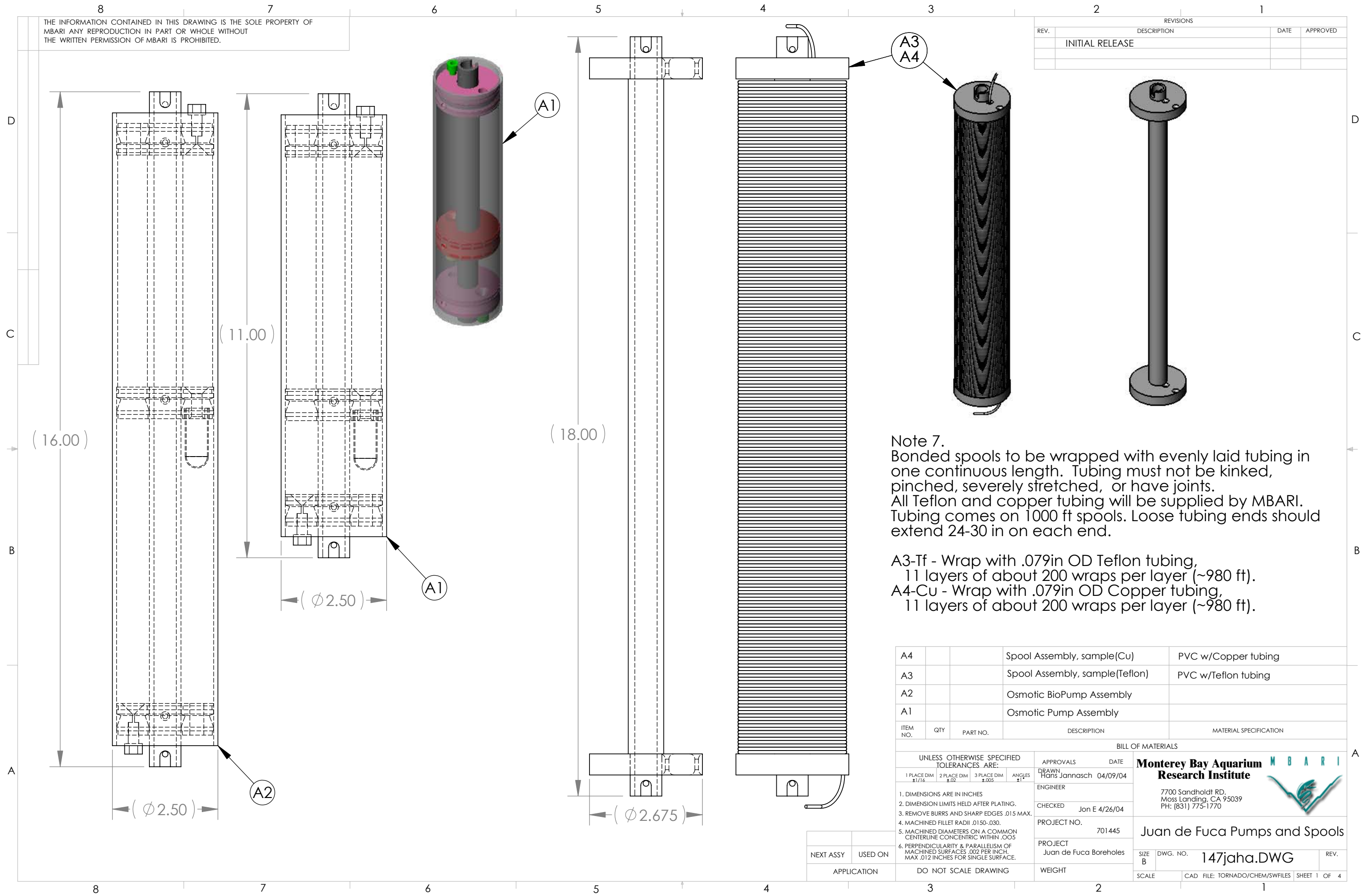


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| REV.      | DESCRIPTION     | DATE | APPROVED |
|           | INITIAL RELEASE |      |          |
|           |                 |      |          |
|           |                 |      |          |



Note 7.  
 Bonded spools to be wrapped with evenly laid tubing in one continuous length. Tubing must not be kinked, pinched, severely stretched, or have joints.  
 All Teflon and copper tubing will be supplied by MBARI. Tubing comes on 1000 ft spools. Loose tubing ends should extend 24-30 in on each end.

A3-Tf - Wrap with .079in OD Teflon tubing, 11 layers of about 200 wraps per layer (~980 ft).  
 A4-Cu - Wrap with .079in OD Copper tubing, 11 layers of about 200 wraps per layer (~980 ft).

