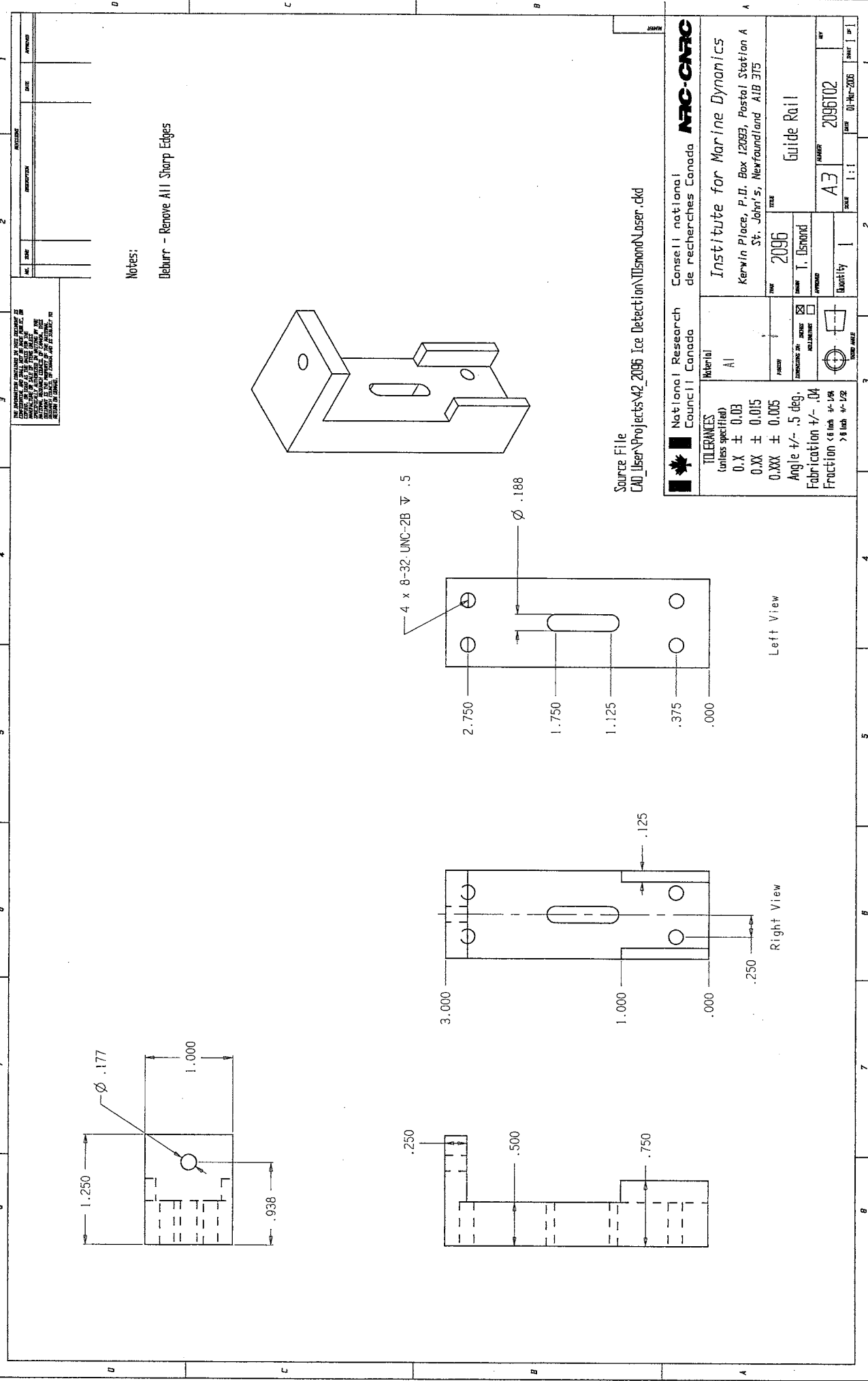
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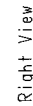
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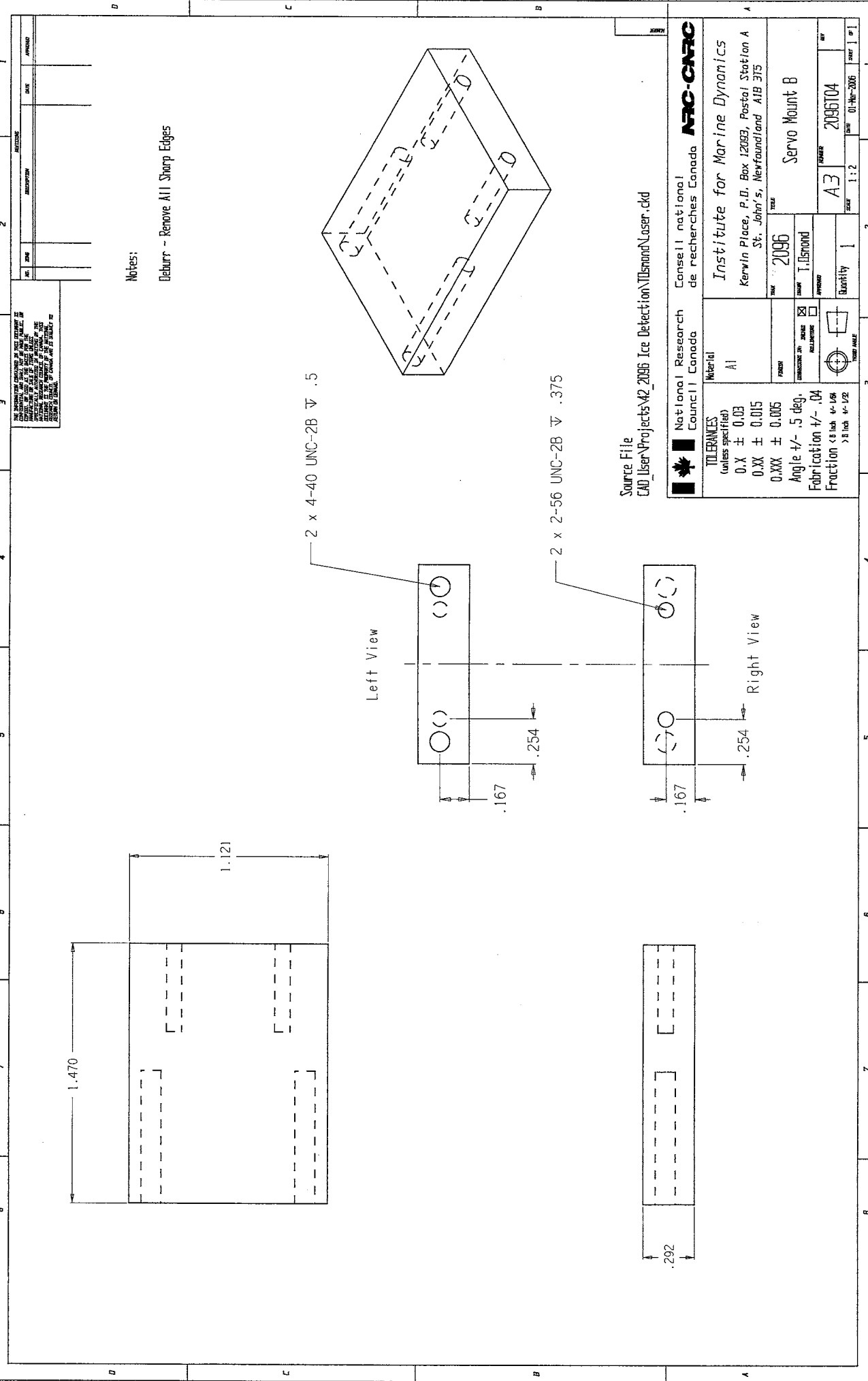
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 TOP VIEW	Quantity 1	DATE 01-Mar-2008		



