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Breakout Session III Notes

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These notes are intended as a supplement to the presentations. The following discussion points were captured by workshop rapporteurs during breakout groups:

- Pressure sensors are, in general, only useful in shallow water because of surface wave attenuation with depth, especially if directional properties of the waves are needed, and an array must be deployed on the bottom. In intermediate and deep water, it is much easier and less expensive to deploy wave buoys instead of pressure gauges. Data telemetry is a much greater problem for an array of pressure gauges, especially if the data are cabled to a control station on shore. An exception to this is the deployment of pressure gauges in deep water tsunami detection, since tsunamis are shallow water waves even in the deepest part of the ocean. A surface float with antenna is usually required for data transmission. Maintenance of a surface wave buoy is much simpler than for an array of pressure gauges on the bottom; it is much less costly.
- Buoy programs are designed for both operational and meteorological/climatological purposes. Additional buoys would support operational wave modeling and navigation programs.
- The key components of wave buoys include the wave measurements, frequently using accelerometers and tilt sensors, wind velocity sensors, and other oceanographic and meteorological sensors; the mooring; the power source which could be on the mooring or cabled from shore or from a remote source; the data control system, which might be transmission and reception from shore stations via satellite, line of sight radio, or by internal recording. There must be a maintenance capability, especially for operational buoys. If the buoy operation is critical, there should be a standby maintenance capability.
- The use of models is of paramount importance in determining optimal locations for wave buoys, especially those used for to provide data for the model, be it testing, validation, assimilation, or estimation of error bars in nowcasts and forecasts. Other considerations are whether data is required in navigational channels, necessitating either an alternative location or a different type of wave sensor. Bottom type may be a consideration if strict station keeping is required.
- The proper buoys should be installed in particular seaways based on factors such as buoy diameter (e.g., hull speed), navigation safety (e.g., visibility), and survivability (deployment depths).
- In general small, lightweight buoys are best in shallow water, whereas large, heavy buoys with substantial moorings are appropriate for deep water.
- Smaller hulls like the MiniTriaxys^{TM} Buoy are light enough for manual deployment from small work boats.
- Buoys are expensive to purchase, mooring design software is expensive, and large ships are usually required for deployment and recovery operations, especially in deep water.
- The minimum set of parameters to be reported would include wave height, direction, frequency, wind speed and direction. In the future, wave steepness should be added because of its importance to boat and ship operation.
- Research buoys are experimental in nature, and may support more sophisticated instrumentation than operational buoys. They may be measuring non-standard parameters, such as small scale turbulence, currents from an ADCP, ambient noise, and acoustic signals.
- Research buoys tend to be turned into operational buoys. Thus, they tend to be sited for modeling or marine forecasting purposes rather than for any practical coastal engineering purposes.

- Operational buoys require more ruggedized components, a very reliable data transmission and control system, backup systems, a fast response maintenance capability. Data streams must be in a standard format. All sensors must be calibrated before and after deployment, and include field verification of operation.
- Several smaller wave buoys are commercially available and may be integrated with anemometers and current meters in order to measure wind speed and direction as well as current speed and direction. Fully integrated sensors are especially important to harbor pilots that need to know winds and waves to effectively turn and dock large vessels. Knowing 10m winds, tidal currents, and offshore waves doesn't necessarily help the harbor pilot turn a container ship at a channel junction. To plan their maneuver, they reportedly want winds impacting the ship, actual currents with depth, and waves in the channel junction.
- Deployed buoys tend to have different uses, e.g., some are used to support port operations while others support weather forecasting; multi-purpose buoys might be more efficient and cheaper
- Data telemetry systems may vary according to distance from land. The majority of operational users benefit from systems that provide access through cellular phones or satellites. Many buoys provide real time data via the internet through Google Maps or online sites. AXYS Technologies, Inc. demonstrated software to view data transmitted from buoys deployed in the Gulf of Mexico.
- There is an increasing use of satellites with WIFI, as the number of dropouts is decreasing, and thus total reliability is increasing. In general satellite transmission is usually employed, especially for drifting buoys. Direct cable connection, and direct line-of-site RF communication are being used less frequently. Data are increasingly transmitted and stored digitally in real time, especially data from operational buoys. Data are increasingly quality controlled on site, at least in a preliminary way, for rapid dissemination to users.
- Automated Identification System (AIS) provides a transmission means to highlight wave parameters for certain vessels. Networks such as SmartBays in Canada are providing buoy information to fishermen and large vessels using AIS. AIS receivers were provided to local fishermen.
- One benefit for AIS is that it alerts ships to the presence of a buoy or other surface expression of equipment and moorings. AIS is very useful in conditions of fog or reduced visibility. One disadvantage is the rather large power requirement. The range needs to be improved.

Session Summary ─ Moored buoys, deployed by various national organizations provide information to make automated weather and oceanographic observations. For example, NDBC, part of NOAA's National Weather Service, operates moored buoys in coastal and offshore waters, worldwide. Wave buoys are equipped with sensors such as accelerometers and inclinometers that measure the heave acceleration or the vertical displacement provided to the buoy by waves passing during a specified time period. Onboard computers are used to process these measurements and generate sea and swell data that are then transmitted to shore stations. These data include significant wave height, average wave period, and dominant wave period during specific sampling intervals. Selected buoys also measure directional wave data, such as mean wave direction. Small directional wave buoys could be deployed by work boats to support WEC technologies.

These rapporteur notes do not necessarily reflect the view of all participants and speakers of the respective breakout groups.