APPENDIX C
Information on Wind and Current Measurement Devices

Foreshore Licence application, Test site sensors

A wind measurement buoy, ~ 2.8 meters in diameter will be located approximately 6kms off Clogher Head, Co. Louth. (Comparable to wind LiDAR buoy shown in Photo 1 below). The co-ordinates for the position are:

Latitude	Longitude
53° 49' 23.7327"	-6° 2' 5.7063"

See Drawing Number QS-000247-02-D460-002 in Appendix B. This buoy will monitor wind speed and direction. Data will be transferred via UHF/VHF radio connection. This will be moored to the sea bed with single point mooring, consisting of a combination of clump weight, chain and rope (Photo 2 below).

Given the low profile of this buoy it is intended to locate nearby a 3 metre high marker buoy on a single point mooring. (Photo 3 and 4, Drawing 1 below). The co-ordinates for this position are:

Latitude	Longitude
53° 49' 23.7327"	-6° 2' 5.7063"

See Drawing Number QS-000247-02-D460-002 in Appendix B.

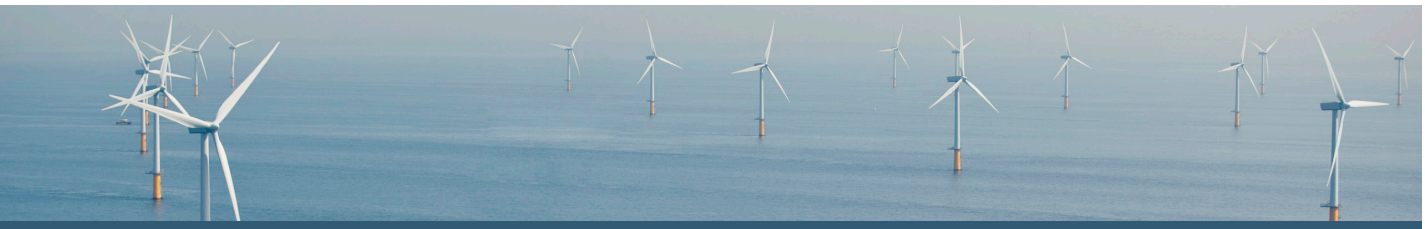
A separate Acoustic Doppler Current Profiler (ADCP) will be located in approximately 40 metres water depth beside the wind LiDAR buoy. See data sheet below. It will be fixed to the seabed. The co-ordinates for the position are:

Latitude	Longitude
53° 49' 23.7013"	-6° 2' 5.7625"

See Drawing Number QS-000247-02-D460-002 in Appendix B.

These deployment locations will be decided based on site conditions.

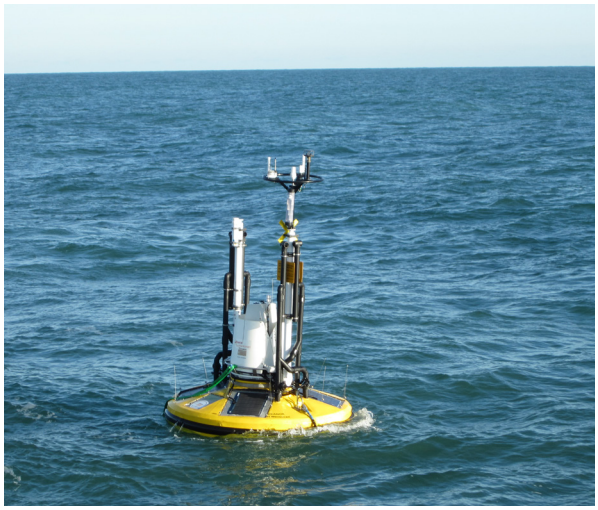
SEAWATCH Wind LiDAR Buoy



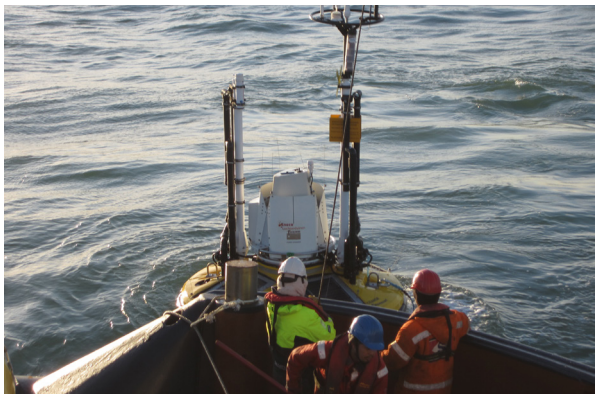
The Wind LiDAR buoy is a cost-effective and reliable solution for measuring wind profiles, waves and current profiles.

