Gavia Guider System: an overview

Osmond, T.

Publisher's version / Version de l'éditeur:
https://doi.org/10.4224/8895756
Student Report (National Research Council of Canada. Institute for Ocean Technology); no. SR-2005-20, 2005

DOCUMENTATION PAGE

REPORT NUMBER	NRC REPORT NUMBER	DATE
SN-2005-20		August, 2005

REPORT SECURITY CLASSIFICATION	DISTRIBUTION
Unclassified	Unlimited

TITLE
Gavia Guider System – An Overview

AUTHOR(S)
Tim Osmond

CORPORATE AUTHOR(S)/PERFORMING AGENCY(S)
Institute for Ocean Technology

PUBLICATION

SPONSORING AGENCY(S)
Institute for Ocean Technology

IOT PROJECT NUMBER	NRC FILE NUMBER		
42_2089_10			
KEY WORDS	**PAGES**	**FIGS.**	**TABLES**
Gavia, Guider, Pipeline Inspection Vehicle	12	3	0

SUMMARY
With the Institute for Ocean Technology, the Gavia ROV is to be used as a demonstration of how ROVs can be used as pipeline inspection vehicles. Gavia is intended to provide this demonstration by passing through a 35-inch diameter pipe. Gavia is almost neutrally buoyant and should theoretically remain dead center of the pipeline while moving through. In practice however, the ROV will not remain dead center due to small amounts of fluid flow in the pipeline as well as the fact that the sub is not exactly neutrally buoyant. The ROV running off course introduces a number of complications for the inspection equipment built into the vehicle. To prevent these complications, a sub guider system has been designed and fabricated. This system will passively hold the ROV in the center of the pipeline to within several inches and allow the demonstration to proceed without complication.

Available under: CAD_User\Projects\42_2091_Pipeline Inspection Vehicule\OEB Demo Test

ADDRESS 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
Institute for Ocean Technology

Conseil national de recherches Canada
Institut des technologies océaniques

Gavia Guider System – An Overview

SR-2005-20

Tim Osmond

August 2005

Introduction

With the Institute for Ocean Technology, the Gavia ROV is to be used as a demonstration of how ROVs can be used as pipeline inspection vehicles. Gavia is intended to provide this demonstration by passing through a 35-inch diameter pipe. Gavia is almost neutrally buoyant and should theoretically remain dead center of the pipeline while moving through. In practice however, the ROV will not remain dead center due to small amounts of fluid flow in the pipeline as well as the fact that the sub is not exactly neutrally buoyant. The ROV running off course introduces a number of complications for the inspection equipment built into the vehicle. To prevent these complications, a sub guider system has been designed and fabricated. This system will passively hold the ROV in the center of the pipeline to within several inches and allow the demonstration to proceed without complication.

The Sub Guider

The sub guider system is composed of two identical support systems, one support for the front end of the ROV and one support for the back end. Each support piece is a collar from which stems three flexible carbon fiber rods. Attached to the end of each rod is a caster wheel (see Figure 1).