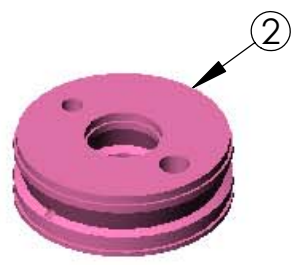
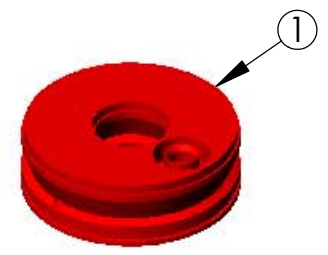
| ITEM NO. | QTY | PART NO. | DESCRIPTION                    | MATERIAL SPECIFICATION |
|----------|-----|----------|--------------------------------|------------------------|
| A4       |     |          | Spool Assembly, sample(Cu)     | PVC w/Copper tubing    |
| A3       |     |          | Spool Assembly, sample(Teflon) | PVC w/Teflon tubing    |
| A2       |     |          | Osmotic BioPump Assembly       |                        |
| A1       |     |          | Osmotic Pump Assembly          |                        |

| UNLESS OTHERWISE SPECIFIED TOLERANCES ARE:                                                                                                                                                                                                                                                                                                      |             |             |          | APPROVALS     |                        | DATE          | <b>Monterey Bay Aquarium</b><br><b>Research Institute</b><br><small>7700 Sandholdt RD.<br/>       Moss Landing, CA 95039<br/>       PH: (831) 775-1770</small> |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-------------|----------|---------------|------------------------|---------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 PLACE DIM                                                                                                                                                                                                                                                                                                                                     | 2 PLACE DIM | 3 PLACE DIM | ANGLES   | DRAWN         |                        |               |                                                                                                                                                                |
| $\pm .1/16$                                                                                                                                                                                                                                                                                                                                     | $\pm .02$   | $\pm .005$  | $\pm 1'$ | Hans Jannasch |                        | 04/09/04      |                                                                                                                                                                |
| 1. DIMENSIONS ARE IN INCHES<br>2. DIMENSION LIMITS HELD AFTER PLATING.<br>3. REMOVE BURRS AND SHARP EDGES .015 MAX.<br>4. MACHINED FILLET RADII .0150-.030.<br>5. MACHINED DIAMETERS ON A COMMON CENTERLINE CONCENTRIC WITHIN .005<br>6. PERPENDICULARITY & PARALLELISM OF MACHINED SURFACES .002 PER INCH. MAX .012 INCHES FOR SINGLE SURFACE. |             |             |          | CHECKED       |                        | Jon E 4/26/04 |                                                                                                                                                                |
|                                                                                                                                                                                                                                                                                                                                                 |             |             |          | PROJECT NO.   | 701445                 |               | <b>Juan de Fuca Pumps and Spools</b>                                                                                                                           |
|                                                                                                                                                                                                                                                                                                                                                 |             |             |          | PROJECT       | Juan de Fuca Boreholes |               |                                                                                                                                                                |
|                                                                                                                                                                                                                                                                                                                                                 |             |             |          | SCALE         |                        |               | SIZE B<br>DWG. NO. 147jaha.DWG<br>REV.                                                                                                                         |
|                                                                                                                                                                                                                                                                                                                                                 |             |             |          | APPLICATION   | DO NOT SCALE DRAWING   |               | SCALE<br>CAD FILE: TORNADO/CHEM/SWFILES SHEET 1 OF 4                                                                                                           |

| NEXT ASSY | USED ON |
|-----------|---------|
|           |         |

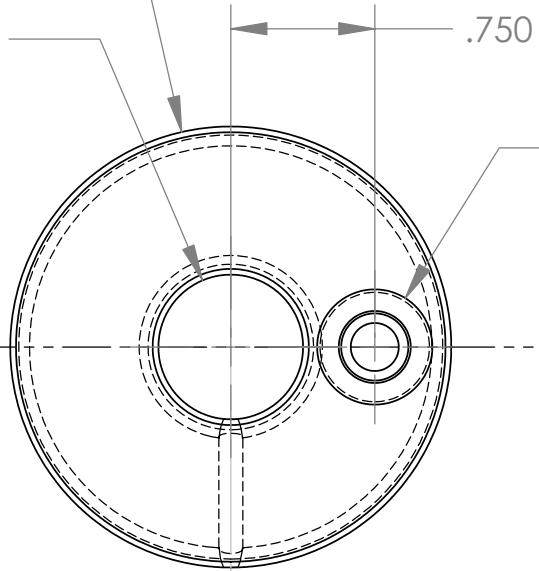
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|           | INITIAL RELEASE |      |          |
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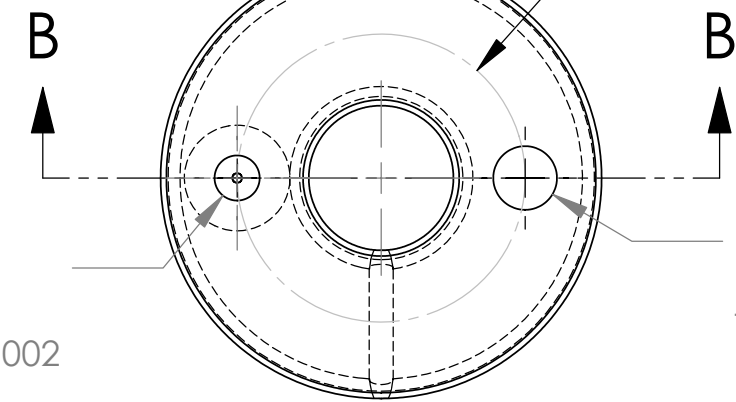
3X  $\phi$  2.296 OD  
2.294

