ToughBoy 1.9 m

User manual

Version 1.0

Contents

1 Introduction

For harbour monitoring, subsea engineering pre-surveys, wave energy studies – and any type of wave and current measurement surveys in between, the ToughBoy 1.9m is the optimum choice. The ToughBoy 1.9m is a sophisticated offshore buoy for use in oceanographic operations in conjunction with a multitude of other equipment and software.

The ToughBoy 1.9m is a wave buoy made from stainless steel and plastic, in an all-round weather and corrosion resistant construction. Its integrated counterweight construction stabilizes the buoy and movement in the waves. Depending on the task, both above and below the water level, there is room for carrying extra sensor equipment.

Figure 1 – ToughBoy 1.9m

The ToughBoy 1.9m is fixed to its location by a chain mooring connected to a clump weight. By design, the mooring minimises its influences of the motion of the buoy, which gives the optimum chance of clean data. While following the waves, an accelerometer tracks the movement of the buoy, and an optional ADCP can track the water currents underneath. This combination of a stable platform and multiple sensors ensures accurate and precise data collection.

While in operation, the ToughBoy 1.9m communicates via GSM, UHF or Iridium with the ToughBoy Onshore server for constant monitoring and control. The uplink also enables transmission of data from a variety of sensors to the ToughBoy Onshore, such as a Met weather station.

2 Buoy overview

2.1 Main parts

Figure 2 shows the main parts of the ToughBoy 1.9m.

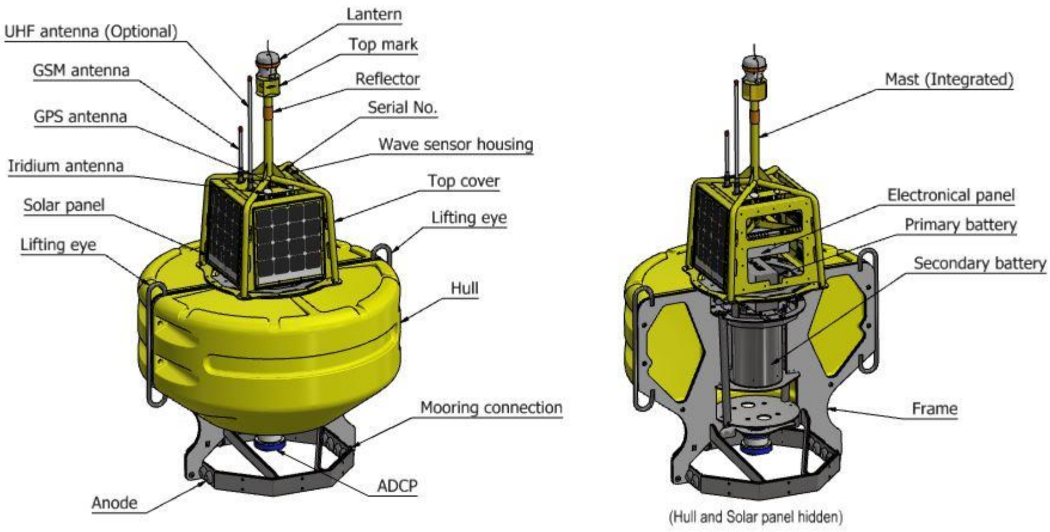

Figure 2 – Main parts

A short introduction to various parts is shown in Table 1, on the next page.

Part	Specification
Hull	PEHD shell filled with foam, collision secured
Frame	Supports the hull, and has built in lifting loops, where the lifting gear can be attached
Top mark	A sea mark with build in radar reflector
Reflector	Yellow luminous reflector near top mark
Mast (Integrated)	Accommodates lantern, top mark and a (optional) met station
Top cover	Accommodates solar panels, electrical panel, mast, GPS & Iridium antenna, GSM antenna and cables etc (& optional UHF antenna)
Serial No.	Each buoy is tagged with a plate designating serial number and model name.
Electrical panel	All electronics, excluding sensors, are encapsulated within this box, and protected against ingress of water
Wave sensor housing	The wave sensor is encapsulated in its own box, mounted in the top of the buoy
Primary battery	Rechargeable battery 100Ah 12V, AGM type, weight app. 40 kg
Secondary battery	Non-rechargeable battery 2000Ah 12V, alkaline type, weight app. 140 kg
Anodes	Protects the bottom frame against corrosion, zinc anodes
ADCP	Workhorse Monitor 600 kHz, optional 300 kHz and 1200 kHz
Met station, optional (Not shown in figure)	Vaisala WXT530 series, see additional information by clicking the following link: https://www.vaisala.com/en/products/instruments-sensors-and-other-measurement-devices/weather-stations-and-sensors/wxt530
Lantern	Carmanah Technologies M650H – for more info, see Section 2.3 'Marking' on page 8

Table 1 – Main parts

2.2 Dimensions

Figure 3 shows the size of the ToughBoy 1.9m.

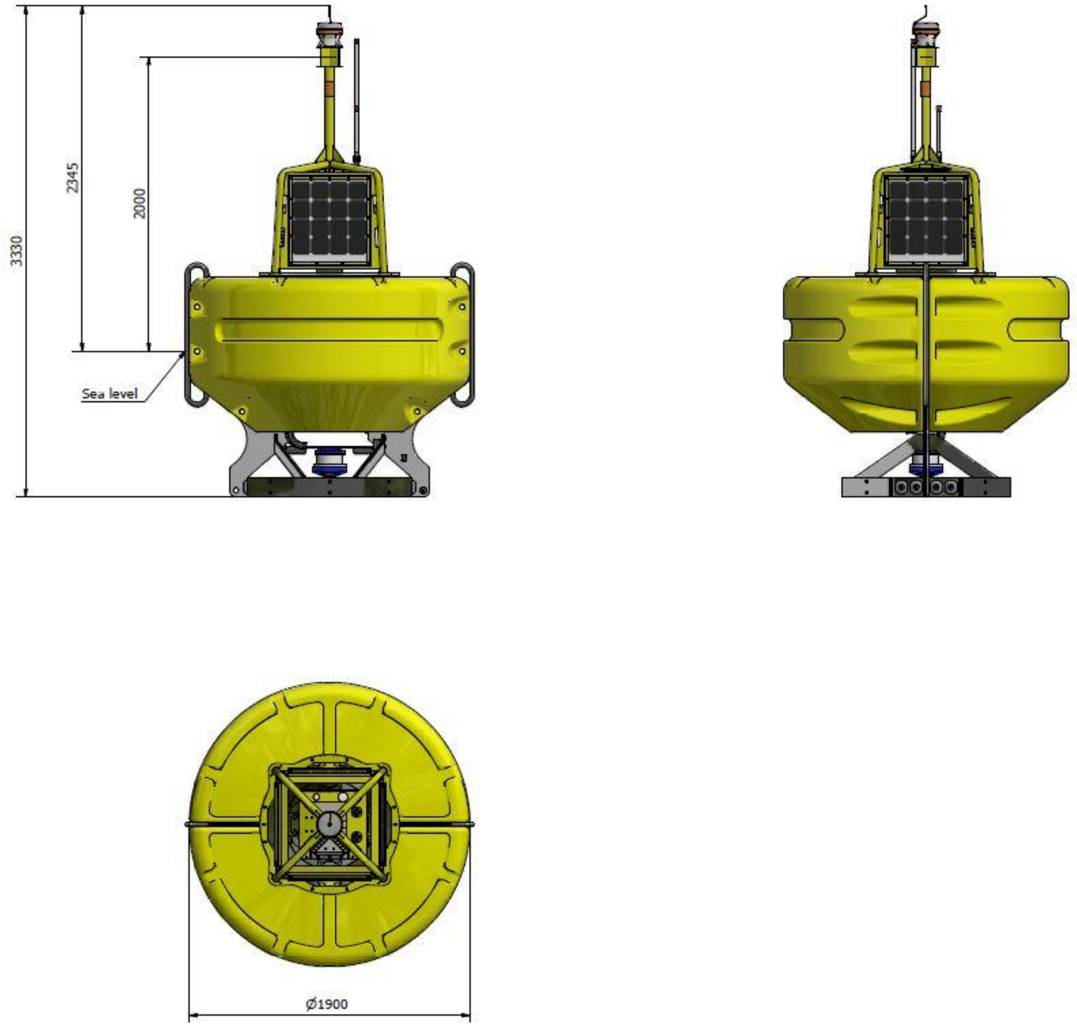

Figure 3 – Buoy dimensions

Height	3.33 m, with optional met station 3.7 m
Diameter	1.90 m
Net weight (air)	1070 kg, with optional met station 1080 kg
Load capacity (maximal)	480 kg extra equipment

Table 2 – Dimensions

2.3 Marking

The buoy is marked for clear visibility. The different types of marking at the buoy are listed below in Table 3.

Part	Specification
Lantern	• Carmanah Technologies M650H • Yellow light, default flash pattern FI(5)Y.20s • Custom flash pattern (IALA-compliant) • Range 3 nautical miles • Placed 2 metres above sea level
Top mark	• Incorporated radar reflector feature • Placed approx. 2 metres above sea level
Reflector	• Yellow luminous reflector near top mark

Table 3 – Marking specification

The different types of marking are illustrated in Figure 4.

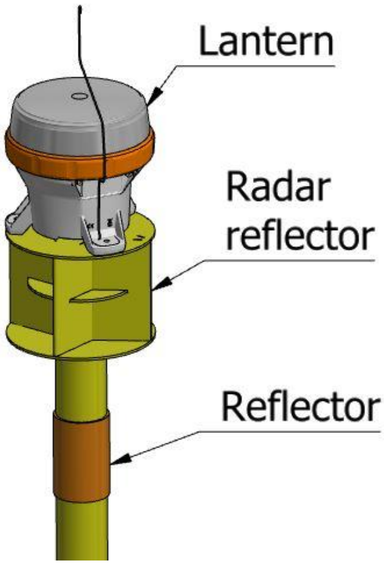

Figure 4 – Mast

The M650H solar marine lantern is produced by Carmanah Technologies. To get detailed information on the lantern, please visit Carmanah's web page.

3 Getting started

3.1 Unpacking and inspection

Shipment of the buoy is decided upon an individual basis, depending on configuration and whether it is shipped by road or air. Variation might occur.

The total height of the buoy dictates that it is not possible to ship it in a standing position without exceeding the legal height limit for road transport.

3.1.1 Air transport boxes

For shipment, the buoy is disassembled and separated into two boxes. Box sizes may vary! The following sizes are examples of a previous shipment.

Table 4 shows the outer dimensions of the transport box containing the bottom half of the buoy. This includes the frame, hull and optionally mounted sensors. Gross weight of this transport box for air cargo is approximately 1400 kilograms.

Figure 5 shows an example of the air transport box A, containing the bottom half of the buoy.

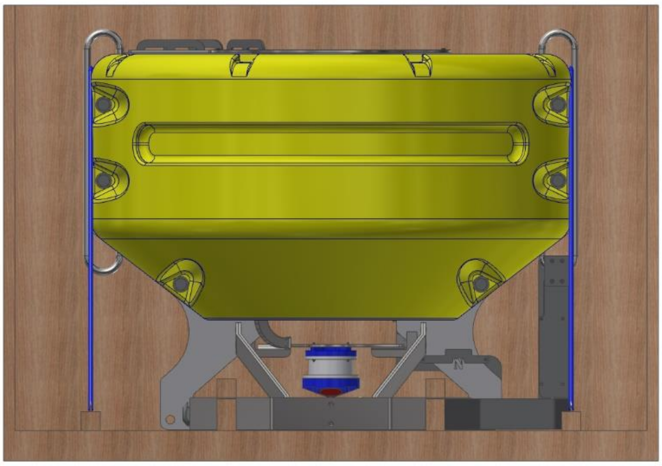

Figure 5 – Air transport box A

Length	2.55 m
Width	2.40 m
Height	1.80 m

Table 4 – Dimensions of transport box A

Table 5 shows the outer dimensions of the transport box containing the top cover and accessories for the buoy. The Gross weight of this transport box for air cargo is approximately 600 kilograms.

Figure 6 shows an example of the air transport box B, containing the bottom half of the buoy.

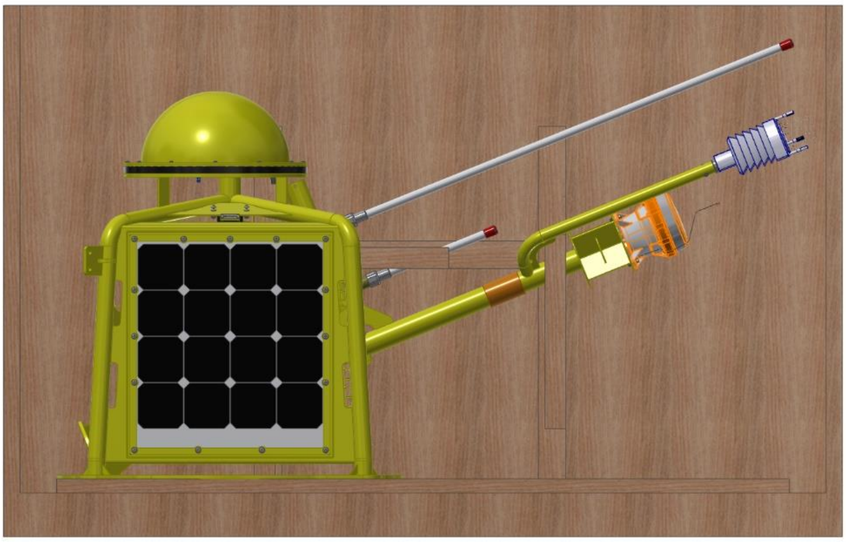

Figure 6 – Air transport box B

Length	1.20 m
Width	1.40 m
Height	1.45 m

Table 5 – Dimensions of transport box B

Before opening the transport boxes, inspect if anything appears damaged during transport. When the parts are unpacked from the transport box, you need to inspect the parts listed in Table 6. See Figure 7 for an illustration of these parts. When opening the boxes, only remove the bolts marked with red markings.

Part	Inspection
Buoy	• Check the hull for any cracks • Make sure the primary- and the secondary battery are tightened • Make sure the ADCP is mounted and intact
Top cover	• Make sure that the solar panels are intact • Make sure the lantern is intact • Make sure the yellow reflector is intact • Make sure the GSM antenna is intact and tightened • Make sure the bolts securing the electrical panel are tightened
Primary- and secondary battery	• Check that M8 bolts are tightened with a torque of 10 [Nm]
Met station, optional	• Make sure the unit is intact

Table 6 – Inspection

When removing the parts from the transport boxes (Figure 5 & Figure 6), make sure all straps, screws and clamps are removed before lifting the units out.

EIVA recommends that you use a safety helmet and safety shoes. **Important**: Never stand underneath the buoy or other components when lifting.

