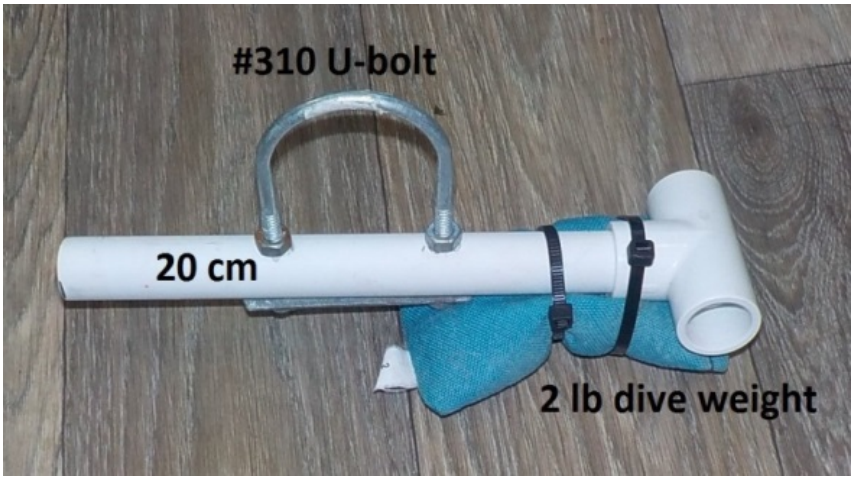
NAVIGATOR Product demonstration prop building instructions

SolidWorks files will be available soon for all product demonstration props. Contact the MATE competition coordinator for access to the NAVIGATOR SolidWorks files. SolidWorks Student Edition is free for MATE competitors. The eDrawings Viewer is a free download that allows the Solidworks files to be viewed dynamically.

See last page for update notes.

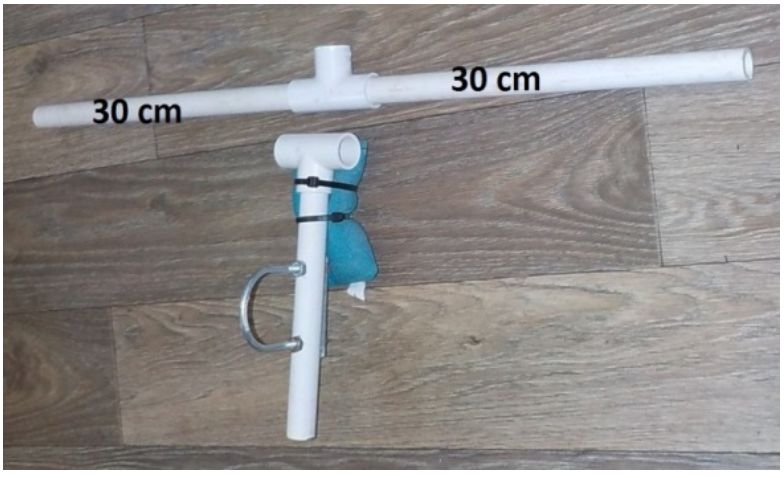
Task 1: Aircraft

Aircraft engine:
The aircraft is constructed of ½-inch PVC pipe with a 2-lb weight and #310 U-bolt.



Note: The 2-lb weight may be a soft weight (as shown) or a solid weight.

Additional pieces of the aircraft will be located near the aircraft engine. This structure will be constructed from ½-inch PVC pipe. The tail structure (see below) will also be located near the aircraft engine.



Lift bag:
The lift bag is constructed from 30 cm of 3-inch ABS pipe with a 3-inch end cap on one end. A 30 cm length of rope (colors may vary) will be connected to the other end of the 3-inch ABS pipe through two holes drilled in the pipe. The rope will run through a 2 cm length of ½-inch PVC pipe. A #6 screw hook will be drilled through the 2 cm length of pipe. The #6 screw hook will attach to the U-bolt on the aircraft engine.

Drill two holes on opposite sides of the bottom of the lift bag. String 30 cm of rope through the holes. Run the rope through the 2 cm long length of pipe with the screw hook attached.

