

November 7-11 2011 Test Plan

Introduction

The tests planned for November 7-11, 2011 are the first deployments of this project that include the conversion of wave energy all the way through to electrical energy. The surface buoy, submerged plate elements, computer systems, and some elements of the power take-off device have all been tested and deployed before, new to this deployment are the hydraulic-electric power conversion elements and the load control electronics. The week long testing plan includes several individual deployments lasting between 4-24 hours depending on weather conditions.

Test Goals

Specific goals of this testing are:

- Deploy and test at sea the new power take-off electro-hydraulic system
- Collect performance data on the power-take off system in an at-sea deployment.
- Collect incident wave data to allow post-test numerical model validation and calibration.
- Evaluate effectiveness of tether guide solution.
- Log data about the sub-surface plate and water motions to inform AUV docking effort.

Activities/Schedule (subject to weather)

Monday November 7th

- Load all equipment (submerged plate, wave-rider, and support computers and radios) on Shana Rae dockside at MBARI.
- Put buoy and PTO assembly in the water
- Ensure all computers are running and reporting data as expected.

Tuesday, November 8th

- Ensure data is being collected and sufficient battery charge exists for planned tests (Buoy system and wave-rider buoy).
- Transit to location with water depth greater than 120 meters.
- Deploy submerged plate from Shana Rae A-frame
- Deploy wave-rider buoy and attach to submerged plate pick-up float.
- Stand by and monitor behavior for 3-4 hours.
- Recover system and return to MBARI
- Evaluate data and plan changes for subsequent deployments

Wednesday-Thursday, November 9-10

- Repeat tuesdays operation, or alternatively leave system out overnight if weather conditions warrant.

Friday, November 11th

- De-mobilize.

Specific Test Plans

The main effort planned involves running the system at various electrical loadings and recording the following system behaviors; buoy motions, plate motions, power take-off extension, power take-off tension, power take-off voltage output, power take-off current output, pneumatic spring pressures, pneumatic spring temperatures, and surrounding water temperatures.

Expected ranges for these values are summarized as follows.

Sea-State	Spring pressures (psi)		Spring temps (deg C)		Load Dump			PTO Extension
	Lower	Upper	Lower	Upper	Temp (deg C)	Voltage	Current	meters
0-2	140 -> 180	50 -> 80	0 -> 25	-10 -> 35	15 -> 40	200	5	.5 - 1.5
3	130 -> 210	45 -> 100	-10 -> 40	-15 -> 45	15 -> 50	400	7	.25 - 1.25
4	120 -> 250	40 -> 110	-15 -> 45	-20 -> 60	15 -> 60	450	9	0 - 2
5	120 -> 250	40 -> 110	-15 -> 45	-20 -> 60	15 -> 60	450	12	0 - 2
6	<i>Do not deploy or terminate test</i>							

A variety of electrical loadings will be investigated during the testing, the response of the system will be measured at each electrical loading and the results analyzed post test to determine optimum settings for the sea-state experienced and to validate the numerical model. The power take-off system is capable of operating in several modes, constant load resistance, constant current draw, and a programmable mode in which the current versus generator voltage behavior follows a relationship pre-determined from lab testing. The following modes will be investigated during the testing, within the limits described in the above table. Each mode will operate for at least 30 minutes to allow sufficient data to be collected for meaningful statistical analysis.

PTO Configuration	Mode	Resistance or Current SetPoint
1	Constant Resistance	50 Ohms
2	Constant Resistance	33 Ohms
3	Constant Resistance	25 Ohms
4	Constant Resistance	15 Ohms
5	Constant Current	4 Amps
6	Constant Current	6 Amps
7	Constant Current	8 Amps
8	Prescribed Voltage/Current Profile	-

Test Location

The testing is planned to take place nominally 5 nautical miles west of Moss Landing. A notice to mariners has been submitted to the coast guard describing the system and the possibility that it will be in that area un-attended.

Calm Weather Contingency Plan

In the case of very calm waves (as occurred Jan 25th, 2011) we will be set-up to perform a tow test from the Shana Rae to evaluate the power required to move the system through the water at various speeds.

Safety Considerations

- These tests will use the R/V Shana Rae, run by Jim Christman out of Santa Cruz, California. On board the vessel Jim will have final authority on all matters involving safety of personnel, ship, and equipment. Jim will conduct a safety briefing each day before leaving the dock that covers life-save equipment and procedures, man-overboard procedures, fire-fighting equipment and procedures, liferaft locations and operation, and deck operations procedures and requirements for work vests, steel toed boots, and hard-hats during overhead operations. In the absence of guidance from the ship captain, standard MBARI ship-board safety procedures which include *International Safety Management* regulations.
- All on-shore work will be performed in accordance with the regulations outlined in the *MBARI Safety Manual* maintained by the MBARI Safety Officer (Norm Steinberg)

- Heavy equipment operations will be performed in accordance with procedures specific to the equipment (Forklift, Crane, and Scissor-Lift), maintained by the MBARI Safety Officer. In all cases equipment operators will have had safety training for the equipment being used.
- Diving operations (if needed) will be performed by divers trained to the standards of the American Academy of Underwater Sciences (2003) in accordance with MBARI scientific diving procedures as established and maintained by the MBARI dive safety officer Kim Reisenbichler. A dive plan will be submitted to, and approved by, the dive safety officer prior to the test dates.
- Should assistance be required from the MBARI Division of Marine Operations during the testing, Steve Etchemendy is the point of contact on-shore.
- Francois Cazenave from the MBARI engineering team is trained and certified in First Aid and CPR procedures.
- Boarding the buoy at sea should not be necessary and is not recommended. If it becomes necessary, the stainless steel box with the power electronics and the yellow high-voltage cable should be avoided, these are the only two locations on the buoy where high-voltage is present.
- At no point should the stainless steel box containing the high-voltage electronics be opened at sea or at any time which the hydraulic ram is able to move.
- Relevant Contact Information:
 - o MBARI Safety Officer – Norm Steinberg (831) 775-1711
 - o MBARI Director of Marine Operations – Steve Etchmendy (831) 775-1902
 - o MBARI Dive Safety Officer – Kim Reisenbichler (831) 775-1720
 - o US Coast Guard – VHF Channel 16

Equipment Needed

- MBARI Grove crane November 7th and November 10/11.
- MBARI dock space.
- MBARI divers on standby.
- Wave-Rider buoy.