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*Student Report (National Research Council of Canada. Institute for Ocean Technology); no. SR-2006-02, 2006*

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## DOCUMENTATION PAGE

<b>REPORT NUMBER</b> SR-2006-02	<b>NRC REPORT NUMBER</b>	<b>DATE</b> April 2006		
<b>REPORT SECURITY CLASSIFICATION</b> unclassified		<b>DISTRIBUTION</b> unlimited		
<b>TITLE</b> <b>CWTT Wave Probe Arm, 2006</b>				
<b>AUTHOR(S)</b> T. Osmond				
<b>CORPORATE AUTHOR(S)/PERFORMING AGENCY(S)</b> National Research Council				
<b>PUBLICATION</b>				
<b>SPONSORING AGENCY(S)</b>				
<b>IOT PROJECT NUMBER</b> 421009		<b>NRC FILE NUMBER</b>		
<b>KEY WORDS</b> Wave Probe Arm		<b>PAGES</b> 4	<b>FIGS.</b> 0	<b>TABLES</b> 0
<b>SUMMARY</b> A new wave probe arm has been designed for the clear water tow tank as of 2006. This arm is much smaller and lighter than the currently existing wave arm. It is intended for low load applications. This document contains the details of this design.				
<b>ADDRESS</b>	National Research Council Institute for Ocean Technology Arctic Avenue, P. O. Box 12093 St. John's, NL A1B 3T5 Tel.: (709) 772-5185, Fax: (709) 772-2462			



National Research Council  
Canada

Conseil national de recherches  
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Institute for Ocean  
Technology

Institut des technologies  
océaniques

## **CWTT Wave Probe Arm, 2006**

SR-2006-02

T. Osmond

April 2006

## Introduction

January, 2006 – the Institute for Ocean Technology has established a need for a folding arm that extends almost half way across the clear water tow tank at full deployment. The arm is intended to be used to attach wave probes. The arm is to be a lighter more practical arm than the one currently employed in the tank. It is to operate in conjunction with the currently existing, much larger arm and is not intended to serve as a replacement. Howard Mesh established the necessity for this arm and its design has been the responsibility of the coop student within the Design and Fabrication Group working under Tony Randell. The design of the new wave probe arm was undertaken during the last three weeks in January, 2006. The arm is a basic aluminum frame hinged from a Stainless Steel bracket, anchored to the cement wall of the Clear Water Tow Tank. Fully deployed the arm extends away from the tank wall at a 90 degree angle. The arm can be locked both fully deployed and folded against the tank wall. An additional support piece has also been designed. Its purpose is to brace the arm against sway should it be a problem. The fabrication of this support piece is subject to its necessity pending testing of the arm. There were two phases to the design of this piece of equipment. The first phase led up to the design review meeting. Following the design meeting the wave probe arm was extensively redesigned to accommodate many new requests and suggestions posed by the group attending the design review meeting. The following report presents the factors of consideration and the features that were implemented into the design of both the wave probe arm and the supporting piece. Full CAD design is available under CAD\_User:\Projects\421009\_cwt\ProbeArm\ProbeArm.ckd.

## Shape

The total length of the wave probe arm is 175 inches from the wall of the tank to the tip of the arm at full deployment. This length includes the added distance of the bracket. The arm is almost 14 inches in height with two inches of width. Two parallel lengths of aluminum box tube are cross braced and supported by three 10 inch long, aluminum box tube supports and two aluminum gusset plates. The

purpose of the supports is to provide structural integrity and to reduce bending in the arm from externally applied loads and under its own weight. The lower length of box tube extends 50 inches beyond the upper as less support is necessary near the end of the arm. The arm is bolted to a stainless steel bracket that was previously fabricated. The bracket is to be modified to suit the purposes of the wave probe arm application. Modifications include two thick stainless steel plates welded to the upper and lower surfaces of the bracket and machined to be parallel with each other. This is necessary because the surfaces of the currently existing bracket are not parallel due to welding deflections during fabrication. Aluminum bushings and screws are used as the axis of rotation for the arm.

### Strength

The strength demands on the design of the wave probe arm are minimal. The weight of the wave probes are merely a few grams therefore the arm must be capable of sustaining very little beyond its own weight. For this reason the arm is designed of only 2 x 2 x 0.188 inch aluminum box tubing. The material is light, corrosion resistance and rigid. By separating the top and bottom lengths of tube a distance of approximately 10 inches the moment of inertia is elevated around the bending axes. This reduces deflection caused by loading of the arm should any loading be necessary in future applications. The box tube and gusset supported design also provide considerable rigidity in torsion and sway and will prevent the arm from folding in or collapsing under increased bending stress.

### Support Component

A supporting component has been designed to brace the wave probe arm against sway. It has not yet been determined whether this component is necessary. Should it be found that there is a flexing in the wave probe arm that interferes with the readings of the wave probes, the supporting component will be fabricated. The supporting component is more complicated in design than the wave probe arm itself. The base plate and joint attachment are made of stainless steel and bolts are used to attach the two together. The height of the

joint attachment is designed to be adjustable  $\pm$  one inch because the exact positioning of the plate through drilling the cement anchors cannot be set accurately. Attached to the joint is a long aluminum hollow rod. An optional cable can be attached to prevent the rod from bending if it is to be left unsupported for extended periods of time. At the end of the rod a threaded bushing is welded and set. A threaded rod is screwed into the bushing and screwed into an aluminum bottle screw at the other end. A rod end screws into the bottle screw and loops over a hook that is welded to the wave probe arm. When the bottle screw is turned it tightens and holds the arm in place.

### Features

As previously mentioned the lower length of the probe arm extends 50 inches beyond the main frame. It is to this section of the arm that the wave probes are intended to be attached. To do this a thin piece of flat bar is welded to the front surface of the arm so that the probes may clip on.

When deployed at full 90 degrees the arm is capable of locking in place. A  $\frac{1}{4}$  inch screw feeds through a hole in the arm near the bracket and screws into the bracket. Tightening this screw down will lock the arm in position. This however may provide little support for the arm against sway so a supporting component has been designed to account for this and is described above. When the arm is folded against the tank wall the bolt may again be tightened down to hold the arm in position.

The entire assembly has been designed to be corrosion resistant because the assembly will be fixed just above the water level in the Clear Water Tank where humidity will be very high. Most of the load bearing components are composed of stainless steel including the bracket, the wall plate for the supporting component and all of the bolts, buckles and anchors. The frame of the arm, the supporting arm and the bushings are made of aluminum and the tie rod end is

made of plastic. No lubrication should be needed for this design because of low loads and no wear applications.

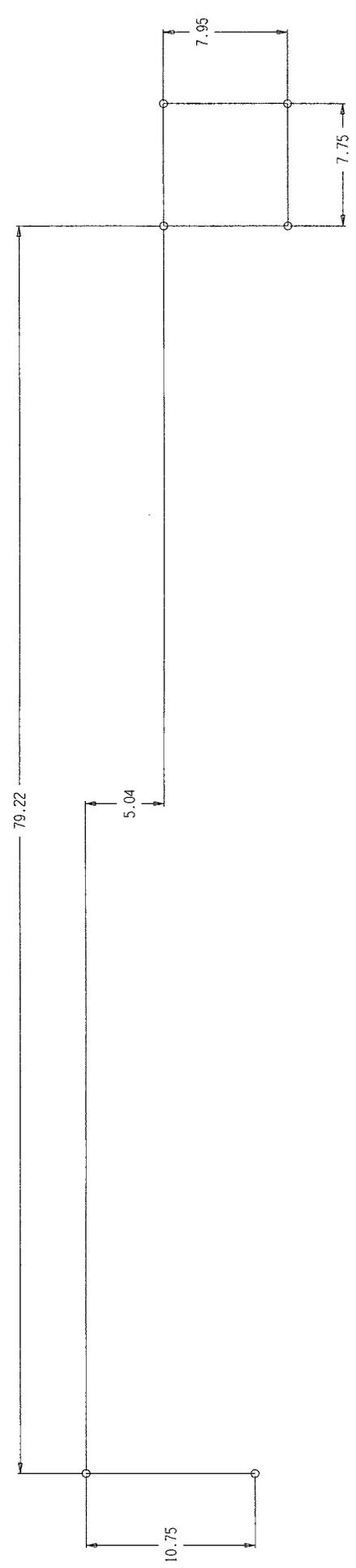
Due to the low demands on the wave probe arm there are few complicated components. No bearings or lubricated components have been incorporated into the design. The arm is a lightweight, low load piece of equipment designed specifically for wave probes however may be used for other low load purposes. The loading limit for the wave probe arm will depend on the acceptable deflection for the application but the arm should not be loaded with any more than 20 lbs at the very tip of the arm.