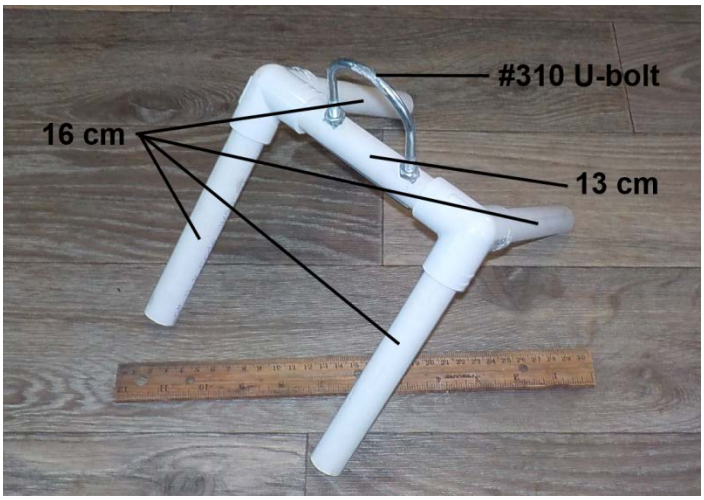
If ABS pipe is not available in your area, PVC pipe can be substituted. However, additional flotation may need to be added to make the lift bag positively buoyant in water. Add foam flotation into the top of the lift bag (3-inch end cap side) to make the lift bag slightly positively buoyant. The length of the PVC pipe should also be increased from 30 cm to 35 cm. When filled with air, the additional volume will compensate for the additional weight of the pipe in water.

A bicycle pump with 3/16-inch airline tubing will be used to inflate the lift bag. Note: the type of bicycle pump at your regional competition may differ.

Aircraft tail structure:
The tail structure is constructed from corrugated plastic sheeting (check sign stores) attached to ½-inch PVC pipe. A number-letter combination on the tail will help companies identify the aircraft. 2-inch black on white letters and numbers are used. The tail shape and tail number will correspond to one of the 30 examples in the **NAVIGATOR Aircraft Identification Handbook**.

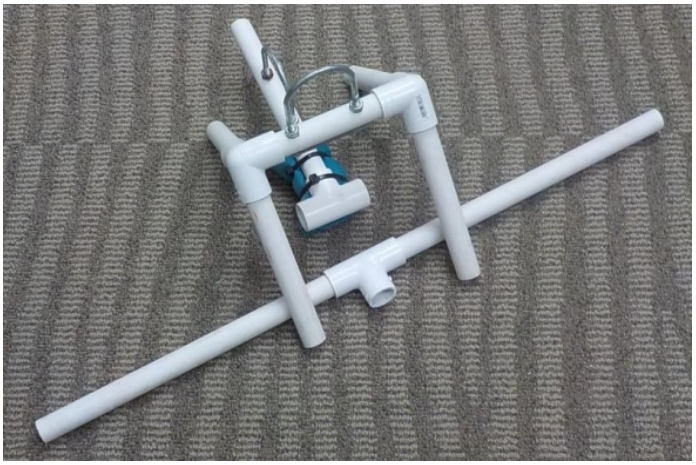
Debris:

The debris is constructed from ½-inch PVC pipe with a #310 U-bolt on top.



Debris on aircraft:

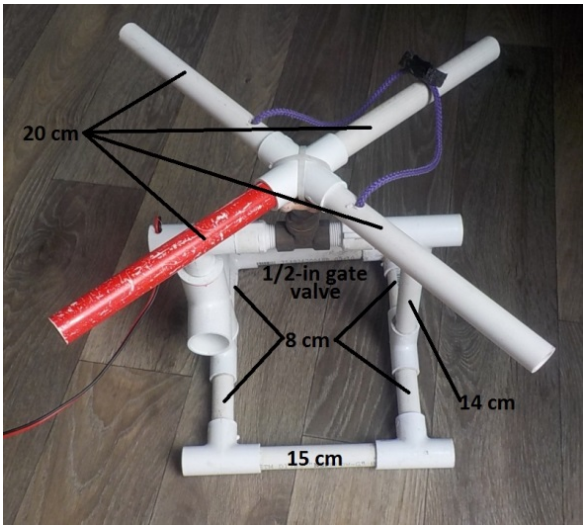
The debris will be placed over the engine and aircraft structure. The debris must be removed before the lift bag is attached to the engine.



Task 2: Earthquakes

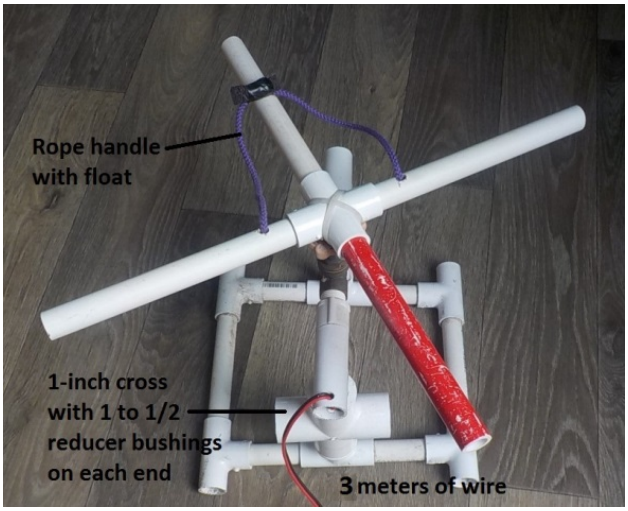
OBS (front view):

