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A Deep Sea Docking Station for ODYSSEY Class Autonomous Underwater Vehicles

by

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Technical Report

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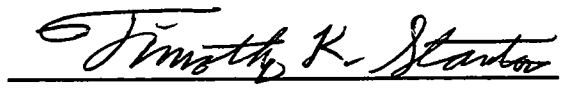

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A Deep Sea Docking Station for ODYSSEY Class Autonomous Underwater Vehicles

Electro-Mechanical Design, Fabrication and Operation for the MIT Sea Grant Autonomous Ocean Sampling Network (AOSN)

Prepared By:
M. F. Bowen, D. B. Peters

Version 1.0

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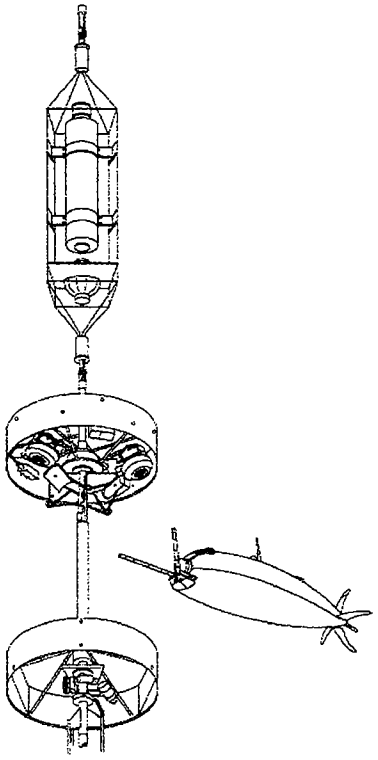

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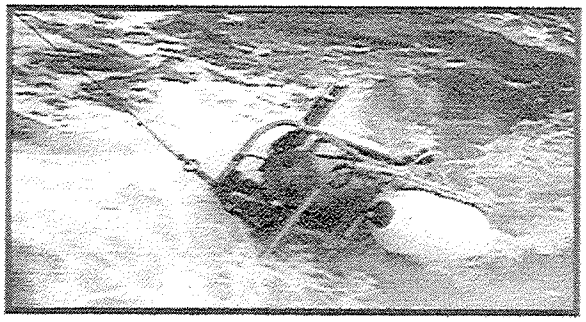

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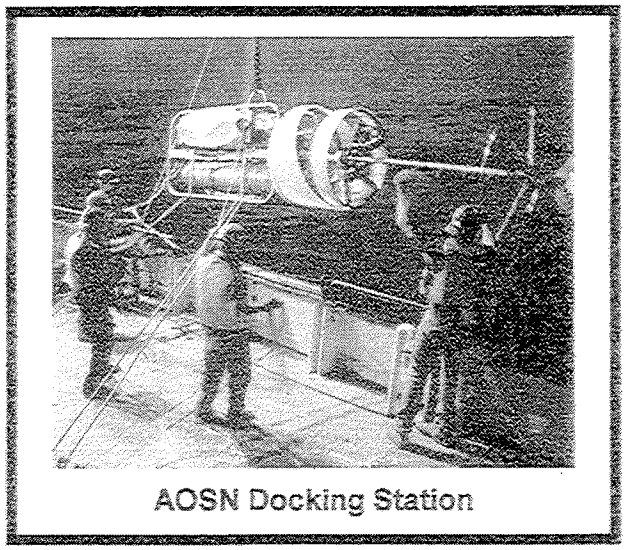


AOSN Docking Station

Abstract

Under subcontract to the Massachusetts Institute of Technology's (MIT) Sea Grant Autonomous Ocean Sampling Network (AOSN) program, engineers and researchers at the Woods Hole Oceanographic Institution (WHOI) designed, fabricated and operated a deep sea Docking Station for ODYSSEY-class autonomous underwater vehicles (AUVs). The docking station provides shelter as well as power transfer and data exchange services for an AUV that is between autonomous midwater missions. The Station is integrated into the main tension member of a deep sea mooring system. A large subsea flotation sphere supports the mass of the Station above the seafloor. A surface expression connected by an umbilical to the Station was capable of bi-directional satellite or radio frequency communications. Primary subsystems of the docking Station described in this report include a dock controller with multi-sensor support, long-duration battery packs, a docking pole with a moving carriage, an inductive link for power and data transfer, and information about how the Station was deployed, operated and recovered. (159) Keywords: AUV, docking, mooring.

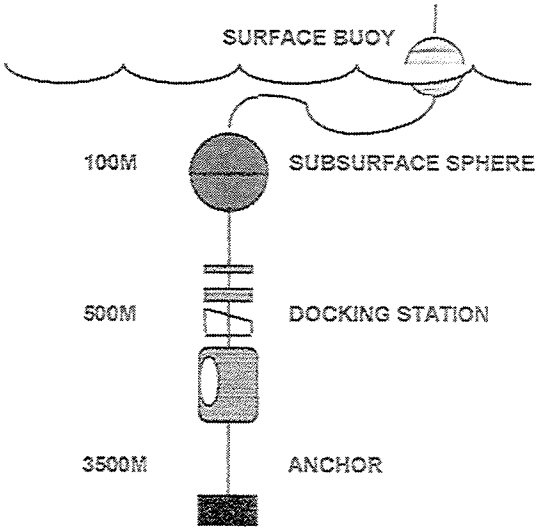
1.0 Introduction

The AOSN Deep AUV Docking Station was designed and built for MIT Sea Grant by the Deep Submergence Laboratory and the Applied Engineering Laboratory of WHOI and Electronic Design Consultants of North Carolina. The Station was fabricated in the summer of 1997, bench tested, wet tested, deployed to a depth of 500 meters in October 1997 during a test cruise to Site D off the New Jersey coast, revised at WHOI, and retested in preparation for an extended deployment. The Station was sealed and powered up again on 17 January for the (now-completed) 1998 AOSN cruise to the Labrador Sea on the R/V KNORR.

The Docking Station has not experienced a crippling failure since 17 January and has not been powered down since that date. The station was deployed a second time to a depth of 500 meters on 28 January for 14 days in the Labrador Sea and recovered successfully. A minimum of 30 days of on-board battery power has been consumed at the writing of this report.

2.0 Mooring Background

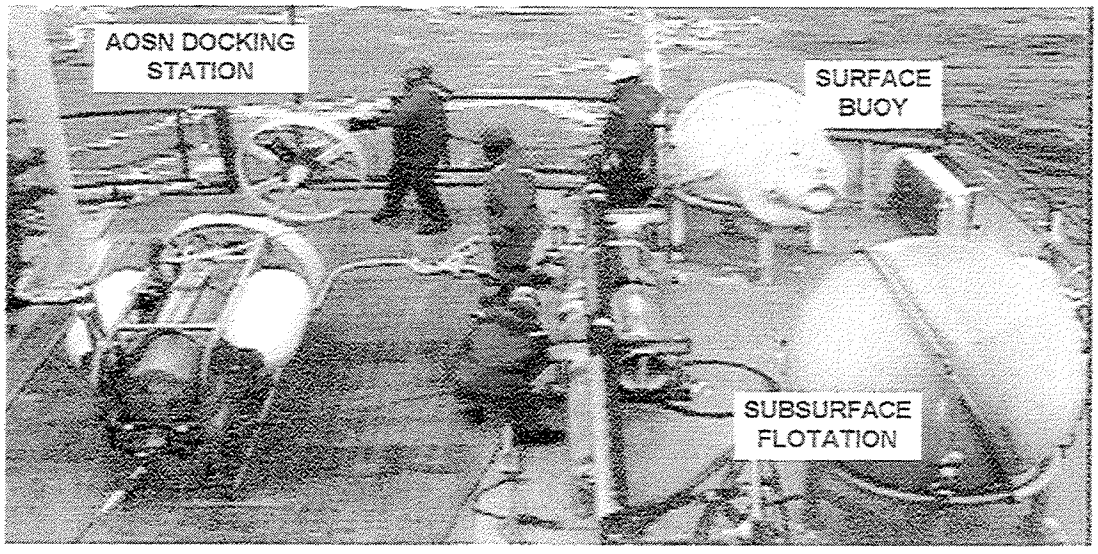
Three major mooring components appear in Figure [1]. The detailed design appears in Figure [24].



Except for the Docking Station itself, the remainder of the components and hardware making up the Labrador Sea AOSN Mooring have recognized histories of reliability and field longevity. The use of heavy duty strain reliefs, proven electro-mechanical terminations, a compliant s-tether configuration, pull-tested wire rope, new hardware and accurate ballast and buoyancy programs allowed mooring designers at WHOI to provide AOSN with a deep-sea system that was virtually trouble-free on two deep deployment opportunities, one in October 1997 and again this year in the Labrador Sea.

Data to and from the mooring, transmitted via satellite communications, are processed by electronics housed in the surface expression. Data transfer between the surface expression and the Docking Station occurs by a hardwired RS485 link. Data transfer between Station and AUV is accomplished by inductive link and acoustics.

Figure [1] AOSN Mooring Components on the Fantail of R/V KNORR



3.0 The Docking Station

A block diagram of the AOSN Labrador Sea Mooring and integral Docking Station appears in Figure [2]. The Docking Station is a tension-bearing device that provides services for an Odyssey class autonomous vehicle between data gathering missions. The Station is also capable of gathering data independent of the vehicle. It can withstand a five-knot mooring deployment transient and static tension through the frame of 3,000 lbs. Its mechanical components consist of a one-atmosphere aluminum frame, two battery housings, a dock controller housing, a docking pole, a moving carriage and motor, external sensors including magnetic switches, collapsible flotation, and wet harnessing. The Station components are pressure tested to 2,000 psig and the complete system is rated to a safe working depth of 1,000 meters. It weighs 2,512 lbs. in air and 930 lbs. at working depth. It is neutrally buoyant at the surface. For testing purposes, the Station can be deployed in water as shallow as 33 meters. A picture of the Station taken during mobilization and being lifted by its side bail appears in Figure [3].

Figure [2] Mooring and Docking Station, Block Diagram

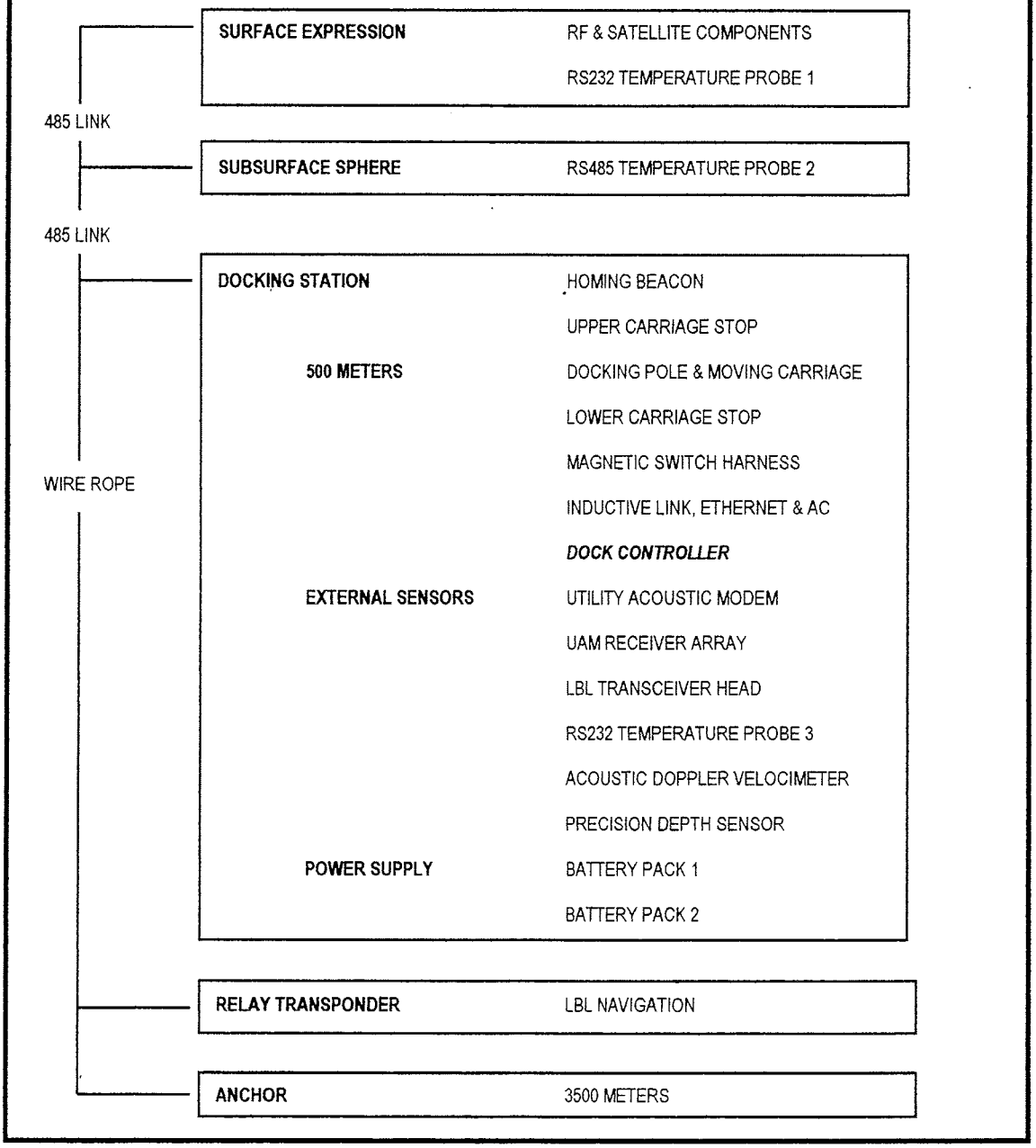
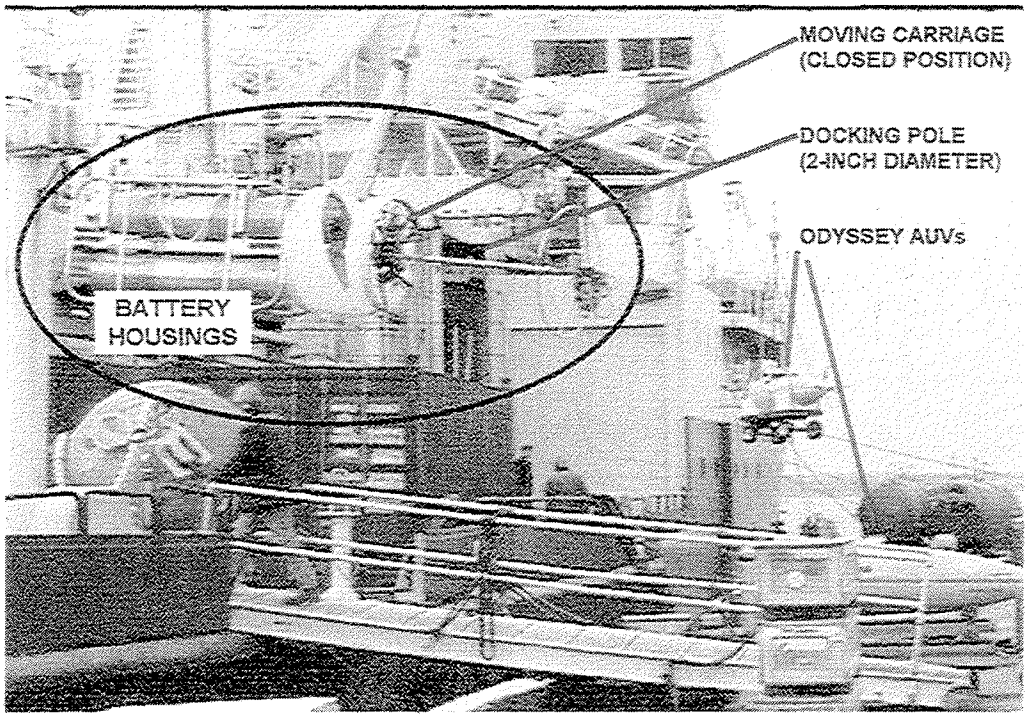


Figure [3] Docking Station (circled) and 2 AUVs



3.1 Docking Station Controller

3.1.1 Housing

The Docking Station Controller (Doccon) is a pressure-proof, cylindrical housing rated to 2,000 psig. The material used for the two endcaps and housing tube is a 6061-T6 aluminum alloy. Other materials used in the construction of the Doccon include Delrin, 300 series stainless steel, and various forms of poly plastics. The aluminum is cathodically protected from corrosion by strategically placed zinc anodes. The housing is nine inches in outside diameter (ten inches with hardware) and fifty-two inches long. It weighs 95 lbs. in air. When sealed, a minimum of ten, ten-gram desiccant packets are added to the volume to ensure humidity control.

3.1.2 Chassis Layout

The Doccon chassis layout appears in Figure [4]. The chassis framework is made up of adjustable aluminum shelves mounted at four corners to perforated aluminum channel. The channel is secured to one endcap only, allowing easy removal of the entire chassis and associated feedthroughs from the housing tube. The chassis is 7.5 inches in diameter. All power conductors are twisted pairs. High voltage circuitry is shielded and/or drained. Craftsmanship in construction meets and exceeds the best commercial practices.

Figure [4] Doccon Chassis, Mechanical Layout

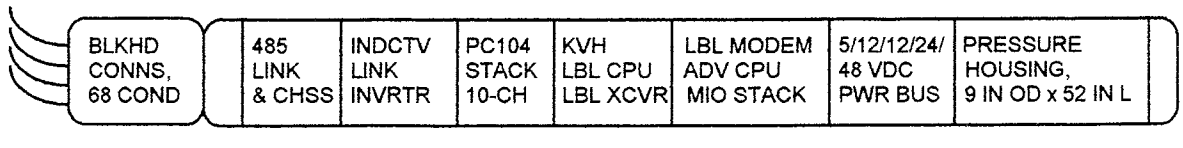
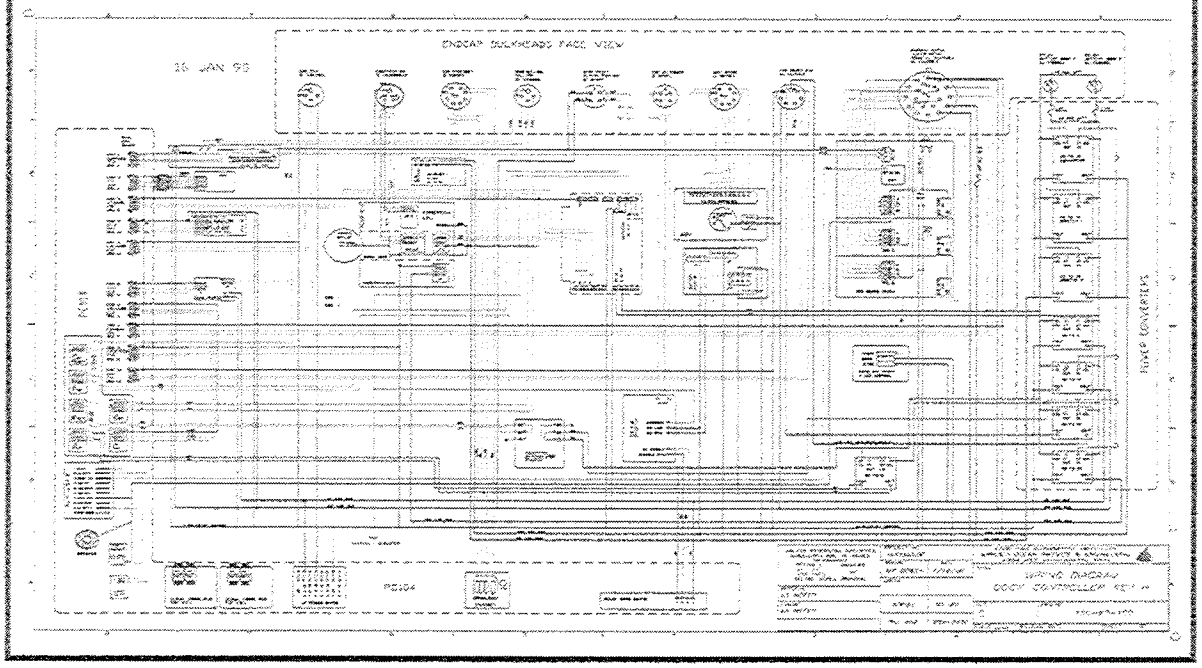


Figure [5] Doccon Chassis Wiring (See Drawing 156-97-100 J, pages 17-20)



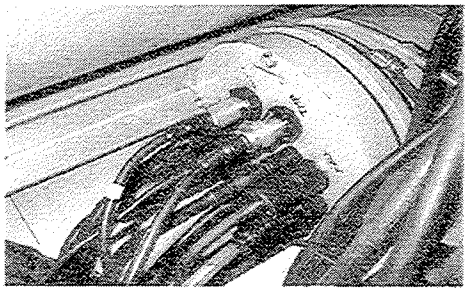
3.1.3 Chassis Wiring

The Doccon chassis wiring diagram appears in Figure [5] and as attached Drawing 156-97-100 Rev J. The drawing conveniently details all circuit interconnects, bulkhead feedthroughs, and the design of the power supply buses in a single D-size document.

The Doccon functions as a one-atmosphere enclosure for all integrated electronics associated with the following subsystems: an RS485 to RS232 converter sends and receives signals from the surface expression; an inverter to drive the inductive link resides within an isolated metal chassis; a dc/dc converter supplies the inverter; a PC104 stack with a 80386 CPU and ten serial inputs is assembled with a hard disk drive, parallel port, relay card, video card, Ethernet card, 485 card, utility card, reset circuitry with inverting optoisolator, inverter enabling circuitry; a KVH digital inclinometer with serial output provides dock pitch and roll data; long-baseline navigation and communications is provided by an Edgetech PS8000 transceiver, an AM200 modem, and a transducer driver stack; another circuit card stack supports an acoustic Doppler velocimeter probe; and a three-card stack provides an interface for eight magnetic switch channels and reset I/O signals. Also included in the chassis are sail to RS 232 converter, disabled watchdog circuitry, and a Vicor-based dc/dc converter power supply bus, which consists of eight modules and boosters. The chassis is densely packaged and secured against cable strumming vibration and shocks caused by ship motion and over the side deployment. All of the chassis components have star-point common returns, which float, with respect to seawater. Only the inverter cage and LBL transducer case are grounded to seawater.

3.1.4 Wet Harnessing

A view of the AOSN Doccon external connections and wet harnessing is provided in Figure [6].

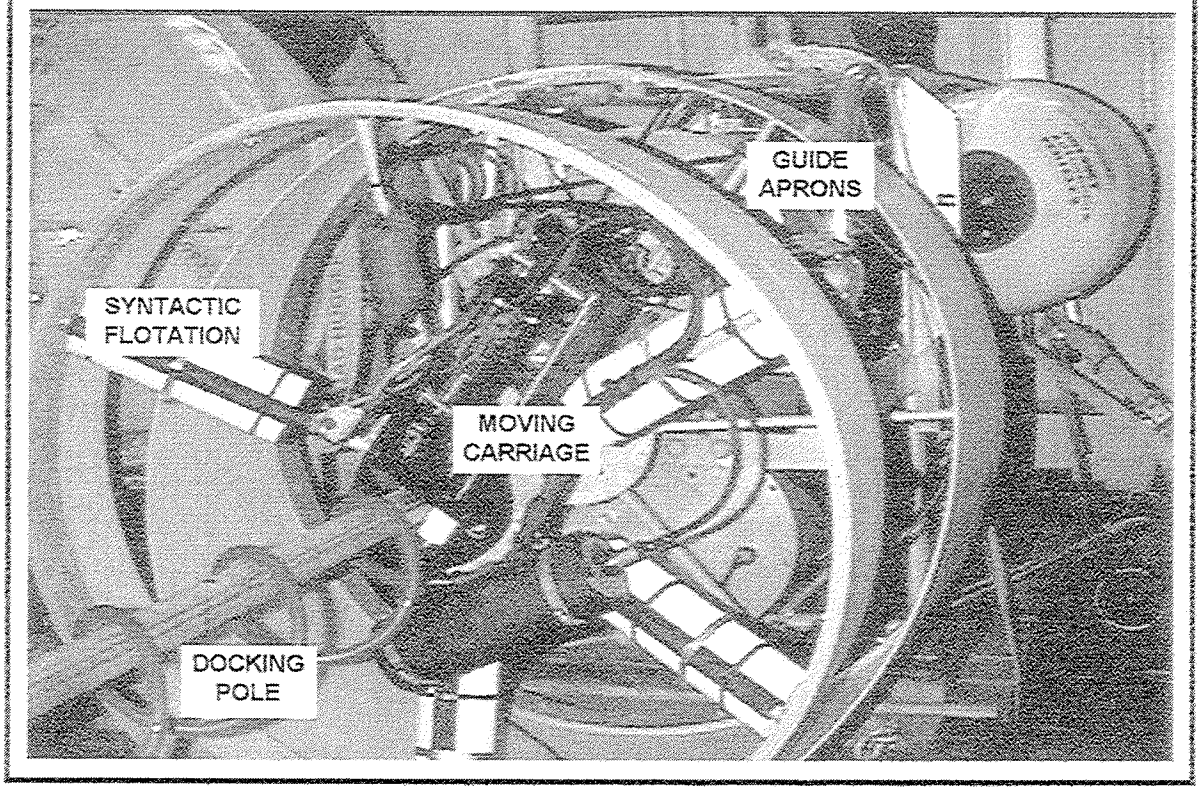


An effort was made to standardize models of pressure-proof connections in procurements from just two manufacturers. We also designed to avoid the pitfalls of interchangeability from bulkhead to bulkhead, which can cause catastrophic interconnection mishaps. The Doccon feedthrough endcap was designed with a 3x pressure safety margin to help guarantee against deformation and threadlocking. The two endcaps each contain radial and face o-ring seals.

3.2 Moving Carriage and Docking Pole

One and one half meters of a two-inch diameter stainless vertical docking pole are nominally available for the Odyssey AUV to latch onto and be serviced between pre-programmed data gathering missions. The pole has a keyway milled down one side through the dockable length. Inside this keyway rides an alignment key attached to a circular movable carriage. The carriage is designed to force the latched vehicle into a position where the inductive link is mated sufficiently to allow both Ethernet file transfer and power transfer. This is called the docked position. Eight bars of 36.5 lb./cuft syntactic foam provide the carriage with 4.8 lbs. of flotation, making the carriage almost neutrally buoyant in seawater at working depth. Docking pole and moving carriage are labeled in Figure [3]. Another view is shown in Figure [7] below.

Figure [7] Moving Carriage and Docking Pole (shown sideways as stowed)



3.2.1 Drive Mechanism

The moving carriage is driven up and down the pole by remote control using a motor, a polyurethane vee-shaped pinch capstan, a Delrin idler wheel and spring tension. The motor is a brushless DC design from WHOI which contains pressure tolerant electronics, hall effect feedback, thermal protection and a 144:1 gearbox enclosed in a 3-inch diameter by 10-inch long plastic housing. The motor, directly coupled to the pinch capstan, is back drivable. The carriage drive mechanism receives 48 VDC and sail commands from the Doccon. It is fused at seven amps.

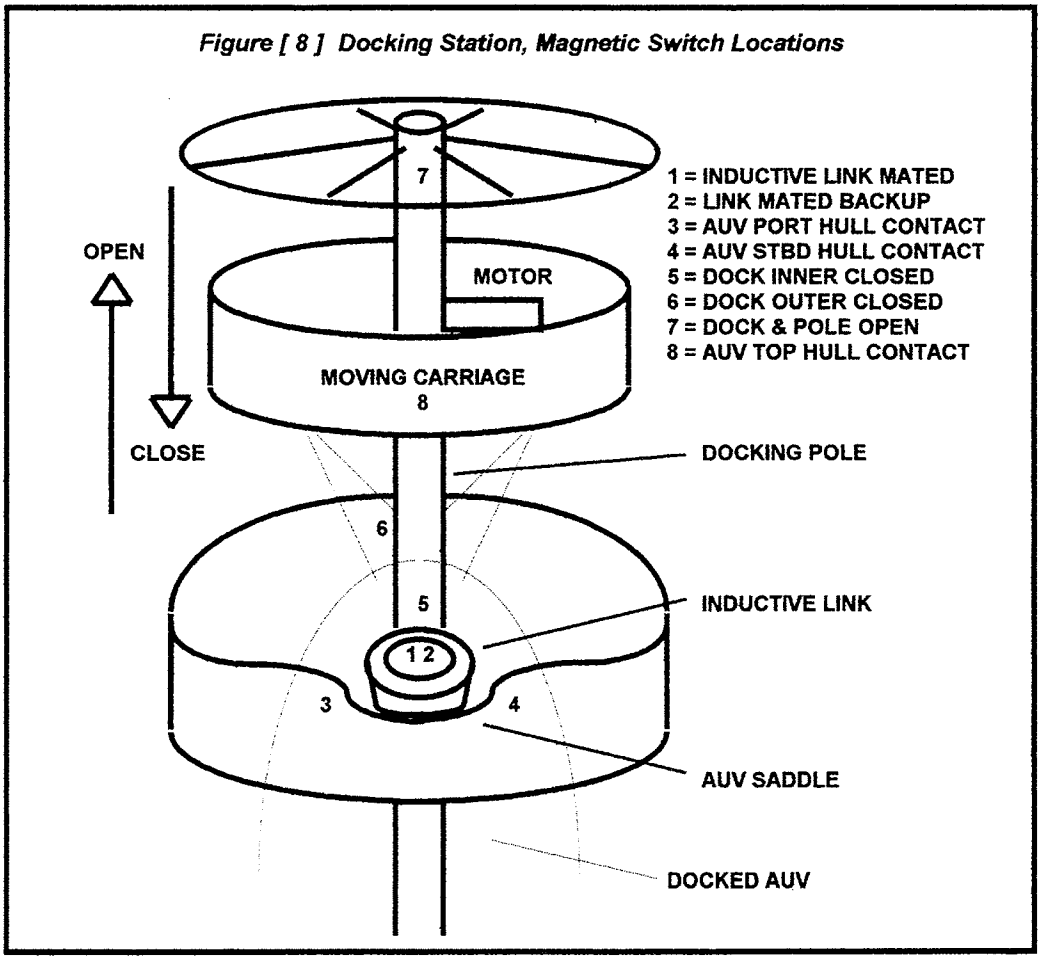
3.2.2 Guide Aprons

The Docking Station carries two cylindrical guide aprons made of aluminum hubs and polyethylene cylinders, see Figure [7]. One apron is mounted to the moving carriage. The second apron is fixed at the bottom of the docking pole. This apron has a bilateral inclined edge and a saddle cut into it which directs a docking vehicle into the proper position for power and data servicing. A previous version of this scheme supported three possible docked positions instead of the single one present now. One station reduces overall station costs, reduces maintenance, reduces sensing requirements, and increases system reliability. The resilient poly material can withstand glancing collisions by a moving vehicle which may be approaching just high or low of the targeted point of collision at the pole's center. The aprons, the closed carriage and the vehicle latch prevent all six degrees of AUV movement.

3.2.3 Magnetic Switch Harness

An array of eight pressure-proof magnetic switches (normally open) wired in parallel to Doccon MIO circuitry provide topside indications of the moving carriage state and the degree to which the AUV has docked correctly. Two switches indicate the dock is closed to moving vehicles and that the carriage is down. One switch indicates that the carriage is up and the dock is ready to receive a vehicle. After a vehicle has latched and been squeezed into a fully docked position by the moving carriage, five magnetic switches describe the result. Two switches are located in the center of the inductive core; one is a backup. Three switches surround the circumference of the vehicle's hull at the starboard lower quadrant, the port lower quadrant and the center top. Figure [8] shows approximate magnetic switch locations.

Figure [8] Docking Station, Magnetic Switch Locations



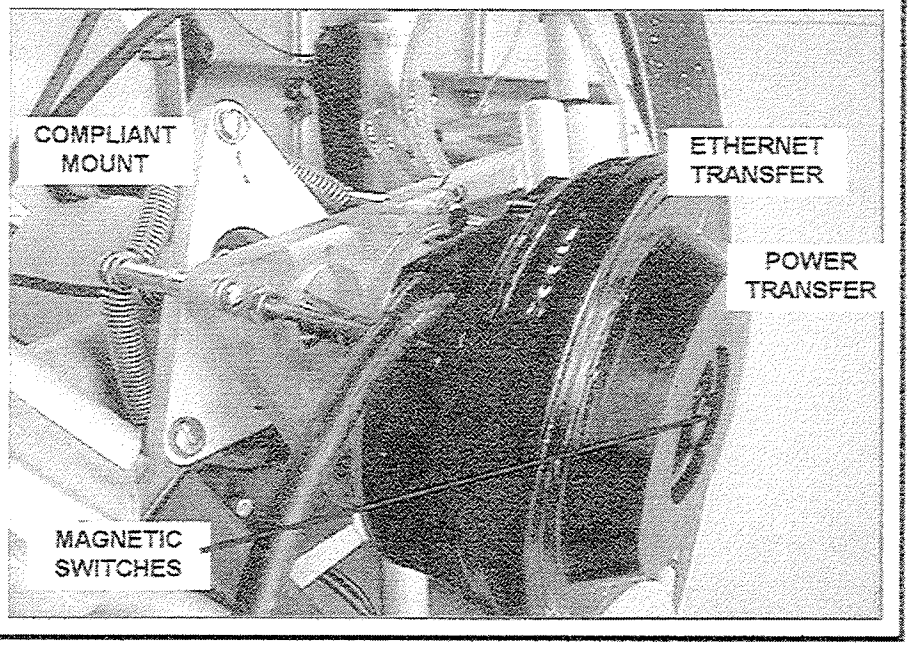
3.3 Inductive Link

The inductive link provides AC power into the vehicle for charging batteries and also provides a half-duplex Ethernet file transfer link. Two cores mate underwater with usually less than one-eighth of an inch between their surfaces. The vehicle carries a female core. The dock carries the mating male core. Both cores contain two epoxy-encapsulated coils for induction; the outer is Ethernet, and the inner is for AC power. (During transit to the operations site in the Labrador Sea a difficult decision was made that eliminated a previously satisfied requirement for power transfer through the Docking Station, however, this did not necessitate alterations, and the ability to induce Ethernet signals through the link was retained.)

3.3.1 Male Core Mounting, Docking Station

The male core is mounted to the Docking Station between the docking pole and the apron saddle. Three threaded stainless rods connect the core mechanically to a six-degree-of-freedom compliant mount. Figure [9] is a close-up image of the male core mounting arrangement. Total compliance of about one-half inch in all directions ensures that the mating cores have the best possible chance of making close contact.