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2. 2 x 4-40 UNC-2B ∇ .5

3. 2 x 2-56 UNC-2B ∇ .375

Left View

Right View

Top View

Bottom View

Isometric View

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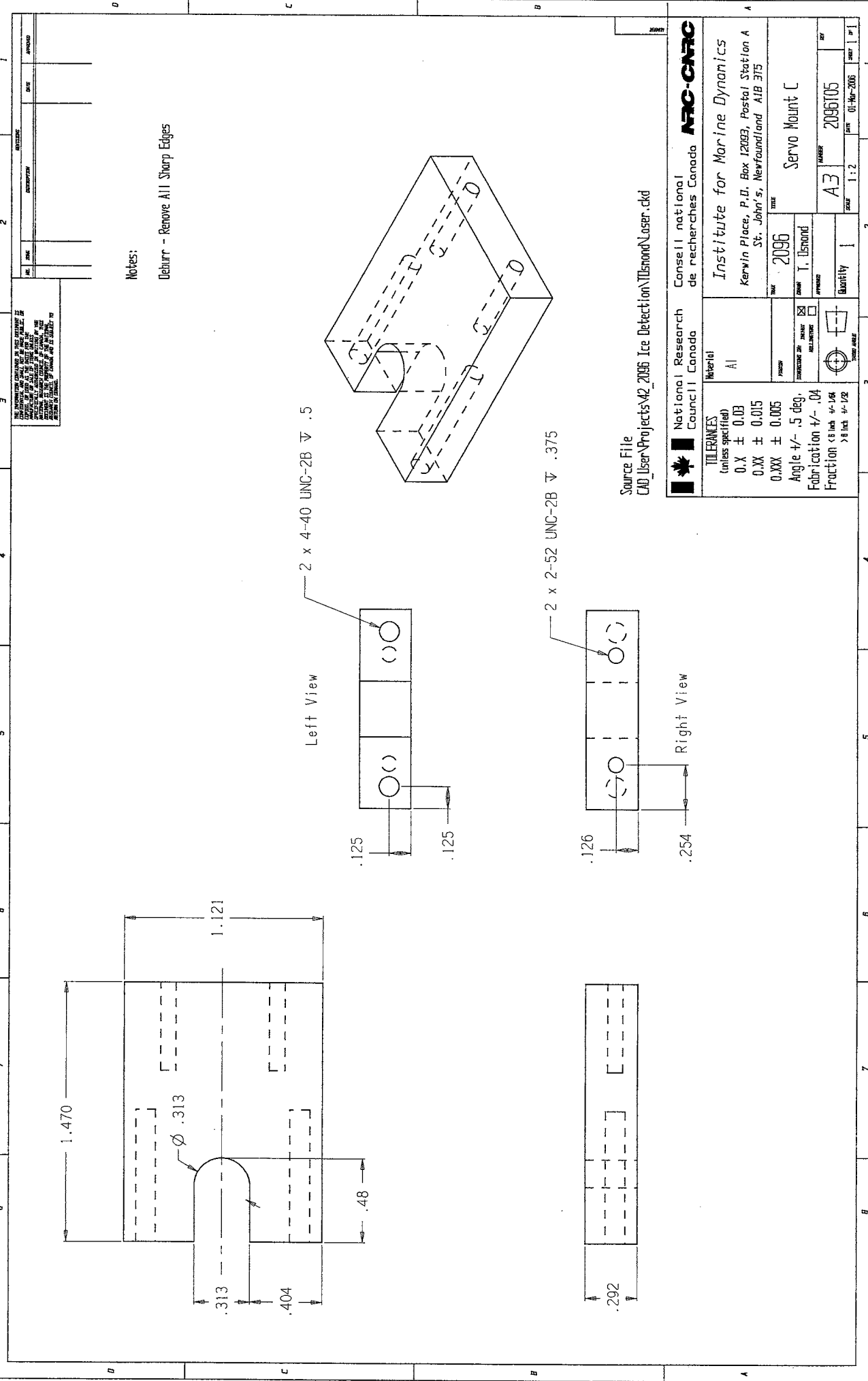
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Institute for Marine Dynamics
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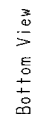
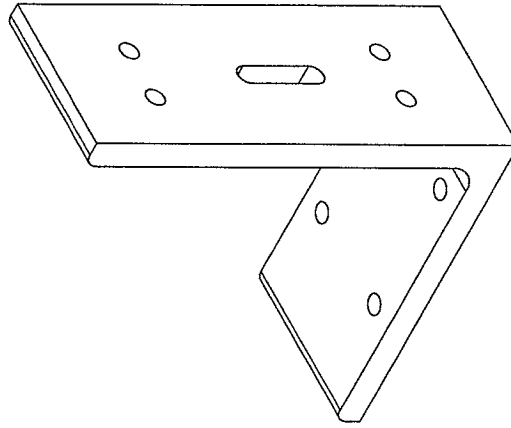
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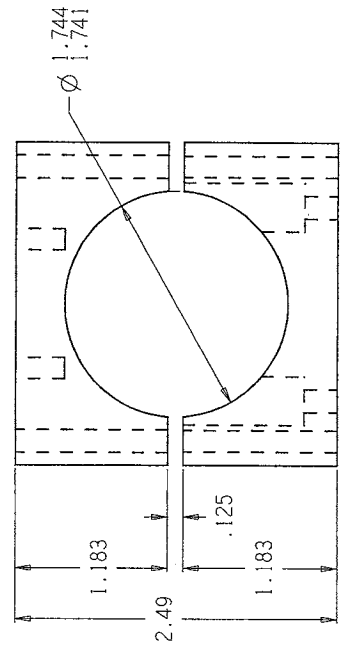
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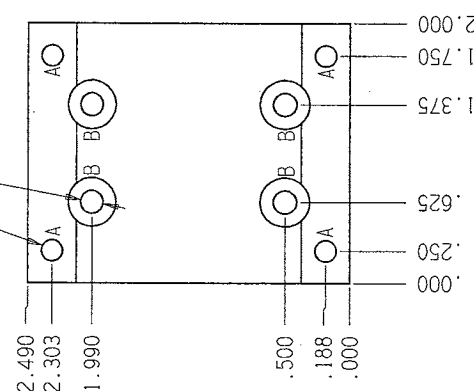
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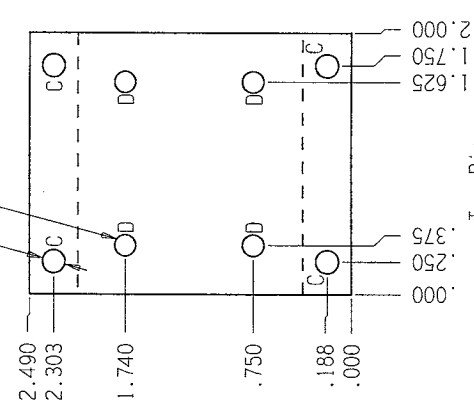


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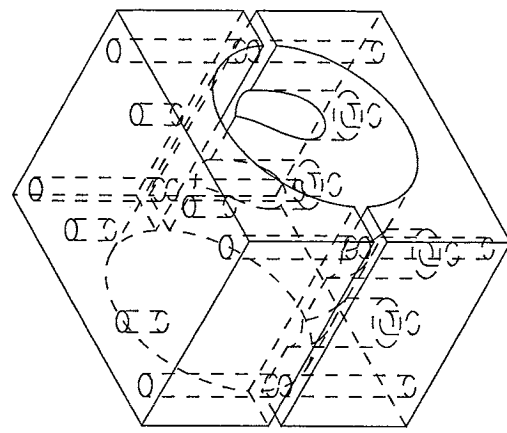


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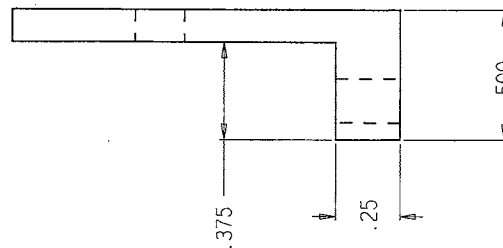


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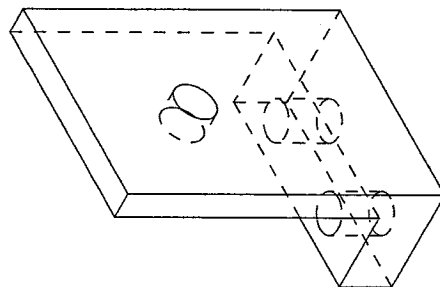


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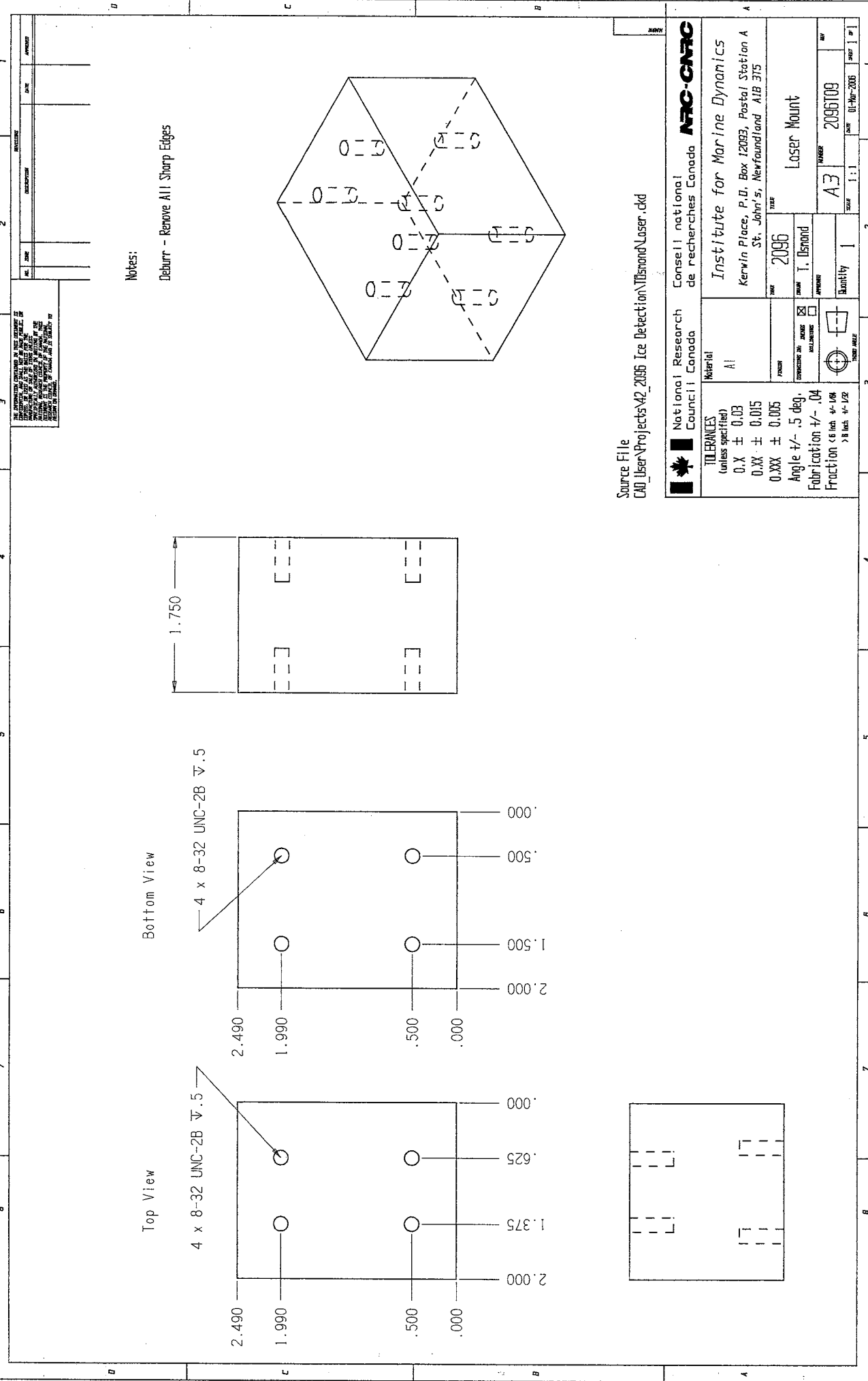