## Drawings

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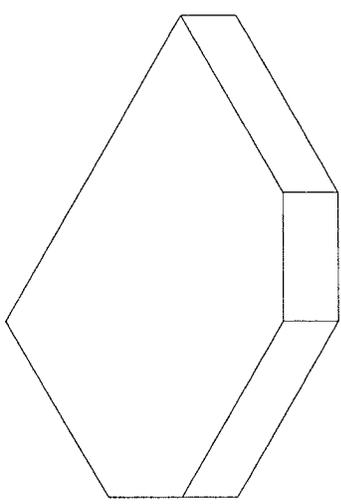
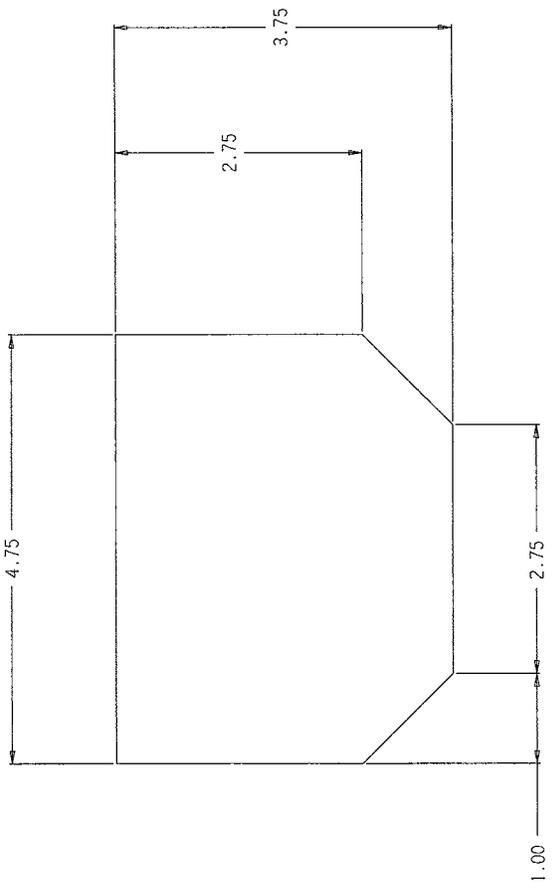
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		DRAWN BY I. Dismond	DATE 2006-Jun-25
TOLERANCES (unless specified) 0.X ± 0.03 0.XX ± 0.015 0.XXX ± 0.005 Angle +/- .5 deg. Fabrication +/- .04 Fraction < 8 inch 1/16 > 8 inch 1/32	PART NUMBER A3	PROJECT NUMBER 009T01	SHEET NUMBER 1 of 1

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<b>TOLERANCES</b> (unless specified) 0.X ± 0.03 0.XX ± 0.015 0.XXX ± 0.005 Angle +/- .5 deg. Fabrication < 8 inch +/- .04 > 8 inch +/- .02	Material SS Heat treatment N/A FINISH FINISHING BY: <input checked="" type="checkbox"/> MACH <input type="checkbox"/> MILLING <input type="checkbox"/> TURNING	Title Hinge Fitting
Part No 009	Drawing I. Usmond	Part No 009T02
Quantity 2	Scale 1:1.43	Date 2006-Jun-25



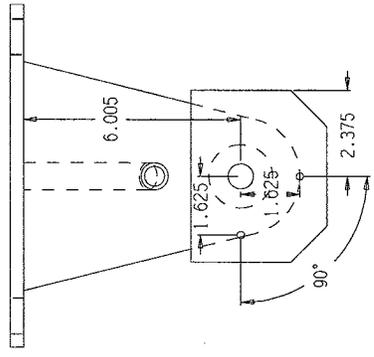
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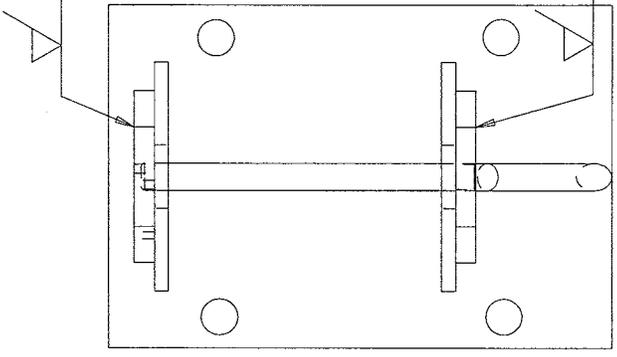
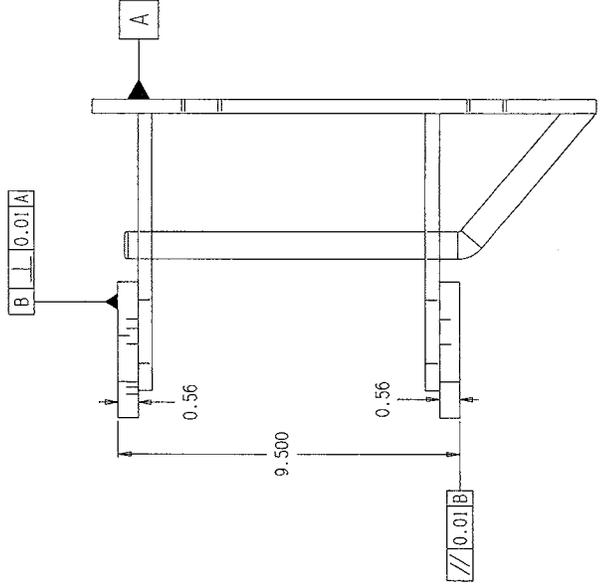
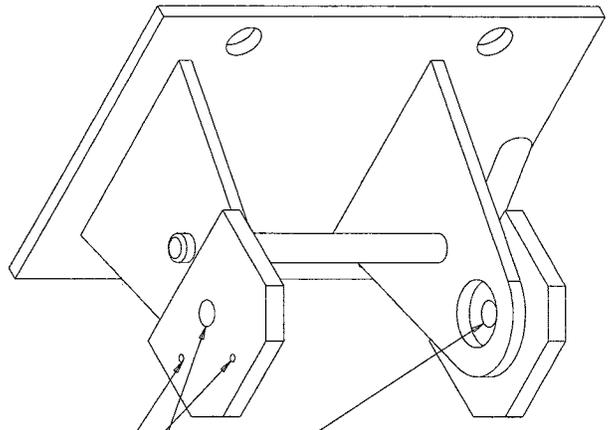
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Ø 1/4-20 UNC-2B  $\nabla$  0.56  
 Ø 3/4-10 UNC-2B THRU