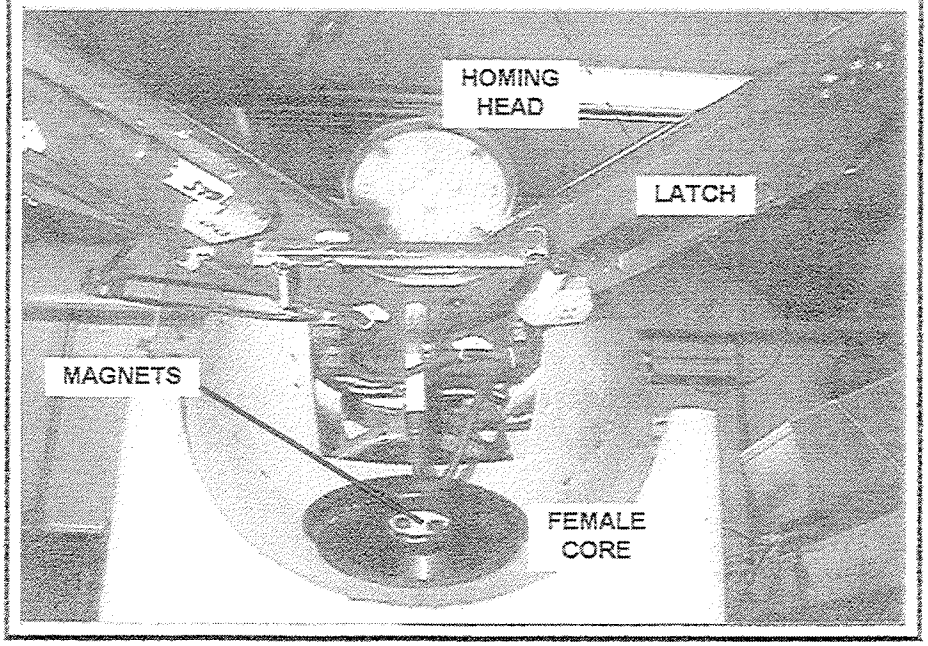
Figure [9] Male Inductive Core Mount, Docking Station Side



3.3.2 Female Core Mounting, Vehicle

Two female inductive cores are currently mounted to the underside (hull) centerline of two Odyssey AUVs behind the docking latch. Three threaded stainless rods connect the core mechanically to a six-degree-of-freedom compliant mount. Figure [10] is an uplooking image of a female core mounting arrangement. Total compliance of about one-quarter inch in all directions ensures that the mating cores have the best possible chance of making close contact. The female core is slightly more constrained in its alignment compliance due to a space limitation in the bow of the AUVs.

Figure [10] Female Inductive Core Mount, AUV Side



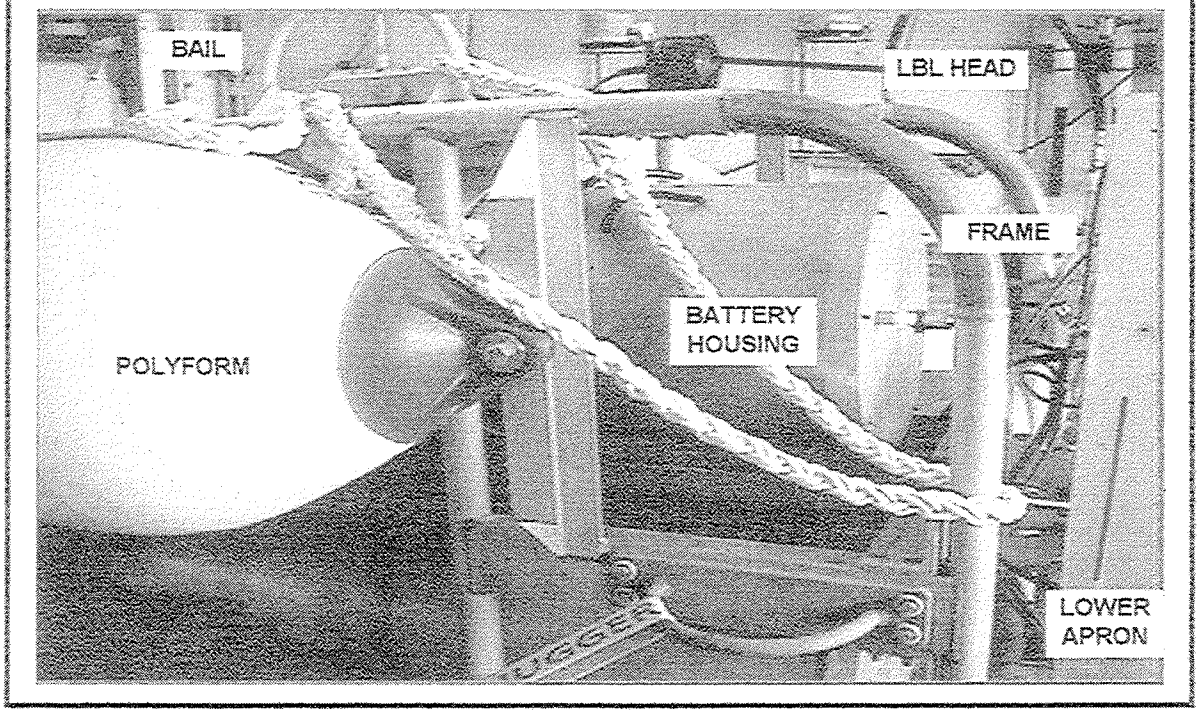
3.4 Housing Frame

The housing frame is a welded and sealed (one-atmosphere), tension-bearing device made of schedule forty 6061-T6 aluminum alloy pipe and fittings. It is an integral part of the mooring and is deployed to a depth of 500 meters when the mooring is paid out. The frame contains brackets and mounting hardware that support two large battery housings, the Doccon housing, wet harnessing, external sensors and collapsible flotation. It has a mooring termination at the bottom end. An adjustable lifting bail (yellow paint, see also Figure [12]) allows operators to move the entire Station from a single pick point whereby the assembled unit is balanced in air. At the top end the frame is bolted to the Docking Station pole. Eight rudder anodes protect the frame from corrosion. The housing frame and battery housings appear in Figures [2], [3] and [11].

3.4.1 Battery Housings

4,960 alkaline D-cells provide a minimum of four months worth of power for the Docking Station components and for vehicle battery bank recharging. The housings provide 65 to 66 VDC nominal output. The D-cells are arranged in pancake packs, stacked and secured inside both battery housings. The packs are diode and fuse protected. Throughout their operational life the housings are cyclically purged of any accumulated explosive gases and resealed with a slight vacuum. The battery assemblies used for the Labrador Sea cruise have been trouble-free. A battery housing, the frame and one polyform float appear in Figure [11].

Figure [11] Battery Housing, Purgable Endcap, Dock Frame, and Polyform Float



3.4.2 External Sensors

Certain integrated subsystems required that specific components be mounted external to the Doccon. These include the UAM, ADV, SBE, LBL and PARO. ADV and LBL have additional electronics that reside in the Doccon one-atmosphere space. UAM, SBE and PARO provide direct serial outputs to the PC104 computer.

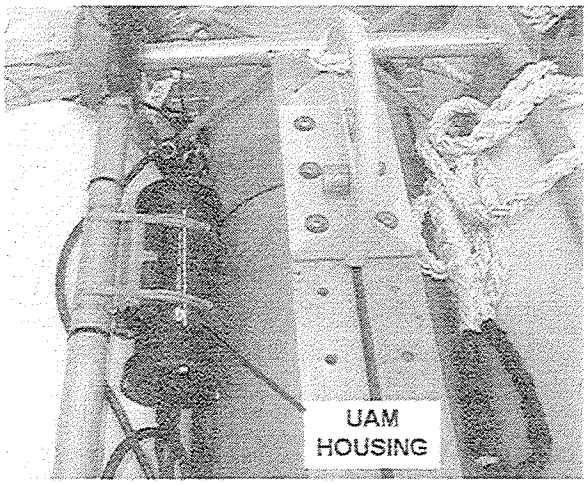
3.4.2.1 Utility Acoustic Modem (UAM)

The WHOI designed and built Utility Acoustic Modem provides 9600 baud cableless communication between the Docking Station and an AUV, and between the Docking Station and a support vessel if either is within one kilometer of the mooring. It consists of: a black-anodized aluminum housing; a four-element receiver array which is mounted to the lower Dock frame; and an optional remote head sound source, which was not deployed on the frame for this cruise. The UAM housing appears in Figure [12].

3.4.2.2 Acoustic Doppler Velocimeter (ADV)

The ADV and probe provide AOSN researchers with precise current measurements in 3D space. The primary ADV electronics reside as a three card stack inside the Doccon. The remote probe was situated so that it pointed away from the body of the Station, and it was mounted at right angles to the axis of the mooring. The probe is fairly delicate, so an effort was made to place it away from Station launch and retrieval tag points. The ADV probe and mount appear in Figure [13].

Figure [12] Utility Acoustic Modem Housing



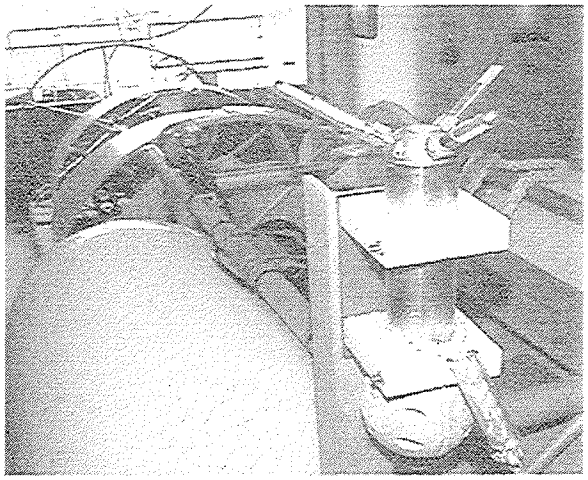


Figure [13] Acoustic Doppler Velocimeter

3.4.2.3 Seabird RS232 Temperature Probe (SBE)

This sensor is one of three Seabird sensors on the AOSN mooring. One is powered from and read at the surface expression. A second is mounted on the subsurface flotation sphere and is read via RS485 link at the Doccon. This middle temperature probe is powered by a self-contained alkaline battery pack mounted to the subsurface sphere. The third sensor is mounted to the Docking Station frame. It has a standard RS232 serial output to the PC104 computer inside the Doccon, which also provides it with a nominal 12 VDC.

3.4.2.4 Long-baseline Remote Transducer Head (LBL)

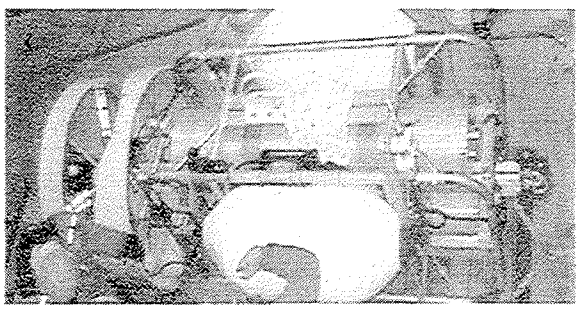
The remote transceiver head for the Edgetech long-baseline navigation system was mounted to the frame near the lifting bail. It appears at the top of Figure [11].

3.4.2.5 Digiquartz Intelligent Depth Sensor (PARO)

A precision Paroscientific depth sensor was mounted to the movable carriage. Data from the sensor relays not only carriage depth but also whether it is moving vertically with respect to the pole when remotely commanded.

3.4.3 Collapsible Flotation

Two large polyform floats were bolted high onto the battery housing frame. When fully inflated, each float provides 465 lbs. of positive buoyancy, see Figure [14] below.



The Docking Station weighs 930 lbs. in seawater. At the sea surface, the two polyforms allow the Station to be neutrally buoyant. This collapsible buoyancy ability increases the chance of deployment without collateral damage, particularly pole bending. As the Station leaves the surface and rotates to become vertical with the axis of the mooring, the polyforms shrink and their influence on the under-water mass is eliminated. One of two floats also appears in Figure [11].

3.5 Performance Analysis

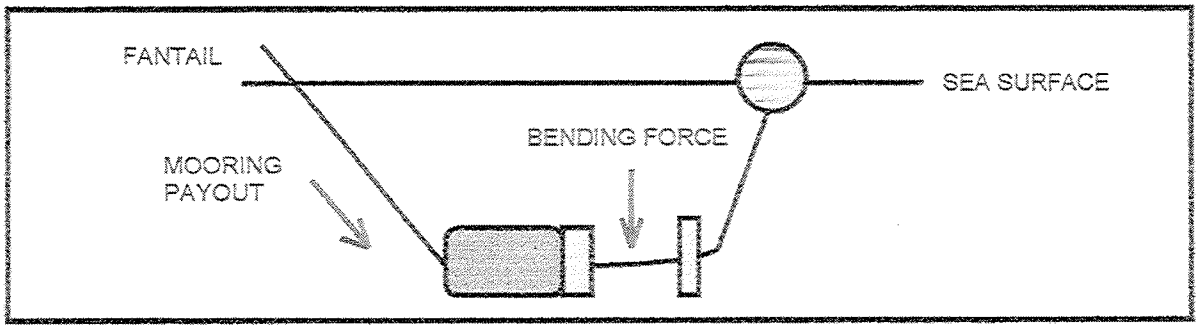
The station experienced four non-crippling faults in subsystems during its first 1998 immersion: the moving carriage became stuck; a battery connector experienced shallow water intrusion; the long-baseline (Edgetech LBL) navigation transmitter failed; and the carriage drive motor flooded during recovery operations.

3.5.1 Moving Carriage Fault

The movable carriage, which aligns a docked AUV into the power transfer position, was stuck in an indeterminate position for the entire deployment. A contingency plan was devised to repair the carriage as soon as the fault became critical to cruise goals. The mooring was recovered after immersion for two weeks for this and other reasons, but was not re-deployed due to constraints of weather and time.

The carriage became unstuck during mooring recovery making fault analysis difficult. An inspection was performed once the system was secured on deck. Our initial impression was that some interference occurred in the pole keyway, however these components had passed all operational tests at WHOI.

The pole was definitely bent during the recovery process while the station barrel-rolled in the water behind the stern and again when it was on the fantail and the rest of the mooring was trailing behind the ship. Conditions were rough. It is possible that the pole was bent earlier, upon deployment, when the dock inverted from a downward slant to an upward slant (see deployment sketch below).



If the pole was bent in this way slightly during deployment then the close tolerance of the moving carriage collar may have interfered with easy sliding on the pole. This theory coincides with depth sensor indications that the carriage was 0.4 meters below the pole center point. In this stuck position none of the three magnetic switches would have been activated.

Mooring tension would not have been sufficient to straighten the pole for normal operations. The moment required to yield the pole in bending is 36,000 in-lb. or 3,000 ft-lb. The mooring tension is 3,000 lb. Therefore the moment arm required for mooring tension to cause pole straightening is 3000 ft-lb./3000 lb. = 1 ft (deflection in the opposite direction).

After recovery of the dock and mooring system the pole was straightened out on deck using a come-along. Pole concentricity was checked in case it had become deformed or "oblong". The pole was measured to have less than 0.010" out of round at the top and bottom, so a lack of concentricity was not part of this fault.

3.5.2 Battery Connector Leak

Accelerated activity in two sacrificial anodes revealed minor leakage inside a battery bulkhead connector. It is assumed that some minimal amount saltwater (less than a fraction of a drop) entered the connector while it was in shallow water. The connection then sealed completely at depth. It operated properly throughout the deployment. It is unlikely, however, that this connection would have continued operating over a full four-month period of immersion. The battery housings are diode and fuse protected so this housing would not have contributed to dock failure over time, it was designed to shut down instead.

The connector has been cleaned, tested and re-mated.

3.5.3 LBL Transmitter Fault

The Edgetech LBL transmitter located in the Docking Station Controller Chassis (Doccon) did not operate properly after final testing at WHOI. Some of its intended functions were replaced by adding a separate relay transponder to the mooring wire below the dock.

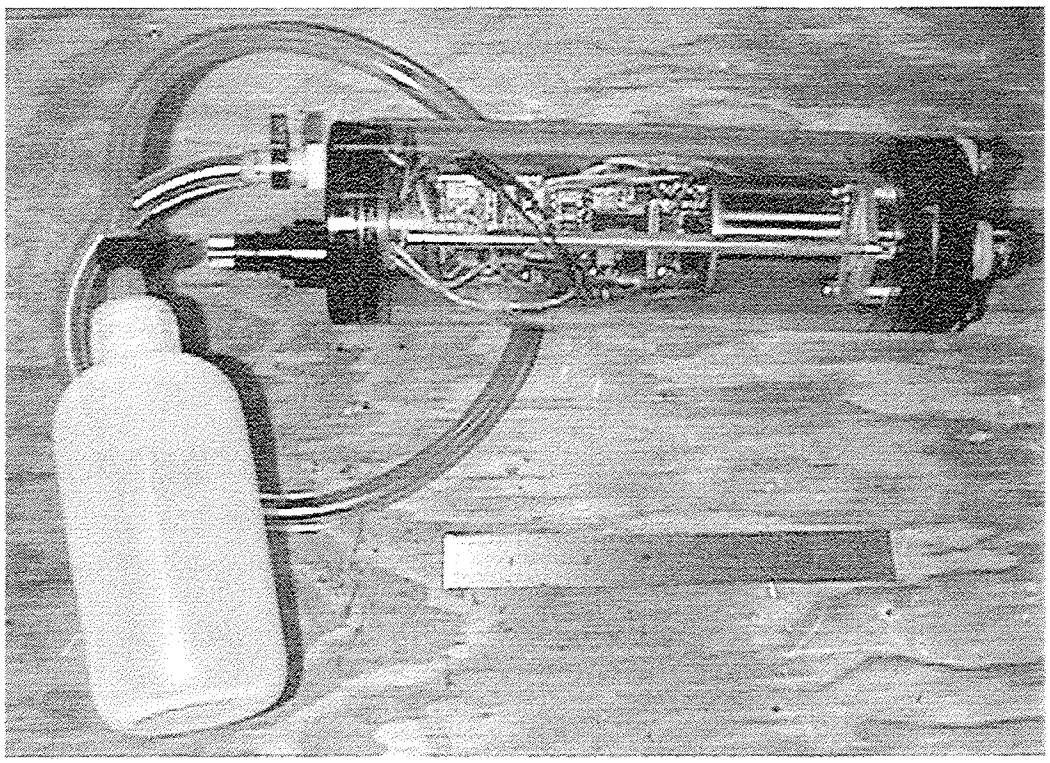
Both remote heads provided with the Edgetech LBL system leaked compensation oil before they were deployed. One was rebuilt and refilled at WHOI just prior the cruise and it operated without failure. The second was taken as an unreliable deep spare and has not yet been rebuilt. Many of the circuit boards had obviously been used, been reworked poorly or were corroded, and some had salt crystals between components.

The Edgetech system as delivered to MIT engineers included substandard commercial hardware and interface efforts with other subsystems of the Doccon were difficult from the beginning.

3.5.4 Carriage Motor Flooding

The carriage motor, which is compensated with non-toxic Carnation mineral oil, was partially flooded when the station reached the surface. It had been working properly throughout the two-week deployment. The motor was disassembled while we were on site. There was evidence that intense cable strumming had caused at least three screws to back out. One of them was critical; the seal screw that holds the whole housing together, end to end. This screw was not Loctited. It is estimated that the strumming occurred during the long recovery process and not during the two week immersion. A carriage motor and a compensation bottle appear in Figure [15].

Figure [15] Carriage Drive Motor, Housing and Compensation Bladder



3.6 Proposed Improvements

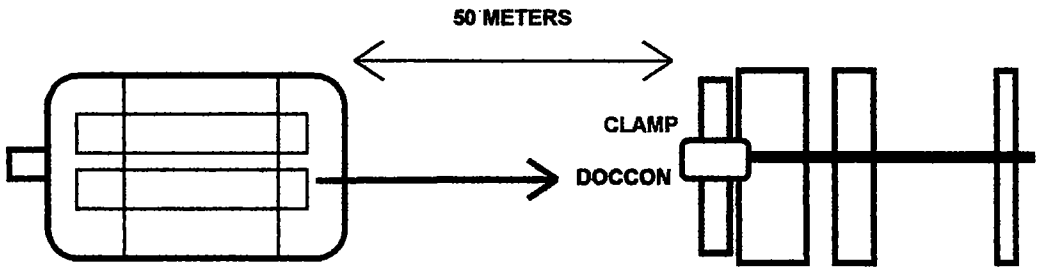
All of the recommendations made below for the improvement of each subsystem mentioned can be implemented before the next AOSN cruise. The Docking Station System as described in this report has performed well under adverse conditions. The existing design, along with minor changes, will provide a timely and successful demonstration of a fully autonomous AOSN Docking Station for our sponsors at ONR and MIT.

3.6.1 Split Station Modification

I recommend that the docking station housing frame be separated from the juicer by fifty meters of four-conductor EM cable, see Figure [16]. WHOI mooring expert John Kemp agrees with this idea. A two-part Docking Station would be shorter, more easily handled, and less prone to pole bending.

The square base of the existing docking pole has a pattern of eight bolt holes. To these we can attach a triple-purpose clamp, which will: 1) support the Doccon housing across the bottom of the juicer; 2) support the ADV probe, UAM housing, UAM array, and LBL head; and 3) provide a new termination point. The batteries will remain in the existing station frame. This change requires the design of a stainless, triple-purpose clamp and an extra shot of terminated electro-mechanical (EM) cable for power transfer.

Figure [16] Proposed Separation of Battery Frame and Docking Pole



3.6.2 Pinch Capstan Modification

The designer of the pinch capstan assembly, WHOI's Don Peters, has been consulted about the sticking fault. He recommends that the design be changed to a totally roller-guided carriage rather than using a sliding collar and clamp arrangement. There is a tradeoff to consider between looseness of a sliding carriage to accommodate slight pole bending and situations whereby a loose key and keyway cause binding will increase. A newly proposed design implements a triad of guide wheels at both the top and bottom of the moving carriage, all of which have a large-OD-ridge that run in grooves in the pole. This way one could tighten the wheel to groove tolerances and still not hinder carriage movement on a curved pole. (The redesign suggested above is a work in process as of 10 June 1998.)

3.6.3 Edgetech Correction

A solution to the Edgetech LBL receiver fault will be discussed under a separate cover (MIT).

3.6.4 Carriage Motor Compensation

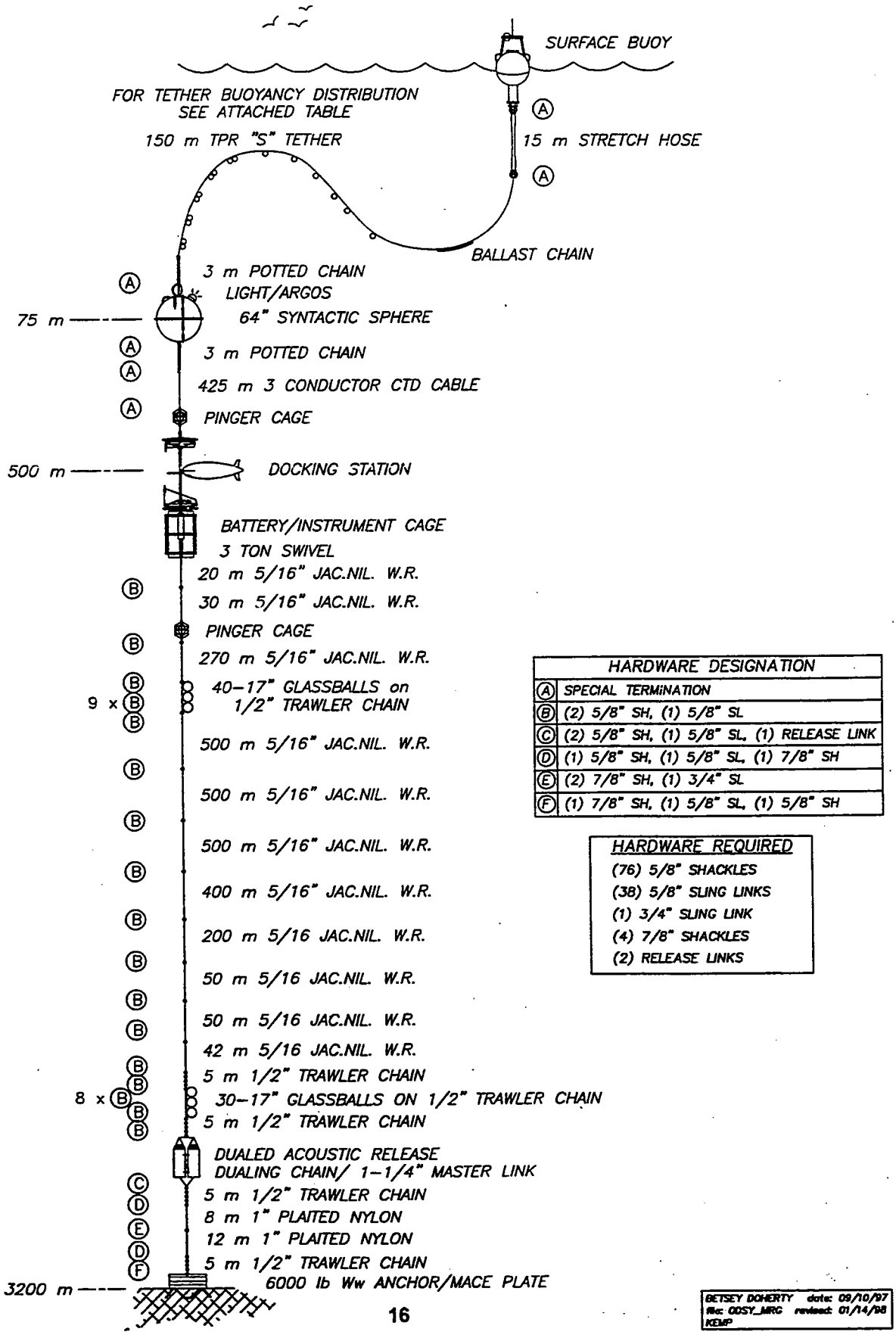
The motor compensation bladder should be pressurized to 2-3 psi above ambient rather than simply kept at ambient. Screws should be Loctited or secured in some manner. Costs and effort for this change are minimal.

3.6.5 Slow Scan Video System Addition

It was difficult to imagine the situation at 500 meters when the vehicle and the station were joined. It is recommended that a snapshot, slow scan video processor and CPU be added to the Doccon and tap into the 485 link to the surface. Also add a hi-resolution camera and 100 w/sec flash to the station carriage, looking downward. An interrupt from the surface or a timer fires off one shot which is reassembled at the surface as soon as the link can manage; however hi-speeds are not crucial. In this way operators will be able to look in on the dock situation without a demand for increased bandwidth from the as-built system.

The idea of a snapshot video system setup to look down the docking pole would satisfy a question raised in early 1997 regarding how the Station would be able to detect the presence of a docked vehicle if the carriage was not closed and the appropriate magnetic switches were not activated.

Figure [17] Odyssey Labrador Sea Mooring Detail, AEL Revision 4



HARDWARE DESIGNATION	
(A)	SPECIAL TERMINATION
(B)	(2) 5/8" SH, (1) 5/8" SL
(C)	(2) 5/8" SH, (1) 5/8" SL, (1) RELEASE LINK
(D)	(1) 5/8" SH, (1) 5/8" SL, (1) 7/8" SH
(E)	(2) 7/8" SH, (1) 3/4" SL
(F)	(1) 7/8" SH, (1) 5/8" SL, (1) 5/8" SH

HARDWARE REQUIRED

(76) 5/8" SHACKLES
(38) 5/8" SLING LINKS
(1) 3/4" SLING LINK
(4) 7/8" SHACKLES
(2) RELEASE LINKS

BETSEY DOHERTY date: 09/10/97
file: ODSY_MRG revised: 01/14/98
KEMP

Deep Submergence Laboratory

DSL

29 MAY 98

ENDCAP BULKHEADS FACE VIE

SBE-232
IE VSG4BCL

EDGETECH RH
IE VSG3PBCLM

EDC ETHERNET
IE MBH9FS

SURFACE-485
SBE-485
SC VSG4BCL

DTMF RES
BEACON P
IE BH4MP

DUAL
DB9
BANKS

COM 1
SURFACE
3F8
IRQ 4

COM 3
ADV
3E8
IRQ 4

COM 5
WTCHDG
280
IRQ 5

COM 7
KVH
2A0
IRQ 10

COM 9
SBE-232
2B0
IRQ 12

COM 2
SAIL
2E8
IRQ 3

COM 4
SBE-485
2F8
IRQ 3

MINIPLUG

RED
YEL

SERIAL

TELEBYTE 365

RIBBON CABLE

ADV

RED +12 VDC
BLK PWR/SIG COM
GRN TXD RS422
BRN TXD RS422
BLU RXD RS232
WHT 20HZ CLOCK

KVH DI

NC
NC

100

J1
J2

+5
COM

SAIL/RS232

E1 +48 VDC IN
E2 48 VDC RTN

DC/DC CONVERTER

E3 +15 OUT
E4 COM
E5 -15 OUT

RG174

PS8000 RCVR

JP4

EDGETECH
LBL

COM

TOROID
DRIVER

RED
BLK

E3 E4
E2
E1

RCVR

JP3

TXD
RXD
COM

AM200 MODEM

J6

EDGETECH CPU

SAIL -
SAIL +

17

PC104

4 3 2 1

W F E D C

ET
WR OUT

WHT
GRN

EDC AC POWER
IE BH4FS

ADV PROBE
IE MBH9FS

UAM MODEM DTE
SC XSJ7BCR

RESET

PARDSCI DEPTH
JUICER MOTOR
MAGNETIC SWITCHES
IE XSL20BCR

23-DAY
BATTERY BANK 1
SC XSG2BCL

23-DAY
BATTERY BANK 2
SC XSG2BCL

48 NEG BATT

7 AMP
REG-BLO

7 AMP
REG-BLO

48 POS BATT

COM
RXD

RS232

BLU

PA7 ON CPU
6811

MIO RESET

7 AMP REG-BLO

-IN GT OUT GT +IN IN

48 TO 48
CONVERTER

-OUT +OUT

1N5352A
ZENER

48 TO 48
BOOSTER 1

48 TO 48
BOOSTER 2

18

16-PIN AMPHENOL

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

3.15A 250VAC
WHITMAN
FUSE

J5

ADV

12 VDC

48 VDC
NOT USED

WATCHDOG
NOT USED

GATE IN
48 VDC RTN

GND
LOOP

48-5
CONV

+48

INV 48
RTN

48 COM

+5VDC

J1

J2

J3

BATTERY
MONITOR

SAIL -

SAIL +

GRY
BLU

D-CMP4

DIN1-4

MIO A

MIO B

MIO BOARD STACK

48V
BUS

SAIL
BUS

DATEL DC/DC
-OUT

DRN

CONVERTERS

COM 6
PARDSCI
288
IRQ 7

COM 8
EDGETECH
2A8
IRQ 11

COM 10
UAM
2B8
IRQ 15

SPRAD

J8
SURF
RESET

J2
DTMF

J1
RESET

J3
SURF

J0
PWR

J4
SBE

GRN
WHT

BLK
BLU

GRN
BLU

W/GRY
W/RED
W/ORN
W/YEL

GRY
BLK

GRN
BLU

V/ORN
ORN
V/GRN
GRN

INVERTING
OPTOISOLATOR
QTCH11G1

NC
BLU
GRY

J5 UTILITY 10-PIN
1 SPKR+
2 LI BATT-
3 RESET 5V
4 KBD 5V
5 KBD DATA
6 KBD CLK
7 GRND RTN
8 KBD PWR
9 LI BATT+
10 PWR GOOD

+5 VDC BUS
+12 VDC BUS
+24 VDC BUS
+48 VDC BUS
48 VDC COM
5/12/12/24 COMMON

CHASSIS / SEAWATER

SPEAKER

SOFT
RESET

LITH
BATT

SERIAL COMMS PCB
TOP VIEW
COM 3 COM 5
COM 4 COM 6

SERIAL COMMS PCB
TOP VIEW
COM 7 COM 9
COM 8 COM 10

J7 POWER 8-PIN
1 GND
2 +5 VDC
3 KEY PIN
4 +12 VDC
5 -5 VDC
6 -12 VDC
7 GND
8 +5 VDC

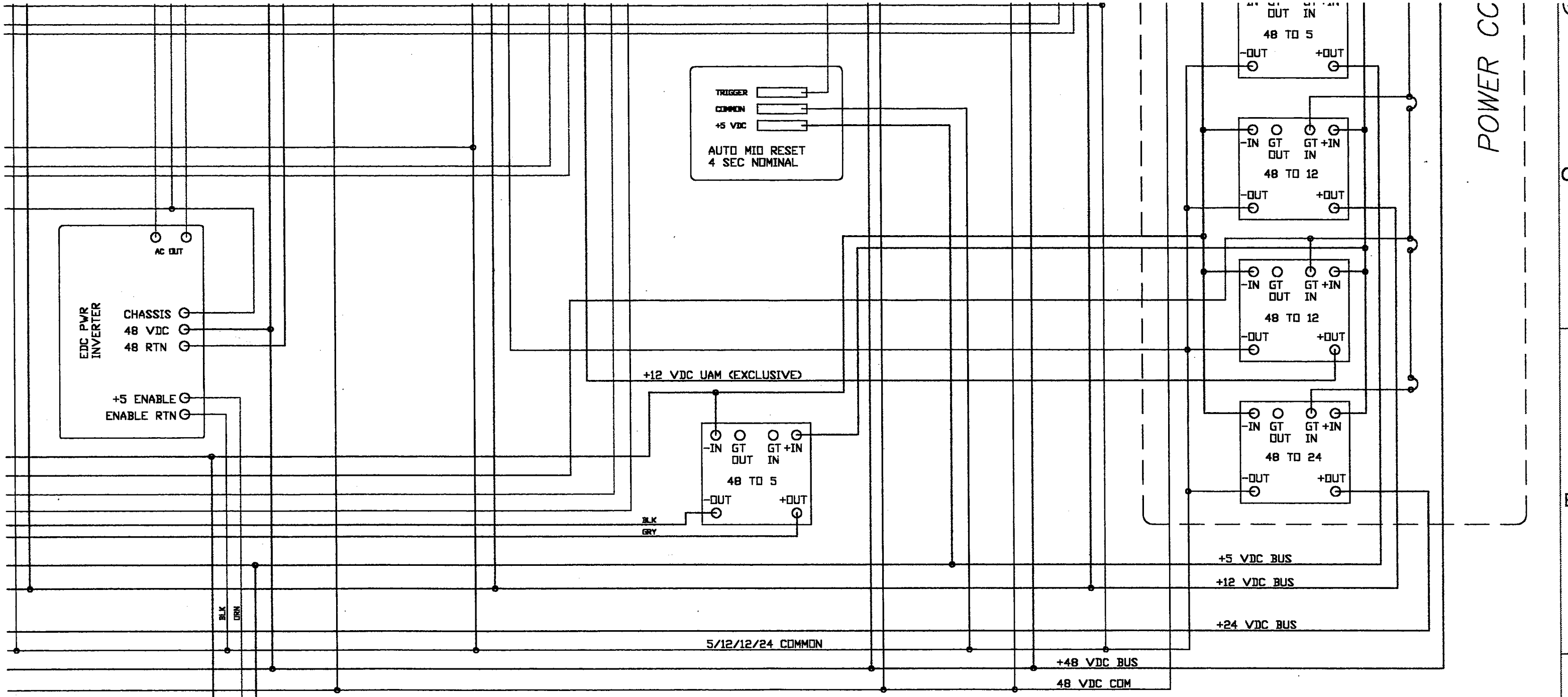
PC104

ETHERNET
LED
1 2 3 6
MODULAR PLUG

19

8 7 6 5

B A



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MATERIAL AS NOTED	DRAWN MF BOWEN / DATE 29 May 98	TITLE WIRING DIAGRAM DOCK CONTROLLER, REV K
FINISH AS NOTED	CHECK	
	AOP&E / MS #9	SIZE D / DWG. NO. 20 156-97-100
	BIG 402 / 289-3420	SCALE NONE / RELEASE DATE / SHEET OF