The OBS is constructed from ½-inch PVC pipe with a 1-inch PVC cross and a ½-inch gate valve. A ½-inch PVC cross is zip-tied to the top of the gate valve. One of the four handles is painted red. The 1-inch cross has two 1-inch to ½-inch reducer bushings to connect it to the 1/2-inch structure. Companies will turn the handle attached to a ½-inch gate valve 360° (one time around) clockwise to level the OBS.



Flotation will be added into the PVC of the handle to make the OBS weight less than 5 Newtons in water.

OBS (side view):

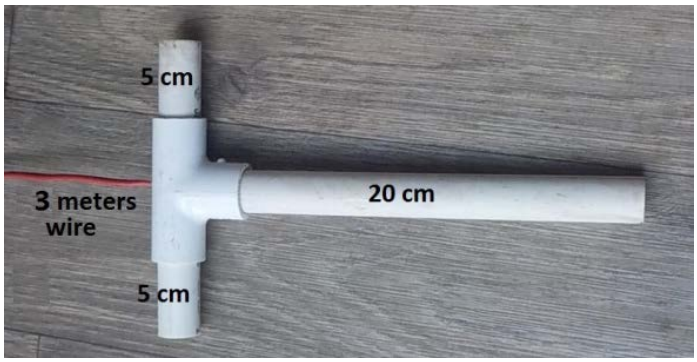


A 40 cm length of rope (colors may vary) may be used as a grab point to move the OBS. The two ends of the rope are approximately 12 cm apart. A small section of foam is attached to center of the rope to provide flotation.

3 meters of cable will connect the OBS to the cable connector. The cable will be constructed from flexible wire.

Cable connector:

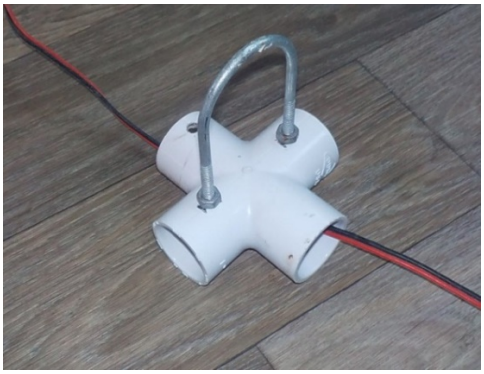
The cable connector is constructed from ½-inch PVC pipe.



Drill a hole into the top of the ½-inch tee. Tie an overhand knot in the wire to secure it inside the tee.

Cable grab point:

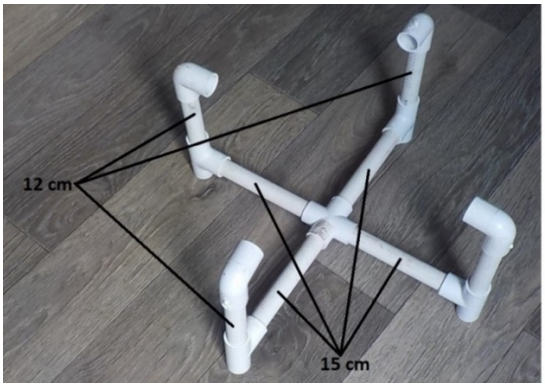
A grab point will be situated along the 3 meters of wire. Companies may use the grab point to position the wire inside the waypoints. The grab point is constructed from a 1-inch PVC cross with a #310 U-bolt attached.

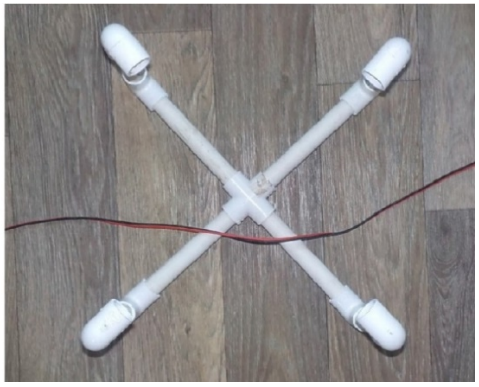


The wire will not be attached to the grab point, but will run through the cross.

Waypoint:

The waypoints are constructed from ½-inch PVC pipe.