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**MIC-CARO**

Bracket Machining

009104  
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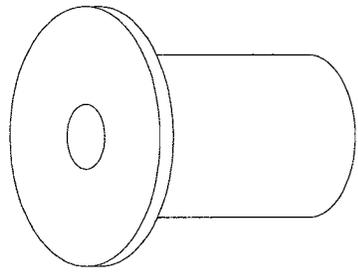
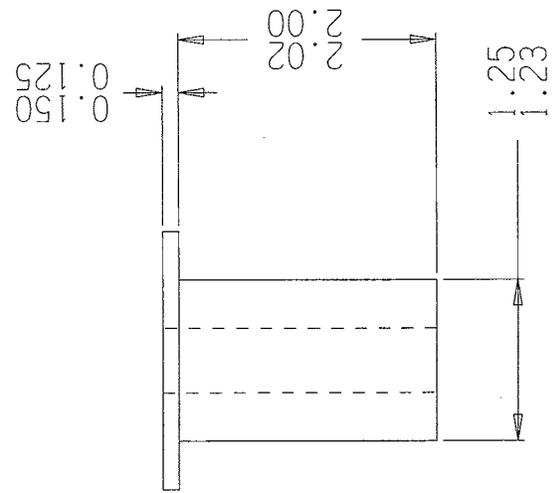
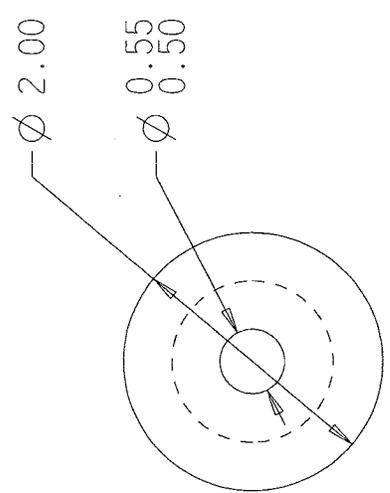
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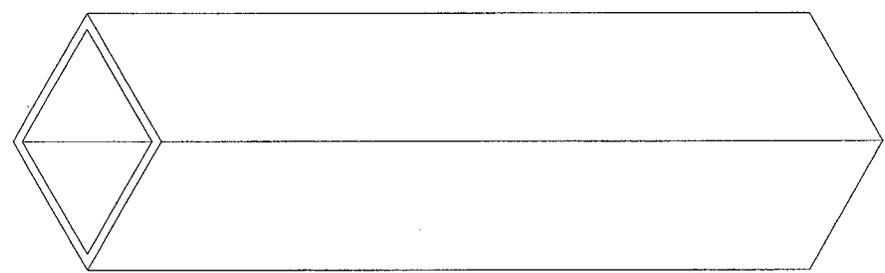
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Notes:  
 2x2x0.120  
 Round Corners  
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9.84  
 9.82

 National Research Council of Canada Conseil national de recherches Canada	Material Al 6016-T6 Square Tubing	FINISH NONE	TITLE 009	PART NUMBER A3	DATE 2006-Jun-25
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National Research Council of Canada Conseil national de recherches Canada <b>NRCC-CNRC</b>		Supports			

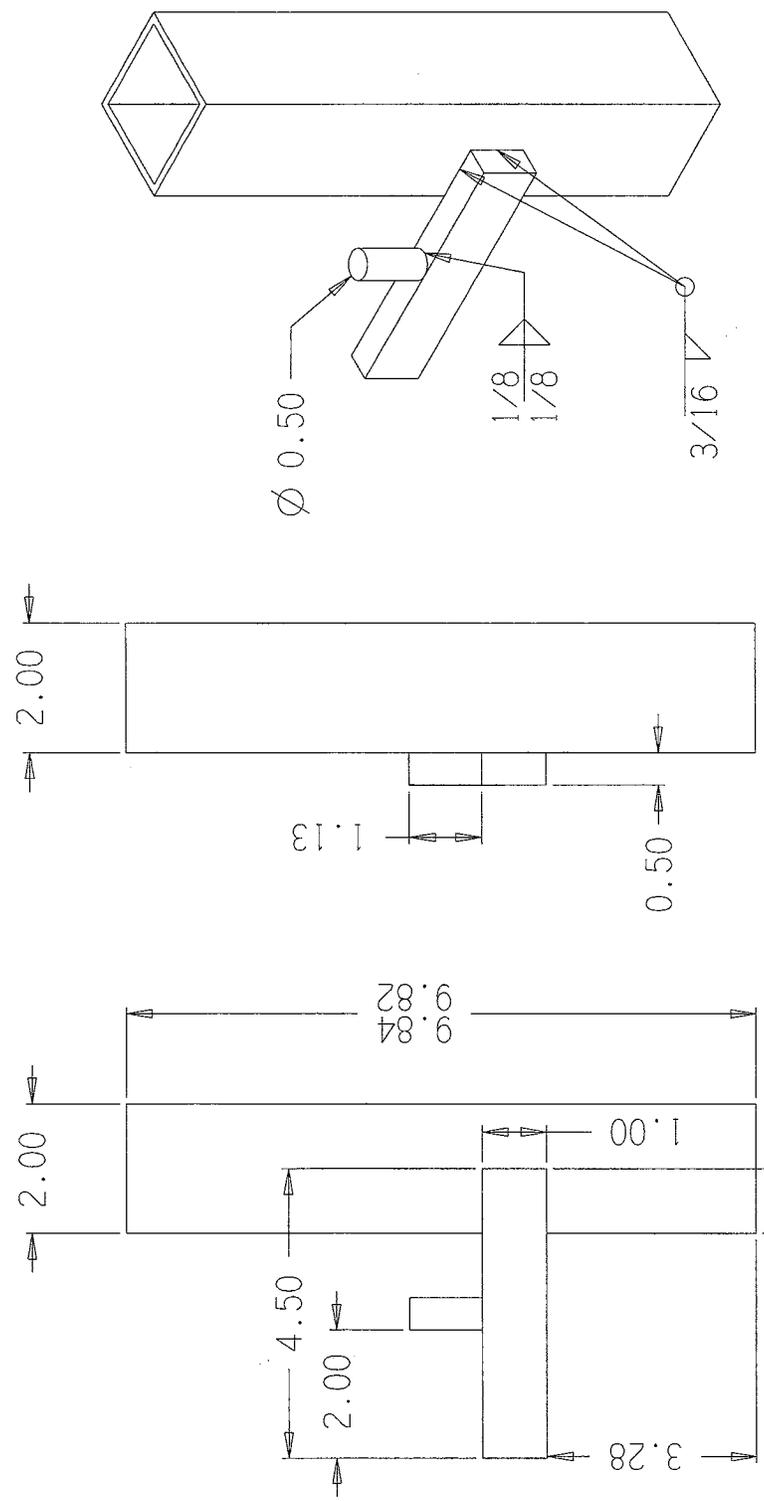
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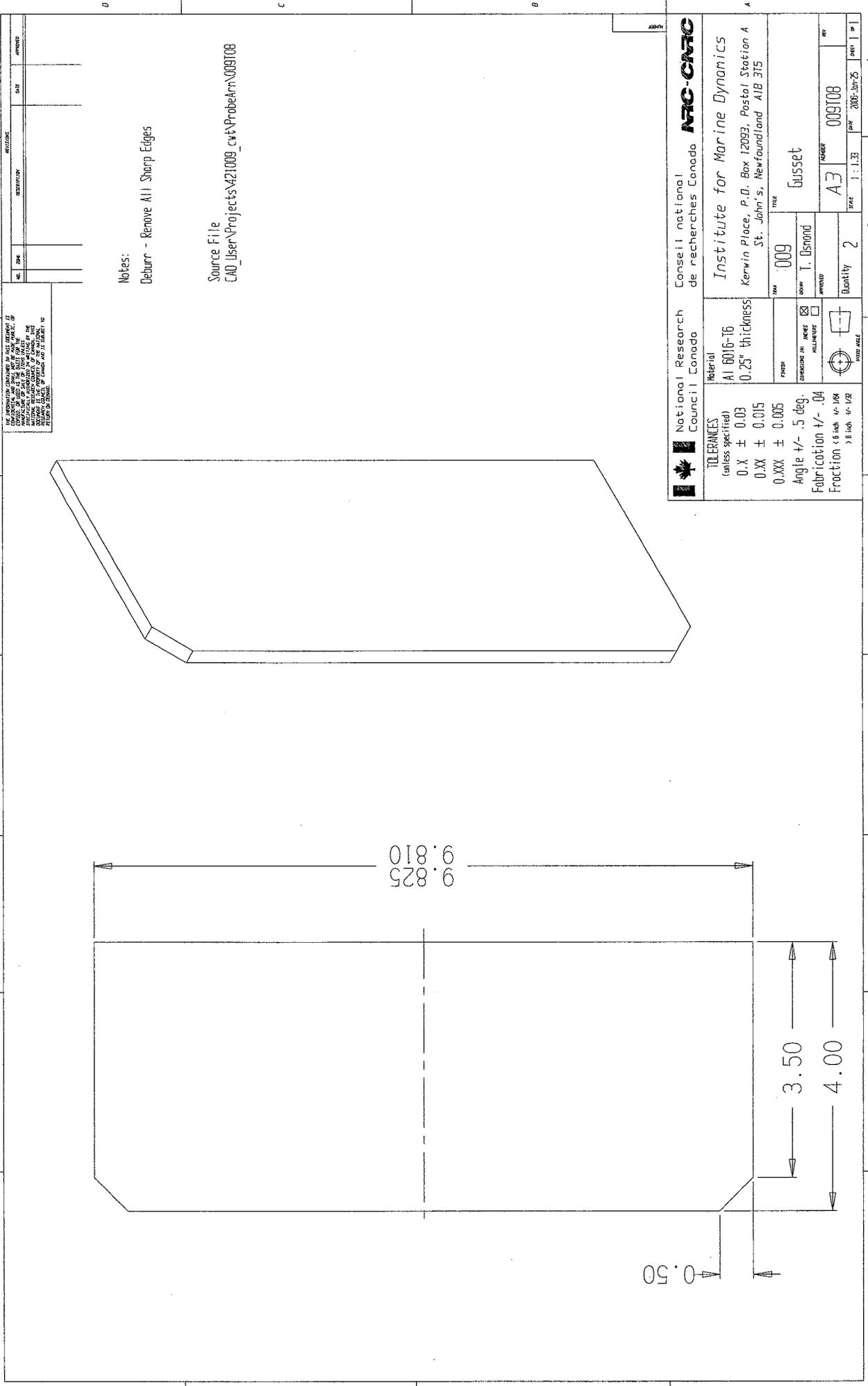
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TOLERANCES (unless specified) 0.X ± 0.03 0.XX ± 0.015 0.XXX ± 0.005 Angle +/- .5 deg. Fabrication +/- .04 Fraction 65 High 1/128 3.5 High 1/128	FINISH OPERATIONS IN: <input checked="" type="checkbox"/> ANNEAL <input type="checkbox"/> MILLING <input type="checkbox"/> DRILLING <input type="checkbox"/>	QUANTITY 1	DRAWN T. Desmond
Material Al 6061-T6		PART 009	TITLE Support with Attachment
Quantity 1		DRAWN T. Desmond	NUMBER 009107
Scale 1:2		DATE 2006-Jun-25	SHEET 1 of 1