Figure 7 shows the minimum strap length for lifting the buoy with a crane (two straps of minimum 2.5 metres length). Use the built-in lifting eyes for connection of the lifting gear.

Before lifting, check that all bolt connections are tightened with the correct torque, see Table 7 below.

Verify that all finger screws are tightened on the primary battery.

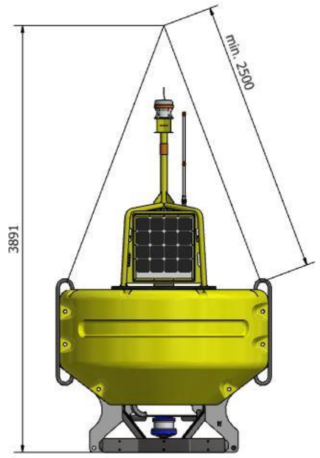

Figure 7 – Lifting the buoy

Dim.	Torque [Nm], stainless steel
M3	1.2
M4	2.7
M5	5.7
M6	7.0
M8	10
M10	30
M30	180

Table 7 – Torque, stainless steel

3.2 Assembly instructions

For easier transportation, the top of the buoy is detachable from the bottom frame. When the buoy arrives at destination, the two halves must be recombined.

The steps to be performed for buoy assembly are:

1. Inspection of components
2. Mounting of buoy top cover & plastic spacers
3. Connect cables
4. Verify connections and function

3.2.1 Inspection of components

All parts should be inspected when they are unpacked. Makes sure no parts are damaged or defective. See Table 6 – Inspection.

3.2.2 Mounting of buoy top & plastic spacers

When mounting the top cover on the frame, it is important that both locating pins are present, and the four quarter circles are placed on top of the frame.

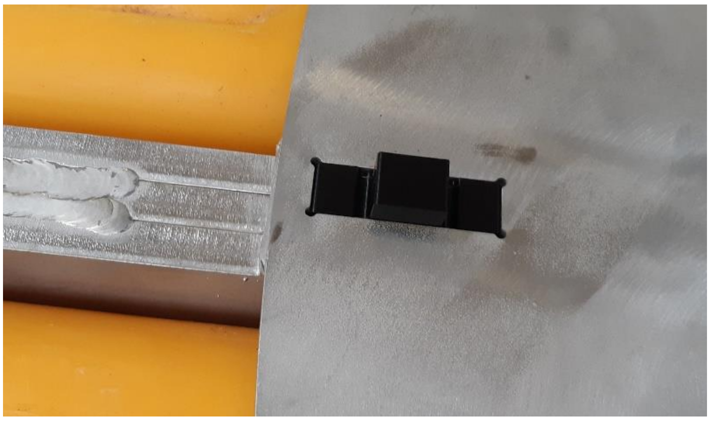

Figure 8 – Locating pin (without four quarter circles)

Figure 9 – Four quarter circles – Guiding pin

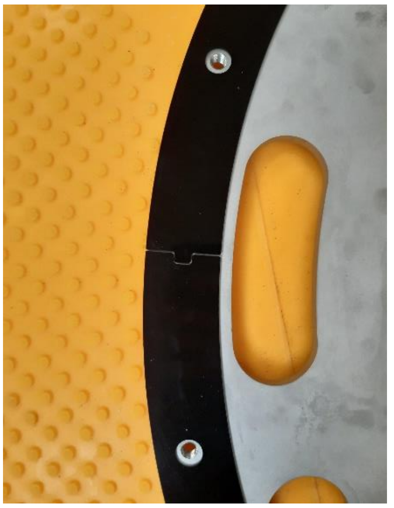

Figure 10 – Four quarter circles – Tapped together

Weighing in at ~140 kg, the top cover should not be lifted by hand, only by hoist or crane. Use appropriate safety gear.

The lifting gear can pass though the openings in the sides, see Figure 11. When positioning the lifting gear, make sure not to squeeze/pinch any cables within the top cover, see Figure 12.

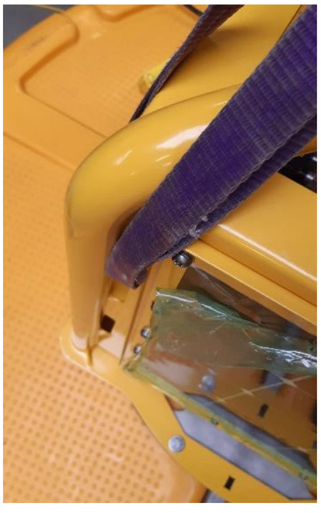

Figure 11 – Placement of lifting gear

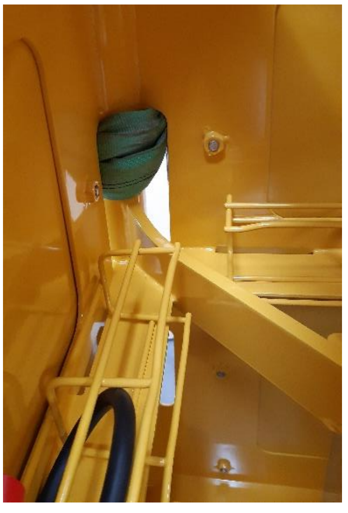

Figure 12 – Placement (from inside)

Using appropriate gear, the top can easily be handled and positioned.

Note: Use straps long enough that they do not interfere with the mast/top of the unit (Figure 13 shows a top cover with side mounted mast).

Figure 13 – Lifting straps

Figure 14 – Alternate position for lifting gear

Note that it is possible to lift the top cover by wrapping the lifting gear like on Figure 14. If this position is chosen, still make sure not to squeeze/pinch any cables within the top cover.

On the buoy, rotate the top cover such that the connectors on the electrical panel are facing towards you when the N (north) marking on the buoy frame is to the right, see Figure 15.

The two plastic locating pins fit within the two slots on the top cover, see Figure 16.

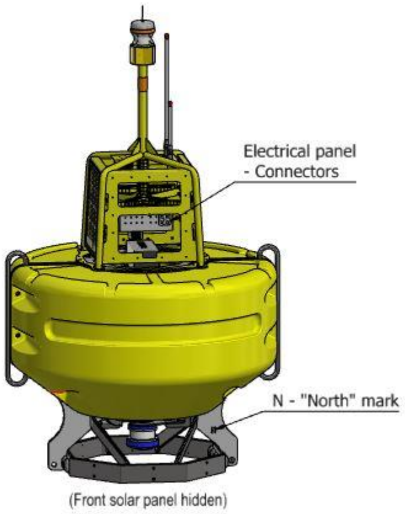

Figure 15 – Top cover rotation

Figure 16 – Top cover locating pin

Position all 12x m10x25 *hex* bolts, so they hold the buoy top in place. Use grease on the thread. Ensure none of the four quarter circles are overlapping between the buoy top and the frame.

With all bolts positioned, tighten them according to Table 7 on page 11.

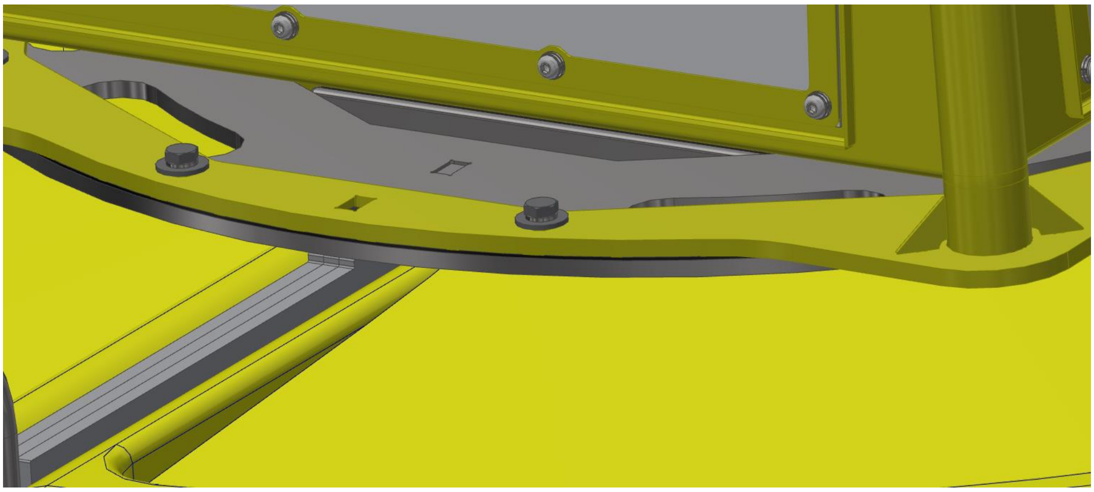

Figure 17 – Buoy top bolted in place

3.2.3 Mounting of cables

When connecting the cables for the batteries, ADCP and optional sensors, the front solar panel must be removed. Follow Section 8.1 ‘Remove solar panel’ on page 43.

Mount cables coming from the lower half of the buoy to the appropriate ports, and check that no other connectors have been switched around.

Part	Port	Connector type
Primary battery	• PRI BAT	4-Pin SubConn
Secondary battery	• SEC BAT	3-Pin SubConn
ADCP	• SER 1	6-Pin SubConn
Met station	• SER 2	6-Pin SubConn
Wave sensor	• SER 3	6-Pin SubConn
(Optional sensor)	• SER 4	6-Pin SubConn

Table 8 – Ports

Use zip ties to secure the cables within the top cover.

Figure 18 – Battery connectors

Figure 19 – Batteries connected

After mounting the cables to the electronic box, verify that all connections look good, that all connections are tightened correctly and that there is no damage on the cables or connectors.

Note: The buoy will not turn on unless the batteries are connected.

Note: EIVA recommends to always disconnect batteries for longer transportation and storage.

3.2.4 Verify function

The buoy is now ready for powering on. This is done by removing the on/off plug and replacing it with a dummy plug.

Figure 20 – Remove on/off plug for powering on the bouy

Figure 21 – Insert dummy plug in on/off connector on controller

The buoy is now powered on, and a notification is sent to ToughBoy Onshore within a few minutes.

Removal and exchange of on/off plug and dummy connector is better shown in the following two figures. It is shown through the front, with the solar panel removed for better visibility, instead of from above, which is necessary when everything is connected.

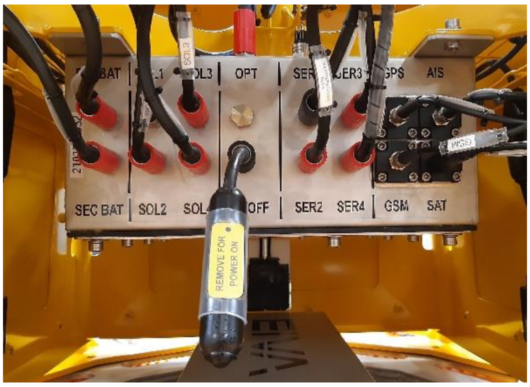

Figure 22 – On/off plug

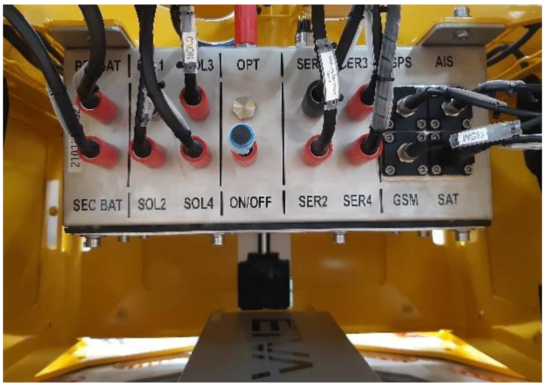

Figure 23 – Dummy mounted

3.3 ToughBoy web interface

The web interface for the ToughBoy is accessible at http://onshore.eiva.com and provides the customer with an overview of their buoy data, a display of the collected data and notifications/alerts that may occur related to the buoy.

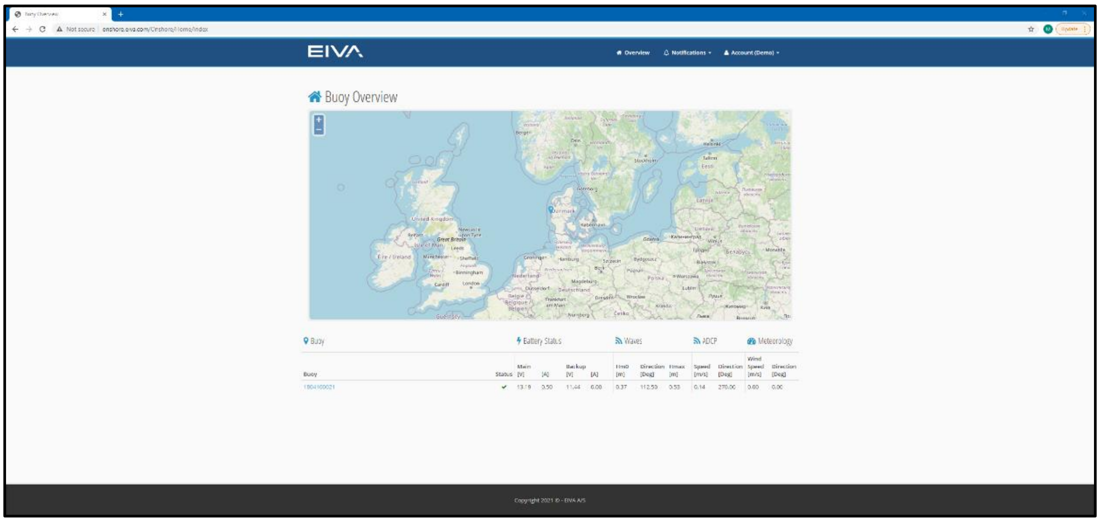

Figure 24 – ToughBoy Onshore buoy overview

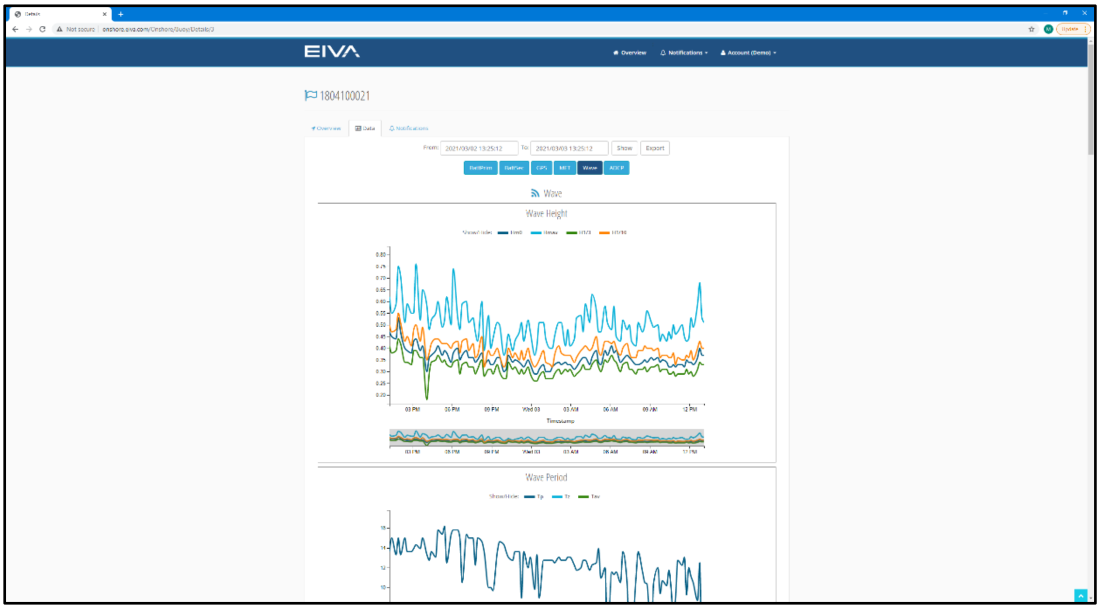

Figure 25 – ToughBoy Onshore wave data

Figure 26 – ToughBoy Onshore ADCP data

The customer can manage their own user logins and divide their users between two groups: ‘User’ and ‘Super user’.