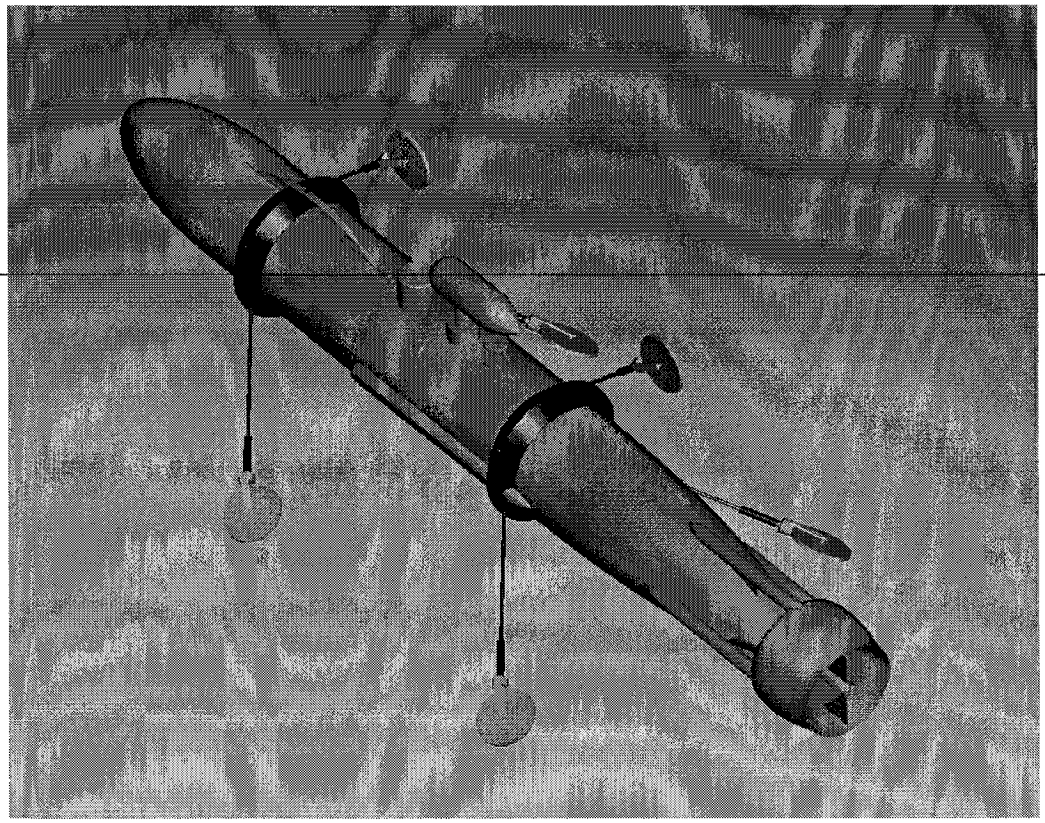


Figure 1 – The Gavia Guider System

The Collar

There are two collars fabricated for the sub guider, each identical. The collar is an Acrylic material taken from scrap material found near the cavitation tunnel in the Institute for Ocean Technologies, phase 3. Five layers of square acrylic 10.5" x 10.5" pieces were bonded together using methylene chloride. A center hole was then selected and drilled. Next the inside of the piece was hollowed out to slightly larger than the diameter of Gavia, 200 mm. The outside was taken down to 10 inches diameter and the outer edges were chamfered at 45 degrees. Both these operations were performed using the lathe (see figure 2 and figure 3). Each collar is designed to screw directly to Gavia using 6 mm screws (purchased from Mcmaster Carr – 94175A520) at 0, 120 and 240 degrees using preexisting threaded holes in the ROV. Thus holes were drilled into the collar for a loose fit for 6 mm nylon screws. The holes were counter bored large enough for a socket wrench to tighten and loosen the screws. Holes were then drilled for the carbon fiber rods at 60, 180 and 300 degrees. The holes were drilled into the chamfered side so that the rods will exit at 45 degrees. Setscrews entering from the opposite side hold the carbon fiber rods in place (see appendix A).