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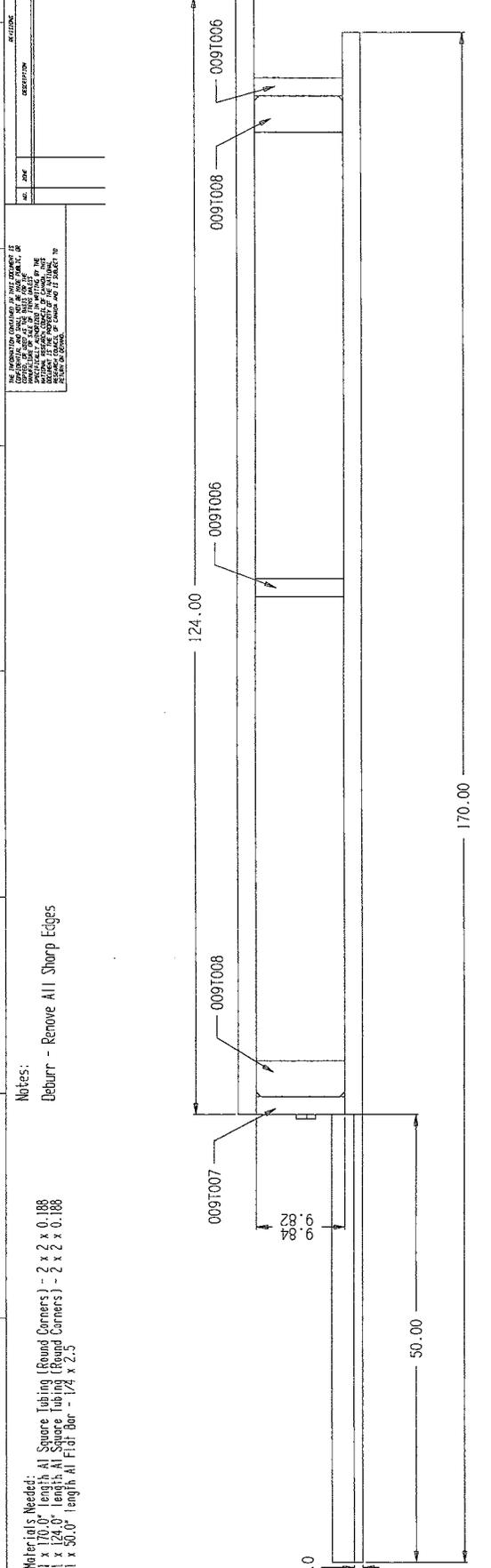
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QUANTITY 2	DRAWN T. Desmond	DATE 2005-Jun-25	SHEET 1 of 1

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 1 x 124.0" length Al Square Tubing (Round Corners) - 2 x 2 x 0.188  
 1 x 30.0" length Al Flat Bar - 1/4 x 2.5



Hole to be drilled through both bars  
 $\phi$  0.27  
 $\phi$  1.27  
 7.00  
 5.38

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 CAD\_User\Projects\421009\_cvt\Problem\009T09

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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 66 inch 1/4 1/8 3/8 inch 1/4 1/2		Material Al 6016-T6 FINISH DIMENSIONS IN INCHES <input checked="" type="checkbox"/> DECIMALS <input type="checkbox"/> FRACTIONS THRU HOLE 	
PART 009 DRAWN T. Dismond APPROVED 		TITLE Probe Arm Gen Assembly 1 QUANTITY 1 DATE 1: 12.5 DATE 2005-JUN-25 SHEET 1 OF 1	

