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Laboratory Memorandum

LM-2005-10

Pressure Measurement on a Pod Strut

T. Slade

May 2005



Canada

DOCUMENTATION PAGE

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LM-2005-10		May 2005
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Unclassified		Unlimited

TITLE

PRESSURE MEASUREMENT ON A POD STRUT

AUTHOR(S)

Trent Slade

CORPORATE AUTHOR(S)/PERFORMING AGENCY(S)

Institute for Ocean Technology, National Research Council, St. John's, NL

PUBLICATION

SPONSORING AGENCY(S)

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980			
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Pressure transducers, opens boat	iii, 20		

SUMMARY

A model of average pod geometry was fabricated from Renshape 460 and instruments with seven endevo pressure transducers.

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PRESSURE MEASUREMENT ON A POD STRUT

LM-2005-10

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May 2005

TABLE OF CONTENTS

Design Criteria 1
Assembly Process 2
Layout 3
Layout Exploded 4
Layout Complete 5
Parts List 6
Master Drawing List 6
(Drawings)
Transducer_loc (Pressure Transducer locations) 7
980X01 – BLANK SPACER 8
980X02 – TUNNEL WINDOW 9
980X03 – BOTTOM SPACER 10
980X04 – SHIM SPACER 11
980X05 – SPACER 3 AND 4 12
980X06 – SPACER 2 13
980X07 – PD SPACER NOSE 14
980X08 – PD SPACER STERN 15
980X10 – POD RIGHT SIDE 16
980X11 – PAD LEFT SIDE 17
980X12 – POD NUT 18
980X13 – SPACER COVER 19
980X14 – SS TUBING 20
980X15 – PROPELLER SPACER 21
Data Sheets 22

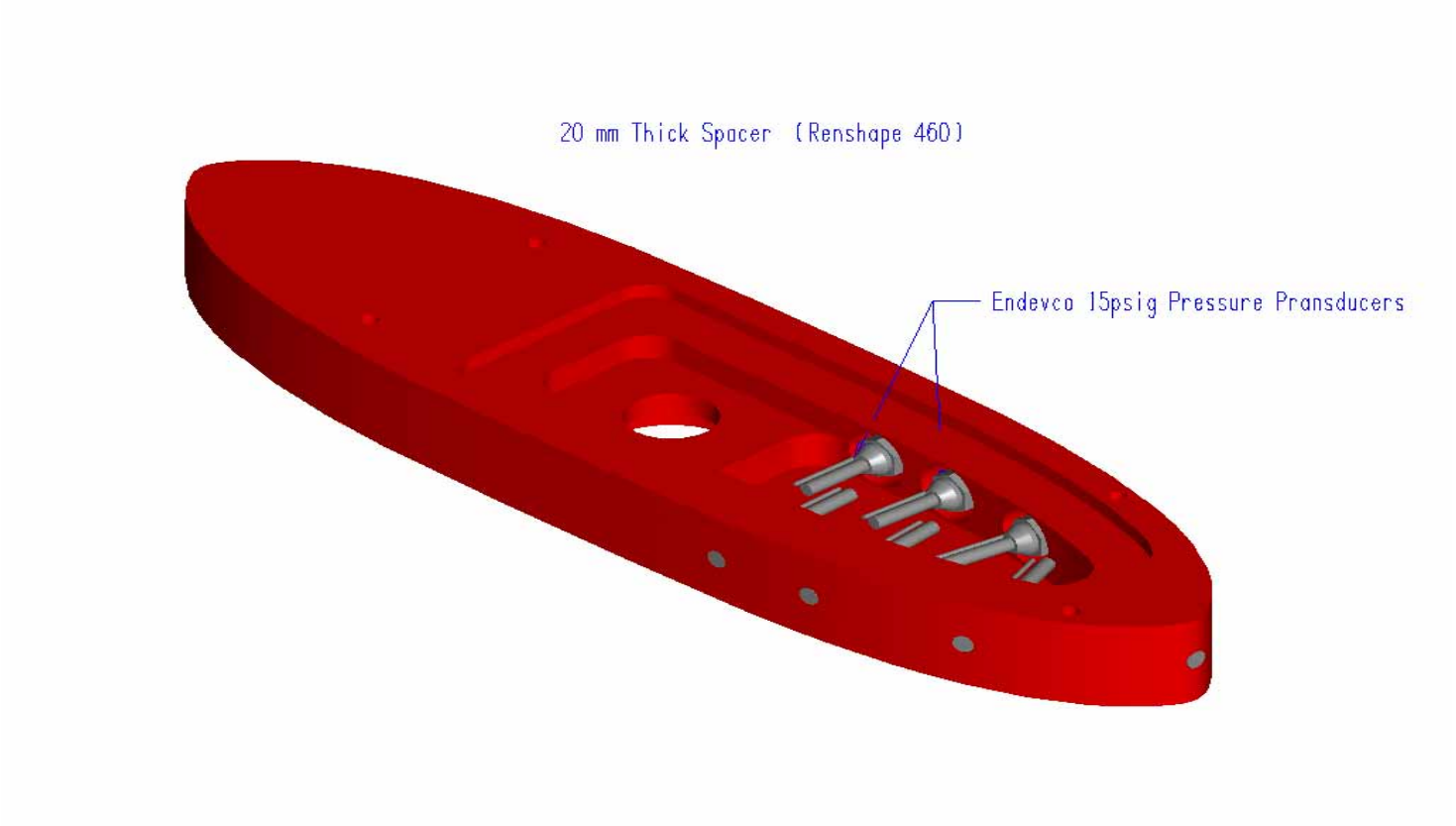
Design Criteria

NSERC PODDED PROPELLERS – Pressure Measurement

Project 980

Project Manager Moquin He

- Average Pod / Strut Dimensions as per Offsets Given.
- Pod to be mounted on the end of the Opens Boat Torpedo in the Cavitation Tunnel.
- 7 Endevco 15 Psig Pressure Transducers to be inserted one on the leading edge of the Pod Strut and 3 on the Port side and three on the Stbd side about center line of spacer.
- Pressure measurements to be at 4 locations in increments of 20mm vertically.
- 3 – 20mm spacers to be fabricated having the pod strut profile.
- The bottom portion of the Pod strut to be bolted to the cavitation tunnel window. 5/8" Stainless Steel tubing for the wires and drainage

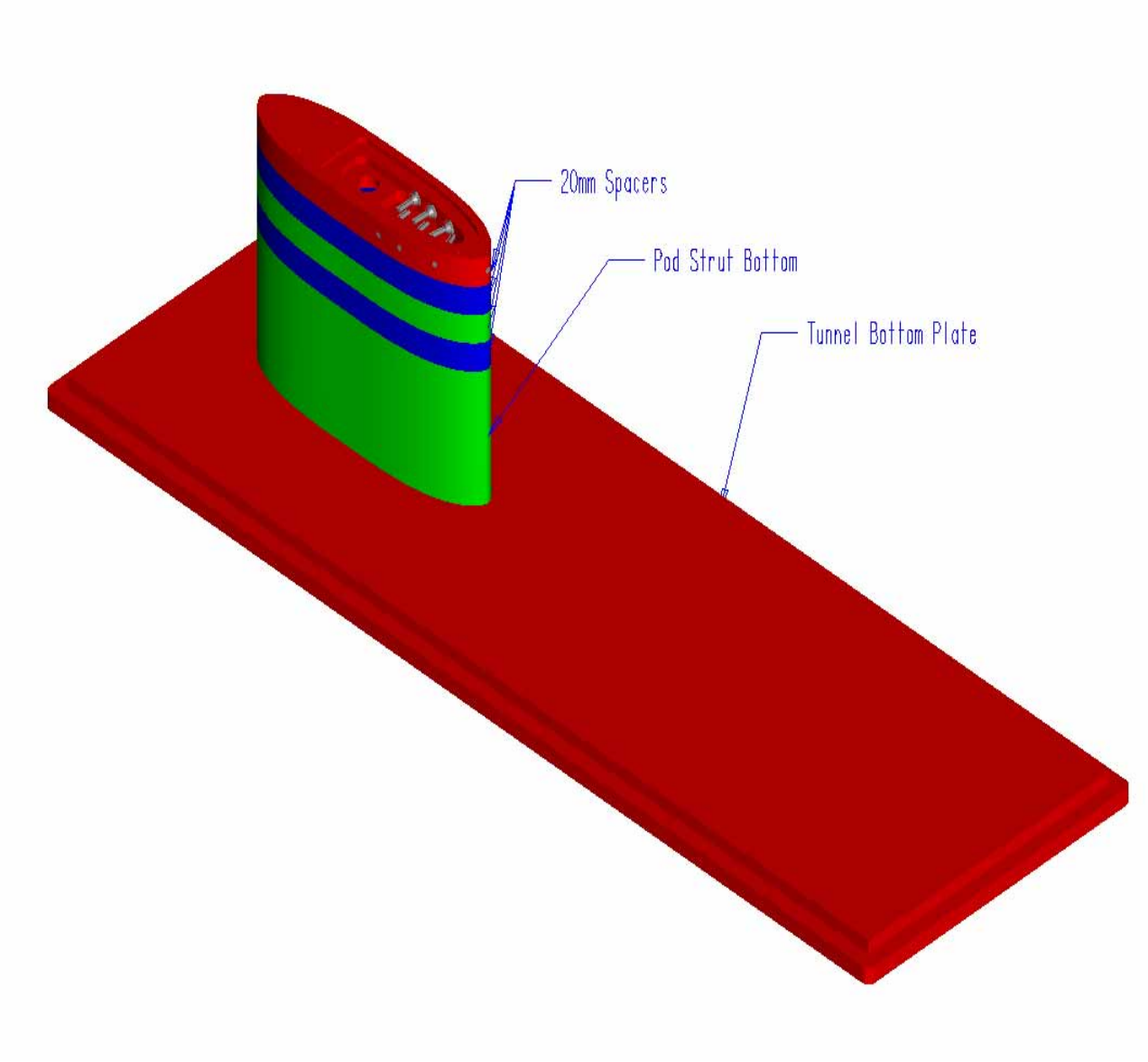


Assembly Process

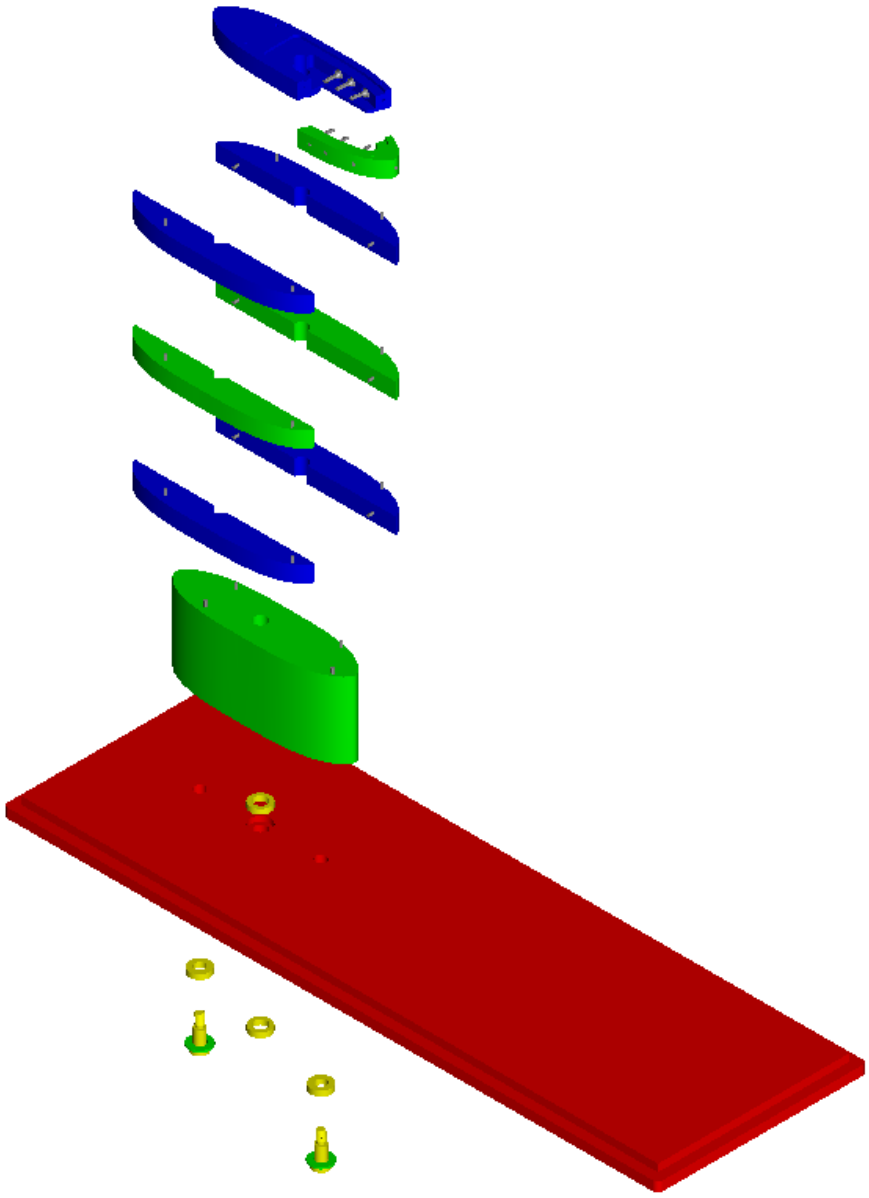
After all components were faired and painted the process of installing the Endevco pressure transducers and final assembly of the Pressure Transducer (PD) Spacer. The installation of the pressure transducers required that a 5/16” deep socket be modified with a 5/32” cut 1” down the length of it for the wires. In order to accommodate all seven (7) - pressure transducers in such a small area the PD spacer had to be split, drawing # 980X07 PD Spacer Nose and 980X08 PD Spacer Stern.

