

ENCLOSURE MAT'L- Attributes - clear for good light transmission, strength, workability

Polycarbonate-colored or clear

-nearly unbreakable

-relatively easy to fabricate, E.G. drilling, tapping, however, sawing difficult. Sawing with a jig saw difficult because the blade overheats, a band saw works quite well. Holes can be drilled/tapped with good results <0.5" (1cm) from edges

- Overall perpendicular visible light transmission good ~86%, about 5% less than Acrylic

-UV transmittance falls off rapidly at about 350nm, about the same as general purpose Acrylic.
Note: in SeaWater, 300nm UV is 99% attenuated @30m, 350nm @87m, 400nm @ 220m, so some UV can penetrate deeply into the photic zone.

-yellows more quickly than acrylic when exposed to daylight UV.

Acrylic- colored or clear

-tougher than glass but will break easily at stressed points

-harder to fabricate- cutting, drilling needs to be done carefully with a non-solvent based cutting fluid paying special attention to heat generation.

-holes should be >0.5"(1cm) from edges to avoid breakout

- Overall perpendicular visible light transmission is very good, 92%

-UV transmission of general purpose Acrylic falls off rapidly at ~350 nm however a version is available, G UVT, which has a 275 nm cut-off when this aspect is important, especially in shallow deployments.

-less yellowing effect when exposed to daylight UV

-can be bonded with methyl chloride, or easily obtainable Weld-On #16

NOTE ON FABRICATION- drilling holes in plastics, polycarbonate and especially acrylic can be difficult because the drill tends to grab and "dig" into the material. Purchase special drills for plastic, which work very well. OR-Modify the cutting edge of a common drill's flutes by filing or sanding the cutting edge to a more vertical "scraping" edge. Keep it sharp and a very nice hole without breakout on the back surface will be the result. See image.



Drill bit mod for plastics

FRAME- Attributes – strong, light, corrosion resistant

FRP-fiber reinforced plastic (fiberglass) – easily worked material that is available in structural shapes like angles, sheets and round or square tubes. Almost impervious to SW.

-FRP is destructive to tooling so cutting/boring tools need to be replaced often as they become dull. Does not hold threads very well, sheet metal screws can be used in $>.25"$ (.6cm) thick materials

6061 Aluminum- if Anodized, holds up well. Corrosion issues when in contact with SS fasteners, insulating washers help.

PVC – can be obtained some places. Common shapes are sheets, bars, tubes, some sizes of angles. Can be found in a clear version so when angles used for reinforcing edges, less blockage of light.

-PVC is easily fabricated and can be drilled/tapped easily. Can also be bonded. It is not as strong as FRP.

UHMW-nearly inert in SW, easy to fabricate, common shapes are sheets, bars, rods. Lighter than SW.

Any of the plastics can be obtained in black to preclude light transmission and improve resistance to UV degradation when at or very near the surface .

Fasteners –

Stainless Steel, 316 preferred, or plastic to mitigate or prevent corrosion from the S.W.

Plastic OK in low strength applications, 316 SS is the most corrosion resistant alloy, but even that should be checked when immersion exceeds 1 year. This is especially true in areas that are wet but the water is trapped as under a washer, these areas become anoxic and severe corrosion can occur. Areas with circulation do much better.

LATCHES - sturdy, corrosion resistant, easy for diver to manipulate

-Cabinet type, SS.

-Block and pin, plastic SS

- fabricated custom design-cam lock, single or paired

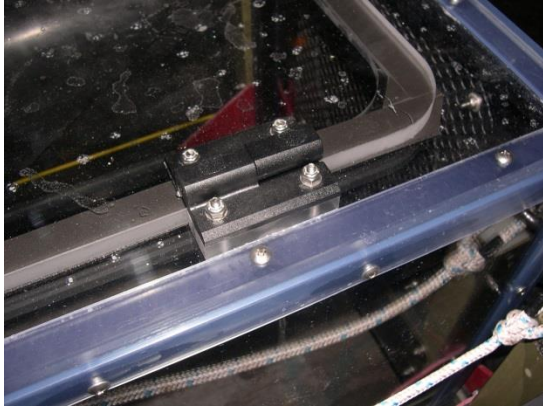


HINGES - sturdy, corrosion resistant

Plastic and Stainless Steel

-piano type, SS

-solid rubber, 1/8-1/4"(.3-.6 cm) thick, screwed in with reinforcing strips



THRUSTERS – high reliability, select appropriate thrust/GPM rating, convenient (available) power requirements (AC/DC, Watts?), easy to control, cost?



Simulating Current

Type	Pro	Con
 Trolling Motor	• Compatible with shallow depths • Easy maintenance/replacement • Compatible with available power (AC/DC, etc.) • Controllable according to requirements • Capable of reasonable volume/rate delivery • Low Cost --\$50-\$200	• Requires modification to fit shroud • Not designed for long term running • Requires close monitoring of shaft seals
 Commercial Thruster	• Technadyne Model 520 Brushless DC • Multiple voltages • Analog or digital control • Magnetically coupled prop • CrustCrawler 400 HFL • 0-50VDC 400watts • 300 ft Depth • Low Cost --\$600	• High Cost --\$3700 • Lip seals
 Submersible Bilge Pump	• Compatible with shallow depths • Large range of flow rates • Large range of DC voltages • Readily available/replaceable • Very inexpensive-- \$20-\$50 Brand Names: Rule, Attwood, Lovett, Johnson, Jabsco,...	• Not designed to run continuously • May need replacing more often

Bilge Pumps- Largest flows available are 3500-4000 GPH for ~\$200. (Flow ratings are with 0 head or backpressure).

shFOCE decided on a Modified 12VDC Navigator Trolling Motor, 35 Lb. Thrust. See Modification Docs. OK for 1 meter depths but needs modifications to shaft seals for deeper applications. \$600



ANCHORS – auger types easiest, Plate type “earth anchors” need to be dug out to retrieve.