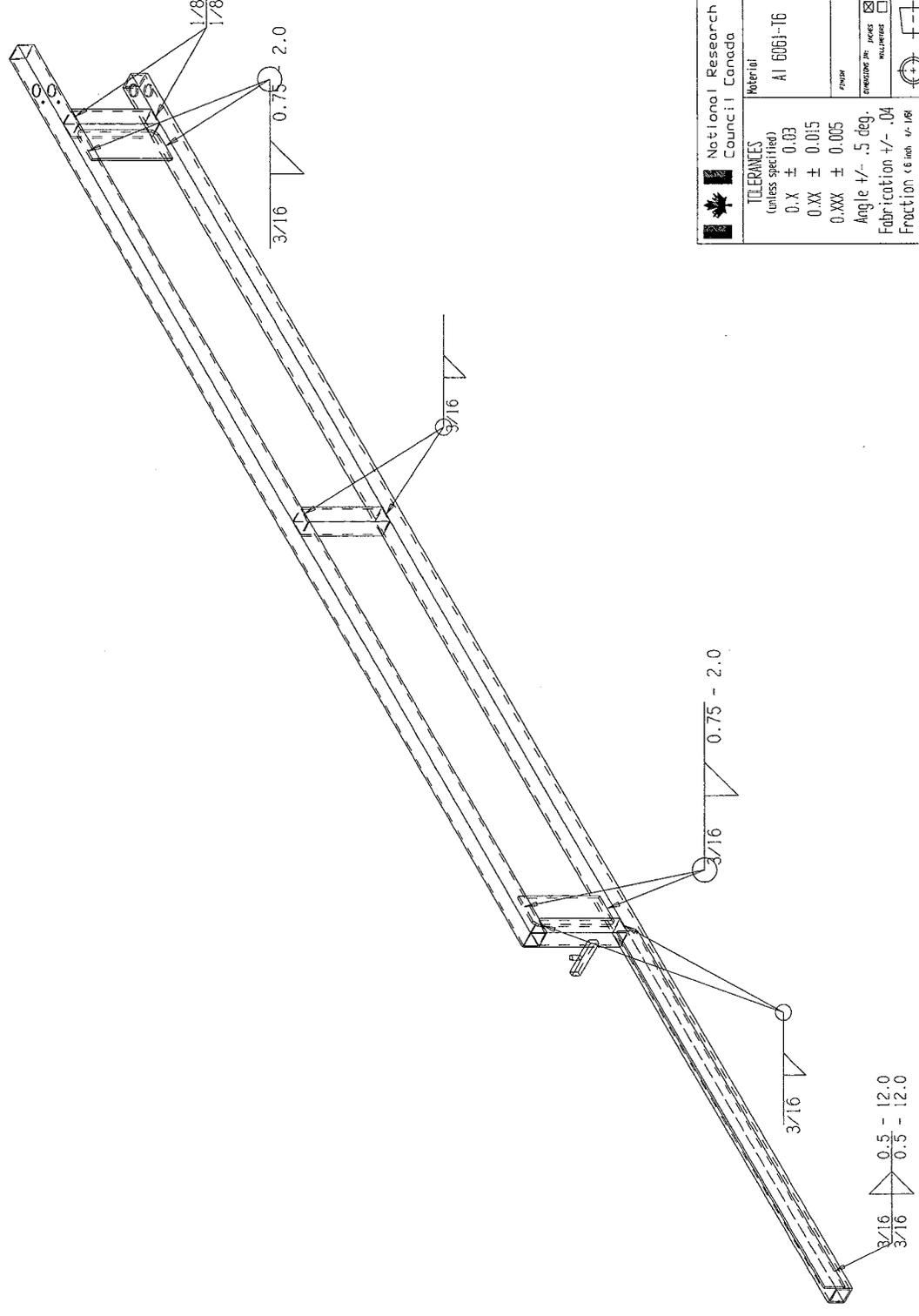
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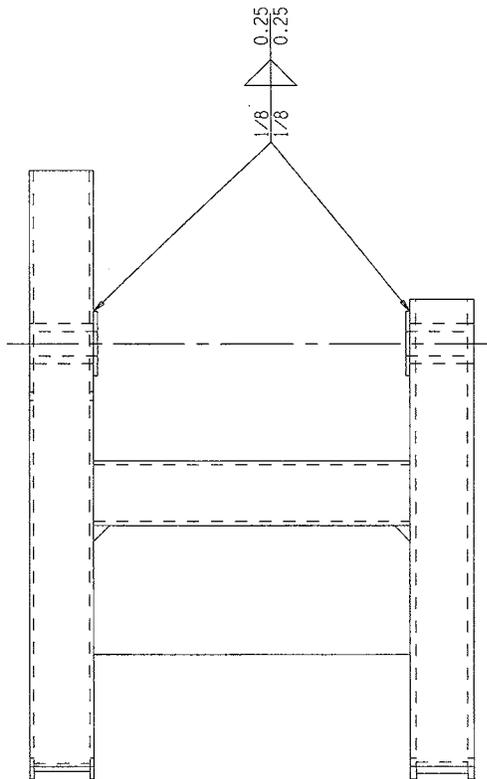
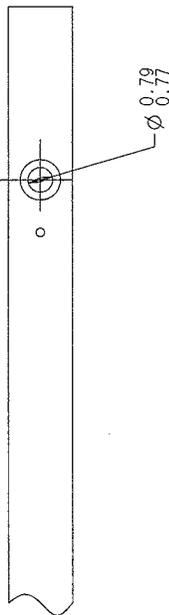
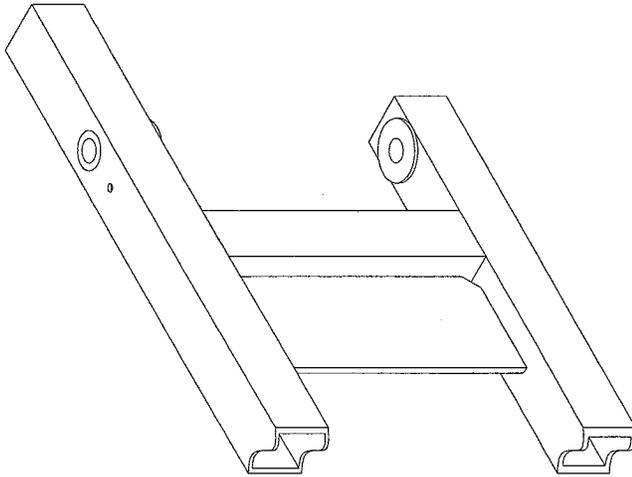
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		TOLERANCES (unless specified) 0.X ± 0.03 0.XX ± 0.015 0.XXX ± 0.005 Angle +/- .5 deg. Fabrication +/- .04 Fraction 6/16th +/- 1/8 3/16th +/- 1/32	DESIGNED BY T. Desmond	DRAWN BY T. Desmond
National Research Council Canada Institut national de recherches Canada <b>NRCC-CNRC</b> Institute for Marine Dynamics Kerwin Place, P.O. Box 12063, Postal Station A St. John's, Newfoundland A1B 3T5	PROJECT NUMBER 009T10	PROJECT TITLE Probe Arm Gen Assembly 2	DRAWN BY T. Desmond	DATE 2006-01-25

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**Notes:**

- Deburr - Remove All Sharp Edges
- Weld bushings in place using minimal weld
- Rebore holes in both bushings to be coaxial

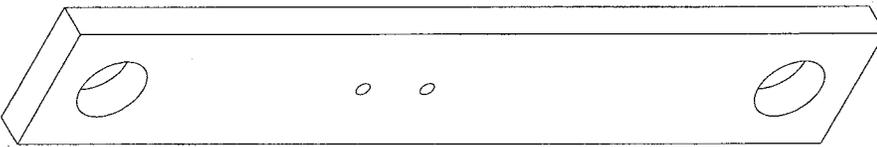
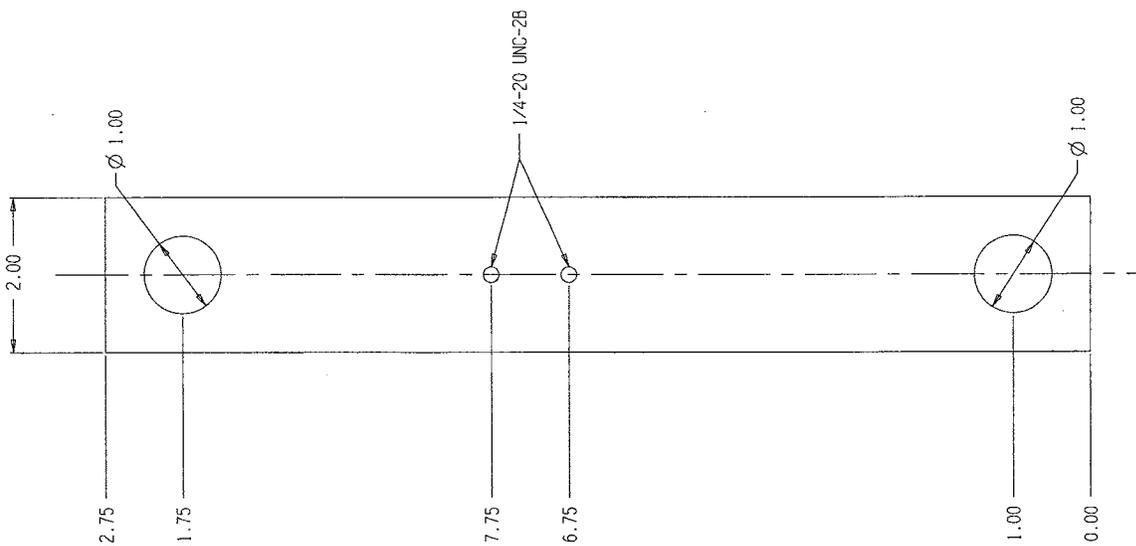