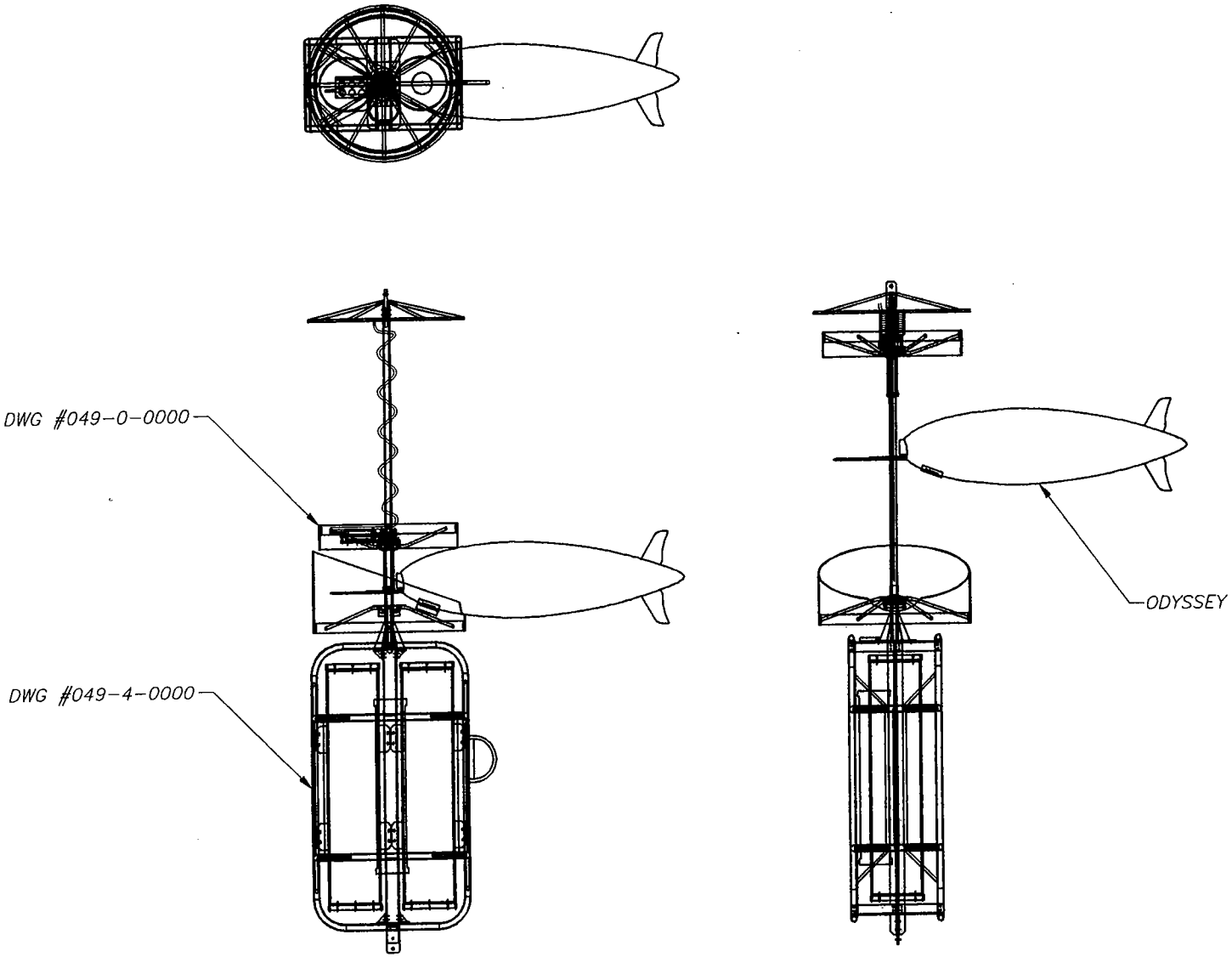
4 3 2 1

C B A

AOSN Lab Sea Vehicle Dock
Drawing Numbers

0490ASSY			Vehicle Dock and Battery Frame Assembly
04900000			Vehicle Dock Assembly
	0491		Pole Structure
*		04910100	Pole Weldment
*		04910101	Pole Anode
*		04910200	Pole Top Bumper
	0492		Hoop/Skirts
*		04920100	Upper Hoop
*		04920101	Hoop Center Plate
*		04920200	Lower Hoop
*		04920300	Hoop Clamp, Lower
*	obs	04920301	Hoop Clamp, Carriage
*	04930000		Dock Carriage
*		04930101	Mount Plate
*		04930102	Bearing Block 1
*		04930103	Bearing Block 2
*		04930104	Motor Mount Block
*		04930105	Spring Post
*		04930200	Friction Drive Wheel
*		04930201	Idler Wheel
*		04930301	Drive Shaft
*		04930302	Idler Shaft
*	obs	04930400	Slider Assembly
*	obs	04930401	Slider Sleeve
*	obs	04930402	Slider Flange
*	obs	04930403	Slider Key
*		04930500	Slider Assembly
*		04930501	Slider Upper Attachment
*		04930502	Slider Lower Attachment
*		04930503	Slider Shaft
*		04930504	Slider Key
*	04940000		Battery Frame Assembly
*		04940100	Frame Weldment
*		04940200	Spine
*		04940201	Upper Crosspiece
*		04940202	Lower Crosspiece
*		04940301	Pickup Bale
*		04940302	Bottom Tang
*		04940401	Battery Case Strap
*		04940501	Instrument Housing Bracket

	0495		Battery Case
*		04950100	Tube
*		04950101	Bulkhead
*		04950200	Endcap
*		04950201	Endcap Penetrations
*		04950202	Endcap Penetration Detail
*	obs	04950300	Mounting Tab Location
*		04950301	Mounting Tab
→			



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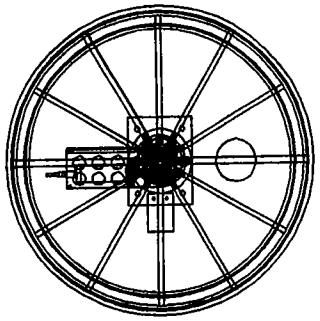
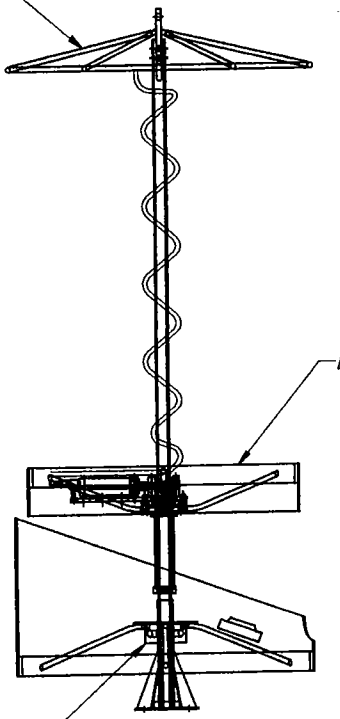
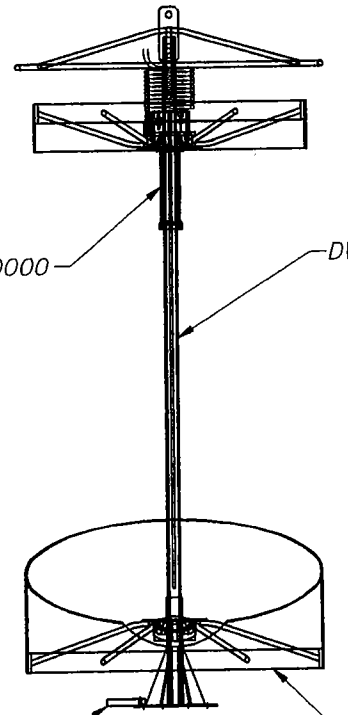
	DRAWN DON PETERS	DATE 07/07/97	TITLE AOSN VEHICLE DOCK AND BATTERY FRAME ASSEMBLY
	CHECK		
MATERIAL AS NOTED			SIZE DWG NO. 049-0-ASSY
FINISH AS NOTED			SCALE RELEASE DATE SHEET OF







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MATERIAL AS NOTED	DRAWN DON PETERS DATE 07/07/97	TITLE AOSN VEHICLE DOCK ASSEMBLY
FINISH AS NOTED	CHECK	SIZE DWG NO. 049-0-0000
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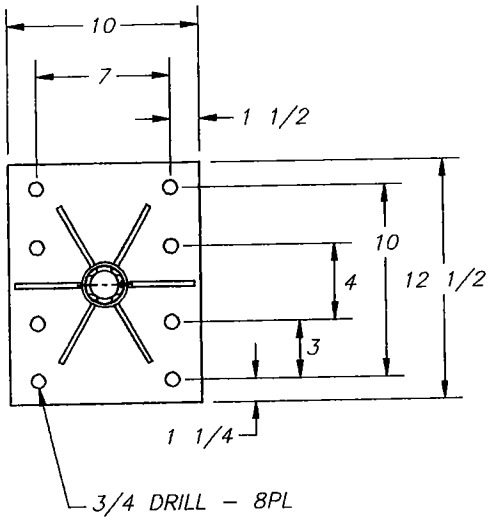
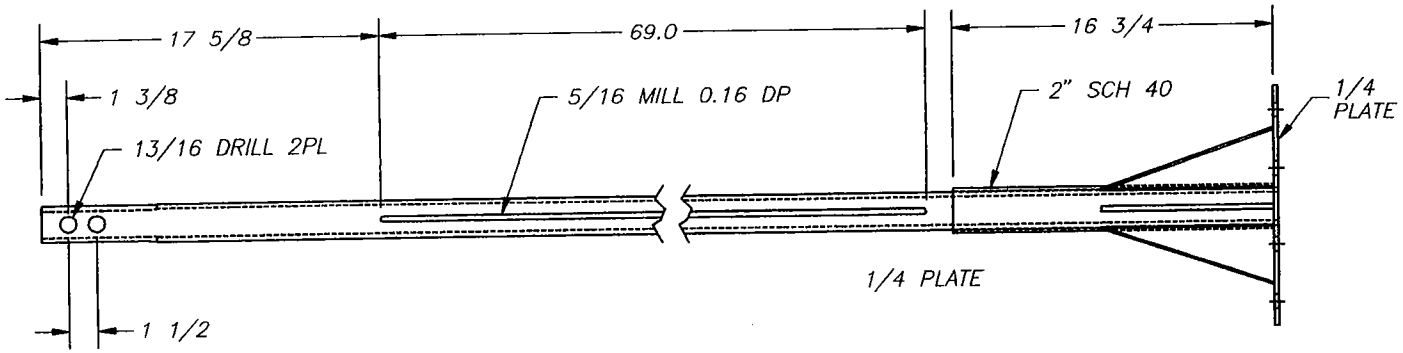
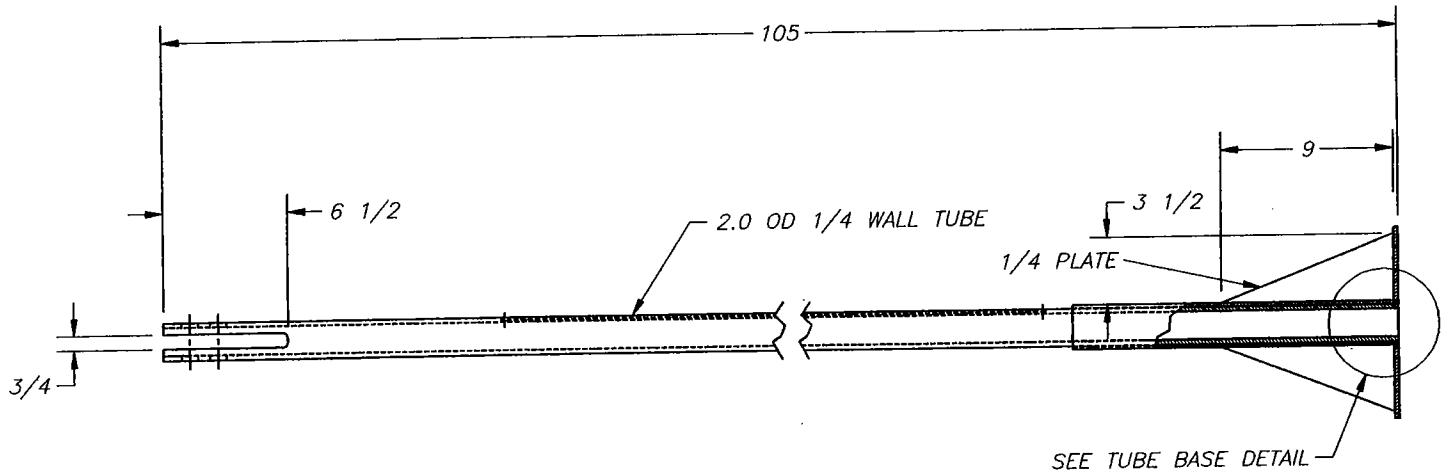
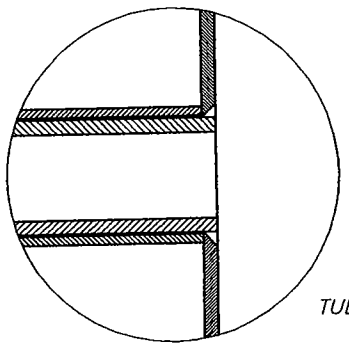




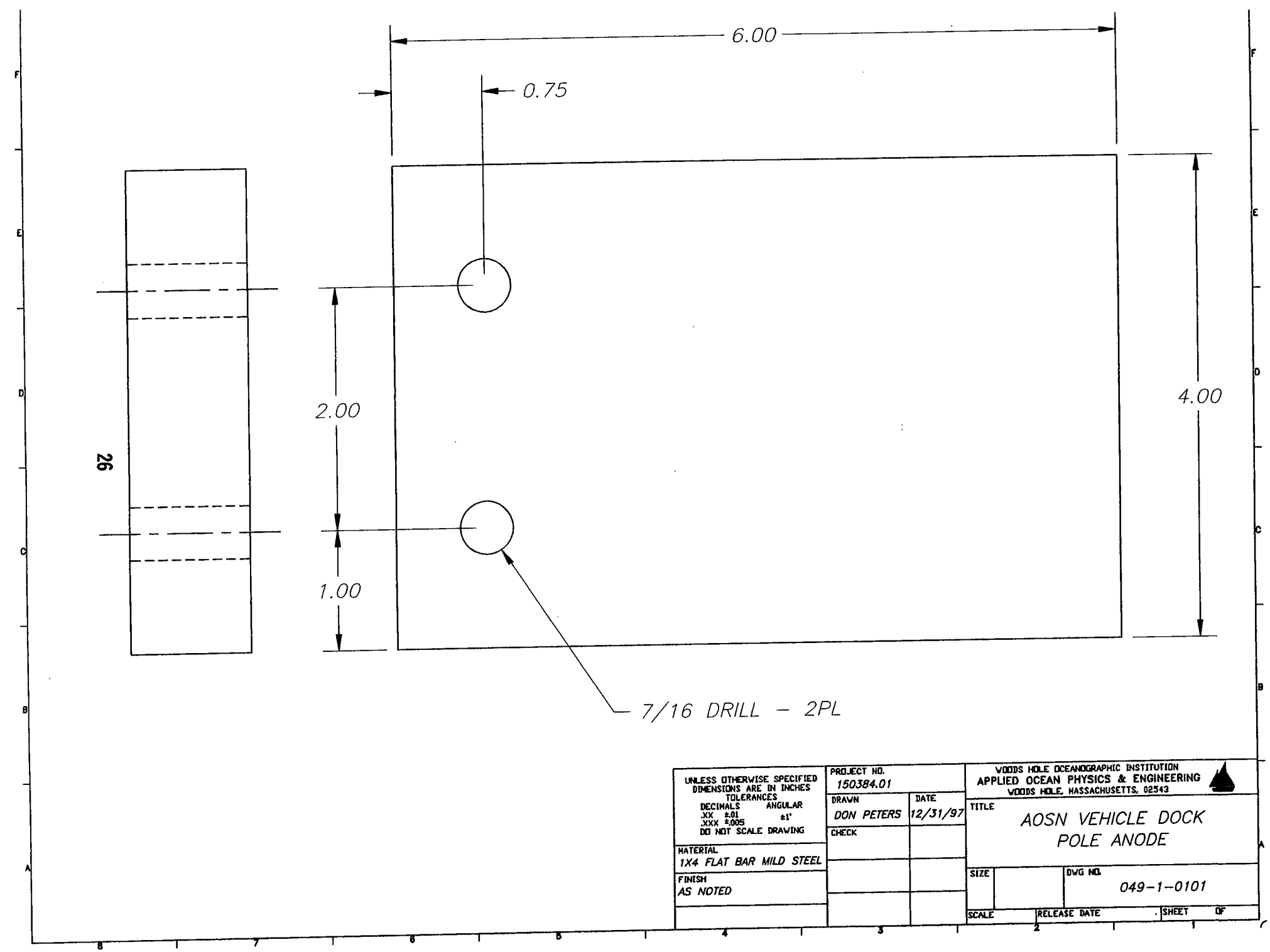




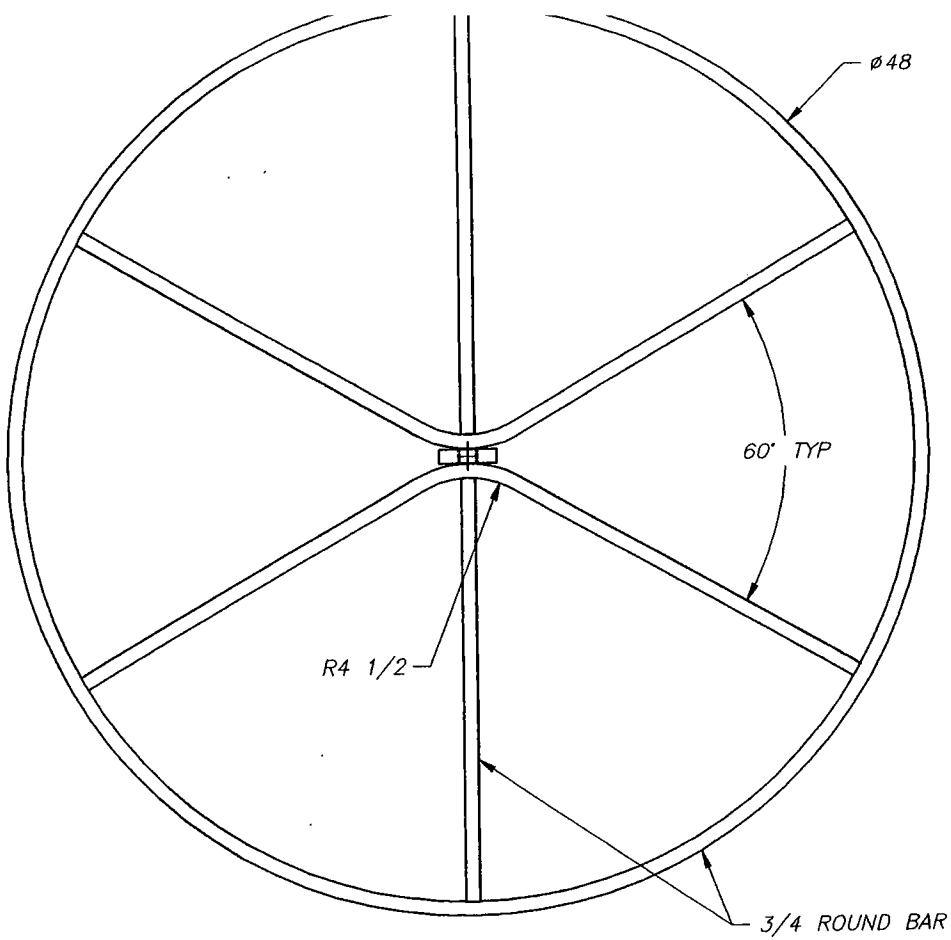
TUBE BASE DETAIL

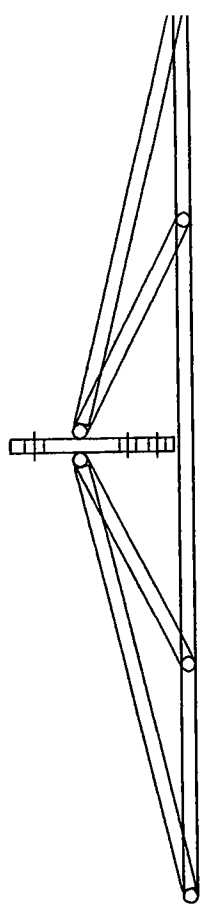
25

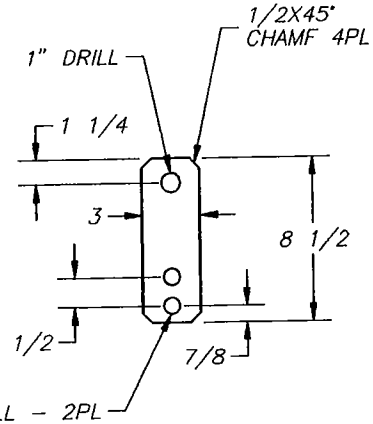
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS ANGULAR .XX ±.01 ±1° .XXX ±.005 DO NOT SCALE DRAWING	PROJECT NO. 156168.08	WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED OCEAN PHYSICS & ENGINEERING WOODS HOLE, MASSACHUSETTS, 02543
	DRAWN DON PETERS — DATE 09/22/97	TITLE: AOSN VEHICLE DOCK DOCKING POLE
MATERIAL: STAINLESS	CHECK	
FINISH: AS NOTED		SIZE — DWG NO. 049-1-0100
		SCALE — RELEASE DATE — SHEET OF



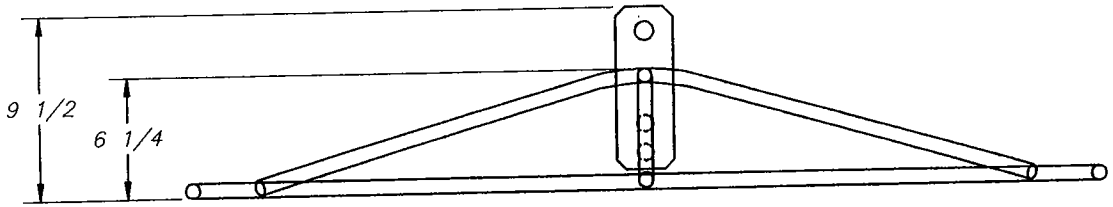
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS .XX ±.01 .XXX ±.005 ANGULAR ±1° DO NOT SCALE DRAWING	PROJECT NO. 150384.01	WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED OCEAN PHYSICS & ENGINEERING WOODS HOLE, MASSACHUSETTS, 02543
MATERIAL 1X4 FLAT BAR MILD STEEL	DRAWN DON PETERS DATE 12/31/97	TITLE AOSN VEHICLE DOCK POLE ANODE
FINISH AS NOTED	CHECK	SIZE DWG NO. 049-1-0101
		SCALE RELEASE DATE SHEET OF







MATERIAL 3/4X3 FLAT BAR



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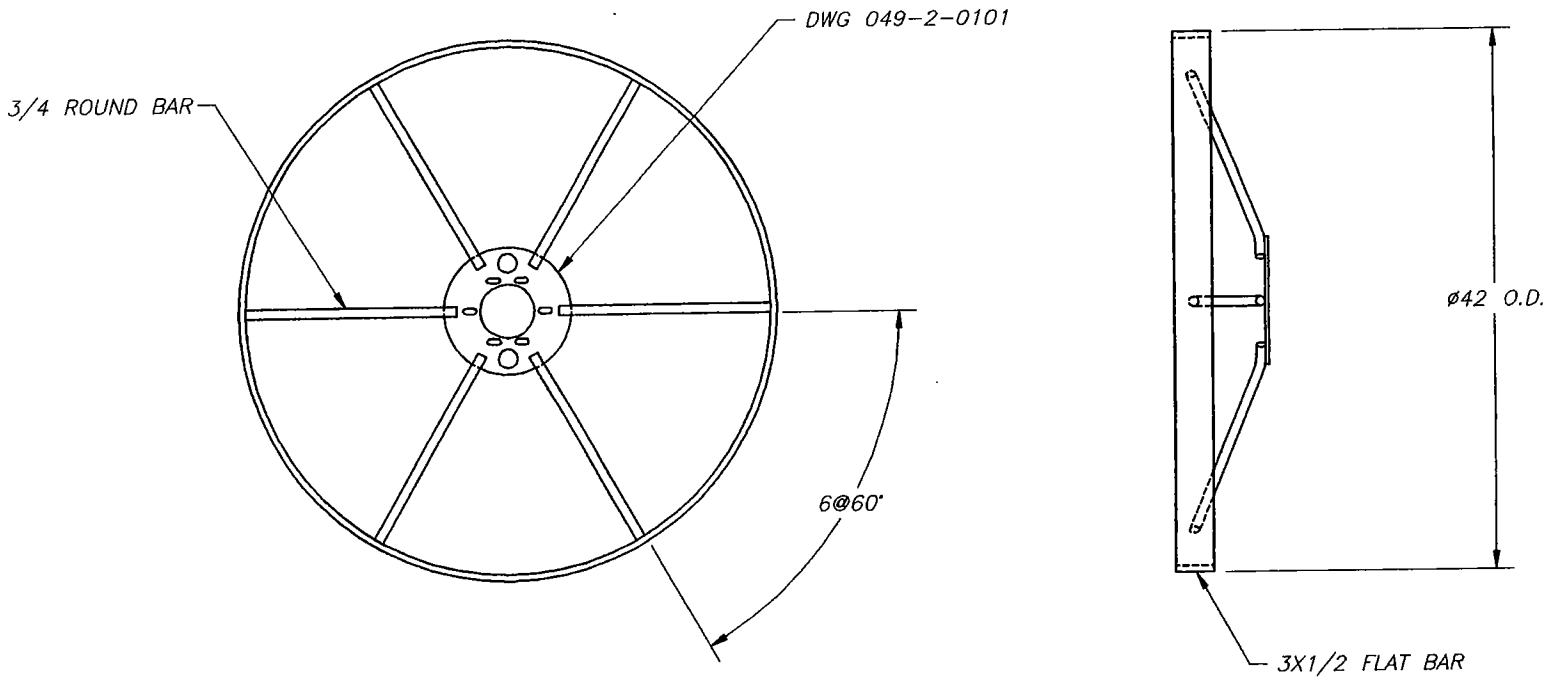
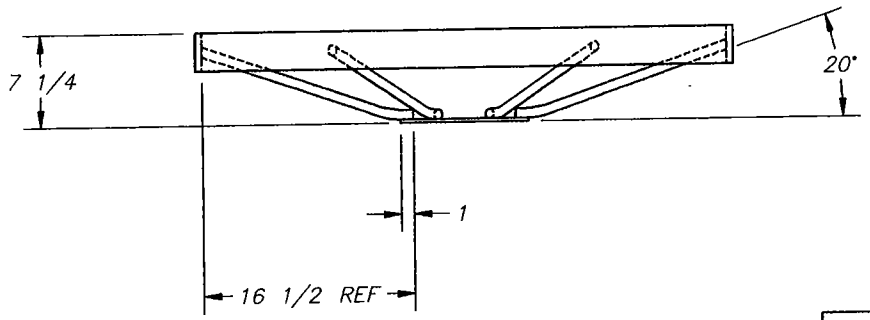
REVISED 09/29/97: HOLE DIAMETERS

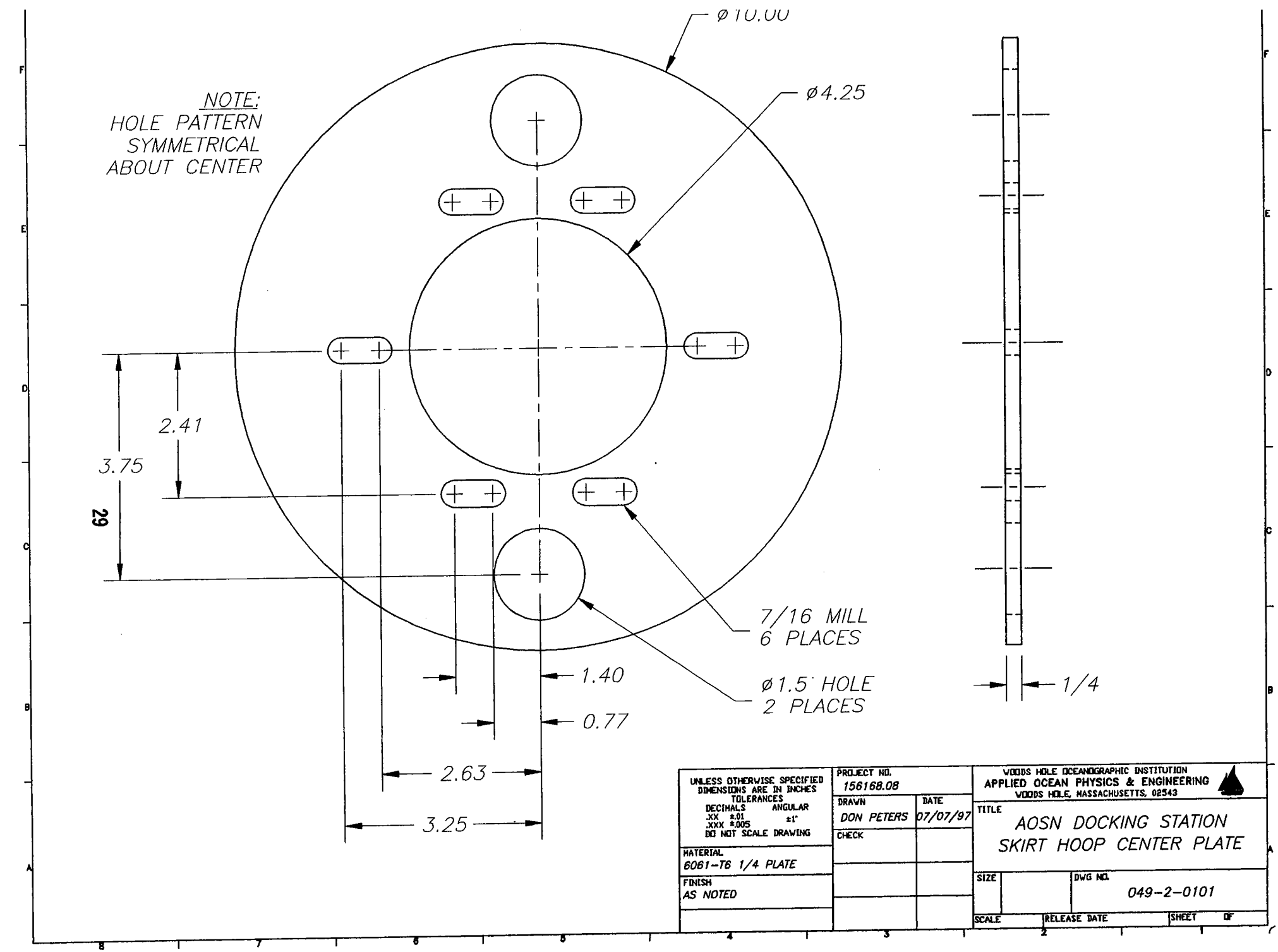
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS .XX ±.01 .XXX ±.005 ANGULAR ±1° DO NOT SCALE DRAWING	PROJECT NO. 156077.00	WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED OCEAN PHYSICS & ENGINEERING WOODS HOLE, MASSACHUSETTS, 02543	
	DRAWN DON PETERS	DATE 09/22/97	TITLE AOSN VEHICLE DOCK POLE TOP BUMPER
	CHECK		
MATERIAL STAINLESS			SIZE
FINISH AS NOTED			DWG NO. 049-1-0200
			SCALE RELEASE DATE SHEET OF



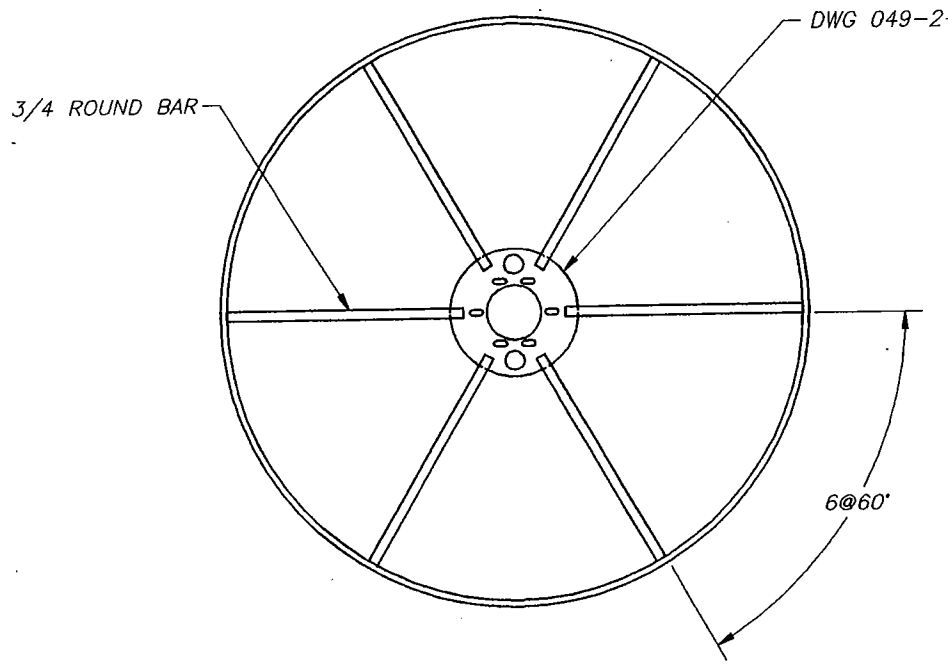


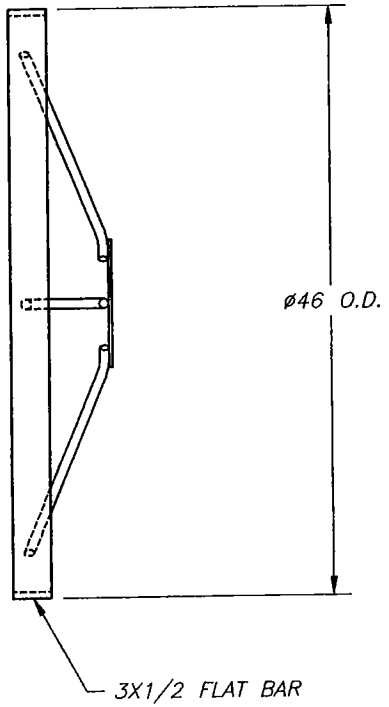
28

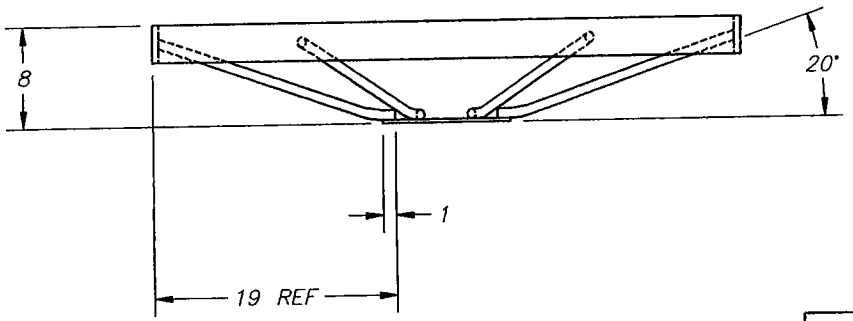
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS .XX ±.01 .XXX ±.005 ANGULAR ±1° DO NOT SCALE DRAWING	PROJECT NO. 156168.08	WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED OCEAN PHYSICS & ENGINEERING WOODS HOLE, MASSACHUSETTS, 02543	
	DRAWN DON PETERS	DATE 07/07/97	TITLE AOSN VEHICLE DOCK UPPER SKIRT HOOP
	CHECK		
MATERIAL 6061-T6 ALUMINUM			SIZE
FINISH AS NOTED			DWG NO. 049-2-0100
			SCALE RELEASE DATE SHEET OF



UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS .XX ±.01 .XXX ±.005 ANGULAR ±1° DO NOT SCALE DRAWING	PROJECT NO. 156168.08	WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED OCEAN PHYSICS & ENGINEERING WOODS HOLE, MASSACHUSETTS, 02543
MATERIAL 6061-T6 1/4 PLATE	DRAWN DON PETERS DATE 07/07/97	TITLE AOSN DOCKING STATION SKIRT HOOP CENTER PLATE
FINISH AS NOTED	CHECK	SIZE DWG NO. 049-2-0101
		SCALE RELEASE DATE SHEET OF

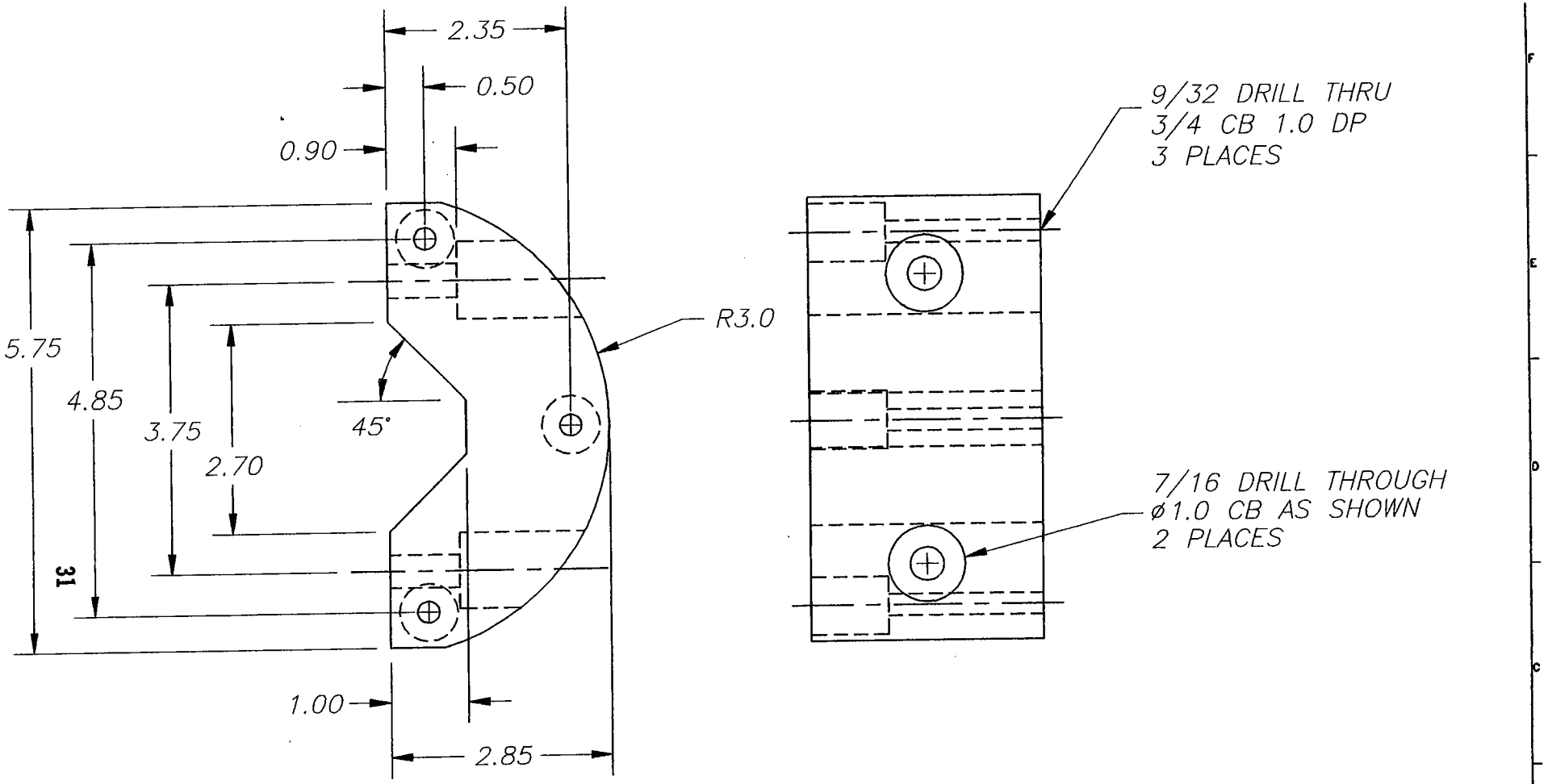




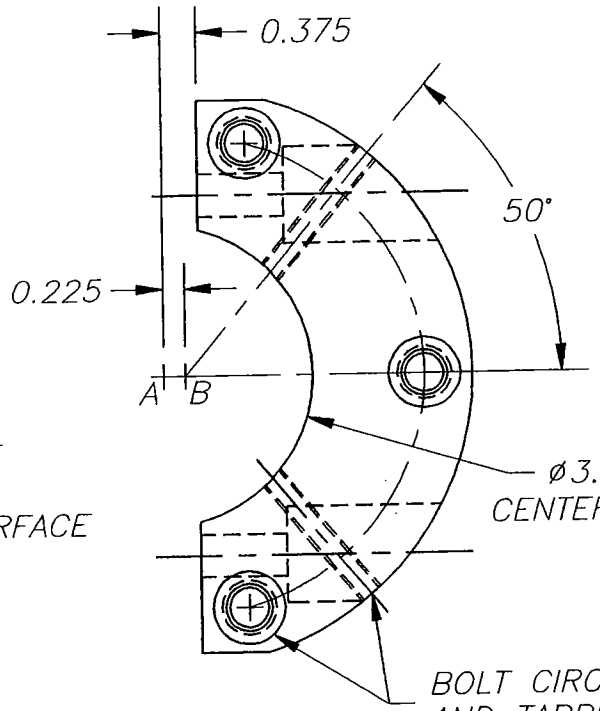


30

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS .XX ±.01 .XXX ±.005 ANGULAR ±1° DO NOT SCALE DRAWING	PROJECT NO. 156168.08	WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED OCEAN PHYSICS & ENGINEERING WOODS HOLE, MASSACHUSETTS, 02543
MATERIAL 6061-T6 ALUMINUM	DRAWN DON PETERS DATE 07/07/97	TITLE AOSN VEHICLE DOCK LOWER SKIRT HOOP
FINISH AS NOTED	CHECK	SIZE DWG NO. 049-2-0200
		SCALE RELEASE DATE SHEET OF

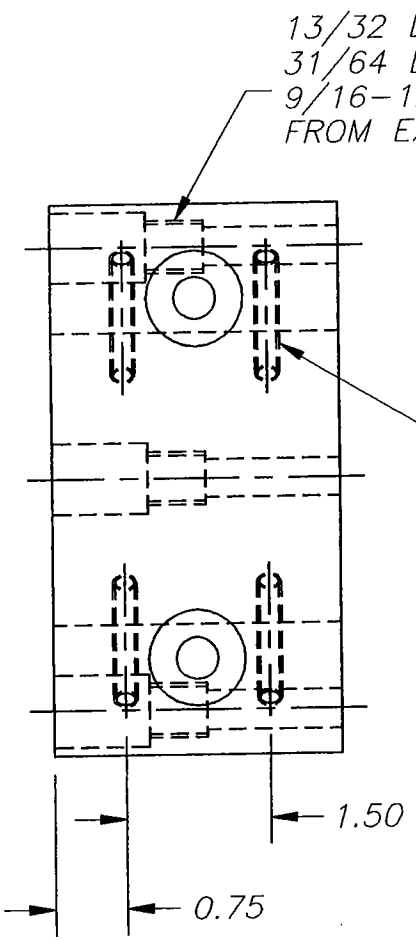


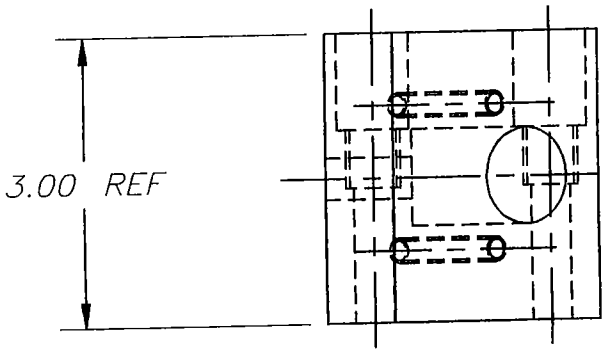
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS .XX ±.01 .XXX ±.005 ANGULAR ±1° DO NOT SCALE DRAWING	PROJECT NO. 156077.00	WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED OCEAN PHYSICS & ENGINEERING WOODS HOLE, MASSACHUSETTS, 02543
MATERIAL ACETAL	DRAWN DON PETERS DATE 09/19/97	TITLE AOSN VEHICLE DOCK DOCKING SKIRT CLAMP RING
FINISH AS NOTED	CHECK	SIZE DWG NO. 049-2-0300
		SCALE RELEASE DATE SHEET OF



NOTE:
A = CENTER OF INSIDE BORE
B = CENTER OF OUTSIDE SURFACE

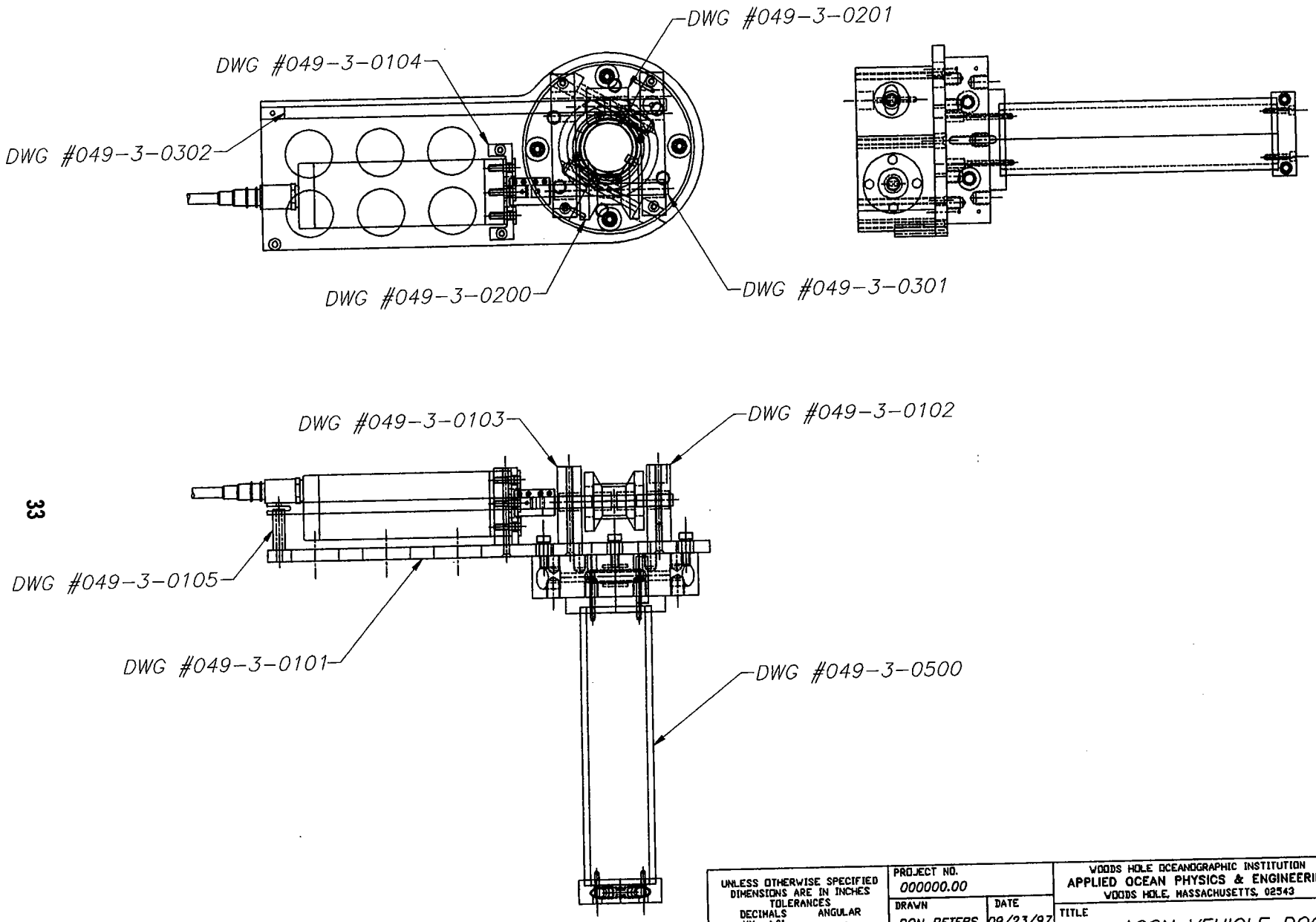
32



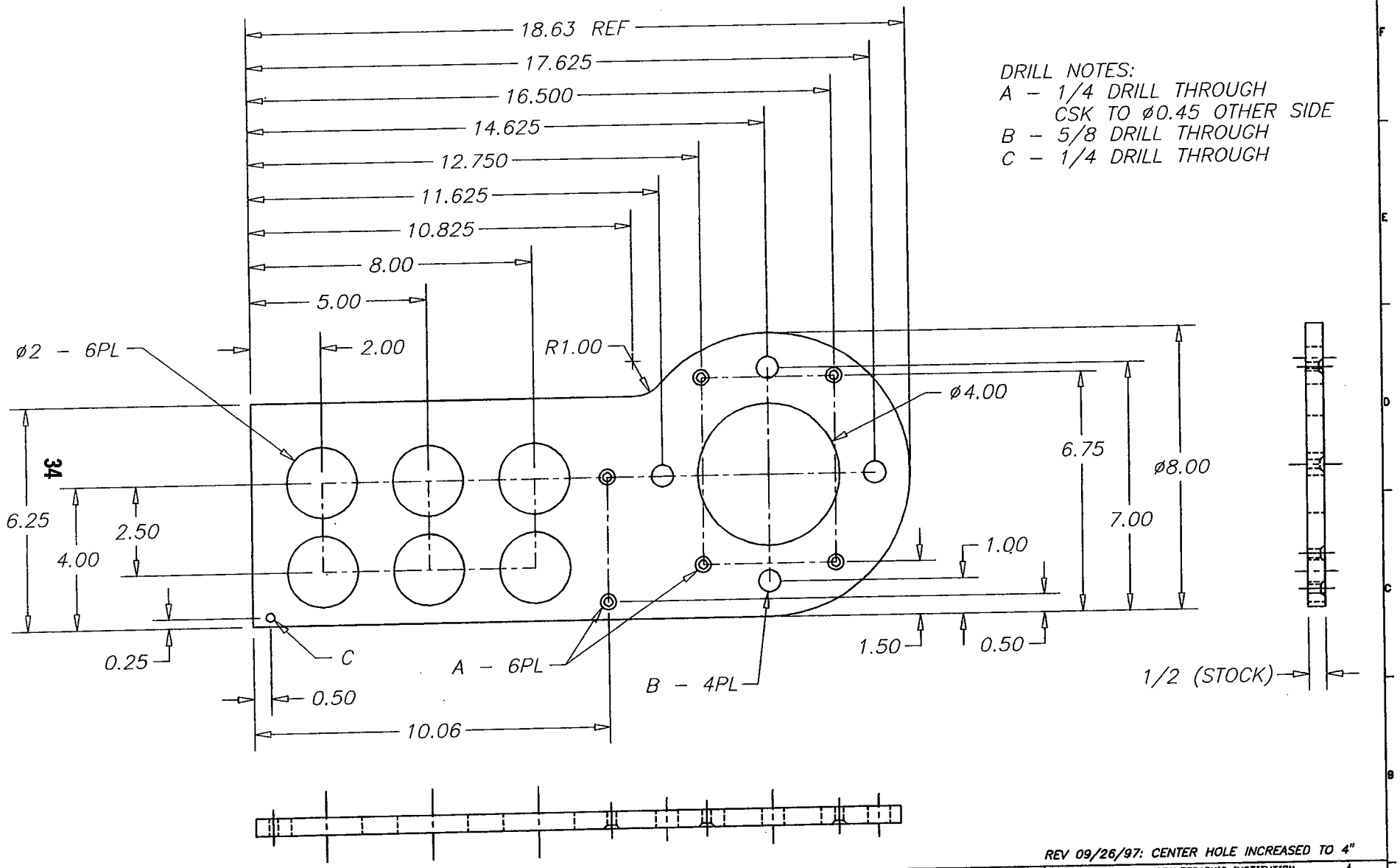


REVISED 01/06/98: ADD'L DIMENSIONS

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS .XX ±.01 .XXX ±.005 ANGULAR ±1° DO NOT SCALE DRAWING	PROJECT NO. 150384.01	WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED OCEAN PHYSICS & ENGINEERING WOODS HOLE, MASSACHUSETTS, 02543
	DRAWN DON PETERS DATE 09/19/97	TITLE AOSN VEHICLE DOCK SKIRT CLAMP MODIFIED
	CHECK	
MATERIAL 049-2-0300 SKIRT CLAMP		SIZE DWG NO. 049-2-0301
FINISH AS NOTED		SCALE RELEASE DATE SHEET OF



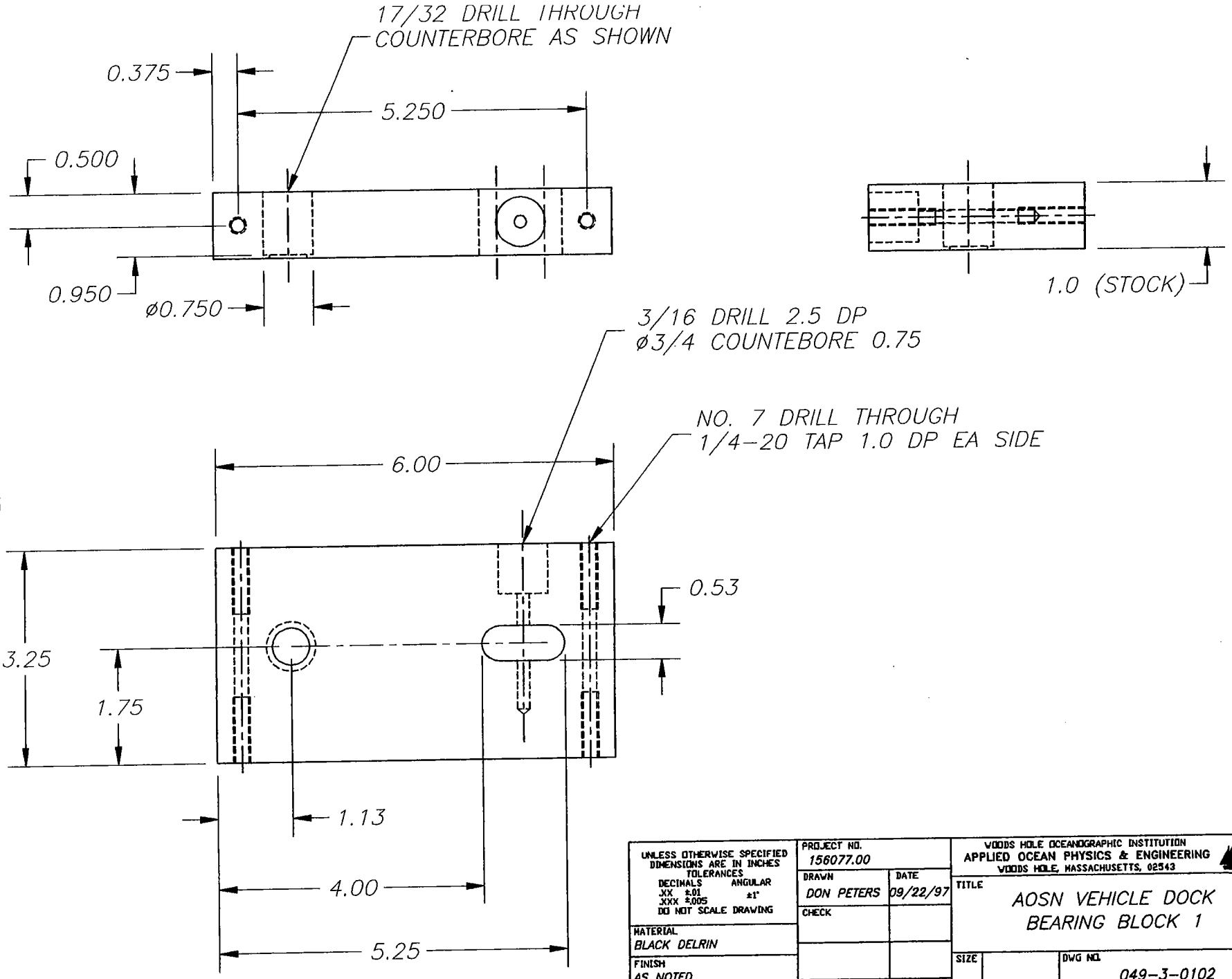
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS ANGULAR .XX ±.01 ±1° .XXX ±.005 DO NOT SCALE DRAWING	PROJECT NO. 000000.00	WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED OCEAN PHYSICS & ENGINEERING WOODS HOLE, MASSACHUSETTS, 02543
MATERIAL AS NOTED	DRAWN DON PETERS DATE 09/23/97	TITLE AOSN VEHICLE DOCK CARRIAGE
FINISH AS NOTED	CHECK	SIZE DWG NO. 049-3-0000
		SCALE RELEASE DATE SHEET OF



DRILL NOTES:
A - 1/4 DRILL THROUGH
CSK TO ø0.45 OTHER SIDE
B - 5/8 DRILL THROUGH
C - 1/4 DRILL THROUGH

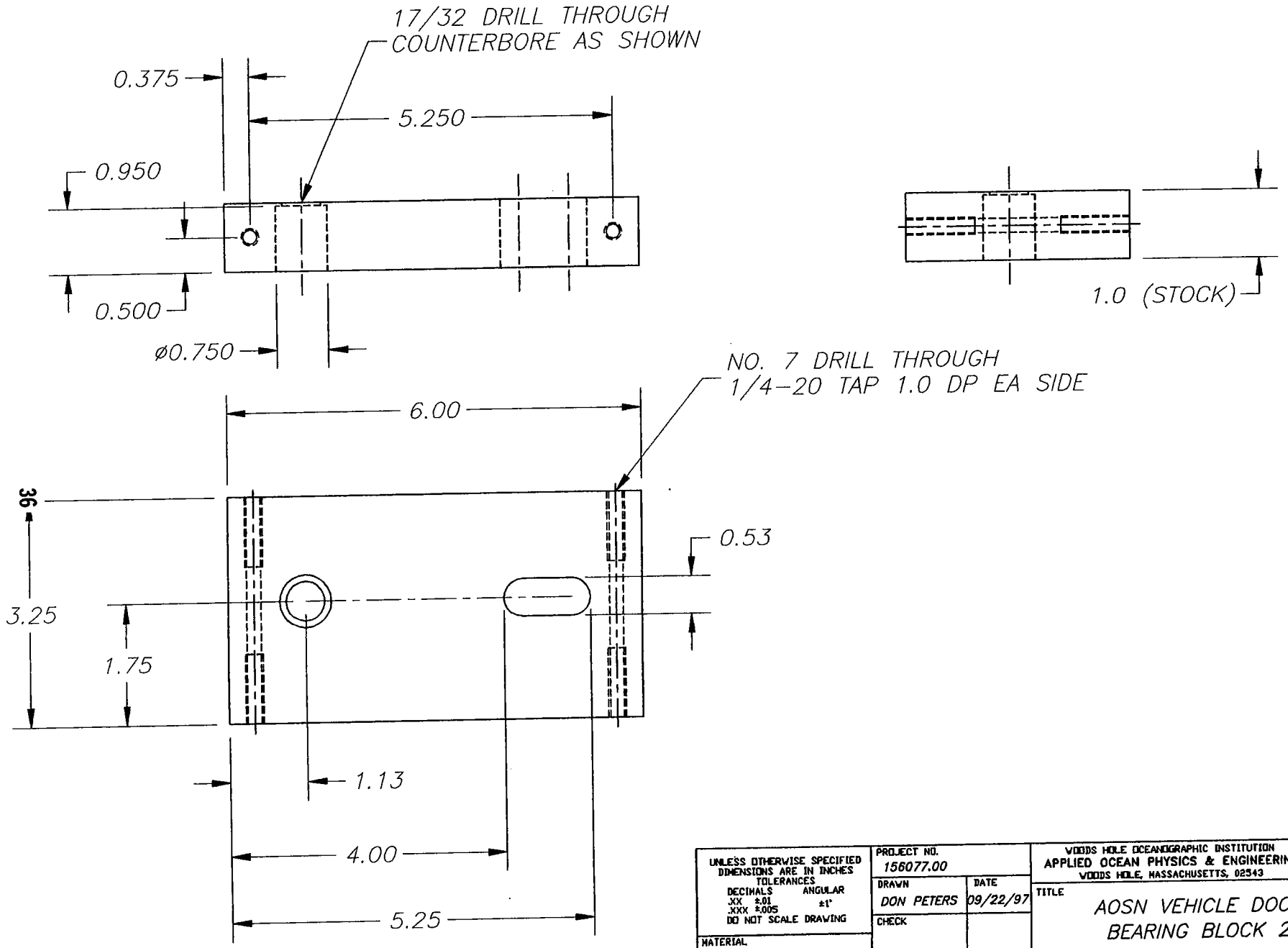
REV 09/26/97: CENTER HOLE INCREASED TO 4"

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS XX ±.01 XXX ±.005 ANGULAR ±1° DO NOT SCALE DRAWING	PROJECT NO. 156077.00	WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED OCEAN PHYSICS & ENGINEERING WOODS HOLE, MASSACHUSETTS, 02543
	DRAWN DON PETERS DATE 09/22/97	TITLE AOSN VEHICLE DOCK DRIVE MOUNT PLATE
	CHECK	
MATERIAL BLACK DELRIN		SIZE DWG NO. 049-3-0101
FINISH AS NOTED		SCALE RELEASE DATE SHEET OF

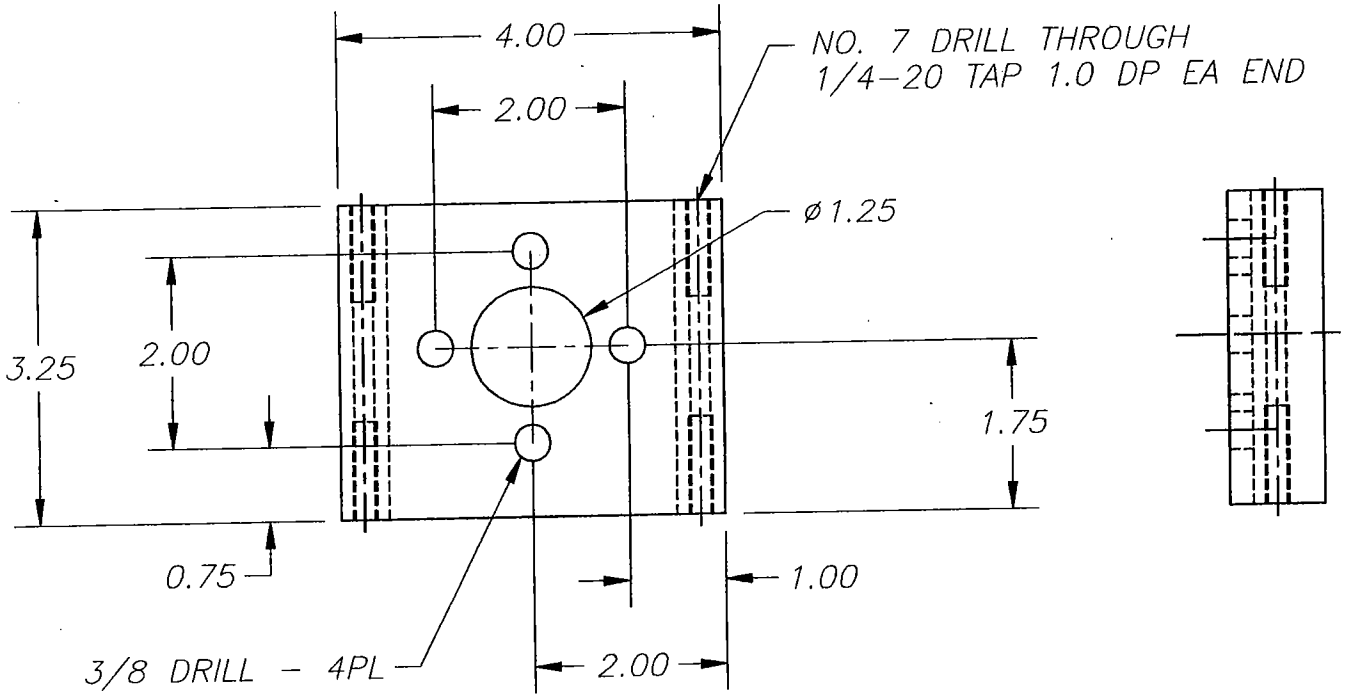


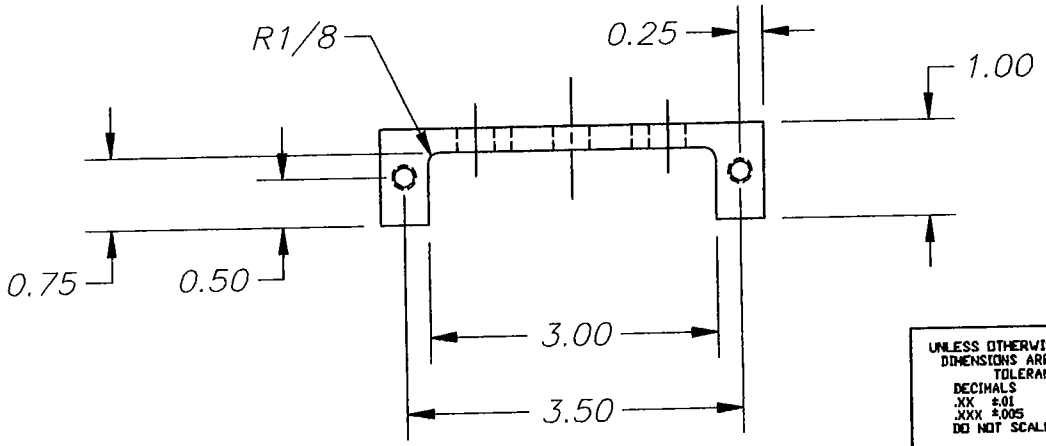
35

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS .XX ±.01 .XXX ±.005 ANGULAR ±1° DO NOT SCALE DRAWING	PROJECT NO. 156077.00	WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED OCEAN PHYSICS & ENGINEERING WOODS HOLE, MASSACHUSETTS, 02543
MATERIAL BLACK DELRIN	DRAWN DON PETERS DATE 09/22/97	TITLE AOSN VEHICLE DOCK BEARING BLOCK 1
FINISH AS NOTED	CHECK	SIZE DWG NO. 049-3-0102
		SCALE RELEASE DATE SHEET OF

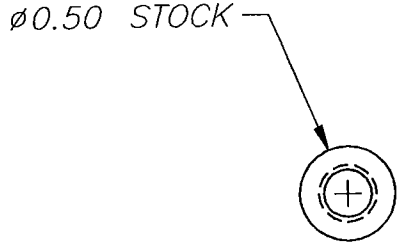


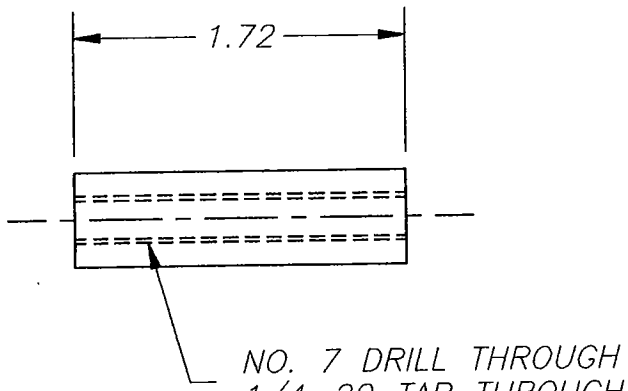
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS .XX ±.01 .XXX ±.005 ANGULAR ±1° DO NOT SCALE DRAWING	PROJECT NO. 156077.00	WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED OCEAN PHYSICS & ENGINEERING WOODS HOLE, MASSACHUSETTS, 02543	
	DRAWN DON PETERS	DATE 09/22/97	TITLE AOSN VEHICLE DOCK BEARING BLOCK 2
	CHECK		
MATERIAL BLACK DELRIN			SIZE
FINISH AS NOTED			DWG NO. 049-3-0103
			SCALE RELEASE DATE SHEET OF





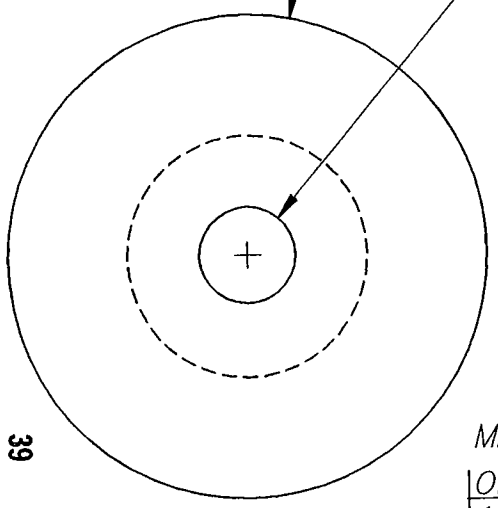
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS .XX ±.01 .XXX ±.005 ANGULAR ±1° DO NOT SCALE DRAWING	PROJECT NO. 156077.00	WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED OCEAN PHYSICS & ENGINEERING WOODS HOLE, MASSACHUSETTS, 02543
	DRAWN DON PETERS DATE 09/22/97	TITLE AOSN VEHICLE DOCK MOTOR MOUNT BLOCK
	CHECK	
MATERIAL BLACK DELRIN		SIZE DWG NO. 049-3-0104
FINISH AS NOTED		SCALE RELEASE DATE SHEET OF