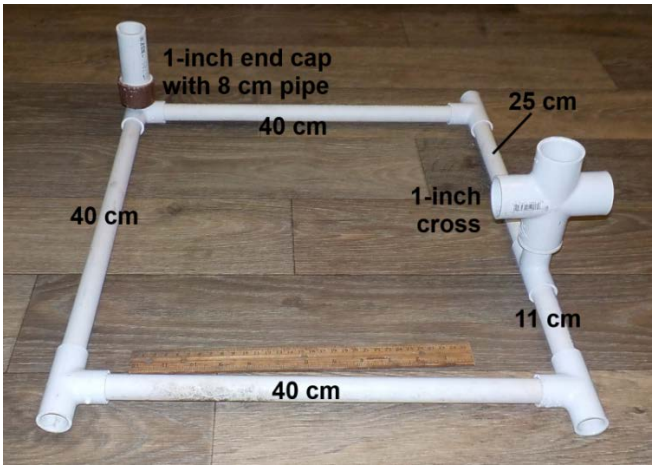




The cable must go through two "legs" of the waypoint. The photo on the right shows the cable through two "legs" of the waypoint.

Elevator:

The elevator is constructed from 1/2-inch PVC pipe with two sections of 1-inch PVC pipe.



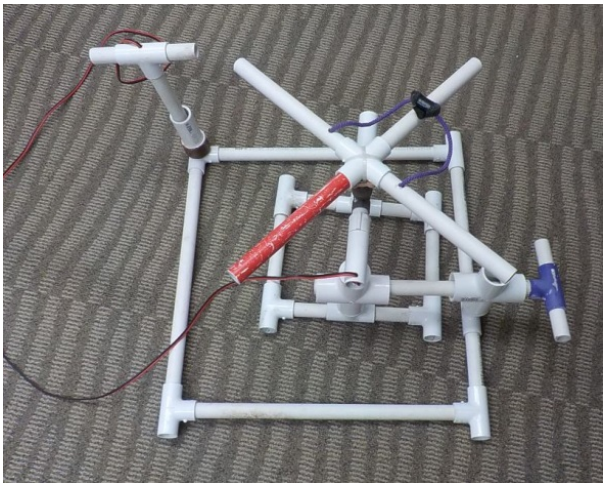
Screw the 1-inch end cap into the tee at corner of the elevator.

The 1-inch cross is connected to the elevator using a 1-inch to ½-inch reducer bushing.

Pin:

The pin is constructed from ½-inch PVC pipe.

The elevator (with equipment):

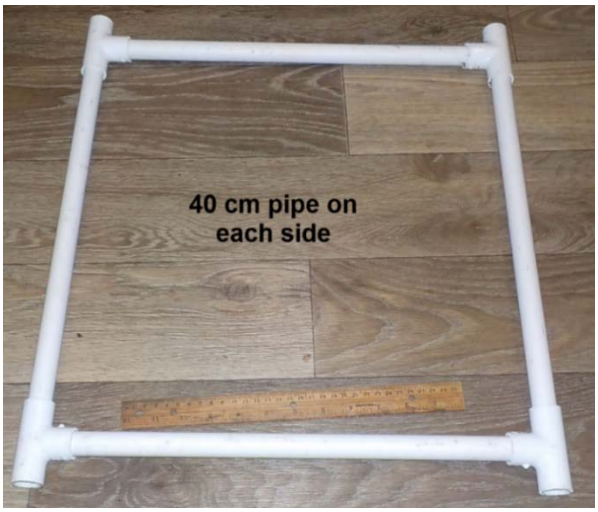


The cable connector is in its holder.

The pin is inserted through the 1-inch cross on the elevator and through the 1-inch cross on the OBS.

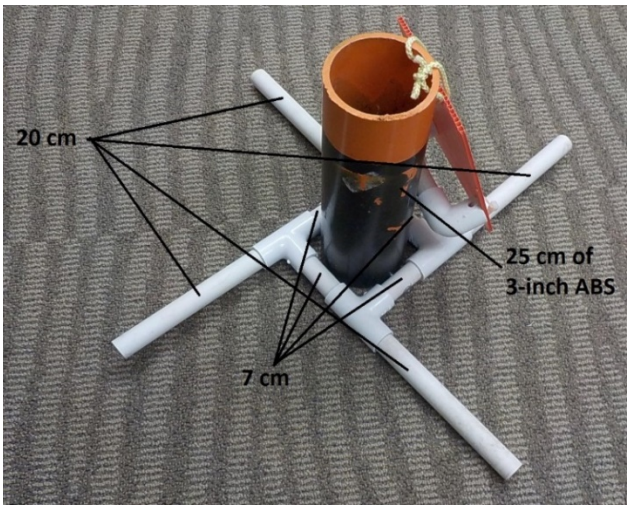
OBS Designated area:

The OBS designated area is constructed of ½-inch PVC pipe.