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 National Research Council Canada	Material Al 6061-T6	PART NO 009	TITLE Probe Arm Gen Assembly 3
	TOLERANCES (unless specified) 0.X ± 0.03 0.XX ± 0.015 0.XXX ± 0.005 Angle +/- .5 deg. Fabrication +/- .04 3/8 inch +/- 1/32	CHECKING BY: <input checked="" type="checkbox"/> MAKE <input checked="" type="checkbox"/> HULLHOUSE	DRAWN BY: T. Dismond APPROVED:
NATIONAL RESEARCH COUNCIL OF CANADA INSTITUT DE RECHERCHES EN SCIENCE ET EN TECHNOLOGIE	INSTITUT DE RECHERCHES EN SCIENCE ET EN TECHNOLOGIE 1205 Avenue de la Recherche Bld. 612, St. John's, Nfld. A1B 3T5	NUMBER 009111	SHEET 1 OF 25

National Research Council Canada Institut national de recherches Canada Institute for Marine Dynamics Kerwin Place, P.O. Box 12093, Postal Station A St. John's, Newfoundland A1B 3T5	DATE: 2006-06-25 DRAWN: 009111
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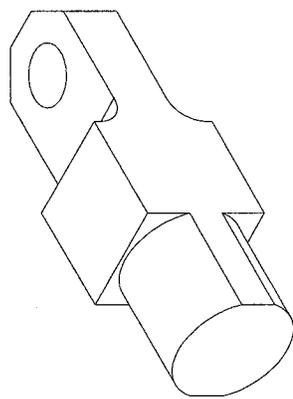
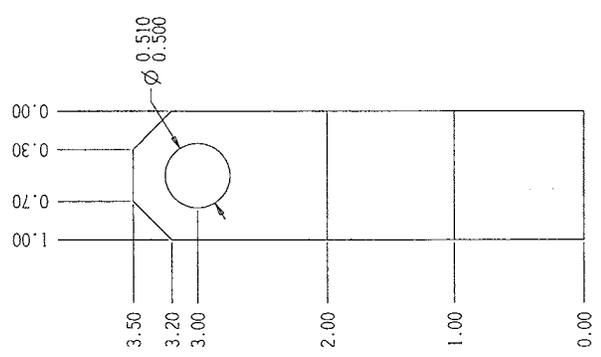
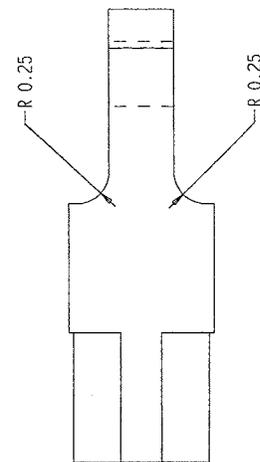
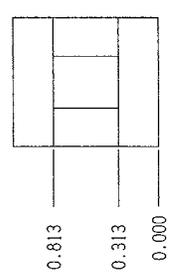
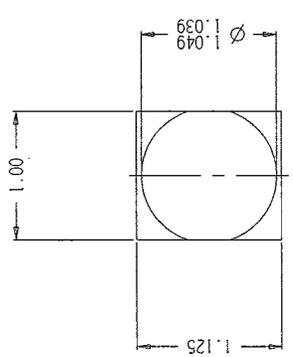
REV.	DATE	DESCRIPTION	BY	APPROVED

National Research Council of Canada Conseil national de recherches Canada	Material SS 1/2" thickness	PART NO 009	TITLE Support Plate
		QUANTITY 1	DATE 2006-Jun-25
TOLERANCES (unless specified) 0.X ± 0.03 0.XX ± 0.015 0.XXX ± 0.005 Angle +/- .5 deg. Fabrication +/- .04 Fraction < 8 inch +/- 1/64 > 8 inch +/- 1/32	FINISH 1/2" thickness	CORRUGATED TO MATCH <input checked="" type="checkbox"/>	MILLING <input type="checkbox"/>
CONTOUR TO MATCH <input checked="" type="checkbox"/>	HOLLOW <input type="checkbox"/>	APPROVED 	REF A3
HOLD ASSEMBLY <input checked="" type="checkbox"/>	QUANTITY 1	DATE 2006-Jun-25	SHEET 1 of 1

Conseil national de recherches Canada  
 Institute for Marine Dynamics  
 Kerwin Place, P.O. Box 12093, Postal Station A  
 St. John's, Newfoundland A1B 3T5



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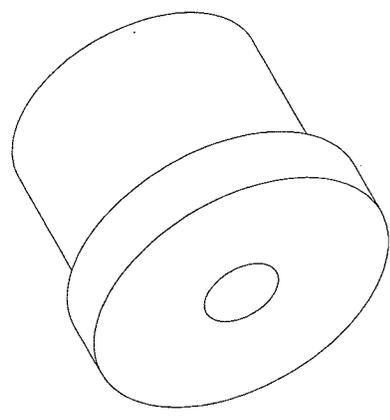
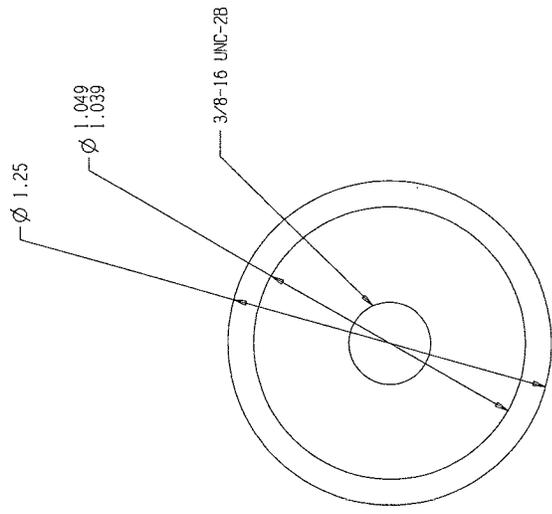
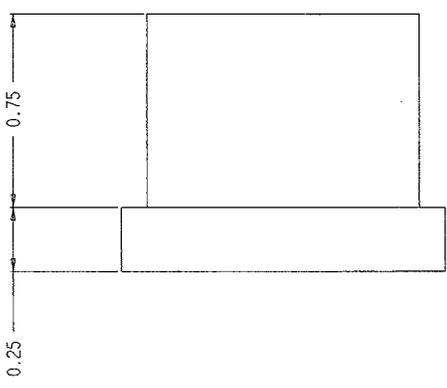
National Research Council Canada Conseil national de recherches Canada		ARC-CATC	
Material AI 6061-T6		Institute for Marine Dynamics Kerwin Place, P.O. Box 12093, Postal Station A St. John's, Newfoundland A1B 3T5	
TOLERANCES (unless specified) 0.X ± 0.03 0.XX ± 0.015 0.XXX ± 0.005 Angle +/- .5 deg. Fabrication +/- .04 Fraction 6/16 inch 1/16 3/16 inch 1/32	FINISH DIMENSIONS IN HANDED <input checked="" type="checkbox"/> HOLLOW <input type="checkbox"/> HOLLOW	PART NUMBER 009	TITLE Insert Joint
DRAWN I. Desmond	APPROVED 	QUANTITY 1	DATE 2006-Jun-25