The PD Spacer Nose had 4 pressure transducers installed and the PD Spacer Stern had three. In order to achieve a watertight seal a shaft seal CR6151 was installed and a 5/8” Stainless Steel tube was passed through and secured. All seven pressure transducer wires and vent tubes had to pass down in inside of the 5/8” tube which had an inside diameter of only ½”. Both PD Nose and Stern were positioned together using dowel pins and glued using two-part epoxy.

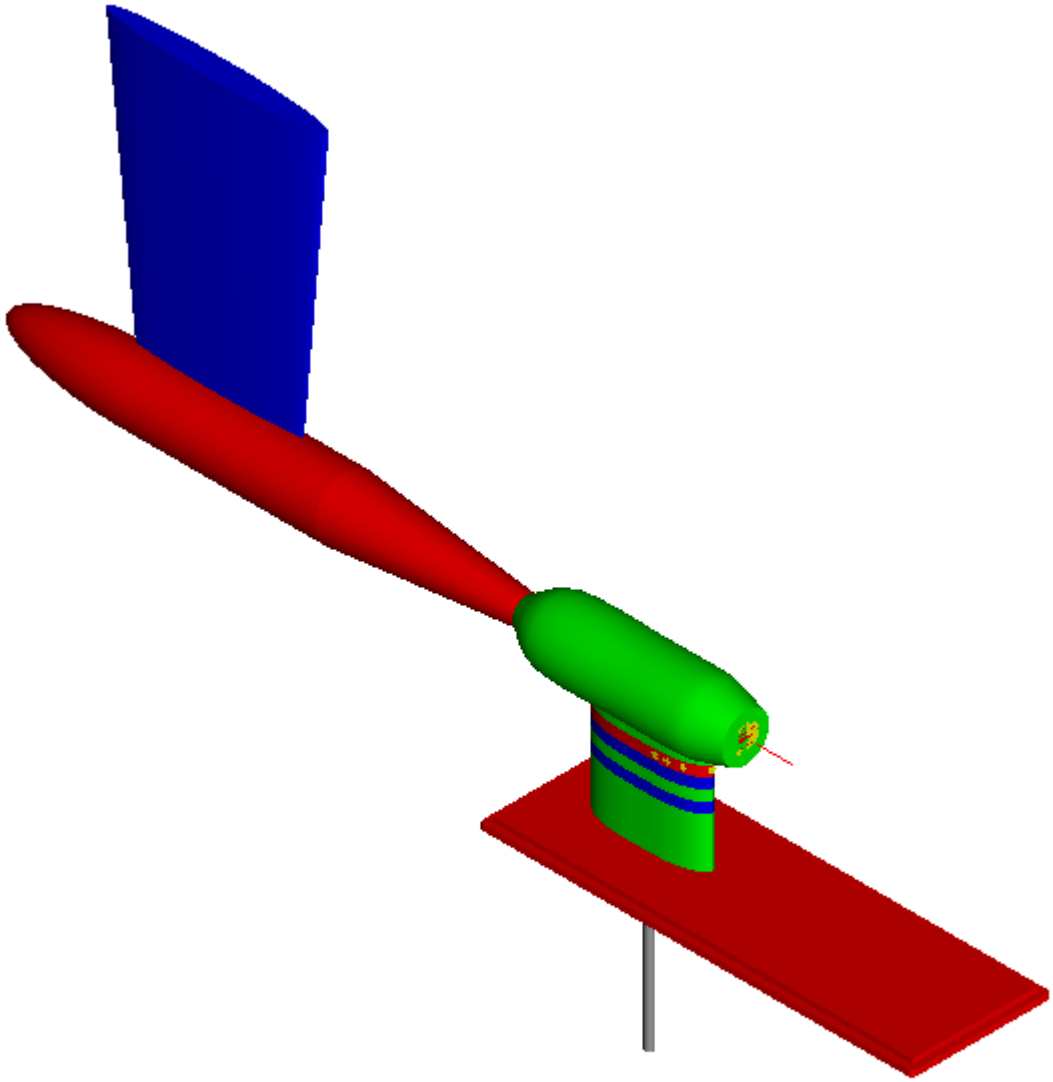
Once the parts were dry the wires were pulled down as far as possible and 980X13 PD Spacer cover was glued making the PD spacer watertight. The only problem was that if anything went wrong the part would have to be destroyed to remove/replace and or all transducers, with this in mind a spare PD spacer was manufactured. The tests were completed without having to use the spare.



Layout



Layout Exploded



Layout Complete

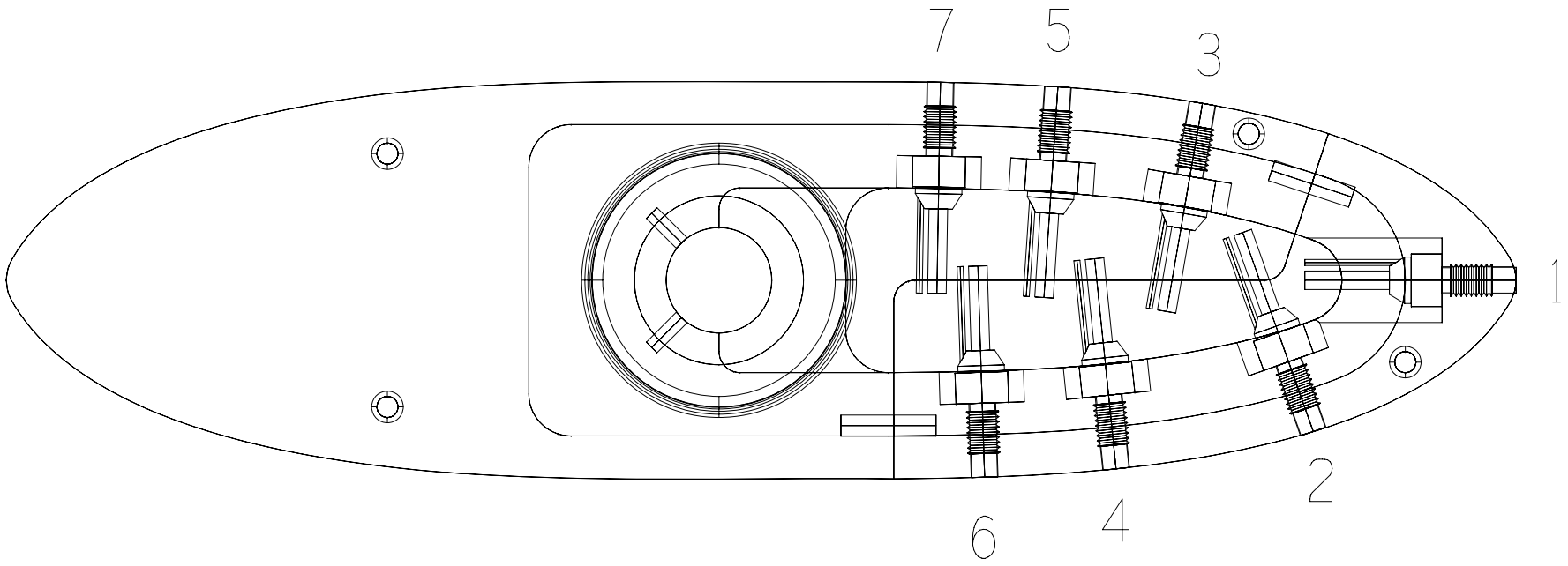
Parts List

1- McMaster Carr 8989K808 SS Tubing 3Ft
2- 2 ea CR Seals #4991 CRWA5
3- 4 ea CR Seals #6151 CRWA5
4- 2 ea Spaenaur Shoulder Bolt #364-828
5- 40 ea 1/8" x .5" dowel pin
6- 10 ea 1/8" x 1" dowel pin
7- 10 ea 1/8" x .75 dowel pin

980 Master Document List

Design & Fabrication Group

DOC #	DOC Type	Owner	File Name	Description
X00	CKD	TSLADE	980X00	MOQUIN NSERC POD FOR TUNNEL
X01	CKD	TSLADE	980X00	BLANK SPACER
X02	CKD	TSLADE	980X00	TUNNEL WINDOW
X03	CKD	TSLADE	980X00	BOTTOM SPACER
X04	CKD	TSLADE	980X00	SHIM SPACER
X05	CKD	TSLADE	980X00	SPACER 3 & 4
X06	CKD	TSLADE	980X00	SPACER2
X07	CKD	TSLADE	980X00	PD SPACER NOSE
X08	CKD	TSLADE	980X00	PD SPACER STERN
X10	CKD	TSLADE	980X00	POD RIGHT SIDE
X11	CKD	TSLADE	980X00	POD LEFT SIDE
X12	CKD	TSLADE	980X00	POD NUT
X13	CKD	TSLADE	980X00	SPACER COVER
X14	CKD	TSLADE	980X00	SS TUBING
X15	CKD	TSLADE	980X00	PROPELLER SPACER

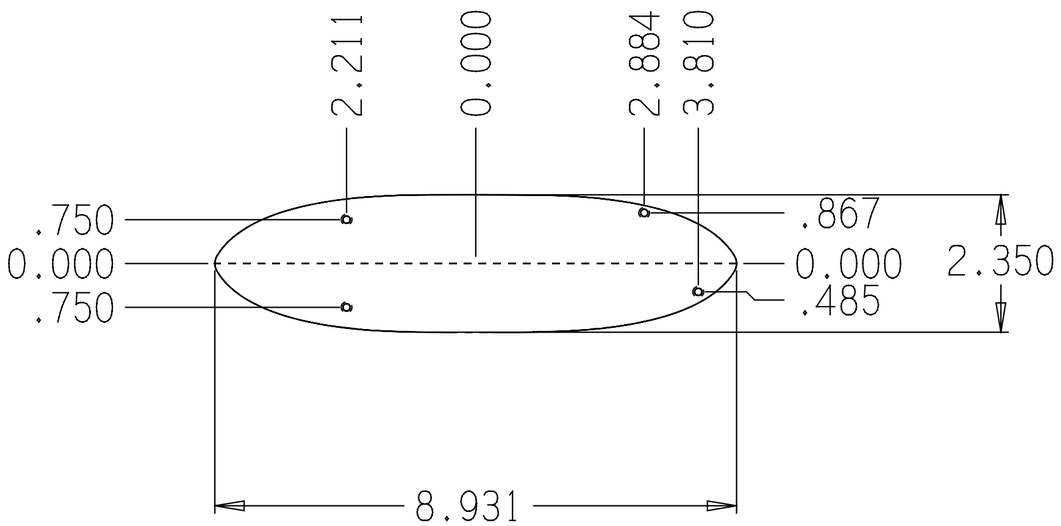

7
5
3
1
2
6
4

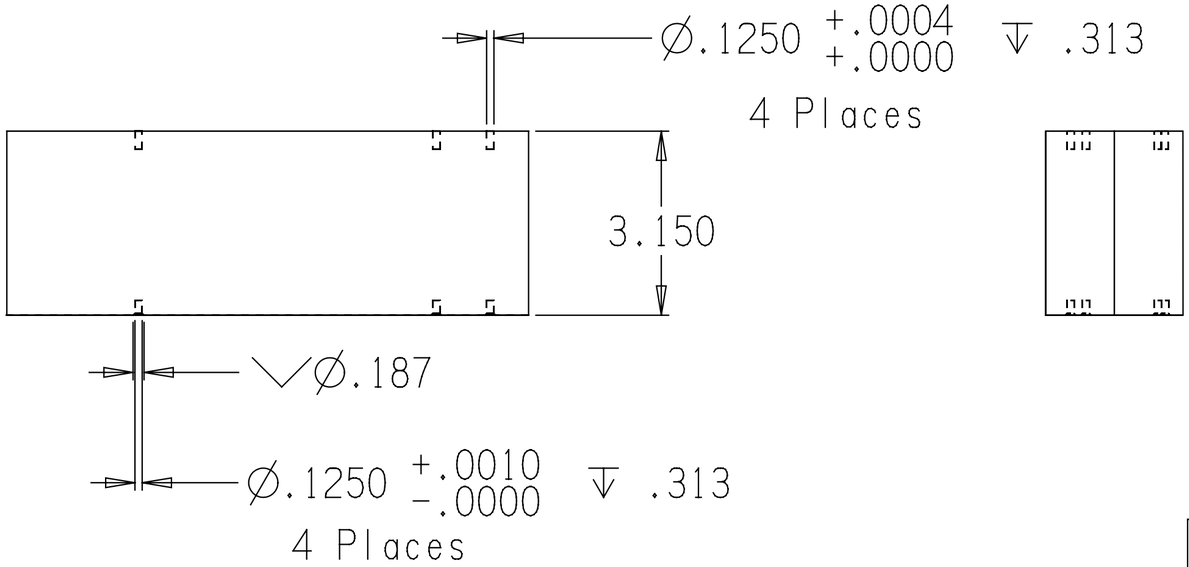
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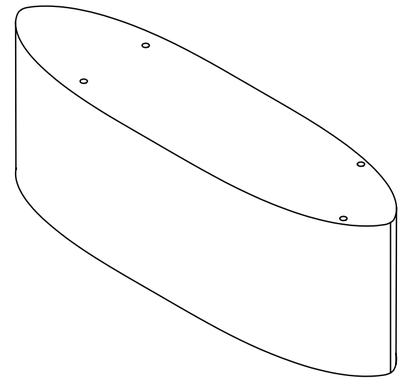
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0.XXX ± 0.005
Angle +/- .5 deg.
Fabrication +/- .04
Fraction < 6 inch +/- 1/64
> 6 inch +/- 1/32