Power and communication hub:

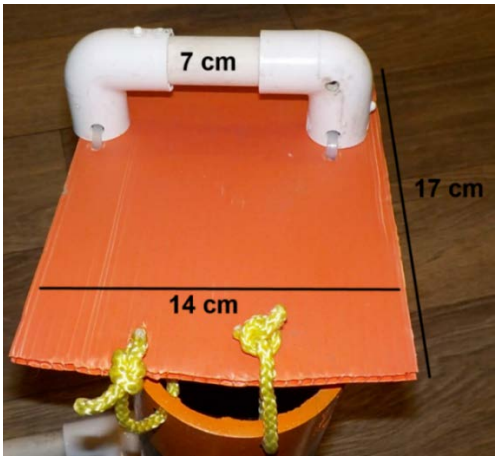
The power and communication hub is constructed from 3-inch ABS (or PVC pipe) screwed into a ½-inch PVC pipe base.



Use 2-inch screws to attach the 3-inch ABS pipe to the PVC base. The screws will go through the ½-inch pipe and into the base of the 25 cm length of 3-inch ABS. Note: 3-inch PVC pipe can be substituted for ABS pipe.

Door of power and communication hub:

The door of the power and communications hub is constructed from corrugated plastic sheeting (check sign stores) with a PVC pipe handle. The door is attached to the top of the power and communications hub by ropes.



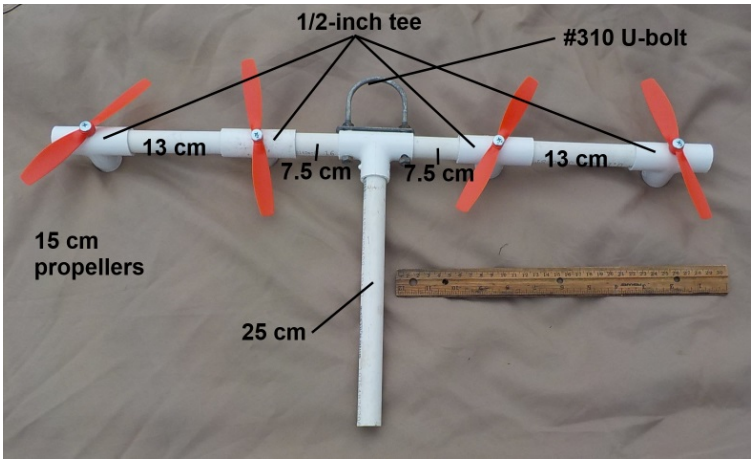
Two 20 cm of rope (colors may vary) are used to attach the door to the top of the hub. The door is 17 cm by 14 cm.

Cable connector inserted into power and communication hub:

Task 3: Energy

Tidal turbine:

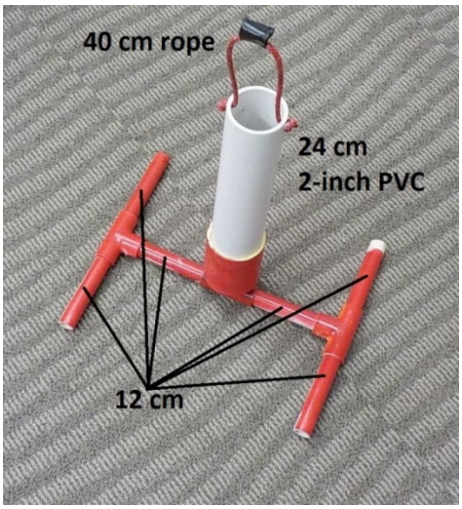
The tidal turbine is constructed from ½-inch PVC pipe. Four propellers are attached to ½-inch PVC tees. A #310 U-bolt is located in the top center of the turbine. The U-bolt goes all the way through the tee.



A red stripe (red plastic tape) will be added approximately 8 cm from the bottom of the tidal turbine. This stripe must be completely within the turbine stand to successfully install the tidal turbine.

Turbine base:

The turbine base is constructed from ½-inch PVC pipe and 2-inch PVC pipe. A 2-inch to ½-inch reducer bushing and 2-inch coupling combines the two different sizes of pipe.