A Super user can manage the other users of the organisation and have the possibility to make changes such as deleting notifications, etc.

A User can only see the buoy, data, and notifications (eg read-only access).

For more info about ToughBoy Onshore, see Section 7 ‘Data Monitoring via ToughBoy Onshore’.

4 Deployment

4.1 Safety

When deploying the buoy, always use proper safety gear, such as a hard hat, safety shoes, life jacket, etc.

It is recommended **not** to deploy the buoy in rough weather, where significant wave height exceeds 1 metre, strong wind, lightning storms, etc.

When the buoy is lifted, always be aware of the buoy's position. Never stand between the buoy and the clump weight. Never stand on the mooring. Watch out for entanglement of the mooring and personnel.

When working with the buoy, use common sense and follow general safety rules.

4.2 Procedure for deploying the buoy

Deploying the buoy consists of three steps:

1. Preparations, which are done at the dock before leaving for the deploy site
2. Deploying the buoy
3. Deploying the clump weight

4.2.1 Preparations

Verify that the mooring is not damaged. Verify that the clump weight is of correct weight and that the shackle mounting is without any damage. Verify that all connectors, cables, sensors and mechanical parts on the buoy are in good condition and are working.

Connect the mooring to the buoy and clump weight with the approved shackle. Verify that the shackle is correctly mounted and locked. Verify that there is no entanglement on the mooring line.

Verify that the buoy can communicate with the ToughBoy Onshore server, as mentioned in Section 3.2.4 'Verify function'. Verify that the data from sensors are received. For more details, see Section 7 'Data Monitoring via ToughBoy Onshore'.

A ship crane is needed for deploying the buoy. The crane must be specified to lift the weight of the buoy and clump weight.

4.2.2 Deploying buoy

Read through the entire procedure before initialising deployment!

When launching the buoy, first turn on the buoy. Verify it is turned on by checking ToughBoy Onshore for received data and that no error messages are occurring. Then launching the system, the buoy must be deployed, followed by the clump weight and mooring.

Lift the buoy with the ship crane in the two lifting eyes integrated in the buoy, see Figure 27.

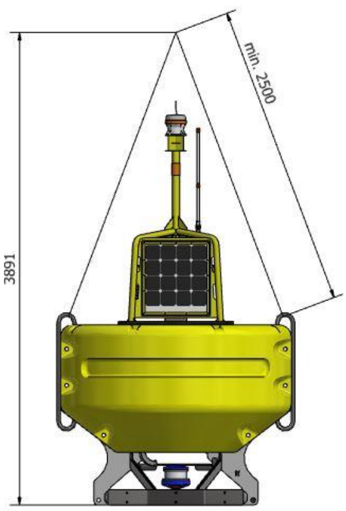

Figure 27 – Lifting the buoy

Notice the direction of the ocean currents and launch the buoy such that the currents slowly will keep it away from the ship. Lower the buoy into the water. When the buoy is floating by itself, release the lifting straps – these should not be left on the buoy and must be retrieved after launch.

When the buoy is in the water, the part of the mooring still on deck, but closest to the buoy, must be tied/secured to the ship. This is done so it will not deploy itself prematurely before the target position is reached – dragging the buoy by the mooring could launch the mooring prematurely, possibly damaging equipment in the process.

Start moving towards the launch coordinates for the clump weight. Slowly moving away from the buoy, while the mooring is still secured to the ship. When the target position is reached, the clump weight can be deployed:

4.2.3 Deploying clump weight

The recommended way to deploy the clump weight is with a release hook on the crane. With the weight hanging over the back/side of the ship, at the launch point. Another way could be by attaching a sacrificial rope to the clump weight and cutting this with a knife. Consult local safety guidelines.

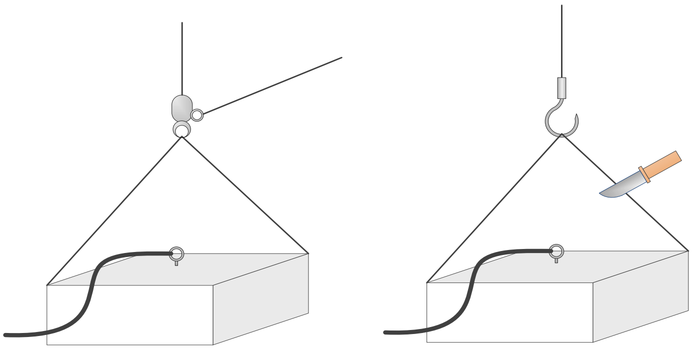

Figure 28 – Self-releasing hook (left) vs knife (right) clump weight release

Leave the mooring on deck in an S form (depending on length, several rows) without any entanglement or any obstacle it can attach to. Lift the clump weight overboard and lower it to the water surface. Release the clump weight, and let it go to the bottom. Wait until the mooring is self-deployed by the drop of the clump weight. It is important that all personnel stay away from the deck during this procedure.

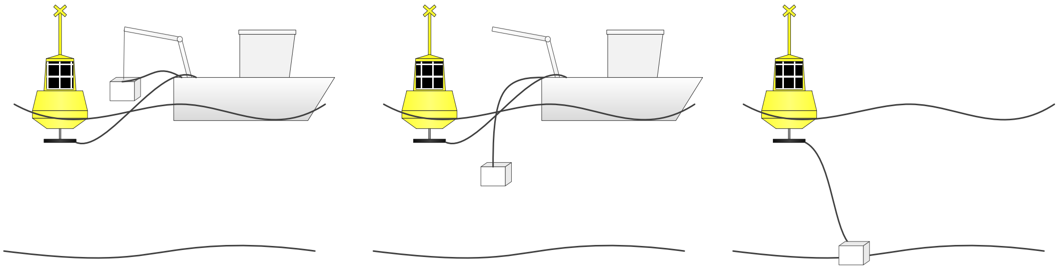

Figure 29 – Deploying clump weight, with mooring on deck (main floater not shown)

For recovery of the buoy, see Section 8 ‘Inspection, maintenance & service’.

5 Data Communication Unit and sensors

The standard ToughBoy 1.9m buoy is mounted with the following sensors and Data Communication Unit.

5.1 EIVA Data Communication Unit

The EIVA Data Communication Unit (DCU) is the main control unit in the buoy. It handles communication with the land station. It interfaces with the onboard sensors and stores data from the sensors. Internal storage can store data for two years. It also handles power management of the buoy and controls the intelligent power sources switch.

Parameter	Symbol	Interval	Resolution	Max value	Accuracy
Primary battery voltage	V_1	10 min – 7 days	100 mV	15 V	0.1 V
Secondary battery voltage	V_2	10 min – 7 days	100 mV	15 V	0.1 V

Table 9 – DCU data

5.1.1 Positioning and communication

The buoy has various ways to communicate with the land station. The buoy has a prioritised communication system, which makes it always possible to communicate with the buoy. This prioritisation gives the buoy the ability to change communication type upon loss of connection – and go back to the prioritised type of communication when re-established.

5.1.1.1 GNSS – positioning

The onboard GNSS receiver measures the location of the buoy. It is possible to make a guard zone for the buoy. If the buoy drifts outside the guard zone, it will send a warning to ToughBoy Onshore.

GNSS	GPS
Accuracy	≤3 m

Table 10 – GNSS data

5.1.1.2 Iridium

Iridium 9603 Short Burst Data (SBD) modem for worldwide data communication.

Iridium 9603	SBD
Band	1616.0–1626.5 MHz

Table 11 – Iridium data

5.1.1.3 GSM

GSM for nearshore data communication.

2G/3G	GSM/GPRS/EDGE/HSDPA
Band	850/900/1800/1900/2100 MHz
SIM card	Mini SIM, 25 mm x 15 mm

Table 12 – GSM data

5.1.2 IO ports

The buoy is equipped with four serial ports for external sensor mounting.

Interface	Number of ports
RS-232	4

Table 13 – Standard payload ports

On request, it is possible to equip the buoy with more payload ports. These payloads can be full-featured RS-232/RS-422/RS-485.

5.2 EIVA wave sensor

The EIVA wave sensor used for accurate wave measurement is based on a 3D accelerometer and 3D gyro, which is sampled at 4 hertz. Sensor offset and drifting is removed by applying a filter removing the low frequency content. The cut-off frequency is adjusted in accordance with the energy distribution of the waves in steps of 8.5 min.

The wave position samples are calculated by double integration of the vertical acceleration.

Calculation of Hm0, Tp, Tzero, etc is based on this document:
http://www.ndbc.noaa.gov/wavemeas.pdf

The hardware comprises of three accelerometers, three rotation gyros and three magnetometers for 3D field measurements.

Parameter	Symbol	Interval	Resolution	Max value	Accuracy
Time	t	n/a	0.1 s	n/a	±0.1 s
Wave mean direction	θ_{mean}	10–180 min	1°	360°	±5°
Significant wave height	H_{m0}	10–180 min	0.1 m	15 m	±0.1 m or 2%
Wave peak period	T_p	10–180 min	0.1 s	25.5 s	±0.1 s or 2%
Wave zero crossing period	T_z	10–180 min	0.1 s	25.5 s	±0.1 s or 2%

Table 14 – Wave sensor data

5.3 ADCP sensor

Teledyne Workhorse Monitor ADCP.

To get more information about the ADCP, please visit Teledyne's support webpage, where you can sign up as a user and in that way get access to the Workhorse manuals.

Parameter	Symbol	Interval	Resolution	Max value	Accuracy
Water temperature	T	10–180 min	0.01°C	45°C	0.4°C
Water depth	D	10–180 min	User-configurable	15–116 m (80 dB)	±1.5 dB
Current velocity 3D	U	10–180 min	1 mm/s	5 m/s	0.3/0.5% of water velocity relative to ADCP ±3/±5 mm/s

Table 15 – ADCP data

5.4 Options

5.4.1 Met station

Vaisala weather sensor WXT530.

Parameter	Symbol	Interval	Resolution	Max value	Accuracy
Barometric pressure	*Pa*	10–180 min	0.1 hPa,	600–1,100 hPa	±0.5 hPa at 0 – +30°C ±1 hPa at -52 – +60°C
Air temperature	*Ta*	10–180 min	0.1°C	-52–+60 °C	±0.3°C at +20°C
Wind – speed	*Sm*	10–180 min	0.1 m/s	0–60 m/s	±3% at 10 m/s
Wind – direction	*Dm*	10–180 min	1°	0–360°	±3°
Relative humidity	*Ua*	10–180 min	0.1 %RH	0–100 %RH	±3 %RH at 0–90 %RH ±5 %RH at 90–100 %RH
Rain accumulation	*Rc*	10–180 min	0.01 mm	-	5%
Rain duration	*Rd*	10–180 min	10 s		-
Rain intensity	*Ri*	10–180 min	0.1 mm/h	0–200 mm/h	-
Hail accumulation	*Hc*	10–180 min	0.1 hit/cm2	-	
Hail duration	*Hd*	10–180 min	10 s	-	
Hail intensity	*Hi*	10–180 min	0.1 hit/cm2h	-	

Table 16 – Met station

6 Mooring and clump weight

The ToughBoy 1.9m must adapt to the wave height to obtain accurate measuring data, and therefore, the mooring system needs to be flexible. This is accomplished by implementing a chain at the seabed and a floater placed subsea in the mooring system. The mooring system setup and materials chosen depends on the specific location and environment data. Please contact EIVA for guidance if in doubt. The following environment parameters are good to know when designing the mooring:

- Depth
- Wave height
- Tide range
- Current velocity
- Type of seabed (mud, sand, rock, etc)

In the following sections, guidance regarding mooring and clump weight is briefly described according to Figure 30.

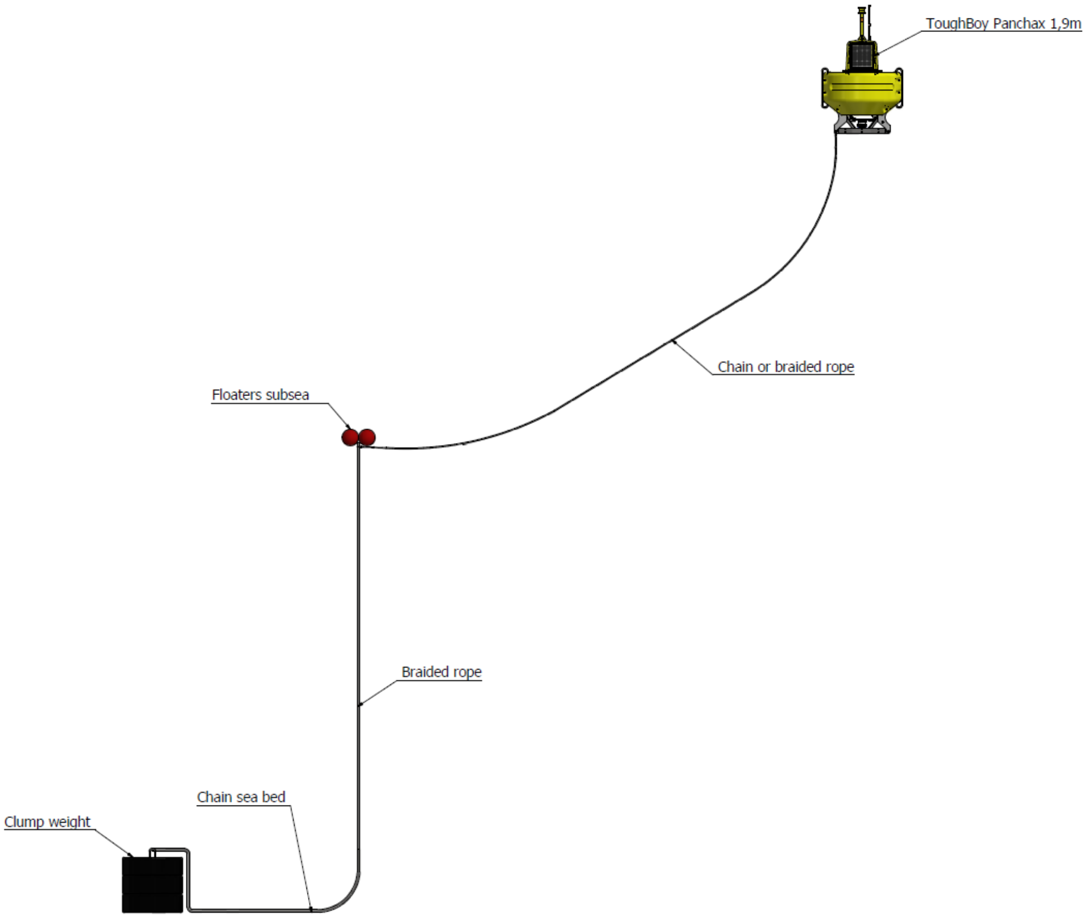

Figure 30 – ToughBoy 1.9m standard mooring setup

6.1 Mooring

The materials used must be strong and durable, especially on the seabed, where a lot of abrasion is affecting the mooring by the constant movement of the buoy and water currents. Therefor a chain is used at the seabed to connect to a clump weight and braided rope, which is very abrasion resistant, connecting the seabed chain to the subsea floater. The chain also adds weight to the overall mooring, so depending on the sea state, the chain will be lifted/straightened from the seabed up in the water column.