Wind Profile, Wave and Current Measurements

The SEAWATCH Wind LiDAR Buoy represents the next generation of multi-purpose buoys tailored for the renewable energy industry. The buoy accurately measures the speed and direction of wind across the diameter of wind turbine rotors, whilst sensors provide oceanographic parameters such as ocean waves and current profiles.



Accurate measurement of wind profile using SEAWATCH Wind LiDAR Buoy



Deployment of the SEAWATCH Wind LiDAR buoy

Features

- Collects data for wind resource assessments and/or for engineering design criteria
- Buoy mast wind profile measurements at 2.5 m, 4 m and 5 m
- Configurable LiDAR wind profile measurements at 10 levels from 12.5 m up to 300 m
- Configurable ocean wave measurements and sea current profiles
- Full on-board processing of all measured data
- Two-way communication link for data transfer and control
- Real-time data transfer and presentation
- Flexible configuration of sensors and data collection
- Modular hull for easy transport and local assembly
- Safe and easy handling and deployment
- Robust and reliable in all weather and temperature extremes
- Position tracker for increased safety
- The Wavescan buoy platform has a successful track record worldwide since 1985

SEAWATCH Wind LiDAR Buoy

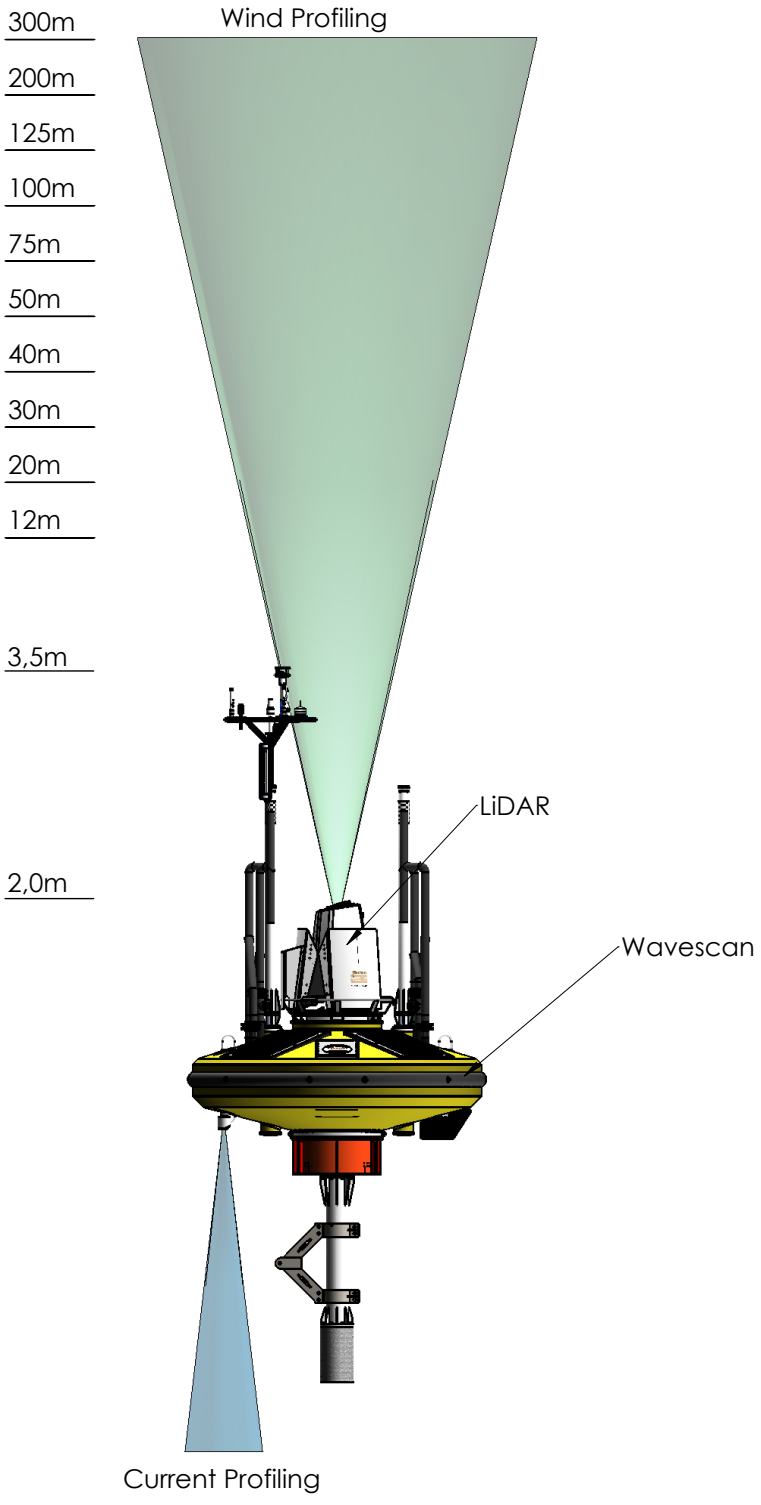
A Unique Cost-Efficient Solution

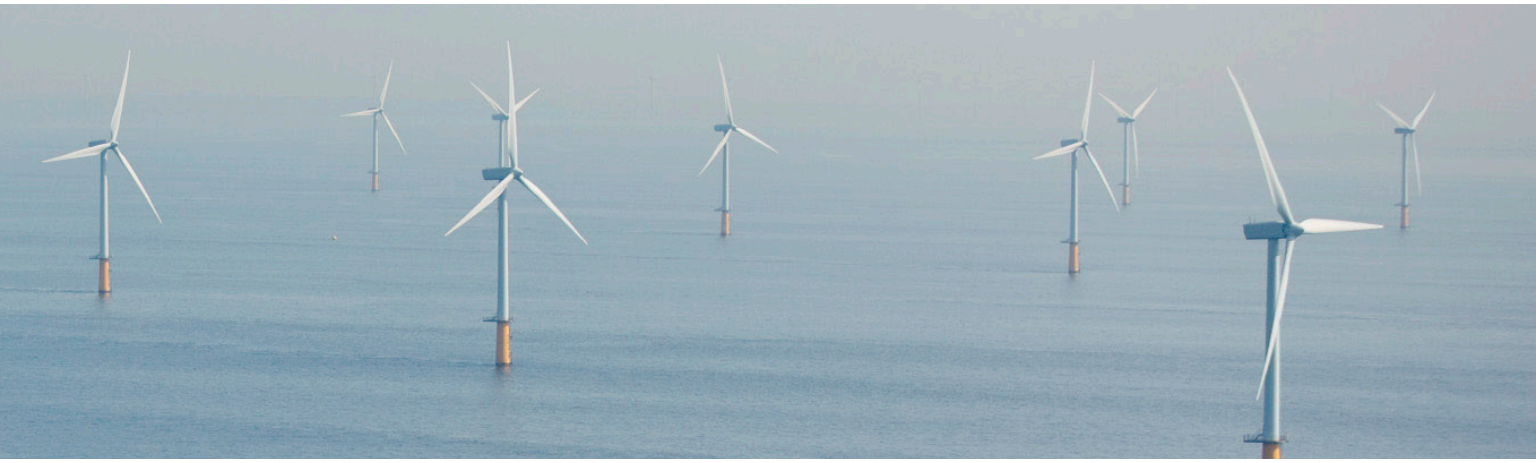
The SEAWATCH Wind LiDAR Buoy is a cost-efficient way to measure wind data at heights of conventional offshore wind turbines for wind resource assessments and engineering design criteria.

It is the first single compact buoy capable of measuring:

- Wind profiles across the blade span of the largest offshore wind turbines
- Ocean wave height and direction
- Ocean current profiles from the surface to the seabed
- Meteorological parameters
- Other oceanographic parameters as required

The smaller SEAWATCH Wind LiDAR Buoy is a proven ocean monitoring solution and is easily deployed and relocated (by towing or lifting onboard vessels) enabling data gathering across multiple locations. This is a more cost-effective alternative to existing wind profiling solutions such as fixed met masts or larger floating buoys.