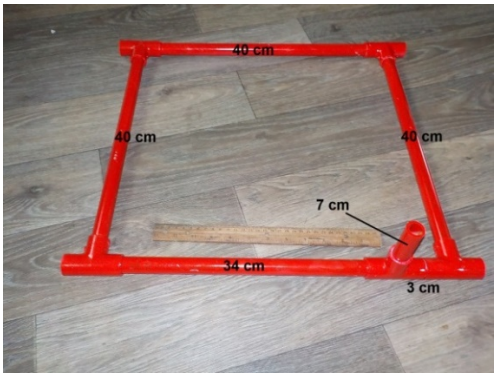


A 40 cm length of rope at the top of the 2-inch PVC can be used as a grab point for moving the base into the designated area.

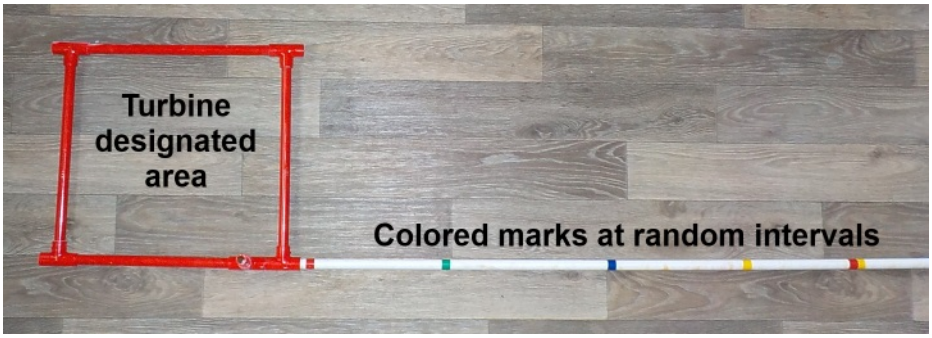
Turbine base with tidal turbine installed and latched:

The rope at the top of the turbine base can be pushed to the side when installing the turbine.

Turbine area:



Turbine area with length measurement:



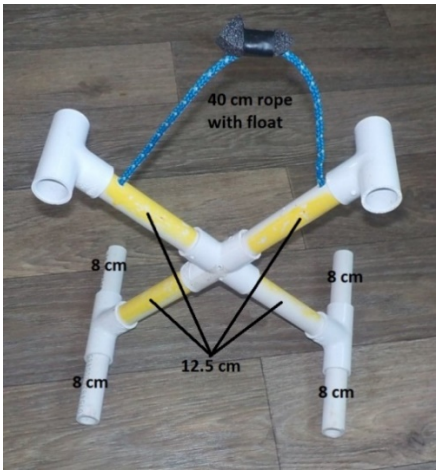
The turbine area will be painted red matching the red painted base of the tidal turbine.

The length of pipe with colored marks will be used for measuring the distance.

Turbine installed in base inside turbine designated area:

I-AMP:

The I-AMP is constructed from ½-inch PVC pipe.

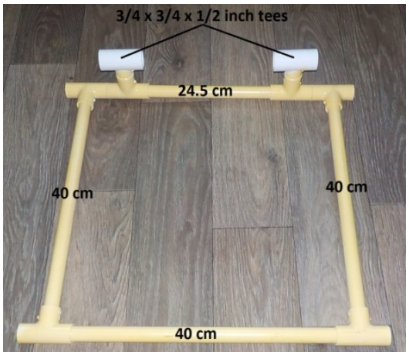


40 cm of rope (colors may vary) is used as a grab point. Drill two holes 0.5 cm below the tees. Insert the rope into the holes and tie an overhand knot to secure the rope in the pipe.

Flotation can be added to the top two 12.5 cm lengths of PVC pipe to help keep the I-AMP upright and to decrease its weight in water.

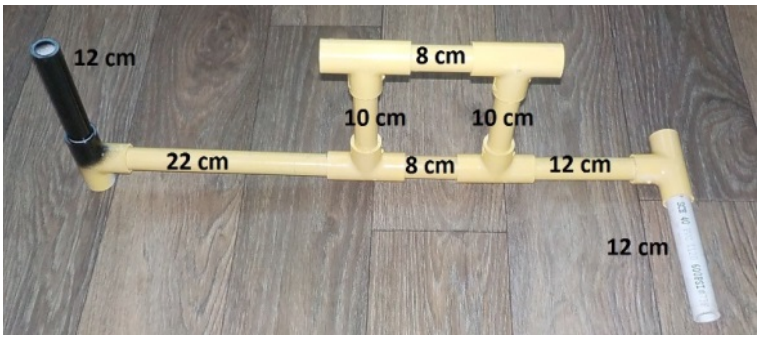
I-AMP designated area:

The designated area is constructed from ½-inch PVC pipe with two ¾-inch x ¾-inch x ½-inch reducing tee (note that the Home Depot website photo does not show the proper tee).