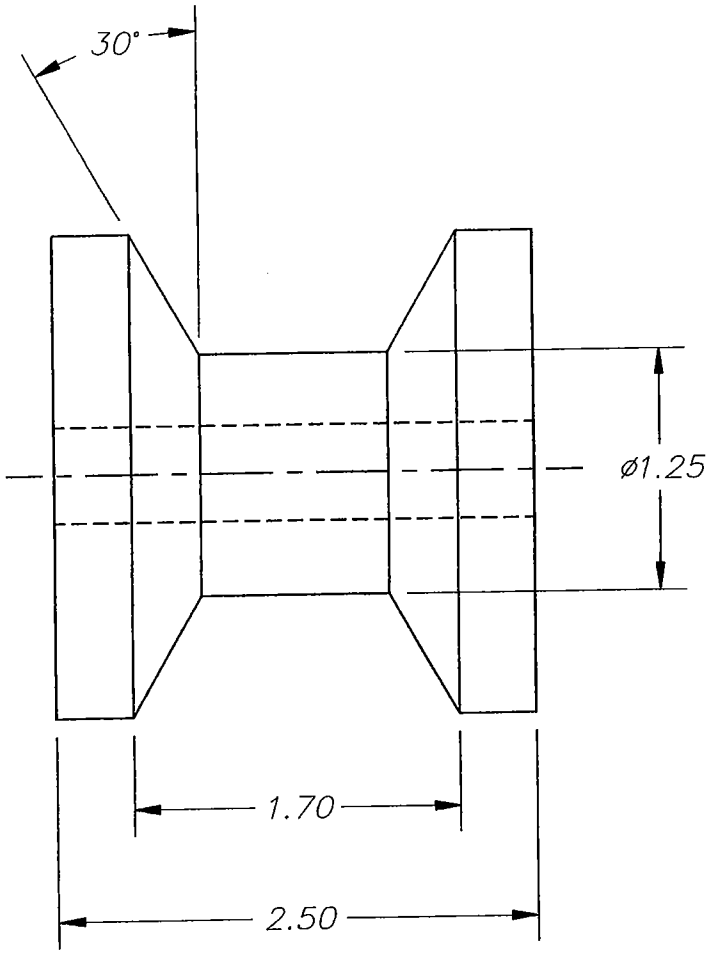




38

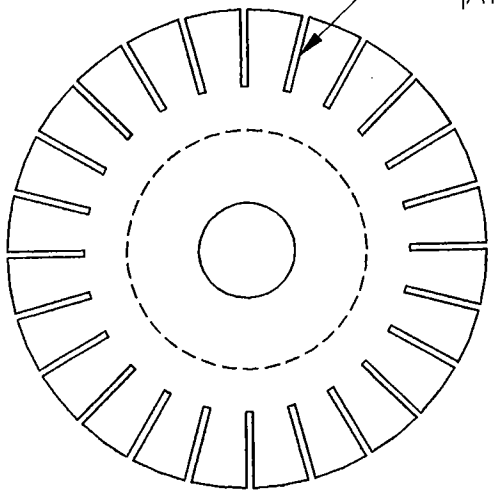
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS .XX ±.01 .XXX ±.005 ANGULAR ±1° DO NOT SCALE DRAWING	PROJECT NO. 156077.00	WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED OCEAN PHYSICS & ENGINEERING WOODS HOLE, MASSACHUSETTS, 02543	
	DRAWN DON PETERS	DATE 09/22/97	TITLE AOSN VEHICLE DOCK SPRING POST
MATERIAL 6061–T6 ALUMINUM	CHECK		
FINISH AS NOTED			SIZE — DWG NO. 049–3–0105
			SCALE — RELEASE DATE — SHEET OF





MAKE FOUR PIECES

ONE PIECE:
1/32 KERF RADIAL
CUT 0.4 DEEP
EQUALLY SPACED
AT 15° - 24PL



39

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS .XX ±.01 .XXX ±.005 ANGULAR ±1° DO NOT SCALE DRAWING	PROJECT NO. 156168.08	WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED OCEAN PHYSICS & ENGINEERING WOODS HOLE, MASSACHUSETTS, 02543
	DRAWN DON PETERS DATE 09/19/97	TITLE ODYSSEY DOCKING FIXTURE FRICTION DRIVE WHEEL
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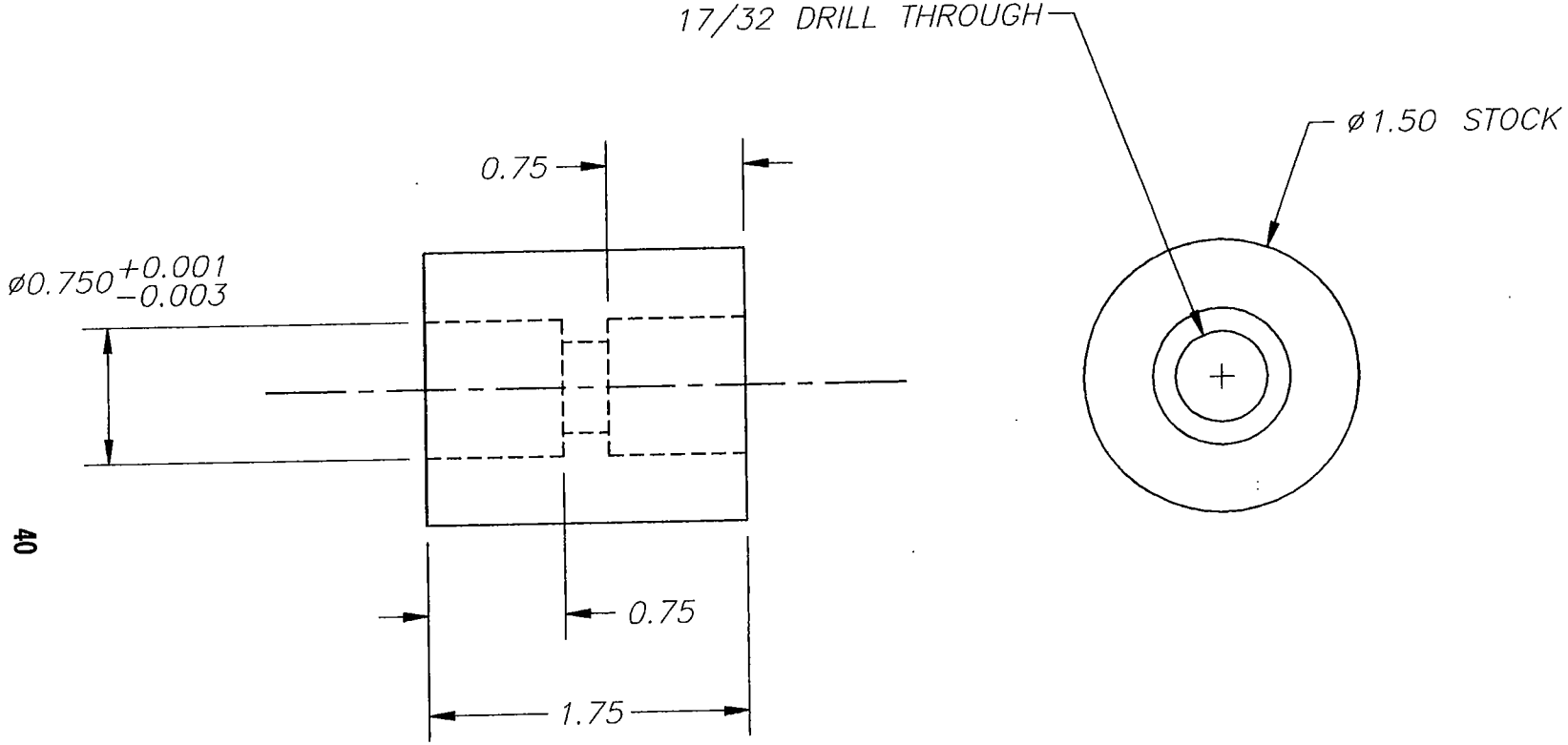
MATERIAL URETHANE WHEEL STOCK		SIZE DWG NO. 049-3-0200
FINISH AS NOTED		SCALE RELEASE DATE SHEET OF



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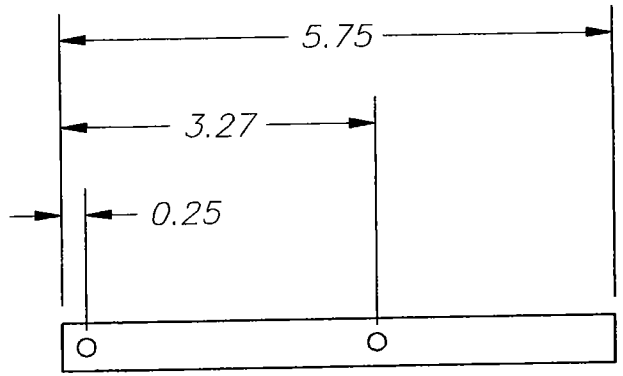
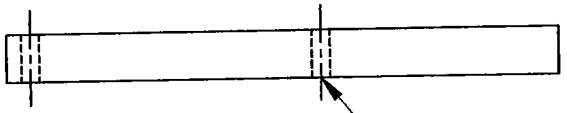
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS .XX ±.01 .XXX ±.005 ANGULAR ±1° DO NOT SCALE DRAWING	PROJECT NO. 156077.00	WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED OCEAN PHYSICS & ENGINEERING WOODS HOLE, MASSACHUSETTS, 02543
	DRAWN DON PETERS DATE 09/22/97	TITLE AOSN VEHICLE DOCK IDLER WHEEL
	CHECK	
MATERIAL WHITE DELRIN		SIZE DWG NO. 049-3-0201
FINISH AS NOTED		SCALE RELEASE DATE SHEET OF

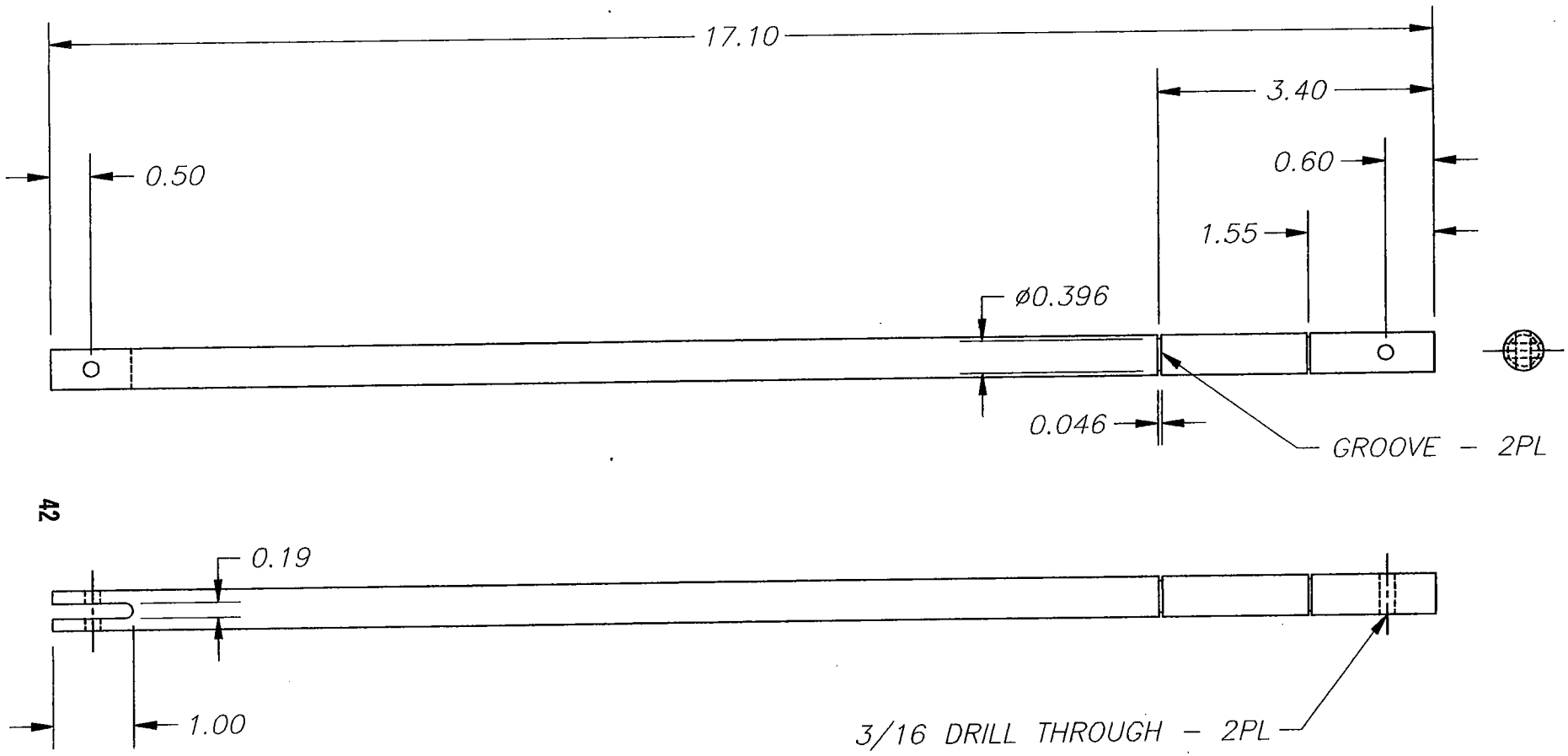




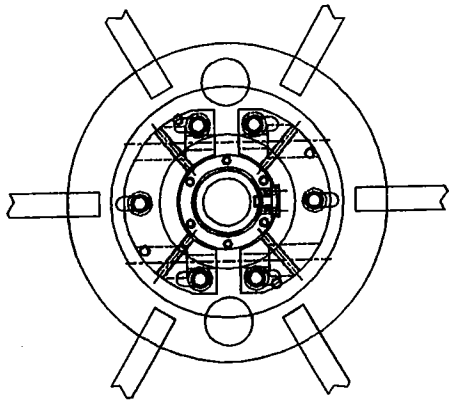
3/16 DRILL THROUGH – 2PL

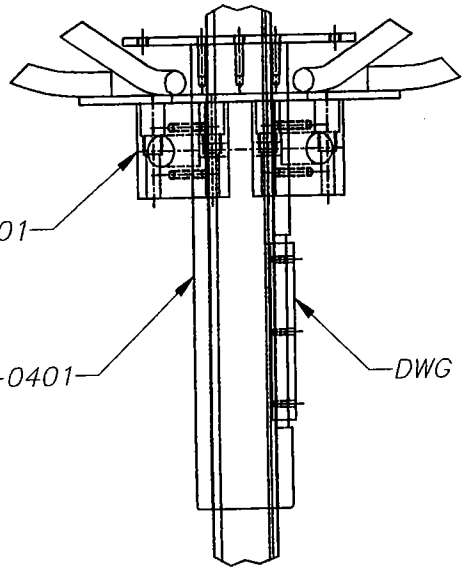
41

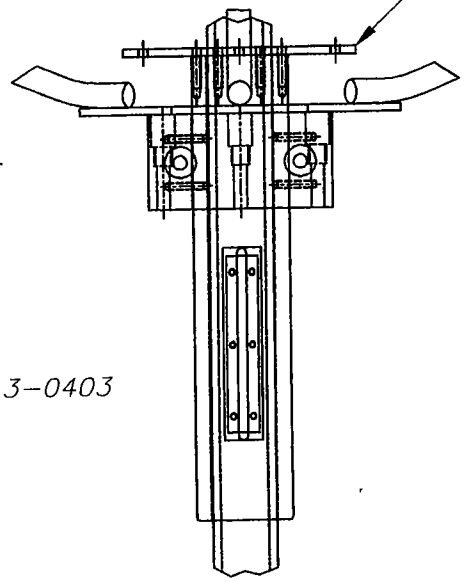
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS .XX ±.01 .XXX ±.005 ANGULAR ±1° DO NOT SCALE DRAWING	PROJECT NO. 156077.00	WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED OCEAN PHYSICS & ENGINEERING WOODS HOLE, MASSACHUSETTS, 02543	
	DRAWN DON PETERS	DATE 09/22/97	TITLE AOSN VEHICLE DOCK DRIVE SHAFT
	CHECK		
MATERIAL 1/2 ROUND BAR 316SS			SIZE
FINISH AS NOTED			DWG NO. 049-3-0301
			SCALE RELEASE DATE SHEET OF



UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS ANGULAR .XX ±.01 ±1° .XXX ±.005 DO NOT SCALE DRAWING	PROJECT NO. 156077.00	WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED OCEAN PHYSICS & ENGINEERING WOODS HOLE, MASSACHUSETTS, 02543
MATERIAL 1/2 ROUND BAR 316SS	DRAWN DON PETERS DATE 09/22/97	TITLE AOSN VEHICLE DOCK IDLER SHAFT
FINISH AS NOTED	CHECK	SIZE DWG NO. 049-3-0302
		SCALE RELEASE DATE SHEET OF

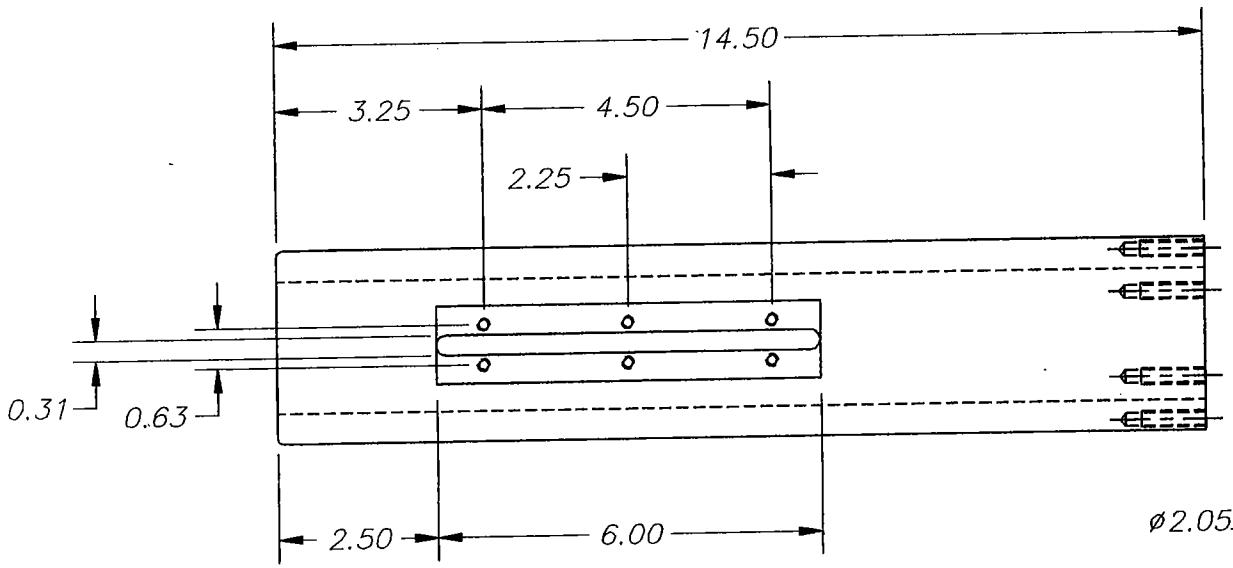


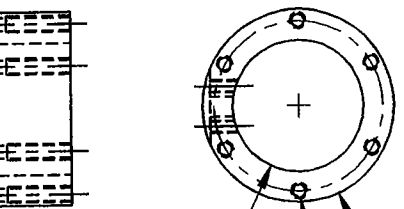




43

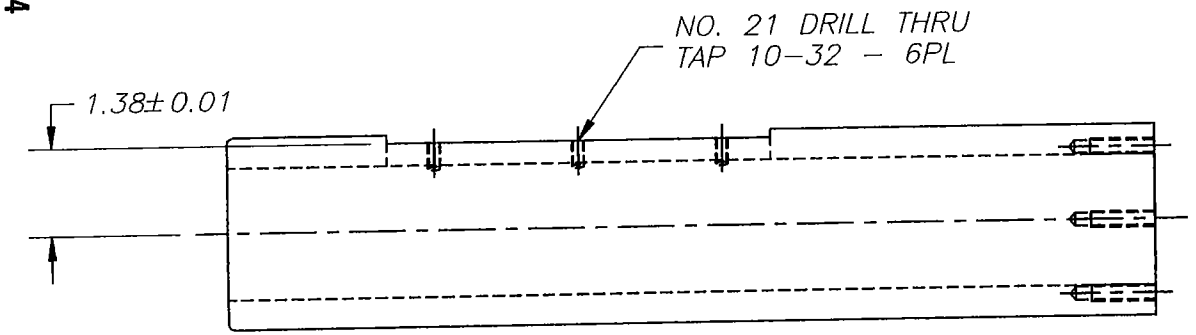
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS ANGULAR .XX ±.01 ±1° .XXX ±.005 DO NOT SCALE DRAWING	PROJECT NO. 156077.00		WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED OCEAN PHYSICS & ENGINEERING WOODS HOLE, MASSACHUSETTS, 02543
	DRAWN DON PETERS	DATE 09/22/97	TITLE AOSN VEHICLE DOCK SLIDER ASSEMBLY
	CHECK		
MATERIAL AS NOTED			SIZE DWG NO. 049-3-0400
FINISH AS NOTED			SCALE RELEASE DATE SHEET OF



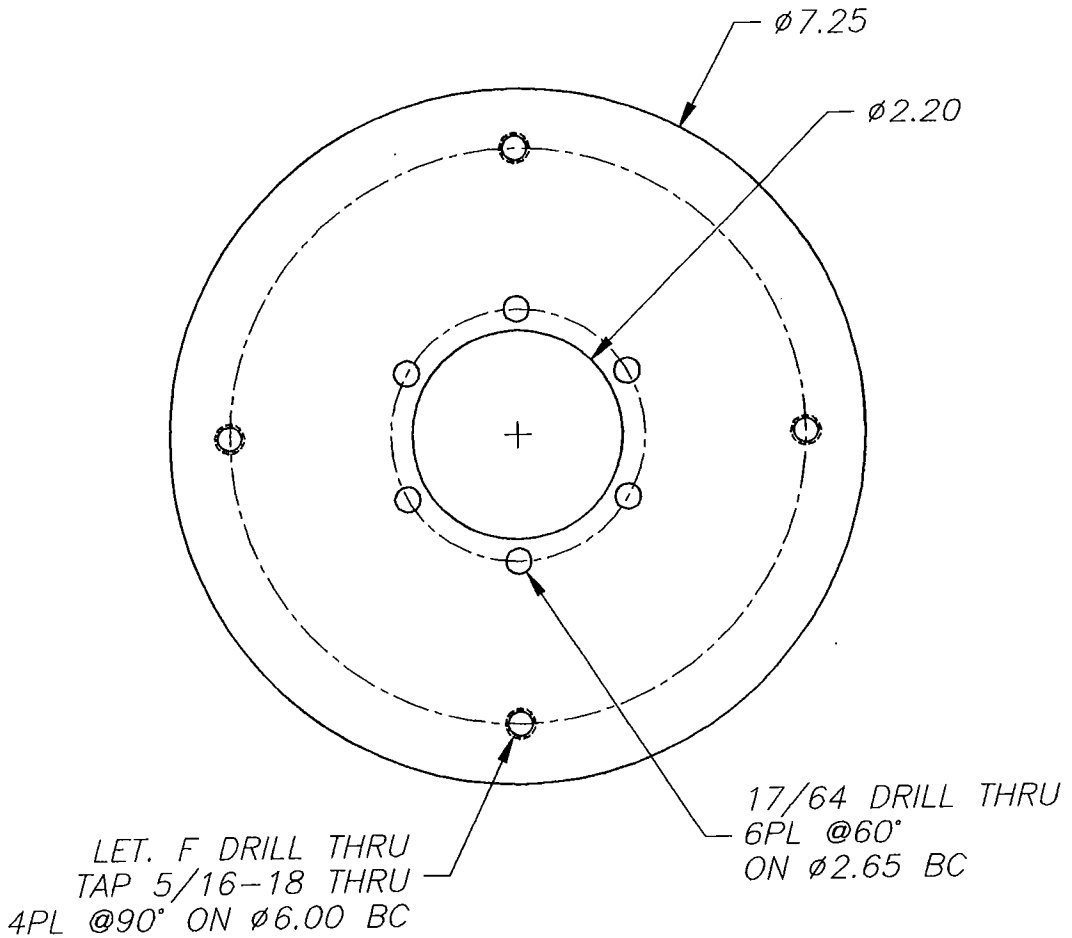


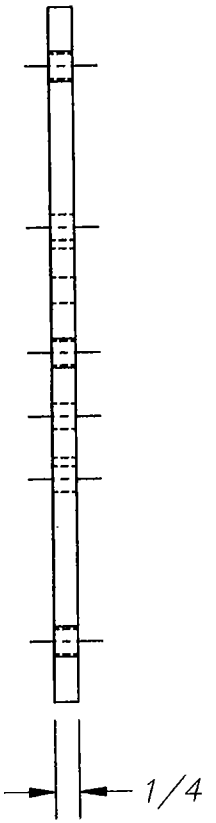
NO. 7 DRILL 1.25 DP
TAP 1/4–20 1.0 DP MIN
6PL@60° ON ø2.65 BC

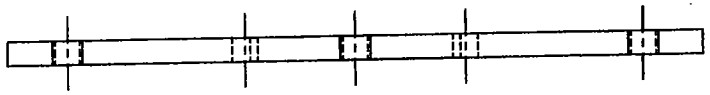
4



UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS .XX ±.01 .XXX ±.005 ANGULAR ±1° DO NOT SCALE DRAWING	PROJECT NO. 156077.00	WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED OCEAN PHYSICS & ENGINEERING WOODS HOLE, MASSACHUSETTS, 02543
	DRAWN DON PETERS DATE 09/22/97	TITLE AOSN VEHICLE DOCK SLIDER HUB
	CHECK	
MATERIAL 3 OD X 2 ID UHMW		SIZE DWG NO. 049–3–0401
FINISH AS NOTED		SCALE RELEASE DATE SHEET OF

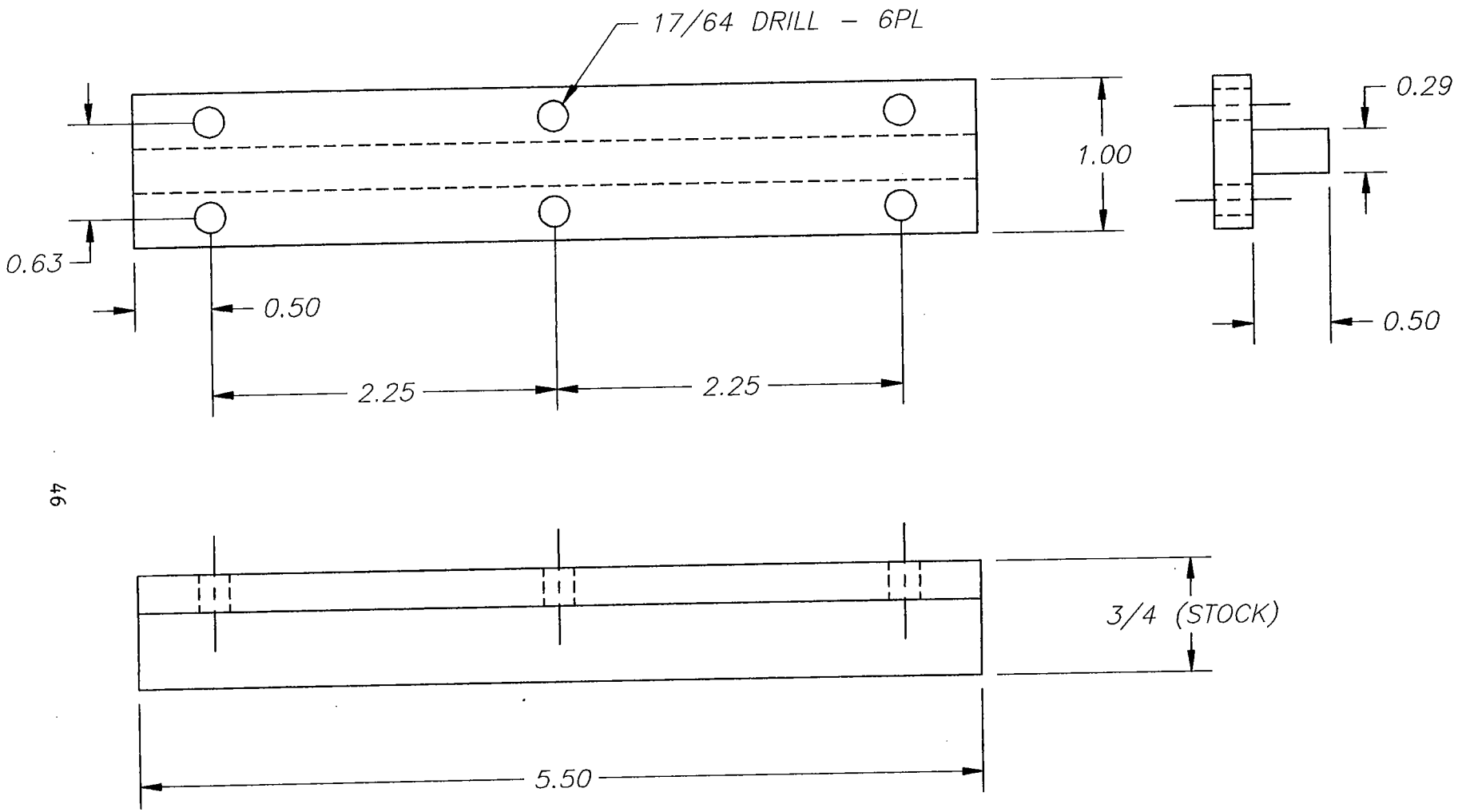




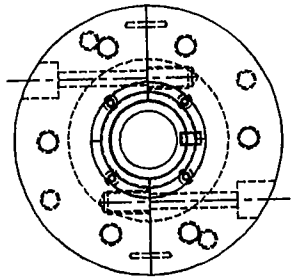


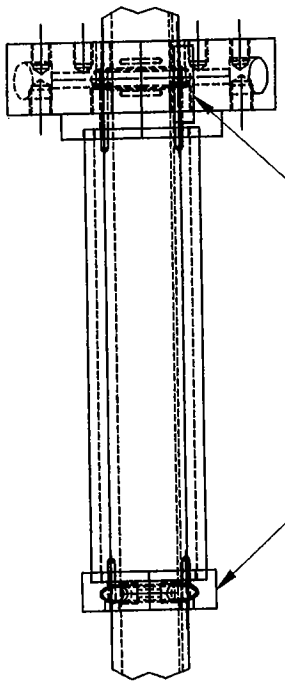
45

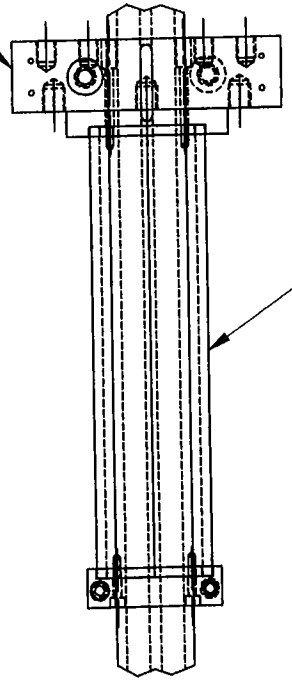
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS .XX ±.01 .XXX ±.005 ANGULAR ±1° DO NOT SCALE DRAWING	PROJECT NO. 156077.00	WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED OCEAN PHYSICS & ENGINEERING WOODS HOLE, MASSACHUSETTS, 02543	
MATERIAL DELRIN	DRAWN DON PETERS	DATE 09/22/97	TITLE AOSN VEHICLE DOCK SLIDER FLANGE PLATE
FINISH AS NOTED	CHECK		SIZE
			DWG NO. 049-3-0402
			SCALE RELEASE DATE SHEET OF



UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS .XX ±.01 .XXX ±.005 ANGULAR ±1° DO NOT SCALE DRAWING	PROJECT NO. 156168.08	WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED OCEAN PHYSICS & ENGINEERING WOODS HOLE, MASSACHUSETTS, 02543	
	DRAWN DON PETERS	DATE 09/22/97	TITLE AOSN VEHICLE DOCK SLIDER KEY BLOCK
	CHECK		
MATERIAL DELRIN			SIZE
FINISH AS NOTED			DWG NO. 049-3-0403
			SCALE RELEASE DATE SHEET OF







DWG #049-3-0501

DWG #049-3-0504

DWG #049-3-0503

DWG #049-3-0502

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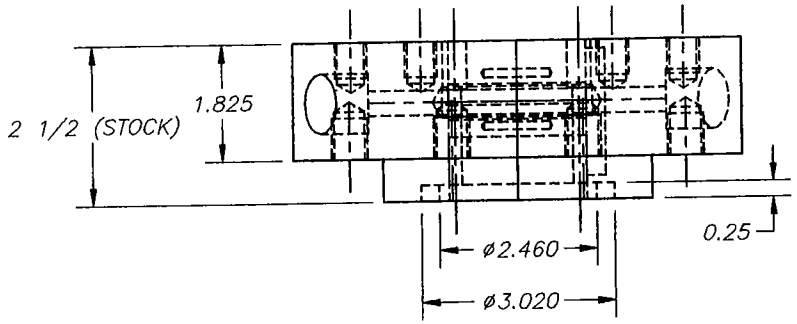
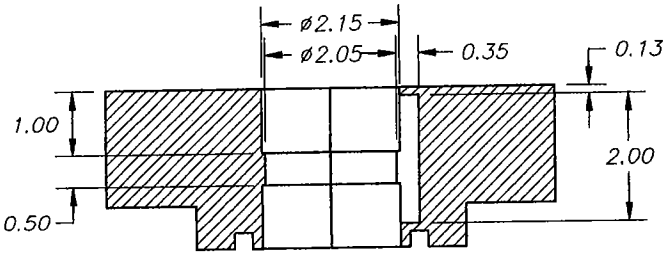
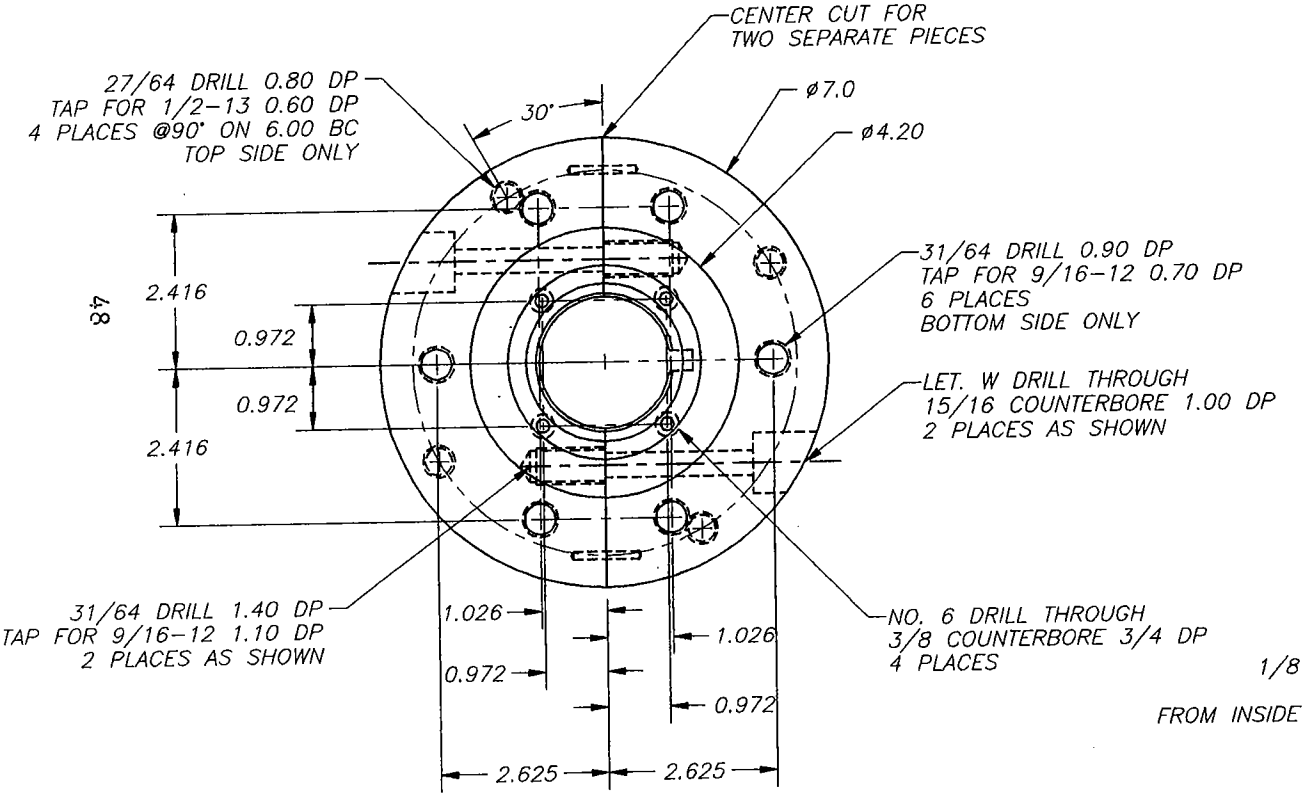
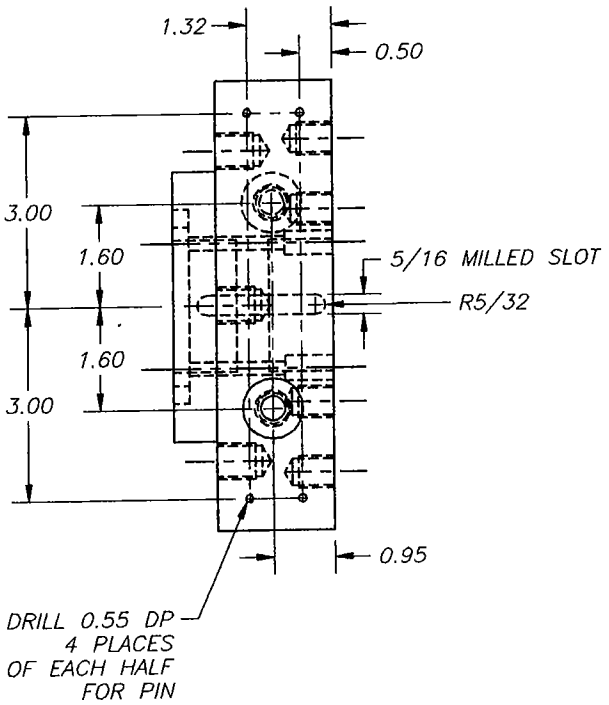
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS ANGULAR .XX ±.01 ±1° .XXX ±.005 DO NOT SCALE DRAWING	PROJECT NO. 156168.08		WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED OCEAN PHYSICS & ENGINEERING WOODS HOLE, MASSACHUSETTS, 02543
	DRAWN C. LUMPING	DATE 09/22/97	TITLE AOSN VEHICLE DOCK SLIDER ASSEMBLY
	CHECK		
MATERIAL AS NOTED			SIZE
FINISH AS NOTED			DWG NO. 049-3-0500
			SCALE RELEASE DATE SHEET OF