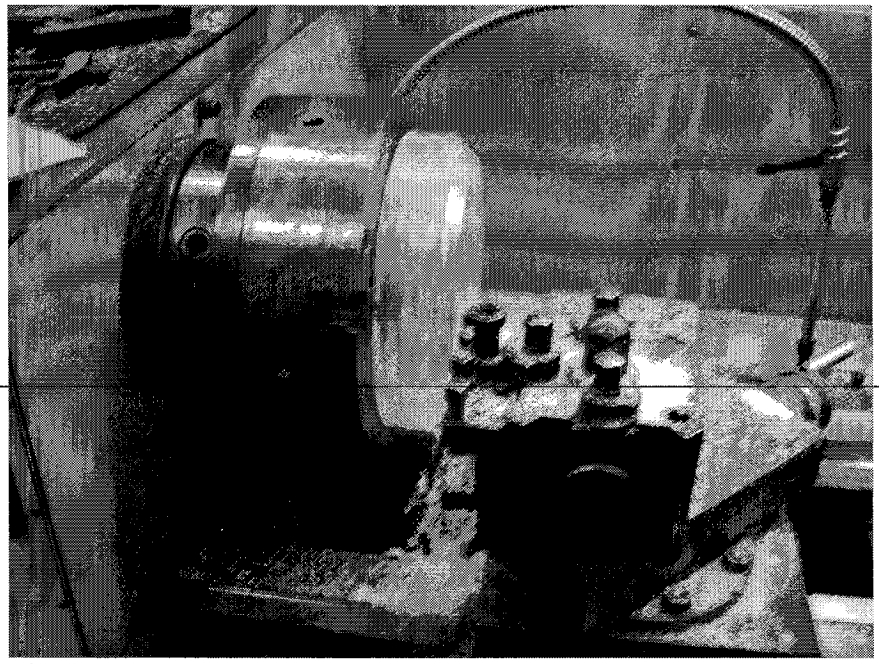


Figure 2 – Collar in Lathe

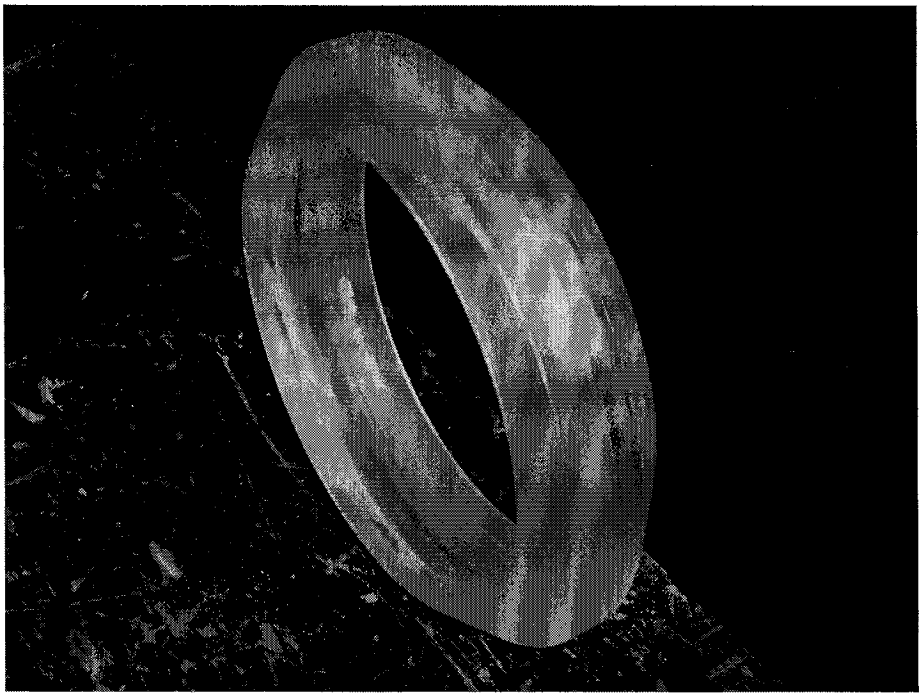


Figure 3 – Collar after Lathe

The Carbon Fiber Rods

The carbon fiber rods are flexible rods, purchased by the Institute at an early time for another project. They come in various lengths and thicknesses. The selection of thicknesses allows the flexibility of the rods to be adjusted to the required stiffness in preparing for the demonstration. There is also a window of approximately 3 inches to which the length of the rods may be cut to provide further control of the stiffness of the supporting rods (see figure 3).[1] It is recommended that the sleeves be cut at 20 inches and shortened as necessary (see appendix B). Sleeves at the end of each rod attach and tighten using 2 setscrews per sleeve. The sleeves screw directly to the caster wheels and allow the wheels to attach to the rod.

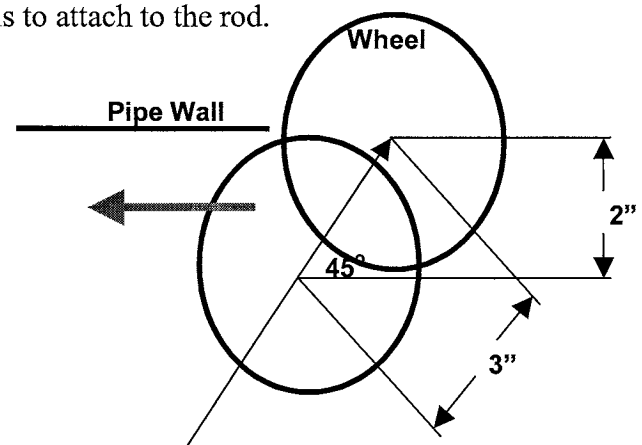


Figure 3 – Wheel Location Against Pipe Wall

[1] The wheel is 4 inches in diameter. The sub will enter the pipe easily if the wheel makes contact with the pipe at a point on the top half of the wheel (top 2 inches). Because the rod is at a 45-degree angle, the distance between the wheel and the sub will increase 2 inches if the rod is lengthened 3 inches.