Between the seabed chain and subsea floaters, a braided rope is used. The abrasion risk is lower away from the seabed, nearer the surface, and so the amount of buoyancy needed at the subsea floaters is reduced, compared to using a full-length chain.

The subsea floaters are preferably made of hard plastic, so they can withstand the tough environment.

With subsea floaters near the surface, damage to the mooring can occur by curious sailors, fishing boats etc, which might sail over the surface mooring at some point. In these cases, a chain is a good choice, but a braided rope could also do the task. A smaller chain size can be used compared with the chain at the seabed.

The length of the mooring is typically in the range of 1.5–2 times the water depth in shallow water areas. In deeper waters please contact EIVA.

The standard specification of the mooring is listed in Table 17 below. Please contact EIVA regarding mechanical strength of the components if in doubt.

Mooring part	Specification
Chain, at seabed	Chain app. Ø32mm class 8, galvanized
Braided rope	Braided floating rope app. Ø40mm
Floater subsea	Hard plastic, buoyancy app. 80-120kg depended on configuration
Chain, at the surface	Chain, app. Ø16mm class 8, galvanized
Shackles	Shackles Ø38mm DNV 2.7-1 type approved EN-13889

Table 17 – Standard mooring specification example

6.2 Clump weight

Durable materials are chosen when designing the clump weight. Typically, concrete or steel is used when manufacturing.

The clump weight is often made by the customer locally so environmental and transport cost is reduced. The weight depends on the local environment conditions, but typically a weight of 1.8 tonnes in water is sufficient for the ToughBoy 1.9m.

In Figure 31, an example of a concrete clump weight is shown. The clump is designed of truck tyres which are filled with concrete. Inside the tyres, a stainless-steel type AISI 316 fixture is used to reinforce the concrete and at the same time applying a lifting eye both to handle the clump and to secure the chain at the seabed.

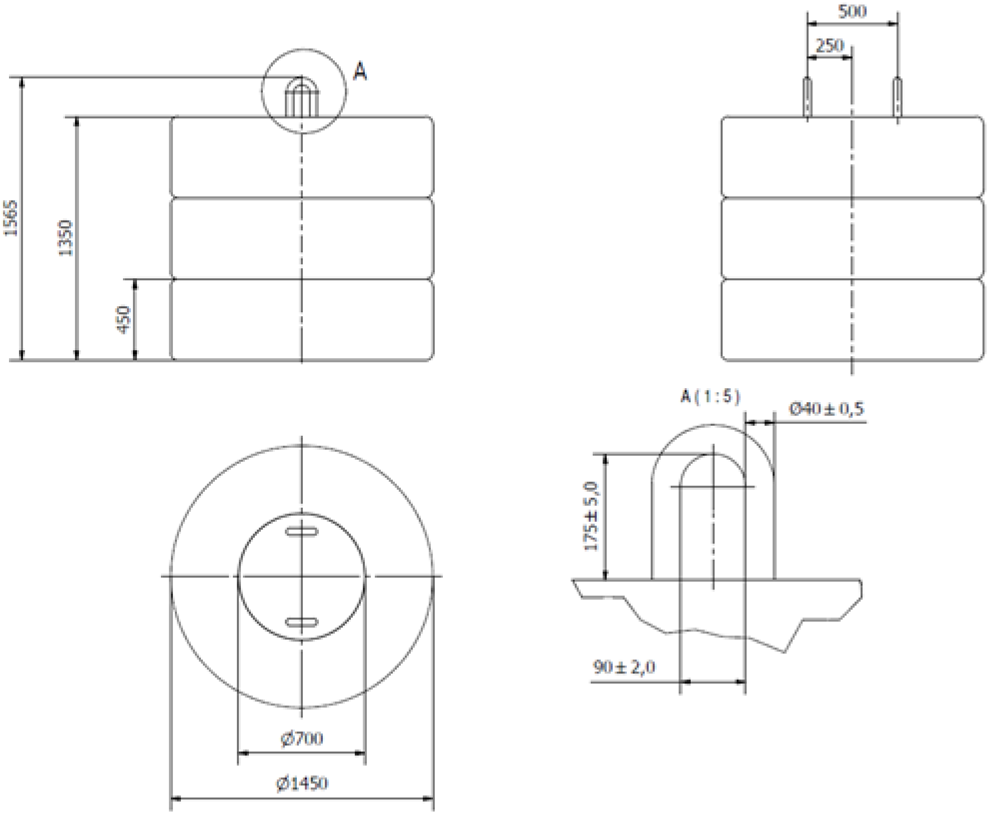

Figure 31 – ToughBoy 1.9m clump weight 1.8 tonnes example

The in-air weight of the clump weight can be reduced if e.g. scrap steel or similar material with a higher density than concrete, is used instead. A steel clump weight must be protected with anodes against corrosion.
The reduced weight in the air could give an advantage against concrete regarding the size of equipment safely used when deploying the clump weight and mooring.

7 Data Monitoring via ToughBoy Onshore

Via ToughBoy Onshore, it is possible to monitor status of the buoy and data from the sensors.

URL: http://onshore.eiva.com

7.1 Daily monitoring

Log in to the ToughBoy Onshore webpage (http://onshore.eiva.com) with your assigned user login information. If you do not have a user and need access to the buoy data of your organisation, please contact your local Super user. See Figure 32.

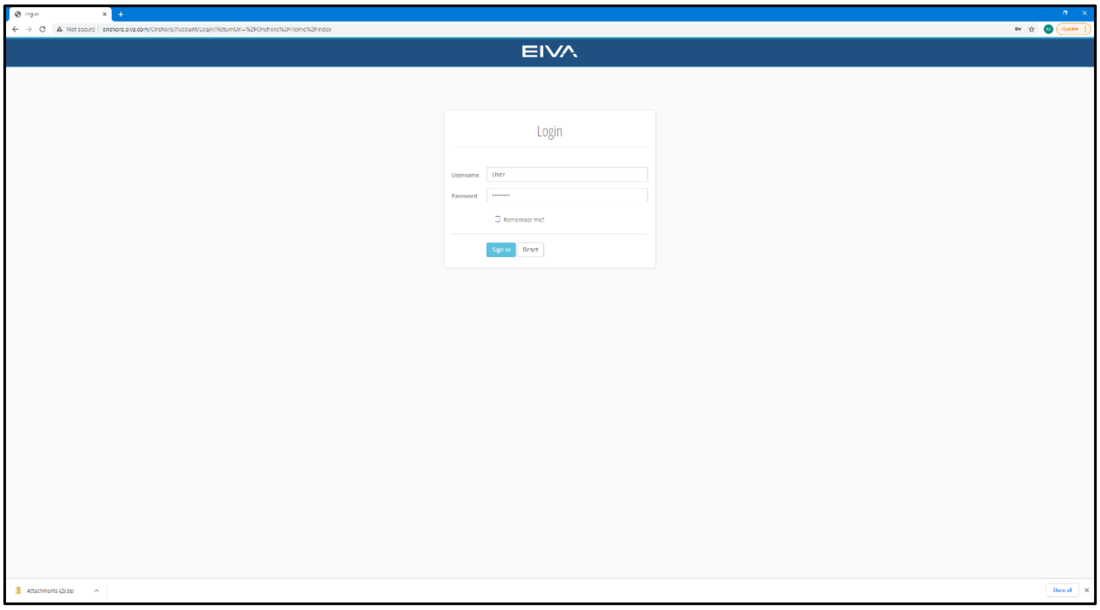

Figure 32 – ToughBoy Onshore login

Once logged in, you arrive on the Buoy Overview page, where you can see a short status on your buoy (below the map). See Figure 33.

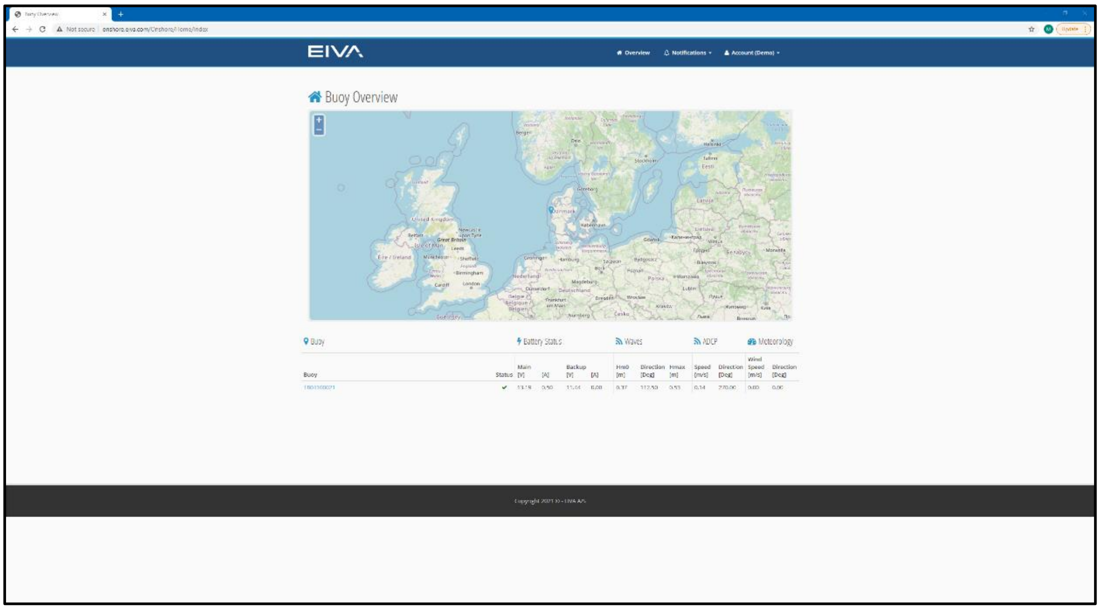

Figure 33 – Buoy Overview

Click on a buoy from the list to get more details about the buoy. Here, you gain access to the data and notifications of the buoy. See Figure 34.

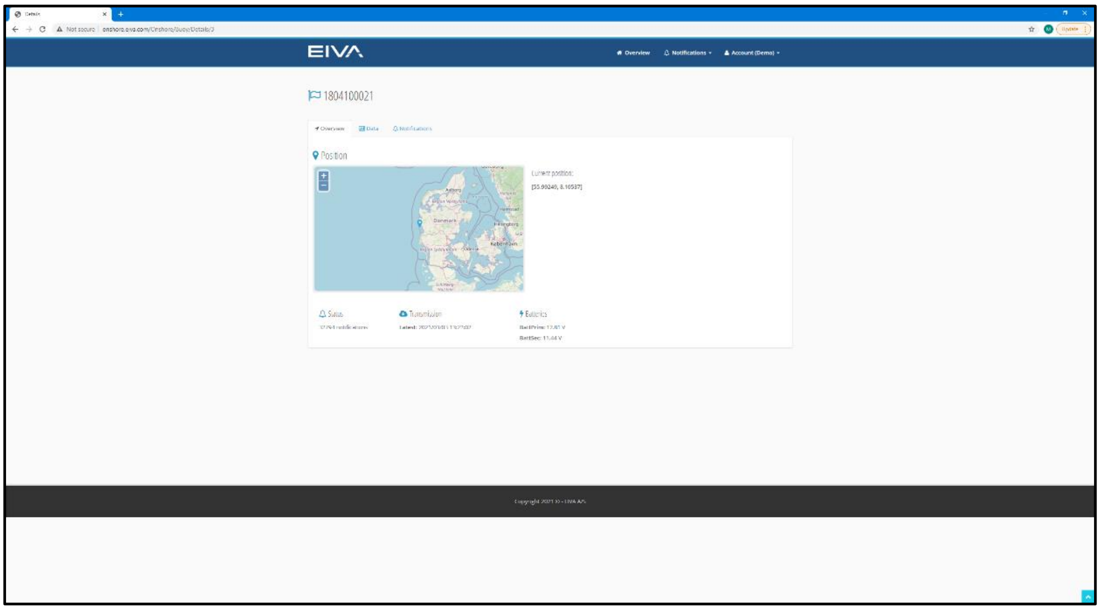

Figure 34 – Data and notifications

7.1.1 Data Tab

Via the data tab it is possible to see the data collected by the buoy and transmitted home, see Figure 35. The amount and naming of sensors is depending on the what sensors the buoy is purchased with. In this example, there are 6 sensors: primary battery, secondary battery, GPS sensor, meteorologic sensor (optional), wave sensor and ADCP sensor (optional). By default, ToughBoy Onshore will display data from the last 24 hours.