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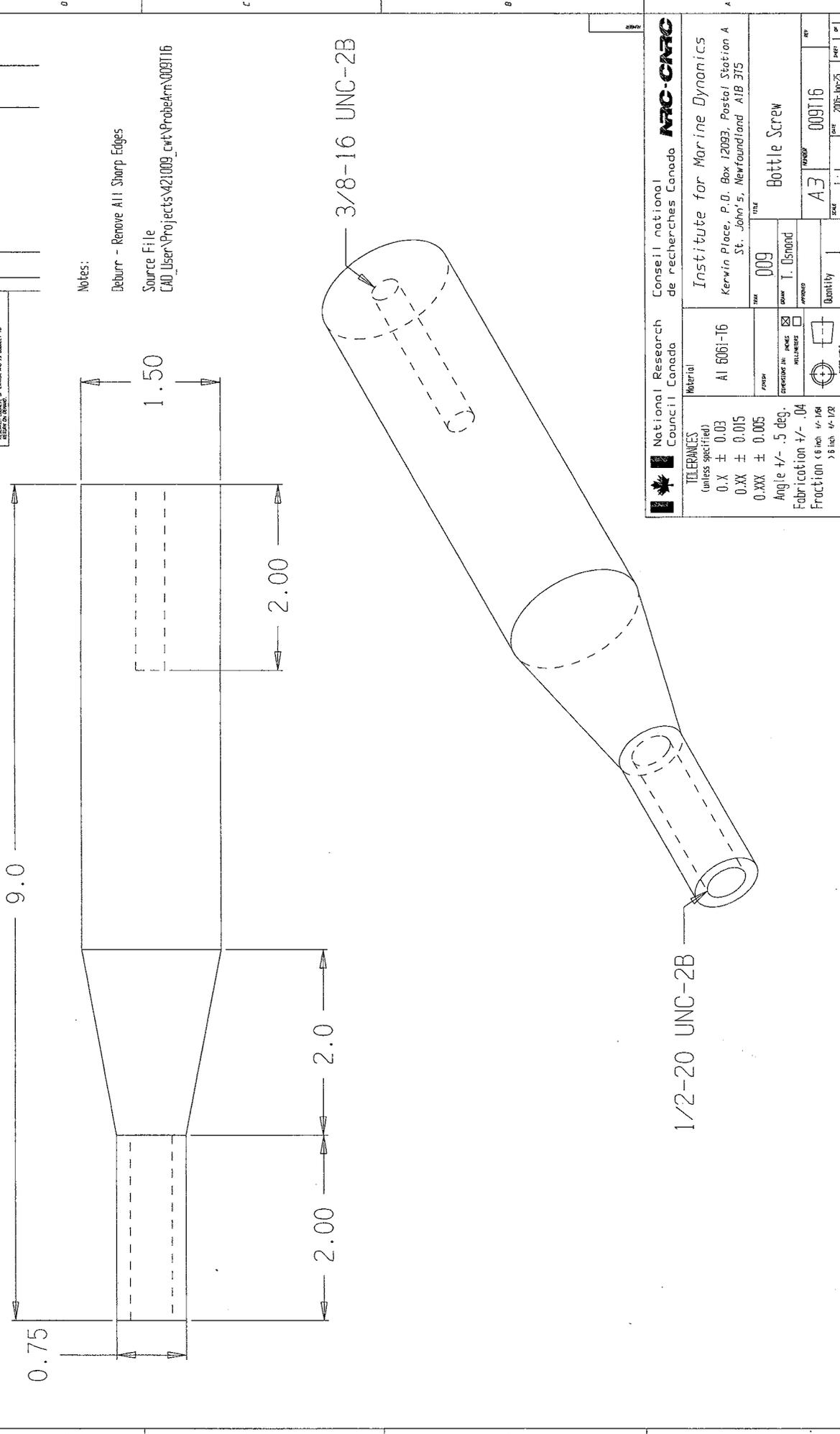
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National Research Council of Canada Conseil national de recherches Canada		MTC-CATC	
Material A1 6061-T6		Institute for Marine Dynamics Kerwin Place, P.O. Box 12083, Postal Station A St. John's, Newfoundland A1B 3T5	
TOLERANCES (unless specified) 0.X ± 0.03 0.XX ± 0.015 0.XXX ± 0.005 Angle +/- .5 deg. Fabrication +/- .04 Fraction < 8 inch +/- 1/64 > 8 inch +/- 1/32	FINISH 009	TITLE Bushing 2	PART NUMBER 009115
CHECKING IN PROGRESS <input checked="" type="checkbox"/>	DRAWN I. Usmond	QUANTITY 1	SHEET 2 : 1
APPROVED 	DATE 2006-Jun-25	SHEET 1 of 1	SHEET 1 of 1

REV	DATE	DESCRIPTION	APPROVED

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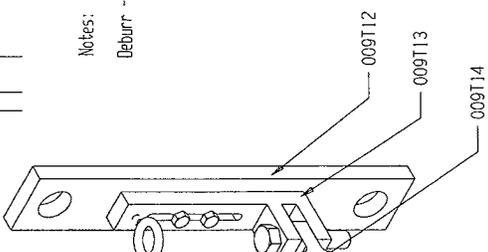
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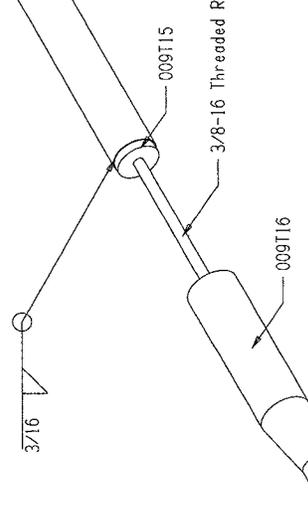
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Material AI 6061-16		Institute for Marine Dynamics Kerwin Place, P.O. Box 12093, Postal Station A St. John's, Newfoundland A1B 3T5	
TOLERANCES (unless specified) 0.X ± 0.03 0.XX ± 0.015 0.XXX ± 0.005 Angle +/- .5 deg. Fabrication +/- .04 Fraction 1/8 inch 1/16 inch 1/32 inch	PART NO 009	DRAWN I. Osmond	TITLE Bottle Screw
<input checked="" type="checkbox"/> CHECKING IN PROCESS <input type="checkbox"/> MILLING <input type="checkbox"/> TAPING	APPROVED Quantity 1	DATE 2006-Jun-25	REV 009T16

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6061-T6 Al  
Schedule 40  
ID  $\varnothing$  1.049  
OD  $\varnothing$  1.315  
Length - 130"