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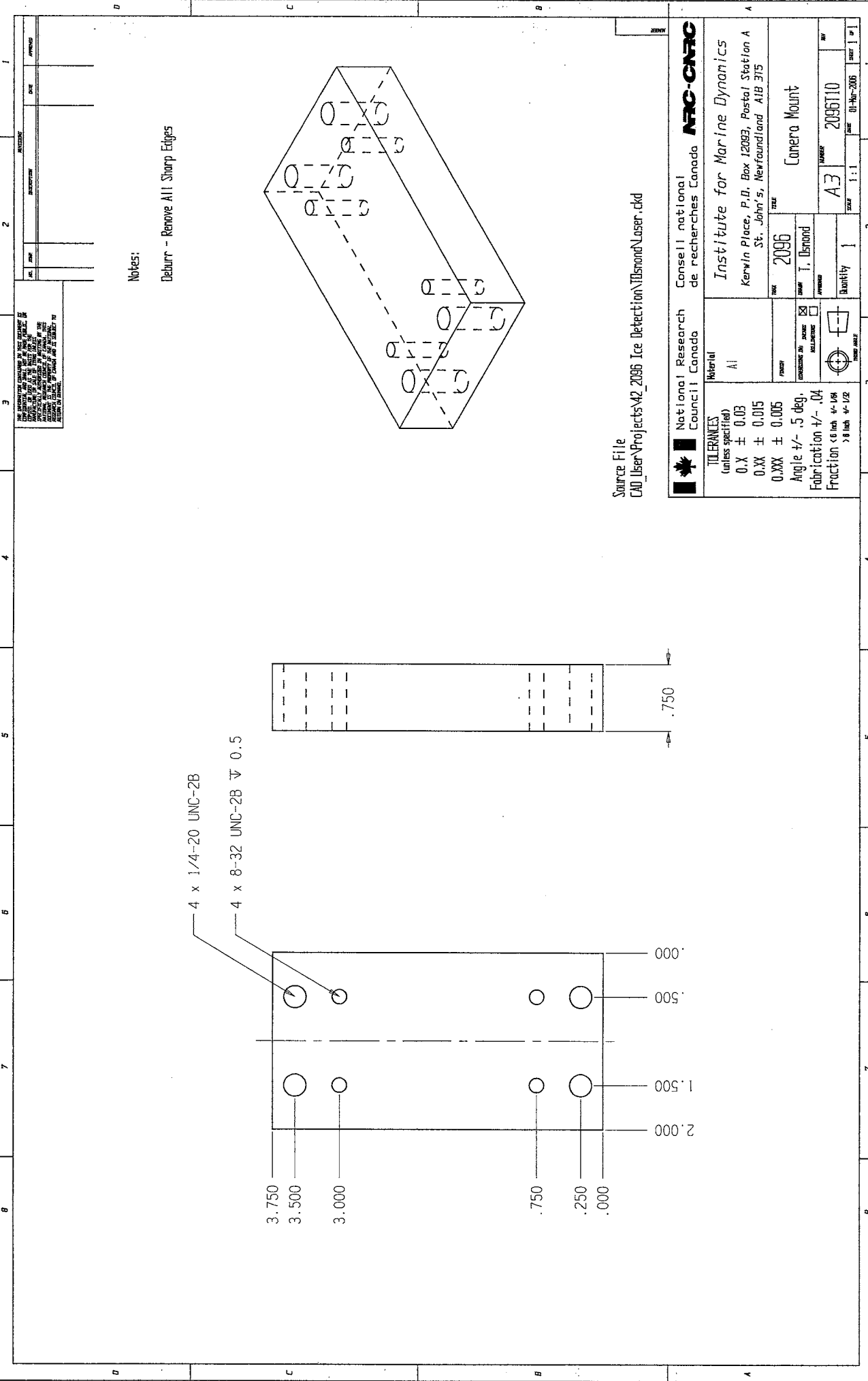
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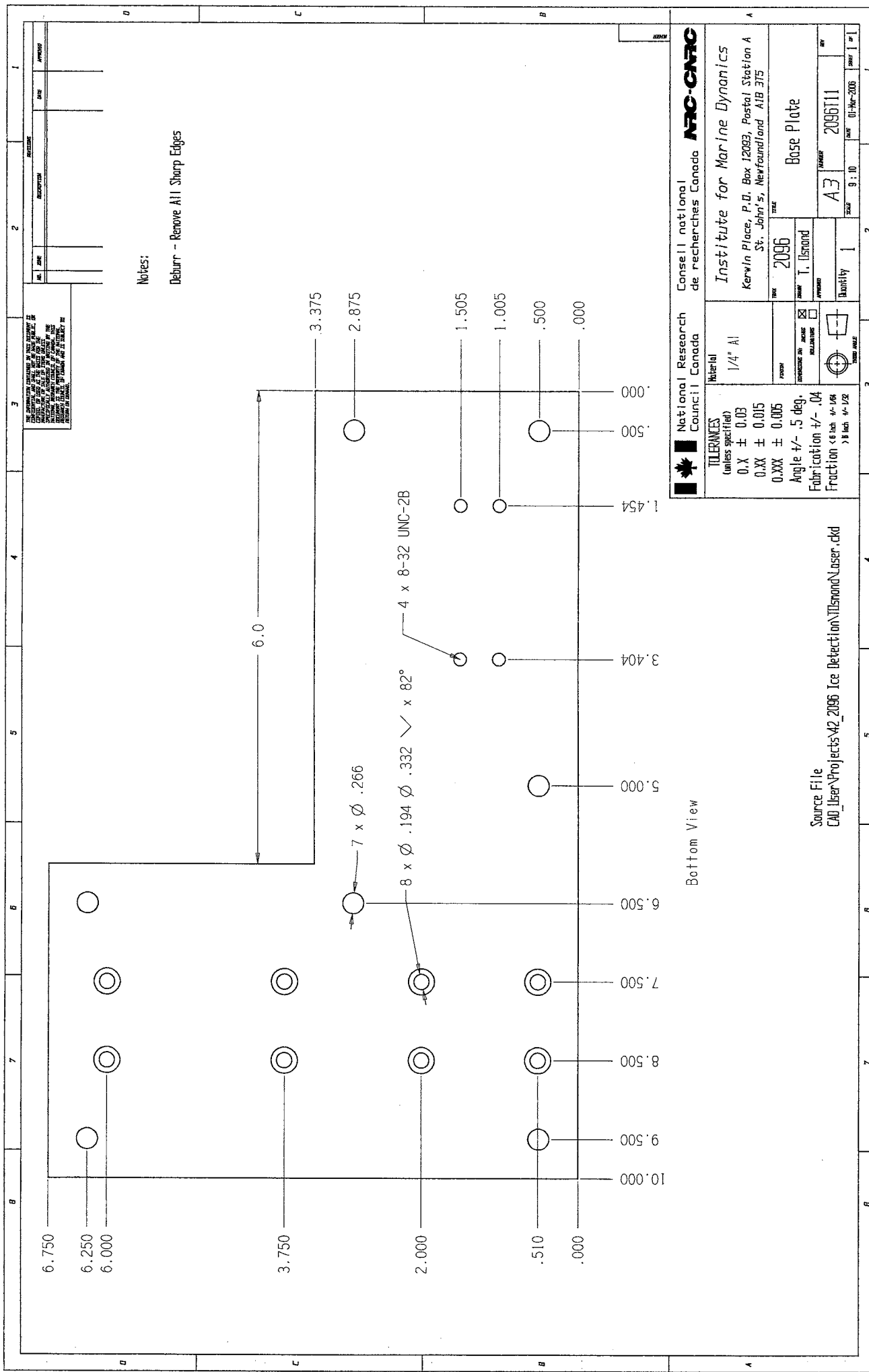
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APPROVED [Signature]		SHEET 1 of 1	



Notes:
Deburr - Remove All Sharp Edges

		National Research Council Canada Conseil national de recherches Canada	
TOLERANCES (unless specified) 0.X ± 0.03 0.XX ± 0.015 0.XXX ± 0.005 Angle 1/2° - 5 deg. Fabrication ± .04 Fraction 1/8 inch 1/4 1/8 1/16		Material 1/4" Al	
PROJECT 2096		TITLE Base Plate	
DRAWN T. Desmond		DATE 01-Mar-2006	
CHECKED 2096T11		SHEET 1 of 1	
QUANTITY 1		SCALE 9:10	

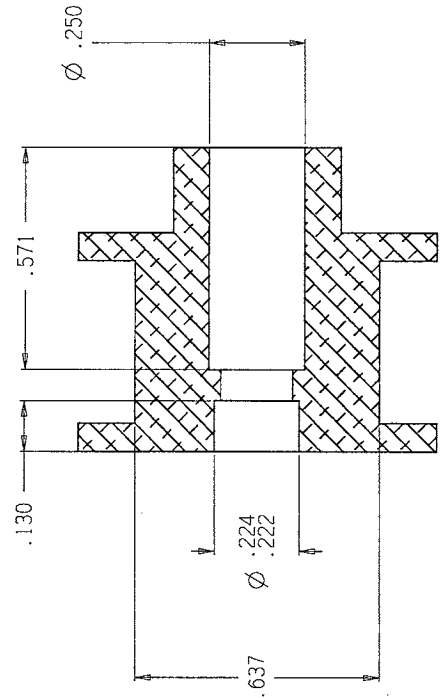
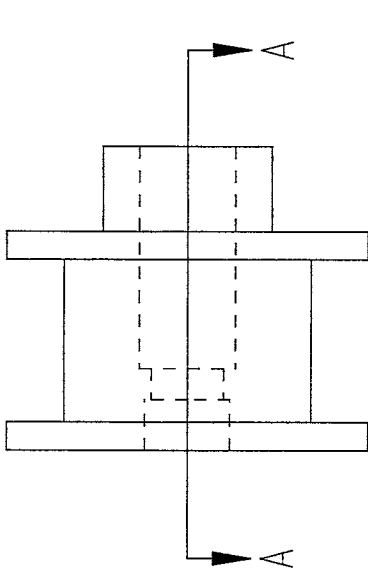
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ALL DIMENSIONS UNLESS OTHERWISE SPECIFIED ARE IN INCHES. DIMENSIONS IN PARENTHESES ARE IN MILLIMETERS. DIMENSIONS IN PARENTHESES ARE NOT TO BE USED FOR FABRICATION. DIMENSIONS IN PARENTHESES ARE NOT TO BE USED FOR FABRICATION. DIMENSIONS IN PARENTHESES ARE NOT TO BE USED FOR FABRICATION.