CROSS SECTION OF LEFT VIEW

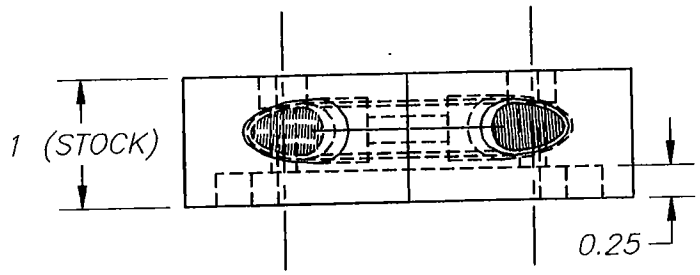


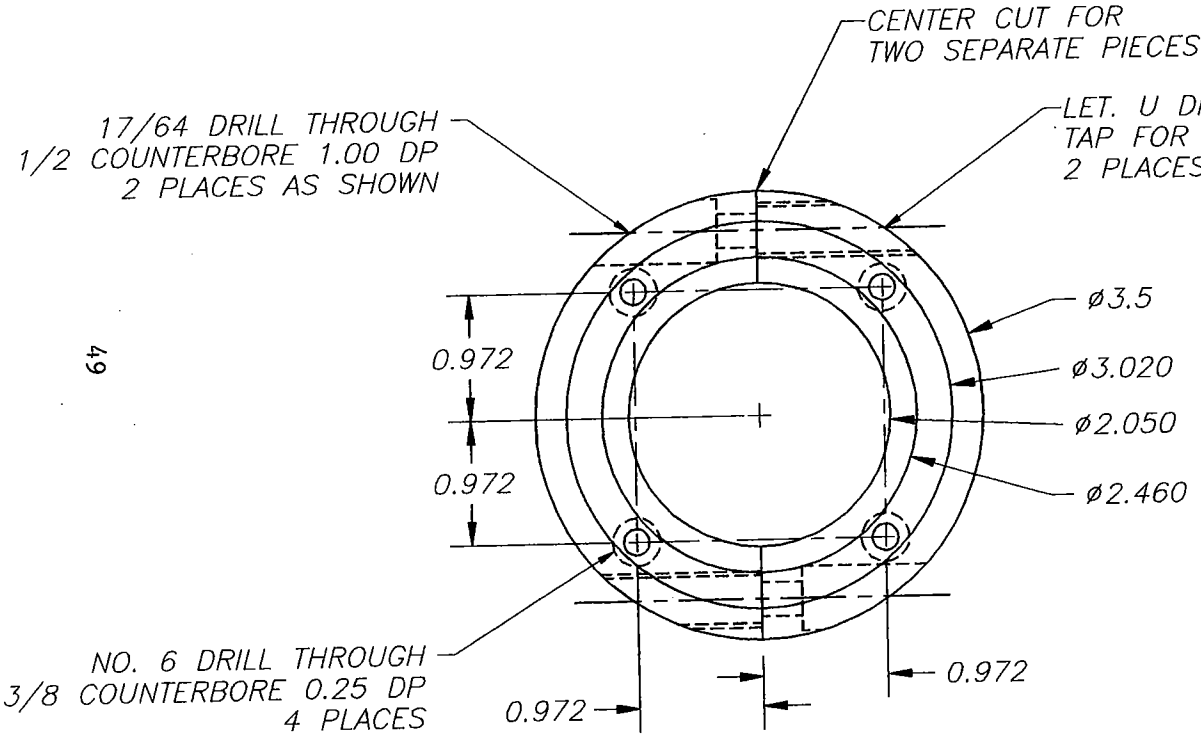


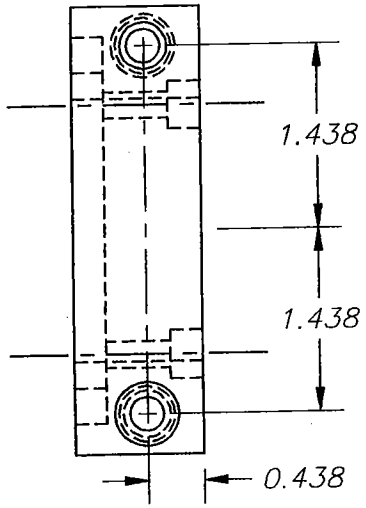
NOTE: DIMENSIONS CORRECT AFTER CUT

REV 05/15/98 – ø2.15 I.D.

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS ANGULAR .XX ±.01 ±1° .XXX ±.005 DO NOT SCALE DRAWING	PROJECT NO. 156168.08	WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED OCEAN PHYSICS & ENGINEERING WOODS HOLE, MASSACHUSETTS, 02543
	DRAWN C. LUMPING DATE 03/30/98	TITLE AOSN VEHICLE DOCK SLIDER UPPER ATTACHMENT
	CHECK	
MATERIAL 2 1/2" ACETAL SHEET		SIZE DWG NO. 049-3-0501
FINISH AS NOTED		SCALE RELEASE DATE SHEET OF



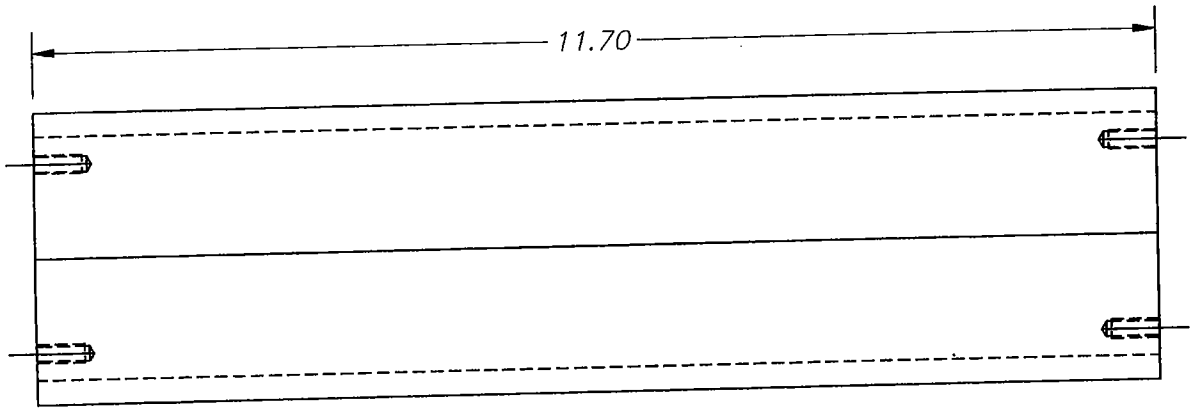




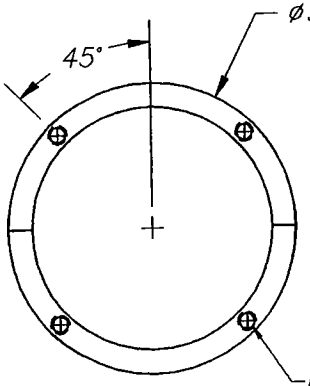
REV 04/24/98 – 2.080 I.D.

NOTE: DIMENSIONS CORRECT AFTER CUT

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS .XX ±.01 .XXX ±.005 ANGULAR ±1° DO NOT SCALE DRAWING	PROJECT NO. 156168.08	WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED OCEAN PHYSICS & ENGINEERING WOODS HOLE, MASSACHUSETTS, 02543
	DRAWN C. LUMPING / DATE 03/30/98	TITLE AOSN VEHICLE DOCK SLIDER LOWER ATTACHMENT
	CHECK	
MATERIAL 1" ACETAL SHEET		SIZE / DWG NO. 049-3-0502
FINISH AS NOTED		SCALE / RELEASE DATE / SHEET OF



50

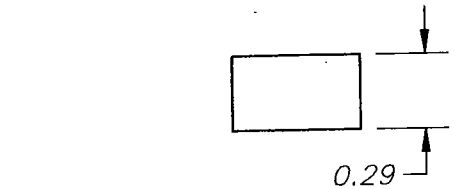


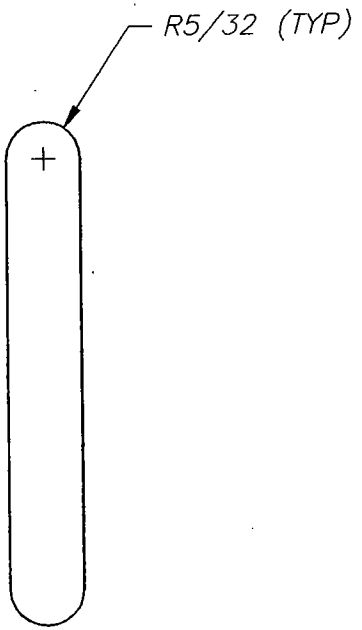
ø3 OD 1/4 WALL (STOCK)

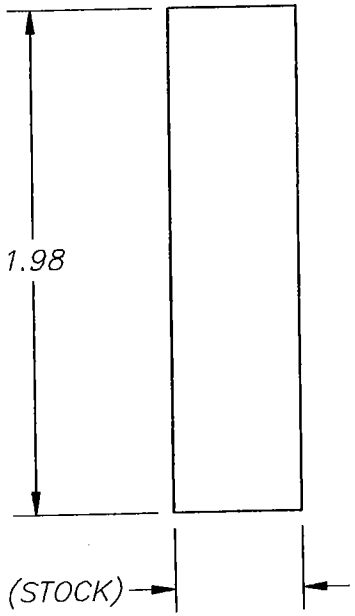
NO. 21 DRILL 0.60 DP
TAP FOR 10-32 0.50 DP
4 PLACES @90°
CENTER ON STOCK
BOTH ENDS

NOTE: DO NOT CUT TUBE IN HALF
UNTIL HOLES HAVE BEEN DRILLED

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS ANGULAR .XX ±.01 ±1° .XXX ±.005 DO NOT SCALE DRAWING	PROJECT NO. 156168.08	WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED OCEAN PHYSICS & ENGINEERING WOODS HOLE, MASSACHUSETTS, 02543
MATERIAL 3" OD ALUMINUM TUBE	DRAWN C. LUMPING DATE 03/30/98	TITLE AOSN VEHICLE DOCK SLIDER SHAFT
FINISH AS NOTED	CHECK	SIZE DWG NO. 049-3-0503
		SCALE RELEASE DATE SHEET OF

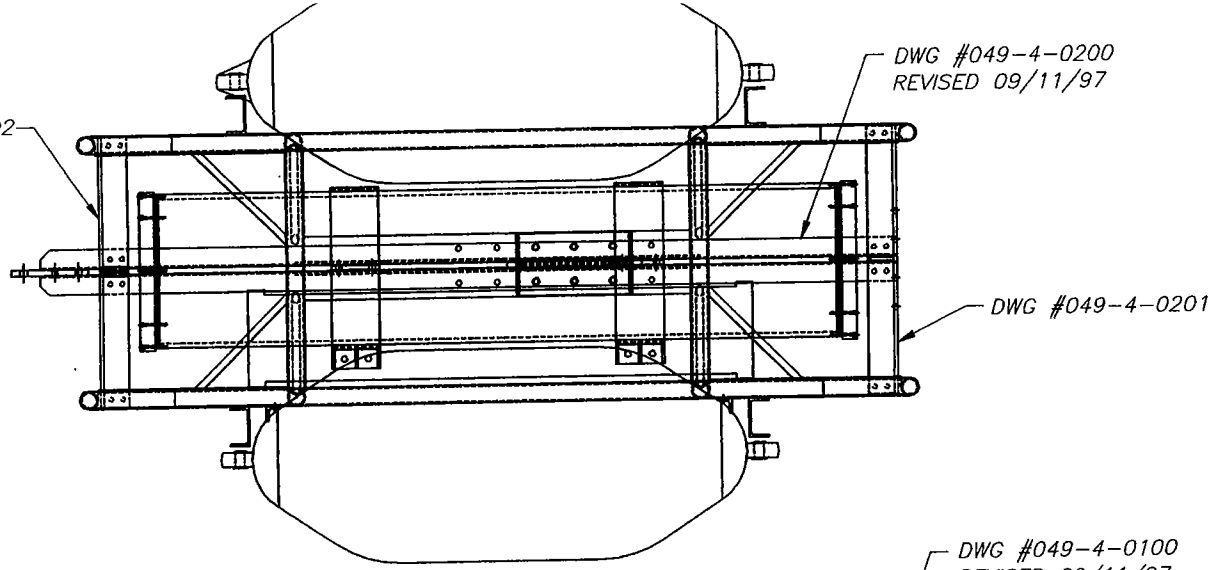


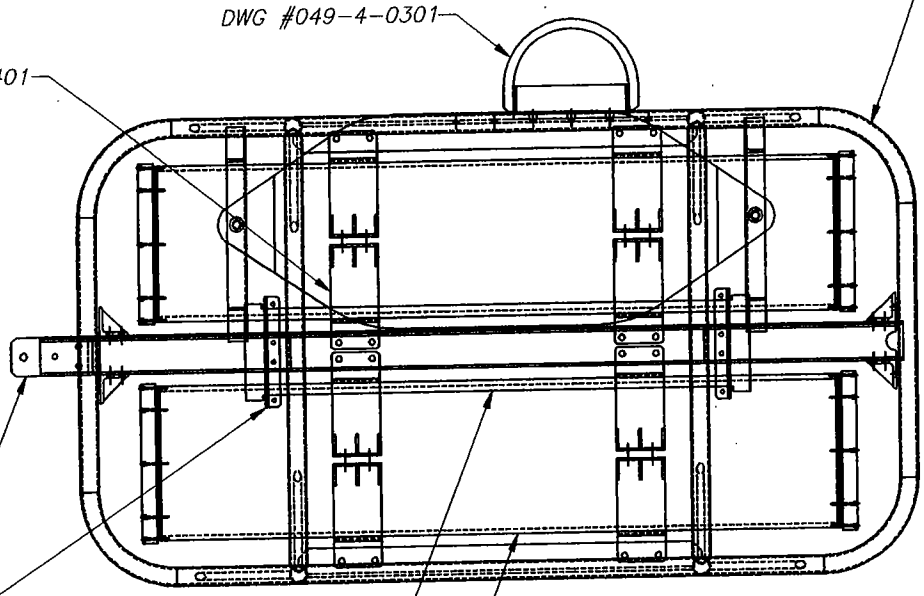


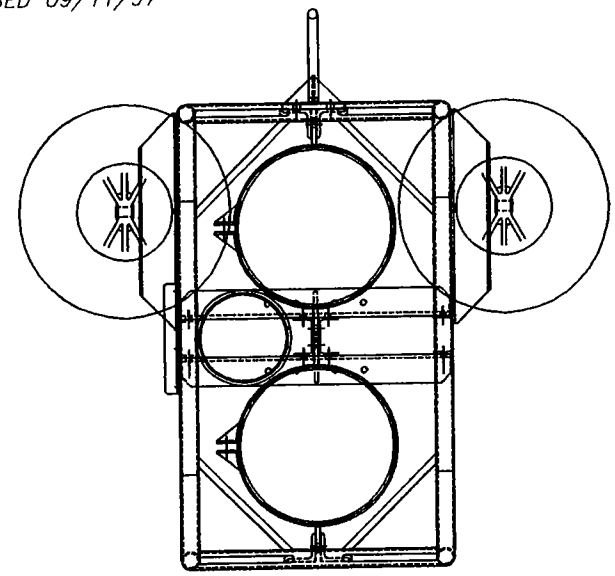


51

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS .XX ±.01 .XXX ±.005 ANGULAR ±1° DO NOT SCALE DRAWING	PROJECT NO. 156168.08	WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED OCEAN PHYSICS & ENGINEERING WOODS HOLE, MASSACHUSETTS, 02543	
	DRAWN C. LUMPING	DATE 03/30/98	TITLE AOSN VEHICLE DOCK SLIDER KEY INSERT
	CHECK		
MATERIAL STAINLESS STEEL			SIZE
FINISH AS NOTED			DWG NO. 049-3-0504
			SCALE RELEASE DATE SHEET OF



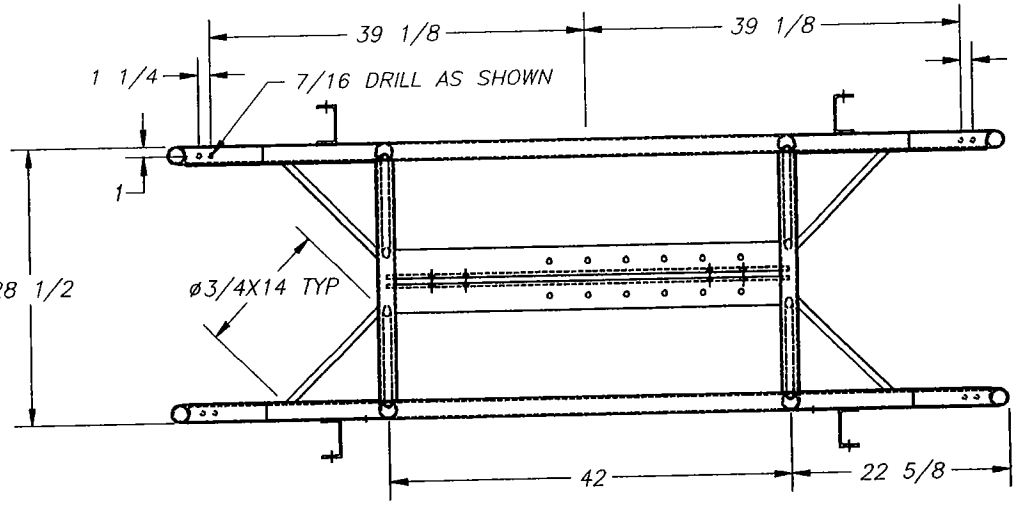


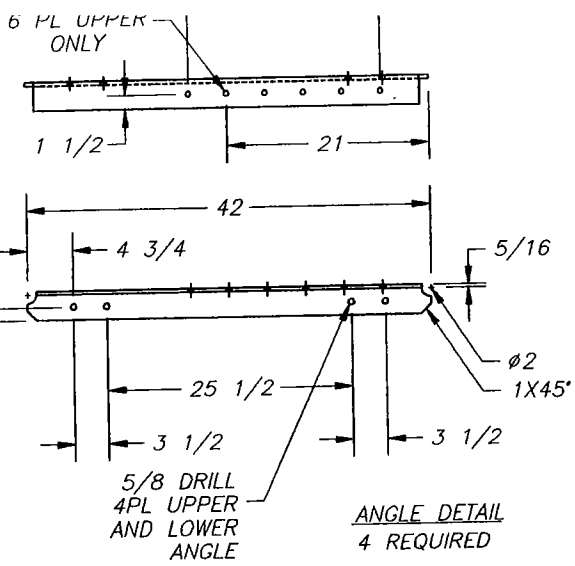


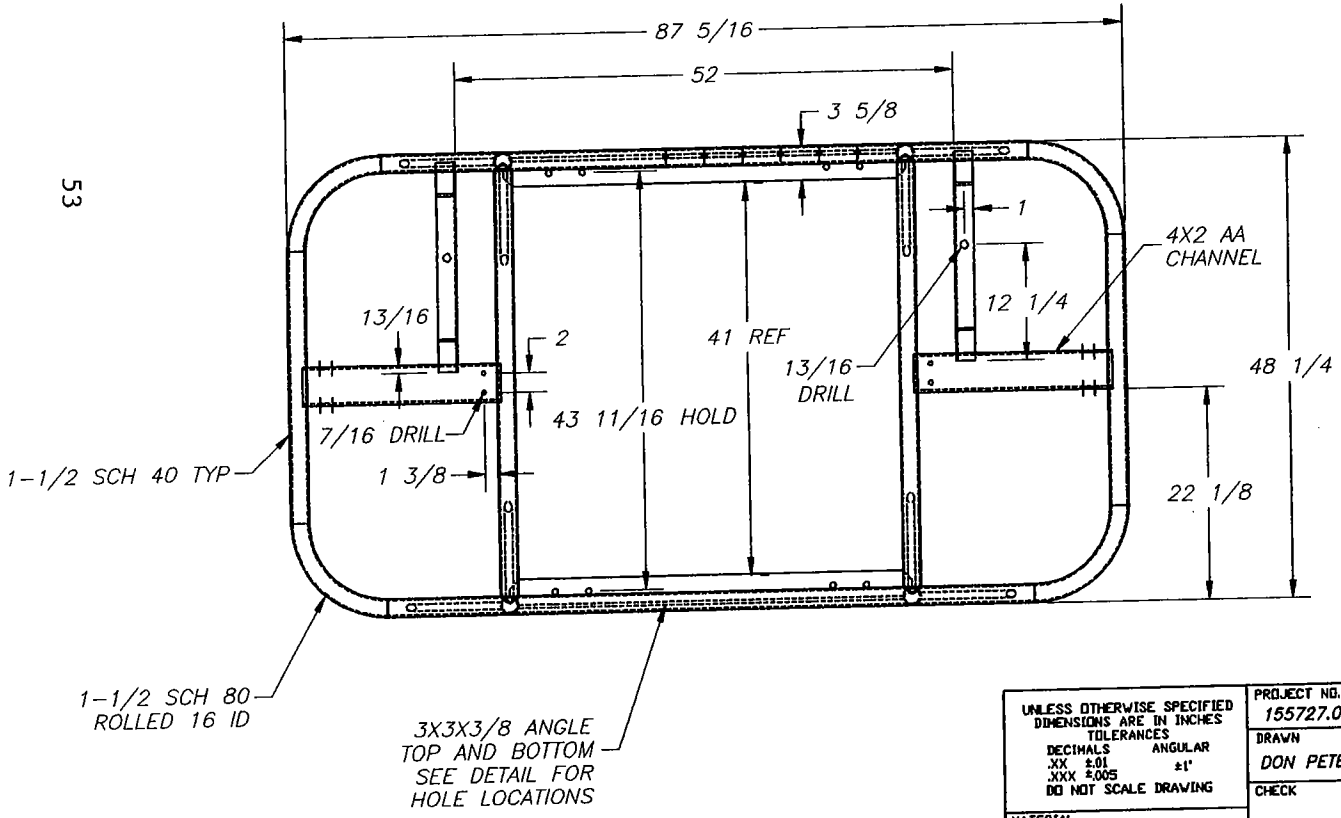
52

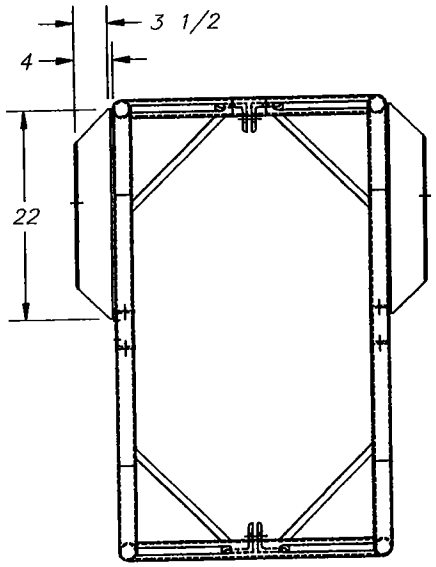
REVISED 10/08/97: INSTRUMENT HOUSING MOUNTS
REVISED 09/26/97: HOUSING BELLY BANDS
REVISED 09/11/97: REVISION NOTES

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS .XX ±.01 .XXX ±.005 ANGULAR ±1° DO NOT SCALE DRAWING	PROJECT NO. 155727.00	WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED OCEAN PHYSICS & ENGINEERING WOODS HOLE, MASSACHUSETTS, 02543	
	DRAWN DON PETERS	DATE 09/02/97	TITLE AOSN VEHICLE DOCK BATTERY/INSTRUMENT CAGE
	CHECK		
MATERIAL AS NOTED			SIZE
FINISH AS NOTED			DWG NO. 049-4-0000
			SCALE RELEASE DATE SHEET OF









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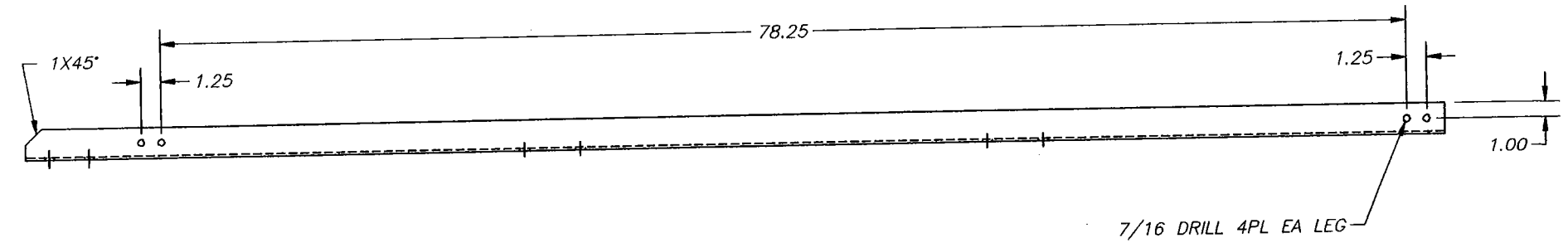
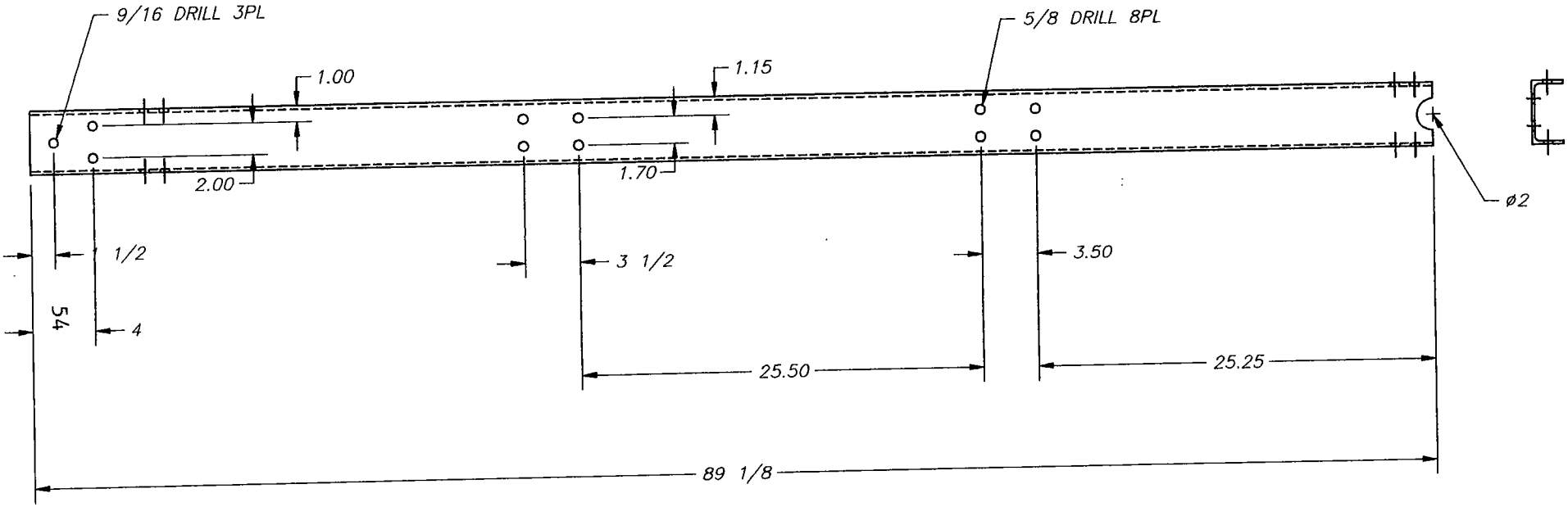
REVISED 10/08/97: INST HSG MOUNT HOLES
REVISED 10/06/97: POLYFORM MOUNTS
REVISED 09/11/97: HOUSING MOUNT LOCATIONS

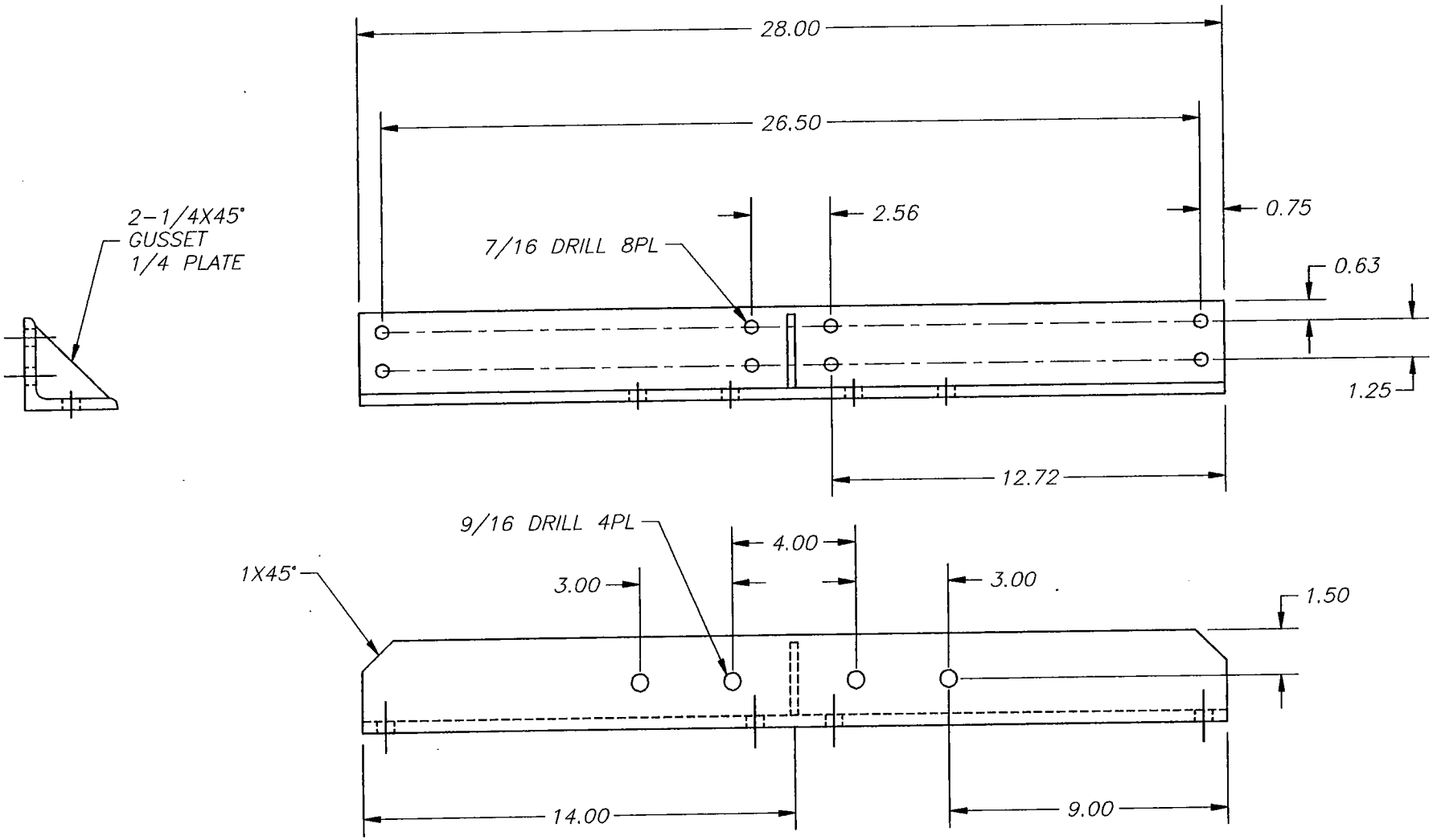
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS .XX ±.01 .XXX ±.005 ANGULAR ±1° DO NOT SCALE DRAWING	PROJECT NO. 155727.00	WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED OCEAN PHYSICS & ENGINEERING WOODS HOLE, MASSACHUSETTS, 02543
	DRAWN DON PETERS / DATE 09/07/97	TITLE AOSN BATTERY CAGE MAIN FRAME WELDMENT
	CHECK	
MATERIAL ALUMINUM		SIZE / DWG NO. 049-4-0100
FINISH AS NOTED		SCALE / RELEASE DATE / SHEET / OF