It should be noted that the carbon fiber rods are undersized to holes in both the sleeves and in the collar. For this reason the width of the rods at the ends will need to be increased. While it would be simple to build rod ends out of a flexible plastic to widen the ends, it is recommended that simply wrapping electrical tape around the ends of the rods is the simplest and easiest way of increasing the diameter of the ends so that the rods fit snuggly into the holes prescribed to them.

The Wheels

The wheels for the sub guider were selected from Kanstor Inc., a company based in Mount Pearl. The wheel selection was the 4 inch diameter, 7/8 tread width, polyolefin casters (product code 1-4354-53). This caster was selected for the following reasons (Colson – Caster-Wheels-Bumpers Catalog 9601):

- The wheel comes from the series 1, the lightest and smallest available from the Kanstor selection. For the intended purpose, only low load capacity wheels are necessary and low weight provides advantages by reducing the weight on the carbon fiber rods and on the ROV.
- The wheel contains a long straight thread stem that simplifies its attachment to the carbon fiber rods. A simple sleeve with a drilled and tapped hole connects the wheel to the rod (see appendix C).
- The wheel has a delrin bearing, corrosion resistant and recommended for excessive water applications.
- The wheel is 4 inches diameter, decided to be the best diameter to ride over the oscillations on the interior walls of the 36-inch diameter pipe.
- The wheel has a 7/8 inch tread width, the smallest available from the Kanstor, reducing drag created by the guider system.
- The wheel material is polyolefin. This material is suitable for excessive water applications as compared to the Polyurethane HI-TECH option, not suitable. The material is harder than the Performa Rubber option, reducing friction caused by the wheel contacting the pipe wall. Another advantage of Polyolefin over Performa Rubber is that the polyolefin wheel has rounded edges as opposed to the sharper edges of the Rubber wheel. The rounded edges should prevent the wheel from steering the ROV in any way while in the pipeline. Polyolefin has a specific density of 0.89, thus with the metal stem, the wheels should be close to neutral buoyancy and further reduce the guider systems affects on the ROV. Polyolefin has a water absorption rate of 0.03, considered low enough for the sub guider application.