REV	DATE	DESCRIPTION	BY	APP'D

Notes:

- Deburr - Remove All Sharp Edges
- McMaster Carr Part Number 6495K711
- PD - .929"
- OD - .637"
- Bore - 3/16"
- Pitch - .2"



SECTION A-A

Source File
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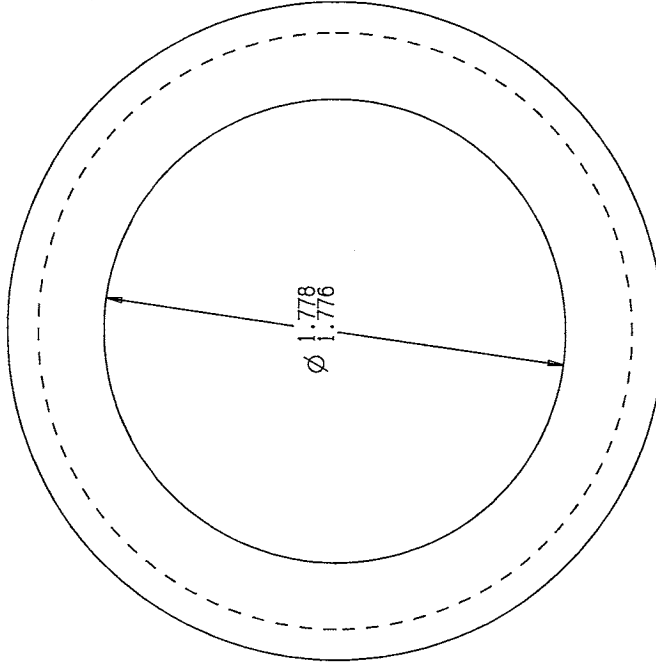
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TOLERANCES (unless specified) 0.X ± 0.03 0.XX ± 0.015 0.XXX ± 0.005 Angle +/- .5 deg. Fabrication +/- .04 Fraction < 8 inch 1/8 > 8 inch 1/4		PART 2096 DRAWN T. Dsmond APPROVED Quantity 1 SCALE 1:3 DATE 01-Mar-2005 PAGE 1 of 1	
Material Al FINISH DIMENSIONS IN PARENTHESES MILLIMETERS TYPICAL SIZE		TITLE 2096 PULLEY 1 Modification NAME 2096T12 REV	

NO DIMENSIONS OR TOLERANCES TO BE SPECIFIED ON THIS DRAWING UNLESS OTHERWISE NOTED. ALL DIMENSIONS ARE TO BE TAKEN FROM THE UNFINISHED SURFACE UNLESS OTHERWISE NOTED. DIMENSIONS TO BE TAKEN FROM THE FINISHED SURFACE UNLESS OTHERWISE NOTED. DIMENSIONS TO BE TAKEN FROM THE UNFINISHED SURFACE UNLESS OTHERWISE NOTED. DIMENSIONS TO BE TAKEN FROM THE FINISHED SURFACE UNLESS OTHERWISE NOTED.

Notes:

Deburr - Remove All Sharp Edges
Light Press Fit over Laser Dial

McMaster Carr Part Number 57105K27
PD - 2.292"
OD - 2.53"
Pitch - .2"



Source File

CAD_User\Projects\42_2096_Ice Detection\TDSmod\Laser.dkd

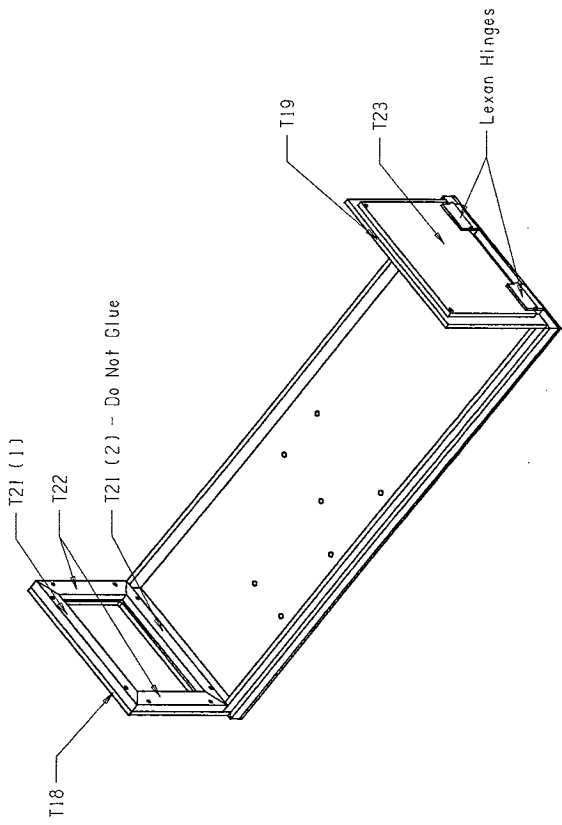
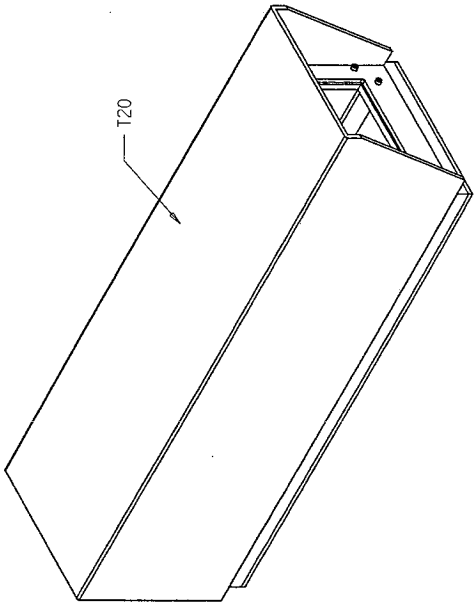
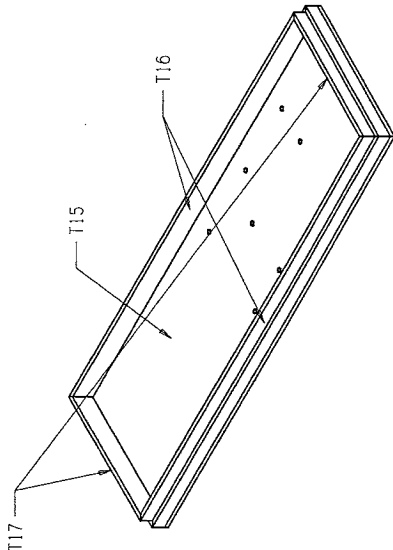
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TOLERANCES (unless specified) 0.X ± 0.03 0.XX ± 0.015 0.XXX ± 0.005 Angle +/- .5 deg. Fabrication +/- .04 Fraction < 8 inch +/- 1/32 > 8 inch +/- 1/16		Material Al	
FINISH ☒ MACHINED ☐ MILLING ☐ TURNING		DATE 2096	
DESIGNED BY T. Desmond		INSTITUTE for Marine Dynamics Kervin Place, P.O. Box 12093, Postal Station A St. John's, Newfoundland A1B 3T5	
QUANTITY 1		PULLEY 2 Modification	
DATE 2096T13		SCALE 1:2	
SHEET 1 OF 1		DATE 01-Apr-2005	

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REV	DESCRIPTION	DATE	APPROVED