REVISED 09/11/97: MOUNT HOLE LOCATIONS

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS .XX ±.01 .XXX ±.005 ANGULAR ±1° DO NOT SCALE DRAWING	PROJECT NO. 155727.00	WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED OCEAN PHYSICS & ENGINEERING WOODS HOLE, MASSACHUSETTS, 02543
MATERIAL 4X2 AA CHANNEL 6061-T6	DRAWN DON PETERS DATE 09/07/97	TITLE AOSN BATTERY CAGE CENTER CHANNEL
FINISH AS NOTED	CHECK	SIZE DWG NO. 049-4-0200
		SCALE RELEASE DATE SHEET OF



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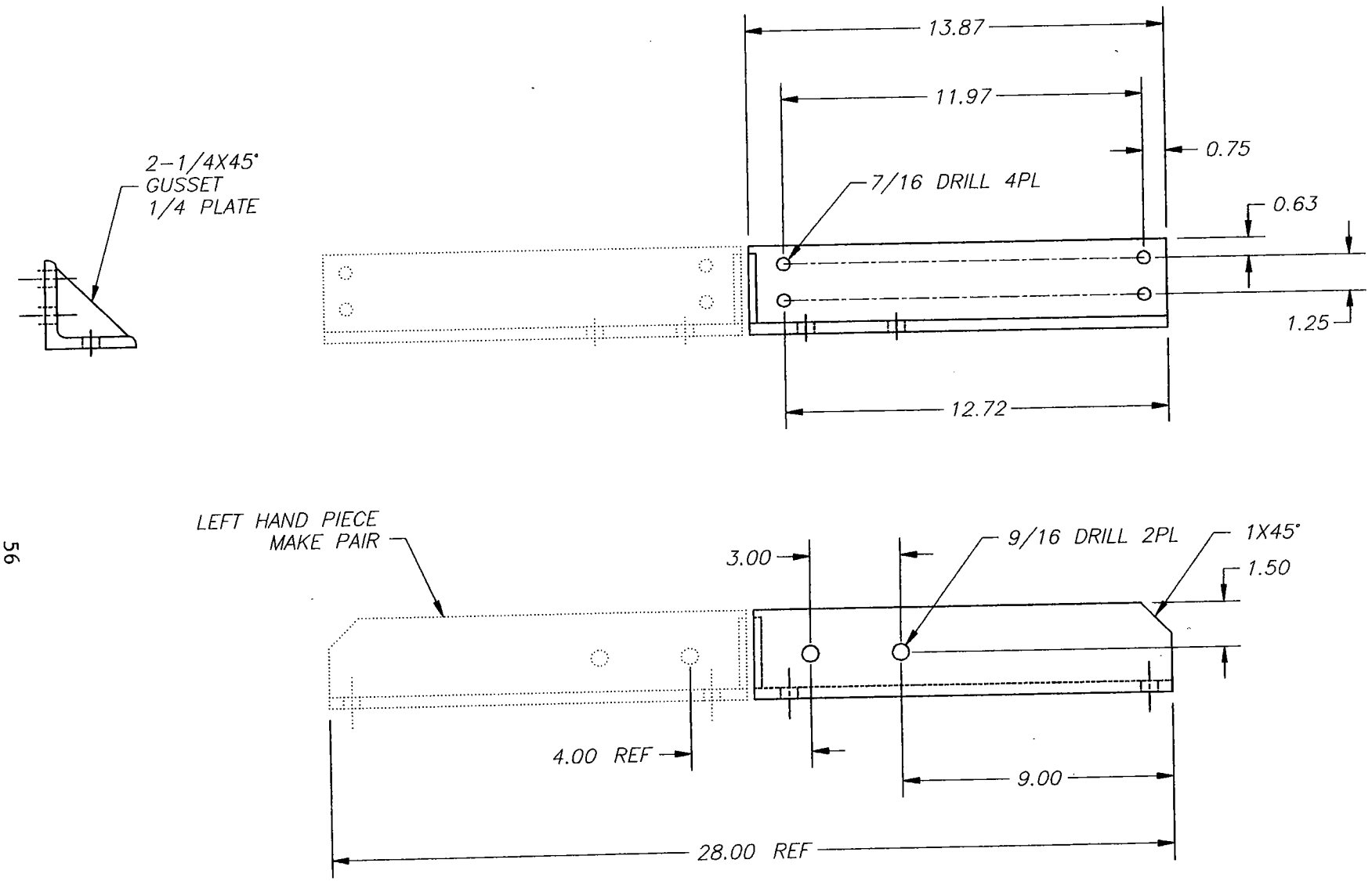
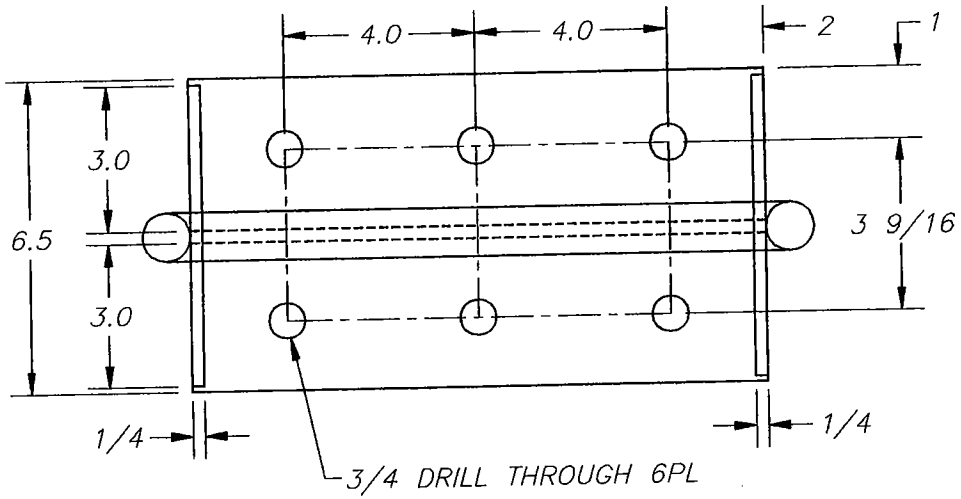
NOTE:
THIS PIECE TO BE MADE
USING 5086-H111 ALUMINUM

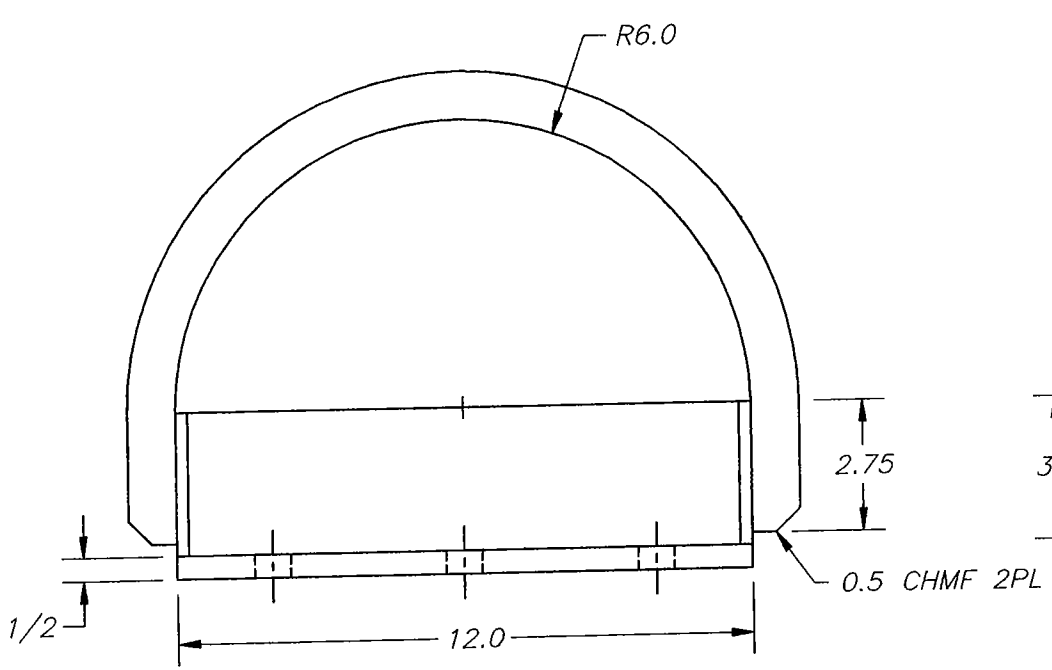
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS XX ±.01 XXX ±.005 ANGULAR ±1° DO NOT SCALE DRAWING	PROJECT NO. 155727.00	WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED OCEAN PHYSICS & ENGINEERING WOODS HOLE, MASSACHUSETTS, 02543
	DRAWN DON PETERS DATE 09/07/97	TITLE AOSN BATTERY CAGE UPPER CROSSPIECE
	CHECK	
MATERIAL 3X3X3/8 5086 ALUMINUM		SIZE DWG NO. 049-4-0201
FINISH AS NOTED		SCALE RELEASE DATE SHEET OF

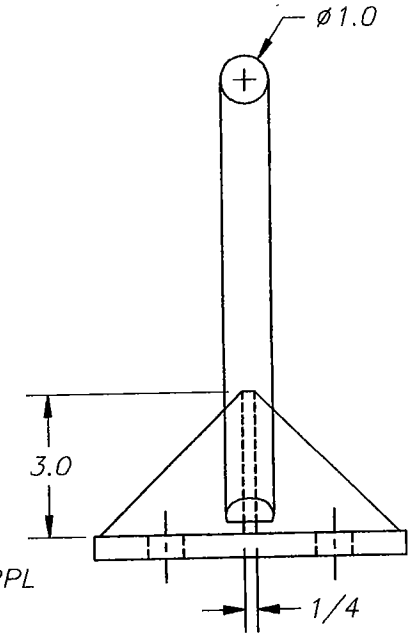


56

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS .XX ±.01 .XXX ±.005 ANGULAR ±1° DO NOT SCALE DRAWING	PROJECT NO. 150188.02	WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED OCEAN PHYSICS & ENGINEERING WOODS HOLE, MASSACHUSETTS, 02543
MATERIAL 3X3X3/8 ANGLE 6061-T6	DRAWN DON PETERS DATE 09/07/97	TITLE AOSN BATTERY CAGE LOWER CROSSPIECE
FINISH AS NOTED	CHECK	SIZE DWG NO. 049-4-0202
		SCALE RELEASE DATE SHEET OF

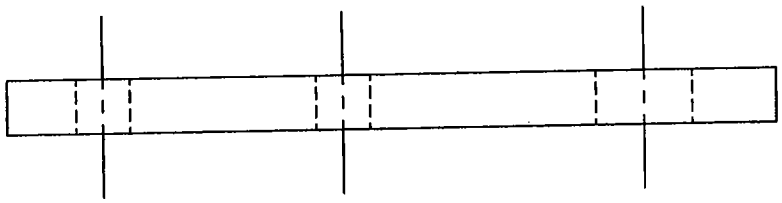


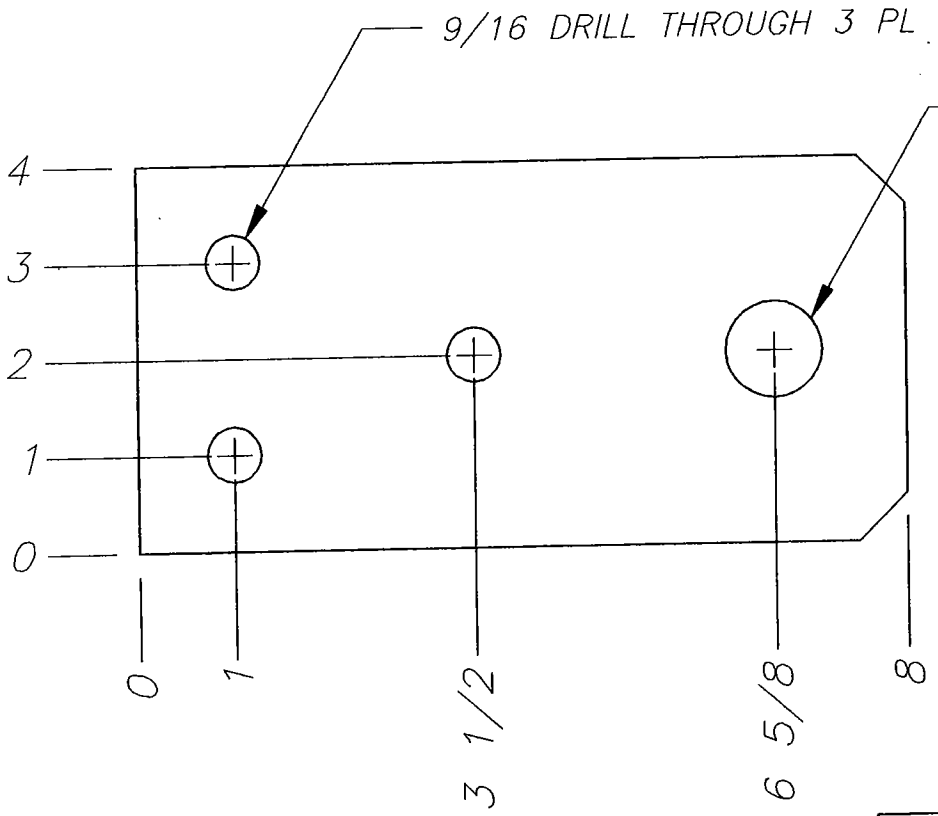


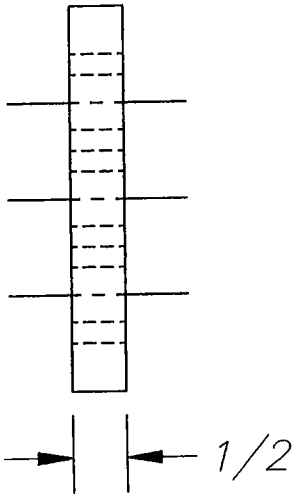


57

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS .XX ±.01 .XXX ±.005 ANGULAR ±1° DO NOT SCALE DRAWING	PROJECT NO.	WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED OCEAN PHYSICS & ENGINEERING WOODS HOLE, MASSACHUSETTS, 02543
	DRAWN: DON PETERS — DATE: 9/9/97	TITLE: AOSN LAB SEA PICKUP BALE
	CHECK	
MATERIAL: STAINLESS STEEL		SIZE — DWG NO. 049-4-0301
FINISH: AS NOTED		SCALE — RELEASE DATE — SHEET OF







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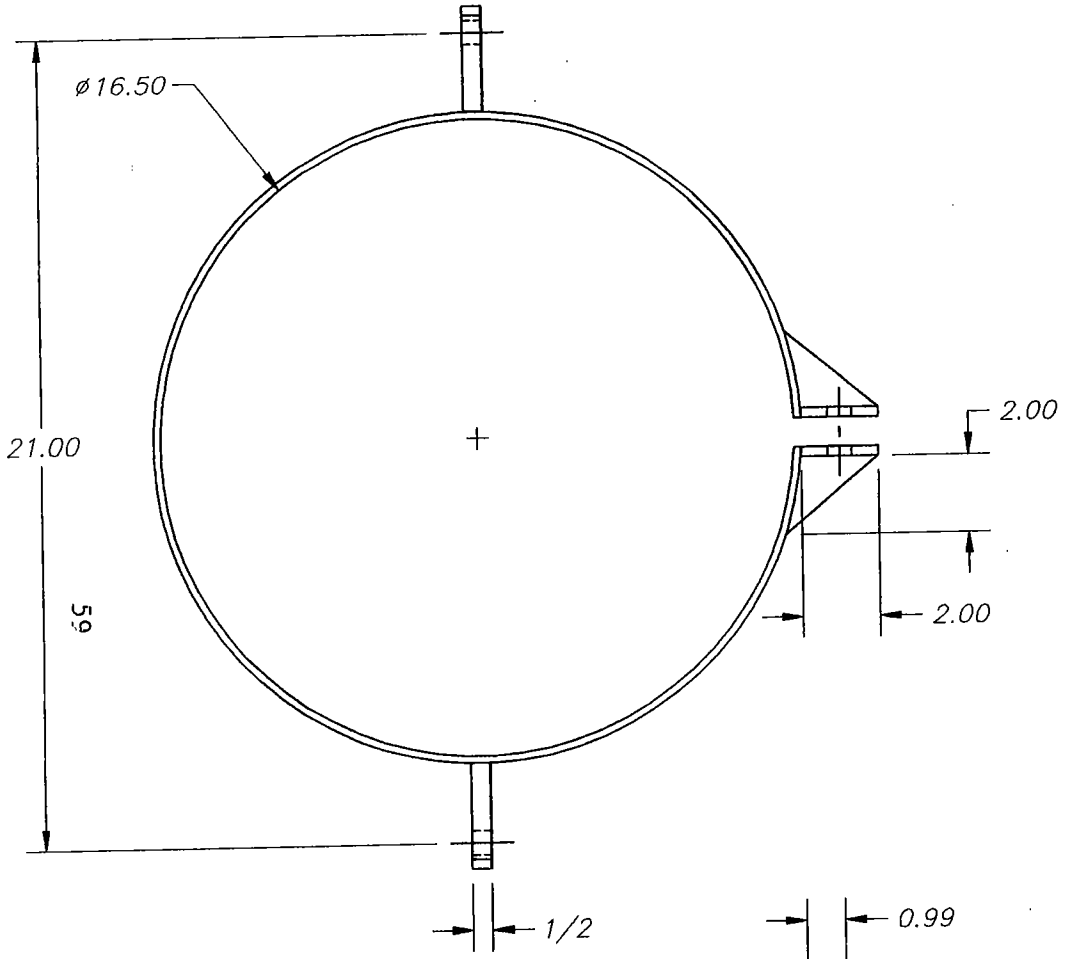
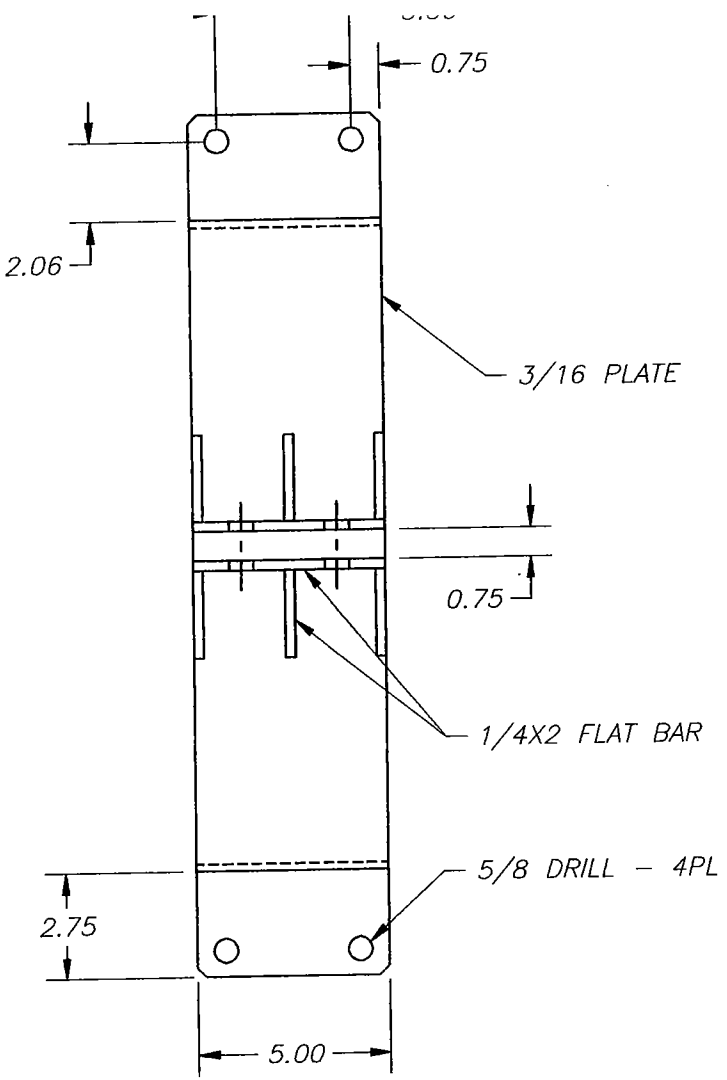
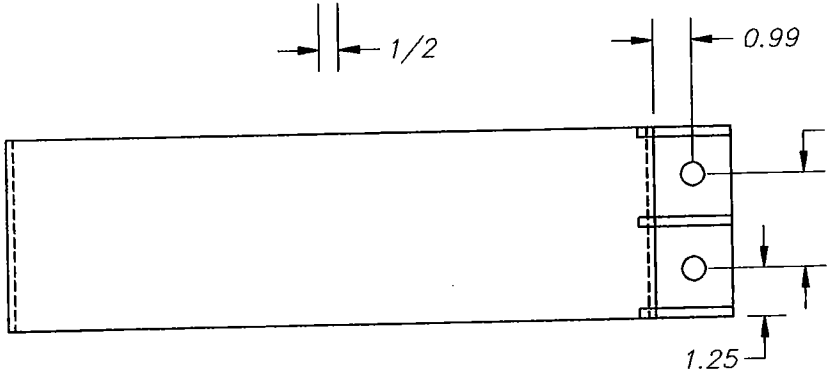
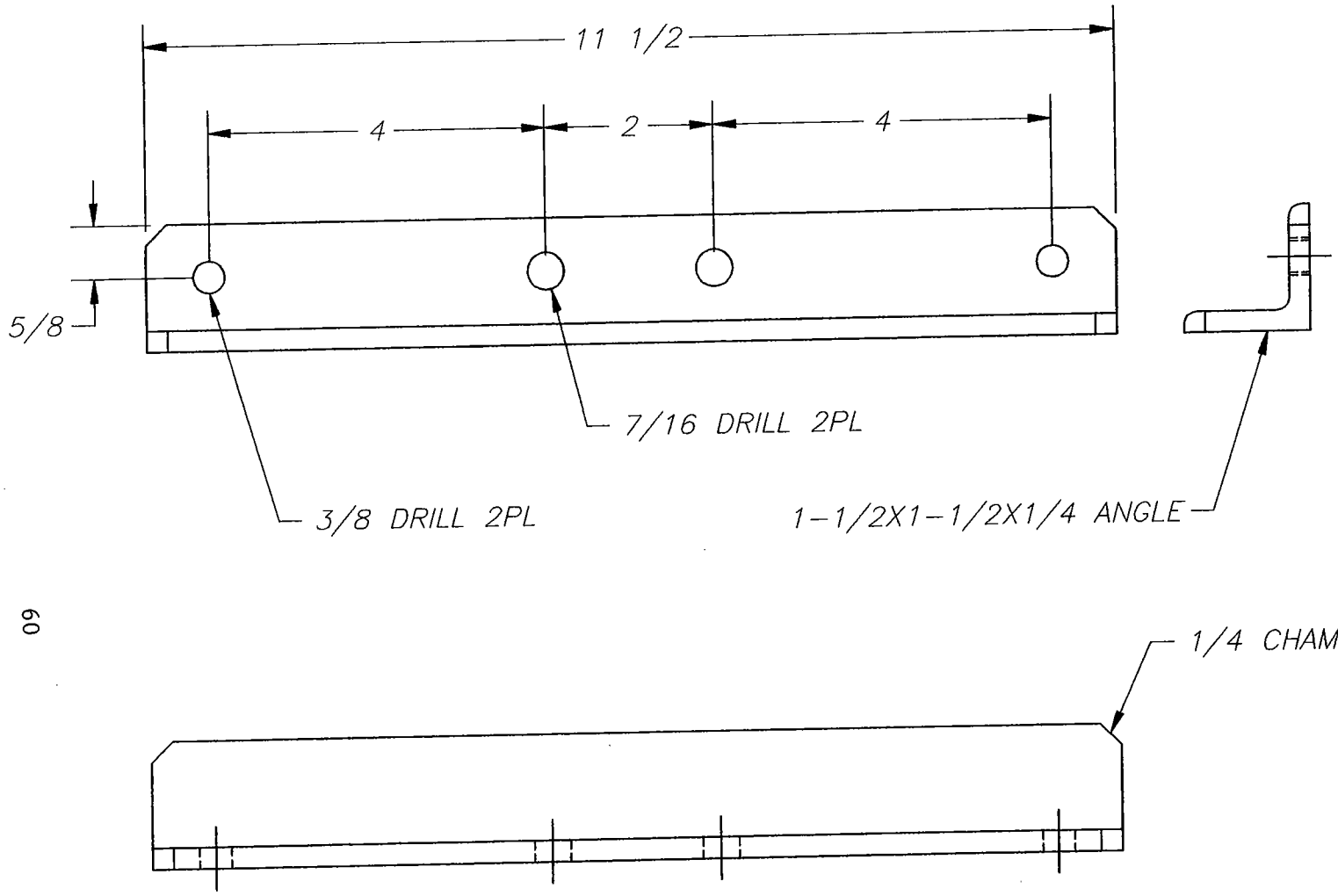
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS .XX ±.01 .XXX ±.005 ANGULAR ±1° DO NOT SCALE DRAWING	PROJECT NO.	WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED OCEAN PHYSICS & ENGINEERING WOODS HOLE, MASSACHUSETTS, 02543
	DRAWN: DON PETERS DATE: 9/9/97	TITLE: AOSN BATTERY FRAME BOTTOM TANG
	CHECK	
MATERIAL: STAINLESS STEEL		SIZE: DWG NO. 049-4-0302
FINISH: AS NOTED		SCALE: RELEASE DATE: SHEET: OF





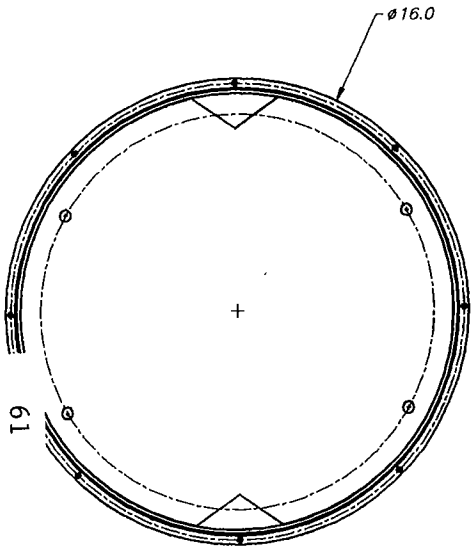


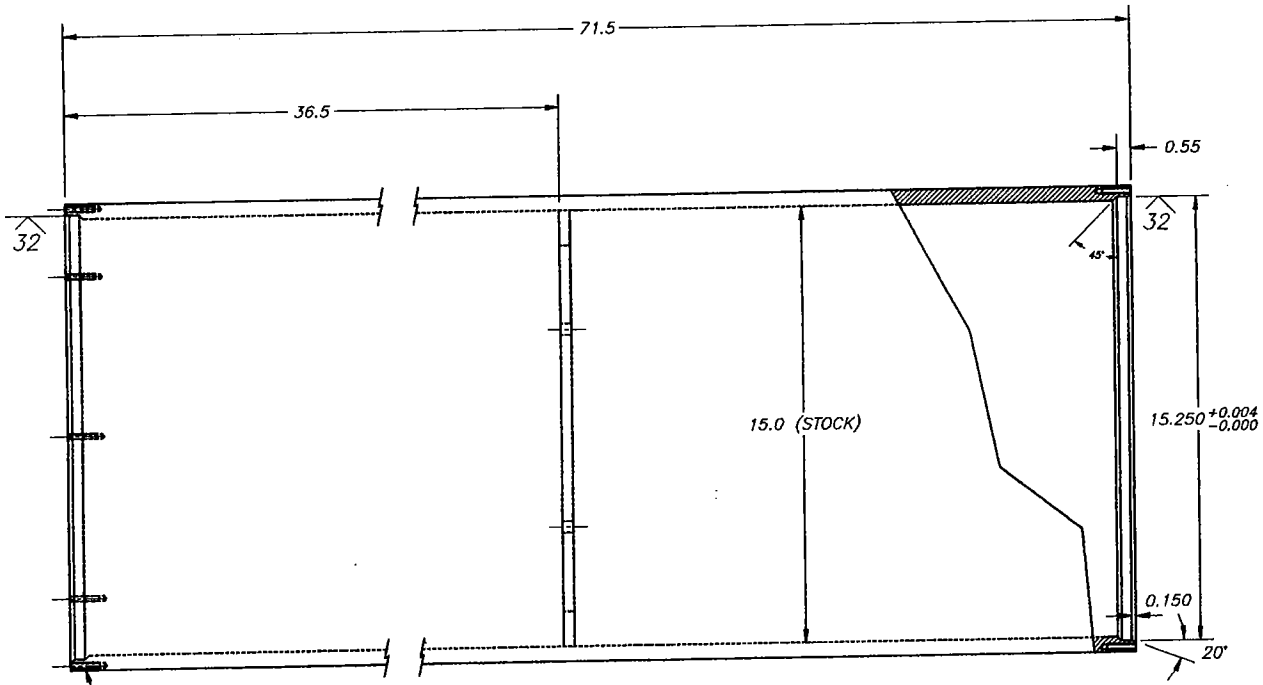
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS .XX ±.01 .XXX ±.005 ANGULAR ±1° DO NOT SCALE DRAWING	PROJECT NO. 156168.08	WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED OCEAN PHYSICS & ENGINEERING WOODS HOLE, MASSACHUSETTS, 02543
	DRAWN DON PETERS DATE 09/26/97	TITLE AOSN VEHICLE DOCK BATTERY HOUSING BAND
	CHECK	
MATERIAL 5086 ALUMINUM		SIZE DWG NO. 049-4-0401
FINISH AS NOTED		SCALE RELEASE DATE SHEET OF



09

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS XX ±.01 XXX ±.005 ANGULAR ±1° DO NOT SCALE DRAWING	PROJECT NO. 156077.00	WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED OCEAN PHYSICS & ENGINEERING WOODS HOLE, MASSACHUSETTS, 02543	
	DRAWN DON PETERS	DATE 10/08/97	TITLE AOSN VEHICLE DOCK INSTRUMENT HOUSING BRACKET
	CHECK		
MATERIAL 6061-T6			SIZE
FINISH AS NOTED			DWG NO. 049-4-0501
			SCALE RELEASE DATE SHEET OF

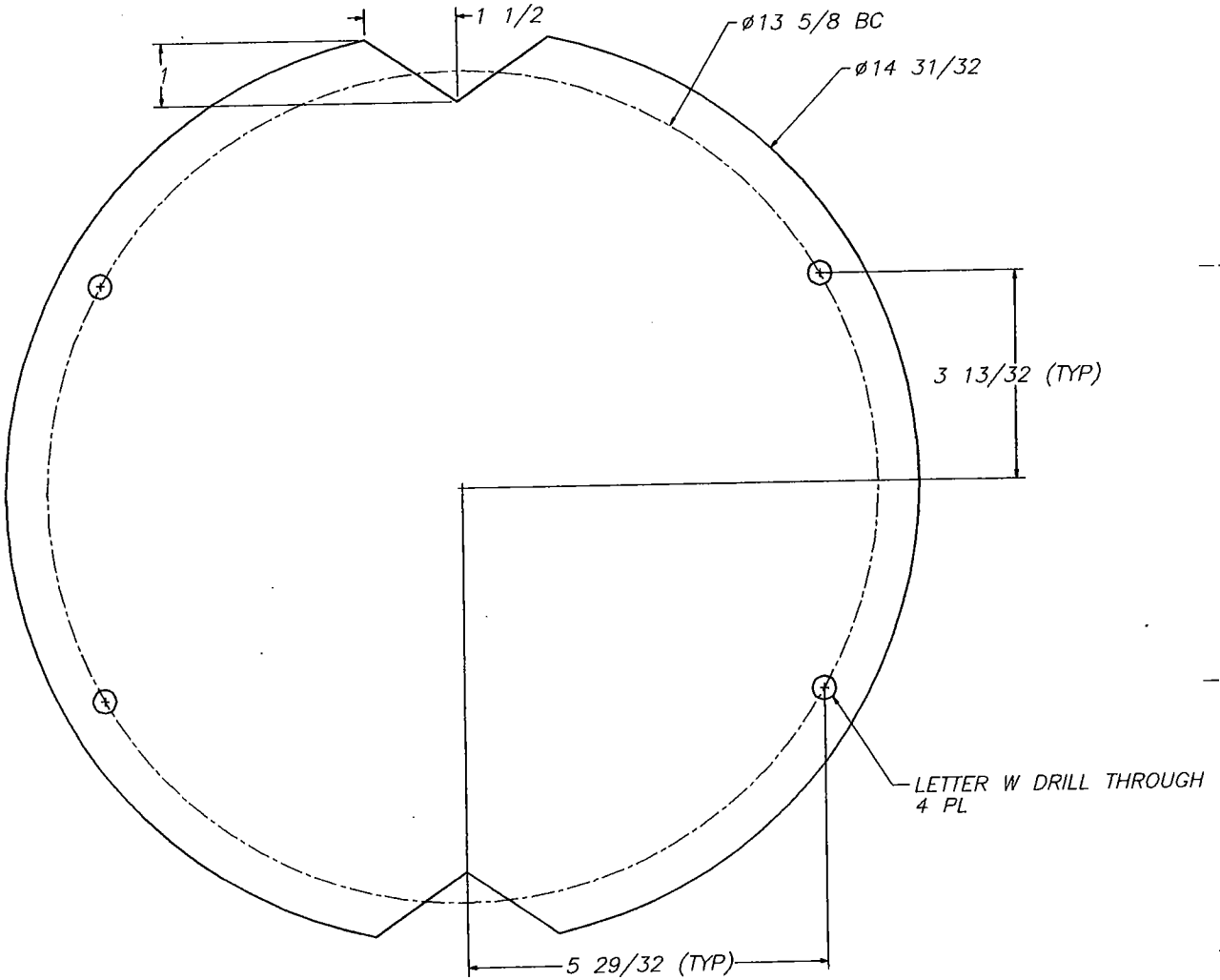




ON ø15.68 BOLT CIRCLE
NO. 21 DRILL 1.25 DP
10-32 TAP 1.0 DP
8 PLACES @ 45 EACH END

REV 09/07/97: DRAWING NUMBER

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS .XX ±.01 .XXX ±.005 ANGULAR ±1° DO NOT SCALE DRAWING	PROJECT NO. 155727.00		WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED OCEAN PHYSICS & ENGINEERING WOODS HOLE, MASSACHUSETTS, 02543
	DRAWN G. McDonald	DATE 8/11/97	TITLE AOSN VEHICLE DOCK BATTERY CASE
	CHECK		
MATERIAL 6061 T-6			SIZE
FINISH AS NOTED			DWG NO. 049-5-0100
			SCALE RELEASE DATE SHEET OF