3X  $\phi$  .754 bore thru  
.752



Membrane Groove  
 $\phi$  .600 OD  
 $\phi$  .375 ID  
 $\nabla$  .250

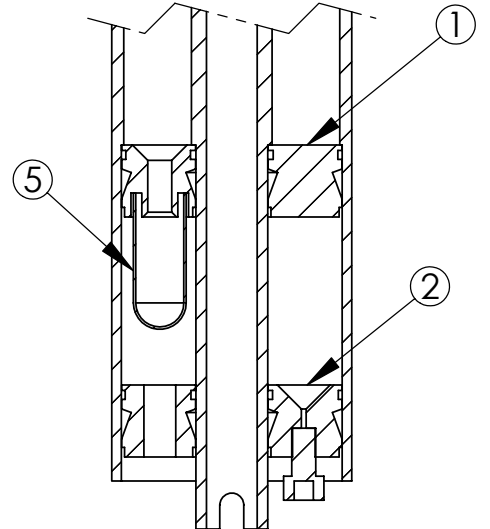
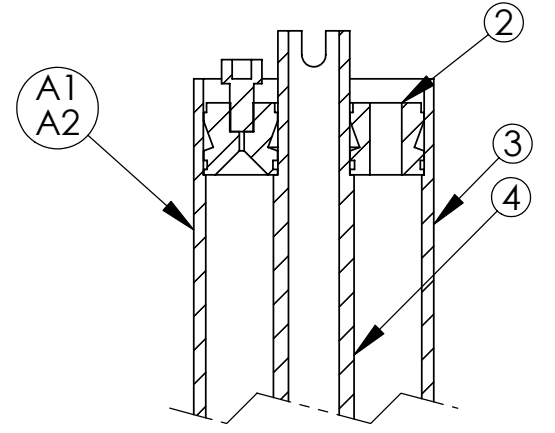
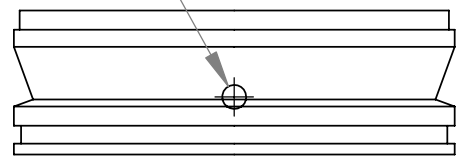
$\phi$  1.500 B.C.



$\phi$  .332 thru  
1/8"-27 NPT-2B  
This side

$\square$   $\phi$  .213  $\nabla$  .300  
1/4"-28 UNF-2B  $\nabla$  .200  
bottom flat to within .002  
after tapping  
Drill  $\phi$  .050 thru

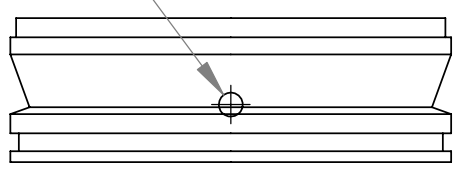
$\phi$  .125 thru  
one side



Section of A1/A2  
Osmotic Pump Assembly  
to be assembled at MBARI

All other dimensions  
same as Part 1

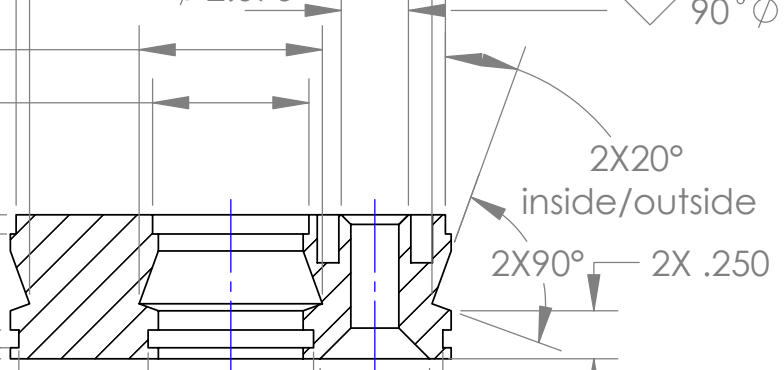
$\phi$  .125 thru  
one side



$\phi$  2.236  
 $\phi$  2.096

$\phi$  .954  
 $\phi$  .814

2X .100  
2X .098  
.093



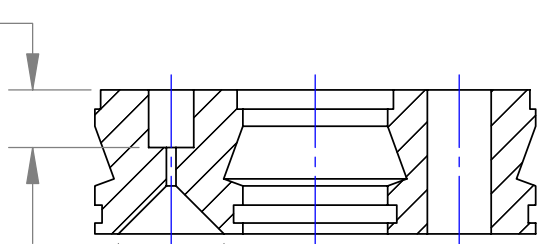
SECTION A-A  
SCALE 1 : 1

$\nabla$  90°  $\phi$  .350

2X20°  
inside/outside

2X90° 2X .250

(.300)