Material: Renshape 460
Heat Treatment:
FINISH:
DIMENSIONS IN: INCHES ☒ MILLIMETERS ☐
THIRD ANGLE

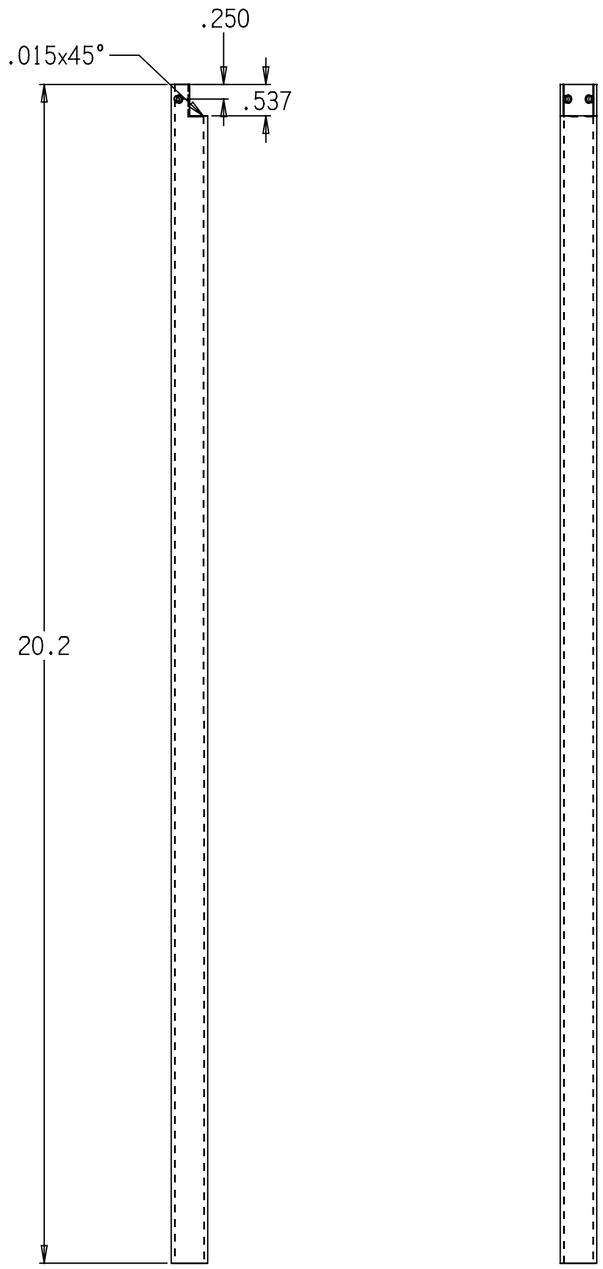
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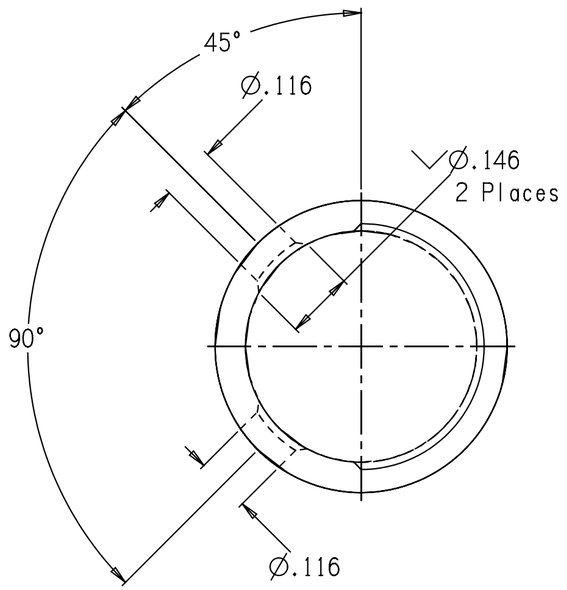
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DRAWN: T.Slade
APPROVED:
Quantity: 1

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SCALE: 1:2 | DATE: 01-Feb-05 | SHEET 1 OF 1

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McMasterCarr Part #8989K808 3Ft

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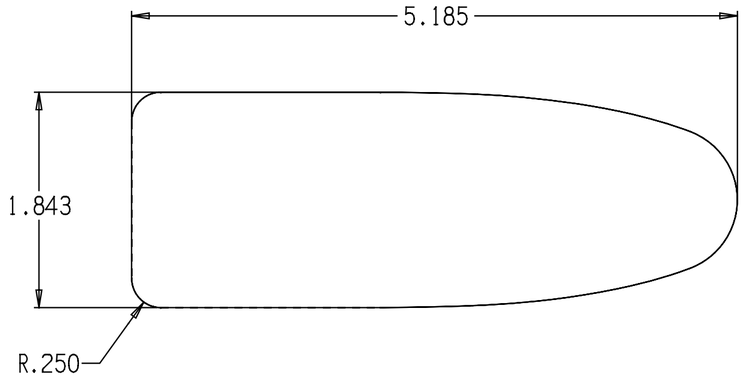
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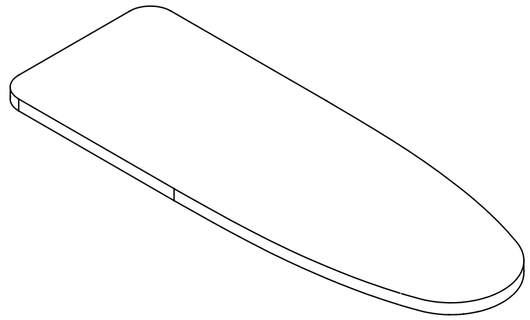
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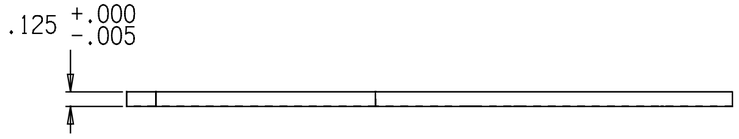
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0.XX ± 0.015
0.XXX ± 0.005
Angle +/- .5 deg.
Fabrication +/- .04
Fraction < 6 inch +/- 1/64
> 6 inch +/- 1/32

Material: Renshape 460
Heat Treatment:
FINISH:
DIMENSIONS IN: INCHES ☒ MILLIMETERS ☐
THIRD ANGLE

TRAX: 980
DRAWN: T.Slade
APPROVED:
Quantity: 2

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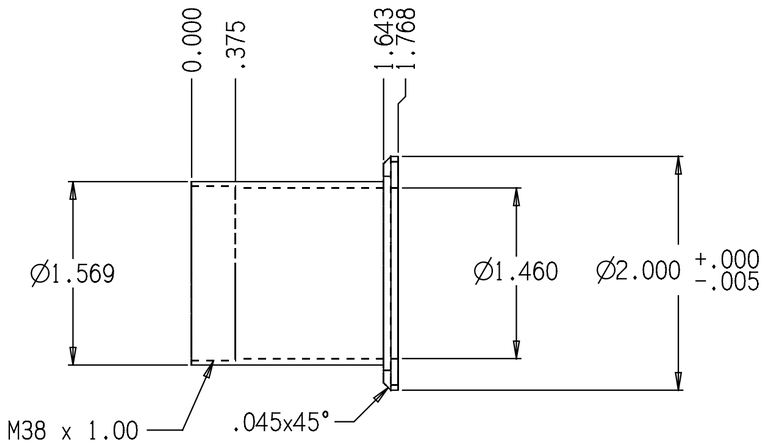
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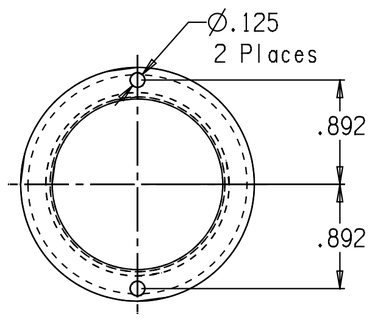
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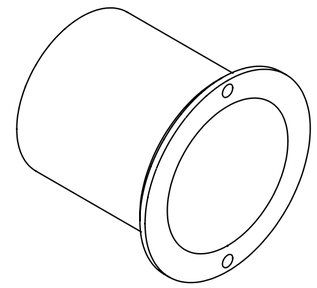
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Angle +/- .5 deg.
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Heat Treatment:
FINISH:
DIMENSIONS IN: INCHES ☒ MILLIMETERS ☐
THIRD ANGLE

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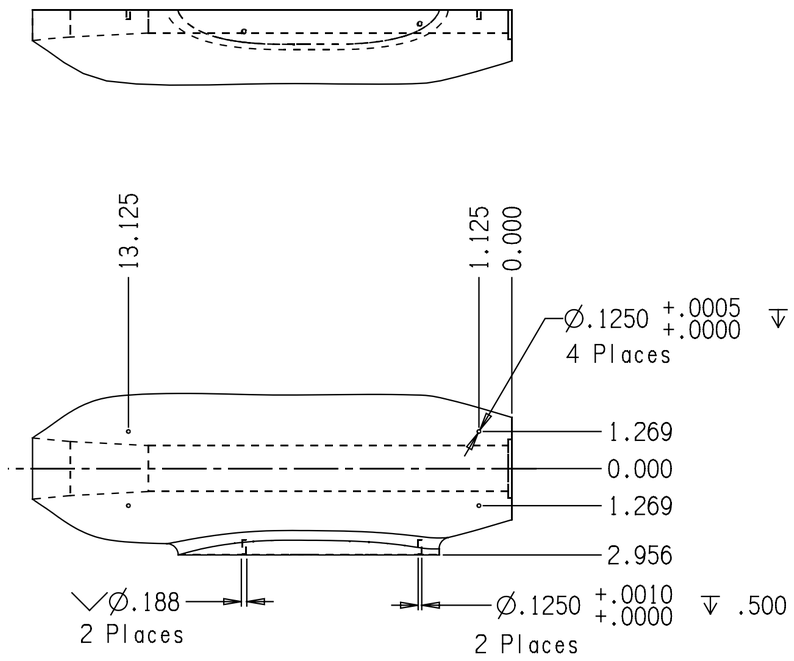
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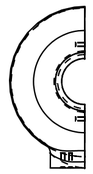
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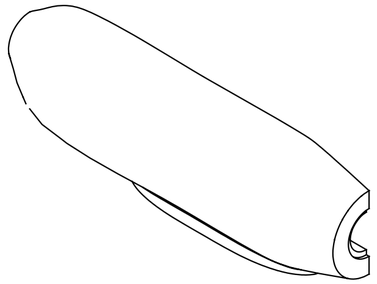
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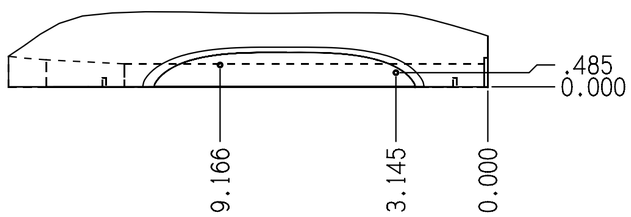
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0.XXX ± 0.005
Angle +/- .5 deg.
Fabrication +/- .04
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> 6 inch +/- 1/32

Material: Renshape 460
Heat Treatment:
FINISH:
DIMENSIONS IN: INCHES ☒ MILLIMETERS ☐
THIRD ANGLE