I-AMP locking mechanism:

The locking mechanism is constructed from ½-inch PVC pipe.



The 12 cm black handle should be parallel (in line with) the central yellow section.

The 12 cm black handle should be perpendicular to (90^{o} off of) the white handle, i.e. if the white handle is flat against the ground (as shown in photo) the black handle should be sticking straight up.

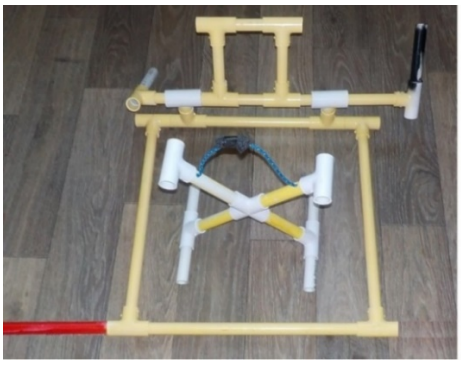
I-AMP base:

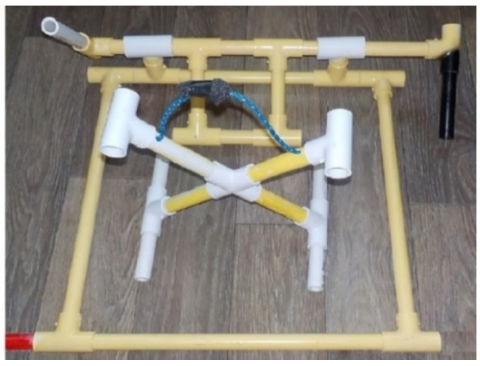
The I-AMP base is composed of the designated area and the locking mechanism.

The ½-inch pipe of the locking mechanism fits through the ¾-inch sections of the tees.

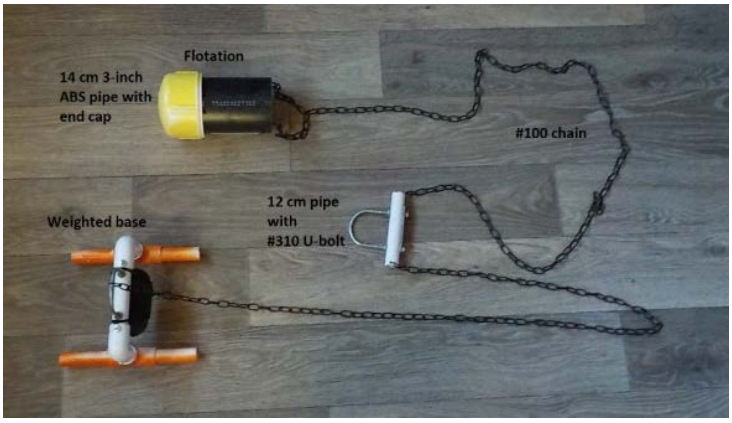
One corner of the I-AMP base is connected to the base for the tidal turbine. See below.

I-AMP installed in the I-AMP base and locked in the I-AMP base:



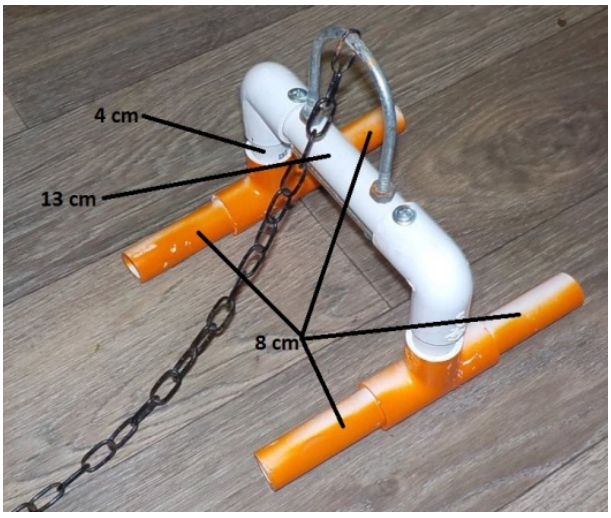


Mooring:



The length of the mooring from the bottom of the base to the top of the flotation should be the depth of the pool plus 5 to 10 cm.

Mooring base:



Two 15 cm lengths of rebar inside the mooring base provide ballast. Use screws to keep the rebar secure inside the mooring base.