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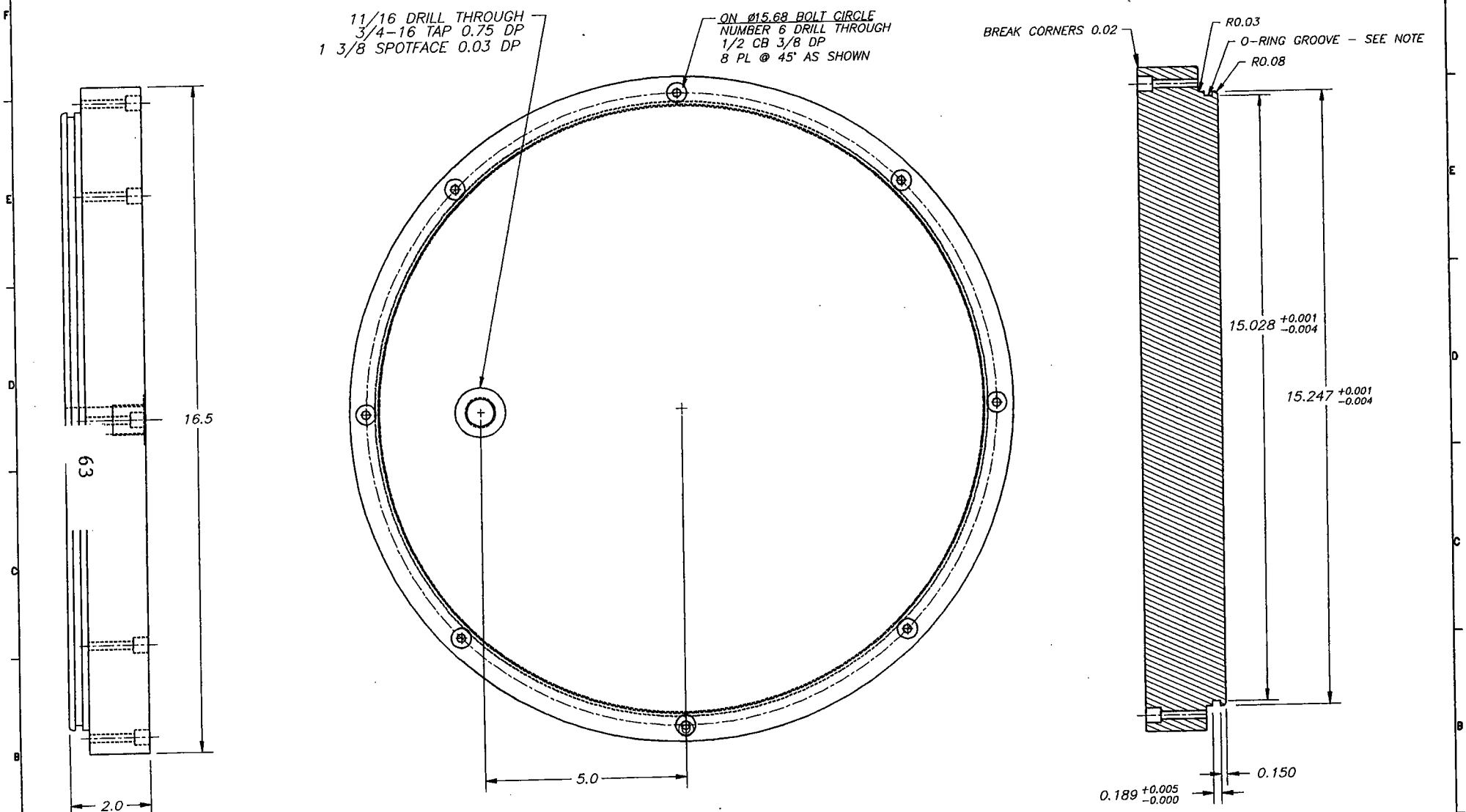
REV 09/07/97: DRAWING NUMBER

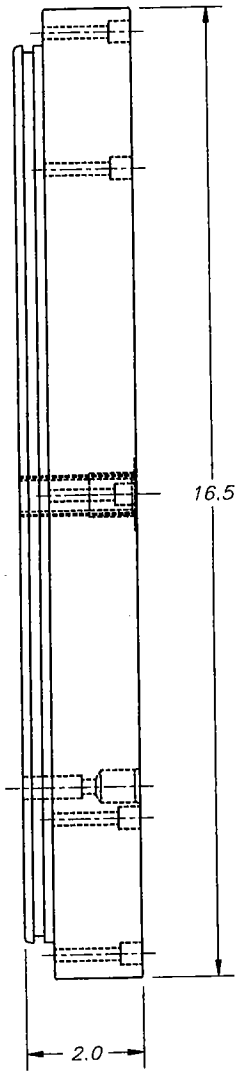
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS .XX ±.01 .XXX ±.005 ANGULAR ±1° DO NOT SCALE DRAWING	PROJECT NO. 155727.00		WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED OCEAN PHYSICS & ENGINEERING WOODS HOLE, MASSACHUSETTS, 02543
	DRAWN G. McDonald	DATE 8/21/97	TITLE AOSN BATTERY CASE BULKHEAD
	CHECK		
MATERIAL 6061-T6 3/8 PLATE			SIZE
FINISH AS NOTED			DWG NO. 049-5-0101
			SCALE 2 / RELEASE DATE / SHEET OF

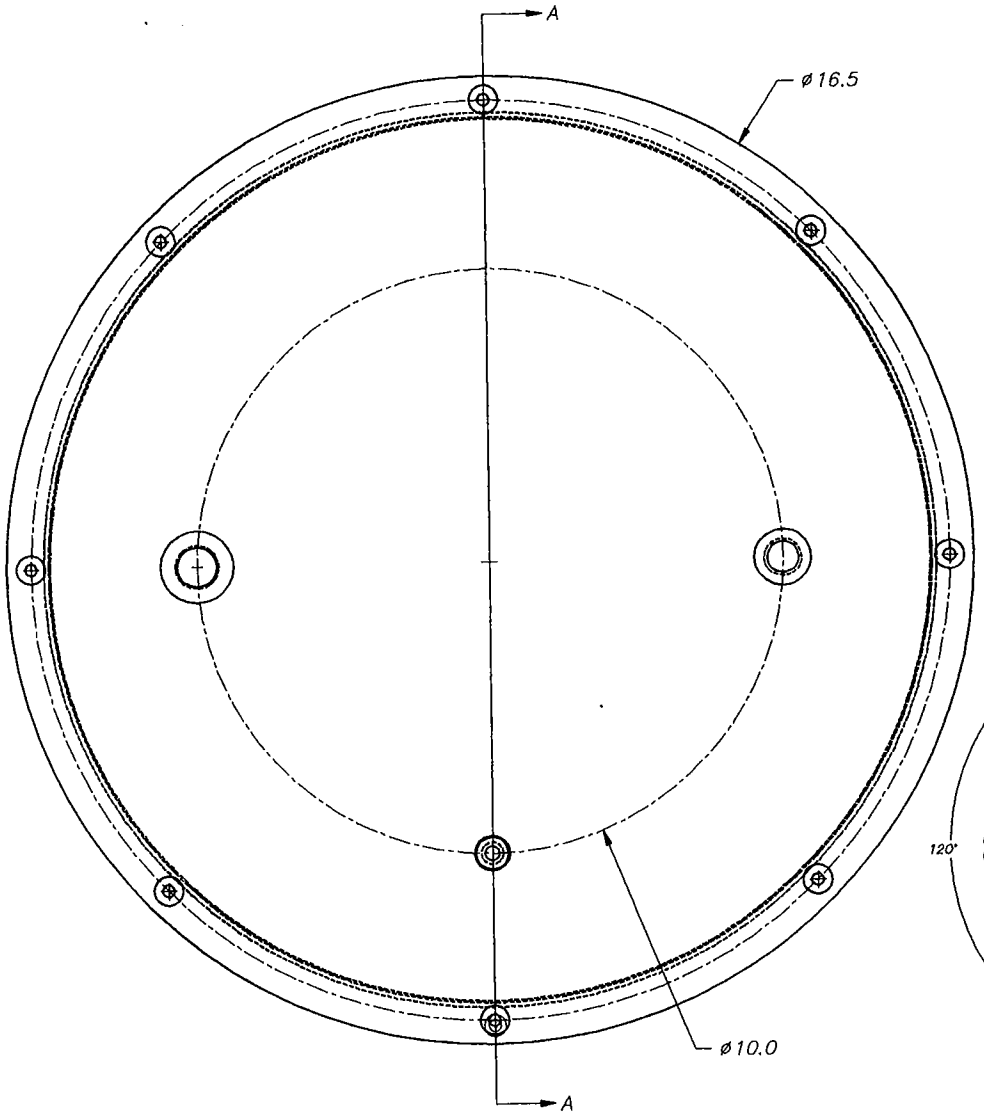


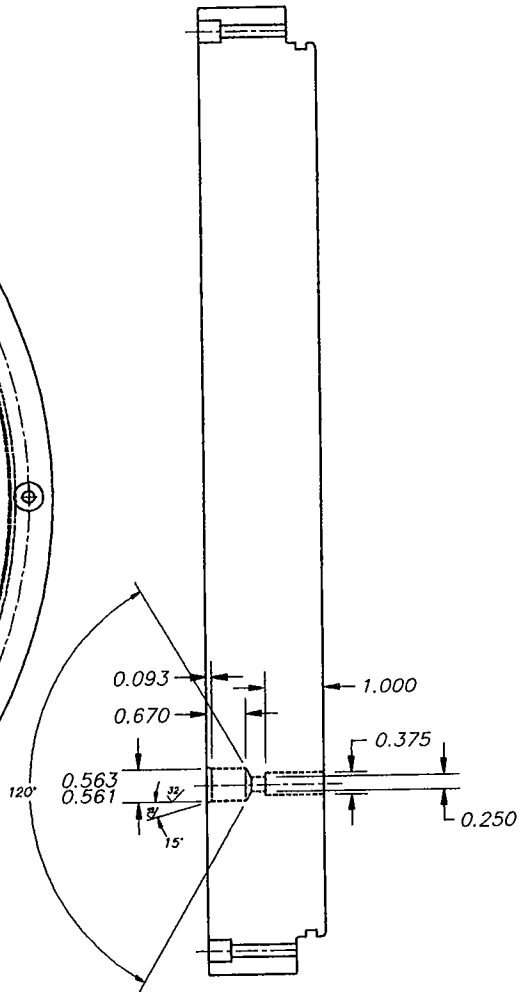
NOTE
O-RING GROOVE FINISH 32 RMS
RADIUS INSIDE CORNERS 0.01-0.02
BREAK OUTSIDE CORNERS 0.005

REV 09/07/97: DRAWING NUMBER

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS .XX ±.01 .XXX ±.005 ANGULAR ±1° DO NOT SCALE DRAWING	PROJECT NO. 155727.00		WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED OCEAN PHYSICS & ENGINEERING WOODS HOLE, MASSACHUSETTS, 02543
	DRAWN G. McDonald	DATE 8/11/97	TITLE AOSN BATTERY CASE ENDCAP
	CHECK		
MATERIAL 6061-T6 PLATE			
FINISH AS NOTED			SIZE DWG NO. 049-5-0200
			SCALE RELEASE DATE SHEET OF



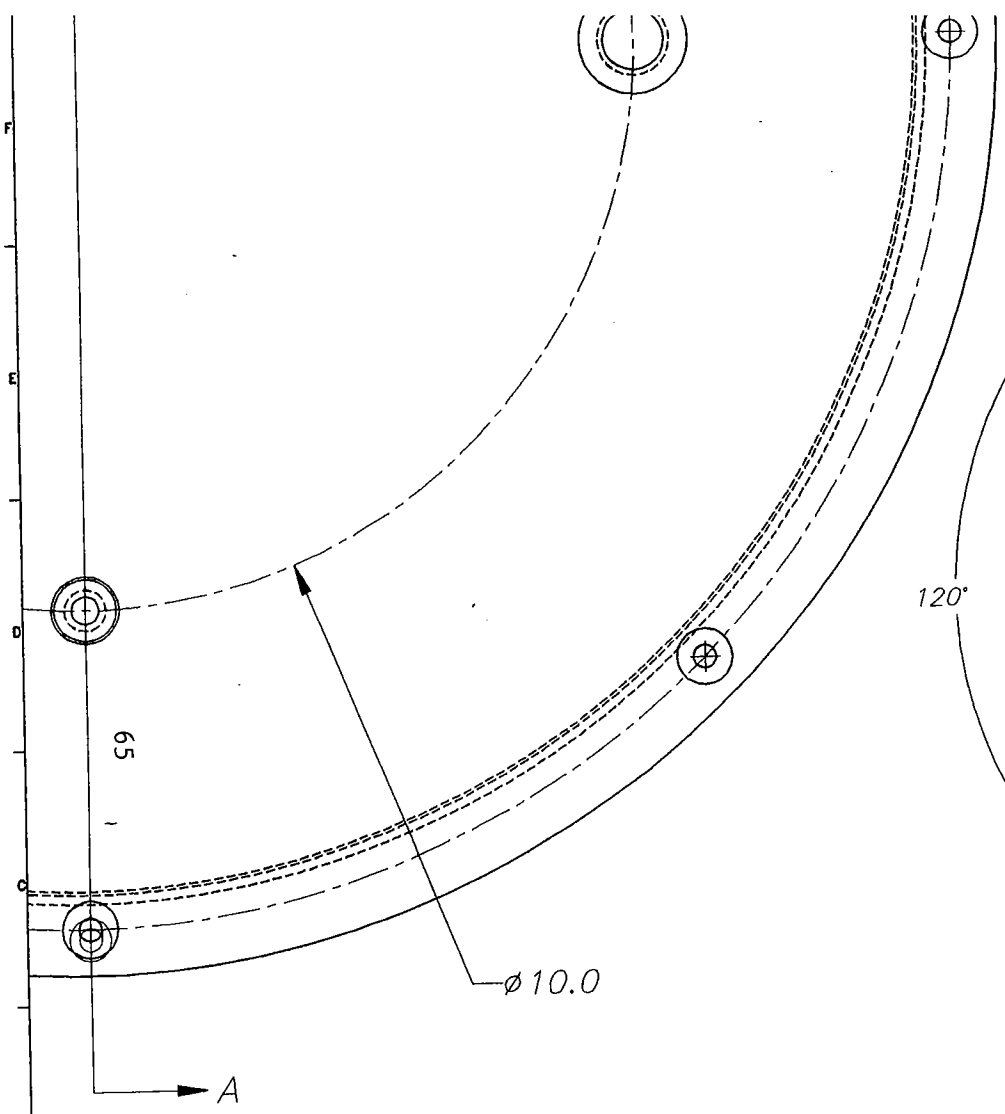


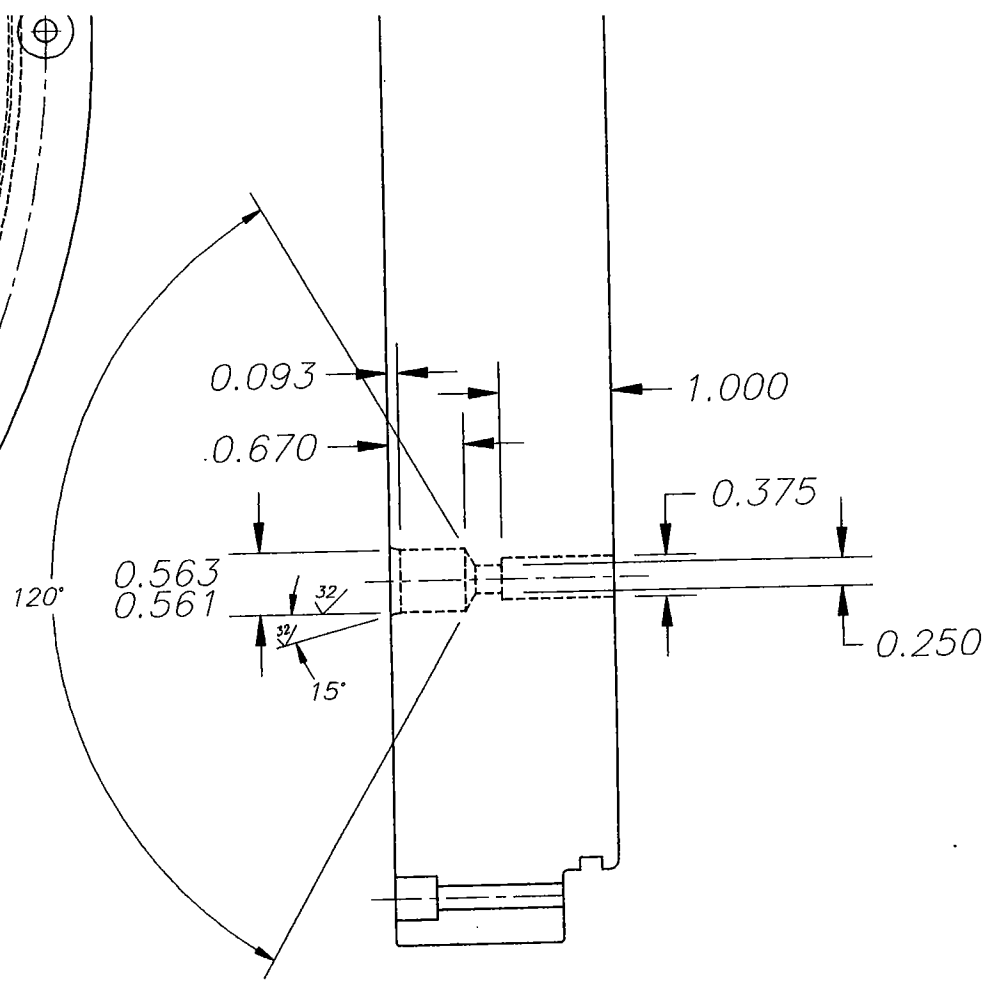


SECTION A–A

NOTE
O–RING GROOVE FINISH 32 RMS
RADIUS INSIDE CORNERS 0.01–0.02
BREAK OUTSIDE CORNERS 0.005

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS .XX ±.01 .XXX ±.005 ANGULAR ±1° DO NOT SCALE DRAWING	PROJECT NO. 155727.00	WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED OCEAN PHYSICS & ENGINEERING WOODS HOLE, MASSACHUSETTS, 02543	
	DRAWN G. McDonald	DATE 9/22/97	TITLE AOSN BATTERY CASE ENDCAP PENETRATIONS
	CHECK		
MATERIAL 6061–T6 PLATE			SIZE
FINISH AS NOTED			DWG NO. 049–5–0201
			SCALE RELEASE DATE SHEET OF

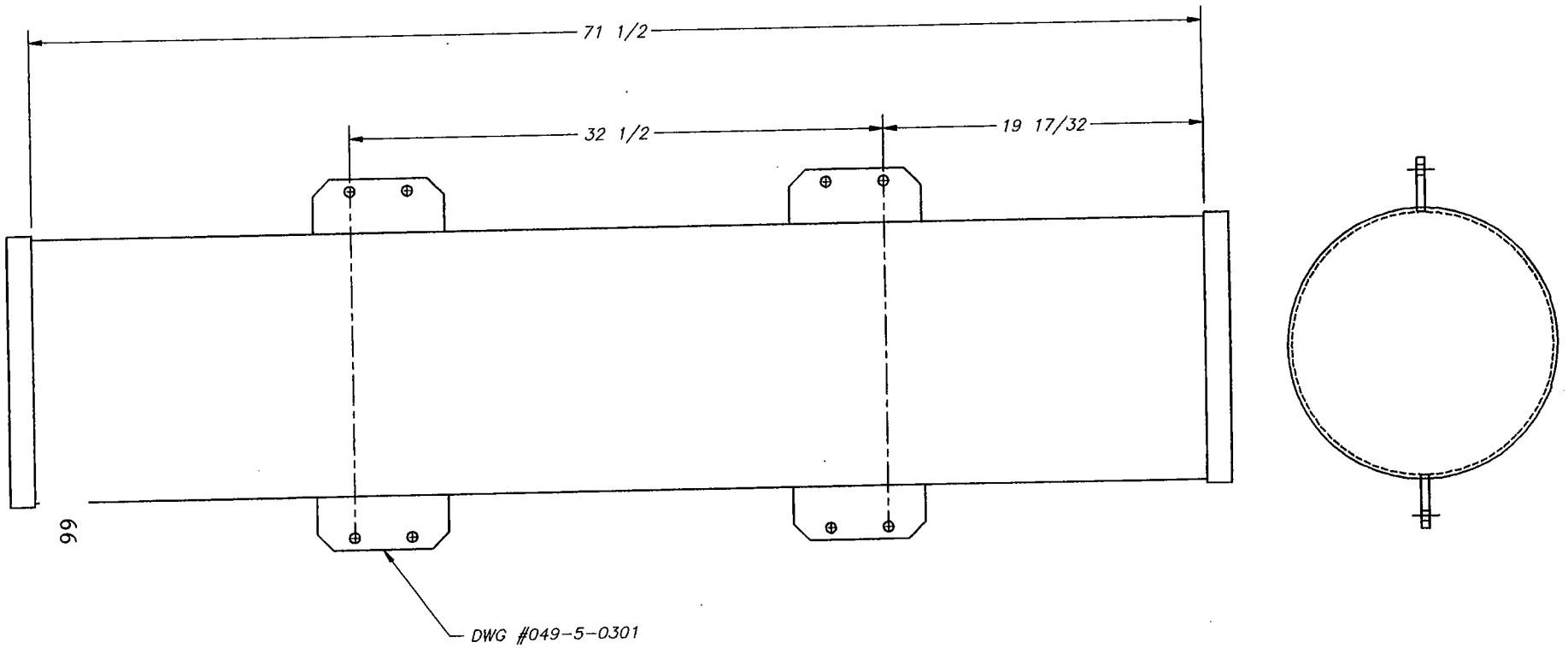




SECTION A–A

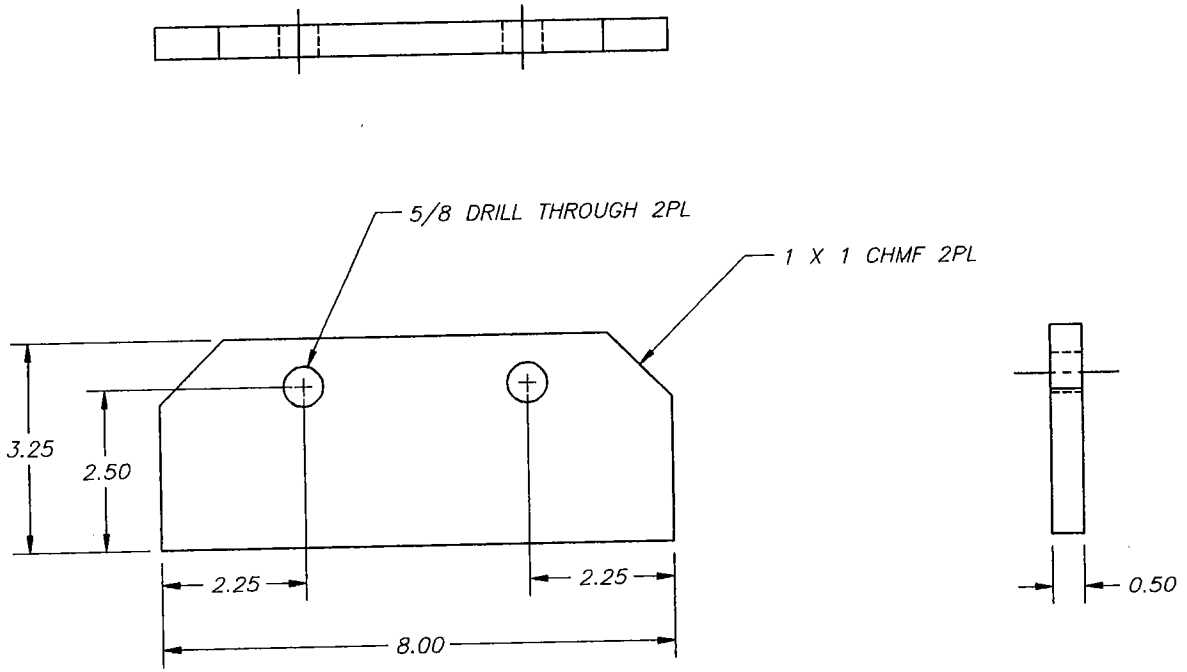
NOTE: DETAIL OF ENDCAP PENETRATION
DWG #049-5-0201

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS ANGULAR .XX ±.01 ±1° .XXX ±.005 DO NOT SCALE DRAWING	PROJECT NO. 155727.00		WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED OCEAN PHYSICS & ENGINEERING WOODS HOLE, MASSACHUSETTS, 02543
	DRAWN G. McDonald	DATE 9/22/97	TITLE AOSN BATTERY CASE ENDCAP PENETRATION DETAIL
	CHECK		
MATERIAL 6061-T6 PLATE			SIZE — DWG NO. 049-5-0202
FINISH AS NOTED			SCALE — RELEASE DATE — SHEET OF



REVISED 09/11/97: MOUNT TAB LOCATION

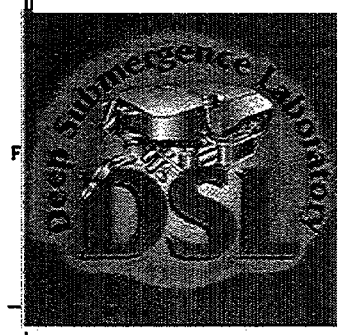
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS .XX ±.01 .XXX ±.005 ANGULAR ±1° DO NOT SCALE DRAWING	PROJECT NO.		WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED OCEAN PHYSICS & ENGINEERING WOODS HOLE, MASSACHUSETTS, 02543
	DRAWN: DON PETERS	DATE: 9/11/97	TITLE: AOSN BATTERY CASE MOUNT TAB LOCATION
	CHECK		
MATERIAL: AS NOTED			SIZE	DWG NO. 049-5-0300
FINISH: AS NOTED			SCALE	RELEASE DATE	SHEET 8



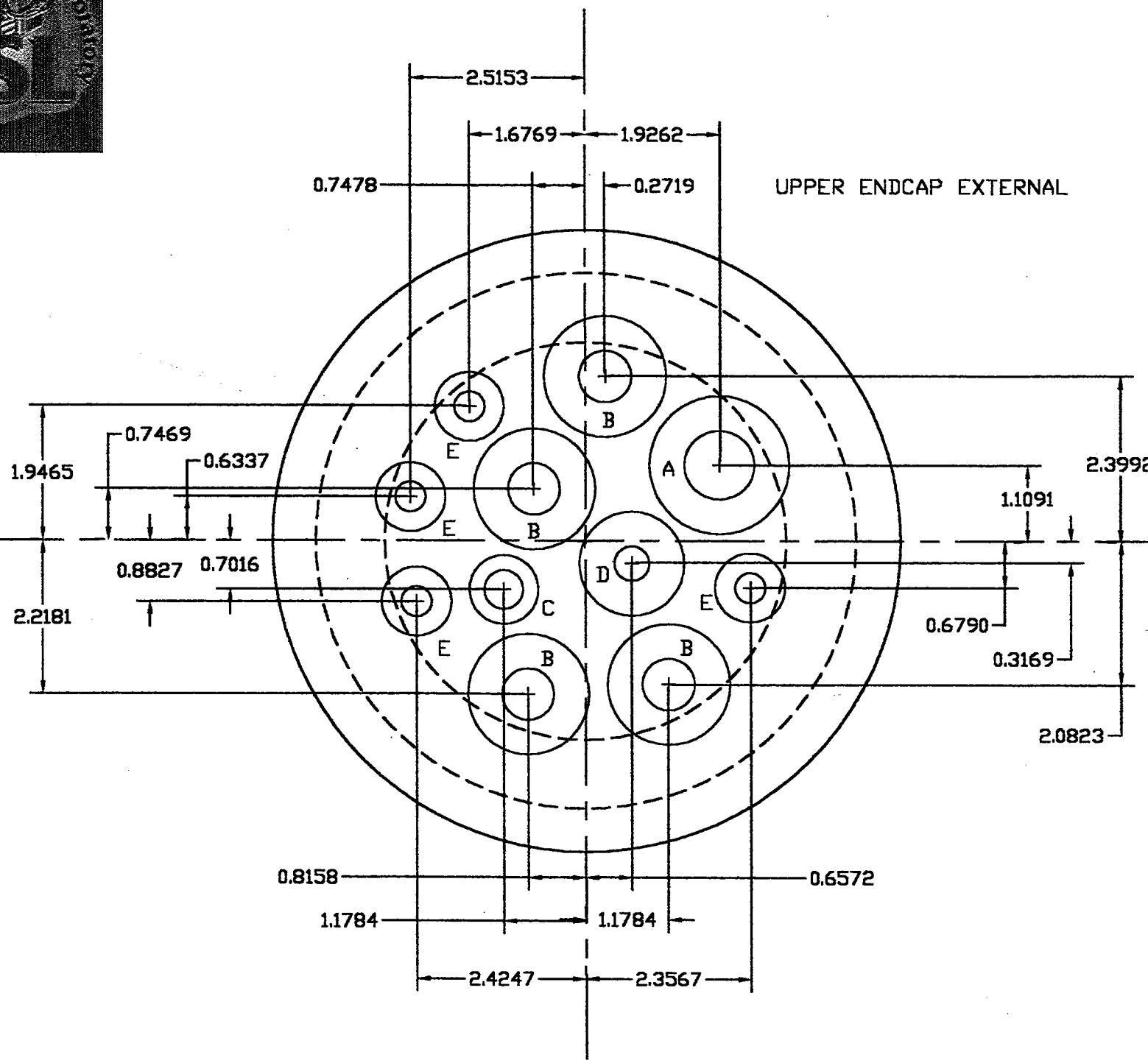
67

REV 09/10/97: DRAWING NUMBER

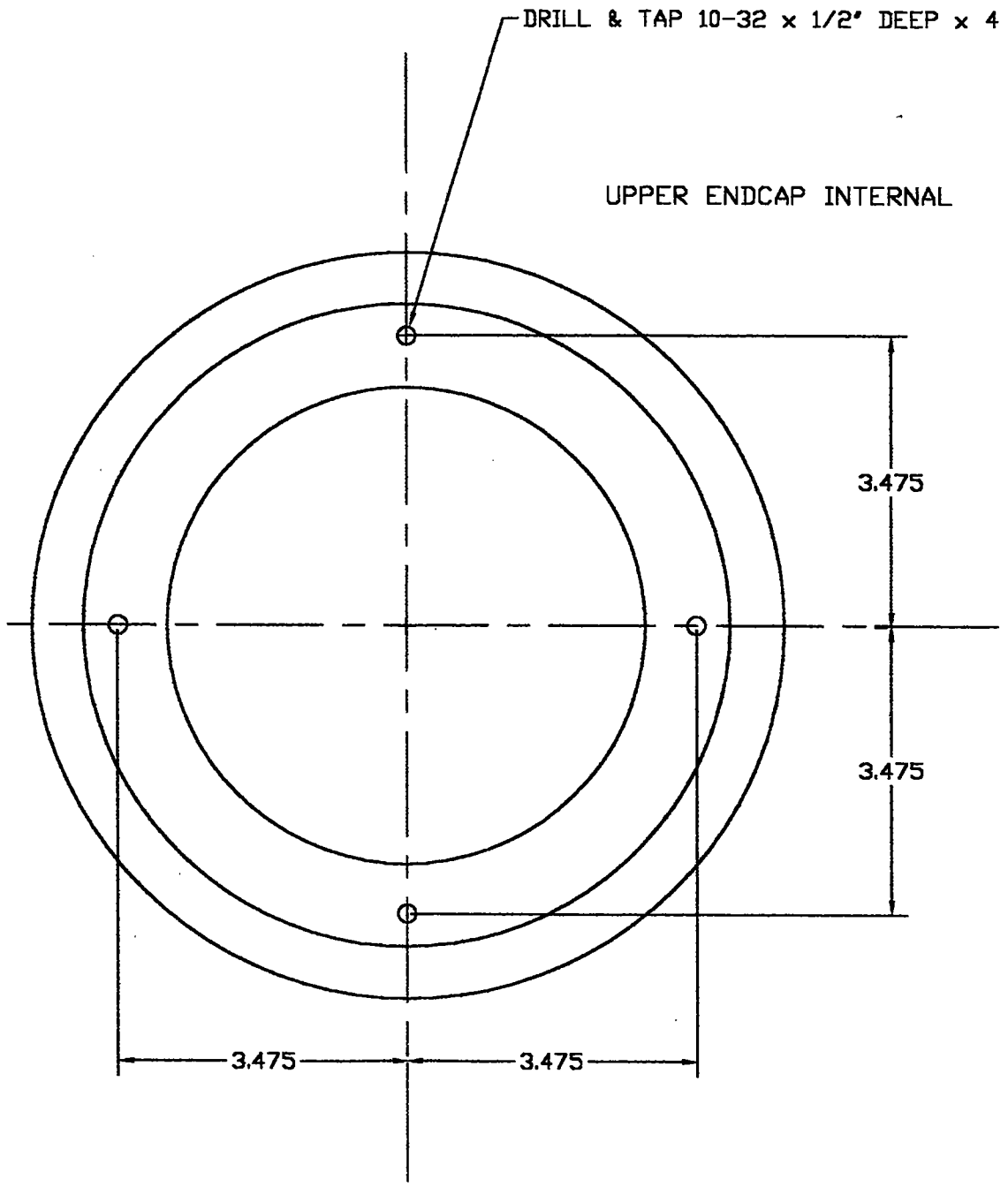
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS .XX ±.01 .XXX ±.005 ANGULAR ±1° DO NOT SCALE DRAWING	PROJECT NO.	WOODS HOLE OCEANOGRAPHIC INSTITUTION APPLIED OCEAN PHYSICS & ENGINEERING WOODS HOLE, MASSACHUSETTS, 02543
	DRAWN: DON PETERS — DATE: 9/9/97	TITLE: AOSN BATTERY CASES MOUNTING TAB
	CHECK	
MATERIAL: ALUMINUM 6061-T6		SIZE — DWG NO. 049-5-0301
FINISH: AS NOTED		SCALE — RELEASE DATE — SHEET OF



UPPER ENDCAP EXTERNAL



UPPER ENDCAP INTERNAL



DRILL & TAP BULKHEAD THRU HOLES AS FOLLOWS:

A = MULTI: 1-14, 2.00 FACE
B = BATT1, BATT2, TEMP, SURF: 3/4-16, 1.75 FACE
C = UAM: 9/16-18, 1.00 FACE
D = EDGE: 1/2-20, 1.5 FACE
E = ADV, EDC1, EDC2, SPARE: 7/16-20, 1.00 FACE

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	DRAWN MF BOWEN	DATE 07/30/97	TITLE: DOCCON HOUSING ENDCAP FEEDTHRU DETAIL
	CHECK 68		
MATERIAL: AS NOTED	AOP&E	MS #13	
FINISH: AS NOTED	BIG G-3	289-3420	SIZE: B; DWG NO. 156-97-022
			SCALE: NONE; RELEASE DATE; SHEET OF

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June 10, 1998

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7. Author(s) M. F. Bowen, D. B. Peters

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16. Abstract (Limit: 200 words)

Under subcontract to the Massachusetts Institute of Technology's (MIT) Sea Grant Autonomous Ocean Sampling Network (AOSN) program, engineers and researchers at the Woods Hole Oceanographic Institution (WHOI) designed, fabricated and operated a deep sea Docking Station for ODYSSEY-class autonomous underwater vehicles (AUVs). The docking station provides shelter as well as power transfer and data exchange services for an AUV that is between autonomous midwater missions. The Station is integrated into the main tension member of a deep sea mooring system. A large subsea flotation sphere supports the mass of the Station above the seafloor. A surface expression connected by an umbilical to the Station was capable of bi-directional satellite or radio frequency communications. Primary subsystems of the Docking Station described in this report include a dock controller with multi-sensor support, long-duration battery packs, a docking pole with a moving carriage, an inductive link for power and data transfer, and information about how the Station was deployed, operated and recovered.

17. Document Analysis a. Descriptors
AUV
Docking
Mooring

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
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