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St. John's, Newfoundland A1B 3T5

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DRAWN: T.Slade
APPROVED:
Quantity: 1

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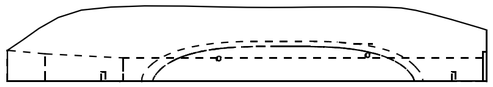
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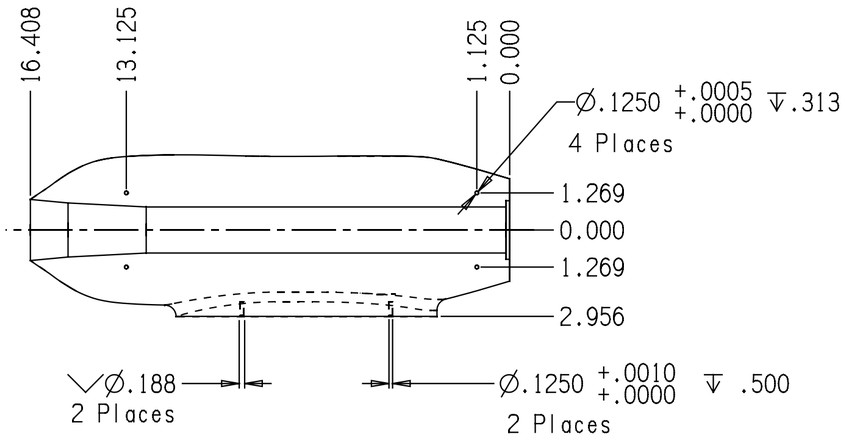
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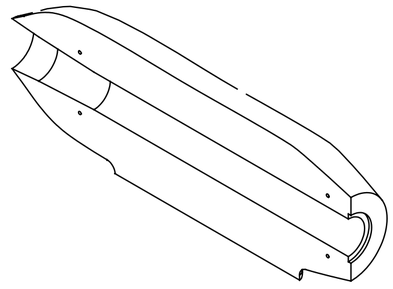
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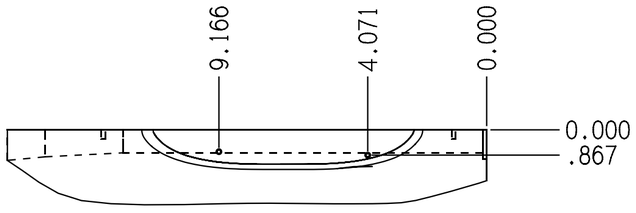
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0.XX ± 0.015
0.XXX ± 0.005
Angle +/- .5 deg.
Fabrication +/- .04
Fraction < 6 inch +/- 1/64
> 6 inch +/- 1/32

Material: Renshape 460
Heat Treatment:
FINISH:
DIMENSIONS IN: INCHES ☒ MILLIMETERS ☐
THIRD ANGLE

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TRAX: 980
DRAWN: T.Slade
APPROVED:
Quantity: 1

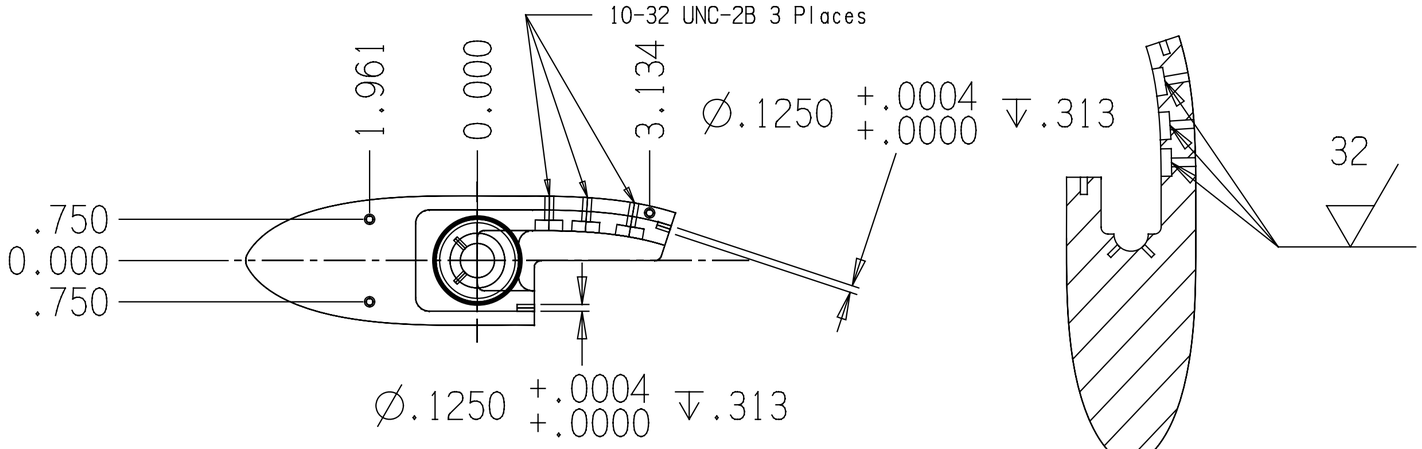
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A2 | NUMBER: 980X10 | REV:
SCALE: 1:4 | DATE: 07-Feb-05 | SHEET 1 OF 1

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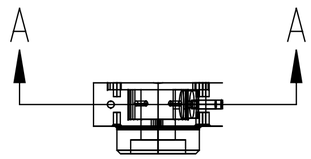
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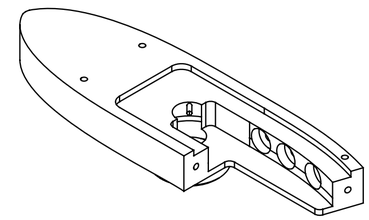
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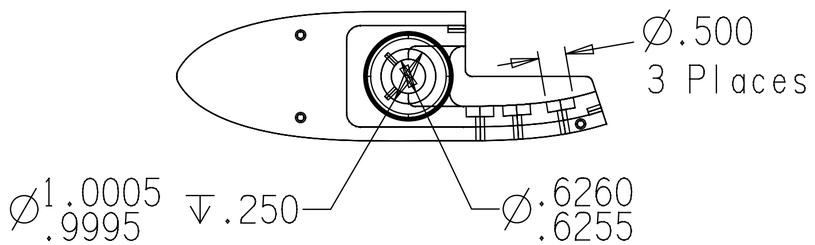
Part File projects/980 Nserc Pod/tslade/cadkey/980X00.ckd



SECTION A–A







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

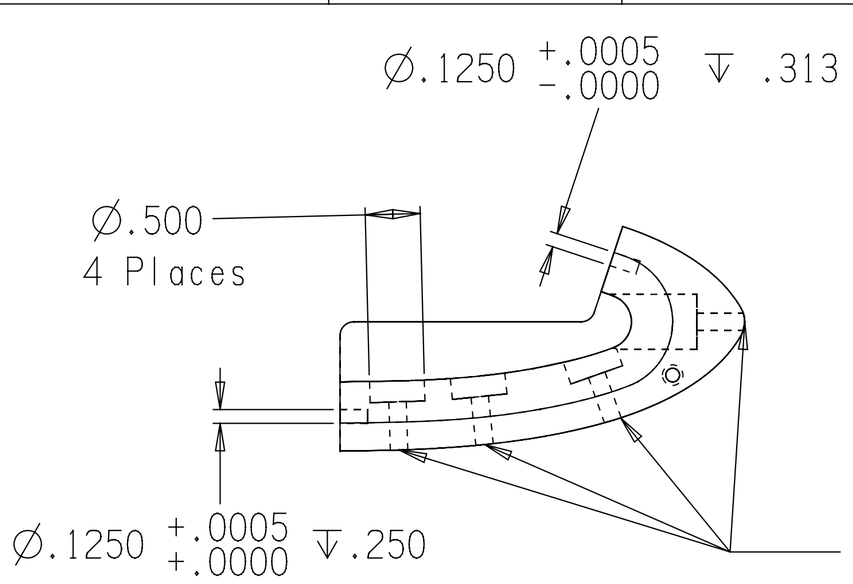
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Material	Renshape 460
Heat Treatment	
FINISH	
DIMENSIONS IN:	INCHES ☒ MILLIMETERS ☐
	THIRD ANGLE
TRAX	980
DRAWN	T.Slade
APPROVED	
Quantity	2
TITLE	NSERC POD Moquin PD Spacer Stern
SIZE	A2
NUMBER	980X08
REV	
SCALE	1:1
DATE	03-Feb-05
SHEET	1 OF 1

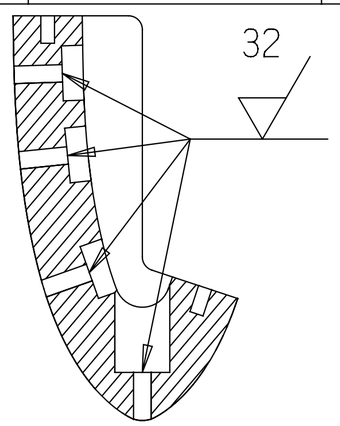
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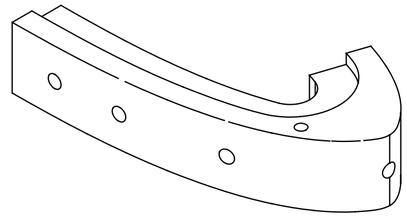
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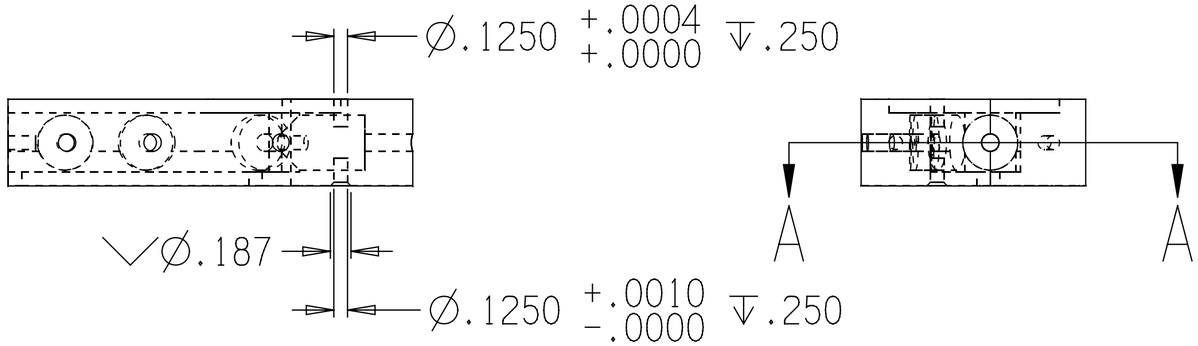
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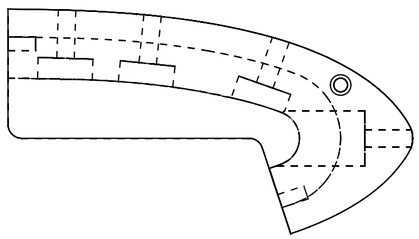