Mooring float:

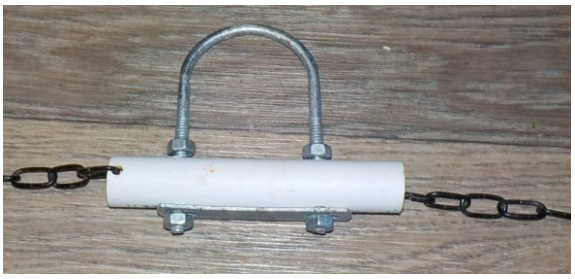
Drill two holes in the end of the 3-inch ABS pipe.

Use pliers to open the chain links and insert one into each hole.

Add foam into the mooring flotation.

The flotation should be 3 Newtons positively buoyant in water.

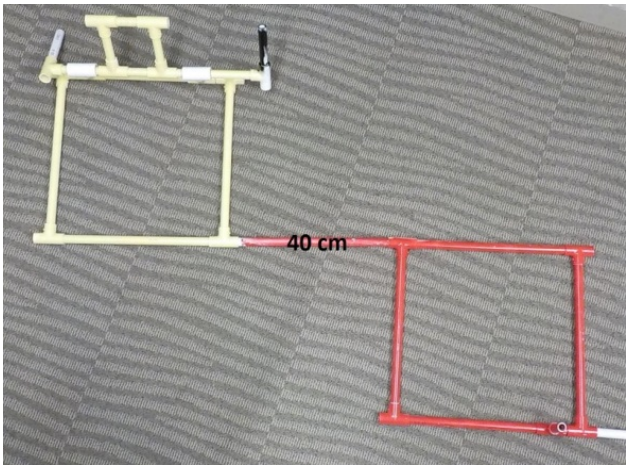
Mooring attachment:



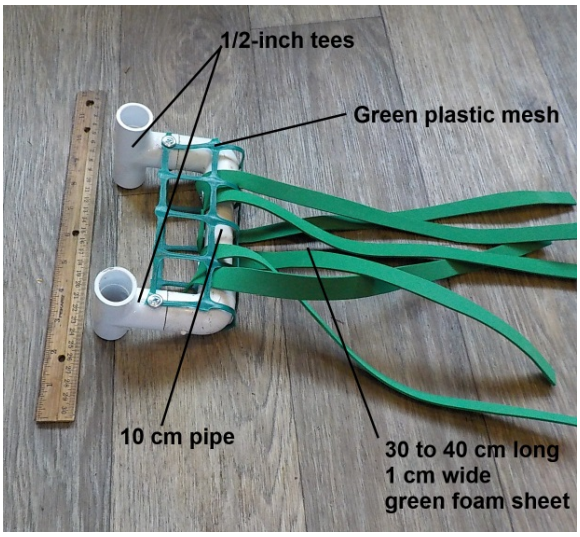
#310 U-bolt into 12 cm of pipe.

Tidal turbine designated area and I-AMP base:

The tidal turbine designated area and the I-AMP base are connected with a length of ½-inch PVC pipe.



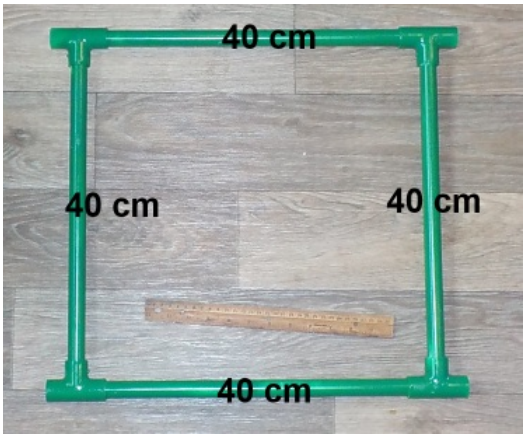
Eelgrass samples and frames:



Foam sheeting is available at Michael's craft store.

Eelgrass frames have green plastic mesh. Eelgrass samples do not have the green plastic mesh. The mesh is created from 1-inch square mesh. A 4 square x 4 square section of mesh is used to create the eelgrass frames.

Eelgrass area:



Update Notes:

Updates are highlighted in yellow.

January 18, 2018

Pages 11 – 13: Updated all of the turbine base photos and information. The turbine base does not have a locking mechanism. All photos showing the turbine base were updated. All photos showing the turbine base with a locking mechanism were removed.

Page 19: Added information about the plastic mesh used on the eelgrass frames.

March 13, 2018

Page 11 - 12: Addition of information on turbine base grab point.

Page 17: Included dimensions on mooring base photo.