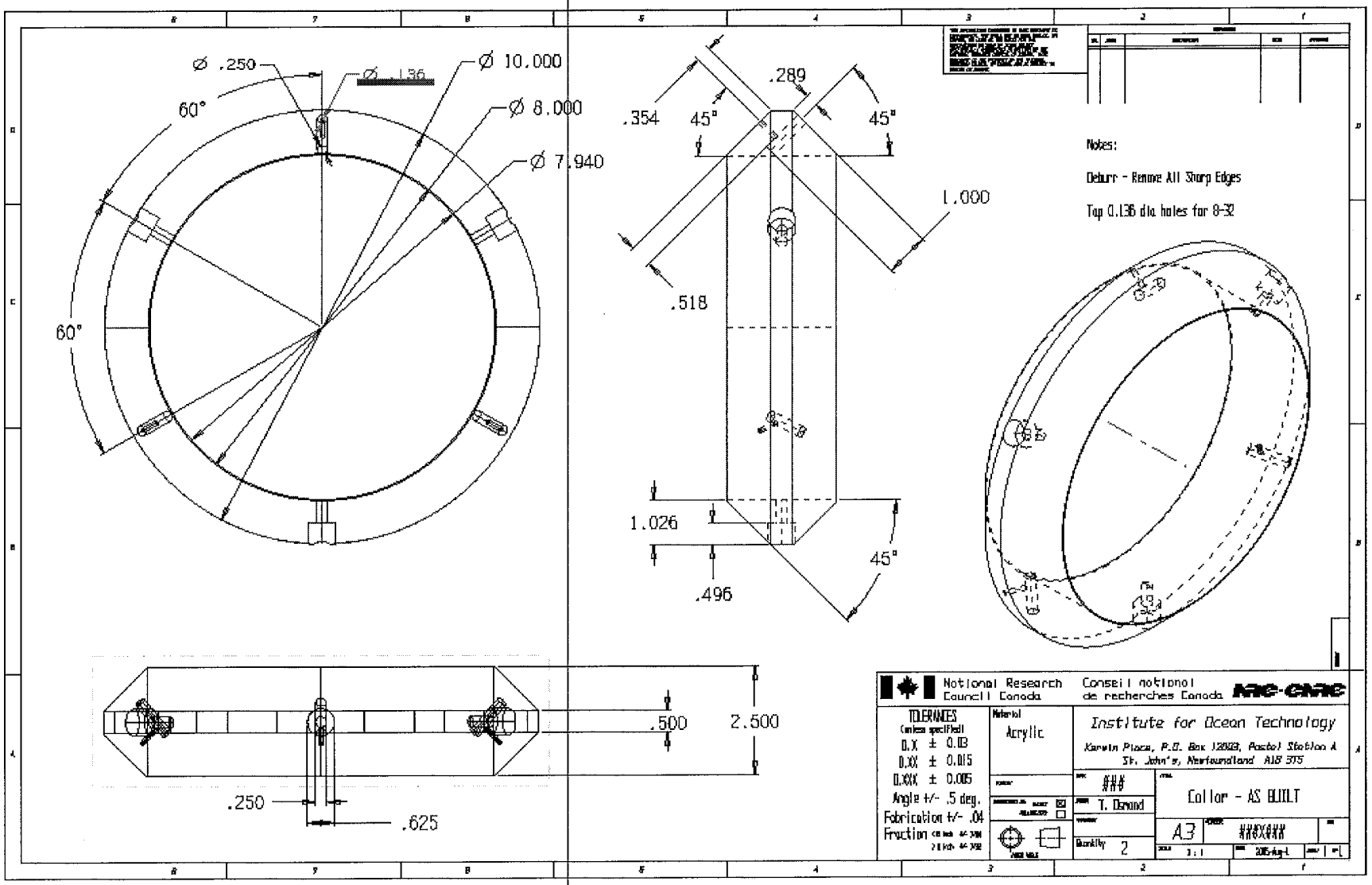
Summary

The Gavia Guider is composed of two identical wheel support systems. Each system is an acrylic collar with three carbon fiber rods. The rods are equally spaced; 120 degrees apart and sweep back over the sub at 45-degree angles. At the end of each rod a caster wheel is attached. One collar will screw into the front end of the ROV and the other screws into the back end, thus a total of six wheels will guide the sub keeping it centered through the pipeline. At present the system is built with limited adjustability to facilitate simplicity and allow for shortened fabrication time. Further adjustability could be build into the system by using rotary hinges between the carbon fiber rods and the collar to

allow the carbon fiber rods to be adjusted from 45 degrees to other angles or to completely collapse the wheels to lie flush with the sub body.

APPENDIX A

APPENDIX A


Ø .250
Ø .136
Ø 10.000
Ø 8.000
Ø 7.940
60°
60°
.289
.354
45°
45°
1.000
.518
1.026
45°
.496
.500
2.500
.250
.625
Notes:
Deburr - Remove All Sharp Edges
Tap 0.136 dia. holes for 8-32
National Research Council Canada
Conseil national de recherches Canada
Institute for Ocean Technology
Arctic Avenue, P.O. Box 12093, Postal Station A
St. John's, Newfoundland A1B 3T5
TOLERANCES
Unless specified
0.X ± 0.13
0.XX ± 0.015
0.XXX ± 0.005
Angle +/- .5 deg.
Fabrication +/- .04
Material
Acrylic
###
T. Denand
Quantity 2
Collar - AS BUILT
A3
#####

APPENDIX B

APPENDIX B

Calculations for Rod Length

Dimensions
Pipe Interior Diameter: 36"
Collar Interior Point Where Rod Begins: 4" from center

Distance to Wall
36" / 2 = 18"
18" – 4" = 14"

Wheel Dimensions (see Colson Casters-Wheels-Bumpers, pg 26)
Load Height: 4.75"
Thread Stem length: 1.5"

Length of Wheel
4.75" + 1.5" = 6.25"