SECTION A−A







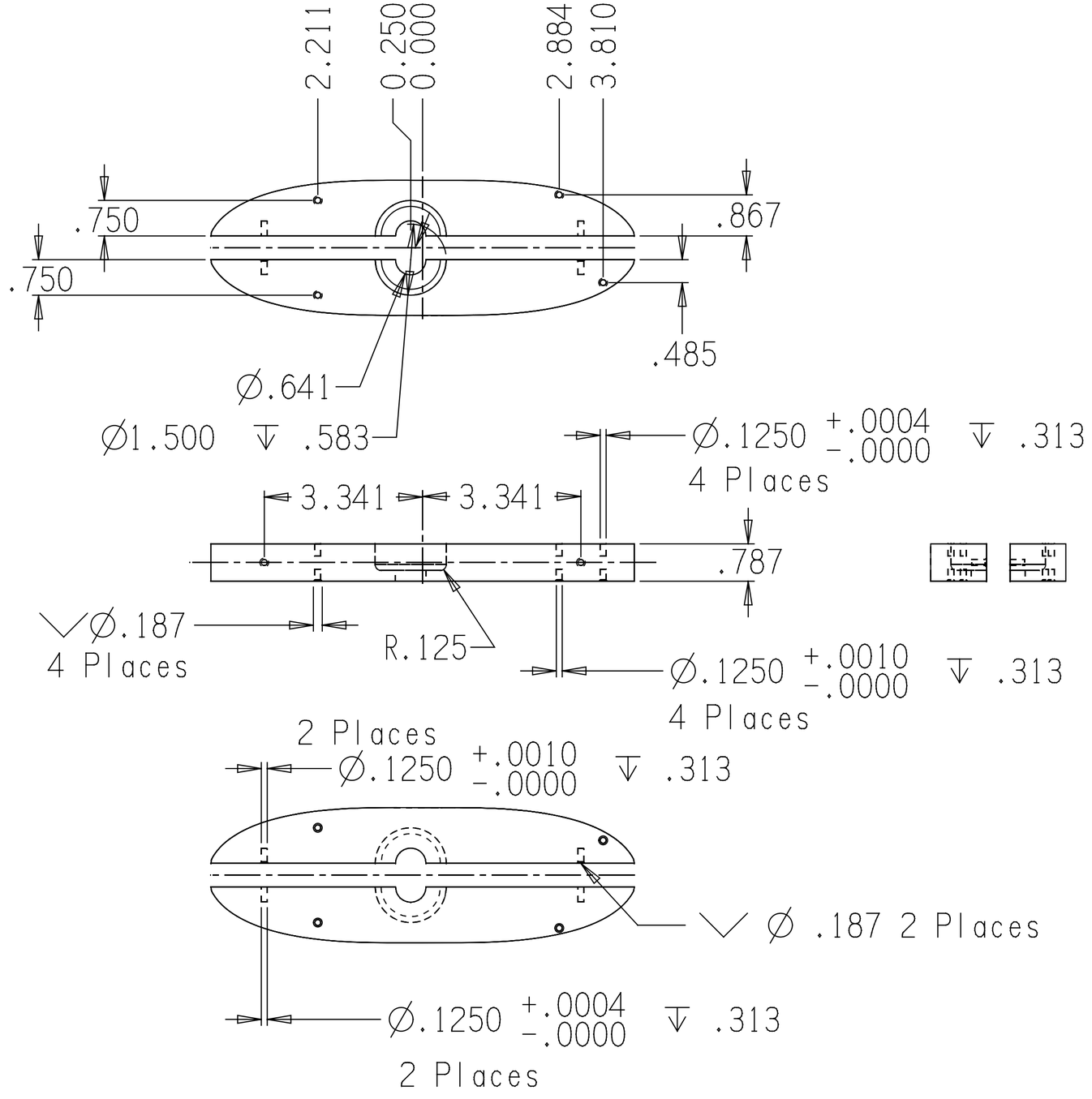
National Research Council Canada / Conseil national de recherches Canada — NRC-CNRC			
TOLERANCES (unless specified) 0.X ± 0.03 0.XX ± 0.015 0.XXX ± 0.005 Angle +/- .5 deg. Fabrication +/- .04 Fraction < 6 inch +/- 1/64 > 6 inch +/- 1/32	Material: Renshape 460 Heat Treatment FINISH DIMENSIONS IN: INCHES ☒ MILLIMETERS ☐ THIRD ANGLE	Institute for Marine Dynamics Kerwin Place, P.O. Box 12093, Postal Station A St. John's, Newfoundland A1B 3T5 TRAX 980 DRAWN T.Slade APPROVED Quantity 2	TITLE: NSERC POD Moquin PD Spacer Nose A2 NUMBER 980X07 REV SCALE 1:1 DATE 01-Feb-05 SHEET 1 OF 1

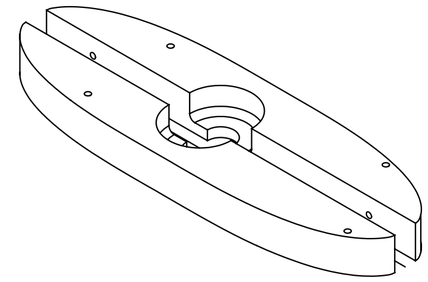
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REVISIONS				
NO.	ZONE	DESCRIPTION	DATE	APPROVED
A0		Issued For Comments	95-xx-xx	

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Part File projects/980 Nserc Pod/tslade/cadkey/980X00.ckd

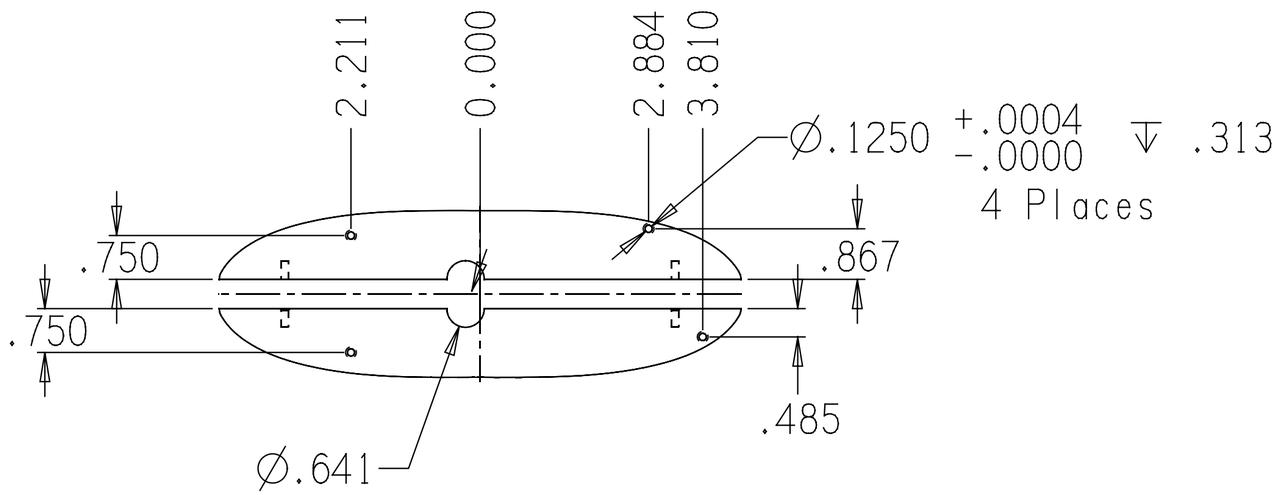


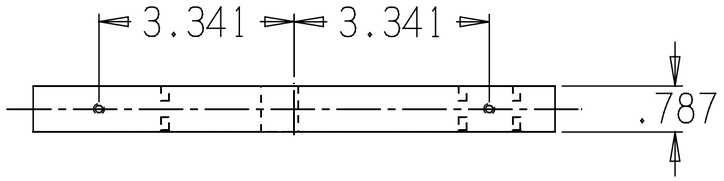


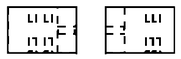
National Research Council Canada / Conseil national de recherches Canada — NRC-CNRC			
TOLERANCES (unless specified) 0.X ± 0.03 0.XX ± 0.015 0.XXX ± 0.005 Angle +/- .5 deg. Fabrication +/- .04 Fraction < 6 inch +/- 1/64 > 6 inch +/- 1/32	Material: Renshape 460 Heat Treatment FINISH DIMENSIONS IN: INCHES ☒ MILLIMETERS ☐ THIRD ANGLE	*Institute for Marine Dynamics* *Kerwin Place, P.O. Box 12093, Postal Station A* *St. John's, Newfoundland A1B 3T5*	
		TRAX 980	TITLE: NSERC POD Moquin Spacer 2
		DRAWN T.Slade	
		APPROVED	A2 — NUMBER 980X06 — REV
		Quantity 1	SCALE 1:2 — DATE 01-Feb-05 — SHEET 1 OF 1

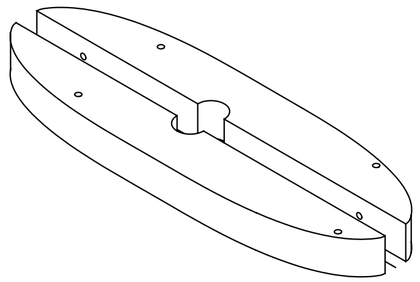
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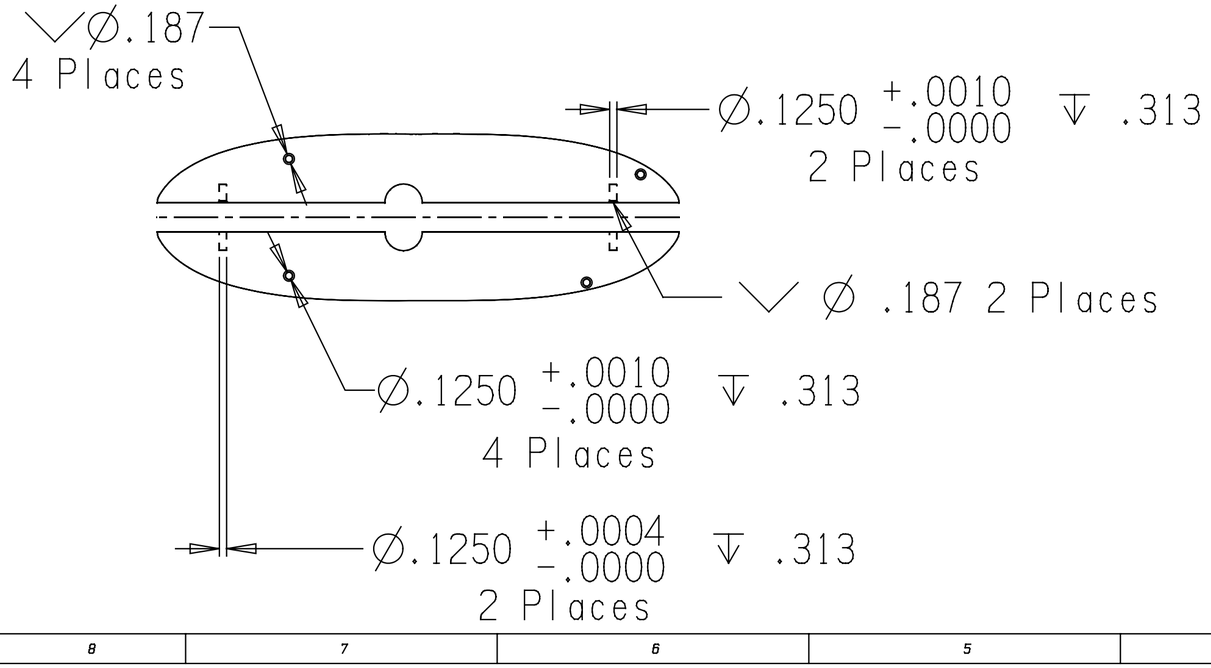






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Part File projects/980 Nserc Pod/tslade/cadkey/980X00.ckd



National Research Council Canada | Conseil national de recherches Canada | NRC-CNRC

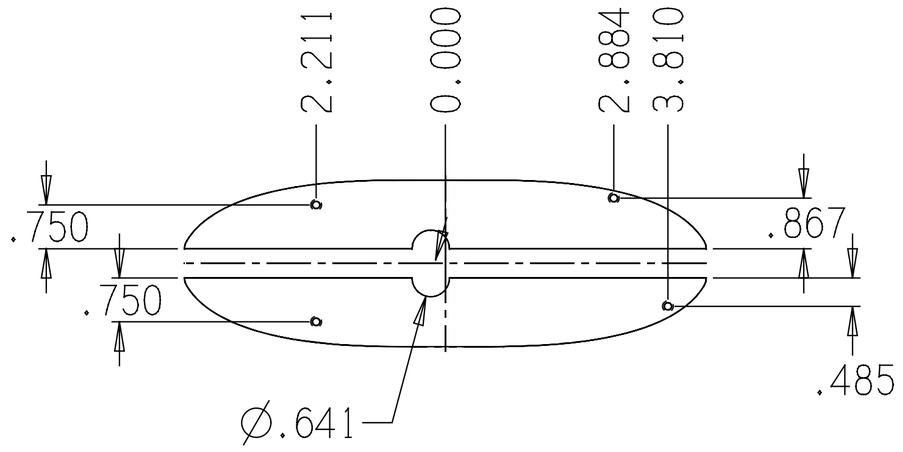
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	FINISH	TRAX: 980	TITLE: NSERC POD Moquin Spacers 3 & 4
	DIMENSIONS IN: INCHES ☒ MILLIMETERS ☐	DRAWN: T.Slade	
	THIRD ANGLE	APPROVED	NUMBER: A2 980X05 REV
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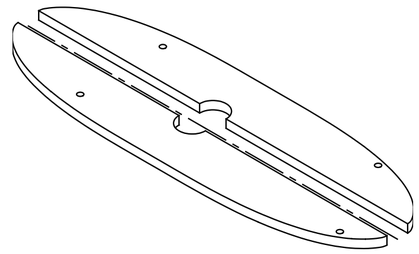
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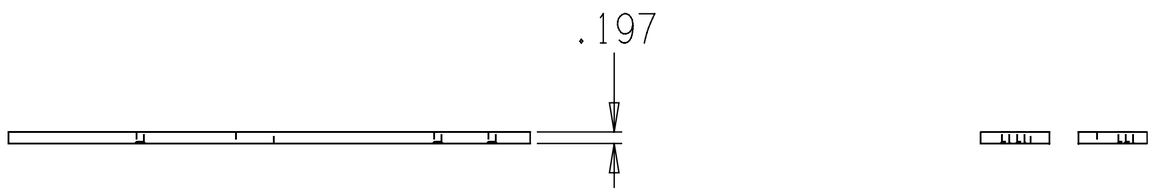
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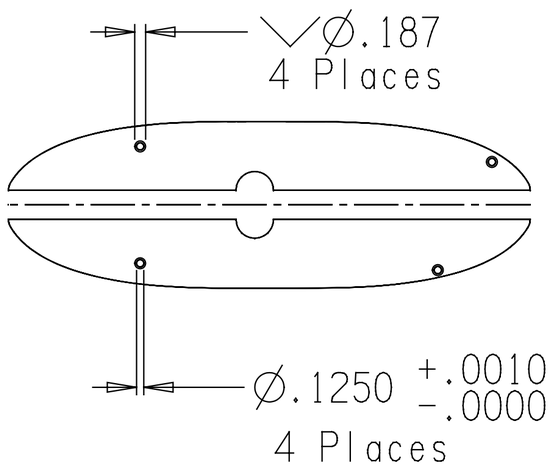
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Part File projects/980 Nserc Pod/tslade/cadkey/980X00.ckd