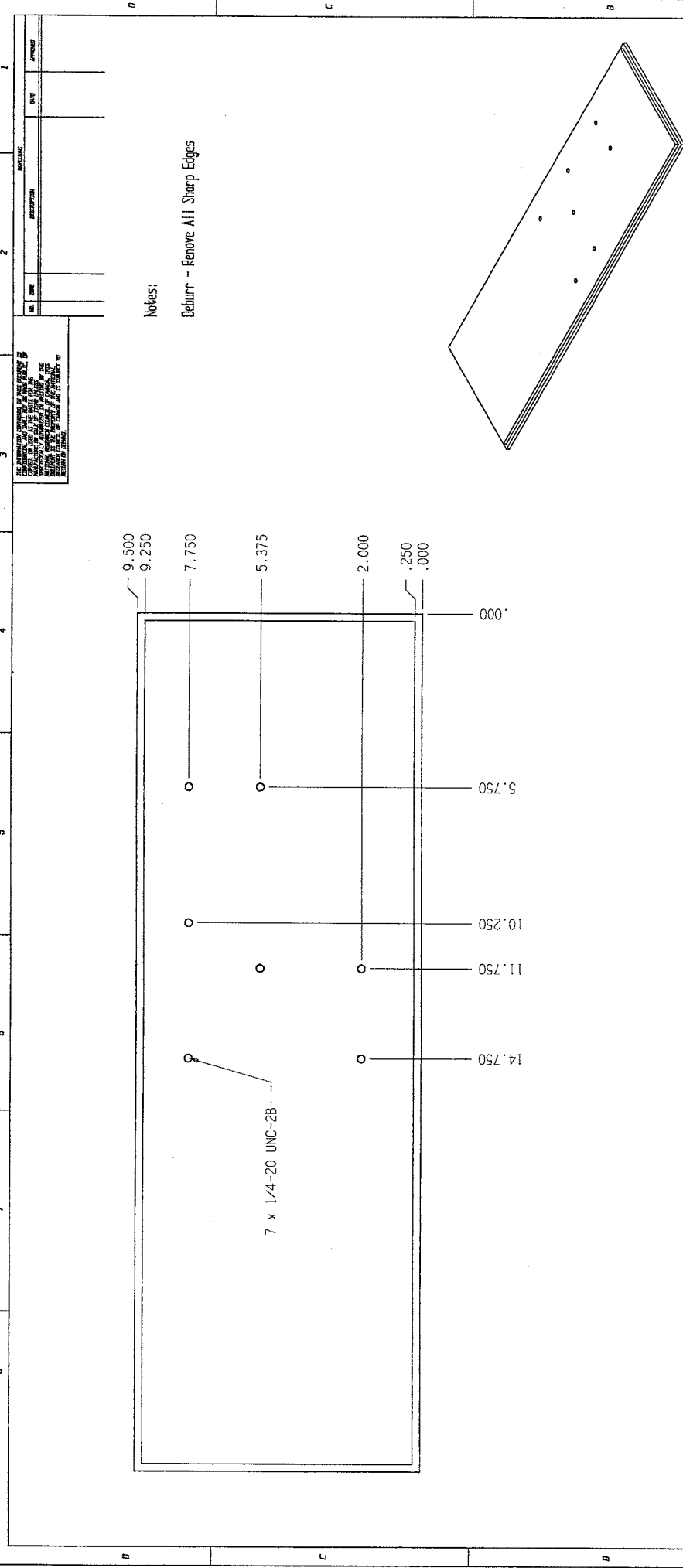
Notes:

- Deburr - Remove All Sharp Edges
- Glue T18, T19, T21 (1), T22 to T20
- Do not glue T21 (2)



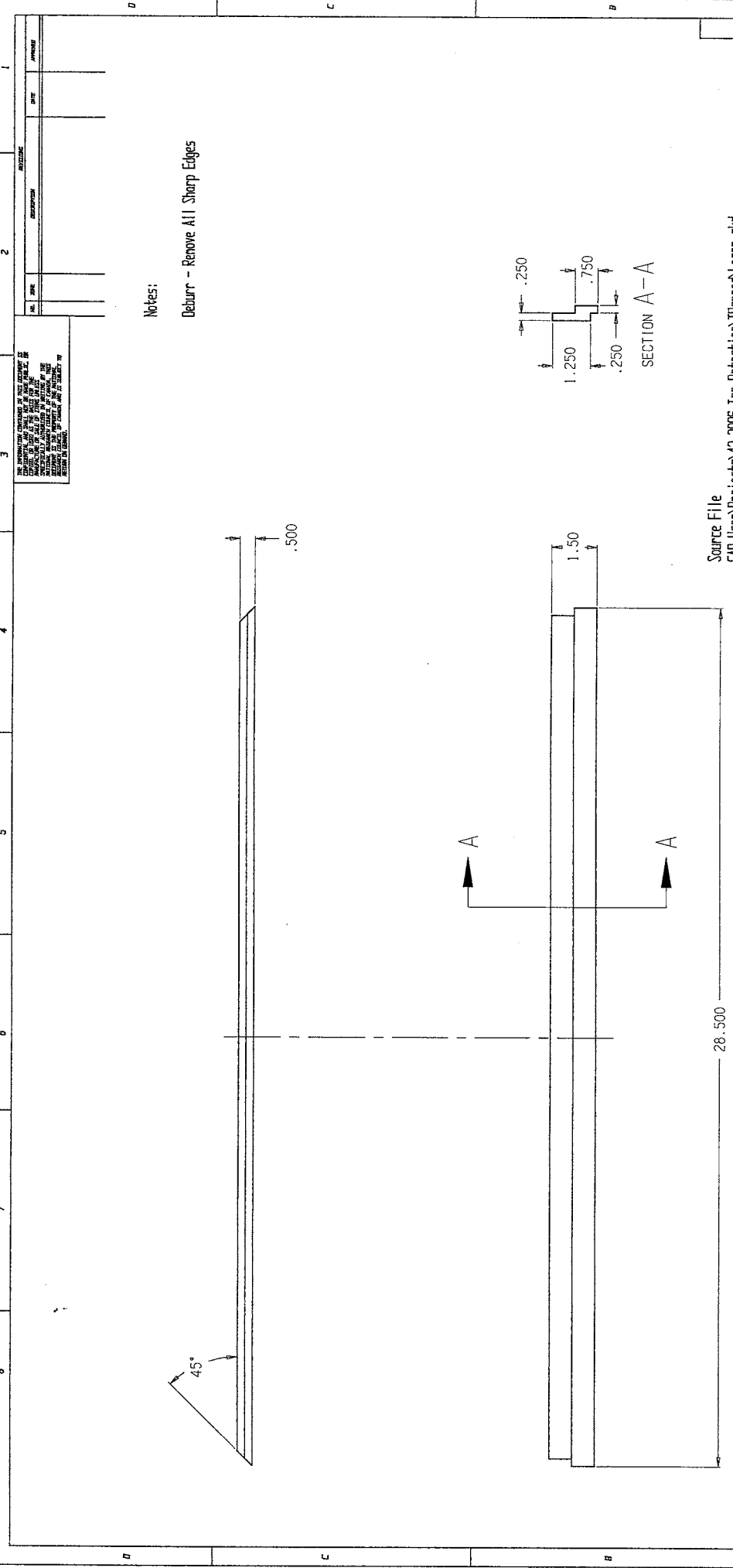
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National Research Council Canada Conseil national de recherches Canada		NRC-CNRC	
Institute for Marine Dynamics Kerwin Place, P.O. Box 12093, Postal Station A St. John's, Newfoundland A1B 3T5		General Assembly - L Housing	
Material Lexan	TOLERANCES (unless specified) 0.X ± 0.03 0.XX ± 0.015 0.XXX ± 0.005 Angle ± .5 deg. Fabrication ± .04 Fraction 1/8 inch ± 1/32	DATE 2096	DRAWN T. Desmond
FINISH ☒ POLISHED ☐ MILL FINISH	QUANTITY 1	SCALE A3	SHEET 2096T14
APPROVED 		DATE 01-Mar-2006	SHEET 1 of 1



Source File
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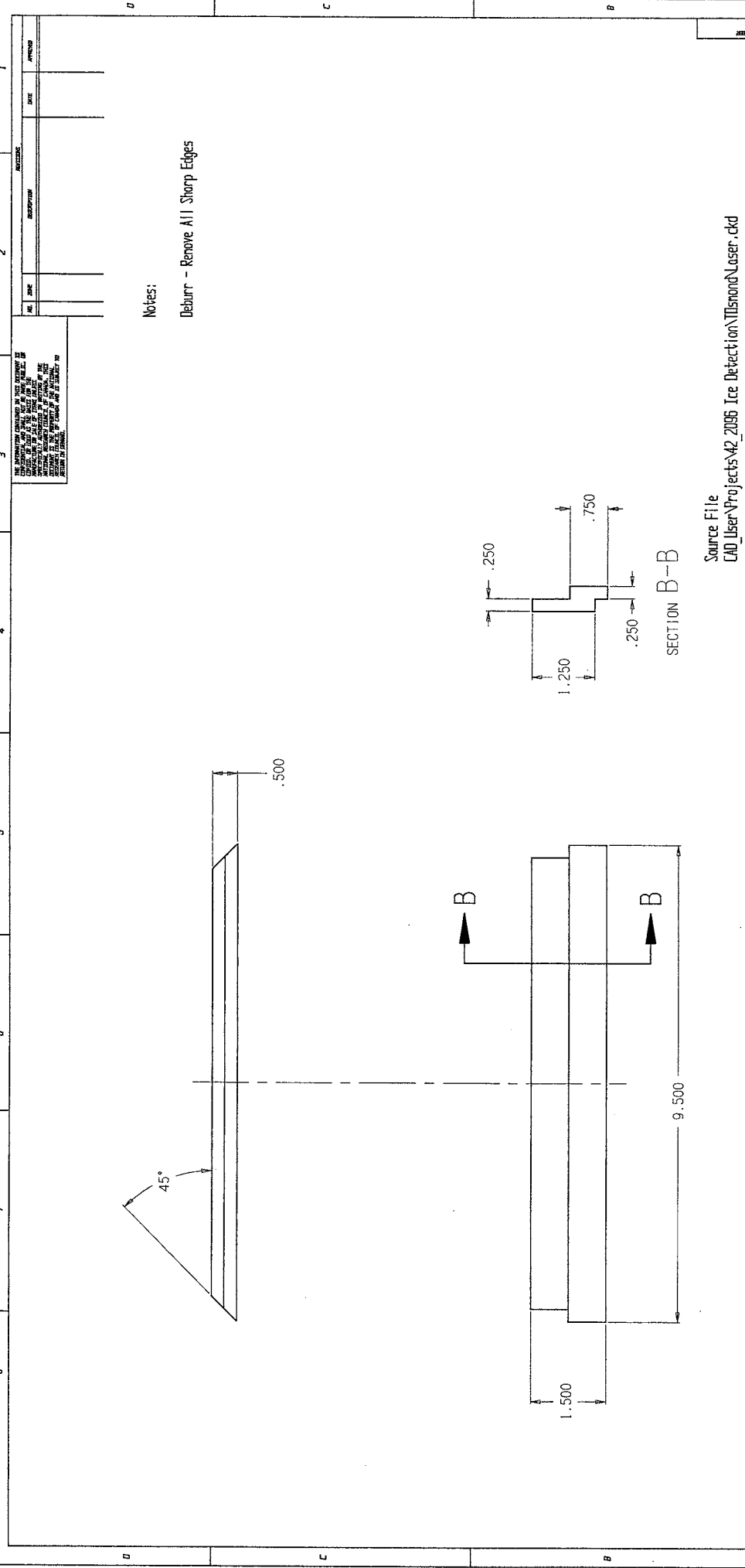
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TOLERANCES (unless specified) 0.X ± 0.03 0.XX ± 0.015 0.XXX ± 0.005 Angle +/- .5 deg. Fabrication +/- .04 Fraction < 8 inch +/- 1/32 > 8 inch +/- 1/16		Material AI	
FINISH EXPOSURE IN JAWES ☒ RELINQUISH ☐		DATE 2096	
APPROVED 		INSTITUTE for Marine Dynamics Kervin Place, P.O. Box 12093, Postal Station A St. John's, Newfoundland A1B 3T5	
THROW AWAY 		Bottom - L Housing	
Quantity 1		Part Number 2096T15	
Scale 3 : 10		Sheet 1 of 1	