Proven Platform and Technology

The SEAWATCH Wind LiDAR Buoy is built on the SEAWATCH Wavescan platform which has been deployed for a large number of satisfied clients in the most hostile oceanographic environments since 1985.

Its well proven SEAWATCH technology, includes the GENI™ controller, an intelligent power management unit and the ZephIR LiDAR.

ZephIR LiDAR

The ZephIR LiDAR was selected after years of testing and comparison of various concepts. The ZephIR 300 provides highly accurate measurements across the entire rotor diameter and beyond and can be configured to measure up to 10 different heights from 12.5 to 300 metres above the sea surface.

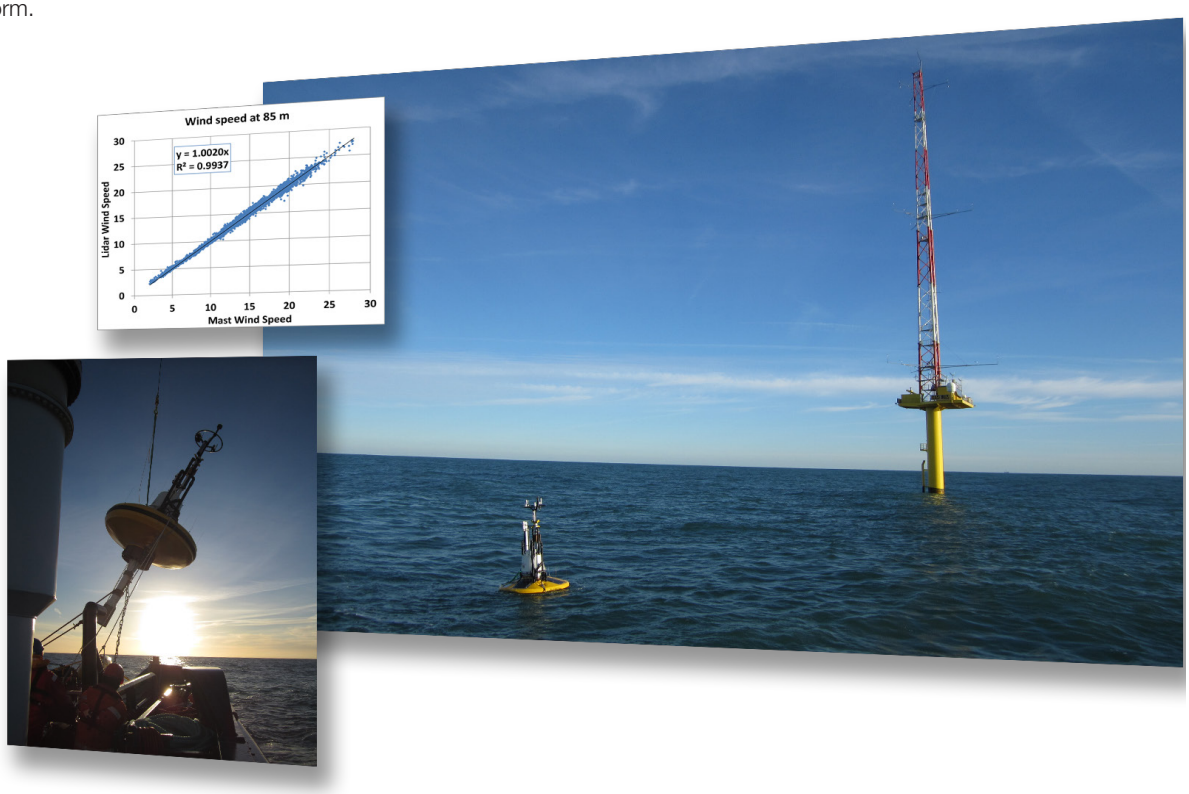
Low power consumption of the ZephIR 300 and intelligent power management are key to efficient operation when using a small low-cost platform.