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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 inch +/- 1/64
> 6 inch +/- 1/32

Material: Renshape 460
Heat Treatment:
FINISH:
DIMENSIONS IN: INCHES ☒ MILLIMETERS ☐
THIRD ANGLE

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

TRAX: 980
DRAWN: T.Slade
APPROVED:
Quantity: 2

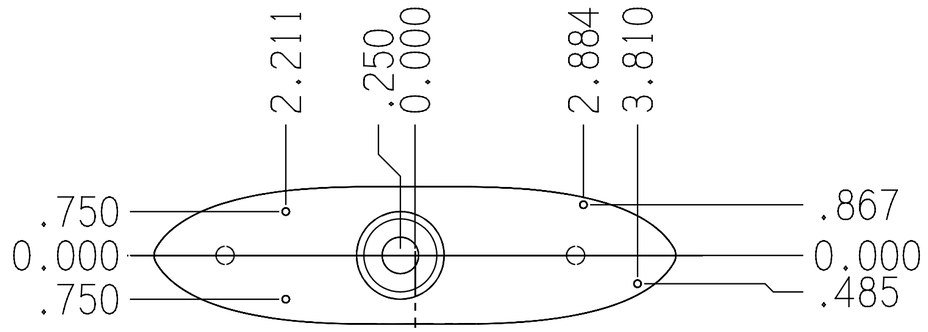
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SCALE: 1:2 | DATE: 01-Feb-05 | SHEET 1 OF 1

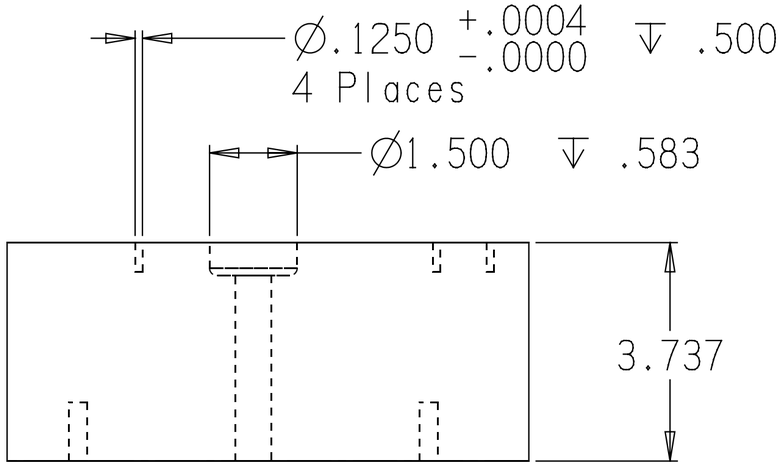
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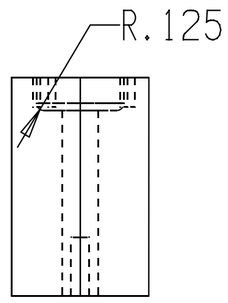
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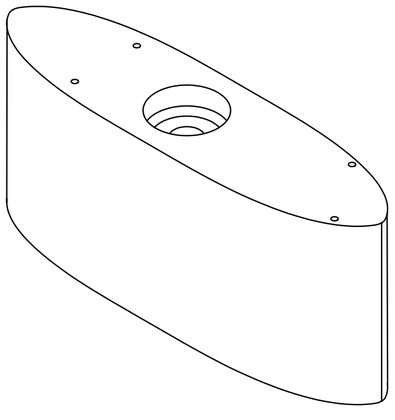
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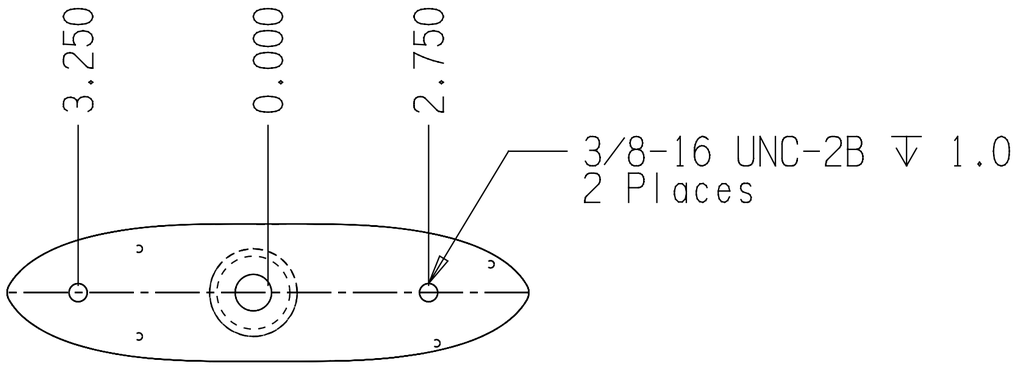
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TOLERANCES (unless specified)
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0.XX ± 0.015
0.XXX ± 0.005
Angle +/- .5 deg.
Fabrication +/- .04
Fraction < 6 inch +/- 1/64
> 6 inch +/- 1/32

Material: Renshape 460
Heat Treatment:
FINISH:
DIMENSIONS IN: INCHES ☒ MILLIMETERS ☐
THIRD ANGLE

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

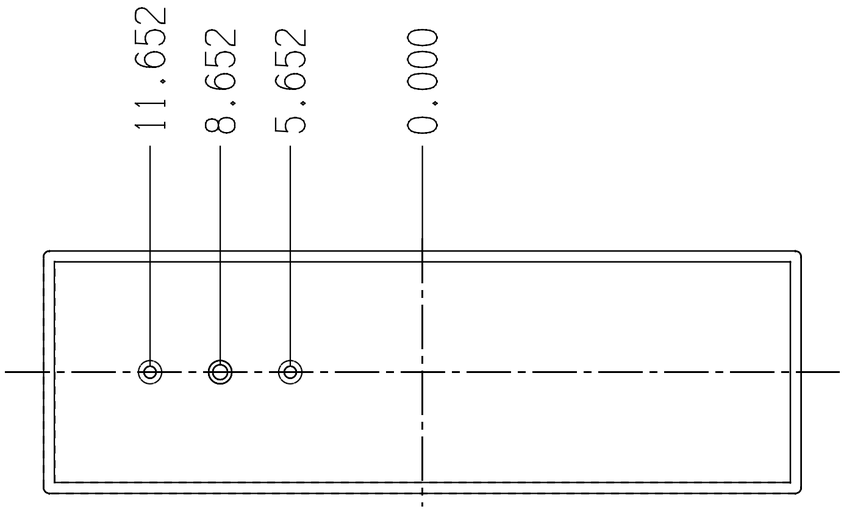
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DRAWN: T.Slade
APPROVED:
Quantity: 1

TITLE: NSERC POD Moquin Bottom Spacer
A2 | NUMBER: 980X03 | REV:
SCALE: 1:2 | DATE: 01-Feb-05 | SHEET 1 OF 1

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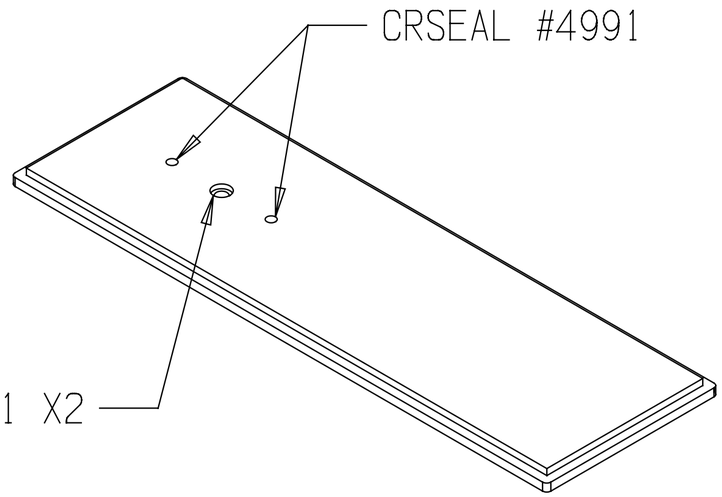
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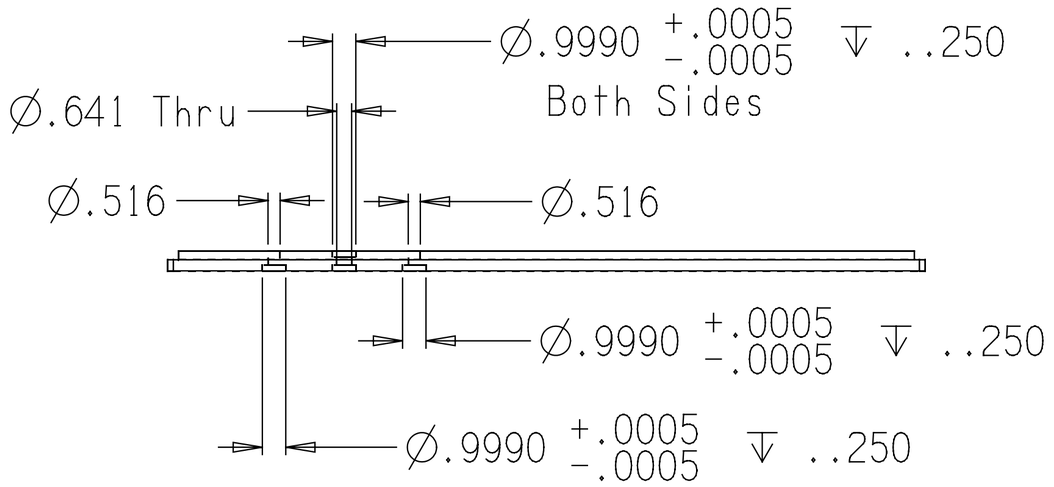
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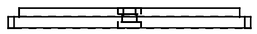


Notes:
Deburr - Remove All Sharp Edges

Part File projects/980 Nserc Pod/tslade/cadkey/980X00.ckd







Spaenaur Shoulder Bolts #364-828 2 Required

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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 inch +/- 1/64
> 6 inch +/- 1/32

Material: n/a
Heat Treatment:
FINISH:
DIMENSIONS IN: INCHES ☒ MILLIMETERS ☐
THIRD ANGLE

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

TRAX: 980
DRAWN: T.Slade
APPROVED:
Quantity: 1

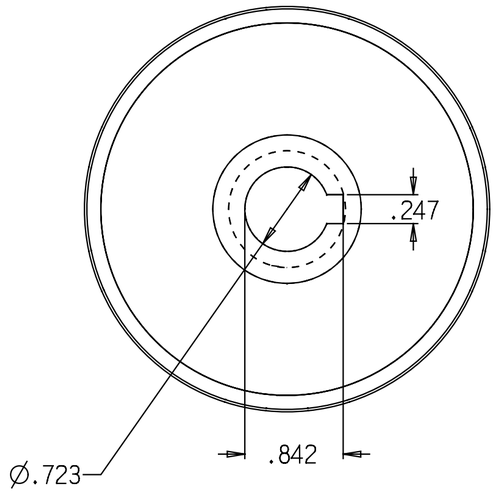
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A2 | NUMBER: 980X02 | REV:
SCALE: 1:5 | DATE: 01-Feb-05 | SHEET 1 OF 1