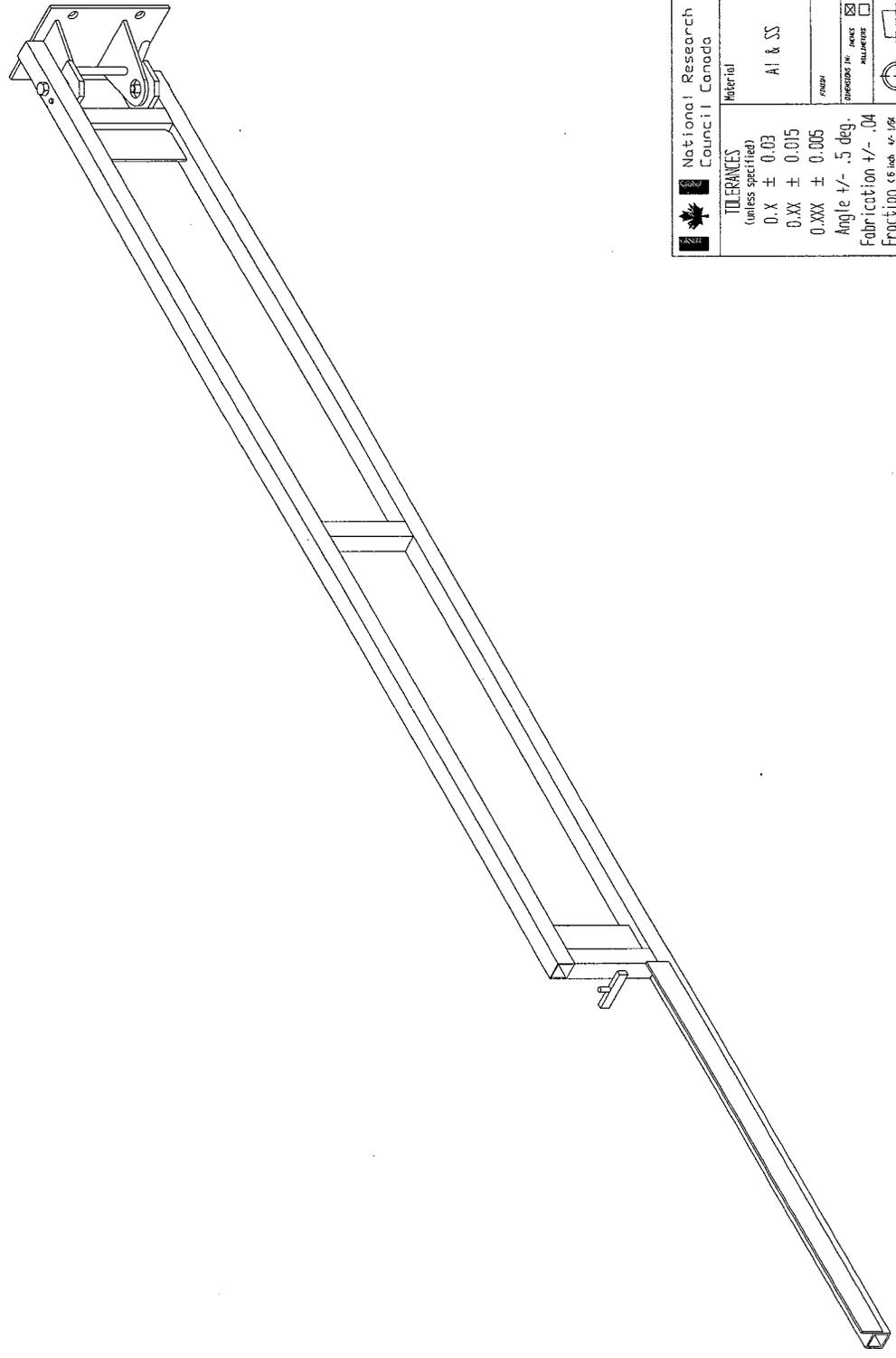


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National Research Council of Canada Conseil national de recherches Canada		NTC-CATC Institute for Marine Dynamics Kerwin Place, P.O. Box 12093, Postal Station A St. John's, Newfoundland A1B 3T5	
<b>TOLERANCES</b> (unless specified) 0.X ± 0.03 0.XX ± 0.015 0.XXX ± 0.005 Angle +/- .5 deg. Fabrication <math>\frac{1}{16}</math> to <math>\frac{1}{8}</math> Fraction <math>\frac{1}{16}</math> to <math>\frac{1}{8}</math>		PART 009 DRAWN T. Ostrand APPROVED QUANTITY 1	TITLE Additional Support Assembly A3 NUMBER 009T17 DATE 2005-Jun-25 SHEET 1 OF 1

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 National Research Council Canada Conseil national de recherches Canada <b>NRC-CNRC</b>	Material <b>Al &amp; SS</b>	PART NO <b>009</b>	TITLE <b>Full Assembly</b>
	TOLERANCES (unless specified) 0.X ± 0.03 0.XX ± 0.015 0.XXX ± 0.006 Angle +/- .5 deg. Fabrication +/- .04 Fraction < 6 inch 1/16 > 6 inch 1/32	FINISH <input checked="" type="checkbox"/> ANODIZE <input type="checkbox"/> POLISH <input type="checkbox"/> TUMBLE	QUANTITY <b>1</b>
NATIONAL RESEARCH COUNCIL OF CANADA INSTITUT NATIONAL DE RECHERCHES EN SCIENCE ET EN TECHNOLOGIE		QUANTITY <b>1</b>	PART NO <b>009T18</b>
SHEET NO <b>1</b>		SHEET NO <b>1</b>	SHEET NO <b>1</b>

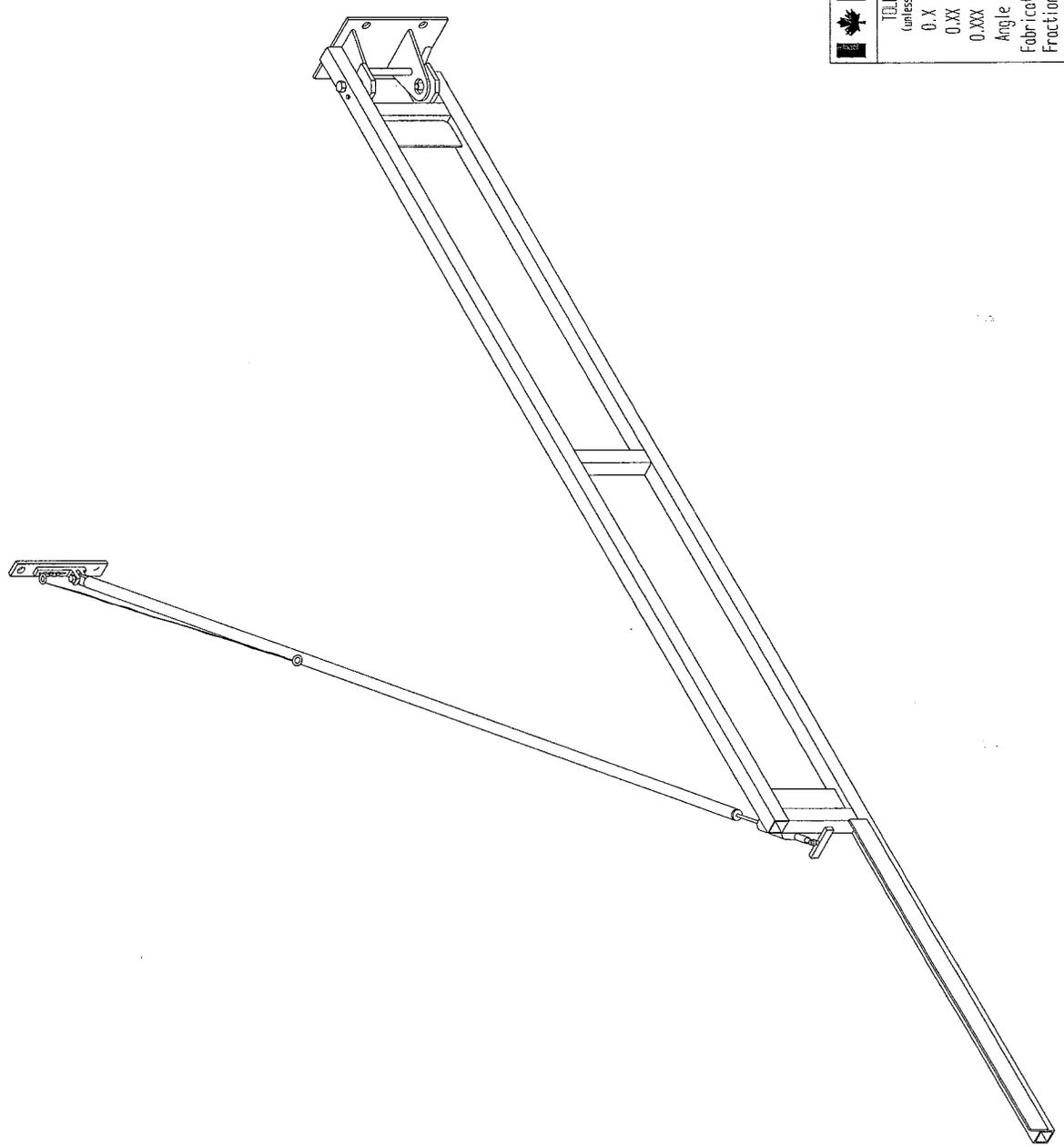
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 CAD\_User\Projects\421009\_cwt\ProbeArm\_009T19



 National Research Council of Canada	Material <b>Al &amp; SS</b>	FINISH <input checked="" type="checkbox"/> POLISHED <input type="checkbox"/> MILL FINISH	PART NUMBER <b>009</b>	TITLE <b>Full Assembly with Support</b>
		TOLERANCES (unless specified) 0.X ± 0.03 0.XX ± 0.015 0.XXX ± 0.005 Angle +/- .5 deg. Fabrication +/- .04 Fraction < 6 inch 1/16 > 6 inch 1/32	DRAWN <b>T. Ostrand</b>	DATE <b>2005-Jun-25</b>
NATIONAL RESEARCH COUNCIL OF CANADA <b>NRCC-CNRC</b>	CONSEIL NATIONAL DE RECHERCHES CANADIENNES <b>NRCC-CNRC</b>	INSTITUT FOR MARINE DYNAMICS Kerwin Place, P.O. Box 12083, Postal Station A St. John's, Newfoundland A1B 3T5	QUANTITY <b>1</b>	SHEET <b>A3</b>