Successful Collaboration

The SEAWATCH Wind LiDAR Buoy is the result of a successful joint industry R&D project, utilising offshore and wind technology expertise from Norwegian universities, research institutes and the energy company Statoil.

Offshore Testing / Validation

The SEAWATACH Wind LiDAR Buoy has been tested and validated at the Ijmuiden met mast in Dutch waters. The wind profile data measured by the SEAWATCH Wind LiDAR Buoy were compared with data from anemometers at 3 heights mounted on the met mast and a ZephIR LiDAR, measuring the wind profile above 90 m. An inter-comparison showed almost no bias and a squared correlation of more than 0.99. The validation test was performed in close cooperation with DNVGL



SEAWATCH Wind LiDAR Buoy

Technical Specifications

General

Material	Polyethylene, Aluminium, Stainless Steel
Flash light	LED based, 3-4 nautical miles range
	IALA recommended characteristic
Positioning	GPS (Inmarsat-C, Iridium, Standalone Receiver)

Buoy Dimensions

Weight (approx)[1]	1700 kg
Overall height	6.1 m
Diameter	2.8 m
Net buoyancy	2500 kg
Mast height (above water)	3.5 m

Power Supply [2, 3]

Solar panels (optional)	180 W
Lead-acid battery bank (optional)	Up to 248 Ah
Lithium battery bank	Up to 9792 Ah
Fuel cells	Up to 25926 Ah

Processing

4 GB data storage

Real-time operating system (Linux)

Large number of serial and analogue inputs

Flexible data acquisition software

Data Communication

Short range	GSM / GPRS
	UHF / VHF radio (two-way)
Long range	Inmarsat-C and Iridium (two-way)
	ARGOS (one-way)

1 - With fuel cells and methanol cartridges

2 - All values are nominal ratings

3 - The buoy consumes roughly 150 Ah per day. Exact power consumptions will be made for each case

Wind Profiler - ZephIR 300 CW LiDAR

Measurement height (configurable)	10 m – 300 m
Probe length at 10 m	0.07 m
Probe length at 100 m	7.7 m
Number of simultaneous heights measured	Up to 10
Sampling rate	50Hz
Average period (configurable)	1 second upwards
Scanning cone angle	30°
Wind speed accuracy	< 0.5%
Wind speed range	< 1 m/s to 70 m/s
Wind direction accuracy	< 0.5°

Various additional sensors are available on request, including but not limited to:

Oceanographic Sensors

Wave height and direction

Surface current velocity and direction

Water temperature

Conductivity / Salinity

Current profile

CTD profile

Meteorological Sensors

Wind speed/direction

Air pressure

Air temperature

Humidity

Precipitation

Solar radiation

Water Quality Sensors

Dissolved oxygen

Light attenuation

Chlorophyll-a

Hydrocarbon

Turbidity

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Photo 1 - Wind LiDAR Buoy

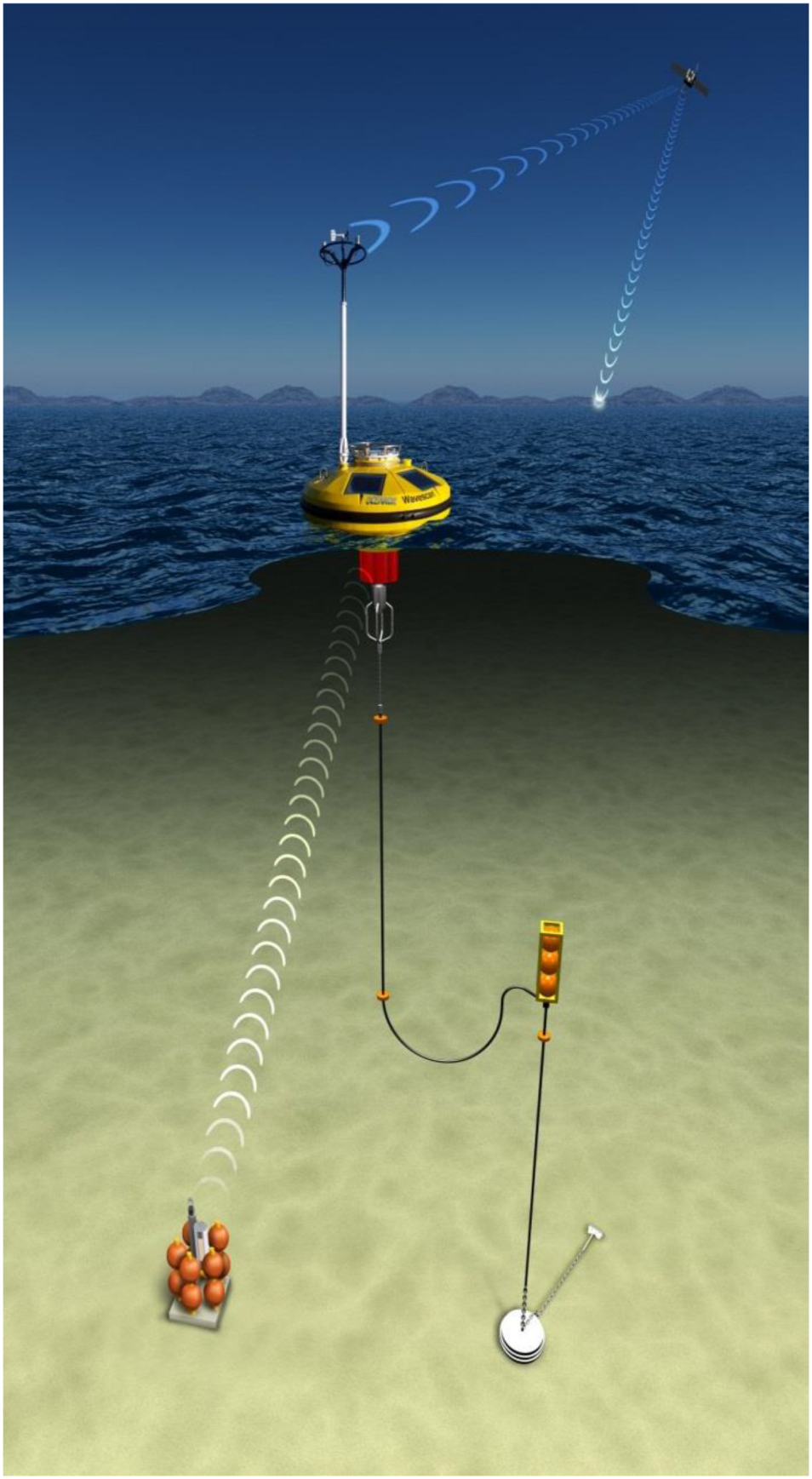


Photo 2 - Wind LiDAR Buoy Mooring Arrangement

Photo 3: 3m diameter Marker Buoy at sea

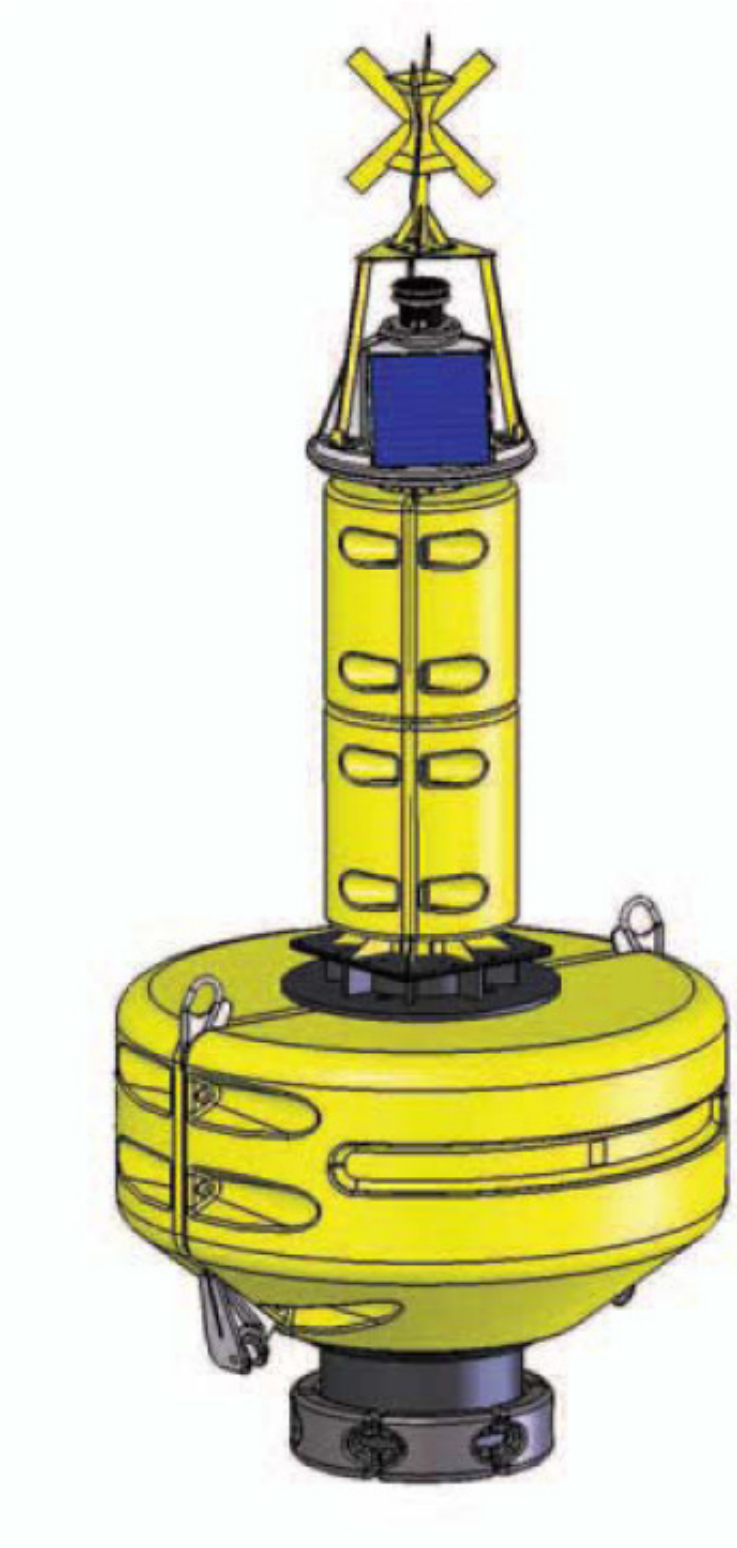
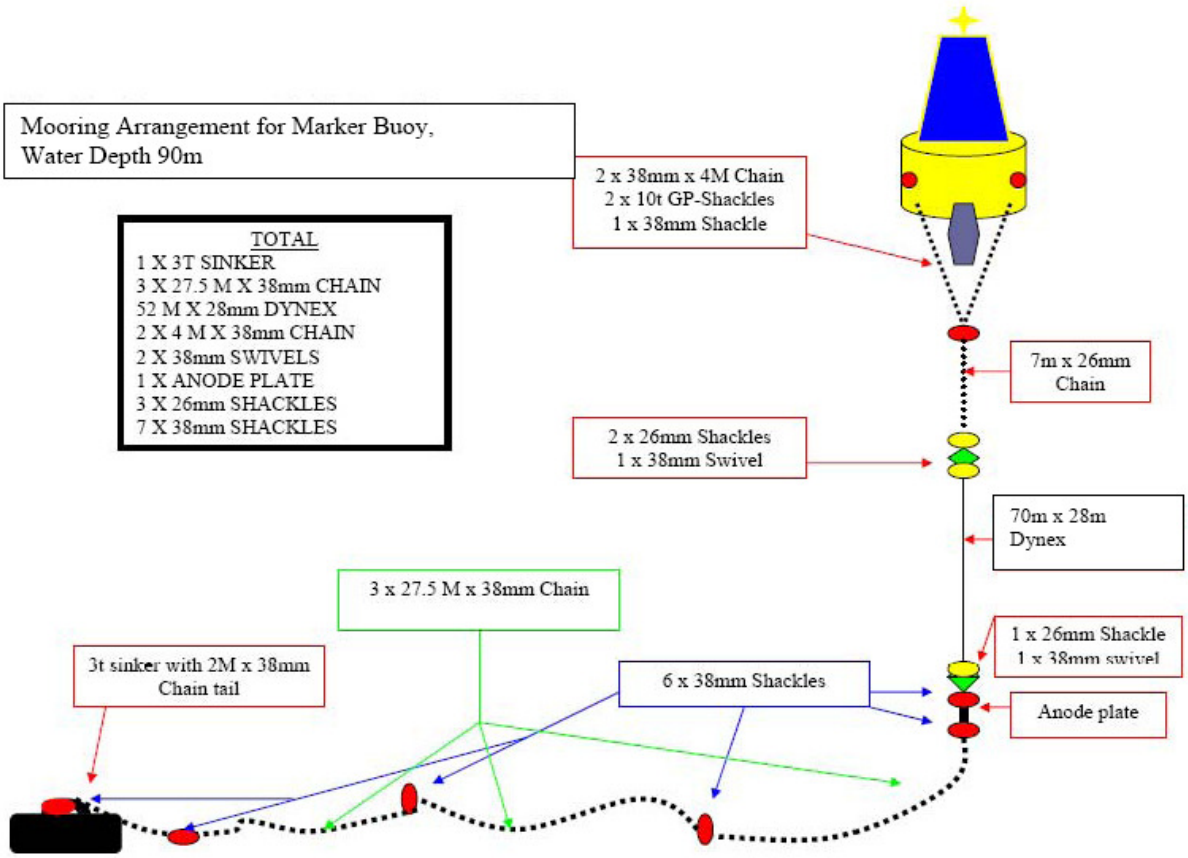