SECTION B-B  
SCALE 1 : 1

$\nabla$  90°  $\phi$  .550

$\phi$  2.208  
 $\phi$  2.206

034 O-ring  
Nonstandard

2X .057

$\phi$  .864  
 $\phi$  .862

018 O-ring  
Nonstandard

| ITEM NO. | QTY | PART NO. | DESCRIPTION               | MATERIAL SPECIFICATION                |
|----------|-----|----------|---------------------------|---------------------------------------|
| 5        | 1@  |          | Pump membranes            | Alzet 2ML1 membranes (MBARI supplied) |
| 4        | 1@  |          | Pump center (2 config's)  | PVC (1/2" Sched 80 pipe)              |
| 3        | 1@  |          | Pump housing (2 config's) | Clear Polycarbonate                   |
| 2        | 2@  |          | Pump endcaps              | Clear Polycarbonate                   |
| 1        | 1@  |          | Membrane manifold         | Clear Polycarbonate                   |
| A1       |     |          | Osmotic Pump Assembly     |                                       |

| UNLESS OTHERWISE SPECIFIED TOLERANCES ARE:                                                                |             |             |          | APPROVALS     |          | DATE                                                               | BILL OF MATERIALS |  |
|-----------------------------------------------------------------------------------------------------------|-------------|-------------|----------|---------------|----------|--------------------------------------------------------------------|-------------------|--|
| 1 PLACE DIM                                                                                               | 2 PLACE DIM | 3 PLACE DIM | ANGLES   | DRAWN         | DATE     | Monterey Bay Aquarium Research Institute                           |                   |  |
| $\pm$ .1/16                                                                                               | $\pm$ .02   | $\pm$ .005  | $\pm$ .1 | Hans Jannasch | 04/09/04 | 7700 Sandholdt RD.<br>Moss Landing, CA 95039<br>PH: (831) 775-1770 |                   |  |
| 1. DIMENSIONS ARE IN INCHES                                                                               |             |             |          | ENGINEER      |          | PROJECT NO. 701445                                                 |                   |  |
| 2. DIMENSION LIMITS HELD AFTER PLATING.                                                                   |             |             |          | CHECKED       |          | PROJECT Juan de Fuca Boreholes                                     |                   |  |
| 3. REMOVE BURRS AND SHARP EDGES .015 MAX.                                                                 |             |             |          | PROJECTED     |          | SIZE DWG. NO. 147jaha.DWG                                          |                   |  |
| 4. MACHINED FILLET RADII .0150-.030.                                                                      |             |             |          | PROJECTED     |          | SCALE                                                              |                   |  |
| 5. MACHINED DIAMETERS ON A COMMON CENTERLINE CONCENTRIC WITHIN .005                                       |             |             |          | PROJECTED     |          | CAD FILE: TORNADO/CHEM/SWFILES SHEET 2 OF 4                        |                   |  |
| 6. PERPENDICULARITY & PARALLELISM OF MACHINED SURFACES .002 PER INCH. MAX .012 INCHES FOR SINGLE SURFACE. |             |             |          | PROJECTED     |          | REV.                                                               |                   |  |