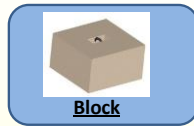




Anchoring

•Semi, Consolidated, and Unconsolidated Sand, Silt, and Clay

- Deadweight
 - Concrete Block
- Direct Embedment
 - Helix
 - Keyed Plate
- Drag Embedment (Primarily for buoy moorings)
 - Danforth, CQR, Delta, Bruce, etc.
- Self-Burying (Better for loose sand, silt)
 - Dor-Mor
 - Mushroom



Block



Stud Gun



Drag Embedment



Self-Burying

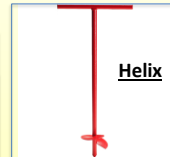
ALL-STEEL MUSHROOM ANCHORS

•Rock and Coral

- Deadweight
 - Concrete Block
- Direct Embedment
 - Powder Actuated Stud Gun (down to 46 meter (150') depth)
 - Epoxyed Stud (Drilled hole)
 - Expansion Bolt (Drilled hole)



Epoxyed Stud



Helix

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-Screw-It Beach anchor, removable handle, Corrosion resistant - \$70, RoxyMarineMart

-Ironwood Pacific – 21", 4" helix, powder coated steel, \$40 each

-Helix – set of 4 for \$23. MilSpec Anchors

-Triangular earth Anchors with Galvanized cables, set of 4. ~\$40

-Corkscrew Types probably OK in stiffer soils

Ducting – Most often used for air handling. Various kinds of plastics with copper, steel wire or urethane reinforcement. 2" - 12" (5-30cm) diameter, various pressure/vac ratings, durability, flexibility, costs.



shFOCE decided on 10" Dia. All plastic, PVC reinforcing strip.

Skirting – To minimize the effects of wave produced surges and the resulting scouring and mounding of sand around and under the test section. A piece of sturdy material (rubber, canvas, synthetics) approx. 1 test section width should be fixed to the perimeter of the test section base. It will need to be weighted down sufficiently to resist the water flow. Native rocks, concrete blocks or shot -filled rubber hose can accomplish this.



Canvas shown(trial deployment), 1/8" rubber much longer lasting (years)

Example of FOCE Test Chamber Fabrication- Use of these materials maximizes light transmission into the test chamber.

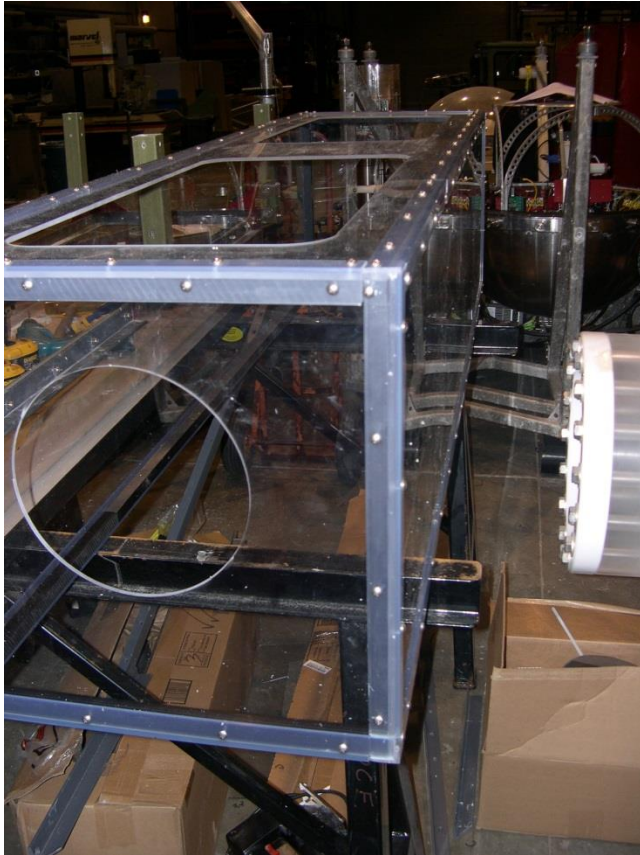
- 1/4"-3/8"(6.5-9.5mm) Clear Acrylic Panels

- 3/16" x 1.5" x 1.5" (.2 x 3.8 x 3.8cm) clear PVC angle used as outside support structure.

- 3/16" x1.25" x1.25"(.2 x 3.2 x 3.2 cm) clear PVC used inside.

- 8-32 x 5/8" (4 x 0.5 x 16mm) screws tapped into inner PVC pieces, 6"(15cm)C/C.





1.125" #8 Stainless Steel Truss screws, similar to sheet metal screws. 3/16 x 1.25" outer clear PVC angle stock, 3/8" Acrylic sheet, 3/4 x 3/4" UHMW inner bar reinforcing. Current shFOCE design. Easier to fabricate and strong, pilot and clearance holes only, no tapping.