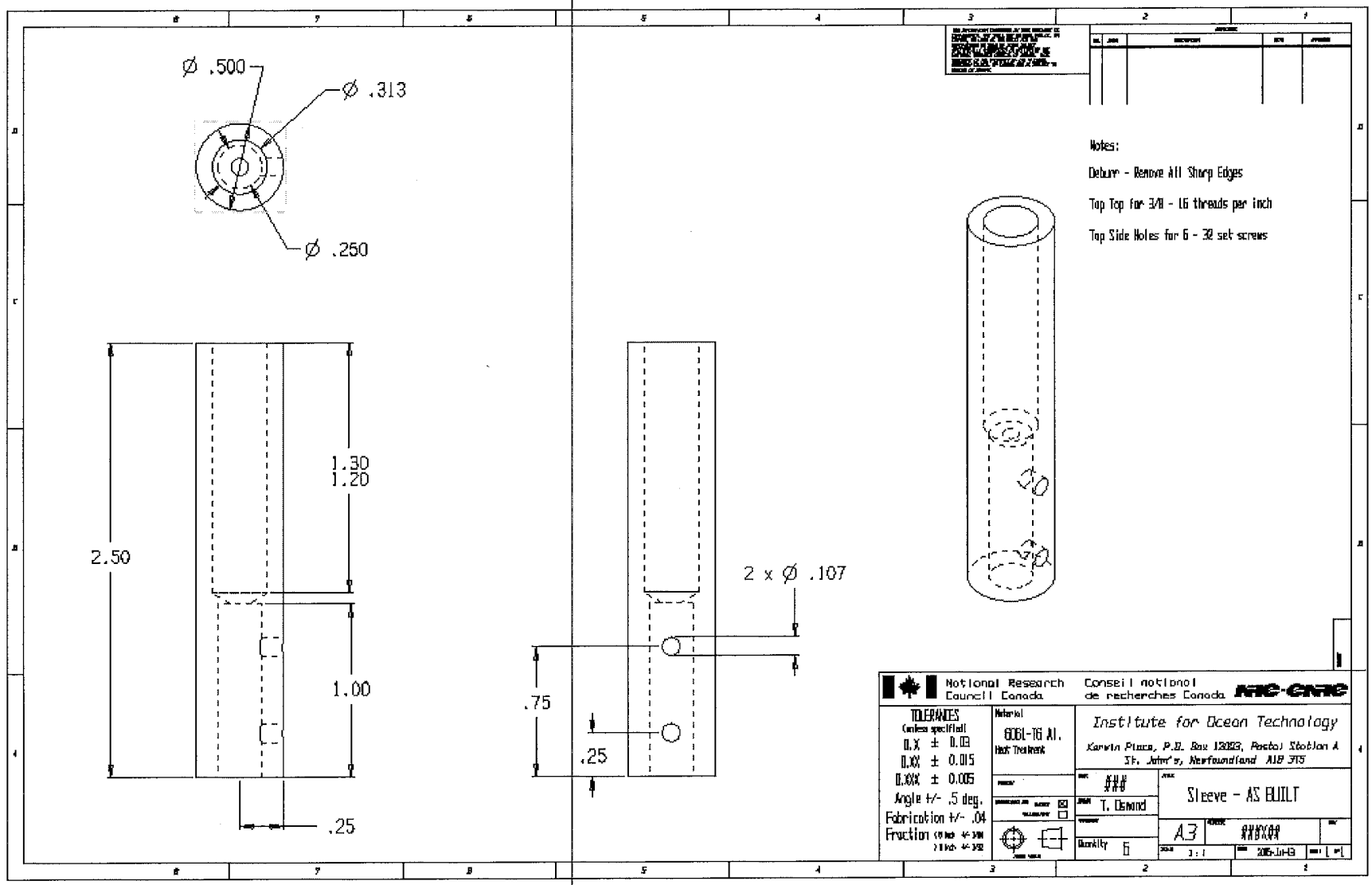
Distance to Wall at 45 degrees
14" / cos(45) = 19.8"

Distance of Rod
19.8" – 6.25" = 13.5"
13.5" + 3" = 16.5

Rod should likely be cut at 20 inches and trimmed as necessary.

APPENDIX C

APPENDIX C


Ø .500
Ø .313
Ø .250
1.30
1.20
2.50
1.00
.25
.75
.25
2 x Ø .107
Notes:
Deburr - Remove All Sharp Edges
Top Top for 3/8 - 16 threads per inch
Top Side Holes for 6 - 32 set screws
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
Material
6061-T6 Al.
Heat Treatment
Institute for Ocean Technology
Arctic Place, P.O. Box 12093, Postal Station A
St. John's, Newfoundland A1B 3T5
###
T. Osmond
Quantity 6
A3
Sleeve - AS BUILT