Note 7  
Assemblies A1 and A2 will be assembled at MBARI

| NEXT ASSY | USED ON |
|-----------|---------|
|           |         |

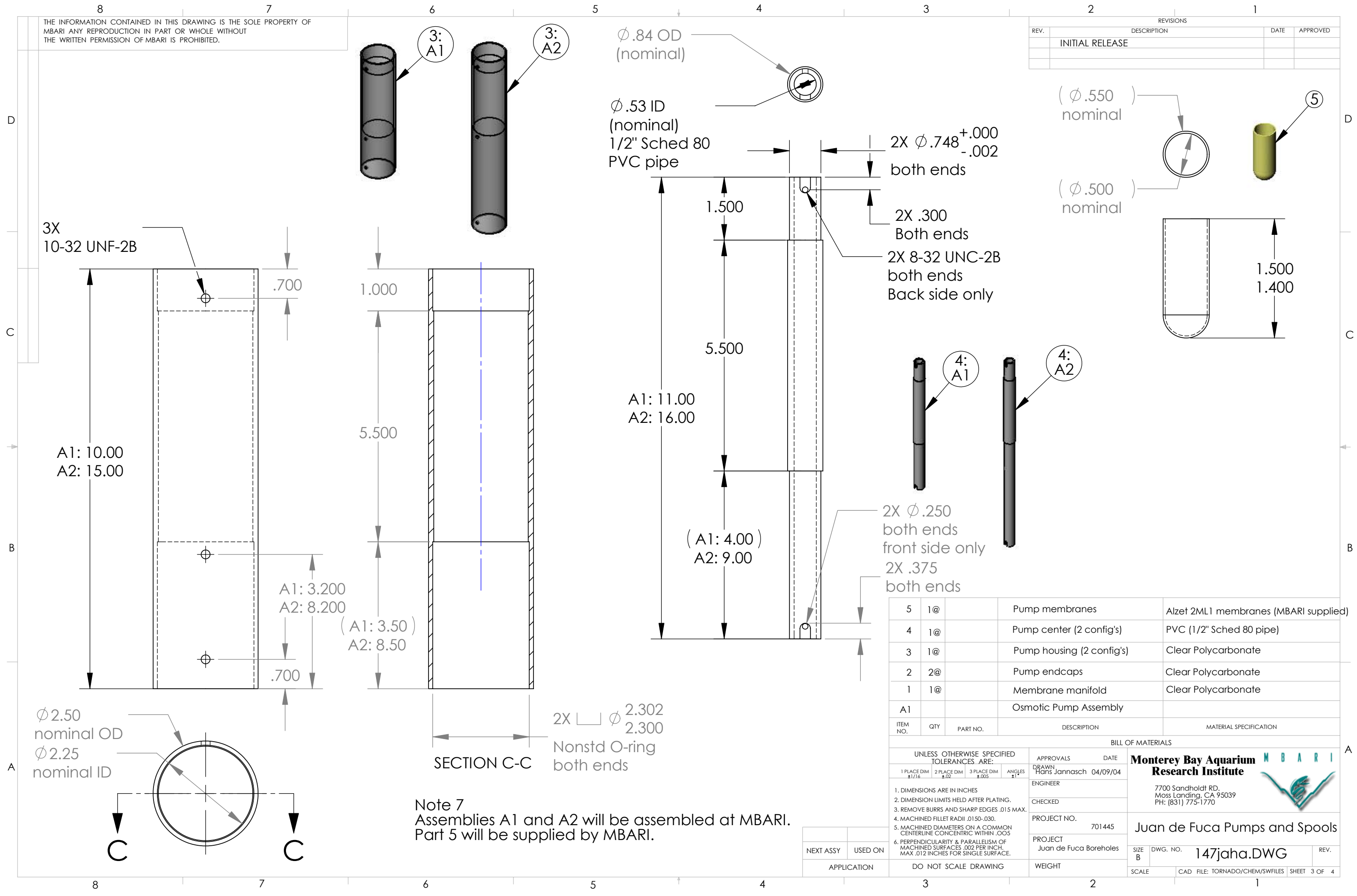
DO NOT SCALE DRAWING

WEIGHT

SCALE

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| REV.      | DESCRIPTION     | DATE | APPROVED |
|           | INITIAL RELEASE |      |          |
|           |                 |      |          |
|           |                 |      |          |



3X  
10-32 UNF-2B

Ø .84 OD  
(nominal)

Ø .53 ID  
(nominal)  
1/2" Sched 80  
PVC pipe

(Ø .550  
nominal)

(Ø .500  
nominal)

2X Ø .748<sup>+0.000</sup>  
-0.002  
both ends

2X .300  
Both ends

2X 8-32 UNC-2B  
both ends  
Back side only

2X Ø .250  
both ends  
front side only

2X .375  
both ends

A1: 11.00  
A2: 16.00

(A1: 4.00)  
A2: 9.00

A1: 3.200  
A2: 8.200

(A1: 3.50)  
A2: 8.50

A1: 10.00  
A2: 15.00

Ø 2.50  
nominal OD  
Ø 2.25  
nominal ID

2X Ø 2.302  
2.300  
Nonstd O-ring  
both ends

Note 7  
Assemblies A1 and A2 will be assembled at MBARI.  
Part 5 will be supplied by MBARI.

| ITEM NO. | QTY | PART NO. | DESCRIPTION               | MATERIAL SPECIFICATION                |
|----------|-----|----------|---------------------------|---------------------------------------|
| 5        | 1@  |          | Pump membranes            | Alzet 2ML1 membranes (MBARI supplied) |
| 4        | 1@  |          | Pump center (2 config's)  | PVC (1/2" Sched 80 pipe)              |
| 3        | 1@  |          | Pump housing (2 config's) | Clear Polycarbonate                   |
| 2        | 2@  |          | Pump endcaps              | Clear Polycarbonate                   |
| 1        | 1@  |          | Membrane manifold         | Clear Polycarbonate                   |
| A1       |     |          | Osmotic Pump Assembly     |                                       |

| UNLESS OTHERWISE SPECIFIED TOLERANCES ARE: |             |             |         |
|--------------------------------------------|-------------|-------------|---------|
| 1 PLACE DIM                                | 2 PLACE DIM | 3 PLACE DIM | ANGLES  |
| $\pm .016$                                 | $\pm .02$   | $\pm .005$  | $\pm 1$ |