Photo 4: Marker Buoy (Isolated Danger Mark), 3m diameter, 5.5m above water, 6.6m overall height



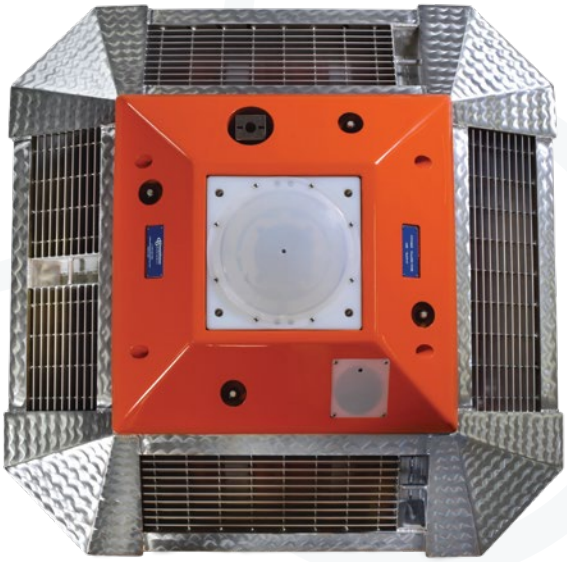
Drawing 1: Sample Mooring Arrangement for Isolated Danger Marker Buoy

Photo 5: CPOD Arrangement

Trawl-Resistant Bottom Mounts

These rugged deployment products are designed to protect instrumentation in areas where trawling is a concern. The AL-200 and AL-500 Trawl-Resistant Bottom Mounts (TRBMs) consist of a buoyant recovery pod designed to permit retrieval of all mounted instruments. The recovery pod is ejected from the base by a user-supplied acoustic release and trails a Spectra recovery line that is attached to the base. The aluminum base can then be winched aboard. Disposable concrete bases can also be provided depending on bottom conditions.

Conditional upon the specific requirements, acoustic recoverable systems are offered for deployment depths of up to 1000 meters. All models feature a special grade of high impact DeepTec® syntactic foam and 5000 series aluminum construction. Adjustable amounts of lead ballast in the base allow the in-water weight of the TRBM to be tailored to specific bottom conditions.



AL-200

The AL-200 is designed for use with smaller, high frequency ADCP/ADP's. In the proper configuration and ocean conditions it can be free-fall deployed or lowered to the bottom. The double axis gimbal keeps the doppler oriented to vertical. Ideal for depths to 200 meters.

AL-500

The AL-500 is a larger version of the AL-200 designed to accommodate larger, low frequency ADCP/ADPs. A recoverable aluminum base can be used for deployment to 500 meters. Disposable concrete bases are available for deployments to 1000 meters.

DeepWater BUOYANCY

Rising to your undersea challenges