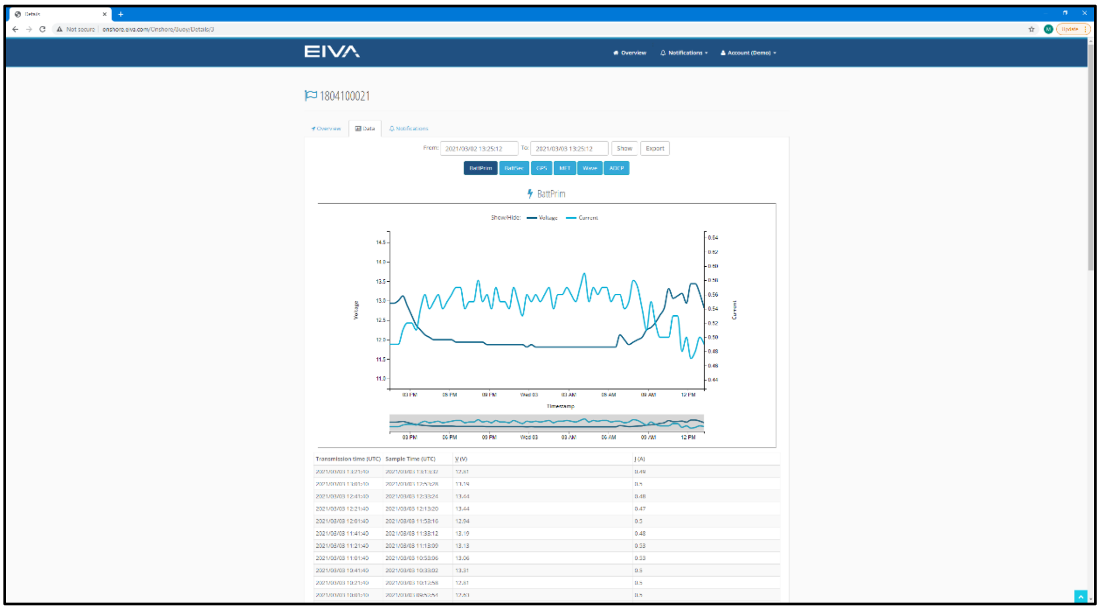

Figure 35 – ToughBoy Onshore data tab showing primary battery

For each sensor, there is a graphical representation of the data along with a table with the corresponding data.

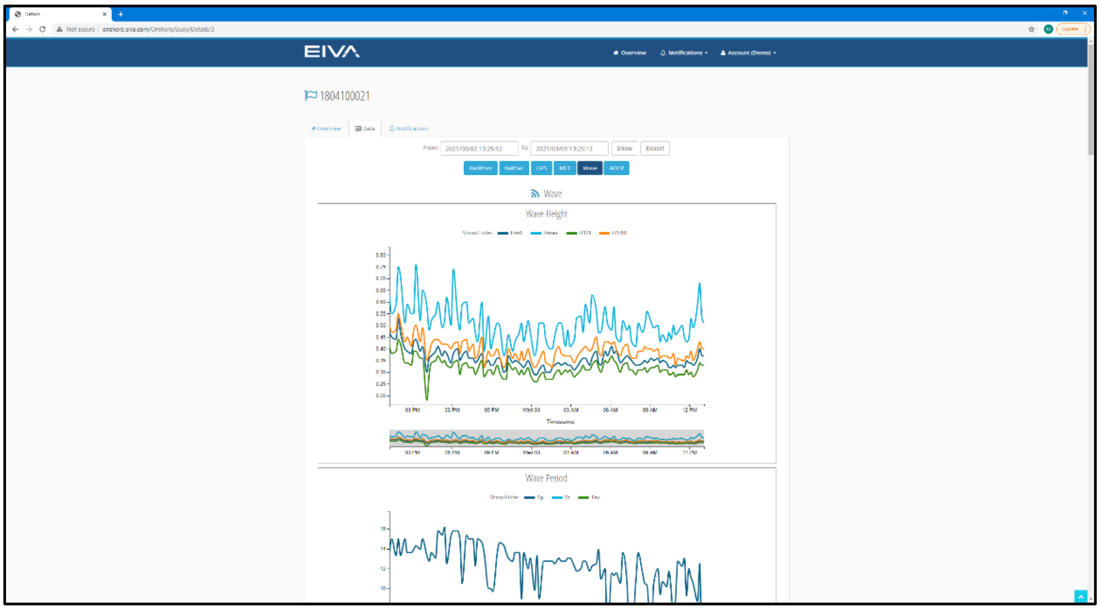

Figure 36 – ToughBoy Onshore wave data graphical representation

Figure 37 – ToughBoy Onshore ADCP data graphical representation

In graphs with multiple data entries, is it possible to switch the data lines on or off by clicking on the data legend.

Figure 38 – ToughBoy Onshore wave data graphical representation, with two data lines set to off

If other data than the standard last 24 hours is needed, then it is possible to define a custom interval for data representation, see Figure 39, Figure 40 and Figure 41.

Figure 39 – Selecting start date of the graphical presentation

Figure 40 – Selecting end date of the graphical presentation

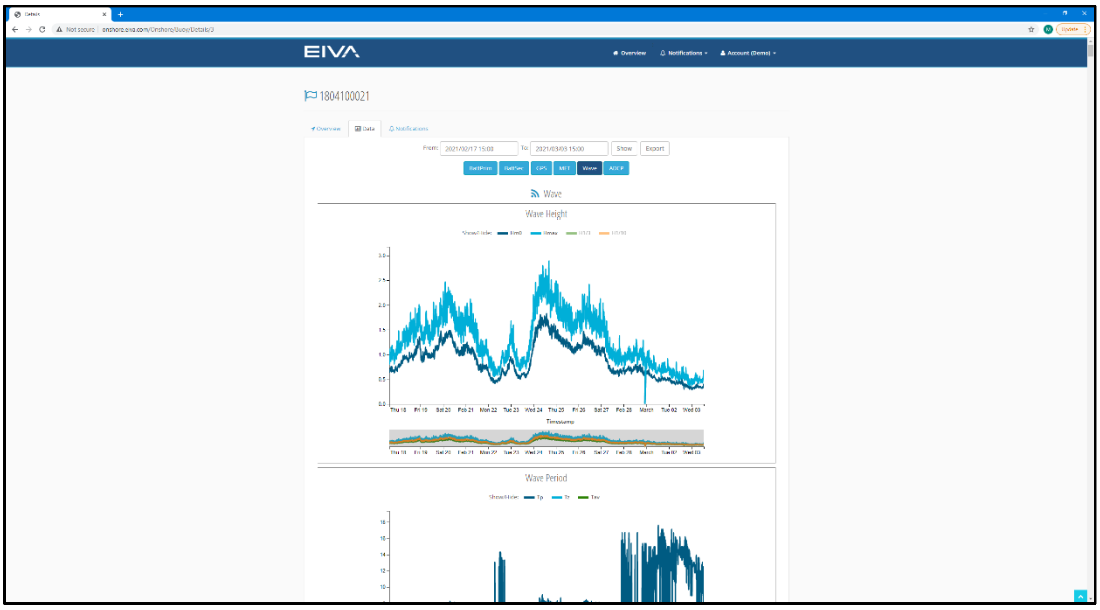

Figure 41 – Wave data representation for a custom interval

It is possible to zoom in on data for a better view. This is done by hovering the mouse over the graph and scrolling back and forth with the wheel to either zoom in or zoom out on the dataset.

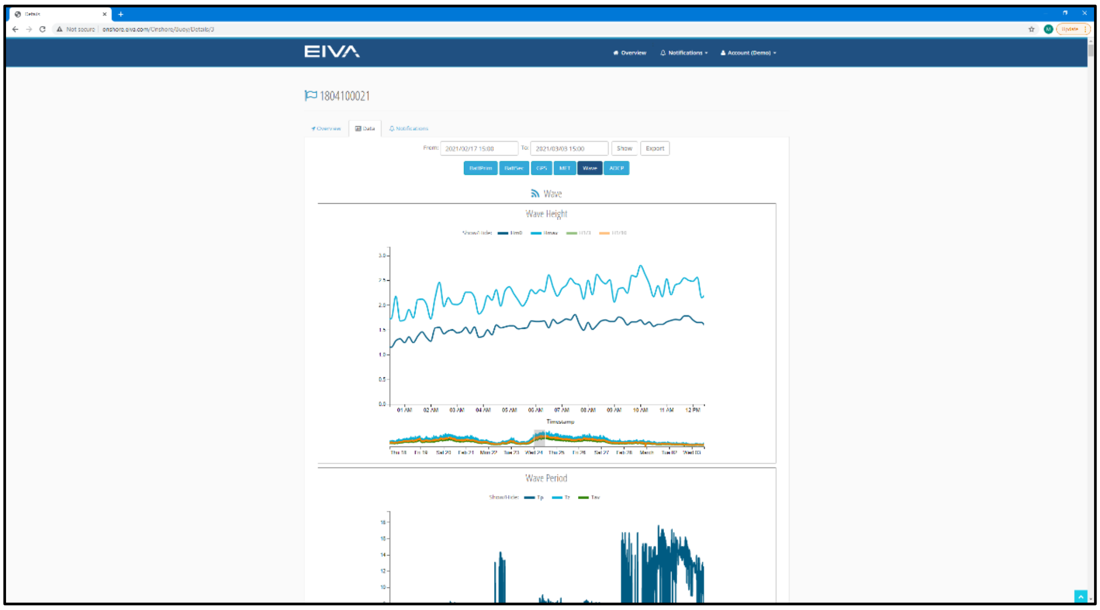

Figure 42 – Zoomed in on a graphical view

7.1.2 Notifications tab

In the Notifications tab, it is possible see warnings and/or error messages sent from the buoy. It is possible to display the notifications from the last **24 hours**, since **Last boot** of the buoy, or **All** notifications.

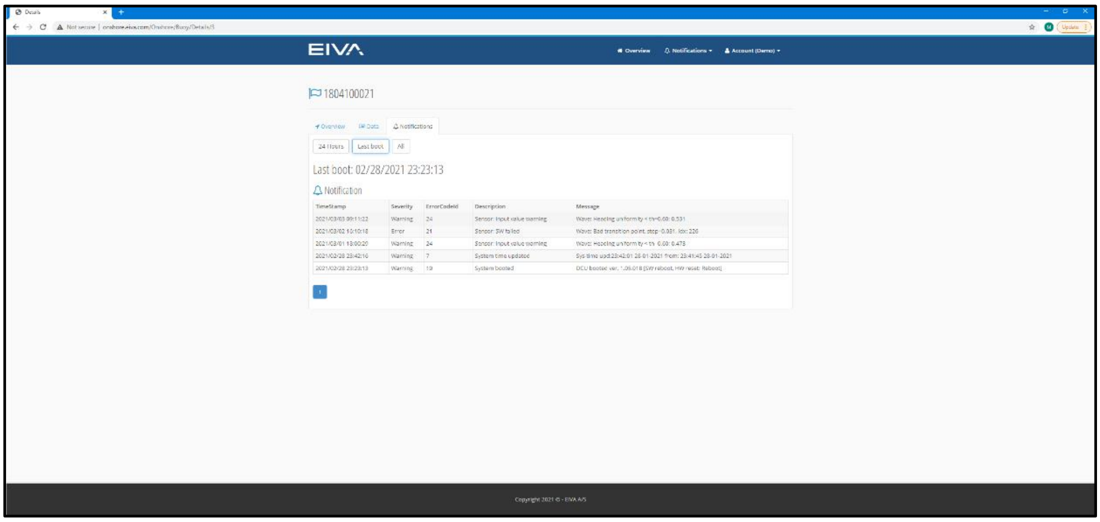

Figure 43 – ToughBoy Onshore notifications tab

7.1.3 Configuration

At delivery, the buoy is pre-configured by EIVA. This is done in cooperation with the customer. It is also possible to reconfigure the buoy when it is online.

The customer cannot by themselves change configuration on the buoy

7.1.4 Output to FTP server

The ToughBoy Onshore Server is able to export incoming data to an FTP server hosted by the customer. EIVA must be granted write access to one of the folders on this server.

Currently, one format is available: Online Limited CSV Export.

7.1.5 Folder and file structure

EIVA will create one folder for each ToughBoy in the server with write access. The name of these folders will be formatted as follows (see also folder in attachment): 'ToughBoy_*SerialNumber*', where *SerialNumber* will be replaced with the serial number of the buoy.

For each sensor, you will get a file with a name formatted as follows: '*Sensor_Time*', where *Sensor* will be replaced with the name of the sensor and *Time* with the time of creation of the file (ISO8601).

```
FTP directory
        '-> ToughBoy_1409100001
                '-> adcp_20140826T151900Z.csv
                '-> met_20140826T151900Z.csv
                '-> wave_20140826T151900Z.csv
        '-> ToughBoy_1409100002
                '-> ... (similar content to first folder)
```

Example 1 – Folder structure

7.1.5.1 Online Limited CSV Export

Inside the files, there will be one header line starting with '#', which gives the order of the data. This order will not change unless we have to add additional values or in any other way have to change the format.

The second line will hold the values from the sensor. The first value is the sampling time for the sensor. The rest is sensor specific, as given by the first line. The values in the examples (Example 2 to Example 4) show a number of decimals, which is expected to change from time to time.

The sensors exported are wave, ADCP and meteorology.

 # Time [s],Hm0 [m],Tp [s],Tz [s],Dm [degrees]
1409053772,3.721,10.24,8.72,165.1

Example 2 – Wave file

The ADCP is a bit special, as the data amount will depend on the configuration (number of bins). After the sample time, it will hold some non-bin-dependent values (water temperature and water depth), and then values for each bin will come in a repeated pattern until all bins have been reported. Each bin will start with the code B*x*, where *x* will be the bin number. Example with two bins:

 # Time [s],t_water [degrees C],Depth [m],BinNo,BinDepth [m],Current_East [m/s],Current_North [m/s],Current_Up [m/s],BinNo,BinDepth [m],Current_East [m/s],Current_North [m/s],Current_Up [m/s]
1409053843,5.6,13.5,B1,2.0,1.85,-0.72,0.13,B2,4.0,1.70,-0.83,0.09

Example 3 – ADCP file

Note that the ADCP header is word-wrapped in the above example in order for it to fit in this document. In the real file, it will be one line.

 # Time [s],Speed [m/s],Direction [degrees],Pressure [hPa],Humidity [%RH],t_air [degrees C],Precipitation [mm]
1409053909,7.23,265.2,1003.6,73.3,12.4,25.3

Example 4 – Meteorology file

8 Inspection, maintenance & service

It is recommended that the buoy is serviced minimum once a year. EIVA can always assist when your buoy needs servicing.

Important: Always use appropriate safety gear when servicing the buoy, such as safety helmet, safety shoes, etc. It is recommended **not** to recover the buoy in rough weather; where significant wave height exceeds 1 metre, strong winds, lightning storms, etc.

The recovery process of the buoy for servicing is roughly the opposite of deploying.

When recovering the buoy, attach the lifting gear to the two lifting eyes on the side of the buoy. Secure the buoy to the ship deck, and slacken the force applied to the mooring. Attach a marking buoy to the mooring and loosen the shackle between the mooring and the buoy. Drop the mooring with the marking buoy back into the water[2].

The buoy needs to be secured with, for example, transport straps to the ship deck. During transport and service fixating the buoy is necessary.

The buoy should be inspected for any damage, such as cracks, loose parts, faulty parts, or missing parts. All visible bolts must be inspected and tightened if they are loose. Faulty or missing parts should be replaced.