**Monterey Bay Aquarium Research Institute**

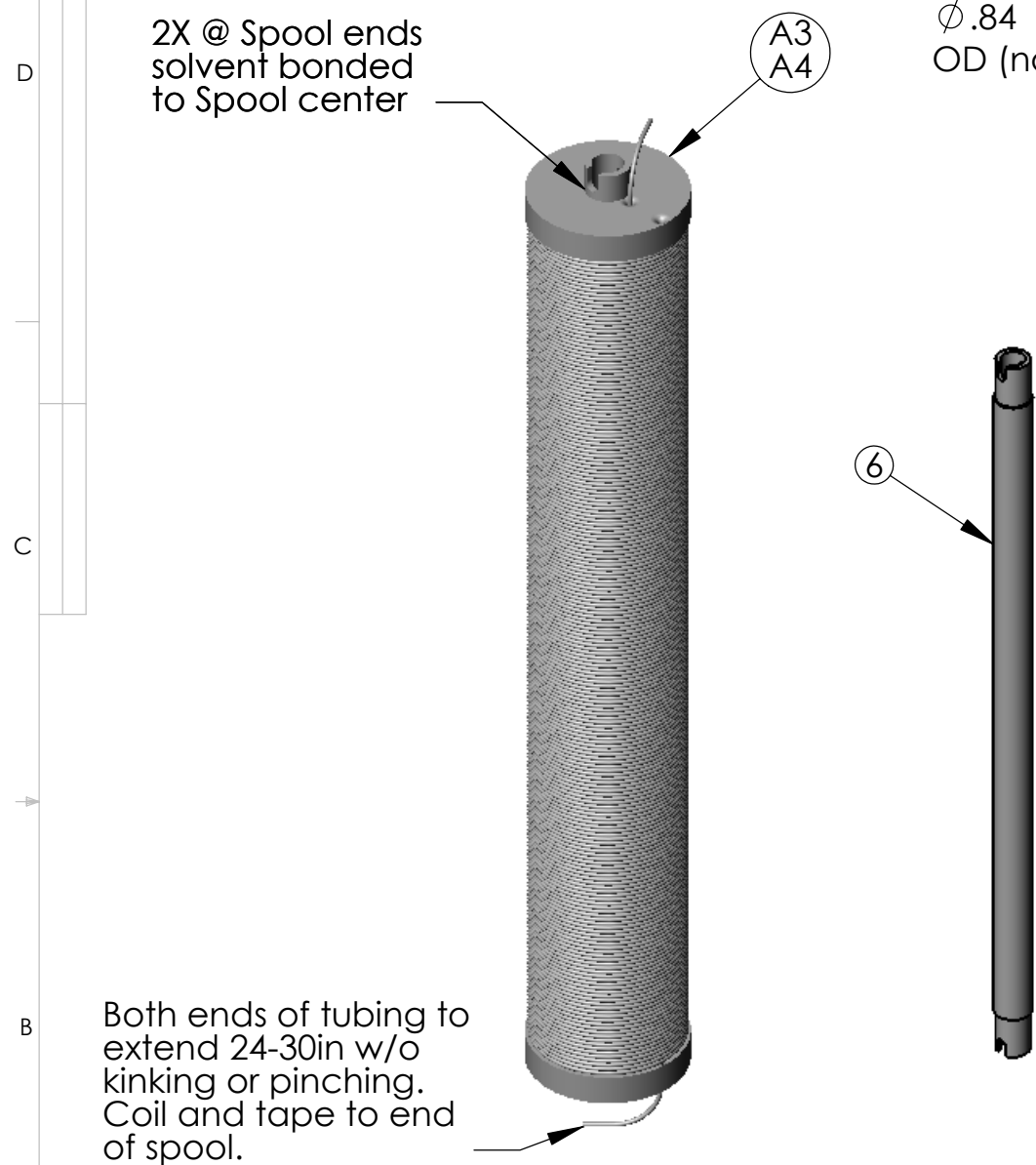
7700 Sandholdt RD.  
Moss Landing, CA 95039  
PH: (831) 775-1770

APPROVALS DATE  
DRAWN Hans Jannasch 04/09/04  
ENGINEER  
CHECKED  
PROJECT NO. 701445  
PROJECT Juan de Fuca Boreholes  
SIZE B DWG. NO. 147jaha.DWG  
SCALE CAD FILE: TORNADO/CHEM/SWFILES SHEET 3 OF 4

| NEXT ASSY | USED ON | APPLICATION | DO NOT SCALE DRAWING | WEIGHT |
|-----------|---------|-------------|----------------------|--------|
|           |         |             |                      |        |

