Prototype Spar-Buoy Performance Notes

From AST Expedition deployment

For Internal Use Only

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Overview

The spar-buoy design implemented for the AST project served a purpose that probably could not have been fulfilled in any other (portable and independent) manner. Sea states during the expedition were moderate to rough with swells ranging to 18 feet and winds reached 30 knots on several days (B7 on final). A fixed buoy would not have done as well -- either mechanically or noise-wise.

When the buoys operated without problems, the life exceeded 100 hours continuous operations. Transmissions were able to be received over a wide latitude of angle from the ship-board antenna, and over distances easily exceeding 500 meters in very rough seas. Such transmissions continued even with swells covering up to half of the buoy's transmit antenna. Distances of several kilometers are expected but not tested. I would also have confidence in deploying through Beufort 6 conditions.

There were problems however, as can be expected from a prototype design. There are also areas of the design that can be improved upon. I hope to address these in the following paragraphs.

Problem Areas

1. Internal Bulkhead

The internal bulkhead presented a water seepage problem. This is due to my use of 1/4" gas fittings on a 0.2" diameter cable, and that I used such a fitting on only the 'dry' side of the bulkhead.

During operations (riding vertical in the seas), this was not a problem except in the very worst conditions (severe angle of ride due to wind loading). The problem appeared once the buoy was recovered and laid flat on the deck.

What would happen is that water collected in the lower compartment during operation would gradually seep into the inside of the bulkhead and then on through to the 'dry' compartment. I addresses this problem as best as possible using silicon sealer but this was not always 100% successful.

The end result of such seepage would be rapid reaction with the battery terminals and in terminal cases, the leaking of the battery. Two batteries were lost in this manner.

2. Connector Strength

Under rough seas and through the process of deployment and recovery, both the Seacon connector backshells and the connector body's threads became cracked and useless. Continuing to employ the buoy after this point placed strain on the cables themselves as well as raising the potential for the cable to become disconnected. The type of connector used were made of delrin. Most of the connector backshells deployed developed these cracks, while only the buoy in sea state B7 had fractures in the connector body.

3. Ballasting

The original ballast calculated (in Ithaca) was for 16lbs. Upon test deployment in the Santa Cruz islands (sea state 3, wind @17 knots) the buoys fell onto their sides. At that time it was found that up to 20lbs were needed. However, one Buoy (ch #14) continues to defy ballasting, with the current ballast being at 16lbs (note that this buoy has it's 6" diameter section almost 2" shorter than the other 2).

I had a box of 20 oz weights picked up before we departed for the AST sight and I worked on ballasting throughout the excursion. What I found was that if one increases the weight by ~2lbs from the ballast point the buoy sinks, reducing the weight by the same causes it to fall over and lie flat. These ballast points appear critical and must be calculated toward the heavier sea state.

4. Mast height

Based on observed wave movement along the support mast (the PVC section that provides the extension up to the antenna), it appears that an extension of this mast from 60" to possibly 72: would be good. This would give a greater buffer for wave travel.

5. Connector Vulnerability

First, the PVC sections used to protect the side-mounted connectors broke off easily. This of course could be fixed by a tighter joint between the protective tubes and the main body.

More important was the vulnerability of the connectors (and the protective tubes) during deployment and recovery. This is due to their protruding out the side of the main body of the buoy.

Recommendations

The following recommendations are made with a bias towards the most economical approach. This includes staying with the PVC pipe concept.

1) Bulkhead Redesign:

(a) A watertight fitting for the cable diameter should be employed on both sides of the bulkhead (e.g. Kepco mfg.).

(b) We may want to examine the merits of drilling holes around the circumference of the 'wet' section to facilitate rapid draining of that compartment. Such would also remove the requirement of opening the buoy (to drain it) after each deployment. One additional advantage of this would be a moderate damping effect on lateral movement. The disadvantage would be that we would have to be abolutely certain the bulhead will not leak.

(c) I believe that the removal of the battery's foam wrap -- replaced with a PVC carrier similar to that of the transmitter -- may also help. This will prevent moisture being retained against the battery and may make the battery (and other items above it) more easily accessible.

2) Connector Strength:

(a) Connectors and their backshells should be the stainless steel varieties.

3) Ballasting:

(a) The optimal ballast point needs to be found per unit length for a sea state of, say, 3.

(b) A means of quickly adding or subtracting ballast weight in the field would be great. This needs to be thought about.

4) Mast Height:

(a) Extension of the mast height in future designs should be considered. A target length of 72" (from 60" presently) should be considered. The drawback is that we will no longer fit within the Fed-X shipping lengths!

5) Connector Vulnerability:

(a) An alternative mounting location needs to be determined (preferably vertically). This will probably require a redesign of the buoy's PVC body itself.

.end of notes