- Full access to the Electronics panel and cables is obtained by removal of the front solar panel. See Section 8.1 'Remove solar panel' & 8.2 'Removal/mounting of Electronics panel'.
- To exchange the primary- or secondary battery, it is necessary to remove the top cover. See Section 8.3.1 'Primary battery' & 8.3.2 'Secondary battery'.
- It is recommended that all 16 zinc anodes on the frame are changed during every service. See Section 8.4 'Anode replacement'.

The most common wear parts and spare parts are shown in Figure 44 and Figure 45. The parts are listed in Table 18 and Table 19 with their corresponding part numbers.

[2] Make sure there is enough buoyancy to carry the weight of the supported mooring system, before throwing it overboard. Inadequate buoyancy will leave the mooring falling to the seabed.

Service view:

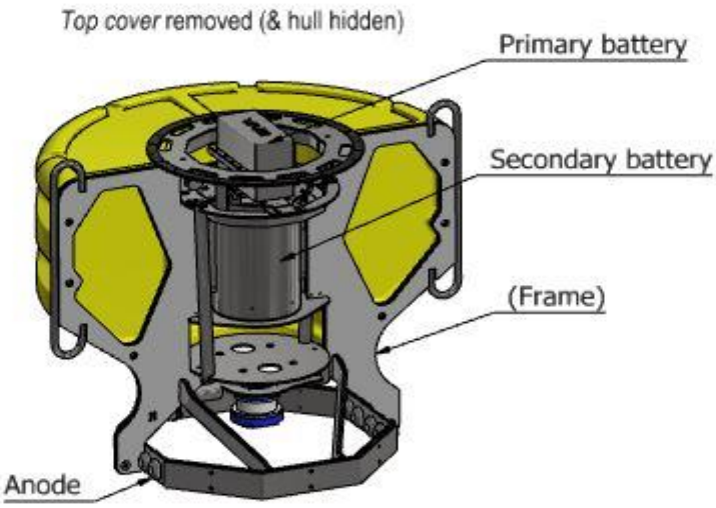

Figure 44 – Buoy service view 1

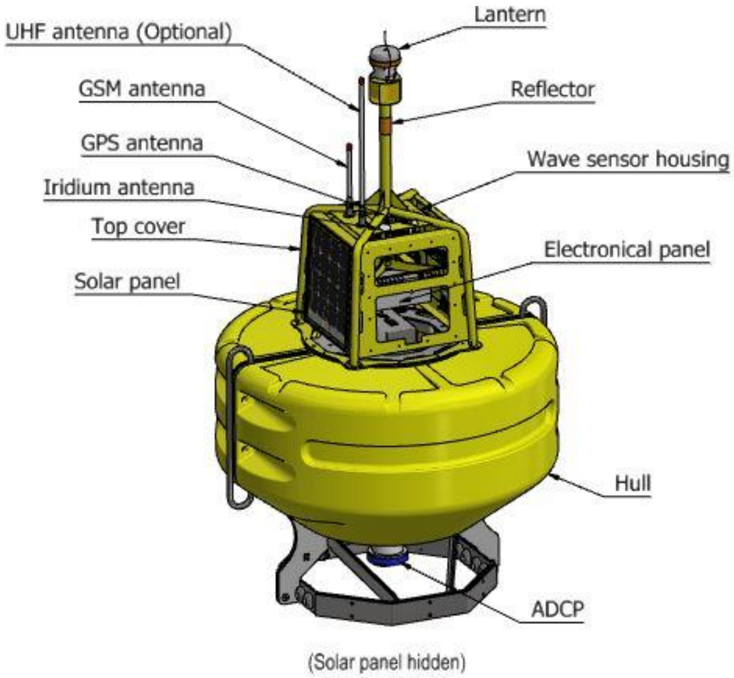

Figure 45 – Buoy service view 2

Specification	Part number	Guide
Primary battery	0329160	8.3.1 Primary battery
Secondary battery	0420253	8.3.2 Secondary battery
Zinc anode	500000196	8.4 Anode replacement
Lantern Battery	500000232	8.5 Lantern battery replacement

Table 18 – Wear parts

Specification	Part number
Solar panel	500000199
GPS antenna	500000229
Iridium antenna	500000230
Lantern	500000231
GSM antenna	24491
GSM cable	033000035
GPS cable	033000036
SAT cable	033000037
UHF cable	033000038
Primary battery cable	033000039
Secondary battery cable	033000040
Solar panel 1–4 (cable)	043000001
ADCP cable, TRDI Workhorse	033000041
Met Station cable, Vaisala WXT520	033000043
On/Off switch	033000047
Wave sensor housing (complete with sensor)	0329937
Electrical panel	0420473
Black POM spacers	0420309

Table 19 – Spare parts

8.1 Remove solar panel

Each solar panel must connect to a specific port on the Electrical panel, this is important for the buoy's ability to recharge effectively. Be mindful of the labels on the solar panels when removing and re-connecting the solar panels to the Electrical panel.

Removal of the front solar panel is necessary to gain full access to the control unit within the buoy top.

Identify the solar panel which is going to be removed and release the corresponding cable from the Electrical panel.

Note the position of the moulding on the backside of the solar panel, and make sure the cable is free to be removed before loosening the fifteen M8 bolts holding the panel in place. Cut zip ties holding the cable and moulding in place.

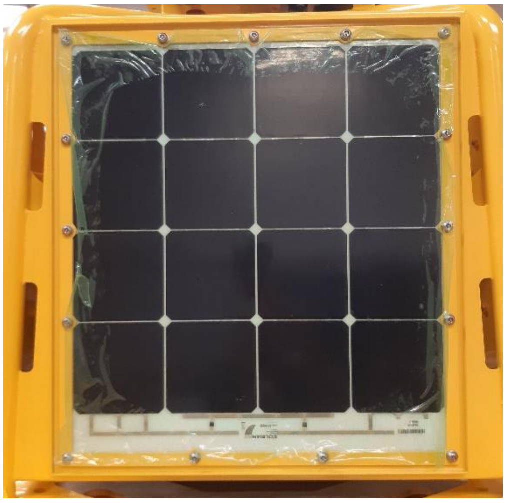

Figure 46 – Solar panel, mounted

Figure 47 – Solar panel backside, mounted

Be careful not to damage or scratch the solar panel, cable or moulding when setting it aside. Pictures of the panel backside can be seen on the next page: Figure 48 & Figure 49.

Solar panel removed from the buoy. Be careful not to damage or scratch the solar panel, cable or moulding during handling.


Figure 48 – Solar panel, removed


Figure 49 – Solar panel, removed

8.2 Removal/mounting of Electronics panel

When removing or mounting the Electronics panel, it is advised to be two persons. One for holding the unit and one for loosening/positioning the bolts holding the unit.

Remove the front solar panel, see Section 8.1 'Remove solar panel'.

Check that all cables are labelled with the corresponding names and loosen them from the electrical panel.

Lay the disconnected cables to the side, maximizing space to lift out the box.

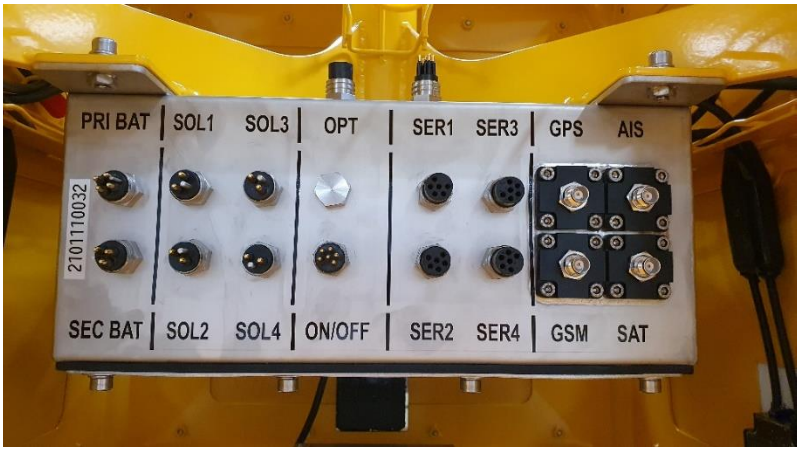

Figure 50 – Electrical box front

While one person is holding the unit from below, through the solar panel opening, the other person removes the 4 bolts that holds the unit in place. When they are removed, the box is free and can be removed from the Top cover.

Note: Do not place the Electrical panel such that it rests on the LAN or USB connectors.

8.3 Battery change

When changing either battery during a service visit, a crane and some lifting straps/rope on the service ship are needed.

Before changing the battery in the buoy, the buoy needs to be securely fixated. If the buoy is not fixated securely to the ship deck/railing, there is a risk of the buoy tipping over.

8.3.1 Primary battery

Remove the top cover and unplug cables for the batteries, ADCP and optional other frame mounted sensors, see Section 3.2 ‘Assembly instructions’ and follow this step backwards to remove the top cover.

The cables for the primary- and secondary battery can be removed together with the top.

The ADCP- and optional frame mounted sensor-cables must be laid to the side, leaving room for the battery to be removed.

Figure 51 – Primary & secondary battery unplugged

Attach lifting straps in the dedicated lifting loops and remove the six finger screws.

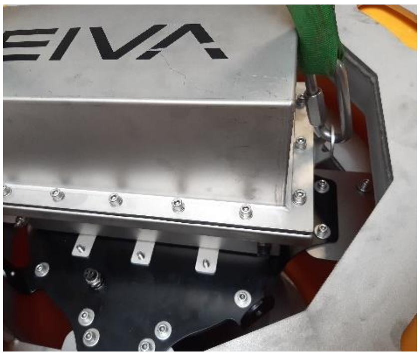

Figure 52 – Attach lifting straps

Figure 53 – Lift the primary battery out

Before lifting the battery out of the buoy, note the orientation of the unit. Power connectors from primary and the secondary battery are on the same side, see Figure 51.

Lift out the primary battery, which weighs about 40 kilograms.

Figure 54 – Lifting primary battery

Figure 55 – Attaching lifting straps to primary battery

8.3.2 Secondary battery

With the top cover and primary battery already removed, loosen the 8x M8 bolts holding the battery in place. Attach lifting straps in the dedicated lifting loops.

Two opposite lifting eyes is enough, all four are not necessary.

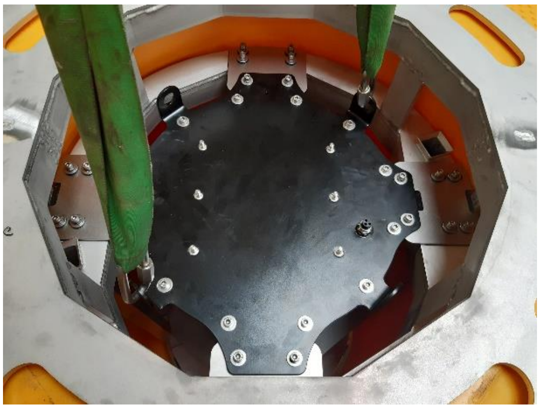

Figure 56 – Attach lifting straps

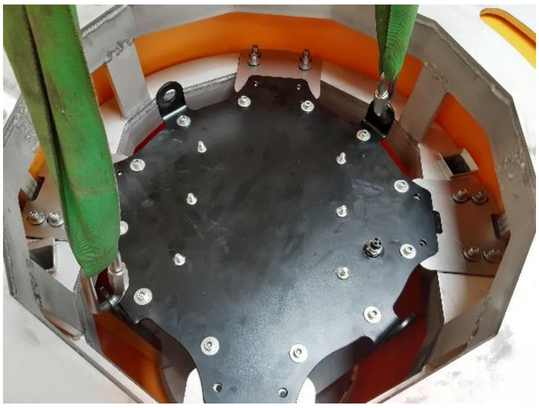

Figure 57 – Remove the 8x bolts

Note the orientation of the battery/placement of the connector. Use this as a guide when the new battery is mounted.

Lift out the secondary battery, which weighs about 140 kilograms.

Before installation of the new battery, check that the underlaying plastic spacer is still located properly withing the frame, see Figure 58 (the six holes in the plastic plate, aligning with six holes in the frame).

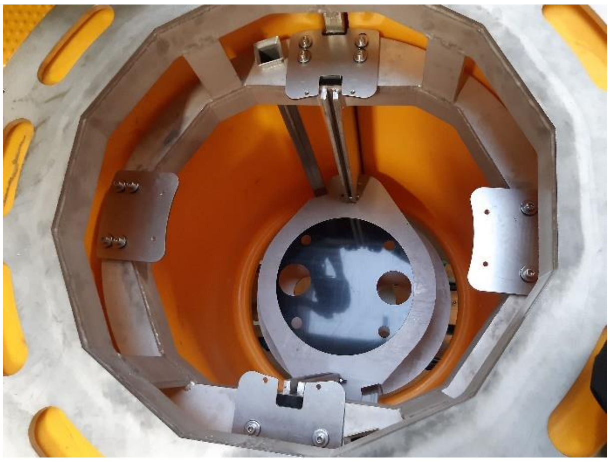

Figure 58 – Secondary battery, plastic spacer

When positioning the new battery, it might be necessary to loosen the 4x plates holding the battery in place. Loosening the four plates just enough that the plates can move and be adjusted for the new battery. This allows for small differences between battery assemblies.

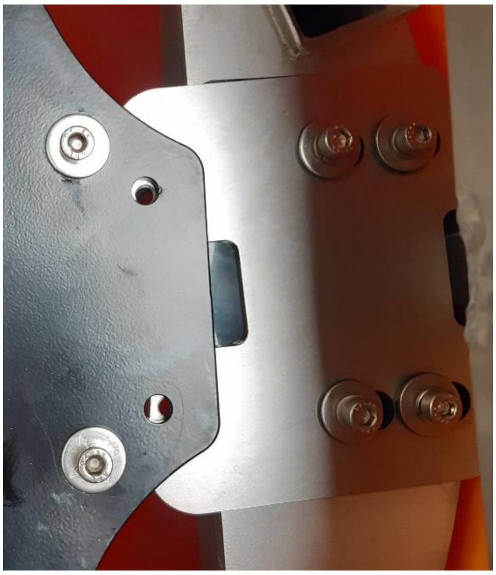

Figure 59 – Plate missaligned

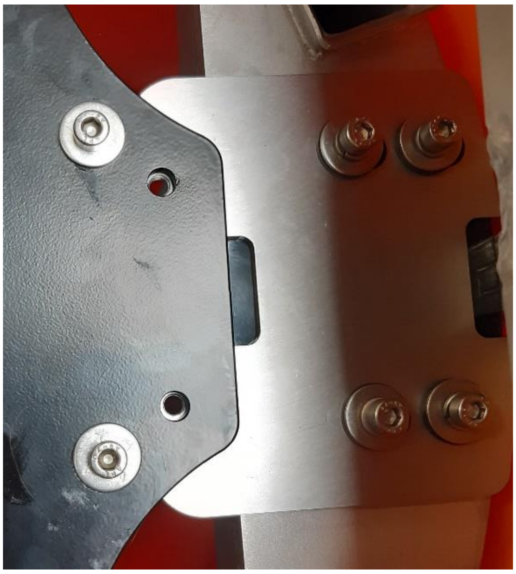

Figure 60 – Plate aligned

Make sure all bolts are tightened after the battery replacement is completed.