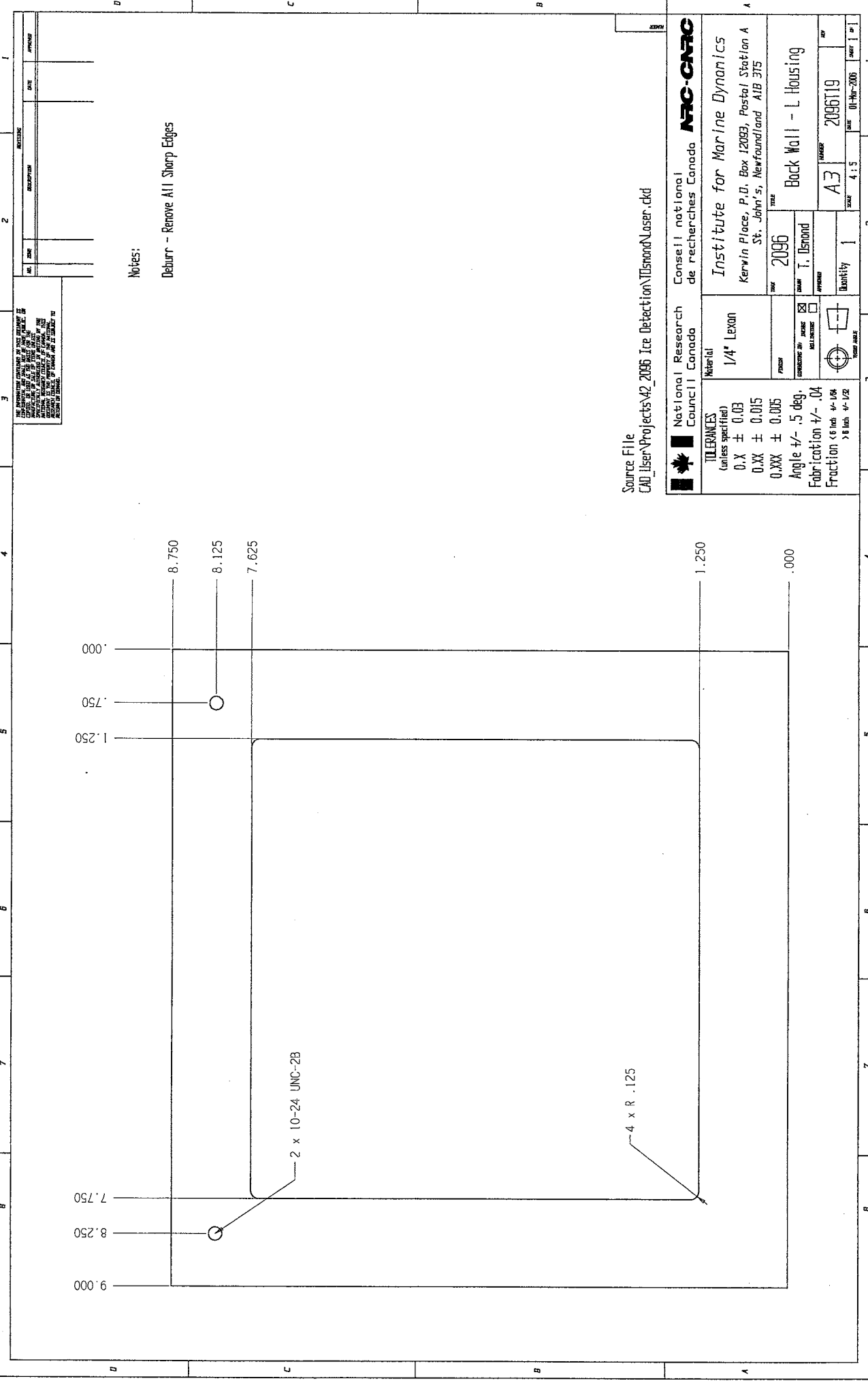
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 Deburr - Remove All Sharp Edges

Source File
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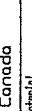
National Research Council Canada Conseil national de recherches Canada			
TOLERANCES (unless specified) 0.X ± 0.03 0.XX ± 0.015 0.XXX ± 0.005 Angle +/- .5 deg. Fabrication +/- .04 Fraction < 6 inch +/- 1/64 > 6 inch +/- 1/32		Material Lexan	
PART 2096		TITLE Edge 1 - L Housing	
DRAWN I. Tilmond		CHECKED A3	
QUANTITY 2		DATE 01-Mar-2006	
SHEET 1		TOTAL SHEETS 1	



Notes:
 Deburr - Remove All Sharp Edges

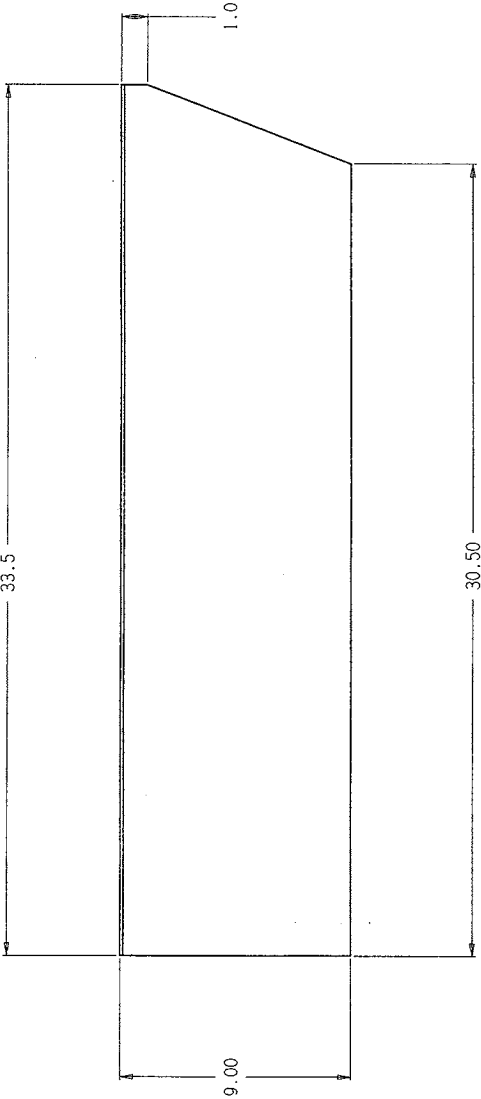
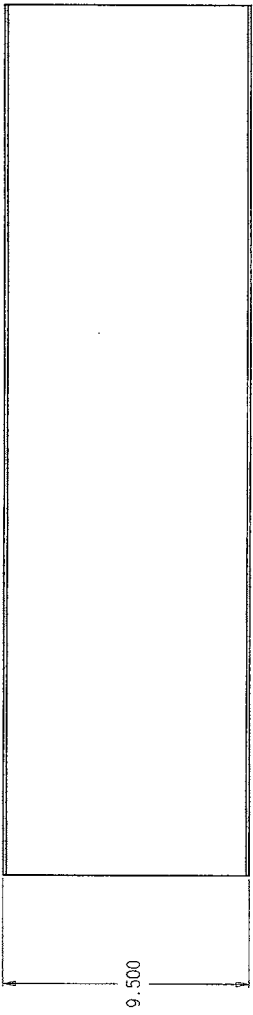
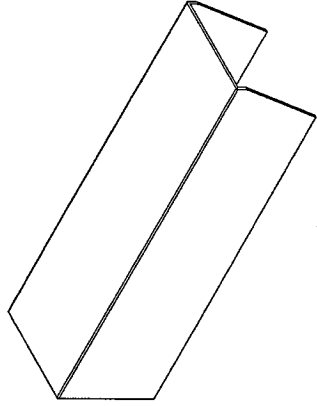


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CAD User\Projects\42 2096 Ice Detection\Ismond\Laser.dxd

 National Research Council Canada	National Council of de recherches Canada		NRC-CNRC	
	Institute for Marine Dynamics Kerwin Place, P.O. Box 12093, Postal Station A St. John's, Newfoundland A1B 3T5			
TOLERANCES (unless specified) $0.X \pm 0.03$ $0.XX \pm 0.015$ $0.XXX \pm 0.005$	Material 1/4" Lexan	DIM 2096	TYPE Back Wall - L Housing	REV 2096T19
		FINISH CONFORMING TO SPARK ☒ MILL FINISH ☐ MILL FINISH	DRAWN T. Desmond	
Angle +/- .5 deg. Fabrication +/- .04 Fraction 1/8 inch +/- 1/32 > 1/8 inch +/- 1/2	QUANTITY 1	APPROVED 	NAME T. Desmond	SHEET 1 of 1