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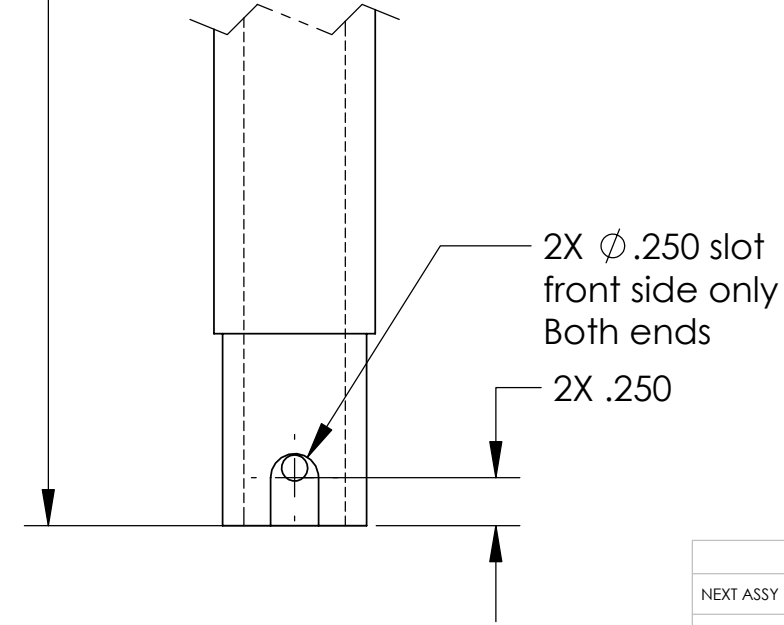
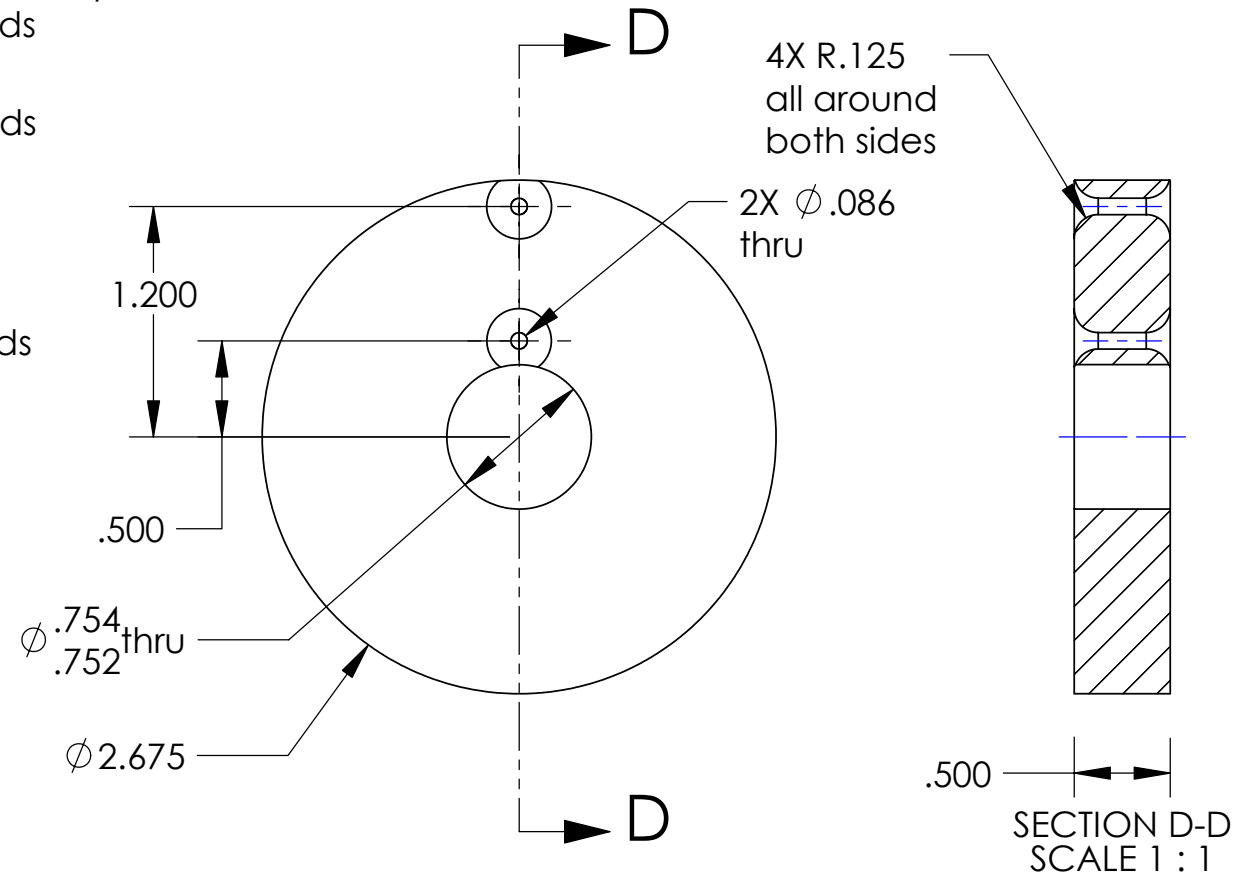
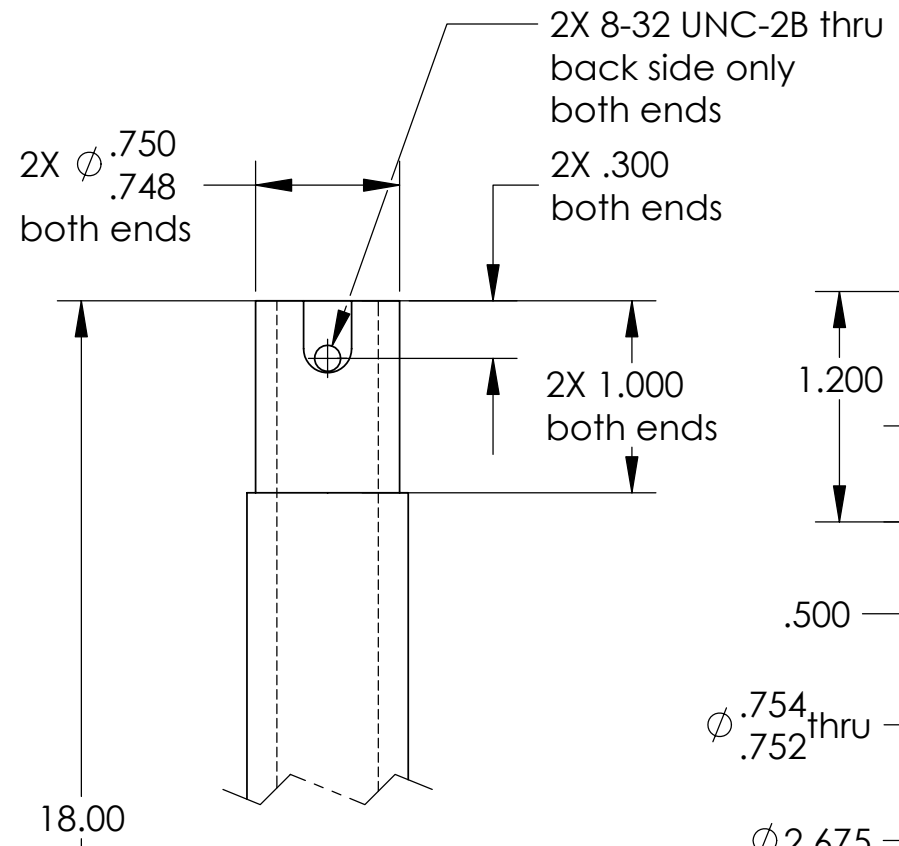
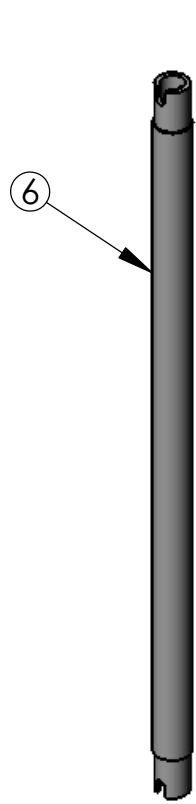
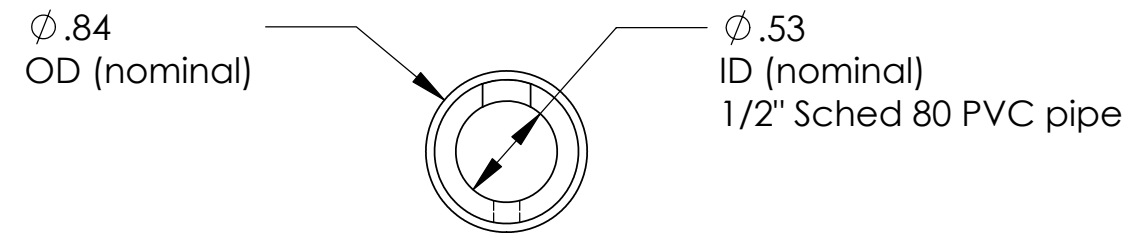
| REVISIONS |                 |      |          |
|-----------|-----------------|------|----------|
| REV.      | DESCRIPTION     | DATE | APPROVED |
|           | INITIAL RELEASE |      |          |
|           |                 |      |          |