Notes for the secondary battery:

The battery is fitted with two plastic rails, one on each side. These help align the battery and guide it into place.

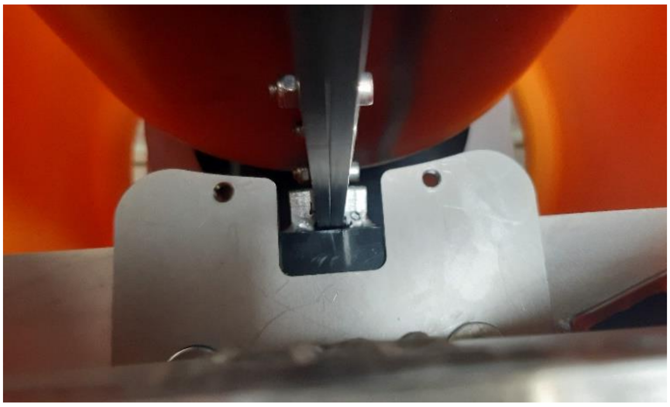

Figure 61 – Plastic rail

Better pictures of how to lift the secondary battery:

Figure 62 – Lifting

Figure 63 – Attach lifting straps

The primary battery is mounted directly on top of the secondary battery. It is possible to remove and mount both batteries in one lift – as long as the 6x finger screws on the primary battery are still mounted. Use the lifting eyes on the secondary battery for this lift.

Figure 64 – Lift battery pack

8.4 Anode replacement

It is recommended that the anodes are replaced during service, where the buoy is placed on deck anyway. The buoy must be safely secured to the deck before the anodes are removed.

Loosen the m8x20 bolt and remove the old anode.

Before mounting the new anode, it might be necessary to clean the area behind and around the mounting area for biofouling.

Use grease on the bolt.

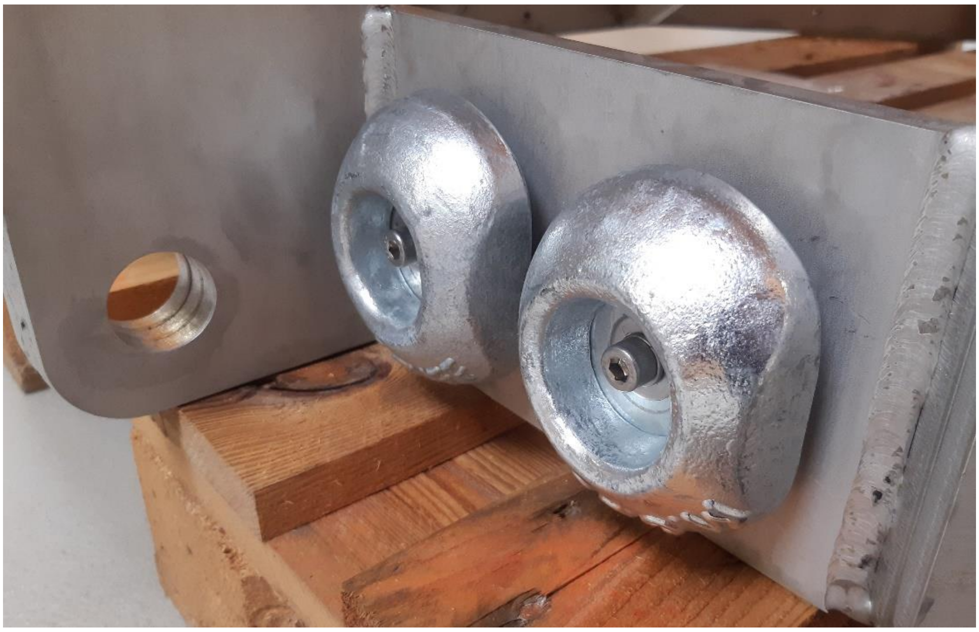

Figure 65 – New zinc anodes

It is recommended that all 16 zinc anodes on the frame are changed at the same time.

8.5 Lantern battery replacement

The *M650H* is a self-contained, low-maintenance solar LED marine lantern. The lantern features a replaceable battery pack, which can easily be replaced if needed.

Remove the lantern from the mast by loosening the three M6 bolts holding it to the mast.

Figure 66 – Lantern on mast

Turn the lantern upside down and place it on some soft cloth (to avoid damaging the housing). Remove the bottom mounted lid by loosening the Philips screw, and rotate it counter clockwise. Disconnect the battery and remove it from the lantern.

Figure 67 – Lantern upside down

Figure 68 – Connector inside lantern

Secure the position of the new battery in the lantern and re-connect the wire.

Install the lid once again, and make sure to push it down evenly until the lid is seated within the housing. While pushing the lid slightly down, rotate it until the locking tab lines up with the locking screw. Then tighten the locking screw to lock the lid in place.

The lantern should reactivate as soon as it registers low light conditions.

Note: The lantern can easily be tested by covering the solar panel with a jacket or similar. With the solar panel covered, wait a moment, and the lantern should activate.

8.6 TNC connector sealing

The TNC connectors are vulnerable, so tape is applied to protect them.
The lifetime of the connectors is only a few months if the sealing is not done correctly.

Figure 69 – Self-vulcanising tape

Figure 70 – Electrical tape

This process is easiest if it is done one connector at a time.

- The tape should be approximately 20 degrees Celsius
- Cut a 10–15 cm piece of the self-vulcanising tape (if one piece isn't enough, then another piece can be applied if done immediately)
- Remove the protection film
- Stretch the tape to the point right before it breaks before applying it (this is necessary to activate the self-vulcanising tape)
- Wrap the self-vulcanising tape around the cable – the self-vulcanising tape MUST be stretched while wrapping

Figure 71 – TNC connector before sealing

Figure 72 – Self-vulcanising tape wrapped on connector

- The self-vulcanising tape **MUST** cover all of the connector
- The self-vulcanising tape **MUST** cover all the shrink tube and minimum 2 cm of the raw cable
- When the self-vulcanising tape is wrapped, hold onto the wrapped cable with a hand to warm it and keep it in place – hold it for several seconds, until the self-vulcanising tape can stay when you let go

Apply electrical tape on all the self-vulcanising tape to protect it while it hardens.

Figure 73 – Electrical tape applied

8.7 Inspecting for biofouling

When servicing the buoy, inspect it for biofouling. This can be algae, calcite deposits, crustaceans, bird droppings, etc.

Clean the lantern of any fouling using a wet cloth.

Inspect the solar panels. If there are bird droppings, wash them off with a wet cloth.

If there are algae and calcite deposits, remove them with a cloth with algae remover, vinegar or similar. Depending on the amount of biofouling, it may need to be soaked for a longer time before scrubbing. A soft brush can be used with caution.

Do not use any hard bristle brush, knife, other sharp objects or similar, to clean the solar panels. If used anyway, there is risk of damaging or reducing efficiency of the solar panels.

Depending on the amount of biofouling, the hull and frame can be cleaned with a hard bristle brush or paint scraper, used with caution.

With the optional ADCP sensor, be extra careful not to damage the sensor head. If scratched/damaged, then the integrity of the sensor and its data will be compromised. Clean with caution. Use cloth to remove to clean the unit.

See Section 9.1 ‘Appendix A - Preventing biofouling’ for information on protecting the buoy from biofouling.

9 Appendix

9.1 Appendix A - Preventing biofouling

Take precautions to protect against biofouling on the buoy parts that are below the sea surface, especially when the buoy is deployed in warm waters.

Preventing biofouling will sustain the data measuring on the ADCP and temperature sensor and extend the lifetime of the buoy parts.

The most efficient way to prevent biofouling is to frequently clean the transducer face of the ADCP, temperature sensor and buoy parts. In most cases, however, this is not a possibility. Below are some methods which can be used to help prevent biofouling.

Anti-fouling paint

- Coat the buoy parts that are below sea surface, including the ADCP, with anti-fouling paint. Ensure that the paint is applied in a smooth layer over the transducer face. See Teledyne RDI`s Workhorse Operation Manual for detailed information about preventing biofouling. EIVA can recommend the following manufacturers of antifouling paints:
    - Interlux Brad Paints: http://www.yachtpaint.com/usa/
    - Severn Marine Technologies: http://www.severnmarinetech.com/index.html
- **Important**: Do not use paints containing cuprous oxide on aluminium parts, because this can cause galvanic corrosion.
- For detailed information about the anti-fouling paint, please read the manufacturer's product datasheet and safety datasheet.
- Always wear appropriate safety gear, such as goggles, mask and gloves.

Anti-fouling grease

- A thin layer of anti-fouling grease can be used. The following manufacture can, for example, be used:
    - Propshield: http://www.prop-shield.com/
- If anti-fouling grease is used, clean the buoy parts below sea level with soapy water after recovering the buoy. Anti-fouling grease can be toxic, so please read the product data sheet before using the product.
- Always wear appropriate safety gear, such as googles, mask and gloves.

Silicone grease

- A thin coat of silicone grease mixed with chili powder in a ratio of 50:50 can be applied to the buoy parts that are below sea surface. Make sure to apply a smooth layer of 1 millimetre on the transducer face of the ADCP. The mixture will wash away over time, and experience shows that this method generally will not last in the long term.

- Always wear appropriate safety gear, such as goggles and gloves.

9.2 Appendix B – Tide buoy configuration

9.2.1 Overview

Figure 74 shows the main parts of the ToughBoy 1.9m in Tide buoy configuration.

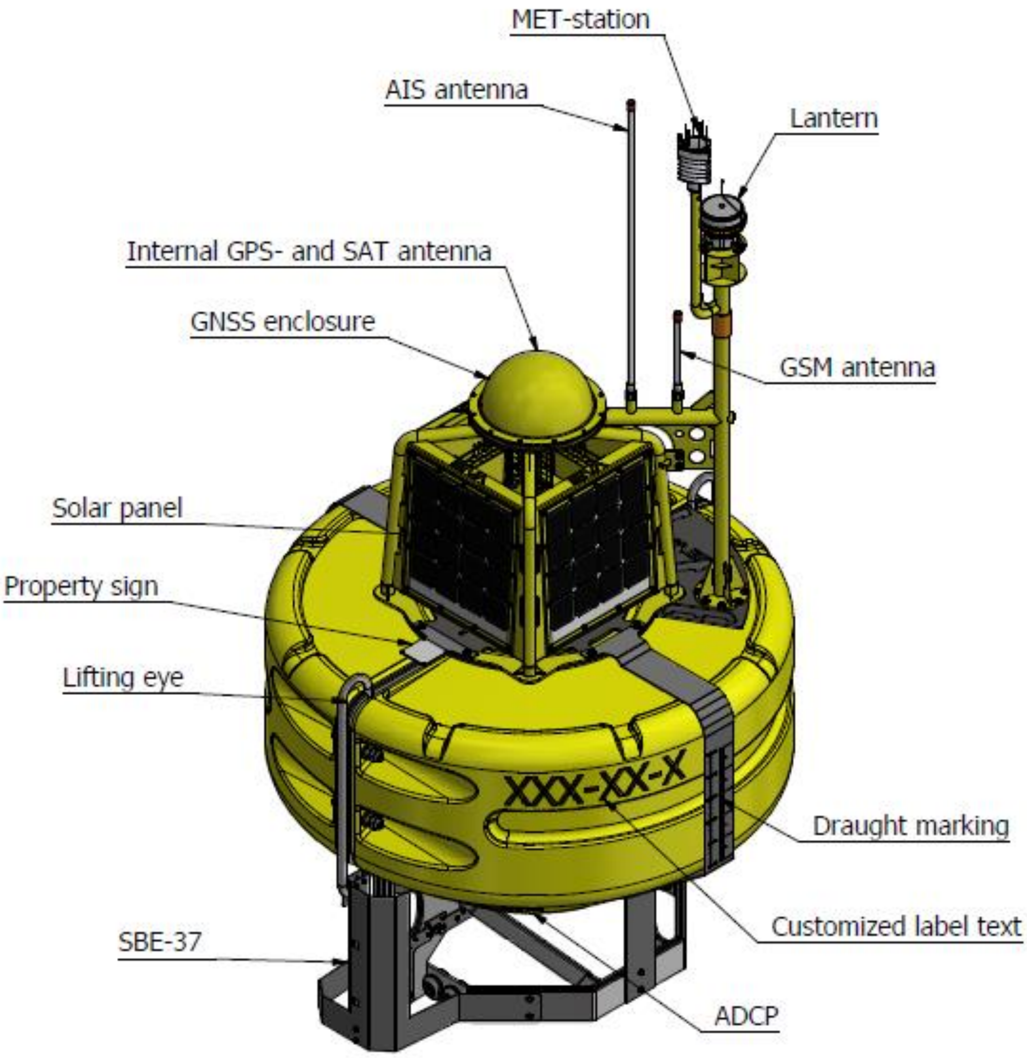

Figure 74 – Main parts

9.2.2 Dimensions

Figure 75 shows the size of the ToughBoy 1.9m in Tide buoy configuration.