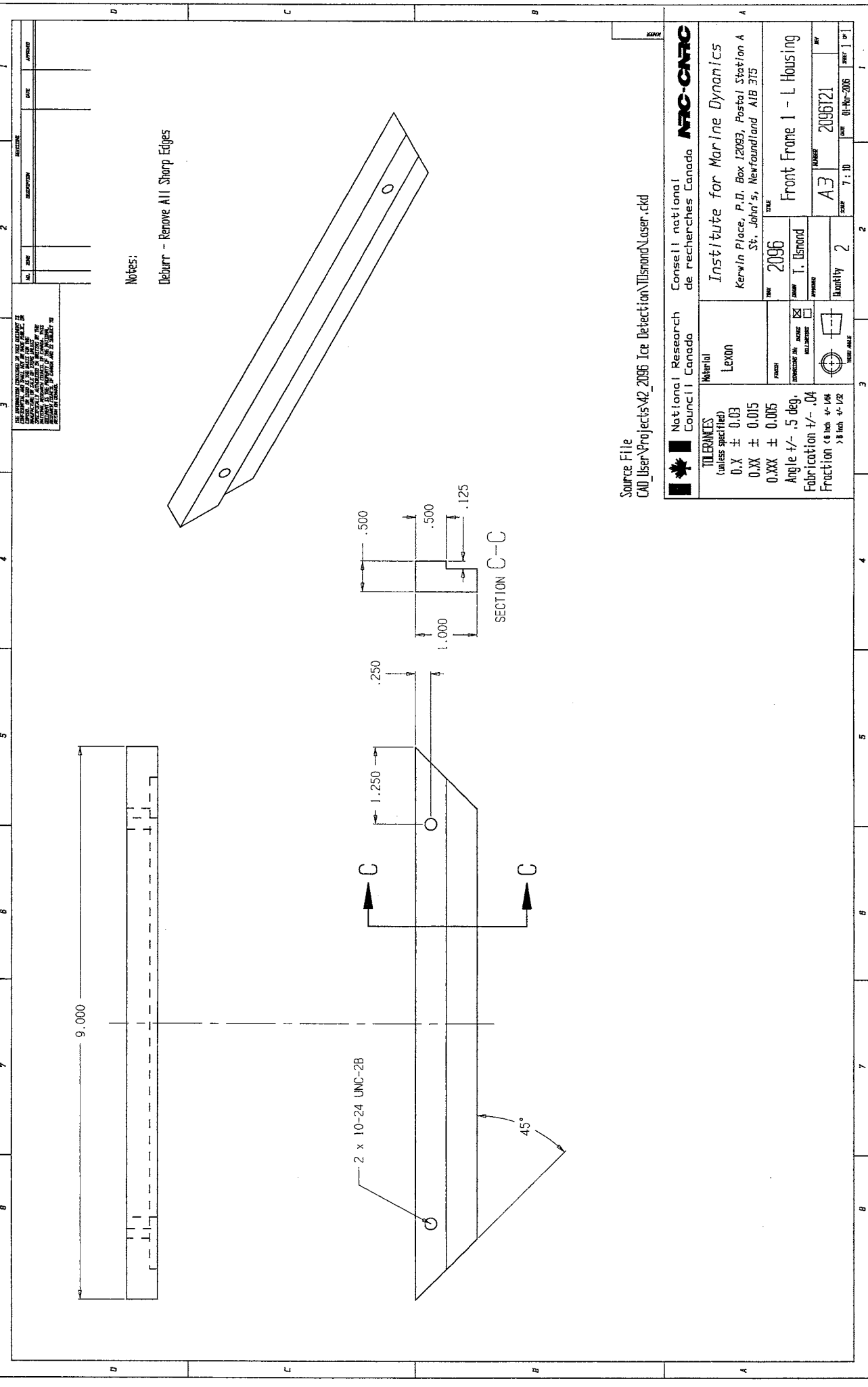
THE INFORMATION CONTAINED ON THIS DRAWING IS THE PROPERTY OF THE NATIONAL COUNCIL OF RESEARCHES CANADA. IT IS TO BE USED ONLY FOR THE PROJECT AND PURPOSE SPECIFICALLY STATED ON THE DRAWING. NO PART OF THIS DRAWING IS TO BE REPRODUCED OR TRANSMITTED IN ANY FORM OR BY ANY MEANS, ELECTRONIC OR MECHANICAL, INCLUDING PHOTOCOPYING, RECORDING, OR BY ANY INFORMATION STORAGE AND RETRIEVAL SYSTEM, WITHOUT PERMISSION IN WRITING FROM THE NATIONAL COUNCIL OF RESEARCHES CANADA.

Notes:
Deburr - Remove All Sharp Edges



Source File
CAD_User\Projects\42_2095 Ice Detection\Tilmond\Laser.dxd

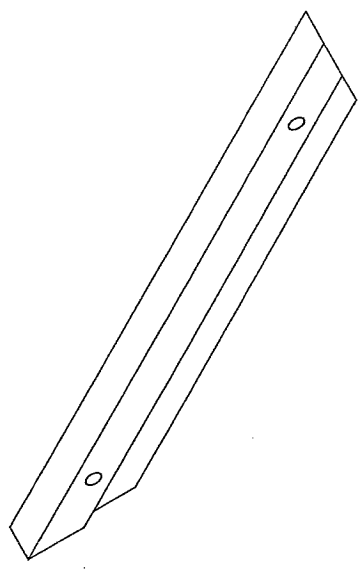
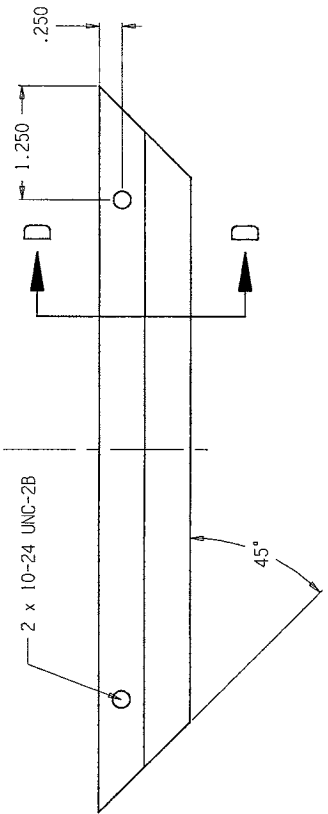
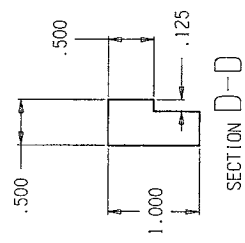
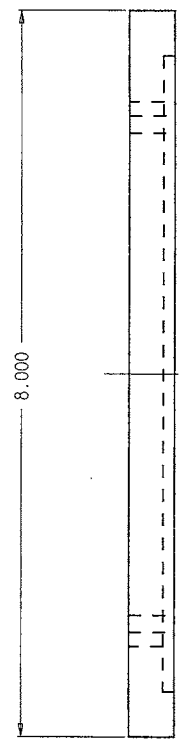
National Research Council Canada Conseil national de recherches Canada		NRC-CNRC	
TOLERANCES (unless specified) 0.X ± 0.03 0.XX ± 0.015 0.XXX ± 0.005 Angle +/- .5 deg. Fabrication +/- .04 Fraction < 6 inch +/- 1/32 > 6 inch +/- 1/16		Material 1/4" Lexan	
PRECISION ☒ DIMENSIONS IN DECIMALS ☐ MILLIMETERS		DATE 2096	
DRAWN I. Desmond		TITLE Top - L Housing	
QUANTITY 1		PART 2095120	
SCALE 1:1		DATE 01-Mar-2005	



NO.	DATE	DESCRIPTION	REVISION

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Notes:
Deburr - Remove All Sharp Edges



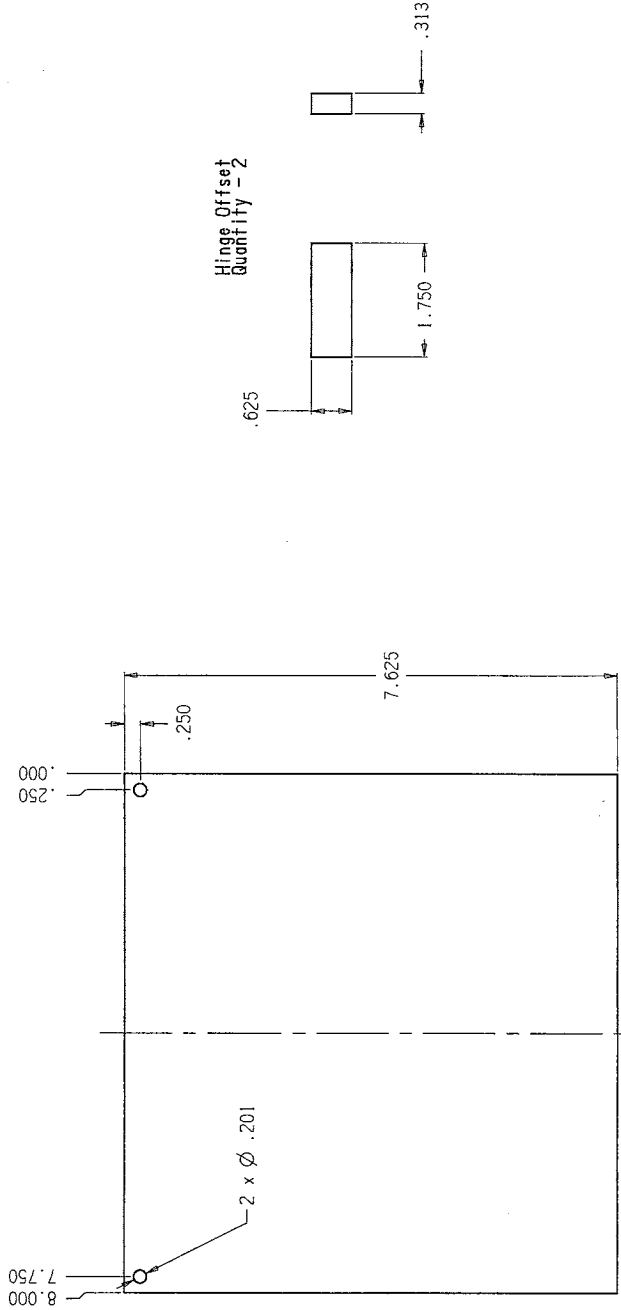
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National Research Council Canada Conseil national de recherches Canada		ARC-CARC Institute for Marine Dynamics Kewin Place, P.O. Box 12093, Postal Station A St. John's, Newfoundland A1B 3T5	
TOLERANCES (unless specified) 0.X ± 0.03 0.XX ± 0.015 0.XXX ± 0.005 Angle +/- .5 deg. Fabrication +/- .04 Fraction < 8 in. +/- 1/64 > 8 in. +/- 1/32	Material Lexan	PART 2096	TITLE Front Frame 2 - L Housing
PREPARED BY T. Ismond	CHECKED BY T. Ismond	QUANTITY 2	DATE 01-Nov-2005
DRAWN BY T. Ismond		PART NUMBER A3	DATE 01-Nov-2005