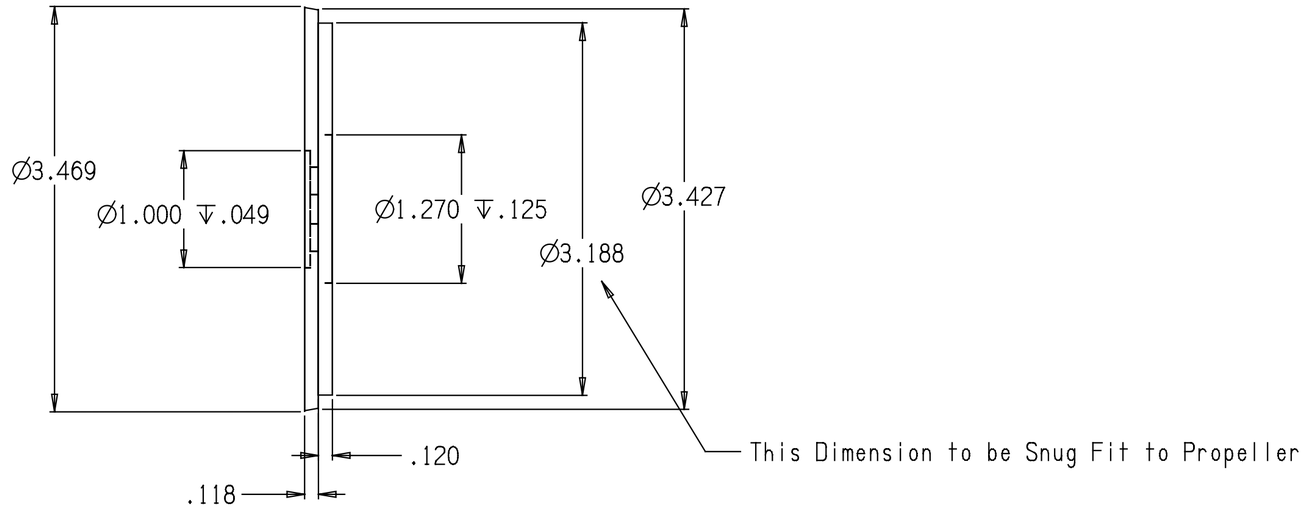
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NO.	ZONE	DESCRIPTION	DATE	APPROVED
A0		Issued For Comments	05-xx-xx	

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Part File projects/980 Nserc Pod/tslade/cadkey/980X00.ckd





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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 inch +/- 1/64
> 6 inch +/- 1/32

Material: Brass
Heat Treatment:
FINISH:
DIMENSIONS IN: INCHES ☒ MILLIMETERS ☐
THIRD ANGLE

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

TRAX: 980
DRAWN: T.Slade
APPROVED:
Quantity: 1

TITLE: NSERC POD Moqun Propeller Spacer
NUMBER: A2 980X15 REV:
SCALE: 1:1
DATE: 09-Mar-05
SHEET 1 OF 1

Piezoresistive Pressure Transducer

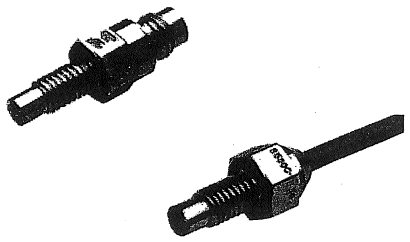
Model 8530C-15, -50 and -100

- **15 to 100 psia, 225 mV Full Scale**
- **Absolute Reference**

ENDEVCO MODEL 8530C

DESCRIPTION

The ENDEVCO® Model 8530C is a miniature, high sensitivity piezoresistive pressure transducer for measuring absolute pressure. The volume behind the diaphragm is evacuated and glass sealed to provide an absolute pressure reference. Full scale output is 225 mV with high overload capability and high frequency response. It is available in ranges from 15 psia to 100 psia. The Model 8530B is available for higher pressure ranges.



Actual size

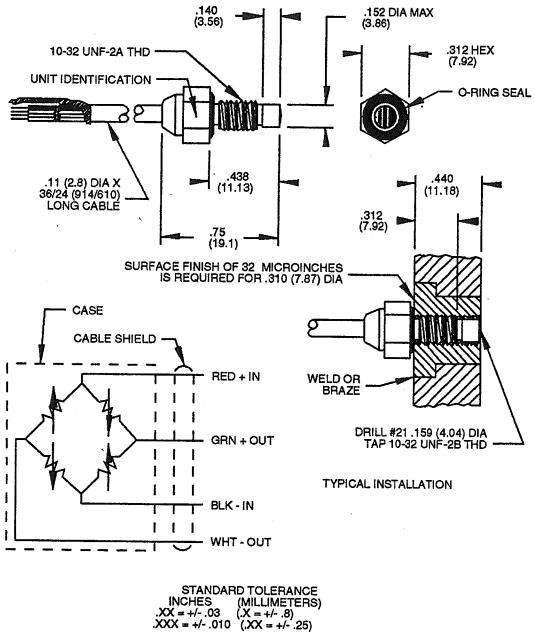
ENDEVCO pressure transducers feature a four-arm strain gage bridge ion implanted into a unique sculptured silicon diaphragm for maximum sensitivity and wideband frequency response. Self-contained hybrid temperature compensation provides stable performance over the temperature range of 0°F to 200°F (-18°C to +93°C).* ENDEVCO transducers also feature excellent linearity (even to 3X range), high shock resistance, and high stability during temperature transients.

The Model 8530C has been used successfully in many blast test situations. For this application, a protective coating is recommended to eliminate photoflash sensitivity and provide particle impingement protection. This coating does not degrade the superior dynamic response characteristics of the sensor.

The Model 8530C is available with Metric M5X0.8 mounting thread as 8530C-XXM5 on special order. Also available with integral four-pin connector as Model 8530C-XXM37.

ENDEVCO Model 136 Three-Channel System, Model 4428A or 4430A Signal Conditioner, or OASIS 2000 Computer-Controlled System are recommended as signal conditioner and power supply.

*Option X: 40°F to 140°F (5°C to 60°C)



SPECIFICATIONS

CERTIFIED PERFORMANCE: All specifications assume +75°F (+24°C) and 10 Vdc excitation unless otherwise stated. The following parameters are 100% tested. Calibration data, traceable to the National Institute of Standards and Technology (NIST), is supplied.

	Units	8530C-15	-50	-100
RANGE [1]	psia	0 - 15	0 - 50	0 - 100
SENSITIVITY [1]	mV/psi Typ (Min)	15.0 (9.3)	4.5 (2.8)	2.25 (1.4)
COMBINED: NON-LINEARITY, NON-REPEATABILITY, PRESSURE HYSTERESIS [2]	% FSO RSS Max	0.50	0.40	0.40
Non-Linearity, Independent	% FSO Typ	0.15	0.1	0.1
Non-Repeatability	% FSO Typ	0.1	0.1	0.1
Pressure Hysteresis	% FSO Typ	0.1	0.1	0.1
ZERO MEASURAND OUTPUT [3]	mV Max	±20	±20	±20
ZERO SHIFT AFTER 3X RANGE	±% 3X FSO Max	0.2	0.2	0.2
THERMAL ZERO SHIFT				
From 0°F to 200°F (-18°C to +93°C)	±% FSO Max	3	3	3
From 40°F to 140°F (5°C to 60°C)	±% FSO Max	3	3	3 X-Option
THERMAL SENSITIVITY SHIFT				
From 0°F to 200°F (-18°C to +93°C)	±% Max	3	3	3
From 40°F to 140°F (5°C to 60°C)	±% Max	3	3	3 X-Option

ENDEVCO MODEL 8530C

Piezoresistive Pressure Transducer

SPECIFICATIONS—continued

TYPICAL PERFORMANCE CHARACTERISTICS: The following parameters are established from testing of sample units.

	Units	8530C-15	-50	-100
RESONANCE FREQUENCY	Hz	180 000	320 000	500 000
NON-LINEARITY AT 3X RANGE	% 3X FSO	1.0	1.0	1.0
ZERO SHIFT WITH MOUNTING TORQUE 15 lbf-in. (1.7 Nm)	% FSO	0.2	0.5	0.5
THERMAL TRANSIENT RESPONSE PER ISA-S37.10, PARA. 6.7, PROCEDURE I [4]	psi/°F	0.003	0.003	0.010
	psi/°C	0.005	0.005	0.018
PHOTOFLASH RESPONSE [5]	Equiv. psi	0.1	0.3	0.6
WARM-UP TIME [6]	ms	1	1	1
ACCELERATION SENSITIVITY	Equiv. psi/g	0.00015	0.00015	0.00015
BURST PRESSURE (Diaphragm)	psia Min	75	250	400
CASE PRESSURE [7]	psia Min	1000	1000	1000

ELECTRICAL

FULL SCALE OUTPUT	225 mV typical (140 mV minimum) at 10.0 Vdc
SUPPLY VOLTAGE [8]	10.0 Vdc recommended, 15 Vdc maximum
ELECTRICAL CONFIGURATION	Active four-arm piezoresistive bridge
POLARITY	Positive output for increasing pressure
RESISTANCE	
Input	2600 ohms typical, 1700 ohms minimum
Output	1500 ohms typical, 2200 ohms maximum
Isolation	100 megohms minimum at 50 Volts; leads to case, leads to shield, shield to case
NOISE	5 microvolts rms typical, dc to 50 000 Hz; 50 microvolts rms maximum, dc to 50 000 Hz

MECHANICAL

CASE, MATERIAL	Stainless Steel (17-4 PH CRES)
CABLE, INTEGRAL	Four conductor No. 32 AWG Teflon® insulated leads, braided shield, gray silicone jacket, 30 ±6 in (760 ±150mm)
DEAD VOLUME (+) PORT	0.0003 cubic inches (0.005 cc)
MOUNTING/TORQUE	10-32 UNF-2A threaded Case 0.438 inch (11.12 mm) long/15 ± 5 lbf-in (1.7 ±0.6 Nm)
WEIGHT	2.3 grams (cable weighs 9 grams/meter)

ENVIRONMENTAL

MEDIA [9]	Internal seals are epoxy compatible with clean dry gas media. Media is exposed to CRES, ceramic, silicon, Parylene C, epoxy, silicone rubber, and the O-Ring. For use in water or corrosive media, contact the factory for modifications and installation precautions which may be taken to extend service life
TEMPERATURE [10]	-65°F to +250°F (-54°C to +121°C)
VIBRATION	1000 g pk
ACCELERATION	1000 g
SHOCK	20 000 g, 100 microsecond haversine pulse
HUMIDITY	Isolation resistance greater than 100 megohms at 50 volts when tested per MIL-STD-202E, Method 103B, Test Condition

CALIBRATION DATA

Data supplied for all parameters in Certified Performance section. Optional calibrations available for all parameters in Typical Performance section.

ACCESSORY

EHR93	O-RING, VITON

OPTIONAL ACCESSORIES

EHR96	O-RING, FLUOROSILICONE
24328	4 CONDUCTOR SHIELDED CABLE

NOTES

1. 1 psi = 6.895 kPa = 0.069 bar.
2. FSO (Full Scale Output) is defined as transducer output change from 0 psia to + full scale pressure.
3. Zero Measurand Output (ZMO) is the transducer output with 0 psia applied.
4. Significantly higher thermal transient errors occur if the excitation voltage exceeds 10 Vdc. For sensitive phase change studies, many users reduce the excitation to 5 Vdc or even 1 Vdc.
5. Per ISA-S37.10, Para. 6.7, Proc. II. The metal screen partially shields the silicon diaphragm from incident radiation. Accordingly, light incident at acute angles to the screen generally increases the error by a factor of 2 or 3.
6. Warm-up time is defined as elapsed time from excitation voltage "turn on" until the transducer output is within ±1% of reading accuracy.
7. Case pressure identifies media containment pressure in the event of diaphragm rupture.
8. For best results when using excitation voltages other than 10.0 Vdc, it is recommended that the transducer be calibrated at the desired excitation during manufacture. Otherwise larger thermal errors may occur, especially at voltages above 10 Vdc.
9. O-Ring, ENDEVCO part number EHR93 PARKER 5-125, compound V747-75 (VITON®) is supplied unless otherwise specified on purchase order. Fluorosilicone O-ring, Endevco part number EHR96 Parker material L677-70, for leak tight operation below 0°F is available on special order.
10. Units can be compensated over any 200°F (93°C) span.
11. Maintain high levels of precision and accuracy using Endevco's factory calibration services. Call Endevco's inside sales force at 800-982-6732 for recommended intervals, pricing and turn-around time for these services as well as for quotations on our standard products.

NOTE: Tighter specifications are available on special order.

Continued product improvement necessitates that Endevco reserve the right to modify these specifications without notice. Endevco maintains a program of constant surveillance over all products to ensure a high level of reliability. This program includes attention to reliability factors during product design, the support of stringent Quality Control requirements, and compulsory corrective action procedures. These measures, together with conservative specifications have made the name Endevco synonymous with reliability.