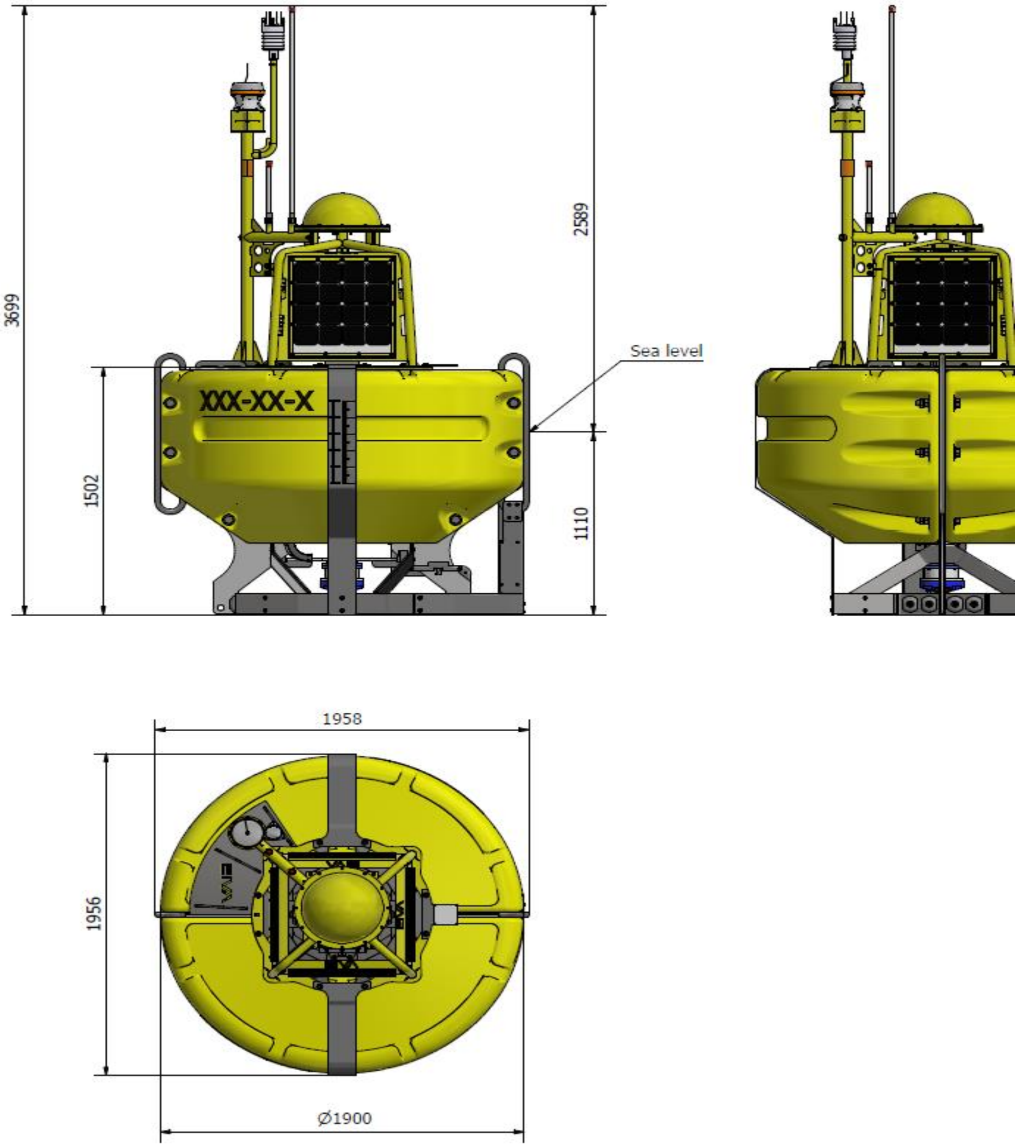

Figure 75 – Buoy, dimensions

9.2.3 Mounting of mast, draught mark and tag plate alongside the buoy top

When assembling the top of the Buoy, in Tide buoy configuration, most of the process is the same as when mounting the top in the standard ToughBoy 1.9m configuration. This section shows the added steps in the assembly process. Here the mounting of the mast, connection of the mast cables, two draught marks and a tag plate (Optional) is shown.

Follow Sections 3.2.2 ‘Mounting of buoy top & plastic spacers’ & 3.2.3 ‘Mounting of cables’ to mount the buoy top, preparing the unit for this step. Those two sections position the buoy top and connect it to the batteries and lower-mounted sensors.

Position the mast on the corner bracket on the buoy frame.

Figure 76 – Mast location

The slit in the horizontal pipe on the mast fits onto one of the four vertical plates under the sensor dome. Loosely mount the M8x80 bolt though the horizontal pipe. Use a locknut and washers. See Figure 77 & Figure 78.

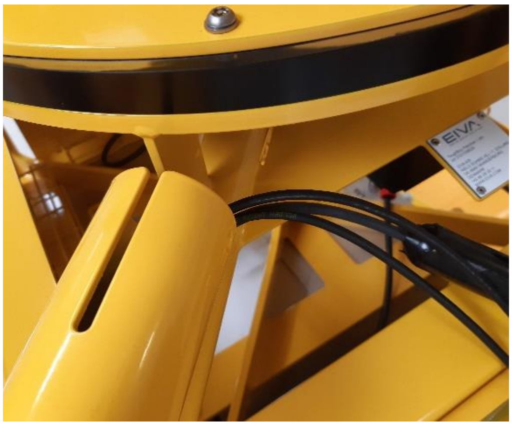

Figure 77 – Slit by the side of dome

Figure 78 – Mast on buoy top

Ensure the vertical plate on the mast is on the correct side of the corner bracket, see Figure 79. Loosely mount the two M10x30 bolts in the vertical plate. Use locknuts and washers.

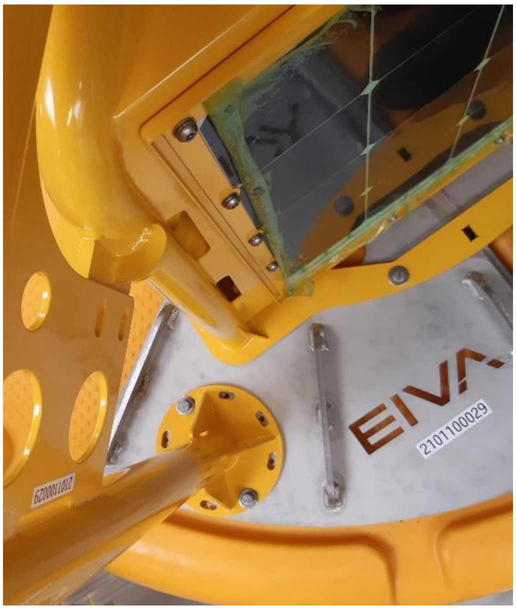

Figure 79 – Vertical plate, mast

Figure 80 – Vertical plate, mast

Position the foot of the mast, and mount eight m10x25 security bolts, fixing the mast to the flange with the EIVA cut-out. Use grease on the thread.

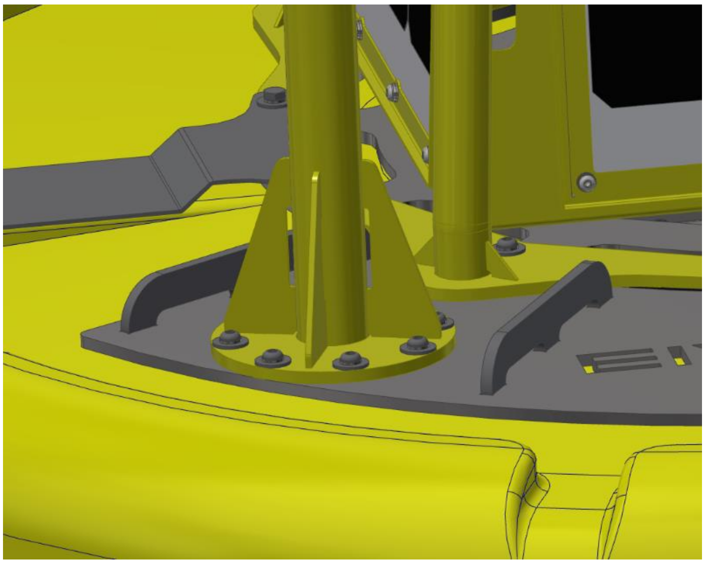

Figure 81 – Mast mounted

With all bolts positioned, tighten all according to Table 7 on page 11.

9.2.3.1 Connect cables from mast

The three cables from the mast must be connected to the appropriate ports. The two TNC connectors are for the AIS and GSM antenna, and the Vaisala weather station connects to SubConn connector labelled SER2.

Cable	Electrical panel -Port	Connector type
Met station	• SER2	• Subcon – 6 pin
GSM	• GSM	• TNC
AIS	• AIS	• TNC

Table 20 – Ports

The GSM and AIS must be wrapped with self-vulcanising tape and electrical tape, according to Section 8.6 ‘TNC connector sealing’.

Be careful not to break or pinch the cables when they are routed from the mast to the Electronics panel. Use zip ties to secure the cables within the top cover.

After mounting the cables to the electronic box, verify that all connections look good, that all connections are tightened correctly and that there is no damage on the cables or connectors.

Verify that all finger screws are tightened on the electronic box and primary battery.

The lantern is self-contained and do not require connection to the *Electrical Panel*. It must be activated before launch of the buoy, by connecting the battery on the inside.

Figure 82 – Battery connector inside lantern

For lantern battery replacement, see Section 8.5 ‘Lantern battery replacement’.

9.2.3.2 Tag plate and draught mark

Replacing two bolts holding the top in place, with two m10x30 bolts, mount the property sign on the side opposite the mast mounting.

See drawing; 992000905-rev1, Buoy 1.9m – tidal measurement or Figure 83*,* for reference. Use grease on the thread.

Figure 83 – Tag plate

When mounting both draught marks, position the upper part first. See Figure 84, use two m10x30 bolts. Use grease on the thread.

Figure 84 – Draught mark, top part

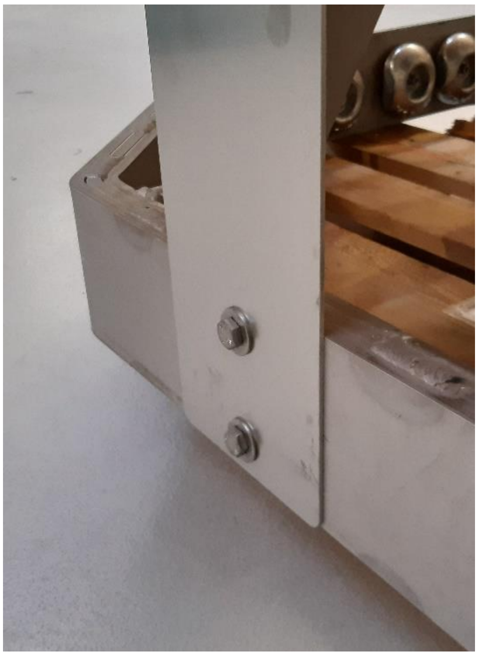

Figure 85 – Draught mark, lower part

Figure 86 – Draught mark

Use two m10x55 bolts on the bottom for each marking, see Figure 85. Mount locknut on each of these bolts. Use grease on the thread.

Note: For the remaining six positions around the top cover flange, use m10x25 security bolts. For more info on the security bolts see Section 9.2.4 ‘Security bolts’. Use grease on the thread.

Before tightening the bolts, ensure none of the four quarter circles are overlapping between the buoy top and the frame.

With all bolts positioned, tighten them according to Table 7 on page 11.

9.2.3.3 Verify function

With the mast mounted and cables connected, the system is ready to be powered up. Go to Section 3.2.4 ‘Verify function’, to turn on the system.

9.2.4 Security bolts

For extra security, special security-bolts are used for mounting of the solar panels, the wave sensor, the top mounted sensor dome and around the top cover and mast. These limit the accessibility of the inside of the buoy, without special tools required to remove them.

Around the buoy three sizes are used: M6 & M8 security bolts of the type 5-Lobe Pin (Figure 87 & Figure 89) and M10 bolts of the type Pin Hex (Figure 91).

Figure 87 – M6 Security bolt

Figure 88 – Security bit *F30-B*

Figure 89 – M8 Security bolt

Figure 90 – Security bit *F40-B*

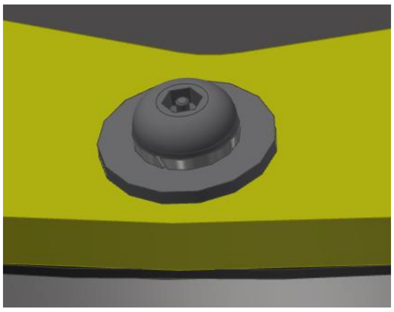

Figure 91 – M10 Security bolt

Figure 92 – Security bit *HM6-B*

The M6 bolts needs an *F30-B* bit driver, the M8 an *F40-B* bit driver and the M10 an *HM6-B*.

The solar panels and wave sensor are mounted with M8 security bolts and the sensor dome with M6 security bolts. Around the Top cover and the mast flange, M10 bolts are used.

9.2.5 Battery core exchange

When exchanging the core of the secondary, non-rechargeable, battery, it is necessary to remove the entire battery assembly from the buoy. See Section 8.3 ‘Battery change’.

For battery core exchange, using a crane or a lift is advised, since the core itself weighs more than 100 kg. With the battery placed on firm ground, remove the lid by loosening the twelve M8 bolts. See Figure 93 & Figure 94.

Figure 93 – Battery

Figure 94 – Lid without bolts

Before the core is lifted out note the orientation of the foam and the core underneath. The new core must be oriented the same way.

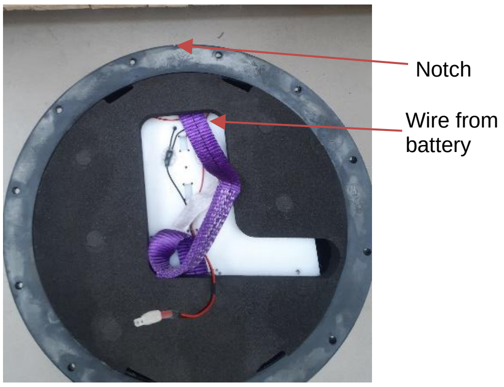

Figure 95 – Lid removed

Figure 96 – Foam removed

Lift the battery out using the purple strap, already mounted around the battery assembly.

Figure 97 – Remove core

Figure 98 – Set battery aside

It might be necessary to hold the barrel down while lifting the core out. Set the old core aside.

When positioning the new core, slowly guide it down into the barrel. Don’t use excess force, the battery should go in by itself – it might be necessary to wiggle it from side to side, since it can get caught in the horizontal plates inside the barrel. See Figure 97.

Reposition the foam and connect the 2pin cables.

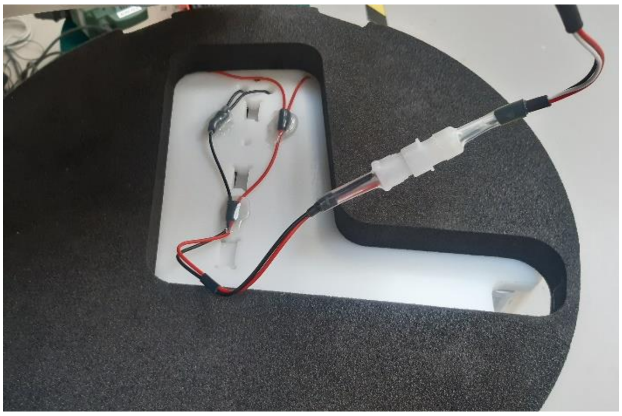

Figure 99 – New core connected

When placing the lid make sure nothing is squeezed/pinched. Position the wire in the cut-out in the foam. The excess of the purple lifting strap must similar be placed within the foam cut-out.

Inspect the gasket and check it is not damaged or incomplete. Without a proper seal, the battery will flood and short out, potentially burn. A damaged gasket must be replaced!

Position the notch on the lid and barrel, such that they align when the barrel is bolted together.

Figure 100 – Notch barrel

Figure 101 – Notch Lid, aligned with barrel underneath

Tighten the twelve M8 bolts to [10Nm] – use grease on the thread.