Both ends of tubing to extend 24-30in w/o kinking or pinching. Coil and tape to end of spool.

Note 7.  
Bonded spools to be wrapped with evenly laid tubing in one continuous length. Tubing must not be kinked, pinched, severely stretched, or have joints. All Teflon and copper tubing will be supplied by MBARI. Tubing comes on 1000 ft spools. Loose tubing ends should extend 24-30 in on each end.

A3-Tf - Wrap with .079in OD Teflon tubing, 11 layers of about 200 wraps per layer (~980 ft).  
A4-Cu - Wrap with .079in OD Copper tubing, 11 layers of about 200 wraps per layer (~980 ft).



| ITEM NO. | QTY | PART NO. | DESCRIPTION                    | MATERIAL SPECIFICATION |
|----------|-----|----------|--------------------------------|------------------------|
| 7        |     |          | Spool Ends                     | CPVC                   |
| 6        |     |          | Spool Center                   | CPVC                   |
| A4       |     |          | Spool Assembly, sample(Cu)     | CPVC w/Copper tubing   |
| A3       |     |          | Spool Assembly, sample(Teflon) | CPVC w/Teflon tubing   |

| UNLESS OTHERWISE SPECIFIED TOLERANCES ARE:                                                                                                                                                                                                                                                                                                      |             |             |         | APPROVALS     |                        | DATE     | <b>Monterey Bay Aquarium Research Institute</b><br>7700 Sandholdt RD.<br>Moss Landing, CA 95039<br>PH: (831) 775-1770 |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-------------|---------|---------------|------------------------|----------|-----------------------------------------------------------------------------------------------------------------------|
| 1 PLACE DIM                                                                                                                                                                                                                                                                                                                                     | 2 PLACE DIM | 3 PLACE DIM | ANGLES  | DRAWN         |                        |          |                                                                                                                       |
| $\pm .016$                                                                                                                                                                                                                                                                                                                                      | $\pm .02$   | $\pm .005$  | $\pm 1$ | Hans Jannasch |                        | 04/09/04 |                                                                                                                       |
| 1. DIMENSIONS ARE IN INCHES<br>2. DIMENSION LIMITS HELD AFTER PLATING.<br>3. REMOVE BURRS AND SHARP EDGES .015 MAX.<br>4. MACHINED FILLET RADII .0150-.030.<br>5. MACHINED DIAMETERS ON A COMMON CENTERLINE CONCENTRIC WITHIN .005<br>6. PERPENDICULARITY & PARALLELISM OF MACHINED SURFACES .002 PER INCH. MAX .012 INCHES FOR SINGLE SURFACE. |             |             |         | CHECKED       |                        |          |                                                                                                                       |
| NEXT ASSY                                                                                                                                                                                                                                                                                                                                       |             | USED ON     |         | PROJECT NO.   | 701445                 |          | Juan de Fuca Pumps and Spools<br>SIZE B DWG. NO. 147jaha.DWG                                                          |
| APPLICATION                                                                                                                                                                                                                                                                                                                                     |             |             |         | PROJECT       | Juan de Fuca Boreholes |          |                                                                                                                       |
| DO NOT SCALE DRAWING                                                                                                                                                                                                                                                                                                                            |             |             |         | WEIGHT        |                        |          | SCALE<br>CAD FILE: TORNADO/CHEM/SWFILES SHEET 4 OF 4                                                                  |