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BORE DIA.	SEAL O.D.	WIDTH OF SEAL	STOCK NO.	TYPE AND STYLE	LIP CODE
.375 SHAFT (Cont.)					
1.124	1.128	.250	**▲3806**	CRW1	R
1.124	1.128	.375	**3807**	†CRW5	V
.404 SHAFT					
.620	.624	.188	**▲4010**	HM14	R
.862	.866	.250	**4012**	HM14	R
.425 SHAFT					
.875	.879	.313	4100	CRWH3	R
.438 SHAFT					
.688		.063	451232	BUW	#
.688		.125	**700101**	BV	R
.688		.125	**721510**	BV	D
.688		.125	**721527**	BV	V
.836	.840	.188	**▲4231**	HM14	R
.875	.879	.250	**4249**	†CRW1	P
.875	.879	.250	**▲4251**	CRW1	R
.875	.881	.250	**4260**	CRWA6	R
.875	.879	.313	4247	HMS1	D
W/SS CASE & SPRING					
.875	.879	.313	4248	†CRSH1	R
.875	.879	.375	**4261**	CRWA1	R
.879	.885	.180	4256	HM8	R
.999	1.003	.250	**▲4340**	HM14	R
.999	1.003	.250	**4356**	†CRW1	V
.999	1.003	.375	**4353**	†CRW1	P
.999	1.003	.375	**▲4355**	†CRW1	R
1.124	1.128	.250	**▲4390**	†CRW1	R
.469 SHAFT					
.703	.707	.125	**4615**	HM3	R
.836	.840	.188	**4623**	HM14	P
.875	.879	.219	**▲4628**	HM14	R
.999	1.003	.313	▲4641	†P2	R
.500 SHAFT					
		.250	**99050**	SSLEEVE	
SHAFT RANGE .498 - .502					
		.180	**400120**	VR1	R
SHAFT RANGE .450 - .530					
		.180	**400124**	VR1	V
SHAFT RANGE .450 - .530					
		.260	**400121**	VR2	R
SHAFT RANGE .450 - .530					
		.260	**400125**	VR2	V
SHAFT RANGE .450 - .530					
.688	.691	.094	▲4911	HM3	R
.688	.691	.170	4909	HMS1	R
P.F. WIDTH .100					
.749	.753	.125	▲4913	HMS1	R
O.A. WIDTH .156					
.750		.063	451225	BUW	#
.750	.754	.125	**▲4912**	†HM14	R
.750		.125	**711806**	BV	R
.750		.125	**721513**	BV	V
.750		.125	**721518**	BV	D
.750	.754	.250	**480050**	KIT	R
SPEEDI-SLEEVE/GREASE SEALS					
.802		.203	**709001**	WS	R
.820	.824	.156	**▲4914**	†HM14	R
.843	.847	.250	**▲4923**	†HM14	R
.875	.879	.125	**4925**	HM14	R
.875	.879	.125	▲527936	BB	R
.875	.879	.125	528760	BB	R
W/STAINLESS STEEL CASE					
.875	.879	.250	**▲4931**	†CRW1	R
.875	.879	.250	**4932**	†CRW1	V

BORE DIA.	SEAL O.D.	WIDTH OF SEAL	STOCK NO.	TYPE AND STYLE	LIP CODE
.500 SHAFT (Cont.)					
.875	.879	.250	**4933**	†CRWA1	V
.875	.879	.250	**4935**	†CRWA1	V
W/SS CASE & SPRING					
.875	.879	.250	**4936**	†CRW1	D
.875	.879	.250	**▲4938**	HM14	R
.875	.879	.313	**4939**	†CRWA1	R
.875	.879	.313	**4940**	†CRWA5	R
.987	.991	.250	**▲4943**	†CRW1	R
.987	.991	.250	4944	†HMS1	R
W/STAINLESS STEEL SPRING					
.999	1.003	.188	**▲4950**	†HM14	R
.999	1.003	.250	**4980**	†CRW1	V
W/STAINLESS STEEL SPRING					
.999	1.003	.250	**▲4984**	†CRW1	R
.999	1.003	.250	**4985**	†CRWA1	R
.999	1.003	.250	**4990**	†HM14	R
.999	1.003	.250	**4991**	†CRWA5	V
W/STAINLESS STEEL SPRING					
.999	1.003	.313	**4996**	†CRWA5	R
.999	1.003	.375	★4995	†SPEC	L
1.000	1.004	.281	504260	SC	R
1.006	1.010	.250	5001	CRS1	R
1.124	1.128	.250	**5045**	†CRW1	P
1.124	1.128	.250	**5062**	†CRWA1	R
1.124	1.128	.250	**5066**	†CRW1	V
1.124	1.128	.250	5067	†CRWA1	V
1.124	1.128	.250	**▲5068**	†CRW1	R
1.124	1.128	.250	**5069**	†CRWA5	R
1.124	1.128	.250	**5072**	†CRWA5	V
1.124	1.128	.250	**▲5085**	†HM14	R
1.124	1.128	.313	**5046**	†CRW1	P
1.249	1.253	.188	5131	CRWH3	R
W/SS CASE & SPRING					
1.250	1.254	.250	**▲5133**	CRW1	R
1.375	1.379	.250	**▲5150**	†CRW1	R
1.375	1.379	.250	**5151**	†CRW1	V
.531 SHAFT					
		.180	**400130**	VR1	R
SHAFT RANGE .490 - .570					
		.180	**400134**	VR1	V
SHAFT RANGE .490 - .570					
.999	1.003	.250	**5321**	†CRWA1	S
1.124	1.128	.313	5334	CRSA1	R
.546 SHAFT					
.875	.879	.250	**5385**	CRW1	P
.551 SHAFT					
1.124	1.128	.203	**▲5399**	†HM14	R
.554 SHAFT					
.999	1.003	.250	**5605**	†CRW1	R
W/SS CASE & SPRING					
.563 SHAFT					
		.250	**99056**	SSLEEVE	
SHAFT RANGE .560 - .566					
		.180	**400144**	VR1	V
SHAFT RANGE .530 - .610					
		.260	**400141**	VR2	R
SHAFT RANGE .530 - .610					
		.260	**400145**	VR2	V
SHAFT RANGE .530 - .610					
.750	.754	.094	**5500**	HM3	R
.810	.817	.188	▲5510	HM3	R
.813		.063	451240	BUW	#
.813		.125	**710696**	BV	R

★ Contact Manufacturer for availability
BOLD NUMBERS are preferred designs
✓ Stocked Large Diameter Product
† Includes Bore-Tite on O.D.
▲ WasteWatcher Numbers

CRSEALS

364-7959

BORE DIA.	SEAL O.D.	WIDTH OF SEAL	STOCK NO.	TYPE AND STYLE	LIP CODE
.563 SHAFT (Cont.)					
.813		.125	**721557**	BV	D
.813		.125	**721569**	BV	V
.875	.879	.188	**▲5522**	†HM14	R
.875	.879	.188	**5523**	†CRW1	D
.999	1.003	.219	**▲5569**	†HM14	R
.999	1.003	.250	**▲5541**	†CRW1	R
.999	1.003	.250	**5542**	†CRW1	V
.999	1.003	.250	**5543**	†CRW1	R
W/SS CASE & SPRING					
.999	1.003	.250	**5606**	†CRWA1	R
1.124	1.128	.250	**5650**	†CRW1	V
1.124	1.128	.250	**▲5652**	†CRW1	R
1.124	1.128	.250	**5662**	†CRWA1	R
1.124	1.128	.250	**▲5685**	HM14	R
1.250	1.254	.250	**▲5707**	†CRW1	R
1.375	1.379	.250	**▲5756**	†CRW1	R
.570 SHAFT					
		.180	**400140**	VR1	R
SHAFT RANGE .530 - .610					
.594 SHAFT					
1.124	1.128	.250	**▲5946**	†HM14	R
1.124	1.128	.313	**▲5926**	†CRW1	R
1.124	1.128	.313	**5927**	†CRW1	V
1.250	1.254	.313	5950	CRSA1	R
1.375	1.379	.313	▲5966	†CRSA1	R
.610 SHAFT					
1.102	1.108	.600	6103	SPEC	V
P.F. WIDTH .236 (6MM)					
.624 SHAFT					
1.131	1.133	.188	**6243**	†HM14	R
.625 SHAFT					
		.313	**99062**	SSLEEVE	
SHAFT RANGE .623 - .627					
		.180	**400160**	VR1	R
SHAFT RANGE .610 - .690					
		.180	**400164**	VR1	V
SHAFT RANGE .610 - .690					
		.260	**400161**	VR2	R
SHAFT RANGE .610 - .690					
		.260	**400165**	VR2	V
SHAFT RANGE .610 - .690					
.813	.816	.094	**▲6105**	HM3	R
.813	.816	.094	6106	HM3	V
.875		.063	451081	BUW	#
.875	.881	.125	6119	HM4	R
.875		.125	**710212**	BV	R
.875		.125	712130	BV	V
.875		.125	**721503**	BV	V
.875		.125	**721520**	BV	D
.875	.879	.188	▲6120	HMS1	R
P.F. WIDTH .125					
.927		.203	**709002**	WS	R
.927		.203	**712120**	WS	V
.933	.937	.188	**▲6125**	†HM14	R
.933	.937	.188	6126	†HM14	V
.937	.941	.188	**▲6130**	†HM14	R
.987	.991	.250	**6134**	†CRW1	R
W/STAINLESS STEEL SPRING					
.999	1.003	.250	**6139**	†CRWA1	V
W/STAINLESS STEEL SPRING					
.999	1.003	.250	**6141**	†CRWA1	R
.999	1.003	.250	**▲6143**	†CRW1	R

BORE DIA.	SEAL O.D.	WIDTH OF SEAL	STOCK NO.	TYPE AND STYLE	LIP CODE
.625 SHAFT (Cont.)					
.999	1.003	.250	▲6147	HMSA11	R
W/SS CASE & SPRING					
.999	1.003	.250	**6151**	†CRWA5	R
1.000	1.004	.125	**▲6152**	†HM14	P
1.062	1.066	.188	**6155**	HM14	R
1.063	1.067	.250	**6157**	†CRW1	R
1.063	1.067	.250	**▲6158**	†HM14	R
1.096	1.100	.445	6159	HMA	R
W/1.250 FLG & AXIAL DIRT LIP					
1.124	1.128	.250	**6191**	†CRW5	R
1.124	1.128	.250	**▲6203**	†CRW1	R
1.124	1.128	.250	**6204**	†CRWA1	R
1.124	1.128	.250	**6213**	†CRW1	V
1.124	1.128	.250	**6215**	†CRWA1	V
1.124	1.128	.250	**▲6225**	†HM14	R
1.124	1.128	.281	504261	SC	R
1.124	1.128	.374	**6231**	†CRWA5	V
1.124	1.128	.375	**6184**	†CRWHA5	R
W/SS CASE & SPRING					
1.124	1.128	.375	**▲6229**	†CRWA5	R
1.125	1.129	.125	▲527937	BB	R
1.125	1.129	.125	528761	BB	R
W/STAINLESS STEEL CASE					
1.126	1.130	.250	**▲6232**	†CRW5	R
W/SS CASE & SPRING					
1.181	1.185	.250	**▲6247**	†CRWA1	R
1.181	1.185	.256	**6248**	†CRWA1	V
1.250	1.254	.250	**6309**	†CRW1	V
1.250	1.254	.250	**▲6315**	†CRW1	R
→ 1.250	1.254	.250	**6316**	†CRWA1	R
1.250	1.254	.250	**▲6323**	†HM14	R
1.250	1.254	.313	**▲6280**	CRWA5	R
W/SS CASE & SPRING					
1.250	1.254	.313	6285	CRWA5	V
W/S.S. CASE & SPRING					
1.259	1.263	.250	**▲6330**	†HM14	R
1.375	1.379	.250	6367	CRWH3	R
W/SS CASE & SPRING					
1.375	1.379	.250	**▲6370**	†HM14	R
1.375	1.379	.250	**6371**	†CRW5	P
1.375	1.379	.250	**▲6372**	†CRW1	R
→ 1.375	1.379	.250	**6373**	†CRWA1	R
1.375	1.379	.250	**6379**	†CRW1	V
1.375	1.379	.250	**6383**	†CRWA1	V
1.375	1.379	.375	**6388**	†CRWA5	R
W/SS CASE & SPRING					
1.377	1.381	.250	**▲6391**	†CRWHA1	R
1.499	1.503	.250	**▲6386**	†CRW1	R
1.500	1.504	.313	**6393**	†CRW5	V
W/STAINLESS STEEL SPRING					
.656 SHAFT					
1.124	1.128	.313	**▲6521**	†CRW1	R
1.250	1.254	.250	**▲6541**	†CRW1	R
1.375	1.379	.313	**▲6556**	†CRW1	R
1.575	1.579	.250	**▲6580**	†CRW1	R
.669 SHAFT					
.999	1.003	.188	**6595**	†CRW1	R
1.064	1.068	.250	**6728**	†CRW1	R
W/SS CASE & SPRING					
1.064	1.068	.250	**▲6729**	†CRW1	R
1.250	1.254	.250	**▲6806**	†HM14	R
1.378	1.387	.276	6641	HMSA124	P
W/1.703 FLANGE					

★ Contact Manufacturer for availability

BOLD NUMBERS are preferred designs

✓ Stocked Large Diameter Product

† Includes Bore-Tite on O.D.

▲ WasteWatcher Numbers