REV	DATE	DESCRIPTION	APPROVED

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Notes:
 Deburr - Remove All Sharp Edges

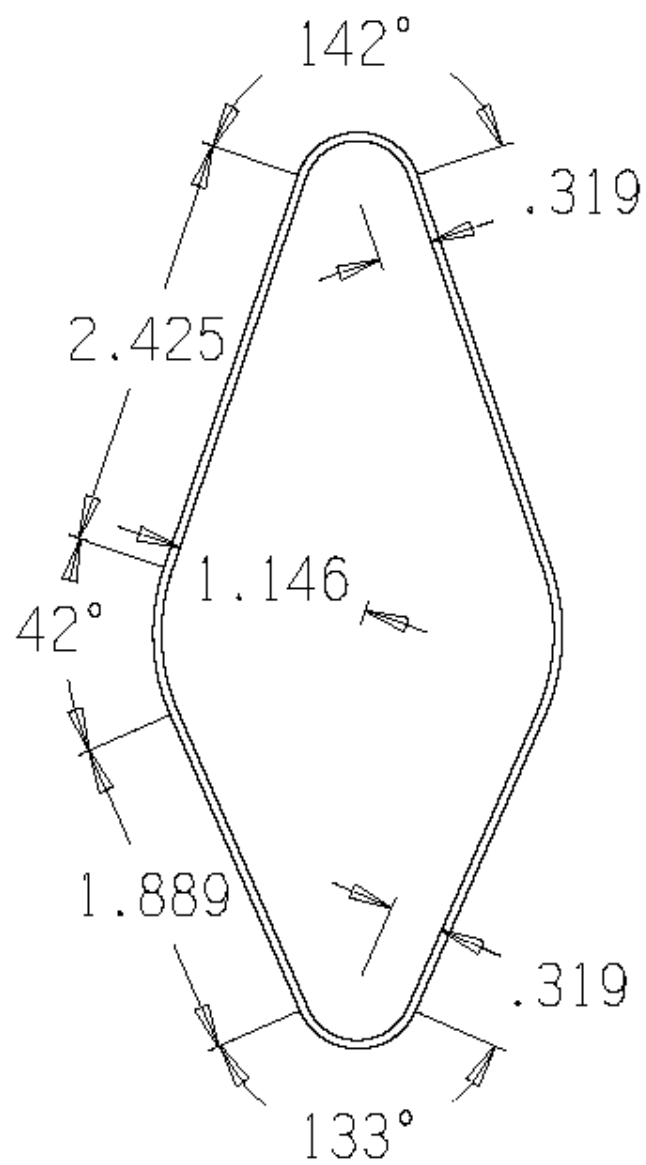


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National Research Council of Canada Conseil national de recherches Canada		ARC-CARC Institute for Marine Dynamics Kerwin Place, P.O. Box 12093, Postal Station A St. John's, Newfoundland A1B 3T5	
Material 1/4" Lexan		Title 2096 Door - L Housing	
TOLERANCES (unless specified) 0.X ± 0.03 0.XX ± 0.015 0.XXX ± 0.005 Angle +/- .5 deg. Fabrication +/- .04 Fraction < 8 in ± 1/32 > 8 in ± 1/16		Date 2096 Drawn T. Ismond Quantity 1	
Precision ☒ DIMENSIONS IN JAWES ☐ MILLIMETERS		Number A3 Date 01-Mar-2006	
Project 2096		Scale 1:2	

APPENDIX B – TIMING BELT DIMENSIONS

Appendix B – Timing Belt Dimensions



APPENDIX C – FASTENER LIST

Appendix C – Fastener List

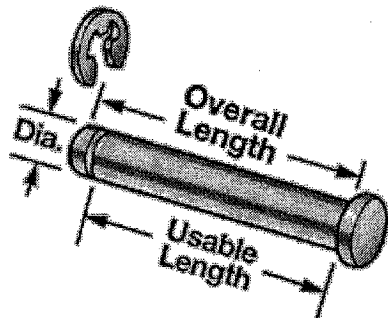
Number	Type	Length	Connecting...	Head
LASER				
4	8-32	0.500	Angle Bar to Laser Lock	Hex
4	8-32	2.000	Laser Lock Together	Hex
4	8-32	0.625	Angle Bar to Adjuster	Hex
1	8-32	1.500	Two adjusting pieces (sliding screw)	Hex
1	8-32	1.500	horizontal adjusting screw	Hex
8	4-40	1.000	servomount pieces	slot flat csk
4	2-56	0.500	servo to servomount	socket screw
8	8-32	0.625	mounts to base plate	slot flat csk
7	1/4-20	0.500	base plate to housing bottom	socket screw
WEATHER HOUSING				
10	8-32	0.625	front glass and back door to housing	socket screw
4	1/2-20	0.500	tilt/pan head to stand	button slot

APPENDIX D – DATA SHEETS

Pin Type > Diameter > Clevis Pin Type > Overall Length

Pins

This product matches all of your selections.

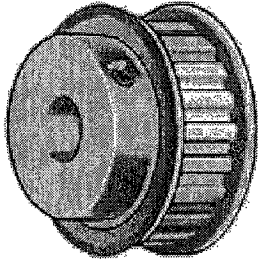


Part Number: 92735A160 \$5.90 per Pack of 5

Material Type	Stainless Steel
Finish	Plain
Stainless Steel Type	18-8 Stainless Steel
Pin Type	Clevis Pins
Clevis Pin Type	Grooved with Retaining Ring
System of Measurement	Inch
Diameter	3/16"
Actual Head Diameter (Min.-Max.)	.300"-.320"
Actual Diameter (Min.-Max.)	.181"-.186"
Usable Length	1-29/32"
Overall Length	2"
Actual Head Height (Min.-Max)	.050"-.070"
Specifications Met	Not Rated
Rockwell Hardness	B83-B95

Timing Belt Series > Number of Teeth on Pulley > Outer Diameter

Pulleys

This product matches all of your selections.

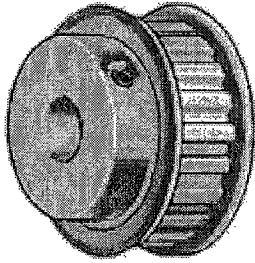
Part Number: 57105K27

\$8.19 Each

Pulley Type	Drive Pulleys
For Belt Type	Timing Belt Pulleys
Timing Belt Series	XL Series
Number of Teeth on Pulley	36
For Timing Belt Width	1/4" and 3/8"
Outer Diameter	2.53"
Bore Type	Finished Bore
Finished Bore Pulley Style	Standard
V-Dimension (Pitch Dia.)	2.292"
Bore Size (ID)	5/16"
W-Dimension	.5"
X-Dimension	5/8"
Y-Dimension	7/8"
Z-Dimension	7/8"
Pitch	.2"
Pulley Material	Acetal Plastic with Aluminum Hub
Keyway Size	1/8" Wd. x 1/16" Dp.

Timing Belt Series > Number of Teeth on Pulley > Outer Diameter

Pulleys

This product matches all of your selections.

Part Number: 6495K711

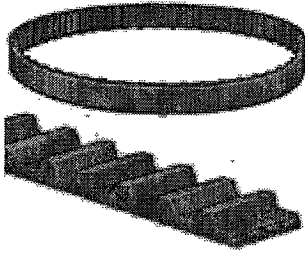
\$8.13 Each

Pulley Type	Drive Pulleys
For Belt Type	Timing Belt Pulleys
Timing Belt Series	XL Series
Number of Teeth on Pulley	10
For Timing Belt Width	1/4" and 3/8"
Outer Diameter	.929"
Bore Type	Finished Bore
Finished Bore Pulley Style	Standard
V-Dimension (Pitch Dia.)	.637"
Bore Size (ID)	3/16"
W-Dimension	.418"
X-Dimension	9/16"
Y-Dimension	25/32"
Z-Dimension	7/16"
Pitch	.2"
Pulley Design	Solid
Pulley Material	Steel

Timing Belts > Belt Construction > Pitch > Trade Size > Belt Width > Compare
Items

Belts

This product matches all of your selections.



Part Number: 6484K222

\$3.62 Each

Trade Size	120XL
Form	Endless Belts
Type	Timing Belts
Timing Belt Series	XL Series
Outer Circle	12"
Belt Construction	Single-Sided with Trapezoidal Teeth
Belt Width	3/8"
Pitch	.2"
Number of Teeth	60
Belt Material	Rubber
Cord Material	Polyester
Color	Black
Accessories	Tension Tester - 60275K21