Underwater noise measurements of a 1/7th scale wave energy converter

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DOE MHK Environmental Webinar Series
December 14, 2011
Wave Energy Converter

Columbia Power Technologies – SeaRay

- 1/7\textsuperscript{th} scale prototype
- Heave and surge point absorber
- 5 kW permanent magnet generators (x2)
- Mechanical yaw
- 3 pt. mooring

http://www.columbiapwr.com/technology.asp
Site Information

Study performed on March 30, 2011 between 10:00 and 14:00 (PDT)

Site: West Point, Puget Sound, WA

• ~ 20 meters deep
Drifter - SWIFT

SWIFT – Surface Wave Instrument Float with Tracking (Thomson, in review)

- GPS for tracking (post-processing)
- Anemometer
- Garmin Astro for real time tracking
- GoPro Hero high definition video camera
- QStarz BT-Q1000eX accelerometer sampling at 5 Hz
- Loggerhead DSG for acoustic measurements
Loggerhead DSG

- Recorded 60 seconds every other minute

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>Sample Rate</td>
<td>80 kHz</td>
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<tr>
<td>Storage</td>
<td>32 GB (Flash)</td>
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<tr>
<td>Effective Sensitivity</td>
<td>-166 dB re 1V/μPa</td>
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<tr>
<td>Linear Response</td>
<td>20 Hz – 30 kHz</td>
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Ancillary Data from SeaRay

Wave and current
- Nortek Acoustic Wave and Current meter (AWAC)

Generator performance
- Shaft speed (fore and aft)
- Generator torque (fore and aft)

Wave Measurements from SWIFT
Generator Speed and Torque

Aft generator  Fore generator
Acoustic Signature
Acoustic Signature

• ~10 identifiable harmonics that oscillate with dominate wave period
• Additional broadband slaps that occur twice per wave period
Masking by Vessel Noise

- Tug passing (< 1km) hydrophone.
- Hydrophone ~ 500 m from SeaRay
Acoustic Spectra

- Acoustic spectra produced from 60 second averages
- Averaged spectra do not adequately describe the time-frequency dependence of noise produced by the SeaRay
The four drift surveys plotted with received SPLs (60 Hz to 30 kHz).

High levels of ambient noise due to vessel traffic are typical in the region (Bassett et al., in prep.).

Received levels are a combination of noise from the SeaRay and vessel traffic.
Source Level Estimation

- Vessel traffic results in regular masking of acoustic signature
- High ambient noise levels made quantifying the source level difficult
Conclusion

• Averaged spectra of acoustic noise provide an incomplete description of noise produced by the device. The inherent periodicity of wave energy requires a detailed time-frequency analysis along side operating parameters.

• Noise from the device is neither continuous nor impulsive.

• The loudest recorded SPLs are attributed to vessel traffic although numerous recordings were taken less than 100 meters from the SeaRay.

• Pilot-scale projects are not likely to significantly alter existing underwater noise levels.

References

Thank You

This material this work is based on is supported by Columbia Power Technologies and the U.S. DOE